July 24, 1962 J. L. MAHER ET AL 3,045,899

MOTOR-COMPRESSOR UNIT

Filed June 5, 1958 4 Sheets-Sheet 1

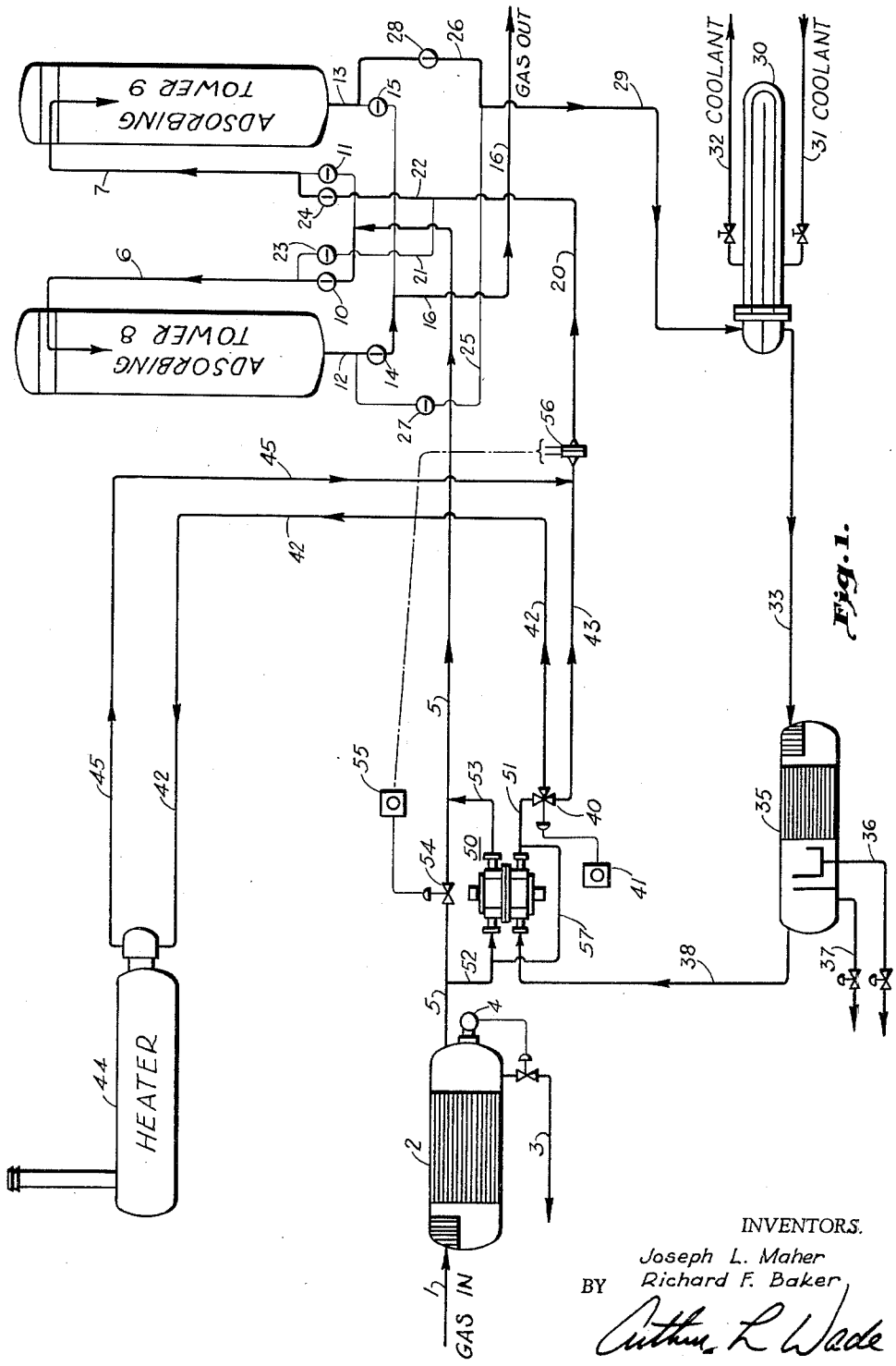


Fig. 1.

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MOTOR-COMPRESSOR UNIT

Filed June 5, 1958 4 Sheets-Sheet 2

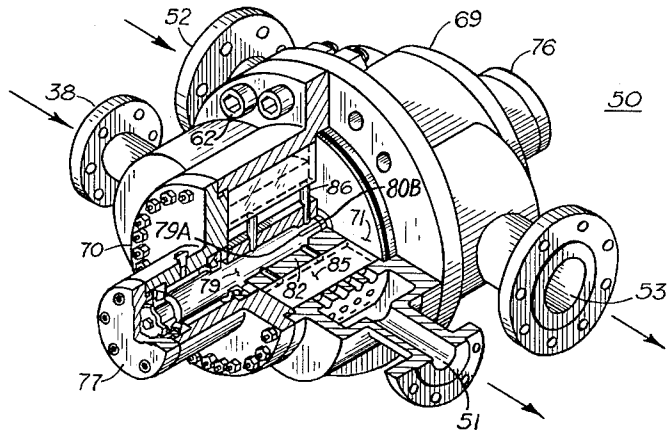


Fig. 2.

