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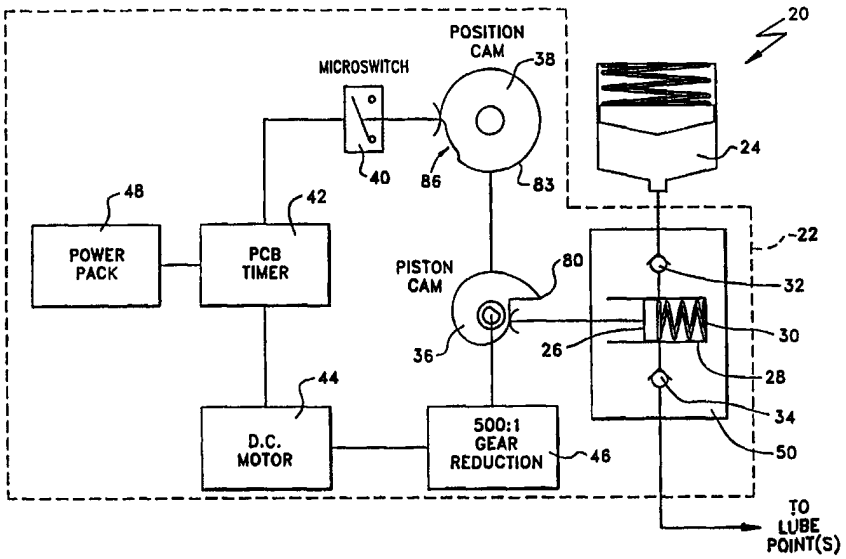

(57) Abstract

A stand–alone, self–contained automatic positive displacement lubricating pump that can generate as much as 400 psi at its output for supplying a predetermined amount of grease or oil to a lubrication point over a wide temperature range and wherein the pump includes a user–adjustable lubrication cycle.

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POSITIVE DISPLACEMENT PUMP

SPECIFICATION

FIELD OF THE INVENTION

This invention relates generally to the field of pumps, more particularly, to positive displacement pumps and associated lubrication reservoirs for lubrication.

BACKGROUND OF THE INVENTION

Conventional lubricator devices for delivering lubricant to a particular point, gas-operated or mechanically operated, do so by generating an output pressure of approximately 100-150 psi. Most of these lubricator devices operate by pushing against the entire lubricant surface of a bellows-type grease container, that is releasably secured inside the pump assembly itself, using a ratchet or jack shaft type operation or pressurized gas generators.

Some of the problems with these conventional lubricator devices is that the entire lubricant surface is being pushed against, and as such, the operator cannot determine just how much grease has been delivered; and since the grease container is disposed inside the pump assembly the operator also cannot determine when to replace the grease container. In addition, many of these conventional lubricator devices are temperature sensitive, i.e., they tend to not work properly at temperatures above and below room temperature. This complicates electronically-driven pumps where electronic timers are used-should the temperature drop and the grease become more viscous, the pump runs only for the time specified regardless of the amount of grease delivered; if the power source comprises batteries, the batteries themselves are temperature sensitive and at low temperatures may not supply the proper current to drive the pump through the timed sequence. The result is a temperature-sensitive lubricating device that delivers a varied amount of lubricant.

The following U.S. patents concern mechanically-controlled lubrication pumps. U.S. Pat. No. 2,792,911 (Harter) discloses a divisional lubricant feeder for transmitting lubricant from a central station to a plurality of lubricating devices. In particular, the device comprises a plurality of blocks of the same size but having internal cylinders of respectively different sizes to deliver respective amounts of lubricant. U.S. Patent No. 2,856,024 (Thomas) discloses a lubricant pump for use in a centralized

lubrication system. U.S. Patent No. 2,899,017 (Liljemark) discloses a lubricant pump that utilizes an external motor for driving a cam element to activate the pump. U.S. Patent No. 3,071,208 (Rasch et al.) discloses a mechanical timer for use with a lubricating device (187) on a vehicle; power to the timer and the lubricating device is provided by the vehicle's ignition switch. U.S. Pat. No. 3,461,990 (Stripp et al.) discloses a trailer lubrication system whose pump is activated when the trailer suspension is vertically displaced. U.S. Pat. No. 3,487,892 (Kiefer) discloses a pump that permits the volume of output lubricant to be varied by varying the length of the pumping element stroke and by varying the frequency of the movement of the pumping element. U.S. Pat. No. 4,006,797 (Keske) discloses a cam actuated lubrication pump that utilizes an inverted cup-shaped member having a cam follower that is reciprocally mounted on an upstanding cylindrical member, the latter of which comprises an annular piston that defines a pair of isolated and expansible first and second chambers. U.S. Pat. No. 4,113,061 (Peaster) discloses an automatic lubricator that uses service gun pressure to provide the lubrication pressure by first trapping the pressure in the device and then slowly feeding out the lubricant to the lube points. U.S. Pat. No. 4,527,965 (Markley) discloses a lubrication means for cyclically discharging lubricant into a fluid working chamber by using a rotary piston. U.S. Pat. No. 4,758,100 (Güttinger) discloses an automatic lubricant metering device that comprises a housing having an internal piston that conveys lubricant through a feeder line to a lubricating location of a revolving shaft and wherein the advance of the piston is a function of the abrasion of the pin that drives the piston. U.S. Patent No. 4,801,051 (Lewis et al.) is directed to a flow micro-adjustment assembly for use with a dispensing device (e.g., a lubricating pump). U.S. Pat. No. 4,893,697 (Tosi) discloses an injection lubricator which includes a lubricant pump having a pumping piston actuated by a pneumatic pulse to deliver a pulse of lubricant. U.S. Patent No. 5,002,156 (Gaunt) discloses a positive displacement pump that utilizes a lubricating piston that delivers one pulse of lubricant for air pulse input supplied from an air pulse source. U.S. Pat. No. 5,178,233 (Nesseth) discloses a continuous lubrication method and apparatus whereby a memory retentive material when inserted within a lubricant reservoir, compresses when initially subjected to lubricant pressure and later expands back to its original shape as lubricant seeps from the reservoir.

The following U.S. patents disclose electrically-controlled lubricating pumps. U.S. Pat. No. 4,836,334 (Vermeiren et al.) discloses a lubricating device that uses a timer for delivering a given quantity of lubricant. U.S. Pat. No. 5,402,913 (Graf) discloses an electrically-controlled lever for controlling a pump to deliver a particular quantity of lubricant; the control may comprise a source of electrical pulses with adjustable pulse duration with or without a cyclically-operated timing relay or can be any duration regulated directly or indirectly in response to the speed of an engine or the speed of a vehicle. U.S. Pat. No. 5,404,966 (Yang) discloses an automatic lubricating device that comprises a container filled with lubricant, a slidable piston fitted within a safety means, a frame welded onto the container, a gas generating means fixed onto the frame, a lubricant outlet and an electronic circuit; when the piston is at the top dead center, the space defined between the bottom of the gas generating member and the upper side of the piston is substantially smaller compared to the rate of gas generation so that prompt initiation of the lubrication is possible. U.S. Pat. No. 5,509,501 (Damme) discloses a battery-operated, electronically-driven lubricating devices. However, unlike the present invention, as is discussed below, the devices disclosed in U.S. Pat. No. 5,509,501 (Damme) do not control the flow rate of the grease since the discharge of grease is dependent upon the pressure developed by the spring.

The following U.S. patents concern lubrication reservoirs that are coupled to the point to be lubricated. U.S. Patent Nos. 2,011,616 (Clarke); 2,294,673 (Prete et al.); 2,857,020 (Otto); 2,985,256 (Simmons et al.); 3,430,731 (Satzinger); 3,498,413 (Krieger); 3,739,877 (Oliveri); 3,842,939 (Satzinger); 5,303,800 (Persson). U.S. Patent No. 5,449,050 (Persson et al.) discloses a grease cup that cooperates with a valve for dispensing lubricant.

