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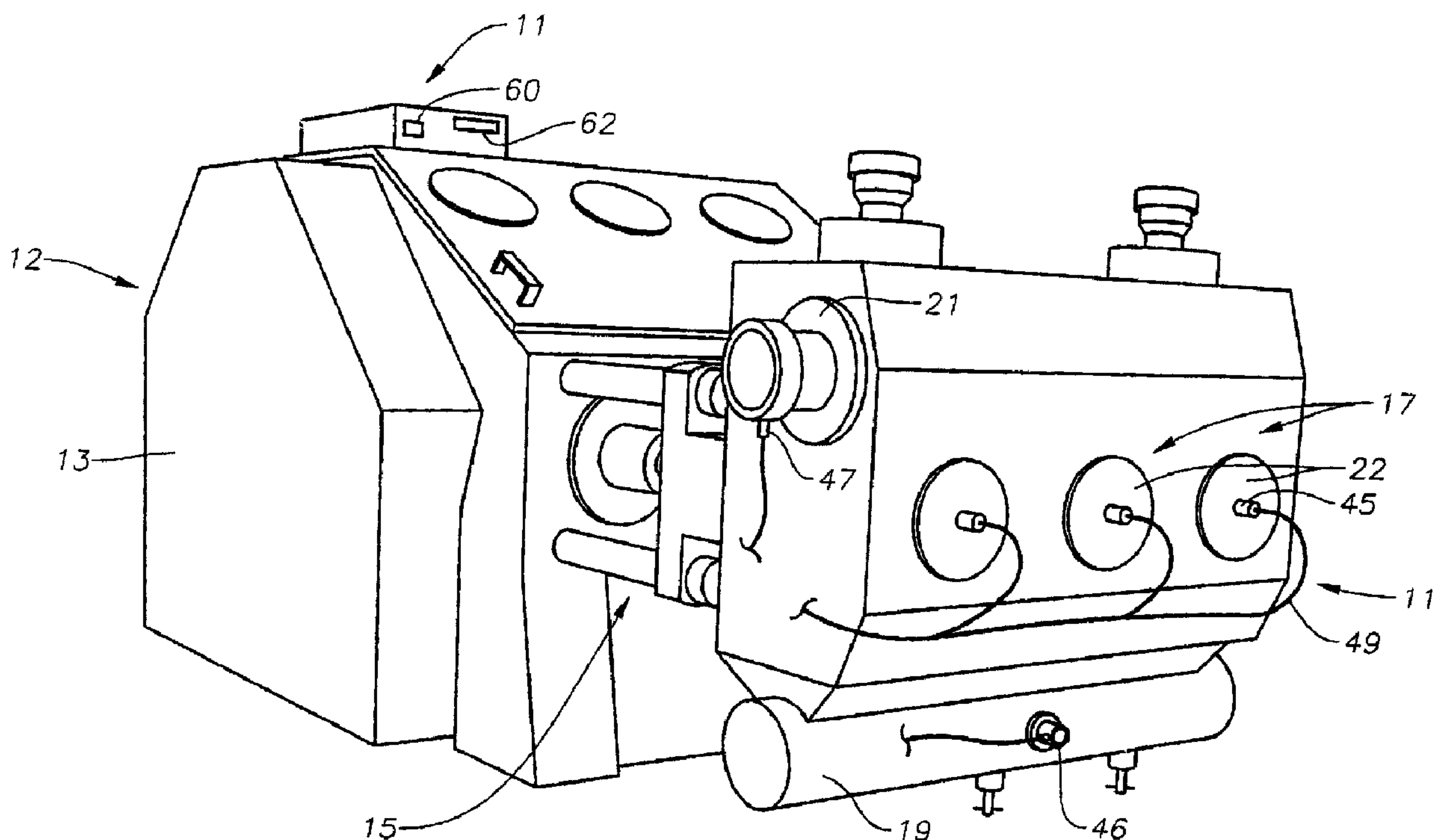
(72) Inventeurs/Inventors:
MATZNER, MARK D., US;
KIGHT, RUSSELL D., US

(73) Propriétaire/Owner:
S.P.M. FLOW CONTROL, INC., US

(74) Agent: FINLAYSON & SINGLEHURST

(54) Titre : SYSTÈME DE CONTRÔLE POUR POMPES ALTERNATIVES

(54) Title: MONITORING SYSTEM FOR RECIPROCATING PUMPS



(57) Abrégé/Abstract:

A reciprocating pump assembly includes a pump housing that houses a crankshaft. Pistons are mechanically connected to the crankshaft for pumping fluid through cylinders. Each cylinder has a fluid inlet and a fluid outlet. The pump also has a monitoring housing connected to the reciprocating pump. Within the monitoring housing is a computer with memory. Pressure sensor assemblies sense a pressure value of a fluid within the pump, and are in electrical communication with the memory. An accelerometer positioned on the pump measures vibrations of the pump and is also in electrical communication with the memory for storage of sensed vibrations or displacements during operations. A proximity sensor in electrical communication with the memory is located within the pump housing to determine the rotational velocity of the crankshaft.

ABSTRACT

A reciprocating pump assembly includes a pump housing that houses a crankshaft. Pistons are mechanically connected to the crankshaft for pumping fluid through cylinders. Each cylinder has a fluid inlet and a fluid outlet. The pump also has a monitoring housing connected to the reciprocating pump. Within the monitoring housing is a computer with memory. Pressure sensor assemblies sense a pressure value of a fluid within the pump, and are in electrical communication with the memory. An accelerometer positioned on the pump measures vibrations of the pump and is also in electrical communication with the memory for storage of sensed vibrations or displacements during operations. A proximity sensor in electrical communication with the memory is located within the pump housing to determine the rotational velocity of the crankshaft.

MONITORING SYSTEM FOR RECIPROCATING PUMPS

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates generally to reciprocating pumps, more specifically to an apparatus for monitoring operating conditions of the reciprocating pump.

