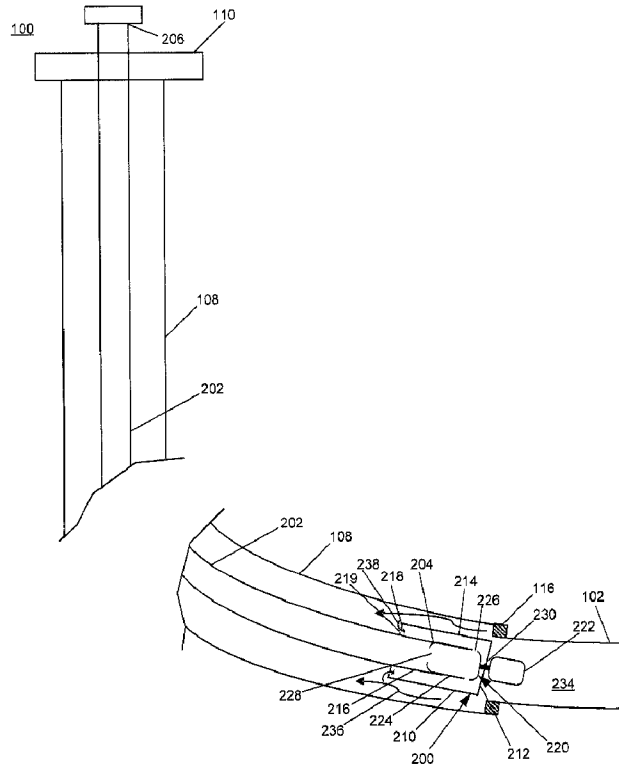




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(57) Abrégé/Abstract:

An apparatus for use in a hydrocarbon production well that includes a casing extending from a segment of the production well to a wellhead. A production conduit extends inside the casing, from a first end in the hydrocarbon production well to a second end at

(57) **Abrégé(suite)/Abstract(continued):**

the wellhead. A receptacle includes a bottom spaced from the first end of the production conduit and at least one sidewall extending around a portion of the production conduit proximal the first end such that the receptacle extends around the first end of the production conduit. The receptacle includes an opening for liquid to pass into the receptacle to separate liquids from gases. A submersible pump is disposed in the production well and includes a motor outside the receptacle and coupled to a pump body inside the receptacle to pump the liquid from a pump inlet in the receptacle, through the production conduit to the second end.

## Abstract

An apparatus for use in a hydrocarbon production well that includes a casing extending from a segment of the production well to a wellhead. A production conduit extends inside the casing, from a first end in the hydrocarbon production well to a second end at the wellhead. A receptacle includes a bottom spaced from the first end of the production conduit and at least one sidewall extending around a portion of the production conduit proximal the first end such that the receptacle extends around the first end of the production conduit. The receptacle includes an opening for liquid to pass into the receptacle to separate liquids from gases. A submersible pump is disposed in the production well and includes a motor outside the receptacle and coupled to a pump body inside the receptacle to pump the liquid from a pump inlet in the receptacle, through the production conduit to the second end.

## HYDROCARBON PRODUCTION APPARATUS

### Technical Field

**[0001]** The present invention relates to the production of hydrocarbons such as heavy oils and bitumen from underground deposits by artificial lifting of the fluid including the hydrocarbons.

### Background

**[0002]** When a hydrocarbon reservoir lacks sufficient energy for oil, gas, and water to flow from wells at desired rates, supplemental production methods may be utilized. Gas and water injection for pressure support or secondary recovery may be utilized to maintain well productivity. When fluids do not naturally flow to the surface or do not naturally flow at a sufficient rate, a pump or gas lift techniques may be utilized, referred to as artificial lift. Lift processes transfer energy downhole or decrease fluid density in wellbores to reduce the hydrostatic load on formations, and cause inflow. Commercial hydrocarbon volumes can be boosted or displaced to the surface. Artificial lift also improves recovery by reducing the bottomhole pressure at which wells become uneconomic and are abandoned. Also, the development of unconventional resources such as viscous hydrocarbons usually include construction of complex wells, and high hydrocarbon lifting rates are desirable to produce oil quickly and efficiently at low cost.

**[0003]** Rod pump, gas lift, and electric submersible pumps are the most common artificial lift systems. Hydraulic and progressing cavity pumps are also utilized. Electric submersible systems use multiple centrifugal pump stages mounted in series within a housing, mated closely to a submersible electric motor on the end of tubing and connected to surface controls and electric power by an armor-protected cable. Submersible systems have a wide performance range. Standard surface electric drives power outputs from 100 to 30,000 barrels per day and variable-speed drives add pump-rate flexibility. High Gas Oil Ratio (GOR) fluids can be handled. Large gas volumes may lock up and destroy pumps, however. Submersible pumps may be operated at temperatures above 350 °F (177 C) utilizing special high-temperature motors and

cables. High GOR, high-gas environments are now common in electric submersible pump applications. Reliable gas-handling technology is desirable to produce hydrocarbons utilizing pumps.

**[0004]** Extensive deposits of viscous hydrocarbons exist around the world, including large deposits in the Northern Alberta oil sands, that are not susceptible to standard oil well production technologies. One problem associated with producing hydrocarbons from such deposits is that the hydrocarbons are too viscous to flow at commercially relevant rates at the temperatures and pressures present in the reservoir. In some cases, such deposits are mined using open-pit mining techniques to extract hydrocarbon-bearing material for later processing to extract the hydrocarbons. Alternatively, thermal techniques may be used to heat the reservoir to mobilize the hydrocarbons and produce the heated, mobilized hydrocarbons from wells. One such technique for utilizing a horizontal well for injecting heated fluids and producing hydrocarbons is described in U.S. Patent No. 4,116,275, which also describes some of the problems associated with the production of mobilized viscous hydrocarbons from horizontal wells.

