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(54) Equipment for suction and high pressure cleaning optimised by a logic unit

(57) An equipment for suction and high pressure cleaning is described, which comprises at lest one drained liquid collection tank (C), a tank for cleaning water, a vacuum pump (PV) to create and maintain a set degree of vacuum inside the drained liquid collection tank (C), a pressure pump (PP) that supplies water at high pressure for cleaning and an engine (M) to drive the two pump (PV,PP) where the number of revolutions of at least one of the pumps (PP,PV) is independent from that of the other pump and from that of the engine (M).

At least one of the pumps (PP, PV) is connected to the engine (M) by means of variable speed power transmissions (TP, TV), controlled by a logic unit (UL) which maintains the engine (M) at the minimum number of revolutions necessary to supply the energy required by the pumps (PP, PV).

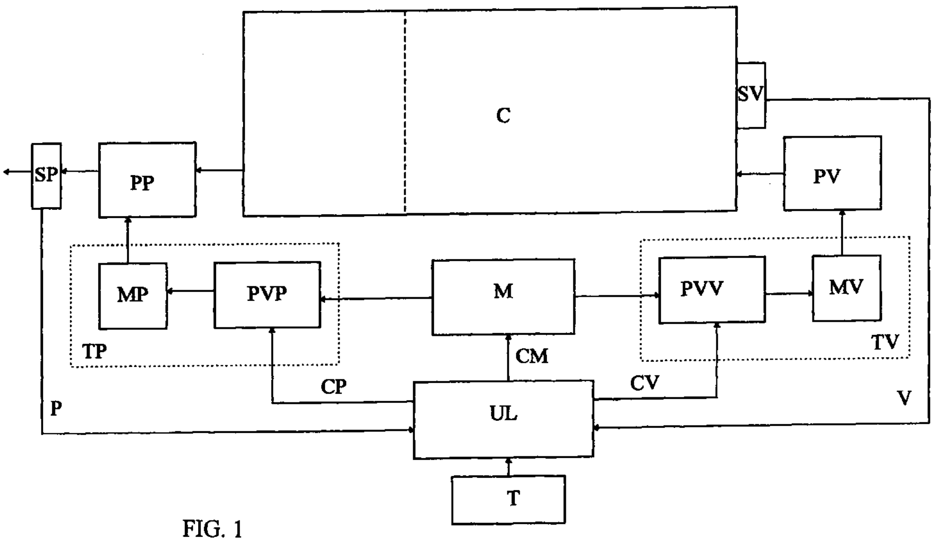

FIG. 1

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Description

Field of the invention.

[0001] The invention consists in an equipment for suction and high pressure cleaning, in which the revolution speed of the vacuum pump, that creates and maintains a set degree of vacuum inside the drained liquid collection tank, is independent of the revolution speed of the pressure pump that supplies water at high pressure for cleaning; moreover the number of revolutions of at least one of the pumps is independent of that of the engine which drives the pumps.

[0002] At least one of the pumps is connected to the engine by means of variable speed power transmissions, controlled by a logic unit which maintains the engine at the minimum number of revolutions necessary to supply the energy required by the pumps.

Prior art

[0003] Equipment for suction and high pressure cleaning are lorries equipped with a drained liquid collection tank and with a series of tools whose functions may be summed up in two:

> firstly to suck away the liquid to be drained (using a vacuum pump in order to create and maintain a set degree of vacuum inside the collection tank), and secondly to supply, by means of a pressure pump (preferably but not necessarily a piston pump), a set quantity of water at relatively high pressure (between 70 and 300 bar ca.) in order to clean pipelines, sewers, drains, etc.

[0004] The power needed to drive this tools and to obtain the above mentioned functions is supplied by the vehicle's engine, or alternatively by an auxiliary engine.

[0005] In currently known suction equipments the transfer of power from the engine (either the vehicle's or the auxiliary) to the vacuum and pressure pumps is made by means of either mechanical or hydraulic fixed ratio transmissions: hence a set number of revolutions of the engine corresponds to a set number of revolutions of the vacuum and pressure pumps.

[0006] The vacuum and pressure pumps' number of revolutions may be different from each other, but the number of revolutions ratio both between the pumps and between each pump and the engine remains constant: if for example, the number of revolutions of the engine is reduced by 50% the revolution speed of the pumps is also reduced by 50%.

[0007] The pumps may obviously be stopped independently of one another using hydraulic or mechanical systems not here described because already well known.

[0008] Fixed ratio transmissions involve numerous drawbacks, among which the following:

- the engine, dimensioned for supplying the maximum power required by the two pumps, works at the same revolution speed even when only one of the pumps is in use, creating a net loss in efficiency.
- if the job being undertaken necessitates the use of only one of the pumps at the maximum number of revolutions, the second pump is also unnecessarily compelled to work at the same speed: the excess energy absorbed by the second pump is dissipated in the form of heat, reducing the system's effective efficiency;
- the person employed to operate the suction equipment, aware of being unable to do otherwise and accustomed to waste, usually maintains the equipment (and consequently the engine) at maximum revolution speed.
- such behaviour by the employee causes an increase in running costs due to waste in fuel and lubricant, accelerates wear in all mobile mechanical parts (engine, pumps, transmissions, etc.) and involves an often relevant environmental impact, due to an excessive and unjustified emission of gas and noise.