Therefore, it is believed that a need exists for a positive displacement pump that is a stand-alone, self-contained unit that can automatically provide an output as high as 400 psi for delivering a predetermined amount of lubricant (e.g., grease or oil) from an ancillary reservoir that is directly coupable to the pump and that can operate over a wide temperature range.

OBJECTS OF THE INVENTION

Accordingly, it is the general object of this invention to provide an apparatus which addresses the aforementioned needs.

It is a further object of this invention to provide a positive displacement pump for delivering a predetermined amount of lubrication automatically.

It is yet another object of this invention to provide a positive displacement pump for delivering a predetermined amount of grease or oil.

It is still yet a further object of this invention to provide a positive displacement pump that is a stand alone, self contained unit having the ability to automatically lubricate a single point.

It is even yet a further object of this invention to provide a positive displacement pump that is a stand alone, self contained unit having the ability to automatically lubricate multiple points simultaneously.

It is even yet a further object of this invention to provide a stand alone, self contained positive displacement pump that can generate as much as 400 psi at the output.

It is even another object of this invention to provide a stand alone, self contained positive displacement pump that operates on a lube cycle whose period is adjustable by the end user.

SUMMARY OF THE INVENTION

These and other objects of this invention are achieved by providing an apparatus for automatically dispensing a predetermined amount of lubricant over a wide temperature range. The apparatus comprises a pump having an inlet port and an outlet port and further comprises a piston movable within a cylinder that is in fluid communication with the inlet port and the outlet port. The piston, cylinder, inlet port and outlet port are contained within a housing. The apparatus further comprises an ancillary lubricant reservoir coupled to the inlet port. The apparatus further comprises means, contained within the housing and coupled to the piston, for positively controlling the dispensing of the predetermined amount of lubricant from the inlet port to the outlet port. The apparatus further comprises power means, contained within

the housing, for powering the means for positively controlling the dispensing of the predetermined amount of lubricant to permit stand-alone operation of the apparatus.

These and other objects of this invention are achieved by providing a method for automatically dispensing a predetermined amount of lubricant over a wide temperature range. The method comprises the steps of: (a) providing a lubricant reservoir that is in fluid communication with a cylinder containing a piston and whereby the reservoir, cylinder and piston are located at a site; (b) automatically driving the piston in a first direction to withdraw a predetermined amount of lubricant from the reservoir through a first check valve; (c) automatically driving the piston in a second direction using positive control to dispense the predetermined amount of lubricant out of the cylinder through a second check valve; (d) repeating the steps b and c in accordance with a user-adjustable lubrication cycle; and (e) providing power means for at the site for supporting steps b-e to permit stand-alone operation of the piston.

DESCRIPTION OF THE DRAWINGS

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a block diagram of the present invention;

Fig. 2 is a side view of the present invention;

Fig. 3 is a side view of a grease lubricator reservoir showing an internal piston partially compressed;

Fig. 4 is a side view of an oil lubricator reservoir;

Fig. 5 is an isometric view of the pump assembly with the lid removed;

Fig. 6 is a cross-sectional view of the pump taken along line 6-6 of Fig. 5;

Fig. 7 is a bottom view, partially cut-a-way, of the gear reduction assembly taken along line 7-7 of Fig. 5;

Fig. 8 is top view of the pump assembly taken along line 8-8 of Fig. 5 with the pump shown in phantom;

Fig. 9 is a timing diagram of the microswitch and the DC motor; and

Fig. 10 is an electrical schematic of the PCB timer.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

Referring now in greater detail to the various figures of the drawing wherein like reference characters refer to like parts, a positive displacement pump (hereinafter "PDP") constructed in accordance with the present invention is shown generally at 20 in Fig. 1.

The PDP 20 is a self contained piston discharge pump actuated by a DC motor driven cam. In particular, the PDP 20 comprises a pump assembly 22 and a lubricant reservoir 24. The pump assembly 22 basically comprises a piston 26, an associated cylinder 28, biasing member 30, an inlet check valve 32, an outlet check valve 34, a piston cam 36, a position cam 38, a microswitch 40, a PCB (printed circuit board) timer 42, a D.C. motor 44, a gear reduction transmission assembly 46 and a power pack 48. The piston 26, cylinder, biasing member 30, input check valve 32 and output check valve 34 define the pump 50.

The lubricant reservoir 24 is a disposable, transparent, spring fed canister (LUBESITE model 404) that is filled with grease, e.g., lithium-based N.L.G.I. No. 1 grease. The reservoir 24 is releasably coupled to the pump assembly 22 at its input. The grease 56 is pushed out of the reservoir 24 by operation of a biasing means 58 and a piston 60, as well as by a partial vacuum created internally by the pump assembly 22, as will be discussed later. As can be seen more clearly in Fig. 3, the reservoir 24 comprises a threaded portion 62 (Fig. 4) that is received by a corresponding threaded inlet port 64 (Fig. 5) of the pump assembly 22.

The pump assembly 22 (Fig. 2) also comprises an outlet port 65 (which is also threaded but not shown) to which there is releasably coupled (e.g., a threaded engagement) a manifold 52. Releasably coupled to the manifold 52 are a plurality of Bijur flow control fittings; each of these fittings comprise Bijur control units (e.g., CJB-5 Bijur control units) 54A, 54B and 54C for evenly distributing the predetermined amount of grease (e.g., ½ cc) to multiple lube points (not shown) via respective tubing 55A, 55B and 55C. It should be understood that a single fitting could also be directly coupled to the pump assembly 22 output without the need for the manifold 52 if only a single lube point is to be connected to the PDP 20.

Fig. 5 shows the pump assembly 22 with its lid 66 removed once a pair of screws 68A and 68B are removed. The pump assembly 22 basically comprises a housing 69 (Figs. 2 and 5) made of high-impact ABS plastic; the pump 50 (Fig. 1) is made of a lightweight, durable material such as aluminum. The PCB timer 42 can be seen positioned in the housing 69 and includes an 8-position DIP switch 70. Discharge cycles and timing (to be discussed later) are controlled by the PCB timer 42 which is set by the end user via the DIP switch 70 for the desired discharge rates. The PCB timer 42 is supported within the housing 69 by a pair of sleeves (only one 72 of which is visible in Fig. 5); a pair of screws 74A and 74B pass through the sleeves and releasably secure the PCB timer 42 to an internal portion (not shown) of the pump housing 69.

The power pack 48 comprises four AA batteries (not shown); the battery connector 76 can be seen in Fig. 5 as well as a top portion of the power pack 48.

As shown in Fig. 6, the piston 26 is actuated by the single lobe piston cam 36 which is driven by the micro D.C. motor 44 (e.g., Douglas International, Inc. M752-F 6VDC motor or F368 6VDC motor, 3000 rpm) via a 500:1 gear reduction transmission assembly 46 (Figs. 7-8). One rotation of the piston cam 36 depresses the piston 26 to provide a ½ cc displacement of grease. The piston 26 is reset by the spring 30 located at the end of the piston 26 inside the cylinder 28. As can be seen most clearly in Fig. 8, the position cam 38 is rotatably mounted on the same shaft 78 as the piston cam 36, shown in phantom. Thus, when the piston cam 38 is rotated by the gear reduction transmission assembly 46 (Figs. 7-8), the position cam 38 is also rotated. The position cam 38 is used with the microswitch 40 to provide position input to the PCB timer 42.

