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[54] **PNEUMATIC PULSE COUNTING DEVICE**

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[51] **Int. Cl.** **F02n 7/00,** F02n 9/00

[58] **Field of Search** ..... 123/179 R, 179 F; 60/17, 60/16, 16 B, 39.14; 137/596, 596.2

[56] **References Cited**

UNITED STATES PATENTS

2,580,368	12/1951	Stevens et al.	60/16 X
2,580,369	12/1951	Stevens	60/16 X
2,640,312	6/1953	Miller	60/16
3,104,659	9/1963	Smith	123/179 F
3,282,259	11/1966	Moor	123/179 R X
3,307,349	3/1967	Brelen	123/179 F X
3,504,946	4/1970	Valentine et al.	137/596.2 X

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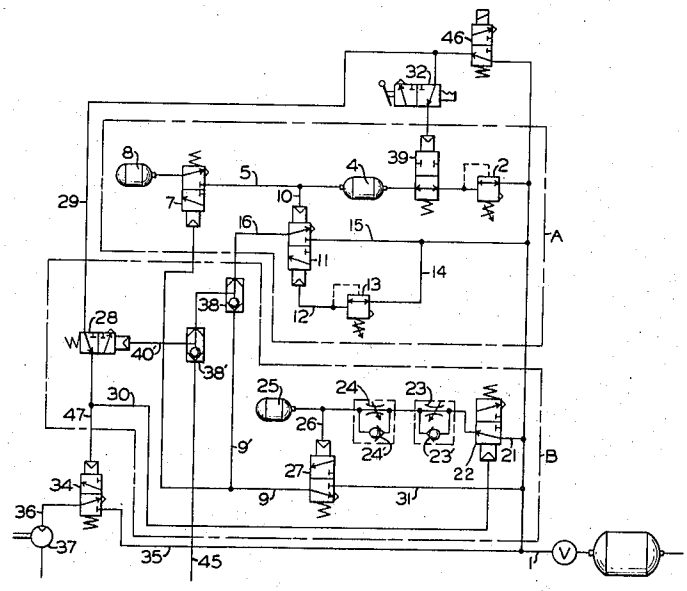
[57] **ABSTRACT**

This invention is concerned with a fluid pressure type pulse counting device. To start an internal combustion marine engine, a starting device is actuated by a repeated supply of compressed air, but this repeated actuation process cannot be carried out unlimitedly. When the engine fails to start after a certain number of actuation processes, the actuation process is discontinued temporarily and the engine is examined. Therefore, it will be of extreme convenience, if a pulse counting device can be installed in the starting device mentioned above to count the number of actuation processes performed.