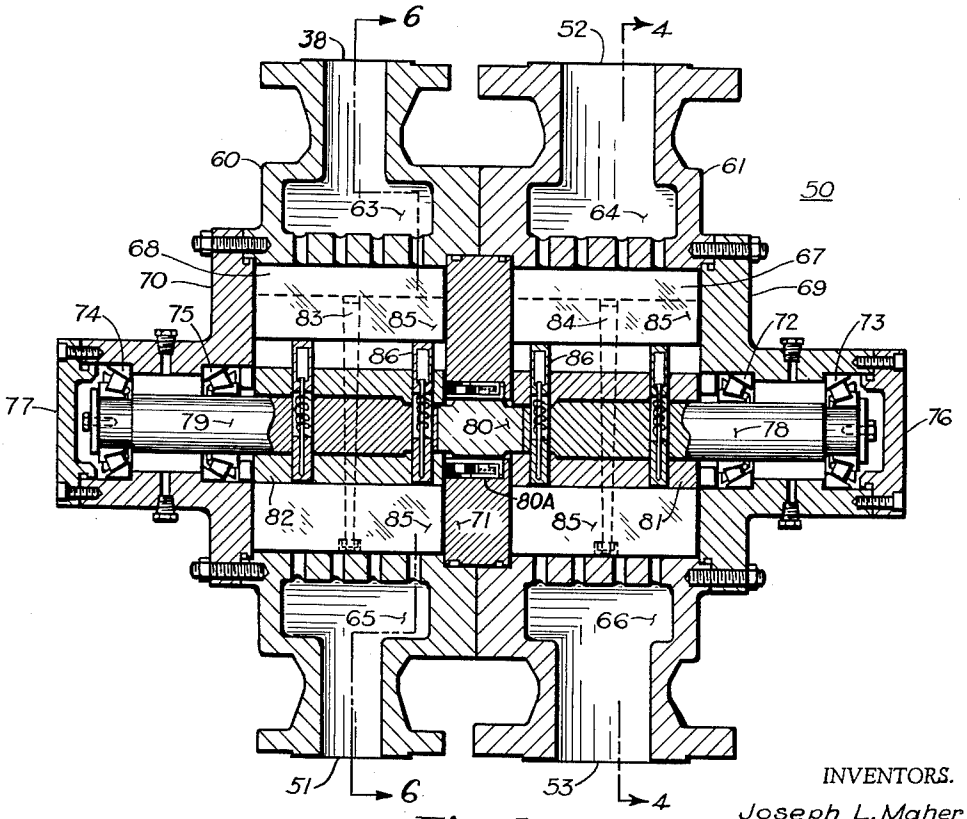


Fig. 3.

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MOTOR-COMPRESSOR UNIT

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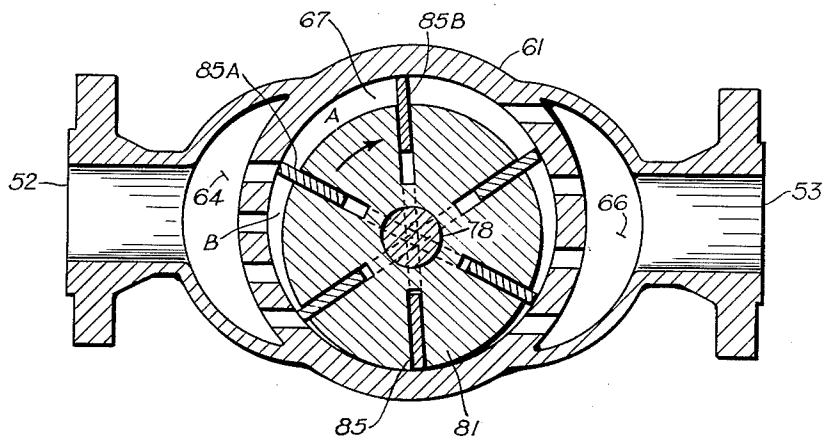


Fig. 4.

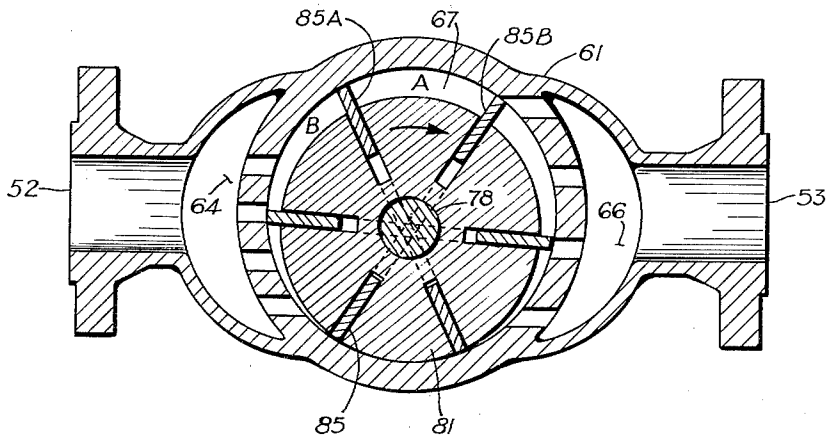


Fig. 5.