**[0005]** One thermal method of recovering viscous hydrocarbons using spaced horizontal wells is known as steam-assisted gravity drainage (SAGD). Various embodiments of the SAGD process are described in Canadian Patent No. 1,304,287 and corresponding U.S. Patent No. 4,344,485. In the SAGD process, steam is pumped through an upper, horizontal, injection well into a viscous hydrocarbon reservoir while hydrocarbons are produced from a lower, parallel, horizontal, production well that is vertically spaced and near the injection well. The injection and production wells are located close to the bottom of the hydrocarbon deposit to collect the hydrocarbons that flow toward the bottom.

**[0006]** The SAGD process is believed to work as follows. The injected steam initially mobilizes the hydrocarbons to create a steam chamber in the reservoir around and above the horizontal injection well. The term steam chamber is utilized to refer to the volume of the reservoir that is saturated with injected steam and from which mobilized oil has at least partially drained. As the steam chamber expands upwardly and laterally from the injection well, viscous hydrocarbons in the reservoir are heated

and mobilized, in particular, at the margins of the steam chamber where the steam condenses and heats the viscous hydrocarbons by thermal conduction. The heated hydrocarbons and aqueous condensate drain, under the effects of gravity, toward the bottom of the steam chamber, where the production well is located. The heated hydrocarbons and aqueous condensate are collected and produced from the production well.

**[0007]** When the pressure in the steam chamber is sufficiently high, the fluids produced, including liquids and gases naturally flow through the production well, to the surface. The gases may include vapor, or water in the form of steam, hydrocarbon gases, and other trace compounds. The liquid may include hydrocarbons, water, and other compounds. Artificial lift may be utilized along with the SAGD process to increase the flow rate from the production well. Electric submersible pumps may be utilized in the production well to facilitate the flow of the fluids to the surface. Such pumps, however, are susceptible to vapor locking, also referred to as air locking or gas locking, when the fluid in the pump intake is too high in gas phase.

**[0008]** Canadian patent 2,228,416 to Kisman discloses a first conduit that is insulated and extends within the well, from the bottom of a hydrocarbon-bearing formation to a well head. The first conduit includes a port through which fluid enters the insulated conduit. A pump near the bottom of the first conduit pumps fluid from the bottom of the first conduit, through a second conduit that extends inside the first conduit, to the surface. Kisman aims to separate the gas and liquid phases upon entry into the first conduit and to avoid reheating of the separated liquid phase. The liquid phase is pumped through the second conduit to the surface and the gas phase moves to the surface through the first conduit. The Kisman apparatus utilizes additional conduits that run coextensive with the well and the length of the first conduit and the location of the port are extremely important to promote separation of the liquid and gases and avoid reheating of the separated liquids.

**[0009]** Improvements in apparatus for use with artificial lift are desirable.

## Summary

**[0010]** According to an aspect of an embodiment, an apparatus for use in a hydrocarbon production well that includes a production well casing that extends from a segment of the hydrocarbon production well to a wellhead. The apparatus includes a production conduit extending inside the production well casing, from a first end located within the hydrocarbon production well to a second end at the wellhead. The apparatus also includes a receptacle including a receptacle bottom spaced from the first end of the production conduit and at least one receptacle sidewall extending around a portion of the production conduit proximal the first end such that the receptacle extends around the first end of the production conduit. The receptacle includes at least one opening for the passage of liquid into the receptacle to facilitate separation of the liquids from gases in the hydrocarbon production well. A submersible pump is disposed in the hydrocarbon production well and includes a motor disposed outside the receptacle and coupled to a pump body disposed inside the receptacle to pump the liquid from a pump inlet in the receptacle into the production conduit and through the production conduit to the second end. The apparatus may be utilized in any suitable hydrocarbon production well, including, for example, a SAGD production well.

## Brief Description of the Drawings

**[0011]** Embodiments of the present invention will be described, by way of example, with reference to the drawings and to the following description, in which:

**[0012]** FIG. 1 is a sectional view through a reservoir, illustrating a SAGD well pair;

**[0013]** FIG. 2 is a side sectional view through a hydrocarbon production well including an apparatus for use in the well in accordance with an embodiment;

**[0014]** FIG. 3 is a side sectional view through a hydrocarbon production well including an apparatus for use in the well in accordance with another embodiment; and

**[0015]** FIG. 4 is a side sectional view through a hydrocarbon production well including an apparatus for use in the well in accordance with still another embodiment.

## Detailed Description

**[0016]** For simplicity and clarity of illustration, reference numerals may be repeated among the figures to indicate corresponding or analogous elements. Numerous details are set forth to provide an understanding of the examples described herein. The examples may be practiced without these details. In other instances, well-known methods, procedures, and components are not described in detail to avoid obscuring the examples described. The description is not to be considered as limited to the scope of the examples described herein.