Flow of grease (or, alternatively, oil as will be discussed later) is shown in Fig. 6. The grease is discharged via displacement of the internal piston 26 utilizing the inlet check valve 32 and the outlet check valve 34 to provide one way flow. In particular, when the piston 26 is permitted to retract due to the position of the piston cam 38 and the force of the spring 30, a partial vacuum is created and due to the biasing means 58/piston 60 in the lubricant reservoir 24, a predetermined amount (e.g., ½ cc) of grease pushes the ball 90 of the inlet check valve 32 away from its seat 92 against the force of a valve spring 94. This predetermined amount of grease then

makes it way into the cylinder 28 in the direction of the arrows 96, at which time the inlet check valve closes 32 (i.e., the ball 90 is returned to its seat 92). When the piston cam 36 drives the piston 26 (as will be discussed below) against the force of the spring 30, the predetermined amount of grease is pushed out of the cylinder 28 and pushes the ball 98 of the outlet check valve 34 away from its seat 100 against the force of a valve spring 103, thereby dispensing the predetermined amount of grease, in the direction of the arrows 102, to the particular lube point(s). Thus, the inlet check valve 32 prevents any back flow of the entered grease into the reservoir 24 during piston 26 compression and the outlet check valve 34 prevents any back flow of the dispensed grease during piston 26 extension. It should be noted that both the inlet check valve 32 and the outlet check valve 34 are both shown closed in Fig. 6; however, one skilled in the art would understand their alternating operation.

Operation of the PDP 20 is set forth below in accordance with Figs. 6-9. It is also assumed that the PDP 20 has already been primed, as will be discussed later. At the beginning of a lube cycle, the PCB timer 42 energizes the DC motor 44, causing the gear reduction transmission assembly 46 to rotate in the directions shown in Fig. 7; the gear reduction transmission assembly 46 reduces the 3000 rpm output of the D.C. motor 44 such that the shaft 78 causes the piston cam 36 (shown in phantom) to begin rotating at about 5 rpm, as well as the position cam 38, in the direction shown by the arrow 79.

As can be seen most clearly in Fig. 8, as the rotation of the shaft 78 continues, the tip 80 of the piston cam 36 sweeps against the piston 26 while a rider wheel 82 of the microswitch 40 rides along the periphery 83 of the position cam 38; when the rider wheel 82 rides along the periphery 83 of the position cam 38, the microswitch 40 is in an open condition. When the tip 80 arrives at the center point 84 of the piston 36, thereby defining the point at which the piston cam 36 has fully depressed the piston 26, the rider wheel 82 is just about to enter a depression 86 in the periphery of the position cam 38. As the shaft 78 continues to rotate, the rider wheel 82 enters the depression 86, thereby closing the microswitch 40; the microswitch 40 remains closed until the rider wheel 82 leaves the depression 86 and again returns to the periphery 83 of the position cam 38.

This closure of the microswitch 40 signals the PCB timer 42 to de-energize the motor 44 for 5 minutes. This results in the piston 36 being held in the fully depressed position, against the spring 30, for 5 minutes. This dwell time of 5 minutes helps to maintain the maximum pressure and ensure that the appropriate volume of lubricant is dispensed through the outlet check valve 34. After this time has expired, the motor 44 is again energized and the shaft 78 begins rotating again, with the tip 80 finishing its sweep across the piston 26 in the direction of the arrow 79 shown in Fig. 8. When the piston cam tip 80 is just about to disengage from the piston 26, and thereby returning to a reset position, the rider wheel 82 begins to ride out of the depression 86 and returns to the periphery 83, thereby opening the microswitch 40. This opening of the microswitch 40 signals the PCB timer 42 to de-energize the motor 44. At this point, the PDP 20 remains idle for the remainder of the selected lube cycle frequency time which is set by the end user via the DIP switch 70. Fig. 9 is a timing diagram of the microswitch 40 and the motor 44 operation.

The following defines the particular operation of the PDP 20 based on the DIP switch 70 settings; references to Switches 1-8 (SW#) and the ON/OFF condition are depicted in the timer electrical schematic of Fig. 10.

1. At Power on (SW1 to the ON position) the PCB timer 42 must operate the motor 44 until a microswitch 40 closure. Then the motor 44 is turned off.

2. The PCB timer 42 then waits 5 minutes, then runs the motor 44 until the microswitch 40 is opened. Once the microswitch 40 is opened, the PCB timer 42 shuts off the motor 44.

3. The motor 44 remains off until the "Off Time" (i.e., the remaining part of the lube cycle-see Fig. 9) is completed.

4. Once the "Off Time" is completed, the PCB timer 42 begins another lube cycle. As can be seen in Fig. 9, the lube cycle consists of operating the motor 44 until a microswitch 40 closure. The motor 44 is then turned off. The PCB timer 42 waits 5 minutes then turns the motor 44 on until the microswitch 44 opens. Once the microswitch 40 opens, the PCB timer 42 turns off the motor 44 and the motor 44 remains off until the "Off Time" is complete. Thus, the "Off Time" should work as a frequency setting. In addition, operation of the lube cycle should occur at the time

selected. For example, if SW7 is in the ON position, then the PDP 20 performs a lube cycle every 6 hours, not 6 hours, 5 minutes.

5. The switch settings must be cumulative (i.e., add to create a total time), for example: if SW7 (6 hours) and SW3 (18 hours) are both in the ON position, then the "Off Time" selected is 24 hours.

6. Priming: When SW2 is in the ON position, the motor 44 must run continuously. When SW2 is moved to the OFF position, the motor 44 stops. Next, SW1 should be moved to the OFF position and then moved back to the ON position. Proper operation of this sequence is important because it insures that the piston 26 of the PDP 20 is in the correct position to begin a lube cycle when the "Off Time" is completed.

As set forth below in Table 1, depending on what lube cycle frequency is selected, the need to replace the reservoir 24 is also provided.

It should be understood that before a lube cycle is established by the end user, it is necessary to prime the PDP 20. In particular, the end user turns SW1 ON; next, SW2 is turned ON and the PDP 20 begins a continuous run. Once grease 56 is emitted from the outlet port 65, the end user turns SW2 OFF and then can select the appropriate switches SW3-8 for the desired lube cycle.

Table 1: DIP Switch Settings

Switch (SW#)	Lube Cycle Frequency "Off Time"	Reservoir Replacement Period
8	3 hours	1 month
7	6 hours	2 months
6	9 hours	3 months
5	12 hours	4 months
4	15 hours	5 months
3	18 hours	6 months
2	Continuous Run (Motor On)	
1	Power On/Off	

As shown in Fig. 10, the PCB timer 42 comprises the 8-position DIP switch 70, surface mount type, and a single sided circuit board 88 containing the necessary timing circuitry with all components being surface mount types; thus, the PCB timer 42 resides on the circuit board 88. As can be seen in Fig. 10, power to the D.C. motor 44 is controlled through the PCB timer 44 by turning ON/OFF the transistor Q1. The D.C. motor 44, the power pack 48 and the microswitch 40 are electrically coupled to the printed circuit board 88 (e.g., via pads 89, only three of which are depicted in Fig. 5). The PCB timer 44 has a 0 to 70 °C operating temperature and 95% relative humidity without condensation operation.

Alternatively, when oil is the lubricant being dispensed, a transparent, disposable canister 104 (LUBESITE model G-5) containing an end-user provided oil (e.g., 150-8000 ssu viscosity) is used. As shown in Fig. 4, the oil reservoir 104 comprises a spring-loaded lid 106 for permitting an oil source (not shown) to fill the reservoir 104. The oil reservoir 104 also comprises a threaded portion 108 for coupling to the threaded inlet port 64 of the pump assembly 22.

Operation of the PDP 20 using the oil reservoir 104 coupled thereto is similar to the operation of the PDP 20 previously described when the grease reservoir 24 is used. However, it should be noted that when the oil reservoir 104 is used, the flow control fittings that are coupled to the outlet port 65 are Bijur meter units (e.g., Bijur FJB meter units, rather than the Bijur control units 54A-54C discussed above) for proportioning the proper amount of oil to the various lube points. A more detailed discussion of both types of flow control fittings are discussed in a Bijur publication, "The Characteristics and Application of Single Line Resistance Type Systems" which is incorporated by reference herein.