2. Background of the Invention

[0003] In oil field operations, reciprocating pumps are often used for various purposes. Some reciprocating pumps, generally known as "service pumps," are typically used for operations such as cementing, acidizing, or fracing the well. Typically, these service pumps run for relatively short periods of time but on a frequent basis. Often they are mounted to a truck or a skid for transport to various well sites. A pump might operate several times a week. Many times, several pumps will be connected in parallel to a flow line. The operator will know the output pressure of the group of pumps due to a pressure gauge on the flow line, but may not know the individual pump output pressure. The operator will often not know the intake pressure, the individual pump speed, or the extent of vibration of a particular pump. A pump might be performing poorly, yet the operator not know.

[0004] To periodically monitor the performance of the pump, an operator typically calls on the services of testing companies that will set up temporary sensors and monitor the performance of the pump during a test period. Generally, the testing service connects pressure gauges to the overall intake and discharge, as well as each individual pressure chamber. The testing service might also monitor the rotational speed and vibration. Then the testing service removes the test equipment and the pump continues operations without monitoring equipment.

[0005] Continuous monitoring of the pump through testing companies is not practical. Moreover, during operations, the pressure of the fluid inside of the pump can become quite high which makes it difficult to obtain readings of pressures within the pump at certain locations without leakage. Operators typically will not often use the testing equipment due to the cost associated with the testing companies. An operator may not have a pump tested unless something appears to be wrong with it. Accordingly, operators are often left in the situation of not knowing what the performance conditions of a pump for long periods of time.

SUMMARY OF THE INVENTION

[0006] In this invention, a reciprocating pump assembly includes a pump housing that houses a crankshaft. A plurality of pistons are mechanically connected to the crankshaft for pumping a fluid through a plurality of cylinders or piston chambers. Each of the cylinders has a fluid inlet and a fluid outlet. The pump also has a monitoring housing connected to the reciprocating pump. Within the monitoring housing is a computer having a memory. The pump also has a plurality of pressure sensor assemblies. Each pressure sensor assembly is in electrical communication with the memory. Each pressure sensor assembly is used to sense a pressure value of a fluid within the pump.

[0007] The invention can optionally also include an accelerometer to measure vibrations by sensing displacement. The accelerometer is typically positioned adjacent the pump housing. The accelerometer is also in electrical communication with the memory of the computer so that the computer can store sensed vibrations or displacements during operations. The invention can also have a proximity sensor located within the pump housing to determine the rotational velocity of the crankshaft. The proximity sensor is in electrical communication with the memory of the computer so that the computer can store sensed proximity values during operations.

[0008] A pressure sensor assembly that can be used in this invention includes a plug member. The plug member is positioned adjacent a sidewall of the pump. The sidewall can be selected from various sidewalls that are in fluid communication with the fluid pumped within the reciprocating pump. A port is located in the sidewall of

the pump that is in fluid communication with the fluid within the pump. The plug member has an aperture that registers with the port when the plug member is positioned adjacent the side wall. A seal member is positioned between the plug member and the sidewall. The seal member has a passageway that allows the aperture to register with the port when the seal member and the plug member are in place. A transducer is located within the plug member and is in fluid communication with the aperture. The transducer converts the pressure into electronic signals that can be communicated to the computer.

[0009] The computer of the pump assembly can also have a port that allows an operator to download the stored sensed values in the memory. This allows an operator to collect the sensed values of the operating conditions over long periods of operation for analysis and monitoring purposes. Alternatively, the memory of the computer can be a replaceable memory device such as a chip or disk. The computer can include a drive for receiving and ejecting the memory so that the operator can easily retrieve and replace the memory after predetermined periods of operations for analysis.

[0009A] The invention in one broad aspect pertains to an oilfield reciprocating pump assembly having a pump housing that houses a crankshaft with a plurality of pistons mechanically connected to the crankshaft for pumping a fluid into a plurality of cylinder chambers, each of the cylinder chambers having a fluid inlet with an inlet valve and a fluid outlet with an outlet valve. A fluid inlet chamber is upstream of the inlet valve of each of the cylinder chambers, and a discharge flange is downstream of the outlet valve of each of the fluid outlets for receiving fluid from the plurality of cylinder chambers. The reciprocating pump comprises a monitoring housing mounted to the reciprocating pump assembly, and a computer is in electrical communication with the monitoring housing, the computer having a memory. A plurality of cylinder chamber pressure sensor assemblies, each mounted to the pump in fluid communication with one of the cylinder chambers is provided to sense a pressure value of the fluid within each of the cylinder chambers of the pump.

[0009B] In a still further aspect, the invention comprehends a method of monitoring the operating conditions of an oilfield reciprocating pump assembly having a pump housing that houses a crankshaft. A plurality of pistons are mechanically connected to the crankshaft for pumping a fluid through a plurality of cylinder chambers, each of the cylinder chambers having a fluid inlet with an inlet valve and a fluid outlet with an outlet valve. A fluid inlet chamber is upstream of the inlet valve of each of the cylinder chambers, and a discharge flange is downstream of the outlet valve of each of the fluid outlets for receiving fluid from the plurality of cylinder chambers. The method comprises mounting a monitoring housing to the reciprocating pump assembly, positioning a plurality of cylinder pressure sensor assemblies in fluid communication with ports leading to each of the cylinder chambers and electrically connecting the sensor assemblies to the computer of the reciprocating pump, and positioning an intake pressure sensor assembly in fluid communication with the fluid inlet chamber and a discharge pressure sensor assembly in fluid communication with the discharge flange. A wire harness is connected between the cylinder pressure, intake pressure and discharge pressure sensor assemblies and the monitoring housing. The pump operates to cause a dynamic fluid pressure within each of the cylinder chambers to increase when its piston makes a pressure stroke and to decrease when its piston makes a suction stroke. The dynamic fluid pressure is sensed within each of the cylinder chambers with the cylinder pressure sensor assemblies, and intake and discharge pressures are sensed with the intake and discharge pressure sensor assemblies. Sensed values of the dynamic fluid pressure, the intake pressure and the discharge pressure from the sensor assemblies are electrically communicated to the monitoring housing via the wire harness, and the sensed values from the monitoring housing are electrically communicated to a computer to determine a condition of the valves.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Figure 1 is a schematic elevational view of a reciprocating pump assembly constructed in accordance with this invention.