20 Claims, 3 Drawing Figures



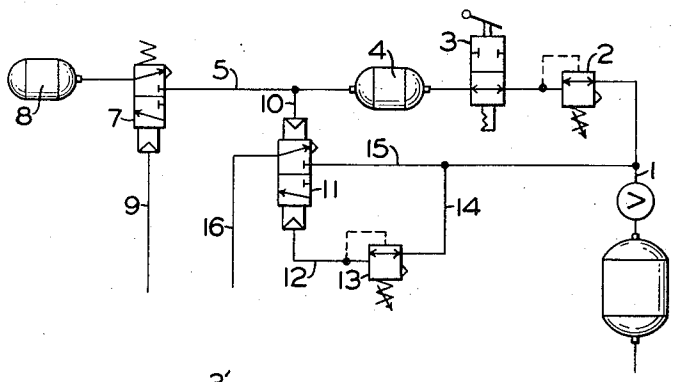


Fig. 1

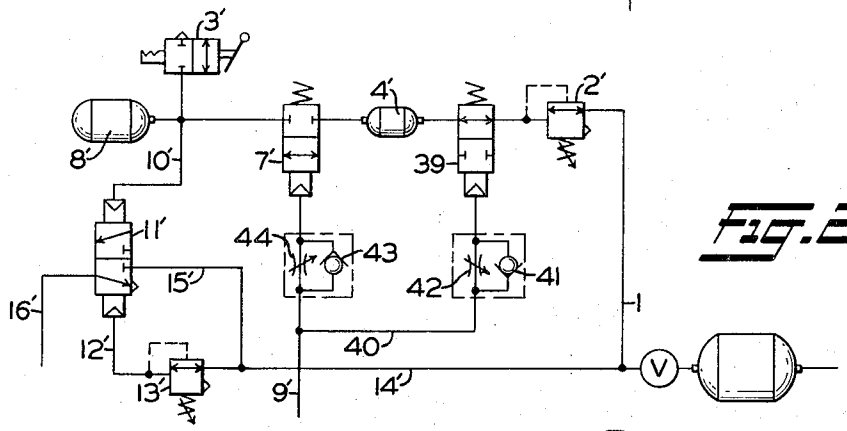


Fig. 2

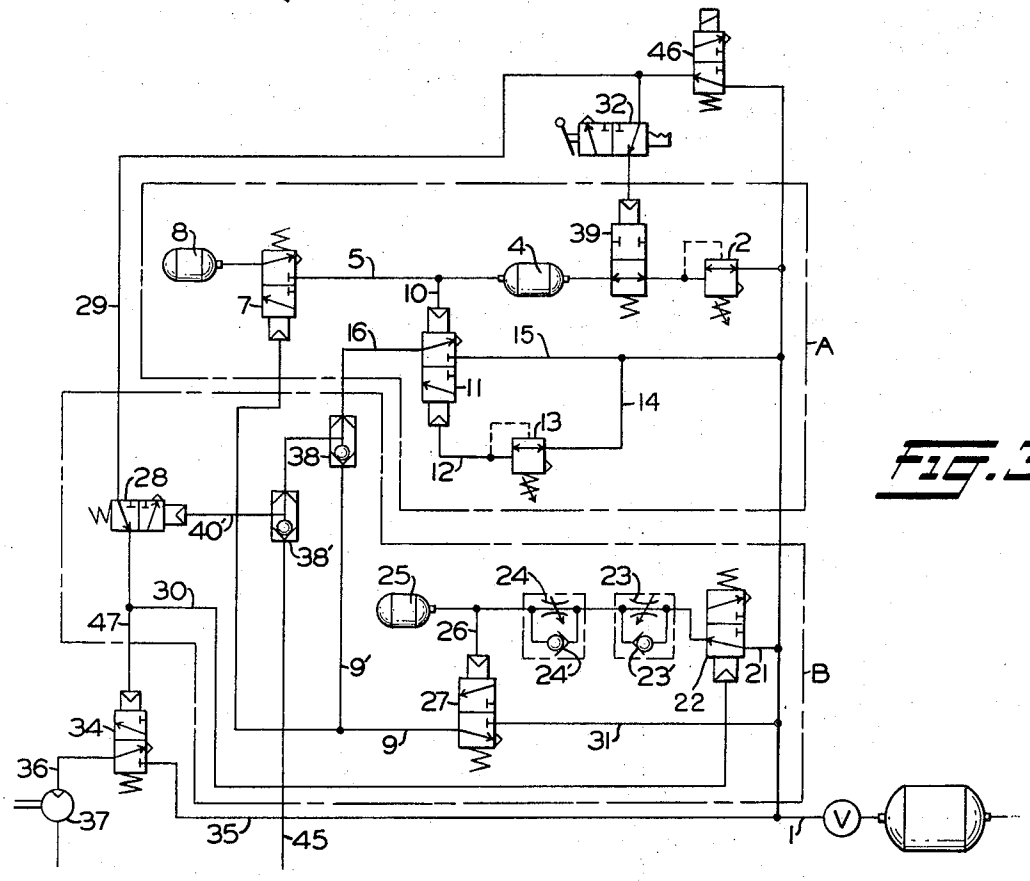


Fig. 3

PNEUMATIC PULSE COUNTING DEVICE

BACKGROUND OF THE INVENTION

An electric type counter has been used frequently for counting pulse but it is not suitable to be used in the place where electric spark may cause fire hazard, such as in a tanker. Also, it cannot be used in an emergency engine which should be actuated during an electric failure. Various pneumatic type counting devices are also used but their structures are usually complicated and are not practical.