[0009] The applicant has produced a suction equipment able to overcome such drawbacks because it is managed by a logic unit, which regulates both the number of revolutions of each pump (or at least of one of the pumps) and that of the engine, in order to satisfy the specific requirements of the moment.

Summary of the invention.

[0010] The subject of this invention is a suction equipment optimised by means of a logic unit, (comprising at least one drained liquid collection tank, a tank for cleaning water, a vacuum pump to create and maintain a set degree of vacuum inside the collection tank, a pressure pump to supply water at high pressure for cleaning and an engine to drive the two pumps) in which the revolution speed of the pressure pump is independent of that of the vacuum pump, and the revolution speed of at least one of the pumps is independent of that of the engine: at least one of the pumps is driven by the engine by means of variable speed power transmissions controlled by a logic unit, which maintains the engine at the minimum number of revolutions necessary in order to supply the total power required by the two pumps.

List of figures.

[0011] The invention will now be better explained in reference to an example, (to be considered only one possible embodiment) shown in the attached figures where:

- figure 1 shows a schematic block diagram of a suction equipment according to the invention.

- figure 2 shows a schematic flow diagram, illustrating the sequence of functional steps performed by the logic unit in order to manage the vacuum pump and the engine.
- figure 3 shows a schematic flow diagram, illustrating the sequence of functional steps performed by the logic unit in order to manage the pressure pump and the engine.
- figure 4 shows a schematic flow diagram, illustrating the sequence of functional steps performed by the logic unit in order to manage the engine if the pressure pump is directly driven by the engine.
- figure 5 shows a schematic form of a flow diagram, illustrating the sequence of functional steps performed by the logic unit in order to manage the vacuum pump and the engine if the pressure pump is directly driven by the engine.
- figure 6 shows a schematic flow diagram, illustrating the sequence of functional steps performed by the logic unit in order to manage the engine if the vacuum pump is directly driven by the engine.
- figure 7 shows a schematic flow diagram, illustrating the sequence of functional steps performed by the logic unit in order to manage the pressure pump and the engine if the vacuum pump is directly driven by the engine.

[0012] In the enclosed figures, the same alphanumeric references are used to identify the same items.

Detailed description.

[0013] Figure 1 shows a block diagram representing a preferred embodiment of a suction equipment according to the invention, which is composed of at least, combined each other, a drained liquid collection tank C, a vacuum pump PV to create and maintain a set degree of vacuum inside the collection tank C, a pressure pump PP to supply at high pressure cleaning water (held in the appropriate section of the collection tank C, shown in figure 1 by a dotted line or alternatively in a separate tank) and an engine M to drive the two pumps (PP,PV). In figure 1 some elements have been omitted in order to simplify the block diagram, such as the suction boom, the high pressure gun, the valves, etc. normally found in suction equipment but not used by this invention.

[0014] In the suction equipment illustrated in figure 1 the engine M, the vacuum pump PV, and the pressure pump PP are managed by a logic unit UL which regulates the number of revolutions of the engine M, of the pressure pump PP and of the vacuum pump PV in order to satisfy the specific requirements of the moment.

[0015] In particular, the logic unit UL manages the pressure pump PP, the vacuum pump PV and the engine M so that the revolution speed of the pressure pump PP is independent of that of the vacuum pump PV and the revolution speed of the said pumps PP and PV is independent of the revolution speed of the engine M.

[0016] Without sorting from the scope of the invention it is possible to substitute the logic unit UL of figure 1, suitable to manage both the pumps (PP,PV) and the engine, with a pair of logic units, each of which manages one of the pumps (PP,PV) and possibly the engine M.

[0017] The pressure pump PP and the vacuum pump PV are driven by the engine M by means of variable speed power transmissions (TP, respectively TV, indicated in figure 1 with dotted lines) controlled by the logic unit UL, whose output speed may be varied continuously from zero to a maximum value.

[0018] This allows the pumps PP and PV to work independently of one another and at variable speed, so optimising their efficiency.

[0019] Furthermore the logic unit UL maintains the engine M at the minimum number of revolutions necessary to supply the power requested by the pumps PP and PV.

[0020] The working of the logic unit will be better described with reference to the flow diagrams shown in figures 2 and 3, to be considered only one possible example.

[0021] According to the embodiment shown in figure 1, each of the variable speed power transmissions (respectively TP and TV) includes an oil engine (respectively MP and MV) which is driven by a variable volume oil pump (respectively PVP and PVV): the variable volume oil pump (respectively PVP and PVV) is driven by the engine M, while the oil engine (respectively MP and MV) drives a pump (respectively PP and PV).