[0011] Figure 2 is a top plan schematic view of the reciprocating pump assembly shown in Figure 1.

[0012] Figure 3 is a sectional view of a portion of the pump assembly shown in Figure 1.

[0013] Figure 4 is a perspective view of the reciprocating pump assembly shown in Figure 1.

[0014] Figure 5 is an enlarged sectional view of a monitoring sensor assembly shown in a cover plate of the reciprocating pump assembly shown in Figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0015] Referring to Figures 1 and 3, reciprocating pump or pump assembly 12 includes a monitoring assembly 11 is shown attached to a reciprocating pump 12. In the preferred embodiment, reciprocating pump 12 includes a crankshaft housing 13 that comprises a majority of the outer surface of reciprocating pump 12 shown in Figures 1 and 3. A plunger or piston rod housing 15 attaches to a side of crankshaft housing 13 and extends to a cylinder 17. Each cylinder 17 preferably includes a fluid inlet 19 and a fluid outlet 21 (Figure 2). As best shown in Figure 3, a cover plate 22 connects to an end of each cylinder 17 opposite from the piston rod housing 15. While pump 12 is shown in Figure 4 as free-standing on the ground, pump 12 can easily be mounted to a trailer that can be towed between operational sites, or to a skid such as for offshore operations. Accordingly a pump assembly is defined as including either a pump 12 mounted directly to the ground or support structure, a skid, or a trailer.

[0016] Referring to Figure 2, piston rod housing 15 is segmented into three portions, each portion comprising a plunger or piston throw 23. Reciprocating pump 12 as shown in Figure 2 has three piston throws 23, which is commonly known as a triplex, but could also be segmented for five piston throws 23, which is commonly known as a quintuplex pump. The description focuses on a triplex pump, but as will be readily apparent to those skilled in the art, the features and aspects described are easily applicable for a quintuplex or other type of pump. Each piston throw 23 houses a piston rod 33 (Figure 3) extending to cylinder 17. As shown in Figure 2, each piston throw 23 extends in the same longitudinal direction from crankshaft housing 13.

[0017] Referring to Figure 3, a portion of reciprocating pump 12 housed within crankshaft housing 13 is shown. Crankshaft housing 13 houses a crankshaft 25, which is typically mechanically connected to a motor (not shown). The motor (not shown) rotates crankshaft 25 in order to drive reciprocating pump 12. In the preferred embodiment, crankshaft 25 is cammed so that fluid is pumped from each piston throw 23 at alternating times. As is readily appreciable by those skilled in the art, alternating the cycles of pumping fluid from each of cylinders 17 helps minimize the primary, secondary, and tertiary (et al.) forces associated with reciprocating pump 12.

[0018] In the preferred embodiment, a gear 24 is mechanically connected to crankshaft 25. Gear 24 can be for mechanically connecting crankshaft 25 to the motor (not shown), or for conveying rotational energy to another gear for driving another assembly, such as a lubrication pump for lubricating. Gear 24 typically has teeth 26 spaced around the circumference of gear 24. In the preferred embodiment, a proximity sensor 28 is positioned adjacent crankshaft 25 for calculating the rotational velocity of crankshaft 25. One manner proximity sensor 28 can help calculate rotational velocity is by counting teeth 26 as gear 24 rotates. For example, one type of proximity sensor creates a magnetic field within its close proximity. As the each tooth 26 rotates past the proximity sensor 28, there is a disruption in the magnetic field. These disruptions can be counted and compared to time to help calculate a rotational speed of the gear 24, which in turn can be used to calculate the rotational speed of crankshaft 25.

[0019] In the preferred embodiment, a connector rod 27 includes an end that connects to crankshaft 25 and another end that engages a crosshead 29. Connector rod 27 connects to crosshead 29 through a crosshead pin 31, which holds connector rod 27 longitudinally relative to crosshead 29. Connector rod 27 pivots about crosshead pin 31 as crankshaft 25 rotates with the other end of connector rod 27. A piston rod 33 extends from crosshead 29 in a longitudinally opposite direction from crankshaft 25. Connector rod 27 and crosshead 29 convert rotational movement of crankshaft 25 into longitudinal movement of piston rod 33.

[0020] A piston 35 connects to piston rod 33 for pumping the fluid passing through reciprocating pump 12. Cylinder 17 connects to the end of piston rod housing 15 extending away from crankshaft housing 13 (Figure 1). Cylinder 17 typically includes a cylinder chamber 39, which is where the fluid being pumped by reciprocating pump 12 is compressed by piston 35. Cylinder 17 preferably includes an inlet valve 41 and an outlet valve 43. Valves 41 and 43 are preferably spring-loaded valves, which are actuated by a predetermined differential pressure. Inlet valve 41 actuates to control fluid flow through fluid inlet 19 into cylinder chamber 39, and outlet valve 43 actuates to control fluid flow through fluid outlet 21 from cylinder chamber 39. Piston 35 reciprocates, or moves longitudinally toward and away from

cylinder 17, as crankshaft 25 rotates. As piston 35 moves longitudinally away from cylinder chamber 39, the pressure of the fluid inside chamber 39 decreases creating a differential pressure across inlet valve 41, which actuates valve 41 and allows the fluid to enter cylinder chamber 39 from fluid inlet 19. The fluid being pumped enters cylinder chamber 39 as piston 35 continues to move longitudinally away from cylinder 17 until the pressure difference between the fluid inside chamber 39 and the fluid in fluid inlet 19 is small enough for inlet valve 41 to actuate to its closed position. As piston 35 begins to move longitudinally towards cylinder 17, the pressure on the fluid inside of cylinder chamber 39 begins to increase. Fluid pressure inside cylinder chamber 39 continues to increase as piston 35 approaches cylinder 17 until the differential pressure across outlet valve 43 is large enough to actuate valve 43 and allow the fluid to exit cylinder 17 through fluid outlet 21. In the preferred embodiment, fluid is only pumped across one side of piston 35, therefore reciprocating pump 12 is a single-acting reciprocating pump. If fluid were also being pumped on the side of piston 35 that connects to piston rod 33, this would be a double acting pump.