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MOTOR-COMPRESSOR UNIT

Filed June 5, 1958 4 Sheets-Sheet 4

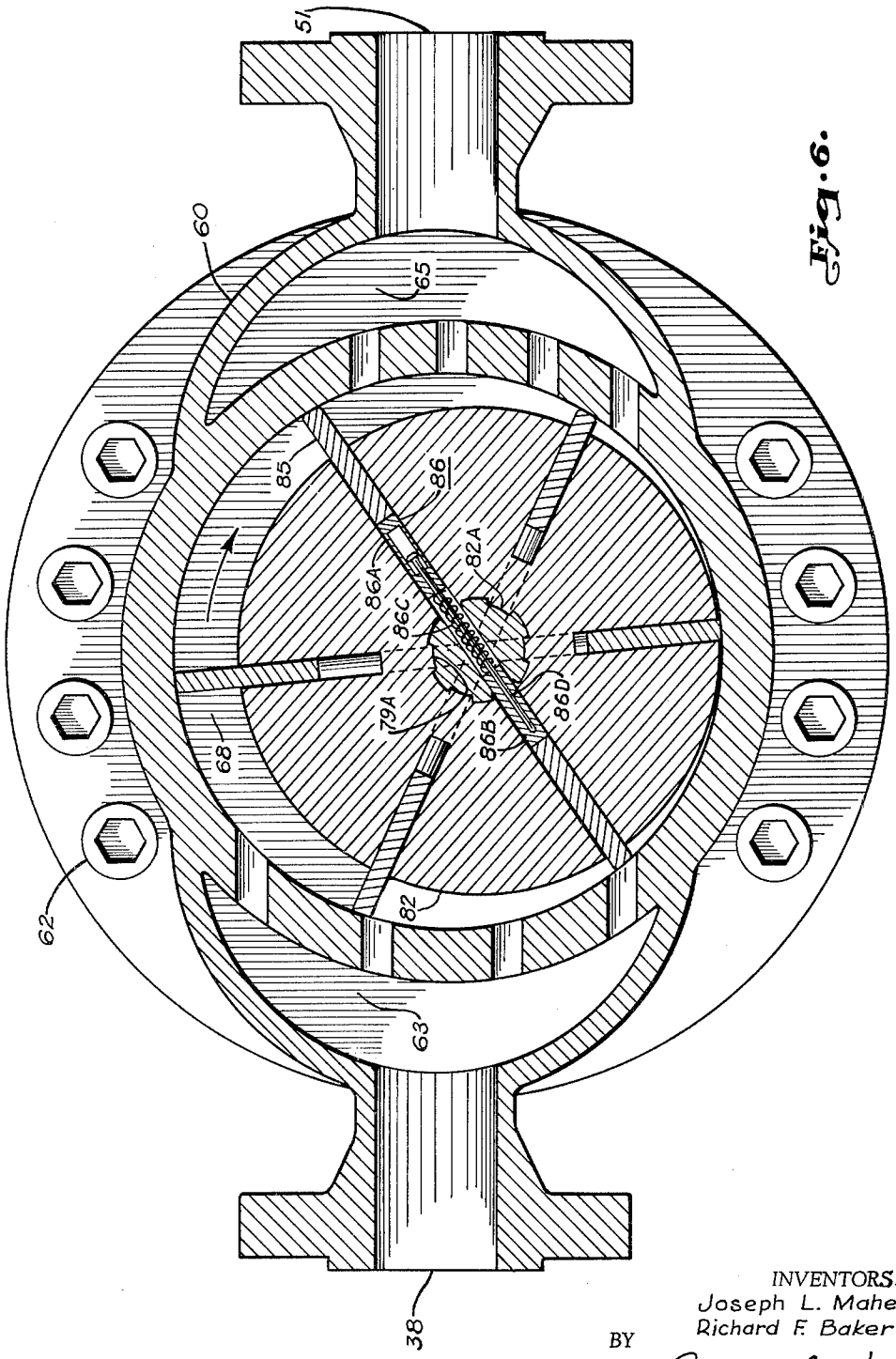


Fig. 6.

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United States Patent Office 3,045,899 Patented July 24, 1962

3,045,899

MOTOR-COMPRESSOR UNIT

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Filed June 5, 1958, Ser. No. 740,143
4 Claims. (Cl. 230—239)

This invention relates to fluid compressors. More particularly, the invention relates to units with which a first fluid is compressed while being driven by a unit powered by another fluid.

Sliding vane types of motors and compressors are presently available only as separate units. Where fluid pressure is available, sliding vane types of motors are simple, rugged, devices with which the fluid pressure is transduced into mechanical energy. Sliding vane types of compressor units are commonly driven by electric motors in elevating the pressure of fluid handled by the compressors. If a fluid pressure stream, as a power source, is available for a sliding vane motor and a fluid stream is to be compressed by a sliding vane compressor, there is the problem of bringing the devices together as the unit, to form a compact mechanical link between the two streams.

A primary object of the present invention is to drive a sliding vane compressor with a sliding vane motor through a common connection and in a unitary housing.

Another object is to provide a common connection with a plurality of parts to facilitate assembly, inspection and maintenance of the motor-compressor combination.

Another object is to provide a force to urge the vanes of a motor-compressor against its cylinder walls at all times to reduce the starting differential of fluid pressure required for the motor and increase the starting efficiency of the compressor.

The present invention contemplates a sliding vane motor and a sliding vane compressor on a common shaft assembly and in a common casing. The casing is divided into a motor section and a compressor section by a wall-partition through which the shaft is journalled as an assembly. The shaft assembly is specifically formed of a motor-shaft and a compressor-shaft splined to a central coupler shaft in the wall-portion by the shaft rotors which are pinned to their respective shafts. Vanes mounted in slots of the rotor are urged radially outward against their cylinder walls by spring-loaded pins.

Other objects, advantages and features of this invention will become more apparent to one skilled in the art upon consideration of the written specification, appended claims, and attached drawings wherein:

FIG. 1 is a schematic illustration of a complete adsorption process in which the disclosed embodiment of the invention has utility;

FIG. 2 is a partially sectioned isometric of the preferred embodiment of the invention as utilized in the system of FIG. 1;

FIG. 3 is a fully sectioned elevation of the embodiment of FIG. 2;

FIG. 4 is an elevated section along lines 4—4 of the embodiment of FIG. 3;

FIG. 5 is similar to FIG. 4 but with the vanes in a different position to illustrate the function of the vane chamber; and

FIG. 6 is an enlarged elevated section along the lines 6—6 of the embodiment of FIG. 3 to show the vanes and pins in place within the rotor slots and the spline between the rotors and shafts.

FIG. 1 shows a complete system in which the motor-compressor of the invention is included. The particular system illustrated represents many different systems in which the invention has utility. In general, the system

of FIG. 1 illustrates the invention utilizing a driving force of a first fluid pressure stream to compress a second fluid pressure stream in driving it through a separate circuit. Thus the embodiment provides a mechanical link between two fluid pressure streams in order to transfer a finite amount of energy between them for circulation of fluid in the second circuit.

Referring specifically to FIG. 1, conduit **1** is illustrated as bringing natural gas into an adsorption process. The adsorption system of FIG. 1 is employed to dry the gas so as to reduce corrosion and obviate hydrate formation in a transmission pipe line. An initial separation of gas and liquid phases of the stream in conduit **1** is provided by separator **2**.