[0022] Without sorting from the scope of the invention it is moreover possible to substitute at least one of the variable speed power transmissions (TP,TV) described above, with other similar systems not described here as they are already well known.

[0023] In another possible embodiment of the invention, one of the two pumps (PP,PV) is directly driven by the engine M and the logic unit UL manages the engine M and the other pump by controlling the relative variable speed power transmissions (TP,TV), while the output speed of the variable speed transmissions to the pump directly driven by the engine M is maintained at a predetermined value, for example, by maintaining the variable speed power transmission's variable volume oil pump (PVP,PVV) at a predetermined value.

[0024] Always without sorting from the scope of the invention, the pump connected directly to the engine M could be driven by traditional mechanical coupling means instead of by the variable speed power transmissions (respectively TP and TV).

[0025] The operations performed by the logic unit if the pressure pump PP is directly driven by the engine M will be better explained with reference to the flow diagrams shown in figures 4 and 5 (to be considered only one possible example); figures 6 and 7 show flow diagrams illustrating the operations performed by the logic unit UL if, for example, the vacuum pump is directly driven by the engine M.

[0026] The pressure pump PP, the vacuum pump PV, the variable volume oil pumps PVP and PVV and the oil engines MP and MV are commercially sold apparatus well known by persons skilled in the art, and will not therefore be described here: to give only some possible examples, the pressure pump PP could be a PRATISSOLI model MS45 or a WOMA model 1503, the vacuum pump PV could be a JUROP model PR250 or a DEMAG model RFW250; the variable volume oil pump PVP could be a PARKER model PV130, the variable volume oil pump PVV could be a PARKER model PV080, the oil engine MP could be a PARKER model F110 and the oil engine MV a PARKER model F080.

[0027] The logic unit UL regulates the revolution speed of the oil engine MV that drives the vacuum pump PV, respectively of the oil engine MP that drives the pressure pump PP by modifying (through commands CV and CP respectively) the delivery of the corresponding variable volume oil pump (respectively PVV and PVP) according to a given parameter.

[0028] For the vacuum pump PV this parameter is the difference between a predetermined value Vo (memorised into the logic unit UL and regulated as necessary) of degree of vacuum inside the collection tank C and the value (V) measured inside the collection tank by a first sensor SV; for the pressure pump PP this parameter is the difference between a predetermined value Po (memorised into the logic unit UL and regulated as necessary) of the delivery pressure of the pressure pump PP and the value (P) measured by a second sensor SP.

[0029] According to the power absorbed moment by moment by the pumps (PP,PV) and by their relative variable speed power transmissions (TP,TV), the logic unit UL modifies the running speed of the engine M in an usual way (using command CM) in order to bring it to the minimum number of revolutions necessary to produce the power required and modifies through commands (respectively CP and CV) dispatched to the variable speed power transmissions (respectively TP and TV) the ratio between the number of revolutions made by the engine M and that made by each of the pumps (PP,PV), in order to constantly maintain each pump (PP,PV) at the revolution speed necessary to the specific working condition, and the engine M at the minimum number of revolutions necessary to supply the power absorbed by the pumps (PP,PV) and their relative variable speed power transmissions (TP,TV).

[0030] Finally, in figure 1 block T is a schematic representation of the equipment's control panel including at least means to activate and deactivate the pressure and vacuum pumps (PP,PV) and possibly means to initialise the logic unit UL.

[0031] Figure 2 shows a schematic flow diagram, illustrating the sequence of steps schematically performed by the logic unit UL in order to manage the vacuum pump PV and the engine M.

[0032] Following an initialisation step, if any (step 1), the logic unit UL verifies (step 20) if the vacuum pump PV is activated: if the vacuum pump PV is not activated the logic unit UL verifies (step 21) if the pressure pump PP is activated.

[0033] If the pressure pump PP is activated the logic unit UL lowers to zero (step 22) the delivery CLV of the variable volume pump PVV using the command CV, and passes (reference P) to manage the engine M and the pressure pump PP (step 30; figure 3). Otherwise the logic unit UL lowers to zero (step 23) the delivery CLV of the variable volume pump PVV using the command CV, and brings the number of revolutions GM of the engine M to a predetermined minimum value GMmin, before returning to stand by condition (step 40).

[0034] As the response times of the mechanical parts utilised in suction equipment are in the order of several seconds, and in any case much greater than the milliseconds needed by the logic unit UL to carry out one or more functional steps, the fact that the logic unit UL, when it abandons the management procedure in progress (for example that of the vacuum pump PV), always returns to beginning of the management procedure for the engine M and for the other pump (the pressure pump PP) does not involve delays or pauses in the management of the engine M and/or of the two pumps (PV PP), and is not therefore detrimental to the efficiency of a suction equipment realised according to the invention.