[0021] In the preferred embodiment, a pressure sensor assembly monitors the pressure of fluid being pumped by reciprocating pump 12. Preferably there are a plurality of pressure sensor assemblies advantageously positioned adjacent various sidewalls of pump 12 to sense fluid pressure values at various locations throughout pump 12. For example, as best shown in Figure 4, there is a pressure sensor assembly 45 mounted to each cover plate 22, which allows for sensing the output fluid pressure individually within each cylinder 17. In the embodiment shown in Figure 4, there is also preferably a pressure sensor assembly 46 mounted to fluid inlet 19, which feeds into each of cylinders 17, to sense the overall suction fluid pressure of the fluid entering pump 12. Additionally, there is also preferably a pressure sensor assembly 47 mounted to each discharge flange or well fluid outlet 21 to sense the individual fluid pressure of the fluid exiting each cylinder 17. In the preferred embodiment, wires 49 are in electrical communication with pressure sensors 45, 46, and 47. In the preferred embodiment, each pressure sensor assembly 45 includes a plurality of wires 49 extending therefrom. A preferred structure of each pressure sensor assembly is provided in more detail below.

[0022] As best illustrated in Figures 2-4, wires 49 extending from each pressure sensor assembly 45 combine to form a single bundle or wire harness 51. Wire harness 51 preferably extends below cylinders 17 toward crankshaft housing 13. Referring back to Figure 2, the end of wire harness 51 extending toward crankshaft housing 13 connects to a wire harness disconnect 53 located on crankshaft housing 13. Wire harness disconnect 53 preferably allows an operator to selectively disengage wire harness 51 while replacing or repairing cylinders 17. A second bundle or wire harness 55 extends from wire harness disconnect 53 toward an upper portion of crankshaft housing 13.

[0023] In the preferred embodiment, a monitoring housing or data collector 57 is located on an upper portion of crankshaft housing 13. Data collector 57 preferably comprises a computer 58 (Fig. 1) that receives and stores data about the operating conditions of pump 12. In a manner known in the art, computer 58 includes memory. As shown in Figure 4, computer 58 can include a port 60 for downloading data from the memory to another computer. Additionally, computer 58 can optionally include portable memory that is removable and insertable through a drive 62. Such replaceable memory allows an operator to store operating conditions on the memory of computer 58 for a predetermined length of time, and then retrieve the memory with the stored data for analysis and replace the previous memory with a replacement memory for storing data for another predetermined length of time.

[0024] The end of wire harness 55 extending from wire harness disconnect 53 connects to data collector 57. Data collector 57 receives and records the inlet and outlet pressures for each of cylinders 17 associated with reciprocating pump 12 as pistons 35 stroke. As will be appreciated by those skilled in the art, the inlet and outlet pressures from each cylinder 17 can then be transmitted from data collector 57 to a centrally located facility or the measurements can be digitally stored until retrieved by an operator. Additionally, proximity sensor 28 (Fig. 3) is also preferably in electrical communication with the memory of computer 58 so that proximity sensor can transmit the sensed proximities of teeth 26 for storage in the memory of computer 58. Computer 58 computes speed of rotation based on the rate that proximity sensor 28 senses teeth 26. In the preferred embodiment, data collector 57 includes memory

that receives and stores the information. Monitoring inlet and outlet pressures within cylinder chambers 39 allows operators to monitor the efficiency of reciprocating pump 12 as well as the differential pressures associated with inlet and outlet valves 41, 43. By monitoring inlet and outlet pressures within cylinder chamber 39, operators can more effectively determine the appropriate time for replacing inlet and outlet valves 41, 43.

[0025] Accelerometer 59 is supported on pump housing 13 and monitors the vibrations of reciprocating pump 12 as crankshaft 25 drives each piston 35 with piston rods 33. Typically, accelerometer 59 transmits various voltages responsive to vibrations to data collector 57 for computer 58 to calculate vibrations. Monitoring vibrations associated with reciprocating pump 12 allows operators to detect any abnormal operating conditions of reciprocating pump 12. In the preferred embodiment, the chip (not shown) in data collector 57 also receives and stores the information from accelerometer 59. In the preferred embodiment, monitoring assembly 11 includes the combined assembly of data collector 57, accelerometer 59, proximity sensor 28, wires and wire harnesses 49, 51, 55, wire harness disconnect 53, and pressure sensor assemblies 45, 46 and 47.

[0026] Figure 5 shows an example of the preferred embodiment of the pressure sensor assembly 45. In the example shown in Figure 5, pressure sensor assembly 45 is connected to one of cover plates 22 to sense discharge pressure. As will be readily appreciated by those skilled in the art, this arrangement is easily suitable for the positioning of pressure sensor assemblies 45, 46, 47 on the other various selected sidewalls of pump 12, like at pump inlet and outlets 19, 21.

[0027] Pressure sensor assembly 45 is positioned on the outer surface of cover plate 22. A port 71 extends from an interior surface of cover plate 22 toward the outer surface of cover plate 22. Port 71 is in fluid communication with the fluid pumped by one of the pistons 35. A plug member 73 preferably extends into a portion of cover plate 22. An aperture 75 extending through a portion of plug member 73 registers with port 71. In the preferred embodiment, a thread 77 formed on a portion of the outer circumference of plug member 73 that engages a counter-bored thread 79

formed in cover plate 22 for securing plug member 73 to cover plate 22. The counter-bore portion of port 71 defines an outward facing shoulder 80.

[0028] A metal seal member 81 is sealingly positioned and compressed between an end of plug member 73 and shoulder 80. A passageway 83 extends longitudinally through seal member 81 so that aperture 75 can register with port 71. In the preferred embodiment, seal member 81 has a pair of frusto-conical surfaces 85 formed at each longitudinal end for engaging plug member 73 and shoulder 80. The pair of frusto-conical ends 85 form a metal to metal seal with seal member 81 between plug member 73 and shoulder 80 when plug member is installed. A transducer 87 is located within plug member in fluid communication with aperture 75. A set of electrical prongs 89 extend from transducer 87 for connection to a plug on each wire 49. Wires 49 (Figures 1-4) communicate sensed pressure values electronically to the memory of computer 58.

