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PATENTS ACT 1953

COMPLETE SPECIFICATION

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IMPROVEMENTS IN OR RELATING TO GAS CYLINDER CHARGING APPARATUS

WE, MASS CONTROL LIMITED, a New Zealand company of 127 Wairau Road, Takapuna, Auckland, New Zealand, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to gas cylinder charging apparatus and in particular relates to apparatus for the charging of C.N.G. (Compressed Natural Gas) cylinders in vehicles.

It is known for C.N.G. retailing outlets to incorporate several, often three or four, storage tanks which are charged by a compressor from a parent supply normally a reticulated utility supply. Charging of a vehicle cylinder is achieved by utilising a pressure differential between that cylinder and the pressure of the supplying tank. Thus, the storage tanks are charged to a pressure higher than that required in the vehicle cylinder. To maintain this pressure differential during a vehicle cylinder charging operation the tanks are switched in in sequence. More particularly as the pressure of a supplying tank lowers owing to the volumetric reduction of gas therein the next storage tank having a full charge and thus being at a higher pressure is switched in to re-establish a significant pressure differential to thereby continue the supply charge. This technique of charging a cylinder is known as sequencing and is performed by an operator observing gauges and listening to the flow and as appropriate manually carrying out the required switching.

An intention of this invention is to provide an apparatus incorporating electronic control circuitry and adjunct components to provide for the automatic sequence charging of a gas cylinder.

According to a first aspect of this invention there is provided a gas cylinder charging apparatus comprising a series of storage tanks connected to a common parent gas supply via means to charge each of the storage tanks to a pressure higher than that required in a gas cylinder to be charged with each having an outlet feeding by way of an associated valve a common mass measuring means, an outlet dispensing means leading from the mass measuring means and adapted for coupling to the valves and the mass measuring means and incorporating a programmed processor unit positioned to monitor the gas flow and coupled to activate the valves to switch from one tank to another, at a selected threshold pressure,to achieve full charge of a gas cylinder.

In further describing the invention reference is made to the accompanying drawings of a preferred embodiment and wherein:

Fig 1 is a block diagram of the automatic sequencing layout and

Fig 2 & 3 are flow charts representing the control program, Fig 3 illustrating a sub-routine of Fig 2.

A C.N.G. retail outlet preferably has three storage tanks 3 charged from a parent supply 5, for example, a reticulated utility supply.

The tanks 3 are preferably charged by way of a compressor (not depicted) each to a pre-determined pressure higher than required in the cylinder to be charged therefrom.

Each of the tanks 3 has an outlet controlled by a valve 3^b which is preferably remotely operable by way of electrical solenoids directly activating the valve 3^b. In an alternative embodiment a compressed air line can be utilised to operate the valves with the compressed air line in turn being controlled by the solenoids to provide an additional safety factor.

Valves 3^b are coupled to a common outlet 6 which incorporates a mass measuring means 7, the outlet 6 terminating with a suitable coupling, for example a dispensing nozzle, to a gas cylinder represented by 8. The mass flow measuring apparatus 7 incorporates an electronic monitoring output 9 which is utilised and incorporated into an electronic control circuit 10 of the apparatus. The control circuit is based on a processor unit appropriately programmed to provide the functions herein described with reference to the flow charts of Figs 2 and 3.

In a preferred embodiment the processor unit is connected to the control valves 3^b via a relay bank 11 to provide the switching thereof, input to the processor control circuit 10 being from the monitoring by the mass measuring means 7.

The relay bank 11 is preferably incorporated into a power supply unit connected back to the valves 3^{b} via line 12. A first function of the processor control circuit 10 is to provide for the switching from one tank 3 to another at a selected low threshold pressure level as monitored by the mass measuring means 7. The processor control circuit 10 also provides a signal that a full charge has been achieved.

Preferably the processor control circuit 10 is a suitable microprocessor together with associated peripheral equipment and programmed memory means. Adjunct functions of the processor control circuit 10 are to signal a display preferably both of volume and cost of a charge from a display board 13.