[0035] If the vacuum pump PV is activated, the logic unit UL verifies (step 24) that the predetermined value of degree of vacuum Vo is greater than value V (measured by sensor SV) minus a first predetermined quantity K1, but lower than said value V plus a second predetermined quantity K2, and waits (step 25) for a time t6 before passing to manage the engine M and the pressure pump PP (step 30, figure 3). Otherwise the logic unit UL verifies (step 26) that the predetermined value of degree of vacuum Vo is not greater than said value V minus the first predetermined quantity K1, before verifying (step 27) if the predetermined degree of vacuum Vo is lower than the said value V plus the second predetermined quantity K2.

[0036] If the predetermined value of degree of vacuum Vo is greater than the said value V (measured by sensor SV) minus the first predetermined quantity K1, the logic unit UL verifies (step 28) that the delivery CLV of the variable volume pump PVV is lower than 100%, before increasing it using command CV by a predetermined quantity dc (step 29) and waiting (step 201) for a predetermined time t2, before passing to manage the engine M and the pressure pump PP (step 30, figure 3).

[0037] Otherwise the logic unit UL verifies (step 202) that the number of revolutions GM of the engine M is lower than a predetermined maximum value GMmax, and that the number of revolutions GPVof the vacuum pump PV is lower than a predetermined maximum value

GPVmax, before using command CM (step 203) to increase the number of revolutions GM of the engine M by a predetermined quantity dg, and waits (step 204) for a predetermined time t1, before passing to manage the engine M and the pressure pump PP (step 30, figure 3).

[0038] If the number of revolutions GM of the engine M is not lower than the predetermined maximum value GMmax, and/or if the number of revolutions GPV of the vacuum pump PV is not lower than the predetermined maximum value GPVmax, the logic unit UL verifies (step 27) that the predetermined value Vo of degree of vacuum is not lower than value V (measured by sensor SV) plus the second predetermined quantity K2, before passing to manage the engine M and the pressure pump PP (step 30, figure 3).

[0039] If the predetermined value Vo of degree of vacuum is lower than the said value V plus the second predetermined value K2, the logic unit UL verifies (step 205) that the number of revolutions GM of the engine M is not greater than the predetermined minimum number of revolutions GMmin, before using command CV to reduce (step 206) the delivery CLV of the variable volume pump PVV by the predetermined quantity dc and waits (step 207) for a predetermined time t3 before passing to manage the engine M and the pressure pump PP (step 30, figure 3).

[0040] If the number of revolutions GM of the engine M is greater than the predetermined minimum value GMmin, the logic unit UL verifies (step 208) that the pressure pump PP is activated and that the delivery CLP of the variable volume pump PVP is greater than 99%, before using command CV to reduce (step 209) the delivery CLV of the variable volume pump PVV by the predetermined quantity dc, and waits (step 210) for a predetermined time t5 before passing to manage the engine M and the pressure pump PP (step 30, figure 3).

[0041] Otherwise the logic unit UL uses the command CM (step 211) to reduce the number of revolutions GM of the engine M by the predetermined quantity dg, and waits (step 212) for a predetermined time t4, before passing to manage the engine M and the pressure pump PP (step 30, figure 3).

[0042] Preferably but not necessarily:

the first predetermined quantity K1 is of about 0.01 bar (and in any case between 0 and 0.08 bar, about), the second predetermined quantity K2 is of about 0.08 bar (and in any case between 0 and 0.3 bar, about);

the waiting times t1 and t2 are of about 0.4 seconds (and in any case between 0 and 60 seconds, about), the waiting times t3, t4 and t5 are of about 0.3 seconds (and in any case between 0 and 60 seconds, about), and waiting time t6 is of about 0.5 seconds (and in any case between 0 and 60 seconds, about).

the maximum number of revolutions, GPVmax, of the vacuum pump PV is of about 1100 rpm. (and in any case between 500 and 5000 rpm., about).

[0043] Furthermore:

the minimum number of revolutions GMmin of the engine M is of about 650 rpm. (and in any case between 100 and 1500 rpm., about), the maximum number of revolutions GMmax of the engine M is of about 1050 rpm. (and in any case between 500 and 4000 rpm., about) , the increasing/decreasing step dg of the number of revolutions GM of the engine M is of about 30 rpm. (and in any case between 1 and 250 rpm., about).

the increasing/decreasing step dc of the delivery (respectively CLV and CLP) of each of the variable volume pumps (respectively PVV and PVP) is of about 2% (and in any case between 0.1% and 50%, about).

[0044] Figure 3 shows a schematic flow diagram, illustrating the sequence of functional steps carried out by the logic unit UL in order to manage the pressure pump PP and the engine M.

[0045] Following an initialisation step, if any (step 1), the logic unit UL verifies (step 30) if the pressure pump PP is activated: if the pump PP is not activated the logic unit UL verifies (step 31) if the vacuum pump PV is activated.