**[0017]** The disclosure generally relates to an apparatus for use in a hydrocarbon production well that includes a production well casing that extends from a segment of the hydrocarbon production well to a wellhead. The apparatus includes a production conduit extending inside the production well casing, from a first end located within the hydrocarbon production well to a second end at the wellhead. The apparatus also includes a receptacle including a receptacle bottom spaced from the first end of the production conduit and at least one receptacle sidewall extending around a portion of the production conduit proximal the first end such that the receptacle extends around the first end of the production conduit. The receptacle includes at least one opening for the passage of liquid into the receptacle to facilitate separation of the liquids from gases in the hydrocarbon production well. A submersible pump is disposed in the hydrocarbon production well and includes a motor disposed outside the receptacle and coupled to a pump body disposed inside the receptacle to pump the liquid from a pump inlet in the receptacle into the production conduit and through the production conduit to the second end. The apparatus may be utilized in any suitable hydrocarbon production well, including, for example, a SAGD production well.

**[0018]** As described above, various hydrocarbon recovery processes, such as SAGD, are known for mobilizing viscous hydrocarbons. In the SAGD process, a well pair, including hydrocarbon production well and a steam injection well are utilized. One example of a well pair is illustrated in FIG. 1. The hydrocarbon production well 100 includes a generally horizontal segment 102 that extends near the base or bottom 104 of the hydrocarbon reservoir 106. The steam injection well 112 also includes a

generally horizontal segment 114 that is disposed generally parallel to and is spaced vertically above the horizontal segment 102 of the hydrocarbon production well.

**[0019]** During SAGD, steam is injected into the steam injection well to mobilize the hydrocarbons and create a steam chamber in the reservoir 106, around and above the generally horizontal segment 112. In addition to steam injection into the steam injection well, light hydrocarbons, such as ethane, propane or butane may optionally be injected with the steam. The volume of light hydrocarbons that are injected is relatively small compared to the volume of steam injected. The addition of light hydrocarbons is referred to as a solvent-assisted process (SAP). Viscous hydrocarbons in the reservoir are heated and mobilized and the mobilized hydrocarbons drain, under the effects of gravity. Fluids, including the mobilized hydrocarbons along with aqueous condensate, are collected in the generally horizontal segment 100. The fluids may also include gases such as steam and production gases from the SAGD process.

**[0020]** Artificial lift may be utilized to facilitate the flow of the heated hydrocarbons and aqueous condensate to the surface, for example, when the SAGD operation is carried out at sufficiently low pressure that artificial lift is required to recover mobilized hydrocarbon at the surface, or when increased rate of movement of the fluid from the well is desirable.

**[0021]** An embodiment of an apparatus 200 for use with a hydrocarbon production well, such as the hydrocarbon production well 100 illustrated in FIG. 1, is illustrated in FIG 2. The hydrocarbon production well 100 includes the generally horizontal segment 102, which is a pipe, also referred to as a slotted liner that is coupled to a production well casing 108, for example, by a liner hanger 116. The production well casing 108 extends from the generally horizontal segment 102 to the wellhead 110.

**[0022]** The apparatus 200 includes a production conduit 202 that extends inside the production well casing 108, from a first end 204 located within the hydrocarbon production well 100, near the liner hanger 114, to a second end 206 at the wellhead 110. The production conduit 202 is tubular and may extend generally concentrically with the production well casing 108.

**[0023]** A receptacle 210 is disposed around the first end 204 of the production conduit 202. The receptacle 210 includes a receptacle bottom 212 that is spaced from the first end 204 of the production conduit 202. In this example, the receptacle includes a generally cylindrical sidewall 214 that extends from the receptacle bottom 212 and around a lower portion 216 of the production conduit 202 near the first end 204. The generally cylindrical sidewall 214 may extend generally concentric with the production conduit 202. The receptacle 210 also includes an inwardly extending flange 218 that extends from an upper edge of the sidewall 214 to the production conduit 202. The inwardly extending flange 218 extends inwardly to the production conduit 202 to close the top of the receptacle 210. The sidewall 214 includes openings 219 in the inwardly extending flange 218, to allow the ingress of fluid and to facilitate the separation of the liquids from the gases in the hydrocarbon production well 100. The openings may be any suitable size or shape to facilitate separation of liquids from the gases. A suitable length of the sidewall 214, or distance from the bottom 212 to the inwardly extending flange 218, is utilized to facilitate separation of liquids in the fluid. The inwardly extending flange 218 may couple the receptacle 210 to the production conduit 202. In this example, in which the receptacle 210 is coupled to the production conduit, the production conduit may be removed or extracted from the hydrocarbon production well 100 for cleaning. Specialized connections may be utilized to couple sections of the production conduit 202 to facilitate extraction for cleaning of the receptacle 210.

**[0024]** An electric submersible pump 220 is disposed in the hydrocarbon production well 100 and includes a pump motor 222 that is disposed outside of the receptacle 210, and a pump body 224 that is disposed inside the receptacle 210 and is coupled to the pump motor 222 by a shaft 230 that extends through the bottom 212 of the receptacle 210. A seal is utilized between the receptacle bottom 212 and the shaft 230 to inhibit the flow of fluid through the bottom 212 of the receptacle 210. Thus, the fluid in the hydrocarbon production well 100 is not in fluid communication with the liquid in the receptacle 210 through the bottom 212.

**[0025]** The pump body 224 includes inlets 226 disposed in the receptacle 210 and a discharge outlet 228 coupled to the first end 204 of the production conduit 202. The discharge outlet 228 is in fluid communication with the production conduit 202 to

pump the liquid from the receptacle 210, through the pump inlets 226, may be spaced from the bottom 212 of the receptacle 210 or spaced from the lowest point in the receptacle 210 to provide a space into which solids may be deposited. Fluid is pumped through the pump inlets 226, into the production conduit 202, and upwardly to the second end 206 at the wellhead 110.