The PDP 20, as described above, provides for the generation of a maximum output pressure of approximately 400 psi at the outlet port 65.

The following table is a summary of exemplary components of the PDP 20 and are not limited to those listed.

Table 2

GREASE LUBRICANT	N.L.G.I. No. 1 lithium grease
CANISTER 404 CAPACITY	4 oz. Per 404 Cartridge
OIL LUBRICANT	150-8000 ssu viscosity oil
CANISTER G-5	5 oz. Per G-5 cartridge
PDP DISCHARGE SETTINGS	1-18 months, 1 month increments
MAX. DISCHARGE PRESSURE	400 psi
POWER SUPPLY	4 AA batteries
BATTERY LIFE	Change when changing grease canister
DIP SWITCH	Grayhill 90HBW085 (8 position SMT DIP switch with tape seal)
MICROSWITCH	any miniature or subminiature microswitch rated for low current (e.g., a low μA), low voltage, "dry circuit" operation, gold contacts
MOTOR	Douglas International, Inc. M752-F 6VDC Motor or F368 6VDC Motor, 3000 rpm

It should be understood that the piston cam 36, the position cam 38, the microswitch 40, the PCB timer 42, the D.C. motor 44 and the gear reduction transmission assembly 46 form a positive control means for the flow rate of lubricant dispensing, i.e., there is a positive control of the lubricant being dispensed. This is in contradistinction to the devices disclosed in U.S. Patent No. 5,509,501 (Damme) where dispensing of the lubricant is determined by the characteristics of the spring that drives its associated piston.

Without further elaboration, the foregoing will so fully illustrate my invention that others may, by applying current or future knowledge, readily adopt the same for use under various conditions of service.

CLAIMS

1. An apparatus for automatically dispensing a predetermined amount of lubricant over a wide temperature range, said apparatus comprising:

a pump having an inlet port and an outlet port and further comprising a piston movable within a cylinder that is in fluid communication with said inlet port and said outlet port, said piston, cylinder, inlet port and outlet port being contained within a housing;

an ancillary lubricant reservoir coupled to said inlet port;

means, contained within said housing and coupled to said piston, for positively controlling the dispensing of the predetermined amount of lubricant from said inlet port to said outlet port; and

power means, contained within said housing, for powering said means for positively controlling the dispensing of the predetermined amount of lubricant to permit stand-alone operation of said apparatus.

2. The apparatus of Claim 1 wherein said means for positively controlling the dispensing of the predetermined amount of lubricant comprises a motor mounted within said housing for rotating a cam that controls said piston.

3. The apparatus of Claim 2 wherein said means for positively controlling the dispensing of the predetermined amount of lubricant further comprises a user-adjustable timer also mounted within said housing and coupled to said motor for activating and deactivating said motor to deliver the predetermined amount of lubricant to said outlet port in accordance with a user-adjustable lubrication cycle.

4. The apparatus of Claim 3 wherein said means for positively controlling the dispensing of the predetermined amount of lubricant further comprises a sensor for detecting the position of said cam that controls said piston and for providing a signal representative of the position to said timer.

5. The apparatus of Claim 1 wherein said power means comprises a power pack for supplying power to said means for positively controlling the dispensing of the predetermined amount of lubricant.

6. The apparatus of Claim 3 wherein said power pack supplies power to said motor and said timer.

7. The apparatus of Claim 1 wherein said lubricant is grease.

8. The apparatus of Claim 1 wherein said lubricant is oil.

9. The apparatus of Claim 1 wherein said outlet port is coupled to a plurality fittings
for supplying said predetermined amount of lubricant to a plurality of lubrication points simultaneously.

10. The apparatus of Claim 2 wherein said apparatus further comprises a gear reduction assembly coupled between said motor and said cam.

11. The apparatus of Claim 4 wherein the length of said user-adjustable lubrication cycle is selected by the user.

12. The apparatus of Claim 11 wherein said lubrication cycle comprises:

a first predetermined time period of motor activation by said timer for dispensing said predetermined amount of lubricant;

a second predetermined time period of motor deactivation by said timer for maintaining said piston in a fully depressed position;

a third predetermined time period of motor re-activation by said timer for resetting said sensor; and

a fourth time period of motor deactivation by said timer in accordance with the user-selected length of said lubrication cycle.

13. The apparatus of Claim 1 wherein said pump can generate as much as 400 psi at said outlet port.

14. A method for automatically dispensing a predetermined amount of lubricant over a wide temperature range, said method comprising the steps of:

(a) providing a lubricant reservoir that is in fluid communication with a cylinder containing a piston, said reservoir, cylinder and piston being located at a site;

(b) automatically driving said piston in a first direction to withdraw a predetermined amount of lubricant from said reservoir through a first check valve;

(c) automatically driving said piston in a second direction using positive control to dispense said predetermined amount of lubricant out of said cylinder through a second check valve;

(d) repeating said steps b and c in accordance with a user-adjustable lubrication cycle; and

(e) providing power means at the site for supporting steps b-e to permit stand-alone operation of said piston.

15. The method of Claim 14 wherein the length of said user-adjustable lubrication cycle is selected by the user.

16. The method of Claim 15 wherein said user-adjustable lubrication cycle is defined as:

(a) driving said piston in said second direction for a first predetermined time period to a fully depressed position to dispense the predetermined amount of lubricant through said second check valve;

(b) maintaining said piston in said fully depressed position for a second predetermined period of time;

(c) driving said piston in said first direction to a retracted position for withdrawing said predetermined amount of lubricant from said reservoir through said first check valve; and

(d) maintaining said piston in said retracted position for the remaining portion of said length of said user-adjustable lubrication cycle.

17. The method of Claim 16 wherein said second check valve comprises an outlet and wherein said method further comprises the step of coupling a plurality of lubrication points to said outlet for supplying the predetermined amount of lubricant to a plurality of lubrication points simultaneously.

18. The method of Claim 14 wherein said piston dispenses the predetermined amount of lubricant with as much as 400 psi of pressure out of said second check valve.