[0046] If the vacuum pump PV is activated, the logic unit UL uses the command CP for lowering to zero (step 32) the delivery CLP of the variable volume pump PVP, and passes (reference V) to manage the engine M and the vacuum pump PV (step 20, figure 2). Otherwise the logic unit UL uses the command CP for lowering to zero (step 33) the delivery CLP of the variable volume pump PVP and brings (using command CM) the number of revolutions GM of the engine M to a predetermined minimum value GMmin, before returning to stand by condition (step 40).

[0047] If the pressure pump PP is activated, the logic unit UL verifies (step 34) that the predetermined value Po of the delivery pressure of the pump PP is greater than the value P (measured by sensor SP) minus a third predetermined quantity K3, but lower than said value P plus a fourth predetermined quantity K4, and waits (step 35) for a time t12, before passing to manage the engine M and the vacuum pump PV (step 20, figure 2).

[0048] Otherwise the logic unit UL verifies (step 36) that the predetermined value Po of the delivery pressure of the pressure pump PP, is not greater than the said value P minus the third predetermined quantity K3, before verifying (step 37) if the predetermined value Po of the delivery pressure of the pump PP is lower than said value P plus the fourth predetermined quantity K4.

[0049] If the predetermined value Po of delivery pressure of the pump PP is greater than said value P (measured by sensor SP) minus the third predetermined quantity K3, the logic unit UL verifies (step 38) that the delivery CLP of the variable volume pump PVP is lower than 100%, before using command CP to increase it (step 39) by the predetermined quantity dc and waits (step 301) for a predetermined time t8, before passing to manage the engine M and the vacuum pump PV (step 20, figure 2).

[0050] Otherwise the logic unit UL verifies (step 302) that the number of revolutions GM of the engine M is lower than the predetermined maximum value GMmax, and that the number of revolutions GPP of the pressure pump PP is lower than the predetermined maximum value GPPmax, before using command CM to increase (step 303) the number of revolutions GM of the engine M by the predetermined quantity dg, and waits (step 304) for a predetermined time t7, before passing to manage the engine M and the vacuum pump PV (step 20, figure 2).

[0051] If the number of revolutions GM of the engine M is not lower than the predetermined maximum value GMmax, and/or the number of revolutions GPP of the pressure pump PP is not lower than the predetermined maximum value GPPmax, the logic unit UL verifies (step 37) that the predetermined value Po of the delivery pressure of the pump PP is not lower than the value P (measured by sensor SP) plus the fourth predetermined quantity K4 before passing to manage the engine M and the vacuum pump PV (step 20, figure 2).

[0052] If the predetermined value Po of the delivery pressure of the pressure pump PP is lower than said value P plus the fourth predetermined value K4, the logic unit UL verifies (step 305) that the number of revolutions GM of the engine M is not greater than the predetermined minimum value GMmin, before using command CP (step 306) to reduce the delivery CLP of the variable volume pump PVP by the predetermined quantity dc and waits (step 307) for a predetermined time t9, before passing to manage the engine M and the vacuum pump PV (step 20, figure 2).

[0053] If the number of revolutions GM of the engine M is greater than the predetermined minimum value GMmin, the logic unit UL verifies (step 38) that the vacuum pump PV is activated, and that the delivery CLV of the variable volume pump PVV is greater than 99%, before using command CP (step 309) to reduce the delivery CLP of the variable volume pump PVP by the predetermined quantity dc and waits (step 310) for a predetermined time t11, before passing to manage the engine M and the vacuum pump PV (step 20, figure 2).

[0054] Otherwise the logic unit UL uses command CM (step 311) to reduce the number of revolutions GM of the engine M by the predetermined quantity dg and waits for a predetermined time t10 before passing to manage the engine M and the vacuum pump PV (step 20, figure 2).

[0055] Preferably but not necessarily:

- the third predetermined quantity K3 is of about 5 bar (and in any case between 0 and 50 bar, about) and the fourth predetermined quantity K4 is of about 12 bar (and in any case between 0 and 50 bar, about);
- waiting times t7 and t8 are of about 0.8 seconds (and in any case between 0 and 60 seconds, about);
- waiting times t9, t10 and t11 are of about 0.4 seconds (and in any case between 0 and 60 seconds, about) and waiting time t12 is of about 0.5 seconds (and in any case between 0 and 60 seconds, about);
- the maximum number of revolutions GPPmax of the pressure pump PP is of about 1450 rpm. and in any case between 400 and 2500 rpm., about.

[0056] Furthermore:

- the minimum number of revolutions GMmin of the engine M is of about 650 rpm. (and in any case between 100 and 1500 rpm., about), the maximum number of revolutions GMmax of the engine M is of about 1050 rpm. (and in any case between 500 and 400_rpm., about) and the increasing/decreasing step dg of the number of revolutions GM of the engine M is of about 30 rpm. (and in any case between 1 and 250 rpm.,about);
- increasing/decreasing step dc of the delivery (respectively CLV and CLP) of each of the variable volume pumps (respectively PVV and PVP) isof about 2% and in any case between 0.1% and 50%, about.