Separator **2** may take several well-known forms. Any of the well-known forms will separate liquid and gaseous phases. Condensed liquid, which may be water and hydrocarbons, is removed through conduit **3**, controlled by level controller **4**. The gaseous phase is removed from separator **3** by conduit **5**. Hydrocarbons and water may be flashed and separated or may be conducted to a stabilization process not shown, and water may be removed and disposed ahead of storage or stabilization of the hydrocarbon phase.

Conduit **5** becomes a first circuit for the main, or flow, stream of natural gas which the process strips of hydrocarbons and water. As illustrated in FIG. 1, the mechanics of removing condensable hydrocarbons and water from the gas of the first circuit is simple to follow. Conduit **5** is divided into branch conduit **6** and branch conduit **7**. The gas of conduit **5** is alternately directed, by the branch conduits, through beds of adsorbent in tower **8** and tower **9**. It is conventional to direct the flow from these branch conduits downwardly through the towers which are, essentially, cylinders arranged vertically.

Valve **10** in branch conduit **6**, and valve **11** in branch conduit **7**, are alternately opened and closed to direct the main stream of conduit **5** through the beds of adsorbent in the towers. The valves may be operated pneumatically or electrically, depending upon the type of control system desired.

Adsorbent Material

Various types of adsorbent material have been employed for this service. Specifically, silica gel has been successfully employed in recovering a large percentage of condensable hydrocarbons. The selection of the specific adsorption material and the arrangement of flow through the towers depends upon specific design conditions which need not be given further consideration at present.

Main Circuit

The main, or flow, stream in conduit **5**, alternately passed to branch conduit **6** and branch conduit **7**, and correspondingly alternately passed through tower **8** and tower **9**, is passed out of the bottom of the towers and into conduit **12** or conduit **13**. Valves **14** and **15** then connect either conduit **12** or conduit **13** to conduit **16** to complete the main circuit. FIG. 1 illustrates the valves **10**, **11**, **14** and **15** positioned to pass the conduit **5** flow through the adsorbent bed of tower **8** and on into conduit **16** as it leaves the dehydration and hydrocarbon recovery process.

The conduit **16**, for the lean and dry gas out of the towers, is shown in FIG. 1 as passing the gas on to a transmission pipe line. However, the gas out of one tower is cool, relatively to the other tower which is simultaneously reactivated with the gas stream heated to vaporize the water and hydrocarbons. Therefore, it is practical to pass the lean, dry and relatively cool gas through the hotter tower to reduce its temperature in

preparation to adsorb hydrocarbons and water from the main, or flow, stream in conduit **5**.

In generalization, the first circuit of the process is characterized by conduits **1**, **5** and **16**, which pass the main, or flow stream of gas through the adsorbing towers. A second circuit is arranged to be passed through the towers to vaporize the hydrocarbons and water adsorbed therein. The circuits are mechanically connected so the main stream can provide energy for the circulation of the reactivation stream of the second circuit. With this energy of the main stream, the reactivation stream is circulated through the towers and through a condensing step to liquefy the water and hydrocarbons. Finally, the liquids are separated and the remaining gaseous portion is heated so it may again be used to vaporize the tower products. As the reactivation gas is alternately heated and cooled to perform its functions in the process, its volume fluctuates. An open circuit is provided between the two circuits in order to exchange gas between the two streams as demanded by the alternate heating and cooling of the reactivation stream.

Reactivation Circuit

The second circuit is clearly traced from conduit **20**, which is connected to branch conduits **21** and **22**. Valve **23** in branch conduit **21** and valve **24** in branch conduit **22** alternately pass reactivation gas from conduit **20** into branch conduit **6** and branch conduit **7**. Obviously, valve **10** is controlled to open as valve **23** is closed, and valve **11** is controlled to close when valve **24** is open. The object of controlling the valves in this manner is to pass the reactivation gas of conduit **20** through the tower **9** which has already adsorbed hydrocarbons and water from the first circuit of conduit **5**.

The reactivation gas passes from the towers, through conduits **12** and **13**. Branch conduit **25** removes the reactivation gas out of tower **8** above valve **14**. Branch conduit **26** is connected above valve **15** for a similar purpose. Valves **27** and **28** are controlled in conduits **25** and **26** to alternately pass reactivation gas into conduit **29**. All the valves in the second, or reactivation, circuit are illustrated in FIG. 1 as passing the gas through tower **9** while the first circuit is valved to pass the main stream through tower **8**. Thus, FIG. 1 illustrates the function of the two circuits in passing the main gas through the adsorbing towers to deposit hydrocarbons and water and passing the reactivation stream through the towers to vaporize and remove the hydrocarbons and water therefrom.

Cooling of Reactivation Gas

The hydrocarbon and water-laden reactivation gas of conduit **29** is a relatively hot stream of the process. To vaporize the adsorbed products of the towers, it is necessary to heat the reactivation stream to a relatively high temperature. The beds of the towers are relatively cool when receiving the main stream, their adsorptive capacity being at a maximum. The main stream will raise the bed temperature a finite amount during the adsorptive period, but the maximum temperature will be reached after passage of the heated reactivation gas through the beds. To condense the hydrocarbons and water, the reactivation stream of conduit **29** must be cooled. Several choices of cooling sources are available. The one, or combination, of these sources selected is a matter of design depending on the characteristics of the particular main stream, the availability of water, size of equipment, and etc.

FIG. 1 illustrates the stream of conduit **29** as being cooled by an available stream of coolant, such as water. Heat exchanger **30** is shown as associating the coolant of conduits **31** and **32** with the captive, reactivation stream of conduit **29**. The result is to pass condensed liquid hydrocarbons and water to conduit **33**, along with uncondensed gas of the second circuit.

Separator 35

Some of the ultimate results of the process are realized in the function of the three-phase separator **35**. Hydrocarbons are removed through conduit **36** and may be conducted to a stabilizer or storage point not shown. Water is removed through conduit **37** for disposal. The cool reactivation gas stream is delivered to conduit **38** for recirculation through the adsorption beds of the towers.