**[0026]** During the production of hydrocarbons, the fluid 234, including hydrocarbons along with aqueous condensate, flows into the generally horizontal segment 102 of the hydrocarbon production well 100. The fluid flows 234 into the production well casing 108 and upwardly, around the receptacle 210. The gases in the fluid rise, as illustrated by the arrows 236, and the liquids, illustrated by the arrows 238 enter the receptacle 210 through the openings 219. The liquids 238 are pumped, through the pump body 224, into the production conduit 202 and to the wellhead 110. The flow path of the liquids is therefore altered to generally separate the gases and cause the gases to flow upwardly while the liquids enter the receptacle 210. A small amount, or small volume, of gases may still enter the receptacle 210. The gases and the liquids separate because the liquids, which are the heavier of the fluids, typically settle and accumulate at the bottom of the production well casing 108. The level of the liquids may rise above the openings 219 in the receptacle 210 and the gases, which are the less heavy fluids, due to buoyancy and gravity segregation. The gases therefore travel toward the wellhead.

**[0027]** A SAGD production well is referred herein as one example of a production well in which the apparatus 200 may be utilized. Use of the apparatus 200 is not limited to a SAGD production well. Instead, the apparatus may be utilized in other production wells, including wells that utilize thermal techniques to mobilize hydrocarbons and wells in that utilize other techniques for recovery of hydrocarbons.

**[0028]** The heat supplied by the motor 222 heats the temperature of the gases in fluids that include dissolved gases, which assists in expelling the dissolved gases from the fluids outside the receptacle 210. When the separated liquids drop into the receptacle 210 and travel downwardly, even with some heat gain, the gas separation within the receptacle 210 is significantly reduced by comparison to gas separation near the intake of a pump without such a receptacle 210 because the fluids have already

passed through a more thermodynamically favourable separation condition. The heat provided by the motor 222 also results in water vapours separating from fluids that include water and steam and the separated liquids fall into the receptacle 210. The temperature does not significantly increase when the water vapours separate because a phase change in a single component system occurs at a constant temperature. Because the temperature does not significantly increase, little further vaporization occurs within the receptacle 210.

**[0029]** Another embodiment of an apparatus 300 for use with a hydrocarbon production well, such as the hydrocarbon production well 100 illustrated in FIG. 1, is illustrated in FIG 3. The hydrocarbon production well 100 includes the generally horizontal segment 102, which is a pipe, also referred to as a slotted liner 102 that is coupled to a production well casing 108, for example, by a liner hanger 116. The production well casing 108 extends from the generally horizontal segment 102 to the wellhead 110.

**[0030]** Many of the elements of the apparatus 300 are similar to those described above with reference to the apparatus illustrated in FIG. 2 and are therefore not described again in detail. In the present example, the liner of the hydrocarbon production well 100 extends past the liner hanger 116 and partly through the production well casing 108. A sealing element 312 is disposed in the liner 102 and forms a bottom of the receptacle 310. The end section of the liner hanger 116 forms the generally cylindrical sidewall 314 of the receptacle 310. In this embodiment, the receptacle 310 does not include an inwardly extending flange and the top of the receptacle 310 is open. Alternatively, the top of the receptacle 310 may include an inwardly extending flange.

**[0031]** The electric submersible pump 320 is disposed in the hydrocarbon production well 100 and includes the pump motor 322 that is disposed outside of the receptacle 310, and the pump body 324 that is disposed inside the receptacle 310 and is coupled to the pump motor 322 by a shaft 330 that extends through the sealing element 312 that acts as the bottom of the receptacle 310. The electric submersible pump 320 may extend through the sealing element 312 by stabbing the pump 320 through the sealing element 312. The sealing element 312 inhibits the flow of fluid through the bottom and into of the receptacle 310. Thus, the fluid in the hydrocarbon

production well 100 is not in fluid communication with the liquid in the receptacle 310 through the sealing element 312.

**[0032]** As described above with reference to FIG. 2, the pump body 324 includes inlets 326 disposed in the receptacle 310 and a discharge outlet 328 coupled to the first end 304 of the production conduit 302.

**[0033]** The liner 102 includes perforations 340 at locations below the sealing element 312 that acts as the bottom of the receptacle 310 to facilitate the flow of fluid from the liner 102 and into the well casing 108.

**[0034]** During the production of hydrocarbons, the fluid 234, including hydrocarbons along with aqueous condensate, flows from the liner 102, through the perforations into the production well casing 108 and upwardly, around the receptacle 310. The gases in the fluid rise, as illustrated by the arrows 336, and the liquids, illustrated by the arrows 338 enter the receptacle 310 through the open top. The liquids 338 are pumped, through the pump body 324, into the production conduit 302 and to the wellhead 110.

**[0035]** Yet another embodiment of an apparatus 400 for use with a hydrocarbon production well, such as the hydrocarbon production well 100 illustrated in FIG. 1, is illustrated in FIG 4. Many of the elements of the apparatus 300 are similar to those described above with reference to the apparatus illustrated in FIG. 2 and are therefore not described again in detail.

**[0036]** In this example, a pipe 442 that is larger diameter than the production conduit 402 and smaller diameter than the well casing 108 is disposed in the well casing, near the liner hanger 116. The pipe 442 is coupled to the well casing by additional packing elements 444 that maintain the pipe 442 in place. A sealing element 412 is disposed in the pipe 442 and forms a bottom of the receptacle 410. The end section of the pipe 442 forms the generally cylindrical sidewall 414 of the receptacle 410. In this embodiment, the receptacle 410 does not include an inwardly extending flange and the top of the receptacle 410 is open. Alternatively, the top of the receptacle 410 may include an inwardly extending flange.