SUMMARY OF THE INVENTION

In the invented device, the pressure inside a fluid tank is successively decreased or increased at each pulse actuation process to count the pulse. When the pressure corresponding to a predetermined pulse number is reached, a signal is dispatched. The circuit of this device is very simple and various shortcomings of the conventional controlling devices mentioned above can be overcome. Any pulse number which will determine the dispatching of a signal can be varied.

Actual examples will be used to explain this invention.

FIG. 1 shows the first example. 1 is a pipe connected to a compressed fluid source containing, such as, compressed air in a storage reservoir. It is also connected to the pressurized fluid reservoir or tank 4 through the pressure adjustment valve or feed valve device 2 set to deliver a constant chosen pressure and the manually operable switching valve 3. The pipe 5 from the fluid tank 4 is connected to the other fluid tank 8 through the return spring type switching valve 7. 9 is a pilot pipe of the switching valve 7 and is used to transmit the fluid pressure pulse produced at a pulse producing device (not shown). Another pipe 10 from the fluid tank 4 mentioned above also forms one of the pilot pipes of the pilot type switching valve 11. The other pilot pipe 12 is connected to the pipe 1 mentioned above through the pressure adjustment valve or feed valve device 13 and the pipe 14. Feed valve device 13 is set to deliver a constant pressure that is less than that delivered by feed valve device 2. The pipe 15 branching out from the pipe 14 is connected to the input port of the switching valve 11 mentioned above and the output port is connected to the pipe 16 used to dispatch signals.

FIG. 2 shows another example of this invention. This example is somewhat different from the one shown in the FIG. 1. In this example, the fluid pressure operated pilot type switching valve 39 instead of the switching valve 3 used previously is installed between the pressure adjustment valve or feed valve device 2′ and the fluid tank or reservoir 4′. The pilot pipe of the switching valve 39 is connected to the pulse transmitting pipe 9′ through the pipe 40 and the flow adjustment choke 42. The flow adjustment choke 42 is equipped with the check valve 41 which will allow fluid to flow in the direction toward the switching valve 39 but will prevent fluid from flowing in the opposite direction. The pipe 9′ is connected to the pilot part of the switching valve 7′ through the flow adjustment choke 44. The flow adjustment choke 44 is equipped with the check valve 43 which will allow fluid to flow only in the direction from the switching valve 7′ to the pipe 9′. The capacity of the fluid tank 8′ is bigger than that of the fluid tank 4′. The pipe 10′ from the fluid tank 8′ becomes a pilot

pipe of the switching valve 11′. The other pilot pipe 12′ of the switching valve 11′ is connected to the pipe 1 of the pressed fluid source through the pressure adjustment valve or feed valve device 13′ and the pipe 14′. The feed valve device 13′ is set to deliver a constant pressure that is less than that delivered by the feed valve device 2′. The fluid tank 8′ is also connected to the switching valve 3′.

FIG. 3 shows an example in which the invented fluid pressure type pulse counting device is installed in a starting device of a marine engine to count the number of actuation process or starting attempts performed. A in the FIG. 3 represents the fluid pressure type counting device shown in FIG. 1 and B represents a circuit of the fluid pressure type pulse producing device. The circuit of the fluid pressure type pulse producing device represented by B will be explained first. 21 is a pipe connected to a pressurized fluid source such as a storage reservoir and it is also connected to the fluid tank or reservoir 25 through the switching valve 22 and the flow adjustment chokes 23 and 24. The flow adjustment choke 23 is equipped with the check valve 23′ which will allow fluid to flow only to the switching valve 22. The flow adjustment choke 24 is equipped with the check valve 24′ which will allow fluid to flow only to the fluid tank or reservoir 25. The pipe 26 branching out from the pipe between the flow adjustment choke 24 and the fluid tank 25 is connected to valve 27 which has its inlet port connected to the pipe 1 through the pipe 31 and its output port connected to the pilot part of the switching valve 28 through the double check valves 38 and 38′. The input port of the switching valve 28 is connected to the pressurized fluid source or storage reservoir through the pipe 29 and its output port is connected to the pulse transmitting pipe 47. The pipe 30 branching out from the pipe 47 is connected to the pilot part of the switching valve 22 mentioned earlier. The pipe 47 is connected to the pilot part of the switching valve 34. The output port of the switching valve 34 is connected to the engine starting device 37 through the pipe 36.