[0057] Figure 4 shows a schematic flow diagram, illustrating the sequence of functional steps carried out by the logic unit UL to manage the engine M if the pressure pump PP is directly driven by the engine M; in this flow diagram (obtained from that of figure 3 by omitting the functional steps with which the logic unit UL verifies or modifies the delivery CLP of the variable volume pump PVP), the functional steps shall be identified using the same references used in figure 3.

[0058] Following an initialisation step (step 1), during which the logic unit UL acquires the predetermined value of output speed of the variable speed power transmissions TP (if present), for example by acquiring a predetermined value of delivery for the variable volume oil pump PVP, the logic unit UL verifies (step 30) if the pressure pump PP is activated: if the pressure pump PP is not activated the logic unit UL verifies (step 31) if the vacuum pump PV is activated.

[0059] If the vacuum pump PV is activated, the logic unit UL passes (reference V) to manage the engine M and the vacuum pump PV (step 20, figure 2). Otherwise the logic unit UL (using command CM, step 313) brings the number of revolutions GM of the engine M to the predetermined minimum value GMmin, before returning to stand by condition (step 40).

[0060] If the pressure pump PP is activated the logic unit UL verifies (step 34) that the predetermined value Po of the delivery pressure of the pump PP is greater than value P (measured by sensor SP) minus a third predetermined quantity K3, but lower than said value P plus a fourth predetermined quantity K4 and waits (step 35) for a predetermined time t12 before passing to manage the engine M and the vacuum pump PV (step 20, figure 2).

[0061] Otherwise the logic unit UL verifies (step 36) that the predetermined value of delivery pressure Po of the pump PP is not greater than the said value P minus the third predetermined quantity K3 before verifying (step 37) if the predetermined value of delivery pressure Po of the pump PP is lower than said value P plus the fourth predetermined quantity K4.

[0062] If the predetermined value of delivery pressure Po of the pump PP is greater than the said value P (measured by sensor SP) minus the third predetermined quantity K3, the logic unit UL verifies (step 302) that the number of revolutions of the engine M is lower than the predetermined maximum value GMmax, and that the number of revolutions GPP of the pressure pump PP is lower than the predetermined maximum value GPPmax before using command CM (step 303) to increase the number of revolutions GM of the engine M by the predetermined quantity dg and waits (step 304) for a predetermined time t7 before passing to manage the engine M and the vacuum pump PV (step 20, figure 2).

[0063] If the number of revolutions GM of the engine M is not lower than the predetermined maximum value GMmax, and/or the number of revolutions GPP of the pressure pump PP is not lower than the predetermined maximum value GPPmax, the logic unit UL verifies (step 37) that the predetermined value of delivery pressure Po of the pressure pump PP is not lower than value P (measured by sensor SP) plus the fourth predetermined quantity K4 before passing to manage the engine M and the vacuum pump PV (step 20, figure 2).

[0064] If the predetermined value of delivery pressure Po of the pump PP is lower than said value P plus the fourth predetermined quantity K4, the logic unit UL verifies (step 305) that the number of revolutions GM of the engine M is not greater than the predetermined minimum value GMmin and waits (step 307) for a predetermined time t9 before passing to manage the engine M and the vacuum pump PV (step 20, figure 2).

[0065] If the number of revolutions GM of the engine M is greater than the predetermined minimum value GMmin, the logic unit UL verifies (step 308) that the vacuum pump PV is activated and that the delivery CLV of the variable delivery pump PVV is greater than 99% and waits (step 310) for a predetermined time t11 before passing to manage the engine M and the vacuum pump PV (step 20, figure 2).

[0066] Otherwise the logic unit UL uses command CM (step 311) to reduce the number of revolutions GM of the engine M by the predetermined quantity dg and waits (step 312) for a predetermined time t10 before passing to manage the engine M and the vacuum pump PV (step 20, figure 2).

[0067] Preferably but not necessarily, the third and fourth predetermined quantities (K3, K4), the waiting times (t7, t9, t12), the maximum number of revolutions GPPmax of the pressure pump PP, the minimum number of revolutions (GMmin) and the maximum (GMmax) one of the engine M and the increasing/decreasing step dg of the number of revolutions GM of the engine M correspond to those previously indicated with reference to figure 3.

[0068] Figure 5 shows a schematic flow diagram, illustrating the sequence of functional steps carried out by the logic unit UL to manage the vacuum pump PV and the engine M if the pressure pump PP is directly driven by the engine M.

[0069] This flow diagram differs from that shown in figure 2 exclusively in that the logic unit UL, having verified (step 205) that the number of revolutions GM of the engine M is greater than the predetermined minimum value GMmin, passes to verify (step 213) that the pressure pump PP is activated before using command CV (step 209) to reduce the delivery CLV of the variable volume pump PVV by the predetermined quantity dc or, alternatively, before using command CM (step 211) to reduce the number of revolutions GM of the engine M by the predetermined quantity dg.