**[0037]** The electric submersible pump 420 is disposed in the hydrocarbon production well 100 and includes the pump motor 422 that is disposed outside of the

receptacle 410, and the pump body 424 that is disposed inside the receptacle 410 and is coupled to the pump motor 422 by a shaft 430 that extends through the sealing element 412 that acts as the bottom of the receptacle 410. The electric submersible pump 420 may extend through the sealing element 412 by stabbing the pump 420 through the sealing element 412. The sealing element 412 inhibits the flow of fluid through the bottom and into of the receptacle 410. Thus, the fluid in the hydrocarbon production well 100 is not in fluid communication with the liquid in the receptacle 410 through the sealing element 412.

**[0038]** As described above with reference to FIG. 2, the pump body 424 includes inlets 426 disposed in the receptacle 410 and a discharge outlet 428 coupled to the first end 404 of the production conduit 402.

**[0039]** The pipe 442 includes perforations 440 at locations between the sealing element 412 and the additional packing elements 444 to facilitate the flow of fluid around the pipe 442 and upwardly in the well casing 108.

**[0040]** During the production of hydrocarbons, the fluid 434, including hydrocarbons along with aqueous condensate, flows from the liner 102, through the perforations in the pipe 442 and upwardly, around the receptacle 410. The gases in the fluid rise, as illustrated by the arrows 436, and the liquids, illustrated by the arrows 438 enter the receptacle 410 through the open top. The liquids 438 are pumped, through the pump body 424, into the production conduit 402 and to the wellhead 110.

**[0041]** The following examples are submitted to further illustrate embodiments of the present invention. These examples are intended to be illustrative only and are not intended to limit the scope of the present invention. The examples are production results utilizing a proprietary computerized wellbore modeling simulator. The data shown is data from simulations. In each case, Source conditions are identified to approximate the temperature, pressure, and composition of fluids entering a typical production well in a SAGD operation. Heat losses along the wellbore were simulated.

**Example 1**

**[0042]** This example illustrates the simulated production results from the well casing and from the production conduit when a receptacle, such as the receptacle described in relation to FIG. 2, is utilized. As described, an electric submersible pump intake is disposed in the receptacle and the motor is disposed outside the receptacle, at the bottom thereof.

**[0043]** The source conditions utilized were:

Water Rate = 300 t/d;

Oil Rate = 150 t/d; and

Methane Rate = 4.63 t/d.

The following constraints were identified:

Constraint Pressure: 6.5e6 Kpa; and

Constraint Rate: 454.628.

**[0044]** The simulated results from the production conduit were taken from a location disposed in the receptacle, spaced from the bottom but near the bottom of the receptacle. Results from the well casing were taken from a location disposed above the receptacle.

TABLE 1: Production Results Utilizing Receptacle

properties	Source			Production Well Casing			Production Conduit			
	Time (days)	water (t)	bitumen (t)	methane (t)	water (t)	bitumen (t)	methane (t)	water (t)	bitumen (t)	methane (t)
0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
30	0.251074	0.125537	0.003804	0.017116	0.000168	0.00020107	5.51722288	0.008301364	7.67765E-05	
30	2.951564	1.475782	0.044721	0.017116	0.000168	0.00020107	22.6429939	0.328802407	0.006175632	
30	15.04782	7.52391	0.227997	0.017482	0.000175	0.06229784	37.6143723	5.815367222	0.102503106	
31	149.9783	74.98914	2.272398	0.029444	0.000203	1.59127522	172.920517	73.45058441	0.639277458	
31	300.0055	150.0027	4.545538	0.109525	0.000203	3.44239831	322.887756	148.4755554	1.067141294	
32	450.0327	225.0164	6.818678	0.443841	0.000203	5.31504583	472.590057	223.4928131	1.470376372	
32	600.06	300.03	9.091818	1.148552	0.000203	7.20106697	621.920715	298.5088501	1.858973742	
33	900.1144	450.0572	13.6381	3.51272	0.000203	11.0056677	919.622864	448.5393677	2.602339506	
34	1200.169	600.0845	18.18438	6.719242	0.000203	14.8368645	1216.47961	598.5687866	3.31843257	
35	1500.223	750.1117	22.73066	10.61535	0.000203	18.6885223	1512.64441	748.5975342	4.013718128	
36	1800.278	900.1389	27.27694	15.08798	0.000203	22.5567207	1808.23071	898.6257935	4.692359447	
37	2100.333	1050.166	31.82322	19.56072	0.000203	26.4247627	2103.81689	1048.654297	5.37101841	
40	3000.496	1500.248	45.46206	35.07769	0.000203	38.0869789	2988.47241	1498.737915	7.348468781	
41	3300.55	1650.275	50.00834	40.42166	0.000203	41.9790764	3283.18359	1648.768066	8.002990723	
45	4500.768	2250.384	68.19346	63.96322	0.000203	57.6059151	4459.86719	2248.878418	10.56170273	
50	6001.041	3000.52	90.92486	96.49311	0.000203	77.222908	5927.61572	2999.015869	13.67611694	
51	6301.095	3150.548	95.47114	103.0815	0.000203	81.1485672	6221.08301	3149.042725	14.29676342	
55	7501.313	3750.656	113.6563	130.4718	0.000203	96.8743973	7393.91846	3749.152588	16.75188065	
60	9001.585	4500.792	136.3876	166.0904	0.000203	116.573494	8858.57617	4499.289063	19.78393745	
75	13502.4	6751.202	204.5819	281.2993	0.000203	175.873993	13244.207	6749.699219	28.66124725	
100	21003.76	10501.88	318.2388	488.6925	0.000203	275.118683	20538.1973	10500.38086	43.05823135	
150	36006.49	18003.24	545.5529	932.1273	0.000204	474.353149	35097.5078	18001.74414	71.12123871	
200	51009.21	25504.61	772.8669	1395.694	0.000204	674.040283	49636.7383	25503.10547	98.67886353	
250	66011.94	33005.97	1000.181	1871.863	0.000204	874.089783	64163.3203	33004.46875	125.921051	
300	81014.66	40507.33	1227.495	2358.739	0.000204	1074.3988	78679.2031	40505.83203	152.8976288	
350	96017.38	48008.69	1454.809	2851.618	0.000204	1274.88074	93189.0469	48007.19141	179.7246552	
400	111020.1	55510.05	1682.123	3351.248	0.000204	1475.5282	107692.148	55508.55469	206.3854065	
450	126022.8	63011.41	1909.437	3856.718	0.000204	1676.31519	122189.414	63009.91406	232.9029236	
500	141025.5	70512.77	2136.751	4365.749	0.000204	1877.19751	136683.109	70511.28125	259.332428	