Tower Cooling

In partial review, the tower bed stripped of hydrocarbons and water is left at a relatively high temperature. If the main stream of conduit **5** would be immediately passed through the hot bed its temperature would be quickly dropped. However, there would also be a finite period of poor adsorption because of the elevated temperature of the bed. Further, dumping this heat into the main stream in this manner would be an unwarranted hazard. The rise in temperature of the flow stream of conduit **16** may dangerously expand downstream lines and connections, resulting in mechanical failures.

The point to be made is that it is usually preferable to use the relatively cool captive stream in conduit **38** to reduce tower temperature. Of course, as indicated supra, it may be feasible to route the processed gas of conduit **16** through the beds if design conditions permit it.

In carrying out the preferable technique of cooling, valve **40** is provided to alternately pass the cool stream of conduit **38** through a heating source and directly to conduit **20**. This valve **40** may be controlled by the actual temperature of the towers. The control illustrated in FIG. 1 is that exerted by a time-cycle controller **41**. In certain instances it is practical to simply set the length of the cooling period with the stream of conduit **38** so the reactivated tower will be brought to a sufficiently cool temperature to efficiently receive the gas of the main stream of conduit **5**. In either event, valve **40** directs the cool stream of **38** through either conduit **42** or **43**. Conduit **42** takes the cool stream through heater **44** to pick up the heat required for reactivation of the adsorbent.

The stream of conduit **42** has its temperature elevated to a relatively high value by heater **44**. Conduit **45** receives this heated reactivation stream and passes it to conduit **20** as an alternate to the cool stream of conduit **43**. Thus is completely illustrated, the periodic heating and cooling of the second circuit of the reactivation gas for passage through the towers. Analysis of the composition of the reactivated stream at various points in its circuit would be informative. However, this general indication of the relative temperatures produced in a practical embodiment of the invention is deemed sufficient to enable one skilled in the art to grasp the design variations encountered in utilizing the invention. Consideration may now pass to the means with which energy is transferred between the two circuits in order to circulate a fluid in the captive circuit.

The present invention is embodied in mechanical means with which to transfer the flow energy of the fluid in conduits **1** and **5** to the captive circuit. This mechanical link is specifically embodied in a preferred form of motor-compressor illustrated in FIG. 1 at **50** and in detail with FIGS. 2–5.

Motor-Compressor 50

Essentially, motor-compressor **50** is a sliding vane type of motor on a common shaft with a sliding vane type compressor. The compressor side of the unit receives the cool stream of conduit **38** and delivers it to conduit **51**, going into valve **40**. Valve **40**, as indicated heretofore, directs this compressor output to either conduit **42** or conduit **43**.

The motor side of unit **50** is in a shunt conduit **52**—**53** around valve **54**. Valve **54** is in conduit **5** and regulates the amount of the processed stream which is passed

through conduit 52—53. Depending upon the setting of valve 54, more or less of the main stream is received by conduit 52 to regulate the speed of the motor-compressor 50.

Valve 54 is regulated by a control instrument 55 which responds to the differentials across orifice 56 in conduit 20. As the differential across orifice 56 varies, controller 55 regulates valve 54 to adjust the amount of the stream in conduit 5 delivered to conduit 52. Motor-compressor 50 thus has its speed adjusted to maintain the differential across orifice 56. This arrangement of control is particularly advantageous in this closed-cycle adsorption process.

Orifice 56

Orifice 56 is exposed to the variation in temperature of the stream in conduit 20 as it is received from either conduit 45 or conduit 43. The flow temperature of the captive stream of conduit 20 thus varies the flow rate through this second circuit in accordance with the flowing temperature of the stream itself. The result is regulation in the correct direction to vary the flow rate. As the flowing temperature decreases from the insertion of the stream of conduit 43 into conduit 20, motor-compressor 50 is caused to increase in output. The flow rate goes up as the flowing temperature goes down. Alternately, as the heated stream of conduit 45 is caused to flow through orifice 56, the differential variation regulates valve 54 to slow the motor-compressor and decrease the flow rate through the second circuit. Thus, automatic regulation results in the correct direction to maintain the flow rate required to efficiently strip the absorbent material of the towers and cool them prior to again receiving the wet stream to be processed.

By-Pass Conduit 57

The second circuit being alternately heated and cooled by the function of valve 40, the inventory of gaseous fluid must fluctuate as the physical volume of the circuit conduits, as a container, remains constant. FIG. 1 illustrates a second connection between the two circuits in the form of conduit 57. Conduit 57 connects the input side of the motor of unit 50 with the output side of the compressor of unit 50. Through this conduit, the gases of the two volumes interchange as they contract and expand relative to each other. The result is a floating, or variable, volume of gas in the reactivation circuit which performs the work of hydrocarbon recovery and water extraction in the process.

Attention is now directed to the specific arrangements of FIGS. 2–5. The motor compressor 50, of FIG. 1 is specifically powered by the energy of the main fluid stream. The mechanical connection of the shaft assembly enables the main fluid stream energy to drive the captive, reactivation stream in its circuit.

Housing

A specific consideration of component arrangement of motor-compressor 50 logically begins with the unitary housing. This housing, or casing, is basically made up from compressor manifold housing 60 and motor manifold housing 61 abutting and bolted to each other by cap screws 62. These manifolds can be formed of castings, however, it was also found practical to form them of separate parts, welded together.

The input and output connections to conduits 38, 51, 52 and 53 are shown in FIG. 2, oriented in direction with the FIG. 1 illustration of the motor-compressor as included in the fluid circuits of the process. Each of these conduits 38, 51, 52 and 53 register with ports in the housing. The ports-holes terminate in chambers 63, 64, 65 and 66 of the housing. The ports-holes are drilled from these chambers through the cylinder walls of the housing.