Referring to Figs 2 and 3 the programming of the control circuit 10 provides for operation of the apparatus substantially within the routine depicted in the flow charts. Fig 2 depicts the principal routine and Fig 3 a sub-routine represented by the SEQUENCE block of Fig 2.

Referring to Fig 2, with switching on (POWER ON) the circuitry is activated and energy is also provided to solenoids controls 3^{b}. Further, a TIME ELAPSE function is activated enabling a time period, discussed in more

detail below, to be selected.

Thereafter the first test stage (DELIVERY) takes place testing to check whether the dispensing nozzle at outlet 8 is in the correct physical mode, that is open ready to dispense. If negative a cyclic re-checking represented by line 14 takes place until the correct mode is achieved. Thereafter the valve 3^{b} solenoids are operated to open two of the tanks 3 being the tanks having the highest and lowest charges, for convenience represented by OPEN TANKS 1 AND 2. The object of initially switching in two tanks 3 and in particular for providing that one of those tanks has the highest charge is to provide an initial substantial flow to a cylinder to be charged.

The routine then provides for the monitoring (FLOW AMOUNT) of the gas flow and this is preferably achieved by the mass measuring means 7 with the FLOW AMOUNT stage incorporating a pre-selected low threshold pressure to detect a lowering of the flow below that level. Such detection activates the switching from one tank 3 to a next tank 3 containing a higher charge. At the initial stage the controls provide an override in respect of the tank at the highest charge such that, providing that threshold pressure is immediately achieved, that tank is closed with dispensing thereafter being from one tank at a time.

Additionally, the FLOW AMOUNT stage provides for a holding cyclic operation, represented by line 15, to operate until the required threshold level is surpassed.

As charging takes place this is preferably displayed with the charging being monitored by way of a SEQUENCE sub-routine. Referring to Fig 3, the SEQUENCE sub-routine includes a TIME ELAPSE as the first test. This test monitors the total time elapsing during a charging operation and also includes a cyclic period (RESET TIMER) preferably of about 3-5 seconds at which intervals the flow is checked.

The flow is checked for a minimum flow (F MIN) and maximum flow (F MAX) with F MIN representing the threshold pressure level referred to above and being, for example, set at 150 cubic meters per hour. Detection of a flow beneath this level provides for the "switching up" as discussed above. A maximum instantaneous flow F MAX during any particular delivery period is checked to test whether a cut over to a tank having a lower charge is in order. In each case a check is via a sub-test (HIGH TANK ON) to ascertain whether the switching is from the tank at the highest charge and if so to provide an exit from the routine via a final test (FLOW CUT OFF) monitoring the final level of flow permitted before delivery is ended. In the alternative the control switches to the next tank to continue the routines.

WHAT WE CLAIM IS:

1. A gas cylinder charging apparatus comprising a series of storage tanks connected to a common parent gas supply via means to charge each of the storage tanks to a pressure with each having an outlet feeding by way of an associated valve a common mass measuring means, an outlet dispensing means leading from the mass measuring means and adapted for coupling to a gas cylinder, an electronic control circuit coupled to the valves and the mass measuring means and incorporating a programmed processor unit positioned to monitor the gas flow and coupled to activate the valves to switch from one tank to another, at a selected threshold pressure, to achieve full charge of a gas cylinder.

2. A gas cylinder charging apparatus as claimed in claim 1 wherein the control circuit and associated processor unit provide that at the start of a charging operation the valves to the tank having the highest charge and one other tank are immediately opened and thereafter for the closing of the valve to the tank with the lower charge providing the selected pressure level is achieved.

3. A gas cylinder charging apparatus as claimed in claim 2 wherein the control circuit and associated processor include as a first test the checking as to

whether the outlet dispensing means is securely coupled to the gas cylinder before any further steps can be taken.