19. The method of Claim 14 wherein said lubricant is grease.

20. The method of Claim 14 wherein said lubricant is oil.

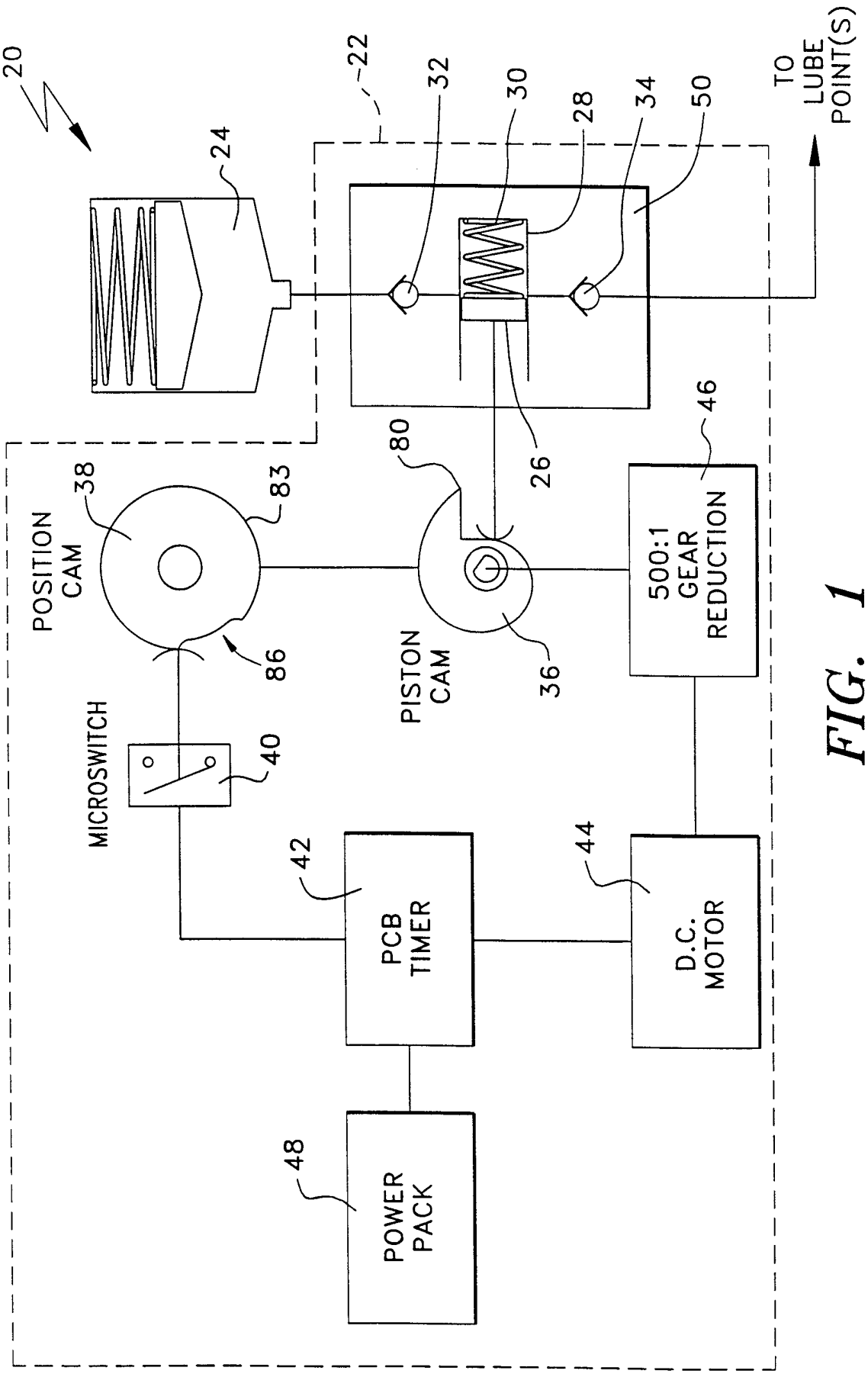
20
22
24
32
30
28
34
50
TO LUBE POINT(S)
26
80
46
38
83
POSITION CAM
500:1 GEAR REDUCTION
86
PISTON CAM
36
MICROSWITCH
40
42
PCB TIMER
44
D.C. MOTOR
48
POWER PACK

FIG. 1

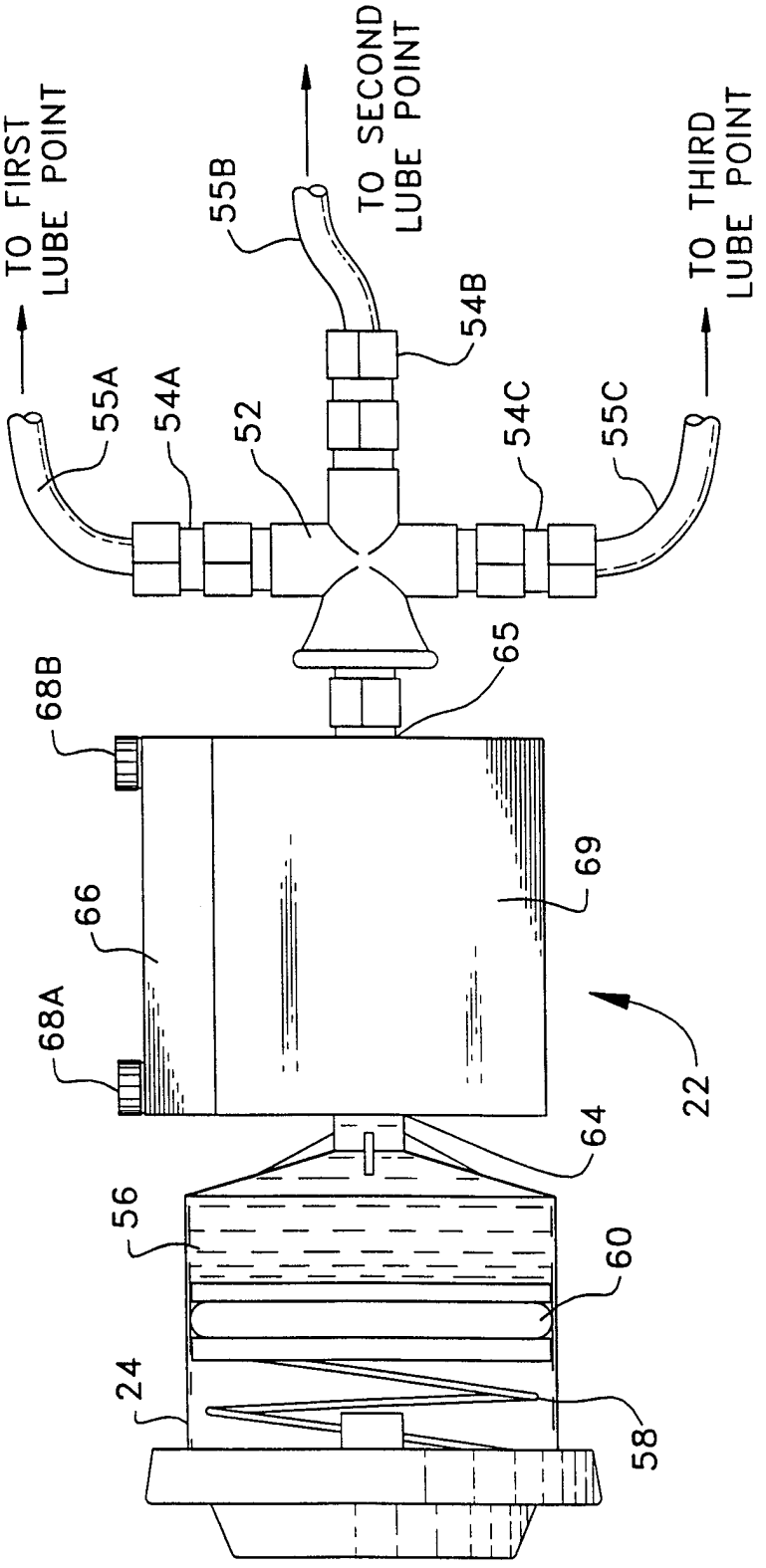
TO FIRST LUBE POINT
TO SECOND LUBE POINT
TO THIRD LUBE POINT
55B
54B
55A
54A
52
54C
55C
65
68B
66
69
68A
22
64
56
60
24
58