**[0045]** As illustrated in Table 1, after 500 days, the total bitumen from the source was 70512.77 tonnes. The total bitumen produced from the production conduit was 70511.28 tonnes. Very little bitumen is produced from the production well casing. After 500 days, the total methane gas from the source was 2136.75 tonnes. The total methane gas produced from the production well casing was 1877.20 tonnes. The total methane from the production conduit was 259.33 tonnes.

**[0046]** Thus, much of the liquids were produced through the production conduit and much of the gas was separated and produced through the production well casing.

**Example 2**

**[0047]** This example illustrates simulated production results from the well casing and from the production conduit when a receptacle is not present. Source conditions and constraints utilized were identical to those described above with reference to Example 1.

**[0048]** The simulated results from the production conduit were taken from the same location relative to the well casing as in Example 1 but no receptacle was present. Results from the well casing were taken from the same location as in Example 1.

TABLE 2: Production Results With No Receptacle

properties	Source			Production Well Casing			Production Conduit			
	Time (days)	water (t)	bitumen (t)	methane (t)	water (t)	bitumen (t)	methane (t)	water (t)	bitumen (t)	methane (t)
0.00	0	0	0	0	0	0	0	0	0	0
30.00	0	0	0	0	0	0	0	0	0	0
30.00	0.300054	0.150027	0.004546	0.077905	0.000767	0.000888	0.30685	1.67E-05	1.42E-05	
30.01	3.000545	1.500273	0.045463	0.109755	0.001081	0.001069	6.255856	0.504917	0.015642	
30.50	150.0272	75.01362	2.27314	0.156757	0.001083	0.430157	163.5936	73.83548	1.769217	
31.00	300.0545	150.0272	4.54628	0.348671	0.001083	1.009318	313.6732	148.8664	3.467092	
31.50	450.0817	225.0409	6.81942	0.642781	0.001083	1.593243	463.4849	223.8853	5.157238	
32.00	600.1089	300.0545	9.09256	1.005043	0.001083	2.180041	613.2172	298.8895	6.844394	
33.00	900.1635	450.0817	13.63884	1.888396	0.001083	3.359571	912.5569	448.8376	10.21134	
34.00	1200.218	600.1089	18.18512	2.981142	0.001083	4.546077	1211.738	598.709	13.57132	
35.00	1500.272	750.1362	22.7314	4.073924	0.001083	5.732541	1510.918	748.5804	16.93133	
36.00	1800.327	900.1635	27.27768	5.166698	0.001083	6.919005	1810.099	898.4517	20.29135	
37.00	2100.381	1050.191	31.82396	6.259464	0.001083	8.105469	2109.279	1048.323	23.65137	
40.00	3000.545	1500.272	45.4628	10.21471	0.001083	11.68563	3006.325	1497.696	33.70915	
41.00	3300.599	1650.3	50.00908	11.58594	0.001083	12.88055	3305.302	1647.469	37.05997	
45.00	4500.817	2250.408	68.19421	17.58536	0.001083	17.67924	4500.845	2246.383	50.44468	
50.00	6001.089	3000.545	90.9256	25.50557	0.001083	23.69952	5995.055	2994.924	67.15402	
51.00	6301.144	3150.572	95.47189	27.05603	0.001083	24.90382	6293.965	3144.668	70.49548	
55.00	7501.362	3750.681	113.657	32.86282	0.852873	29.73366	7489.076	3743.377	83.84832	
60.00	9001.634	4500.817	136.3884	40.39681	3.010169	35.79669	8981.937	4491.253	100.516	
75.00	13502.45	6751.226	204.5826	64.32987	10.47331	54.04676	13458.94	6734.112	150.4607	
100.00	21003.81	10501.91	318.2396	106.4586	24.16001	84.56349	20918.25	10471.06	233.6012	
150.00	36006.54	18003.27	545.5536	194.9442	53.68817	145.7794	35832.58	17942.85	399.6823	
200.00	51009.26	25504.63	772.8676	287.0654	85.02808	207.1438	50743.23	25412.86	565.6212	
250.00	66011.98	33005.99	1000.182	381.5346	117.5289	268.6006	65651.52	32881.71	731.4697	
300.00	81014.71	40507.36	1227.496	477.5292	150.7812	330.1155	80558.27	40349.81	897.2678	
350.00	96017.43	48008.71	1454.81	573.8802	184.2078	391.6404	95464.66	47817.73	1063.057	
400.00	111020.2	55510.08	1682.124	670.231	217.6342	453.1653	110371	55285.66	1228.845	
450.00	126022.9	63011.44	1909.438	766.5814	251.0619	514.6907	125277.4	62753.59	1394.635	
500.00	141025.6	70512.8	2136.751	862.9318	284.4959	576.2169	140183.8	70221.52	1560.423	

**[0049]** As illustrated in Table 2, after 500 days, the total bitumen from the source was 70512.8 tonnes. The total bitumen produced from the production conduit was 70221.52 tonnes. The total bitumen produced from the production well casing was 284.50 tonnes. After 500 days, the total methane gas from the source was 2136.75 tonnes. The total methane gas produced from the production well casing was 576.22 tonnes. The total methane from the production conduit was 1560.42 tonnes.