Next, the function of this invented device will be explained by the use of FIG. 1. When the valve between the storage reservoir and pipe 1 is opened, pressurized fluid will pass through the pipe 1, the pressure adjustment valve or feed valve device 2, and the switching valve 3 to maintain a constant pressure in the fluid tank or reservoir 4 corresponding to the setting of feed valve device 2. Manual actuation of the switching valve 3 will disconnect the passage to the pressurized fluid source. If a fluid pressure pulse is transmitted to the pipe 9, the pilot part of the switching valve 7 will receive the fluid pressure pulse and the switching valve 7 will be switched. Now the pressurized fluid in the fluid tank or reservoir 4 will flow to the fluid tank or reservoir 8 via the pipe 5 and the switching valve 7, and the pressure in the fluid tank 4 will go down. When the fluid pressure pulse in the pipe 9 disappears, the switching valve 7 will be returned to its original state by a spring to shut off the passage between the fluid tanks or reservoirs 4 and 8. Then pressurized fluid in the fluid tank or reservoir 8 will be discharged to atmosphere. When the fluid pressure pulse is transmitted to the pipe 9 again, the passage between the fluid tanks or reservoirs 4 and 8 will be connected for a certain period of time, and the pressurized fluid in the fluid tank or reservoir 4 will flow to the fluid tank or reservoir 8. The pressure in the

tank or reservoir 4 will, therefore, be reduced further.

By repeating the procedures mentioned above, the pressure in the fluid tank or reservoir 4 will be reduced gradually. When the fluid pressure in the pipe 10 is reduced below the fluid pressure in the other pipe 12 which is preadjusted to a desired pressure by the pressure adjustment valve or feed valve device 13, the switching valve 11 will be switched and the pressurized fluid of the pipe 1 will be transmitted into the pipe 16 as a fluid pressure signal through the pipe 15, and the switching valve 11. In this way, the pressure in the pipe 12 which is adjusted by the pressure adjustment valve or feed valve device 13 becomes slightly higher than the reduced pressure in the fluid tank or reservoir 4 following a certain number of pulse transmissions to the pipe 9. The switching of the switching valve 11 will now transmit into the pipe 16 a fluid pressure signal indicating that the predetermined number of pulses has been counted. The switching valve 3 can be manually switched back to the original state shown in the FIG. 1. The device is now re-set and counting can be carried out again.

The function of the device shown in FIG. 2 will be explained next. Pressurized fluid will flow into the fluid tank or reservoir 4' from the pipe 1 through the pressure adjustment valve or feed valve device 2' and the switching valve 39. When the fluid pressure pulse is supplied through the pipe 9', the pulse will pass through the pipe 40 and the check valve 41 and will reach the pilot part of the switching valve 39. The switching valve 39 will be switched and the passage between the pipe 1 and the fluid tank or reservoir 4' will be shut off. At the same time, the fluid pressure pulse from the pipe 9' will pass through the flow adjustment valve or choke 44 at a slow rate and will reach the pilot part of the switching valve 7'. Therefore, after a certain time lag, the valve 7' will be switched and the fluid tanks or reservoirs 4' and 8' connected. Since the capacity of the fluid tank 8' is larger than that of the fluid tank 4', the pressurized fluid stored in the fluid tank 4' will flow into the fluid tank 8'. When the fluid pressure pulse in the pipe 9' disappears, the pressurized fluid in the pilot part of the switching valve 7' will pass through the check valve 43 and will be discharged from the pipe 9'. The switching valve 7' will switch to the close position. The pressurized fluid in the pilot part of the switching valve 39 will also be discharged through the flow adjustment valve or choke 42 and the switching valve 39 will assume the open position after a certain time lag. By repeating the procedures mentioned above, the pressurized fluid in the fluid tank or reservoir 4' will flow after each pulse into the fluid tank or reservoir 8' with a bigger capacity and the pressure in the fluid tank or reservoir 8' will gradually go up. The pipe 10' from the switching valve 11' is connected to the fluid tank or reservoir 8'. When the pressure in the pipe 10' exceeds that in the pipe 12', the switching valve 11' will be switched to connect the pipe 15' and 16'. The pressurized fluid will now serve as a signal to indicate the completion of counting of a certain number of pulses and will be transmitted to the pipe 16'.