[0029] In operation, pressure assemblies 45, 46, 47 are fixedly positioned adjacent various selected sidewalls of pump 12. Seal member 81 of each pressure sensor assembly 45 provides a seal against leakage of the fluid pumped by pump 12 from exiting through pressure sensor assemblies 45. Wires 49 are connected to pressure sensor assemblies 45 so that wires 49 are in electrical communication with prongs 89 extending from each transducer 87. During operation of pump 12, the fluid communicates with transducer 87 through port 71, passageway 83, and aperture 75. Transducer converts the sensed pressure to an electrical signal and communicates the signal to the memory in computer 58 via wires 49. In the preferred embodiment, accelerometer 59 and proximity sensor 28 are also communicating their sensed displacement and proximity readings to the memory in computer 58.

[0030] Computer 58 stores the sensed values from pressure sensor assemblies 45, 46, 47, accelerometer 59, and proximity sensor 28 in the computer memory. The operator can download the sensed values from the memory via a port 60. In the preferred embodiment, the operator can alternatively remove the memory with the stored values from computer 58 via drive 62, and insert a replacement memory for receiving and storing continued sensed operating conditions. This allows continuous monitoring of sensed pressure values of fluid at various positions, and at high pressures within

reciprocating pump 12 during long periods of operation rather than only during short test runs.

[0031] While the invention has been shown in only some of its forms, it should be apparent to those skilled in the art that it is not so limited, but is susceptible to various changes without departing from the scope of the invention. For example, wires 49 can extend through various sides or ends of cylinders 17 to connect with pressure transducers 45, 46, 47. Furthermore, in situations where the pump assembly is mounted to a skid or a trailer, it will be readily appreciated by those skilled in the art that equipment that is mounted to a pump or crankshaft housing (e.g. data collector 57) can easily be mounted to the skid or trailer instead of the crankshaft housing with a minimal changes and a little extra length of wiring. As a further example, while all the figures illustrate service pumps that are typically used for cementing, acidizing, or fracing, the monitoring assembly 11 could also easily be used on mud pumps for drilling operations.

WHAT IS CLAIMED IS:

1. In an oilfield reciprocating pump assembly having a pump housing that houses a crankshaft, a plurality of pistons mechanically connected to the crankshaft for pumping a fluid into a plurality of cylinder chambers, each of the cylinder chambers having a fluid inlet with an inlet valve and a fluid outlet with an outlet valve, a fluid inlet chamber upstream of the inlet valve of each of the cylinder chambers, and a discharge flange downstream of the outlet valve of each of the fluid outlets for receiving fluid from the plurality of cylinder chambers, the reciprocating pump comprising:

a monitoring housing mounted to the reciprocating pump assembly;

a computer in electrical communication with the monitoring housing, the computer having a memory; and

a plurality of cylinder chamber pressure sensor assemblies, each mounted to the pump in fluid communication with one of the cylinder chambers to sense a pressure valve of the fluid within each of the cylinder chambers of the pump.

2. The pump assembly according to claim 1, further comprising:

an intake pressure sensor assembly mounted to the fluid inlet chamber to sense the intake fluid pressure of the fluid entering the pump;

a discharge pressure sensor assembly mounted on the discharge flange for sensing discharge pressure in the discharge flange; and

a wire harness leading from the sensor assemblies to the monitoring housing to enable the computer to collect and analyze data received from the sensor assemblies to determine conditions of the valves.

3. The pump assembly according to claim 1, further comprising a proximity sensor assembly in electrical communication with the memory and positioned adjacent the crankshaft to calculate a rotational velocity of the crankshaft.

4. The pump assembly according to claim 3, wherein the crankshaft is mechanically connected to a gear assembly having a plurality of teeth, and the proximity sensor counts teeth on the gear assembly to calculate the rotational velocity of the crankshaft.
5. The pump assembly according to claim 1, further comprising an accelerometer in electrical communication with the memory and positioned on the pump housing to sense vibrations of the pump.
6. The pump assembly according to claim 1, further comprising a port extending through a sidewall of each of the cylinder chambers of the reciprocating pump;
wherein each pressure sensor assembly further comprises a plug member having an aperture that registers with one of the ports; and
a seal member positioned between the sidewall of each of the cylinder chambers of the reciprocating pump and each of the plug members.
7. The pump assembly according to claim 6, wherein each of the seal members further comprises a passageway extending longitudinally therethrough, so that the aperture registers with the port.
8. An oilfield reciprocating pump assembly, comprising:
a pump housing that houses a crankshaft for the reciprocating pump;
a plurality of piston rods extending from the pump housing, each being mechanically connected to and driven by the crankshaft, each of the piston rods having a piston portion on the end extending away from the crankshaft;
a plurality of cylinder chambers in fluid communication with the piston portion of each of the piston rods, each of the cylinder chambers receiving fluid to be pumped by the piston portion of each of the piston rods, each of the cylinder chambers having a fluid inlet with an inlet valve and a fluid outlet with an outlet valve such that a dynamic pressure within each of the cylinder chambers increases with each pressure stroke of the piston portion and decreases with each suction stroke of the piston portion;

a fluid inlet chamber upstream of the inlet valve of each of the cylinder chambers;
a discharge flange downstream of the outlet valve of each of the fluid outlets for receiving fluid from the plurality of cylinder chambers;
a plurality of ports, each extending through one of the cylinder chambers of the reciprocating pump;
a monitoring housing mounted to the reciprocating pump;
a computer in electrical communication with the monitoring housing, the computer having a memory;
a plurality of pressure transducers, each in electrical communication with the memory and mounted to one of the ports and in fluid communication with the fluid within one of the cylinder chambers to sense the dynamic pressure;
an intake pressure transducer mounted to the fluid inlet chamber to sense the intake fluid pressure of the fluid entering the pump;
a discharge pressure transducer mounted to the discharge flange for sensing discharge pressure in the discharge flange;
a plurality of electrical wires formed into a pressure transducer wire harness and leading from the pressure transducers to a wire harness disconnect;
a wire harness leading from the cylinder pressure, intake pressure and discharge pressure transducers to the monitoring housing, for providing signals to the computer so that the computer can determine a condition of the valves.