FIG. 2

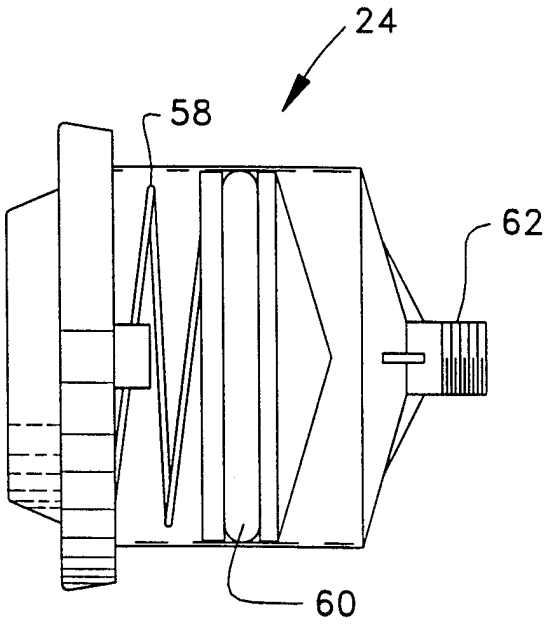

FIG. 3

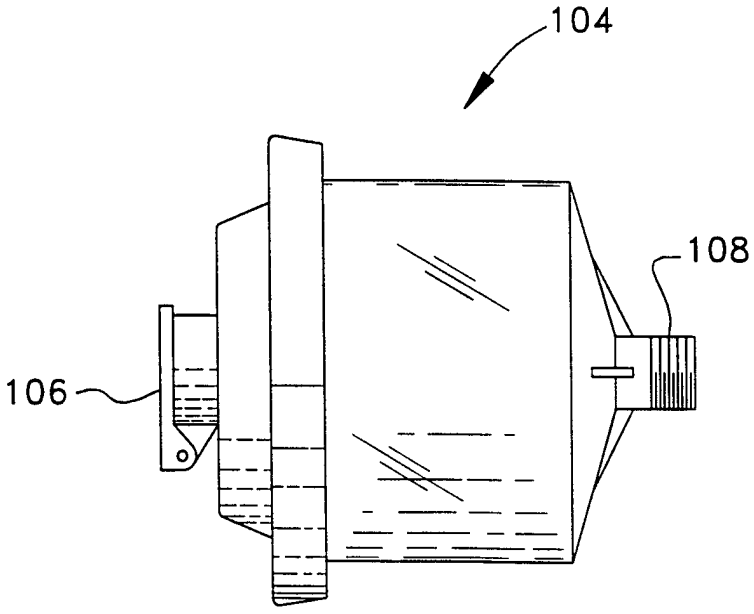

FIG. 4

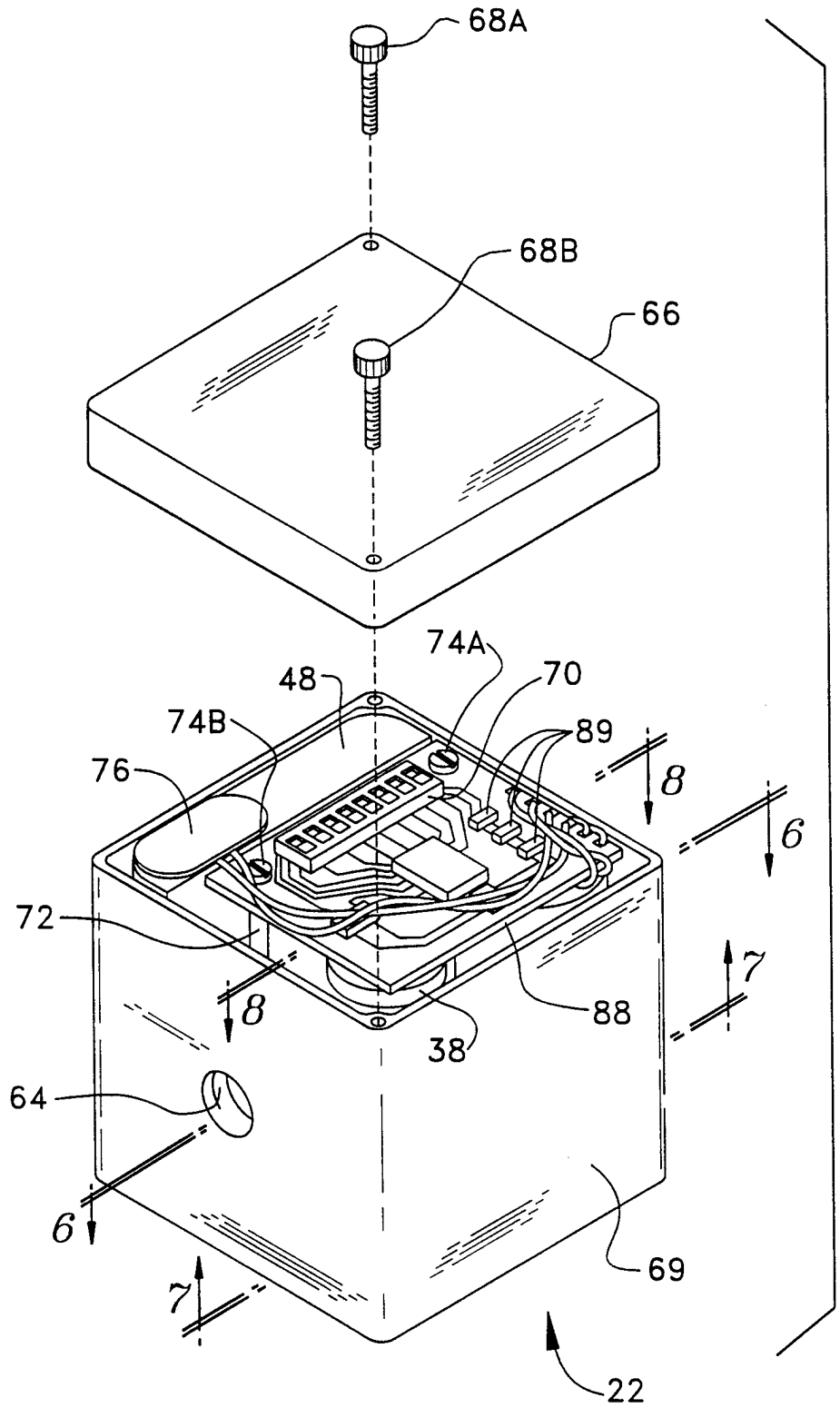

FIG. 5

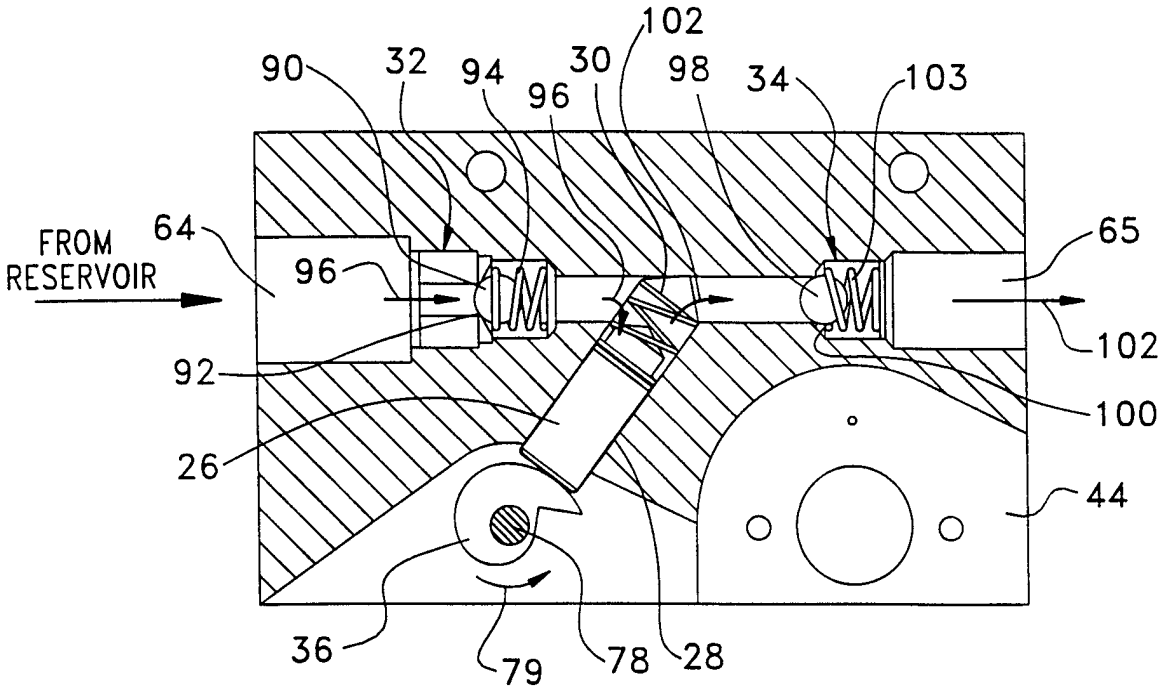
102
90
32
94
30
98
34
103
96
FROM RESERVOIR
64
96
65
92
102
100
26
44
36
79
78
28