[0070] Preferably but not necessarily, the first and second predetermined quantities (K1, K2), the waiting times (t1-t6), the maximum number of revolutions (GPVmax) of the vacuum pump PV, the minimum number of revolutions (GMmin) and the maximum (GMmax) one of the engine M, the increasing/decreasing step dg of the number of revolutions GM of the engine M and the increasing/decreasing dc of the delivery CLV of the variable volume pump PVV correspond to those previously indicated with reference to figure 2.

[0071] Figure 6 shows a schematic flow diagram, illustrating the sequence of functional steps carried out by the logic unit UL to manage the engine M if the vacuum pump PV is directly driven by the engine M; in this flow diagram (obtained from that of figure 2 by omitting the functional steps with which the logic unit UL verifies or modifies the delivery CLV of the variable volume pump PVV), the functional steps shall be identified using the same references as in figure 2.

[0072] Following an initialisation step (step 1), in which the logic unit UL acquires the predetermined value of output speed for the variable speed transmissions TV (if present), for example by acquiring a predetermined value of the delivery CLV of the variable volume oil pump PVV, the logic unit UL verifies (step 20) if the vacuum pump PV is activated: if the vacuum pump PV is not activated the logic unit UL verifies (step 21) if the pressure pump PP is activated.

[0073] If the pressure pump PP is activated, the logic unit UL (step 22) passes (reference P) to manage the engine M and the pressure pump PP (step 30, figure 3), otherwise (using command CM, step 213) it brings the number of revolutions GM of the engine M to a predetermined minimum value GMmin before returning to stand by condition (step 40).

[0074] If the vacuum pump PV is activated, the logic unit UL verifies (step 24) that the predetermined value of degree of vacuum Vo is greater than value V (measured by sensor SV) minus the first predetermined quantity K1, but lower than said value V plus a second predetermined quantity K2 and waits (step 25) for a time t6 before passing to manage the engine M and the pressure pump PP (step 30, figure 3).

[0075] Otherwise the logic unit UL verifies (step 26) that the predetermined value of degree of vacuum Vo is not greater than said value V minus the first predetermined quantity K1 before verifying (step 27) if the predetermined value of degree of vacuum Vo is lower than value V (measured by sensor SV) plus the second predetermined quantity K2.

[0076] If the predetermined value of degree of vacuum Vo is greater than the said value V (measured by sensor SV) minus the first predetermined quantity K1, the logic unit UL verifies (step 202) that the number of revolutions GM of the engine M is lower than a predetermined maximum value GMmax, and that the number of revolutions GPV of the vacuum pump PV is lower than a maximum value GPVmax, before using command CM to increase (step 203) the number of revolutions GM of the engine M by a predetermined quantity dg and waits (step 204) for a predetermined time t1 before passing to manage the engine M and the pressure pump PP (step 30, figure 3).

[0077] If the number of revolutions GM of the engine M is not lower than the predetermined maximum value GMmax, and/or if the number of revolutions GPV of the vacuum pump PV is not lower than the predetermined maximum value GPVmax, the logic unit UL verifies (step 27) that the predetermined value of degree of vacuum Vo is not lower than value V (measured by sensor SV) plus the second predetermined quantity K2 before passing to manage the engine M and the pressure pump PP (step 30, figure 3).

[0078] If the predetermined value of degree of vacuum Vo is lower than said value V plus the second predetermined quantity K2, the logic unit UL verifies (step 205) that the number of revolutions GM of the engine M is not greater than the predetermined minimum value GMmin and waits (step 207) for a predetermined time t3 before passing to manage the engine M and the pressure pump PP (step 30, figure 3).

[0079] If the number of revolutions GM of the engine M is greater than the predetermined minimum value GMmin, the logic unit UL verifies (step 208) that the pressure pump PP is activated and that the delivery CLP of the variable volume pump PVP is greater than 99% and waits (step 210) for a predetermined time t5 before passing to manage the engine M and the pressure pump PP (step 30, figure 3).

[0080] Otherwise the logic unit UL uses command CM (step 211) to reduce the number of revolutions GM of the engine M by the predetermined quantity dg and waits (step 212) for a predetermined time t4 before passing to manage the engine M and the pressure pump PP (step 30, figure 3).

[0081] Preferably but not necessarily the values of the first and second predetermined quantities (K1, K2), the waiting times (t1, t3-t6), the maximum number of revolutions GPVmax of the vacuum pump PV, the minimum number of revolutions (GMmin) and the maximum one (GMmax) of the engine M, the increasing/decreasing step dg of the number of revolutions GM of the engine M and the increasing/decreasing step dc of the delivery CLV of the variable volume pump PVV correspond to those previously indicated with reference to figure 2.

[0082] Figure 7 shows a schematic flow diagram, illustrating the sequence of functional steps carried out by the logic unit UL in order to manage the pressure pump PP and the engine M, if the vacuum pump PV is directly driven by the engine M.