4. A gas cylinder charging apparatus substantially as herein described with reference with the accompanying drawings.

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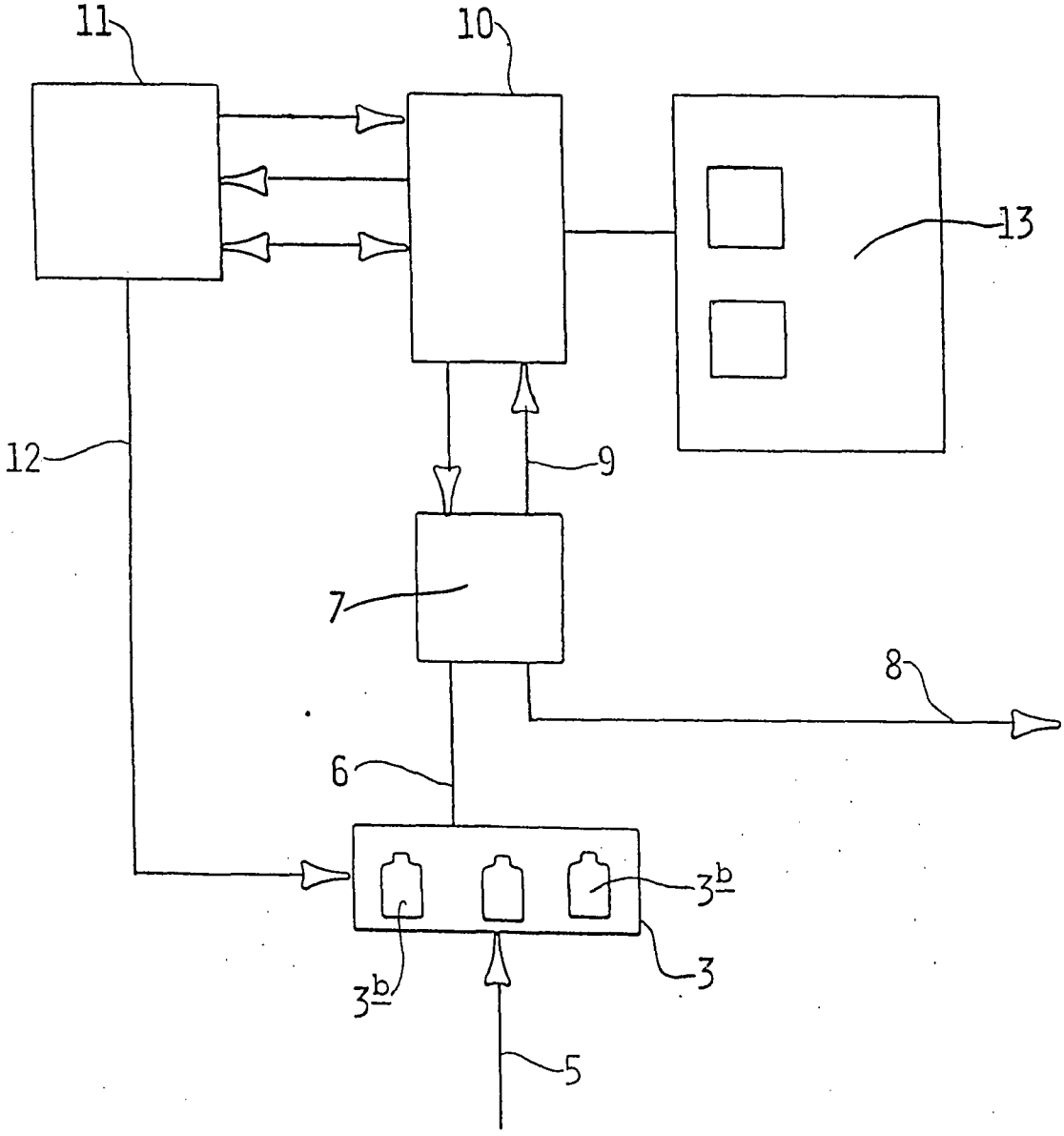