The function of the fluid pressure type pulse producing device represented in FIG. 3 by B will be explained first. When the pressurized fluid is supplied through the pipe 1 by opening the valve between the main storage reservoir and this pipe, the pressurized fluid will flow into the fluid tank 25 through the pipe 21, the switching valve 22, the flow adjustment choke 23, and the check valve 24'. After a certain period of time, the pressure in the fluid tank 25 will reach a constant level and equal the pressure in pipe 1. The switching valve 27 will then undergo switching due to the fluid pressure in the pipe 26, and the pressurized fluid in the pipe 1 will flow into the pipe 9 via the pipe 31 and the switching valve 27. This fluid pressure pulse will act upon the pilot part of the switching valve 28 through the pipes 9 and 9', the double check valves 38 and 38' and the pipe 40'. The switching valve 28 will undergo switching to shut off the supply of pressurized fluid from the pipe 29 and at the same time, the pressurized fluid in the pipe 30 will be discharged. Therefore, the switching valve 22 will be switched to the position opposite that shown in FIG. 3 and the pressurized fluid in the fluid tank 25 will pass through the flow adjustment choke 24 and the check valve 23' and will be discharged to atmosphere via the valve 22 after a certain period of time. Therefore, the fluid pressure in the pipe 26 will also decrease and the switching valve 27 will be switched to the position shown in FIG. 3 to discharge the pilot pressure of the switching valve 28. The switching valve 28 will now be switched to assume the position as shown in FIG. 3 and the pressurized fluid in the pipe 29 will be transmitted as pulse pressure to the pipe 47. The transmitting and discharging of the pressurized fluid mentioned above will be repeated at a certain time interval determined by the flow adjustment chokes 23 and 24. The pulse signal indicating fluid pressure change at the pipe 9 mentioned above will be transmitted to the fluid pressure type pulse counting device represented by A in FIG. 3.

The function of the fluid pressure type pulse counting device A equipped with the fluid pressure type pulse producing device B as shown in FIG. 3 will be explained next. When pressurized fluid flows into the system while the positions of the switching valves 32 and 46 is that as shown in FIG. 3, the pressurized fluid will reach the pilot part of the switching valve 34 through the pipe 1, the switching valve 46, the pipe 29, and the switching valve 28. The fluid under pressure supplied through switching valve 32 increases to a value sufficient to operate switching valve 39 to its cut-off position thereby trapping the fluid under pressure in reservoir 4. At the same time the pressure fluid will also enter the input port of the switching valve 34 via the branch pipe 35 from the pipe 1. The pressurized fluid will thus pass through the pipe 36 and actuate the starting device 37. The fluid pressure type pulse counting device A and the fluid pressure type pulse producing device B will be actuated as mentioned above and after a certain period of time, the intermittent fluid pressure pulse will be supplied to the pipe 9. This fluid pressure pulse will pass through the pipe 9 and will be transferred to the fluid pressure type pulse counting device A. The pressurized fluid will now pass through the pipe 9', the double check valves 38 and 38' and the pilot pipe 40' to switch the switching valve 28 mentioned above. The pipe 29 is now closed and the pilot pressure of the switching valve 34 is discharged to atmosphere The switching valve 34 will undergo switching to shut off the passage to the starting device 37. This will stop the starting process. After a certain period of time, the fluid pressure pulse in the pipe 9' mentioned above will disappear and the switching valve 28 will be switched