9. The pump assembly according to claim 8, further comprising an accelerometer in electrical communication with the memory and positioned on the pump housing to sense vibrations of the pump.

10. The pump assembly according to claim 8, further comprising a proximity sensor assembly in electrical communication with the memory and positioned adjacent the crankshaft to calculate a rotational velocity of the crankshaft.

11. A method of monitoring the operating conditions of an oilfield reciprocating pump assembly having a pump housing that houses a crankshaft, a plurality of pistons mechanically connected to the crankshaft for pumping a fluid through a plurality of cylinder chambers, each of the cylinder chambers having a fluid inlet with an inlet valve and a fluid outlet with an outlet valve, a fluid inlet chamber upstream of the inlet valve of each of the cylinder chambers, and a discharge flange downstream of the outlet valve of each of the fluid outlets for receiving fluid from the plurality of cylinder chambers, the method comprising:

mounting a monitoring housing to the reciprocating pump assembly;

positioning a plurality of cylinder pressure sensor assemblies in fluid communication with ports leading to each of the cylinder chambers and electrically connecting the sensor assemblies to the computer of the reciprocating pump;

positioning an intake pressure sensor assembly in fluid communication with the fluid inlet chamber and a discharge pressure sensor assembly in fluid communication with the discharge flange;

connecting a wire harness between the cylinder pressure, intake pressure and discharge pressure sensor assemblies and the monitoring housing;

operating the pump to cause a dynamic fluid pressure within each of the cylinder chambers to increase when its piston makes a pressure stroke and to decrease when its piston makes a suction stroke;

sensing the dynamic fluid pressure within each of the cylinder chambers with the cylinder pressure sensor assemblies;

sensing intake and discharge pressures with the intake and discharge pressure sensor assemblies;

electrically communicating sensed values of the dynamic fluid pressure, the intake pressure and the discharge pressure from the sensor assemblies to the monitoring housing via the wire harness; and

electrically communicating the sensed values from the monitoring housing to a computer to determine a condition of the valves.

12. A method of claim 11, further comprising:

mounting an accelerometer to the pump housing and electrically connecting the accelerometer to the monitoring housing;