Cylinders 67 and 68

The housing of the motor-compressor 50 has two cylinders 67 and 68 into which the respective fluids are received and removed through the ports-holes of chambers 63, 64, 65 and 66. A set of sliding vanes is provided in each cylinder to form the rotating chambers of variable size which expand under the pressure of the main stream fluid and compress the fluid of the reactivation stream in energy transfer.

The cylinders 67 and 68 are closed by motor end bell 69 and compressor end bell 70 bolted to their respective manifold housings. Plate member 71 forms a wall-partition with which to bridge the junction of the manifold housings and is recessed into each of them. Center plate 71 is thus firmly captured to provide an inner side wall for each cylinder 67 and 68. Between the walls of the end bells and the faces of the center plate 71, the vanes slide on the cylinder walls of the manifold housing to transfer the fluids between 52, 53 and 38, 51.

Central Shaft

In addition to functioning to close the cylinders 67 and 68, the end bells house the bearings for each end of the shaft about which the sliding vanes rotate. Two pairs of roller bearings are given stable support for their races in bells 69 and 70. Bearings 72 and 73 are mounted in motor end bell 69 and bearings 74 and 75 are mounted in compressor end bell 70. The central shaft structure, offset from the central axis of the cylinder, rotates in these bearings. Bearings 72 and 73 are mounted near each other and support the right end of the central shaft structure as viewed in FIG. 3. Bearings 74 and 75 are mounted near each other and support the left end of the central shaft structure. Caps 76 and 77 are bolted to the ends of bells 69 and 70 to complete the housing, or casing, enclosure for the moving parts of the motor-compressor.

The central shaft structure rotating between the end bearings 72—75 is made up of three parts. Motor shaft 78 and compressor shaft 79 are the parts specifically carried in the two pairs of bearings. The inner ends of these two shafts abut a coupler shaft 80 which is, itself, journalled in a mechanical seal structure 80A in center plate 71. The inner end of the shafts 78 and 79 which abut the coupler shaft 80 have female splines aligning with male splines of the coupler shaft. When these splines are bridged by members having male splines, the shafts turn together as a unitary assembly.

Rotors 81 and 82

Bridging male splines are provided for the shafts and coupler with motor rotor 81 and compressor rotor 82. These rotors are cylindrical in form and extend between their respective end bells and the faces of center plate 71. The rotors are pinned to their respective shafts by pins 83 and 84 and support the sliding vanes which form the variable volumes with the cylinder walls, the supporting rotors, the inner faces of the end bells and the faces of the center plate 71.

Vanes 85

The rotors are formed with three pairs of longitudinal vane slots. Each pair of slots are in a common plane through the rotor center. As the center of rotor and shaft is off-set from the axis of the cylinders, the vanes carried in the slots will move over a range, radially, in the slots to follow the cylinder walls with their edges.

Vanes 85 are in the form of flat plates sliding in the rotor slots. A pair of holes are drilled transverse the axis of the rotor and shaft, in the bottom of the slots. Of course, each hole, in the common shaft, must be longitudinally offset from each other hole to avoid interference in passing across the axis of the shaft. In each hole is arranged a spring-loaded pin 86 which con-

tinually urges its pair of vanes 85 radially outward against the cylinder walls.

FIG. 6 is established to disclose the pins 86 in their several components and their structural relation to the vanes. Each pin 86 is an assembly of two shafts 86A and 86B with a spring 86C between them. The spring 86C exerts its force to urge the two pin shafts apart. Guide pin 86D maintains the spring and shafts aligned. The springs of these pins 86 can be compressed to facilitate assembly as the rotors, shafts and vanes are slipped into the cylinders. Once in position, the pins 86, as an assembly, vary in length while continually exerting their spring forces against the vanes 85 to make them follow the circular cylinder walls about the off-set axis of the shaft.

FIG. 6 also shows the spline connection between the rotors and the shafts over which they are journalled to further advantage. Female spline 79A is partially disclosed in FIG. 2. However, FIG. 6 shows the complete spline 79A in cross section. A female spline 80B is formed on the end of coupler shafts 80 extending out from partition-wall 71 to abut the end of shaft 79. Male spline 82A is formed on the end of rotor 82 contiguous partition-wall 71. This spline 82A is shown, in FIG. 6, engaging spline 79A. From FIG. 3 it can be seen that spline 79A engages both the spline on shaft 79 and the spline on the coupler shaft 80. This bridging the abutting splines of the two shafts is the means whereby both shafts are made to turn together. In turn, through identical spline structure, shaft 80 and shaft 78 turn together. In the position illustrated, the support for each rotor is the shaft on which it is journalled from a point near the bearing structure in the housing wall to the coupler shaft end extending from the partition-wall 71.

Interchangeability

Note is to be made of the fact that the motor and compressor sides of the unit 50 are mirror-images of each other in every detail. From shafts 78, 79 to housings 60, 61 the parts of each are duplicated in arrangement and function.

The implications of the duplications between motor and compressor parts are evident. The compactness of the unit as a whole is paralleled by the relatively simple inventory of parts needed for repair and replacement.

Not to be underestimated is the relative simplicity of the service functions necessary for replacement and maintenance. Personnel are readily trained to service a unit as compact and simple as disclosed. The problems are reduced to the point where it is feasible to place the unit in the care of relatively unskilled oil field personnel.

Operation of Motor-Compressor 50

The shaft of the motor-compressor is rotated by the pressure differential between its conduits 52 and 53. The fluid entering from conduit 52 is ported from chamber 64 into the chambers formed by the vanes in cylinder 67 when the vane chambers have volume smaller than the volume they have as they rotate to the ports of chamber 66. The differential pressure between the conduits, across the vanes, as they move past the chamber 64 ports, develop the force which rotates the vanes and shaft.

The turning of the shaft causes the vane-chambers of cylinder 68 to rotate from the ports of chamber 63 toward the ports of chamber 65. As the vane-chambers of the compressor rotate, they reduce in size as they go from their position at the ports of chamber 63 to their position at the ports of chamber 65. The differential developed across each vane as it is rotated from chamber 63 to chamber 65 is the result of the transfer of a finite portion of the energy of the stream of conduits 52, 53 into the stream of conduits 38, 51.