to connect the pipe **29** to the pilot part of the switching valve **34.** The switching valve **34** will undergo switching and the pressurized fluid will be again supplied to the starting device **37** to carry out the starting process. The process mentioned above is repeated and if the engine starts during the process, a fluid pressure signal indicating the completion of starting will be transmitted to the pipe **45.** For example, in a diesel engine, a time delay built into a low oil pressure shut-down device allows time for engine lubricating oil pressure to build up. When sufficient oil pressure develops, a corresponding fluid pressure will be established in the pipe **45.** As the pressure in the pipe **45** is thus increased, the double check valve device **38'** will be operated to establish a communication between the pipes **45** and **40'** whereupon fluid under pressure flows from the pipe **45** to to pipe **40'** to cause operation of switching valve **28** to close communication between pipes **29** and **47.** The pressurized fluid in the pipe **47** will be discharged to atmosphere and the switching valve **34** will undergo switching to stop the starting device **37.**

If the engine fails to start after actuating the starting device **37** for a predetermined number of times, the fluid pressure type pulse counting device A will keep counting the pulse from the pipe **9** as mentioned above. When the predetermined number is reached by reducing the pressure in reservoir **4** in steps until switching valve **11** switches, the fluid pressure signal will be exhausted from the pipe **16** to atmosphere. The signal fluid under pressure will pass through the multiple check valves **38** and **38'**, and the switching valve **28** will undergo switching to temporarily stop the starting process. The fluid pressure type pulse counting device can be re-set by manually switching the switching valve **32** to release fluid under pressure from the switching valve **39** so that it returns to the position shown and thus the starting device can be actuated again for the predetermined number of times.

This invented device with the structures described above can count pulses by detecting the pressure increases or drop in the fluid tank **4.** The circuit of this device is, therefore, very simple and can be used in the place where a fire hazard is a problem. This device also has the following characteristics: it can dispatch a signal indicating that the engine cannot be started, any number of pulses dispatched before the appearance of the above-mentioned signal can be selected, and the reset of the counting device can be accomplished simply by the use of the switching valve **32.**

Having now described the invention what I claim as new and desire to secure by Letters Patent, is:

1. Fluid pressure control apparatus comprising:

a. a pair of reservoirs,

b. means operable to control charging of one of said reservoirs to a first chosen pressure,

c. means operable to establish a first communication between said one reservoir and the other of said reservoirs and a second communication between said other reservoir and atmosphere while said first communication is closed, and

d. fluid pressure operated valve means subject oppositely to a constant chosen fluid pressure that is less than said first chosen pressure and a variable fluid pressure, and operable, while said constant chosen fluid pressure exceeds said variable fluid pressure, to establish one communication, and, while said variable fluid pressure exceeds said constant chosen fluid pressure, to establish another communication, said variable fluid pressure being dependent upon the pressure in one of said reservoirs.

2. Fluid pressure control apparatus, as recited in claim **1,** further characterized by a first feed valve device operable to deliver fluid at said first chosen pressure, and a second feed valve device operable to deliver fluid at said constant chosen fluid pressure that is less than said first chosen pressure.

3. Fluid pressure control apparatus, as recited in claim **1,** further characterized in that said means operable to control charging of one of said reservoirs comprises:

a. a feed valve device operable to deliver fluid at a constant pressure to said one reservoir, and

b. manually operable means interposed between said feed valve device and said one reservoir for selectively establishing or cutting off flow between said feed valve device and said one reservoir.

4. Fluid pressure control apparatus, as recited in claim **1,** further characterized in that said means operable to control charging of one of said reservoirs comprises:

a. a feed valve device operable to deliver fluid at a constant pressure to said one reservoir, and

b. fluid pressure operable means interposed between said feed valve device and said one reservoir for selectively cutting off or establishing flow of fluid under pressure between said feed valve device and said one reservoir accordingly as fluid under pressure is supplied thereto or released therefrom.

5. Fluid pressure control apparatus, as recited in claim **1,** further characterized in that said means operable to establish communication between said reservoirs comprises:

a. a valve operable from a first position in which it establishes said second communication to a second position in which it establishes said first communication,

b. means biasing said valve to its said first position, and

c. fluid pressure operated means for operating said valve against the yielding resistance of said biasing means from its said first position to its said second position.