**[0050]** Thus, a much greater percentage of gas is produced through the production conduit than in Example 1. Gas separation is greatly improved and less gas

enters the electric submersible pump in Example 1. Similar advantages are expected utilizing the receptacles shown in FIG. 3 and FIG. 4.

**[0051]** Advantageously, the motor 222 of the electric submersible pump 220 is disposed outside of the receptacle 210. Heat generated from the motor 222 raises the temperature of the fluid, which may include gases and liquid outside of the receptacle 210. Also, electric submersible pumps heat up during use in a hydrocarbon production well, which may reduce the life of the pump. By locating the motor 222 outside of the receptacle 210, the motor 222 is cooled by a large volume of fluid from the hydrocarbon production well. Thus, a large volume of fluid may be utilized to exchange heat with the pump and thereby cool the motor. Less heat is generated inside the receptacle. Optionally, all or part of the receptacle 210 may be insulated to reduce heat transfer through the receptacle 210, to the liquid in the receptacle 210. In one example, the bottom 212 of the receptacle 210 may be insulated to reduce heating of the liquid in the receptacle 210 by, for example, the pump motor 222. The insulation, however, is not required and the receptacle 210 may be advantageously utilized without insulation. Furthermore, only one production conduit is utilized and may be located generally concentrically within the production casing. The use of a packer is not necessary.

**[0052]** The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the claims should not be limited by the preferred embodiments set forth in the examples, but should be given the broadest interpretation consistent with the description as a whole. All changes that come with meaning and range of equivalency of the claims are to be embraced within their scope.

## Claims

1. An apparatus for use in a hydrocarbon production well that includes a production well casing that extends from a segment of the hydrocarbon production well to a wellhead, the apparatus comprising:

a production conduit extending inside the production well casing, from a first end located within the hydrocarbon production well to a second end at the wellhead;

a receptacle including at least one receptacle sidewall comprising a portion of a pipe and a receptacle bottom comprising a sealing element disposed in the pipe and spaced from the first end of the production conduit, the receptacle extending around a portion of the production conduit proximal the first end such that the receptacle extends around the first end of the production conduit, the receptacle including at least one opening therein for the passage of liquid into the receptacle to facilitate separation of the liquids from gases in the hydrocarbon production well;

a submersible pump disposed in the hydrocarbon production well and comprising a motor disposed outside the receptacle and coupled to a pump body disposed inside the receptacle to pump the liquid from a pump inlet in the receptacle into the production conduit and through the production conduit to the second end,

wherein the pipe is coupled to the production well casing by at least one packing element.

2. The apparatus according to claim 1, wherein the pump body is coupled to the motor by a coupling that extends through the receptacle bottom.

3. The apparatus according to claim 2, wherein fluid in the hydrocarbon production well is not in fluid communication with the liquid in the receptacle through the receptacle bottom.
4. The apparatus according to claim 1, wherein the receptacle comprises an inwardly extending flange that extends from an upper edge of the receptacle sidewall.
5. The apparatus according to claim 4, wherein the inwardly extending flange extends inwardly to the production conduit.
6. The apparatus according to claim 5, wherein the inwardly extending flange includes at least one opening to facilitate the flow of liquid into the receptacle.
7. The apparatus according to claim 1, wherein the receptacle sidewall is generally cylindrical.
8. The apparatus according to claim 1, wherein the receptacle sidewall is generally concentric with the production conduit.
9. The apparatus according to claim 1, wherein the receptacle sidewall is generally concentric with the production well casing.
10. The apparatus according to claim 1, wherein the top of the receptacle is open to facilitate the flow of liquid into the receptacle.

11. The apparatus according to claim 1, wherein pipe includes openings disposed between the sealing element and the at least one packing element to facilitate the flow fluid from the segment, around the receptacle.

12. The apparatus according to claim 1, wherein the receptacle is insulated to reduce heat transfer through the receptacle, to the liquid in the receptacle.

13. The apparatus according to claim 1, wherein the receptacle bottom is insulated to reduce heat transfer through the receptacle bottom, to the liquid in the receptacle.