FIG. 6

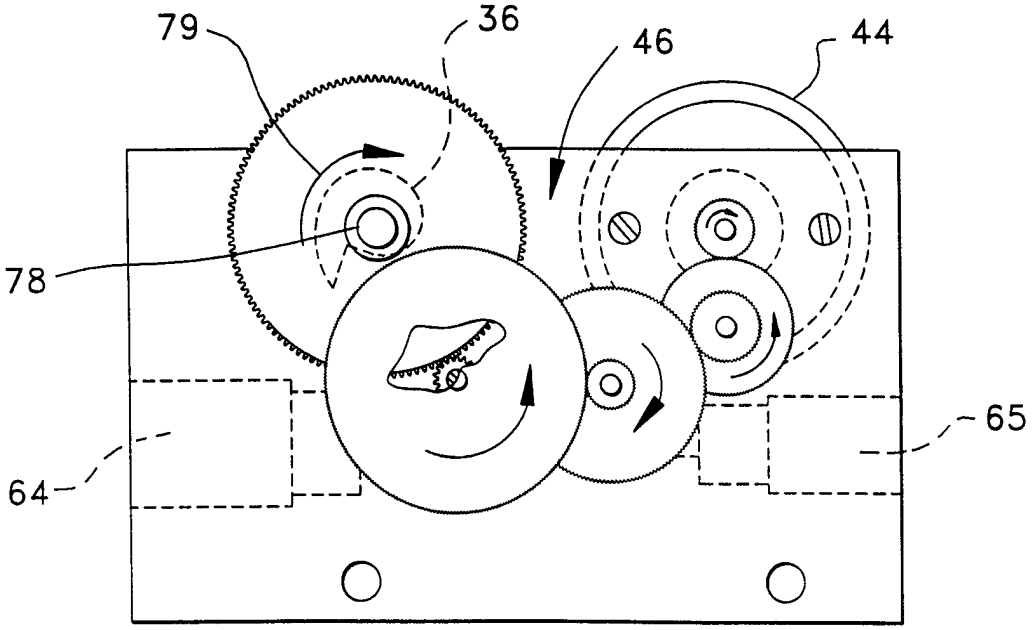

FIG. 7

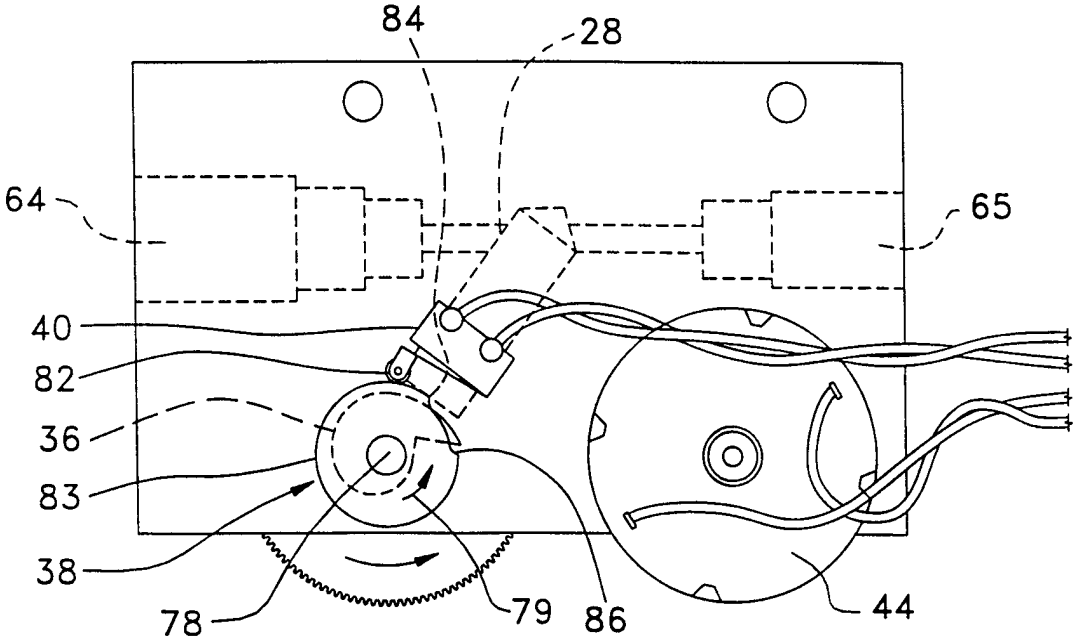

FIG. 8

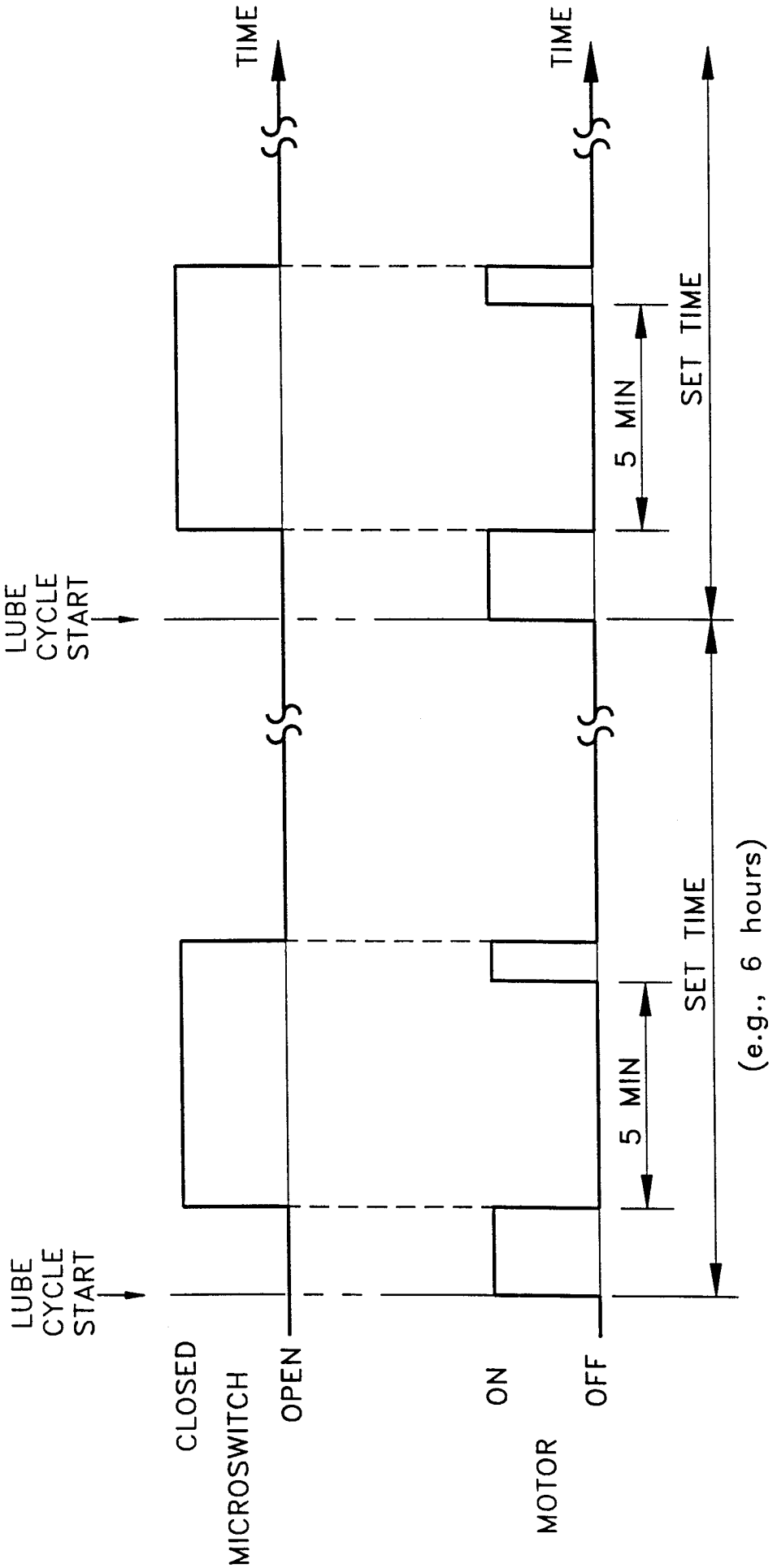
TIME
TIME
LUBE CYCLE START
LUBE CYCLE START
5 MIN
SET TIME
5 MIN
SET TIME
(e.g., 6 hours)
CLOSED
MICROSWITCH
OPEN
ON
MOTOR
OFF