6. Fluid pressure control apparatus, as recited in claim **1,** further characterized in that said means operable to establish a first communication between said one reservoir and the other of said reservoirs and a second communication between said other reservoir and atmosphere while said first communication is closed, comprises:

a. fluid pressure operable means interposed between said reservoirs for selectively cutting off or establishing said first communication accordingly as fluid under pressure is released therefrom or supplied thereto, and

b. manually operable means interposed between said other reservoir and atmosphere for establishing said second communication between said other reservoir and atmosphere independently of said fluid pressure operable means.

7. Fluid pressure control apparatus, as recited in claim **1,** further characterized in that said means operable to control charging of one of said reservoirs comprises:

a. a feed valve device operable to deliver fluid at said first chosen pressure to said one reservoir, and

b. fluid pressure operable means interposed between said feed valve device and said one reservoir for selectively cutting off or establishing flow of fluid under pressure between said feed valve device and said one reservoir accordingly as fluid under pressure is supplied thereto or released therefrom, and said means operable to establish said first communication between said one and said other reservoirs comprises:

c. fluid pressure operable means interposed between said reservoirs for selectively cutting off or establishing said first communication accordingly as fluid under pressure is released therefrom or supplied thereto.

8. Fluid pressure control apparatus, as recited in claim **1**, further characterized in that the volume of said other reservoir exceeds that of said one reservoir.

9. Fluid pressure control apparatus, as recited in claim **1**, further characterized in that said fluid pressure operated valve means is subject opposingly to aid constant chosen fluid pressure and the pressure in said other reservoir.

10. Fluid pressure control apparatus, as recited in claim **1**, further characterized in that said means operable to establish said first and second communications comprises means responsive to the supply of fluid under pressure thereto to cause the establishment of said first communication and responsive to the release of fluid under pressure therefrom to cause the establishment of said second communication.

11. Fluid pressure control apparatus, as recited in claim **2**, further characterized in that said first feed valve device delivers fluid at said first chosen pressure to said one reservoir, and said second feed valve device delivers fluid at said constant chosen pressure that is less than said first chosen pressure to said fluid pressure operated valve means, said fluid pressure operated valve means being subject to the pressure in said one reservoir and thereby operable accordingly as the pressure in said one reservoir exceeds that or is less than the pressure delivered to said fluid pressure operated valve means by said second feed valve device.

12. Fluid pressure control apparatus, as recited in claim **4**, further characterized by means providing for an unrestricted rate of flow of fluid under pressure to said fluid pressure operable means and a restricted rate of flow of fluid under pressure therefrom.

13. Fluid pressure control apparatus, as recited in claim **4**, further characterized by manually operable means for controlling the flow of fluid under pressure to and the release of fluid under pressure from said fluid pressure operable means.

14. Fluid pressure control apparatus, as recited in claim **6**, further characterized by means providing for a restricted rate of flow of fluid under pressure to said fluid pressure operable means and an unrestricted rate of flow of fluid under pressure from said fluid pressure operable means.

15. Fluid pressure control apparatus, as recited in claim **7**, further characterized by:

a. means providing for an unrestricted rate of flow of fluid under pressure to said fluid pressure operable means interposed between said feed valve device and said one reservoir,

b. means providing for a restricted rate of flow of fluid under pressure from said fluid pressure operable means,

c. means providing for a restricted rate of flow of fluid under pressure to said fluid pressure operable means interposed between said reservoirs, and

d. means providing for an unrestricted rate of flow of fluid under pressure from said fluid pressure operable means interposed between said reservoirs.

16. Apparatus for controlling the starting of an internal combustion engine having a fluid pressure operated starting means responsive to the supply of fluid under pressure thereto to effect the supply of fluid under pressure to cause the application of turning effort to said engine and to the release of fluid under pressure therefrom to effect the release of fluid under pressure to cause the termination of said application of turning effort, said apparatus comprising the combination of:

a. a first fluid pressure operated valve means having a control chamber and being responsive to the venting of fluid under pressure from said control chamber to effect the supply of fluid under pressure to the fluid pressure operated starting means and responsive to the supply of fluid under pressure to said control chamber to effect the release of fluid under pressure from said starting means.