FIG 1

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FIG 2

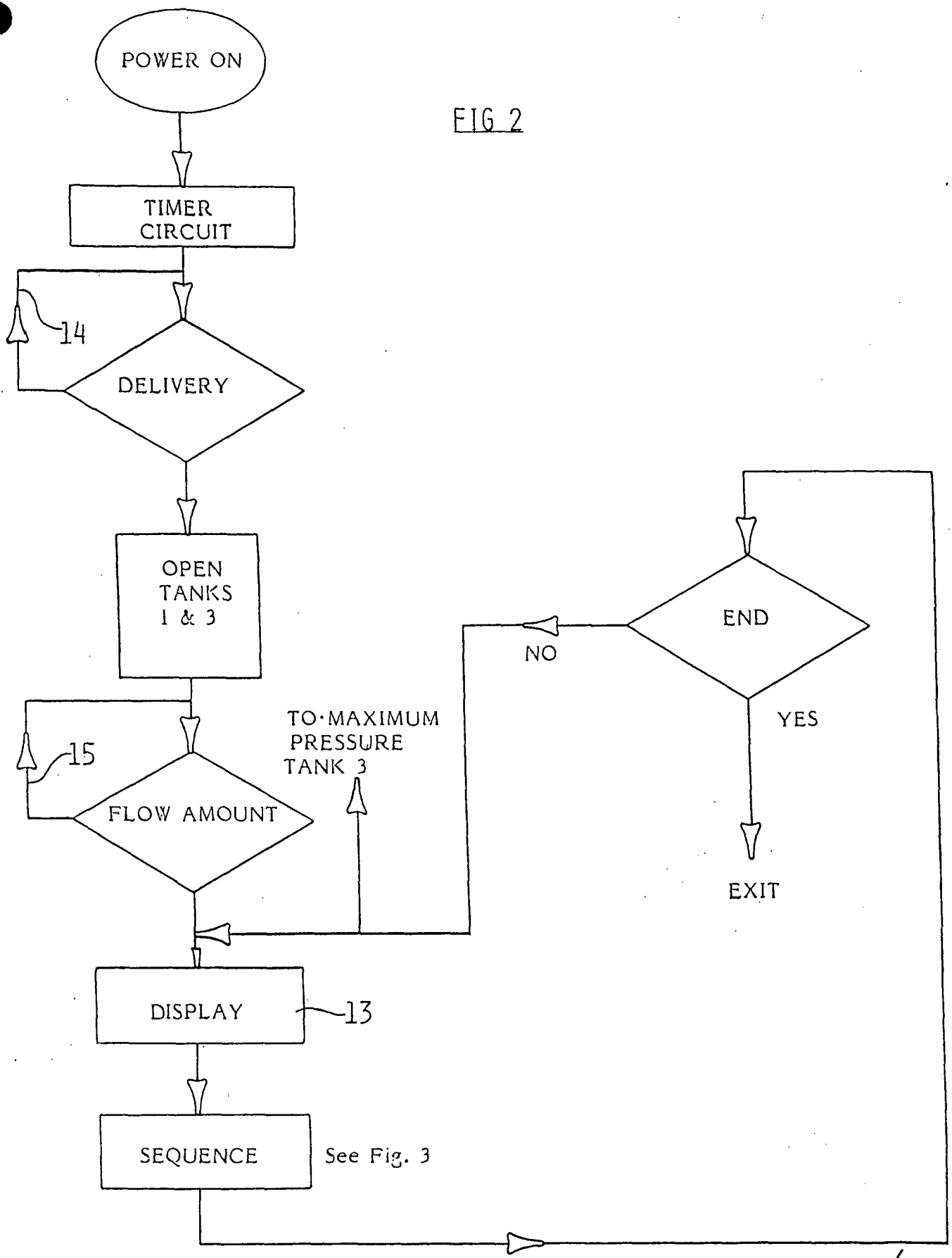