Referring specifically to FIGS. 4 and 5, there has been shown a full section in elevation along lines 4—4 of FIG. 3. FIG. 4 designates one of the vanes 85, specifically, as vane 85A, positioned to define vane-chamber A in the motor cylinder 67 as a closed chamber expanding as rotation takes place from the ports of chamber 64 to the ports of chamber 66. Another vane 85, designated specifically as vane 85B, completes the vane-chamber A. The pins 86, which urge the vanes 85 radially outward, are not illustrated in the interest of simplicity. An analysis of the power developed across the vanes 85 is made with vane 85A as chamber A is rotated from the position illustrated in FIG. 4 to the position illustrated in FIG. 5.

Clockwise rotation of rotor 81, in FIG. 4, positions vane 85A to terminate communication between chamber A and the last of the ports to chamber 64. As the volume of chamber A increases with rotation, the constant pressure of conduit 52 fluid, in chamber 64, is effective in chamber B to cause an increase in pressure differential across vane 85A. This differential across vane 85A adds to the rotational force applied to the shaft 78. However, the work produced by expansion of the fluid in chamber A, from the FIG. 4 position to the FIG. 5 position, is but a portion of the total work produced.

FIG. 5 shows the vane 85B ready to communicate chamber A with conduit 53. This communication increases the differential pressure between chamber A and chamber B to the limit of the lower value at which the pressure of conduit 53 is maintained. This differential in pressure developes the major portion of the power delivered to shaft 78. The power delivery is, of course, continuous as successive vane-chambers rotate from the FIG. 4 position to the FIG. 5 position, developing force on the vanes 85 by expansion of the fluid of conduit 52 as it is transferred to conduit 53.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. A fluid pressure motor and compressor unit including;

a first drive shaft having,

(*a*) a cylindrical form,

(*b*) a shape for bearing support from one end,

(*c*) and a female spline on the other end;

a second driven shaft having,

(*a*) form, shape and female spline identical to that of the first drive shaft,

(*b*) and alignment with the first drive shaft in which the female splines are toward each other;

a third coupler shaft having,

(*a*) a cylindrical form,

(*b*) a shape for bearing support at its middle,

(*c*) a female spline on each end,

(*d*) and positional orientation between the first and second shafts and abutting both shafts so as to bring the female splines of each of the first two shafts into contiguous alignment with one of the female splines of this third coupler shaft;

a casing having a symmetrical cavity in which the shafts rotate;

a wall-partition within the cavity arranged to divide the casing into two cylindrical chambers of identical

form through each of which one of the first two shafts extend;

a bearing-seal structure in the wall-parition receiving the middle of the third coupler shaft to support the shaft as the shaft turns with the female splines of the shaft extending away from the wall-partition;

a first bearing structure mounted in the wall of the casing and arranged to support the first drive shaft from the end remote from the coupler shaft;

a first cylindrical rotor journalled on the first drive shaft and extending from the wall-partition to the chamber wall opposite and having a male spline engaging the female splines of the drive and coupler shafts to couple the shafts together while the rotor is supported in the casing chamber between the coupler shaft adjacent the wall-partition and the first drive shaft at a point remote from the wall-partition;

a second bearing structure mounted in the wall of the casing and arranged to support the second driven shaft from the end remote from the coupler shaft;

a second cylindrical rotor journalled on the second driven shaft with a form identical to the first rotor and arranged to couple the driven and coupler shafts together in the same manner;

a plurality of vanes wherein,

(*a*) each vane is in the form of a flat plate,

(*b*) each vane is disposed in a radially extended longitudinal slot of each of the identically formed cylindrical rotors,

(*c*) and each vane moves in its slot from the center of shaft-rotor rotation when the shaft rotates;

first connections into the first of the cylinder chambers through which is passed a first fluid to develop power in the chambers of the first cylinder between the vanes and against the vanes to rotate the shaft assembly;

and second connections into a second of the cylinder chambers through which is passed a second fluid which is compressed in the chambers between the vanes as the shaft assembly is rotated by the power of the first cylinder.

2. A fluid pressure motor and compressor unit including;

a first drive shaft having,

(*a*) a cylindrical form,

(*b*) a shape for bearing support from one end,

(*c*) and a female spline on the other end;

a second driven shaft having,

(*a*) form, shape and female spline identical to that of the first drive shaft,

(*b*) and alignment with the first drive shaft in which the female splines are toward each other;

a third coupler shaft having,

(*a*) a cylindrical form,

(*b*) a shape for bearing support at its middle,

(*c*) a female spline on each end,

(*d*) and positional orientation between the first and second shafts and abutting both shafts so as to bring the female spline of each of the first two shafts into contiguous alignment with one of the female splines of this third coupler shaft;

a casing having a symmetrical cavity in which the shafts rotate;

a wall-partition within the cavity arranged to divide the casing into two cylindrical chambers of identical form through each of which one of the first two shafts extend;

a bearing-seal structure in the wall-partition receiving the middle of the third coupler shaft to support the shaft as the shaft turns with the female splines of the shaft extending away from the wall-partition;

a first bearing structure mounted in the wall of the casing and arranged to support the first drive shaft from the end remote from the coupler shaft;

a first cylindrical rotor journalled on the first drive shaft and extending from the wall-partition to the chamber wall opposite and having a male spline engaging the female splines of the drive and coupler shafts to couple the shafts together while the rotor is supported in the casing chamber between the coupler shaft adjacent the wall-partition and the first drive shaft at a point remote from the wall-partition;

a second bearing structure mounted in the wall of the casing and arranged to support the second driven shaft from the end remote from the coupler shaft;

a second cylindrical rotor journalled on the second driven shaft with a form identical to the first rotor and arranged to couple the driven and coupler shafts together in the same manner;

a plurality of vanes wherein,

(*a*) each vane is in the form of a flat plate,

(*b*) each vane is disposed in a radially extended longitudinal slot of each of the identically formed cylindrical rotors,

(*c*) and each vane moves in its slot from the center of shaft-rotor rotation when the shaft rotates;

a spring loaded pin in each radially extended longitudinal rotor slot arranged to engage the vane in the slot and urge the vane from the center of rotor rotation onto the cylinder walls as the vane moves over the surface of the wall;

first connections into the first of the cylinder chambers through which is passed a first fluid to develop power in the chambers of the first cylinder between the vanes and against the vanes to rotate the shaft assembly;

and second connections into a second of the cylinder chambers through which is passed a second fluid which is compressed in the chambers between the vanes as the shaft assembly is rotated by the power of the first cylinder.