operating the pump and sensing vibrations with the accelerometer; and

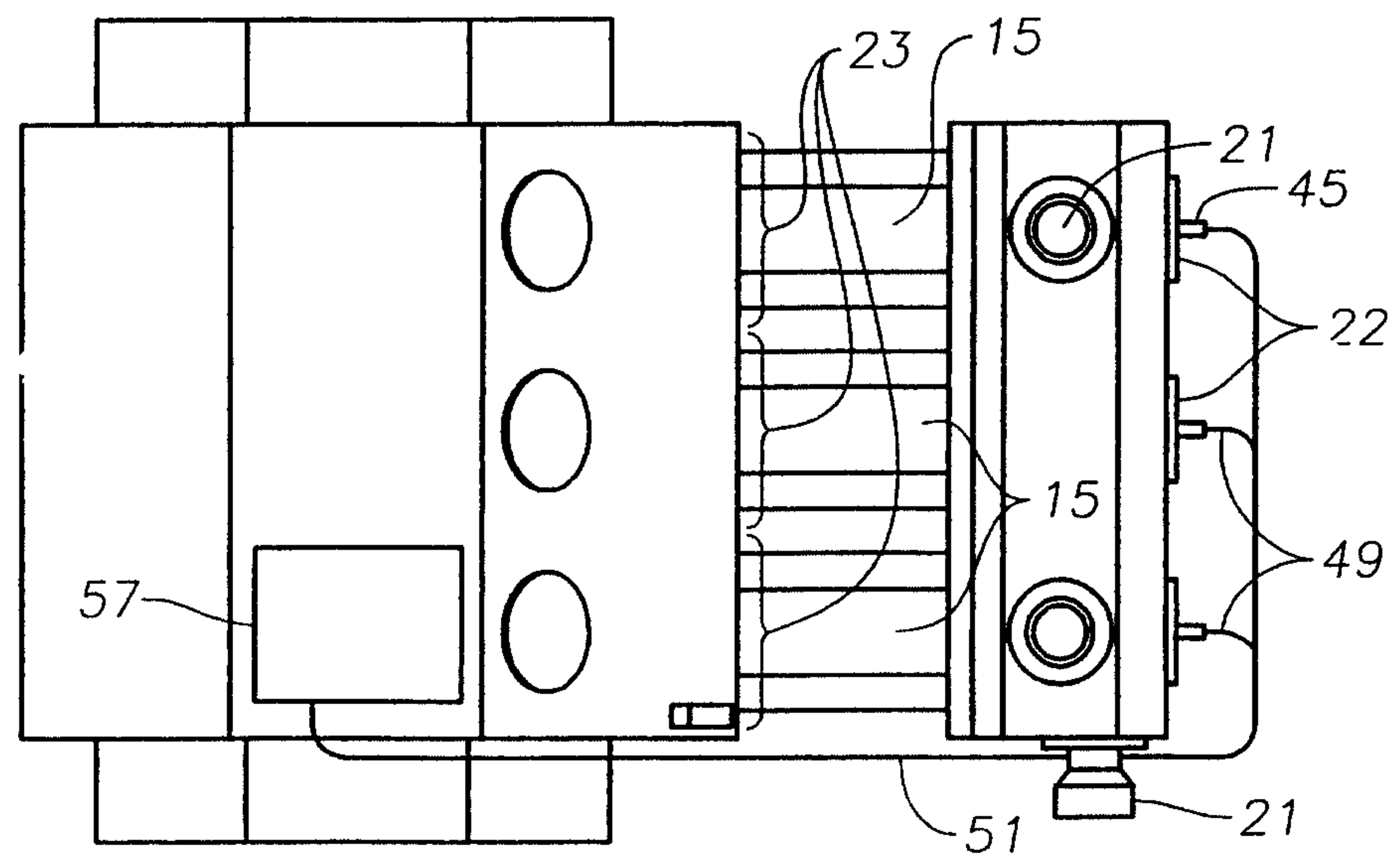
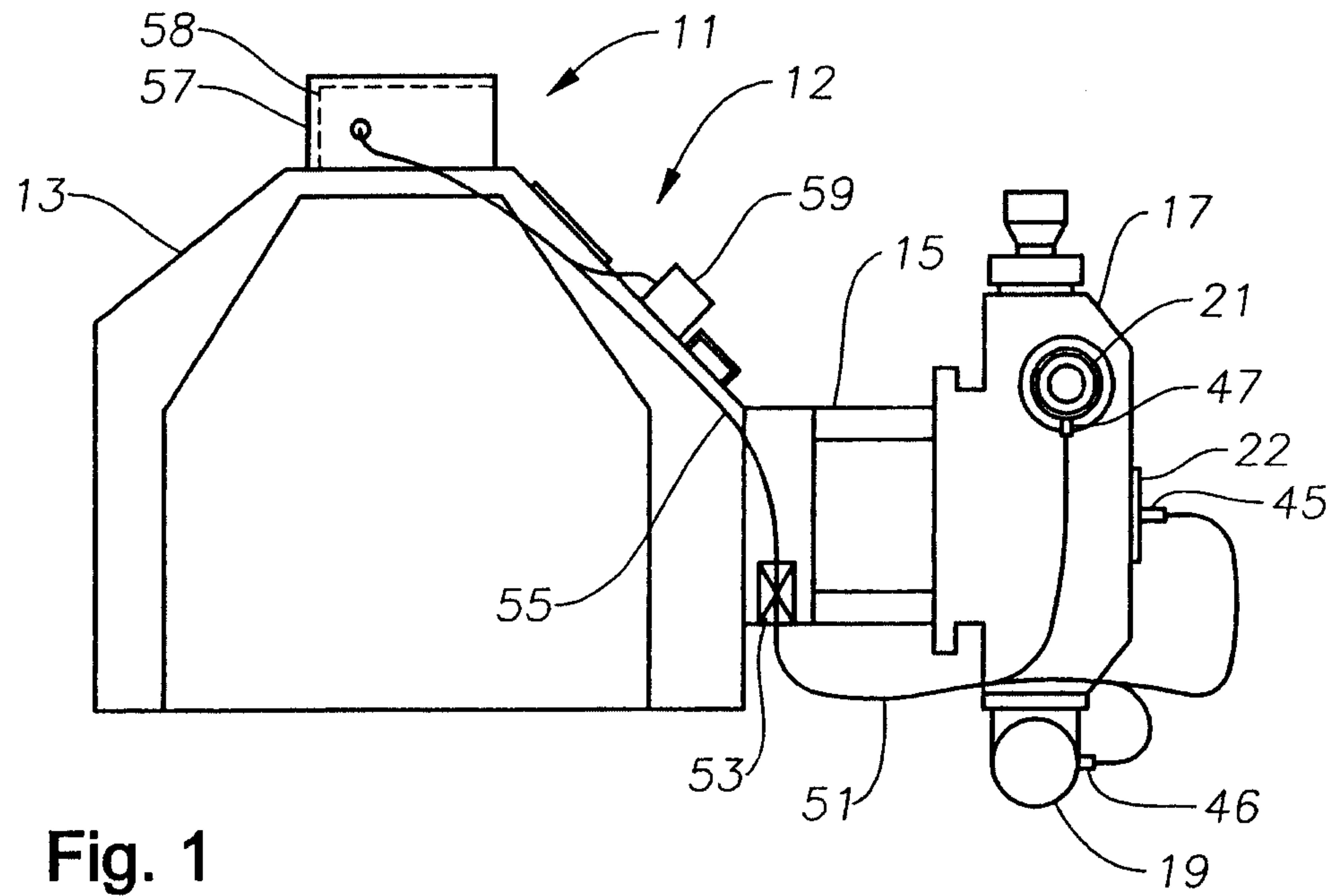
electrically communicating a sensed vibration value from the accelerometer to the monitoring housing and from there to the computer.