FIG. 9

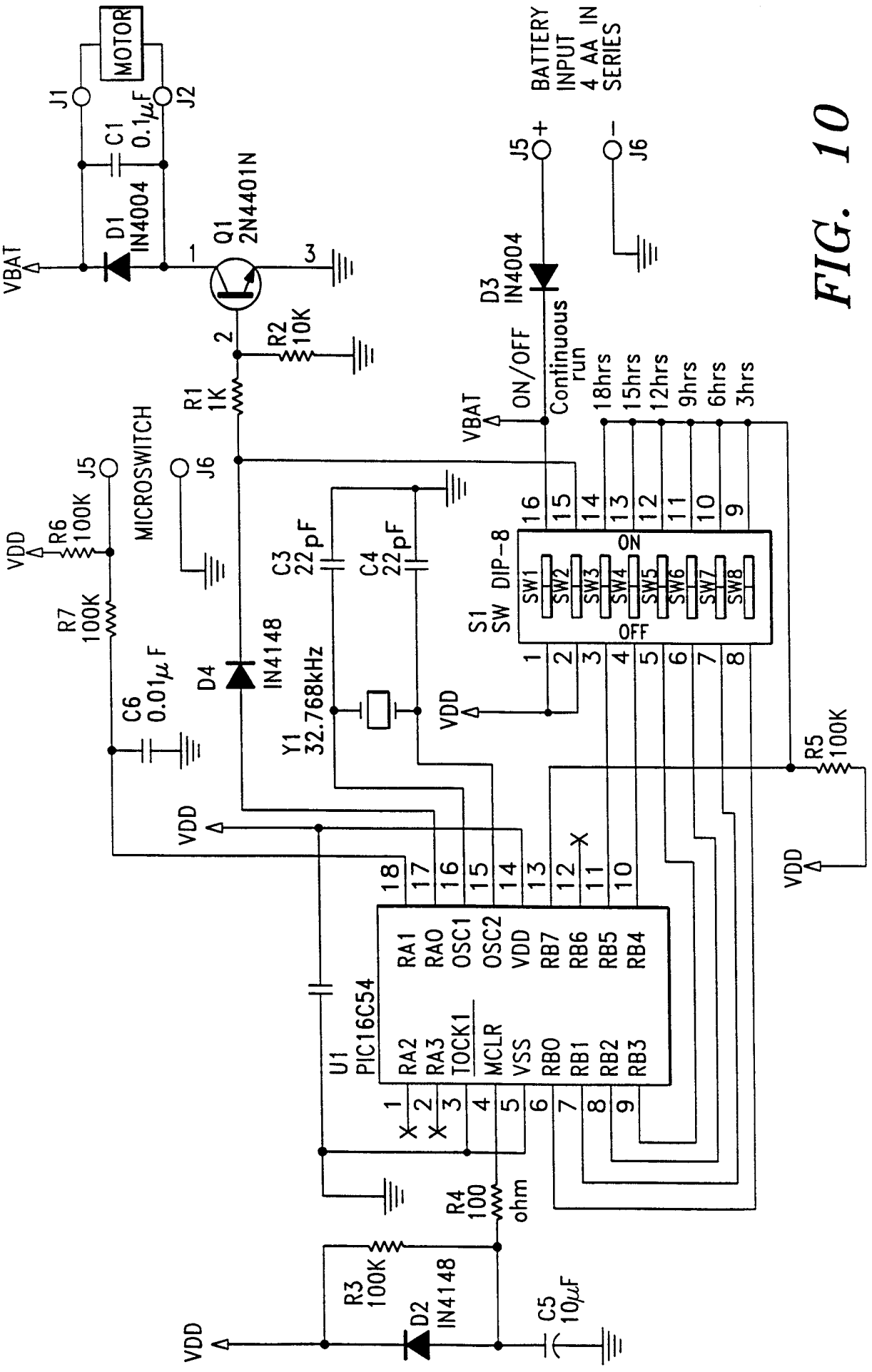
MOTOR
J1
J2
C1
0.1μF
D1
IN4004
Q1
2N4401N
VBAT
R2
10K
R1
1K
MICROSWITCH
J5
J6
R6
100K
R7
100K
C6
0.01μF
D4
IN4148
C3
22pF
C4
22pF
Y1
32.768kHz
VDD
BATTERY
INPUT
4 AA IN
SERIES
J5
+
J6
−
D3
IN4004
ON/OFF
Continuous
run
18hrs
15hrs
12hrs
9hrs
6hrs
3hrs
S1
SW DIP-8
ON
OFF
SW1
SW2
SW3
SW4
SW5
SW6
SW7
SW8
R5
100K
U1
PIC16C54
RA1
RA0
OSC1
OSC2
VDD
RB7
RB6
RB5
RB4
RA2
RA3
TOCK1
MCLR
VSS
RB0
RB1
RB2
RB3
R4
100
ohm
R3
100K
D2
IN4148
C5
10μF

FIG. 10

INTERNATIONAL SEARCH REPORT

Ir ational Application No
PCT/US 98/02931

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F16N13/14 F16N13/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F16N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 271 528 A (CHIEN HUI-MEI) 21 December 1993 see column 2, line 27 - column 4, line 21; figures ---	1-8,10, 11,14, 15,18-20
Y	US 2 873 003 A (MEINELT) 10 February 1959 see column 2, line 3 - column 4, line 45; figures ---	1-8,10, 11,14, 15,18-20
A	WO 93 23698 A (DAMME ERIC VAN) 25 November 1993 see page 9, line 36 - page 30, line 34; figures --- -/--	1

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 May 1998	10/06/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Mouton, J

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PCT/US 98/02931

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 182 862 A (DEAKIN) 11 May 1965 see figures	1
A	FR 1 054 880 A (AUTO RESEARCH CORPORATON) 15 February 1954 see page 1, column 1, line 10 - line 17 see page 2, column 2, line 2 - page 5, column 2, line 29; figures	1
A	FR 1 203 061 A (CRAF) 15 January 1960 see the whole document	1
A	US 1 767 515 A (DAVIS) 24 June 1930 see the whole document	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

In tional Application No
PCT/US 98/02931

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		AU 4065793 A	13-12-1993
		DE 59306124 D	15-05-1997
		EP 0640196 A	01-03-1995
		ES 2102647 T	01-08-1997
		JP 8500416 T	16-01-1996
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US 1767515 A	24-06-1930	NONE	