3. A fluid pressure motor and compressor unit including;

a first drive shaft having,

(*a*) a cylindrical form,

(*b*) a shape for bearing support from one end,

(*c*) and a female spline on the other end;

a second driven shaft having,

(*a*) form, shape and female spline identical to that of the first drive shaft,

(*b*) and alignment with the first drive shaft in which the female splines are toward each other;

a third coupler shaft having,

(*a*) a cylindrical form,

(*b*) a shape for bearing support at its middle,

(*c*) a female spline on each end,

(*d*) and positional orientation betwen the first and second shafts and abutting both shafts so as to bring the female splines of each of the first two shafts into contiguous alignment with one of the female splines of this third coupler shaft;

a casing having a symmetrical cavity in which the shafts rotate;

a wall-partition within the cavity arranged to divide the casing into two cylindrica lchambers of identical form through each of which one of the first two shafts extend;

a bearing-seal structure in the wall-partition receiving the middle of the third coupler shaft to support the shaft as the shaft turns with the female splines of the shaft extending away from the wall-partition;

a first bearing structure mounted in the wall of the

casing and arranged to support the first drive shaft from the end remote from the coupler shaft;

a first cylindrical rotor journalled on the first drive shaft and extending from the wall-partition to the chamber wall opposite and having a male spline engaging the female splines of the drive and coupler shafts to couple the shafts together while the rotor is supported in the casing chamber between the coupler shaft adjacent the wall-partition and the first drive shaft at a point remote from the wall-partition;

a second bearing structure mounted in the wall of the casing and arranged to support the second driven shaft from the end remote from the coupler shaft;

a second cylindrical rotor journalled on the second driven shaft with a form identical to the first rotor and arranged to couple the driven and coupler shafts together in the same manner;

a plurality of vanes wherein,

(*a*) each vane is in the form of a flat plate,

(*b*) each vane is disposed in a radially extended longitudinal slot of each of the identically formed cylindrical rotors,

(*c*) and each vane moves in its slot from the center of shaft-rotor rotation when the shaft rotates;

a pair of spring-loaded pins in each radially extended longitudinal rotor slot arranged normal to a plane of the shaft axis so each pin will urge a pair of identically formed vanes from the center of the shaft rotation in opposite directions onto one of the cylinder walls as the pair of identical vanes engages with and move over the surface of the cylinder wall;

first connections into the first of the cylinder chambers through which is passed a first fluid to develop power in the chambers of the first cylinder between the vanes and against the vanes to rotate the shaft assembly;

and second connections into a second of the cylinder chambers through which is passed to second fluid which is compressed in the chambers between the vanes as the shaft assembly is rotated by the power of the first cylinder.

4. A fluid pressure motor and compressor unit including;

a first drive shaft having,

(*a*) a cylindrical form,

(*b*) a shape for bearing support from one end,

(*c*) and a female spline on the other end;

a second driven shaft having,

(*a*) form, shape and femal spline identical to that of the first drive shaft,

(*b*) and alignment with the first drive shaft in which the female splines are toward each other;

a third coupler shaft having,

(*a*) a cylindrical form,

(*b*) a shape for bearing support at its middle,

(*c*) a female spline on each end,

(*d*) and positional orientation between the first and second shafts and abutting both shafts so as to bring the female spline of each of the first two shafts into contiguous alignment with one of the female splines of this third coupler shaft;

a casing having a symmetrical cavity in which the shafts rotate;

a wall-partition within the cavity arranged to divide the casing into two cylindrical chambers of identical form through each of which one of the first two shafts extend;

a bearing-seal structure in the wall-partition receiving the middle of the third coupler shaft to support the shaft as the shaft turns with the female splines of the shaft extending away from the wall-partition;

a first bearing structure mounted in the wall of the casing and arranged to support the first drive shaft from the end remote from the coupler shaft;

a first cylindrical rotor journalled on the first drive shaft and extending from the wall-partition to the chamber wall opposite and having a male spline engaging the female splines of the drive and coupler shafts to couple the shafts together while the rotor is supported in the casing chamber between the coupler shaft adjacent the wall-partition and the first drive shaft at a point remote from the wall-partition;

a second bearing structure mounted in the wall of the casing and arranged to support the second driven shaft from the end remote from the coupler shaft;

a second cylindrical rotor journalled on the second driven shaft with a form identical to the first rotor and arranged to couple the driven and coupler shafts together in the same manner;

a plurality of vanes wherein,

(*a*) each vane is in the form of a flat plate,

(*b*) each vane is disposed in a radially extended longitudinal slot of each of the identically formed cylindrical rotors,

(*c*) and each vane moves in its slot from the center of shaft-rotor rotation when the shaft rotates;

first connections into the first of the cylinder chambers made at first locations about the circumference relative to the chambers of the first cylinder between the vanes which enables a first fluid to develop power in the chambers of the first cylinder between the vanes and against the vanes to rotate the shaft assembly;

and second connections into a second of the cylinder chambers made at second locations about the circumference relative to the chambers of the second cylinder between the vanes which pass a second fluid which is compressed in the chambers between the vanes as the shaft assembly is rotated by the power of the first cylinder.

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