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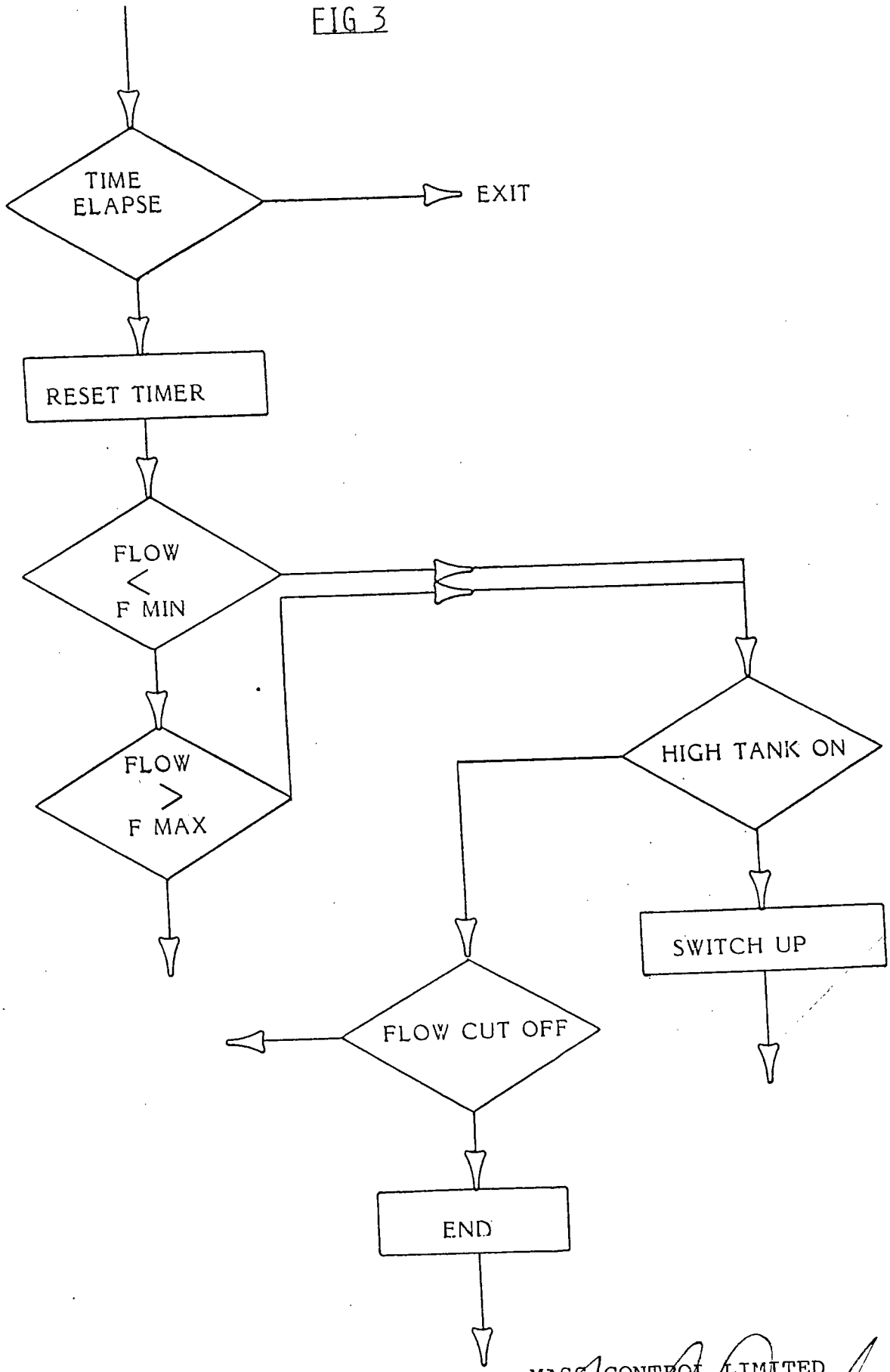
FIG 3



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