1/4

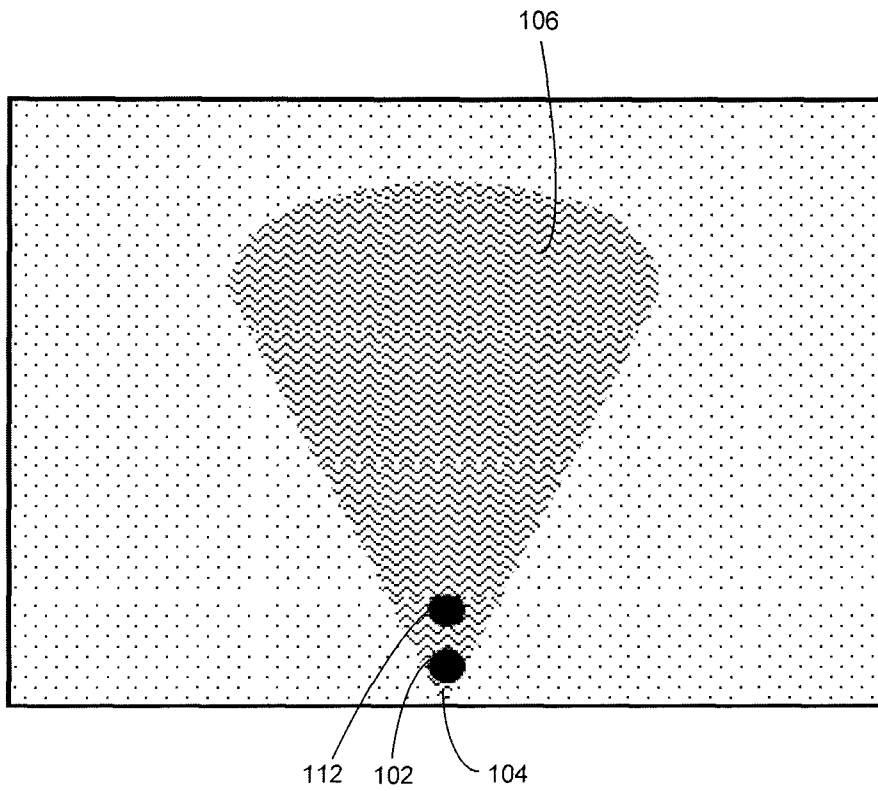


FIG. 1

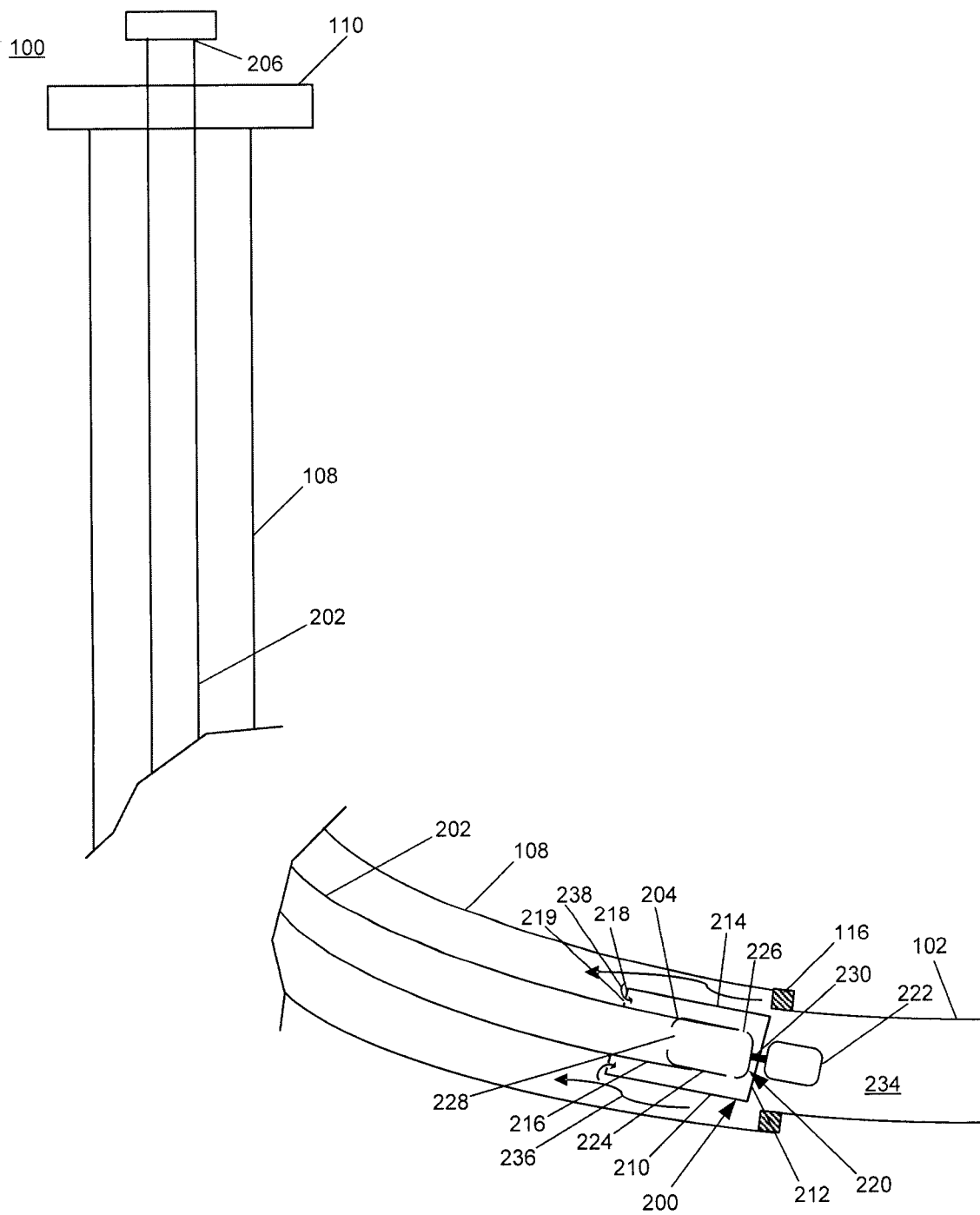


FIG. 2