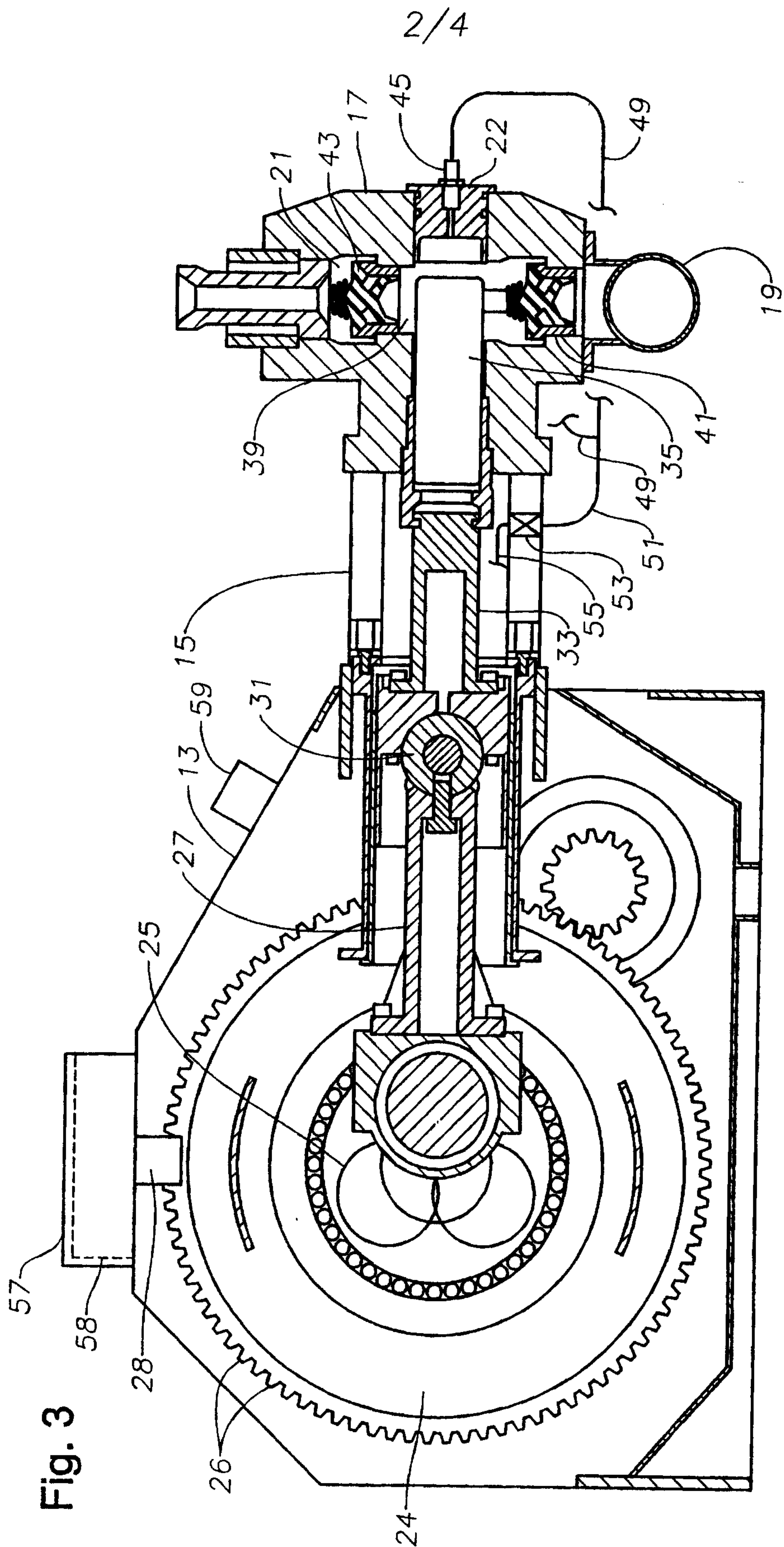
13. A method of claim 11, further comprising:

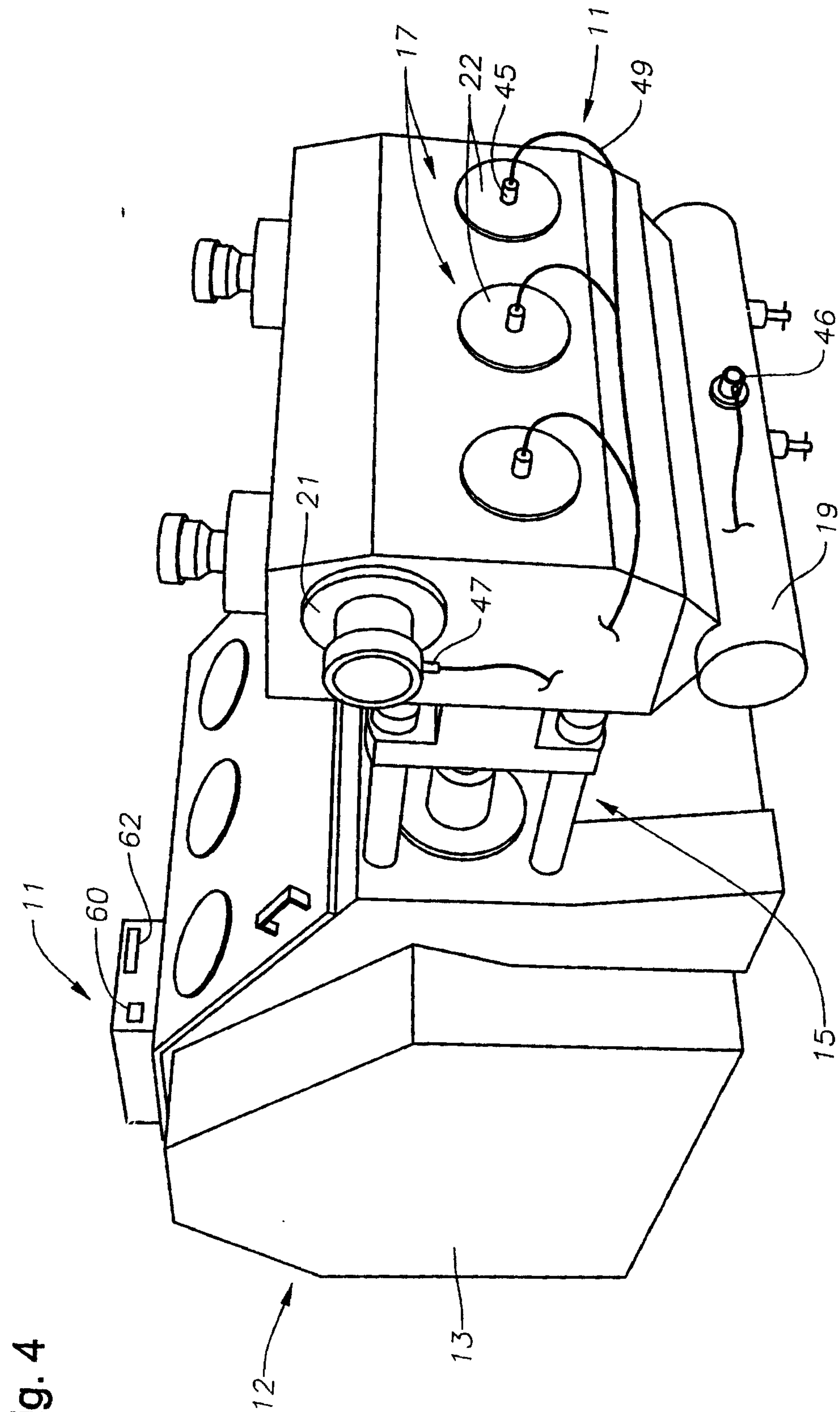
positioning a proximity sensor adjacent the crankshaft to calculate a rotational velocity of the crankshaft;

electrically communicating a counted value of sensed proximity values from the proximity sensor to the monitoring housing and from there to the computer.

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Fig. 5