b. a pair of double check valve devices each having a pair of inlets and an outlet, said outlet of one of said double check valve devices being connected to said control chamber, one of said inlets being connected to the outlet of the other of said double check valve devices, and the other of said inlets being subject to a fluid pressure provided in response to the engine running independently of said engine starting means,

c. a pair of reservoirs,

d. means operable to effect charging of one of said reservoirs to a first chosen pressure,

e. means operable to trap fluid under pressure in said one reservoir,

f. first spring-biased fluid pressure operated valve means operable in response to the supply of fluid under pressure thereto to close a communication between the other of said pair of reservoirs and atmosphere and establish a communication between said reservoirs to effect a chosen reduction in the pressure of the fluid trapped in said one reservoir,

g. a third reservoir,

h. a second spring-biased fluid pressure operated valve means subject to the pressure in said third reservoir and operable in response to the pressure in said third reservoir establishing a force in excess of the force established by the spring bias to effect the supply of fluid under pressure simultaneously to said first spring-biased fluid pressure operated valve means and, via one inlet of said other double check valve device and said one double check valve device, to said first fluid pressure oerated valve means,

i. second fluid pressure operated valve means subject opposingly to a constant chosen fluid pressure that is less than said first chosen pressure and the pressure in said one reservoir, and operable in response to the reduction of the pressure in said one reservoir to a value less than said constant chosen fluid pressure to effect the supply of fluid under pressure

to the other inlet of said other double check valve device,

j. a third spring-biased fluid pressure operated valve means operable by the fluid under pressure supplied by said first fluid pressure operated valve means to the fluid pressure operated starting means to control the supply of fluid under pressure to and from said third reservoir, and

k. means so controlling the supply of fluid under pressure to and from said third reservoir as to provide that said third spring-biased fluid pressure operated valve means effects the release of fluid under pressure from said third reservoir to cause said second spring-biased fluid pressure operated valve means to release fluid under pressure from said first spring-biased fluid pressure operated valve means and said one inlet of said other double check valve device only subsequent to successive operations of said first spring-biased fluid pressure operated valve means to reduce the pressure of the fluid trapped in said one reservoir to said value less than said constant chosen fluid pressure to cause said second fluid pressure operated valve means to operate to effect the supply of fluid under pressure to the other inlet of said other double check valve device and thence via said one double check valve device to said control chamber of said first fluid pressure operated valve means to cause operation thereof to simultaneously release fluid under pressure from the fluid pressure operated starting means and said third spring-biased fluid pressure operated valve means thereby causing operation of the starting means to terminate said application of turning effort to said engine and release of fluid under pressure from said third reservoir to atmosphere to cause said second spring-biased fluid pressure operated valve means to operate to release fluid under pressure from said first spring-biased fluid pressure operated valve means and said one inlet of said other double check valve device.

17. Apparatus for controlling the starting of an internal combustion engine, as recited in claim **16,** further characterized in that said means operable to trap fluid under pressure in said one reservoir comprises:

a. fluid pressure operated cut-off valve means, interposed between said one reservoir and said means operable to control charging of said one reservoir to said first chosen pressure, and

b. manually operable means for effecting the supply of fluid under pressure to and the release of fluid under pressure from said fluid pressure operated cut-off valve means.

18. Apparatus for controlling the starting of an internal combustion engine, as recited in claim **16,** further characterized by means for providing the supply of fluid under pressure to said third reservoir at one rate and the release of fluid under pressure therefrom at a different rate.

19. Apparatus for controlling the starting of an internal combustion engine, as recited in claim **16,** further characterized by a first feed valve device for providing said first chosen pressure, and by a second feed valve device for providing said constant chosen fluid pressure that is less than said first chosen pressure.

20. Apparatus for controlling the starting of an internal combustion engine, as recited in claim **18,** further characterized in that said means for providing the supply of fluid under pressure to said third reservoir at said one rate comprises a choke and a check valve interposed between said choke and said third reservoir and opening in the direction of said third reservoir, and said means for providing for the release of fluid under pressure from said third reservoir at said different rate comprises a second choke connected in parallel relation to said first check valve, and a second check valve connected in parallel relation to said first choke and opening in the direction away from said third reservoir.

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