[0083] This flow diagram differs from that shown in figure 3 exclusively because the logic unit UL, having verified (step 305) that the number of revolutions GM of the engine M is greater than the predetermined minimum value GMmin, passes to verify (step 314) that the pressure pump PP is activated before using command CP (step 309) to reduce the delivery CLP of the variable volume pump PVP by the predetermined quantity dc. Or otherwise, the logic unit UL uses command CP (step 313) to reduce the number of revolutions GM of the engine M by the predetermined quantity dg.

[0084] Preferably but not necessarily the values for the third and fourth predetermined quantities (K3, K4), the waiting times (t7-t12), the maximum number of revolutions (GPPmax) of the pressure pump PP, the minimum number of revolutions (GMmin) and the maximum one (GMmax) of the engine M and the increasing/decreasing step dg of the number of revolutions GM of the engine M, correspond to those previously indicated in reference to figure 3.

[0085] Without sorting from the scope of the invention, the logic unit UL could be used moreover to manage suction equipment comprising only one pump (normally the vacuum pump) by carrying out one of the sequences of functional steps illustrated in the previous figures, in which the missing pump (respectively PP or PV) is considered by the logic unit UL to be permanently deactivated.

[0086] Always without sorting from the scope of the invention, the suction and high pressure cleaning equipment here presented may be modified and upgraded by a technician, according to the techniques in every day use and their natural evolution.

Claims

1. Suction and high pressure cleaning equipment optimised by a logic unit, comprising at least one drained liquid collection tank, a tank for cleaning water, a vacuum pump to create and maintain a set degree of vacuum inside the collection tank, a pressure pump to supply water at high pressure for cleaning, and an engine to drive the two pumps, the equipment being characterised in that the revolution speed of the pressure pump (PP) is independent of that of the vacuum pump (PV), and in that the revolution speed of at least one of the pumps (PP, PV) is independent of that of the engine (M).

2. Suction equipment as in claim 1, characterized in that at least one of the pumps (PP, PV) is driven by the engine (M) through variable speed power transmission means (respectively TP and TV) suitable to continuously vary their output speeds between 0 and a maximum value controlled by a logic unit (UL) which moreover maintains the engine (M) at the minimum number of revolutions necessary to supply the power required by the pumps (PP, PV).

3. Suction equipment as in claim 2, characterized in that each of the variable speed power transmission means (TP, TV) includes an oil engine (respectively MP and MV) powered by a variable volume oil pump (respectively PVP and PVV) which are in their turn driven by the engine (M).

4. Suction equipment as in claim 3, characterized in that the logic unit (UL) regulates the revolution speed of the oil engine (MV) that powers the vacuum pump (PV) and that of the oil engine (MP) which powers the pressure pump (PP) by modifying the delivery of the corresponding variable volume oil pump (respectively PVV and PVP).

5. Suction equipment as in claim 4, characterized in that the logic unit (UL) modifies the delivery of the variable volume oil pump (PVV) according to the difference between a predetermined value (Vo) of degree of vacuum inside the collection tank (C) and the value (V) of degree of vacuum measured inside tank (C) by a first sensor (SV).

6. Suction equipment as in claim 4, characterized in that the logic unit (UL) modifies the delivery of the variable volume oil pump (PVP) according to the difference between a predetermined value (Po) of delivery pressure of the pressure pump (PP) and the value (P) of the delivery pressure measured by a second sensor (SP).

7. Suction equipment as in claim 3, characterized in that the logic unit (UL) manages the engine (M) and the vacuum pump (PV) through the following sequence of functional steps:

- following an initialisation step, if any, to verify if the vacuum pump (PV) is activated: if the vacuum pump (PV) is not activated to verify if the pressure pump (PP) is activated,
- if the pressure pump (PP) is activated, to lower to zero the delivery (CLV) of the variable volume oil pump (PVV) relative to the variable speed power transmission means (TV) which drive the vacuum pump (PV) before passing to manage the engine (M) and the pressure pump (PP); otherwise to lower to zero the delivery (CLV) of the variable volume pump (PVV) relative to the variable speed power transmission means (TV) which drive the vacuum pump (PV) and to bring the number of revolutions (GM) of the engine (M) to a predetermined minimum value (GMmin), before returning to stand by condition;
- if the vacuum pump (PV) is activated, to verify that the predetermined value of degree of vacuum (Vo) is greater than value (V) measured by a first sensor (SV), minus a first predetermined quantity (K1), but lower than said value (V) plus a second predetermined quantity (K2) and to wait for a time t6 before passing to manage the engine (M) and the pressure pump (PP); otherwise to verify that the predetermined value of degree of vacuum (Vo) is not greater than the said value (V) minus the first predetermined quantity (K1), before verifying if the predetermined value (Vo) of degree of vacuum is lower than said value (V) plus the second predetermined quantity (K2);
- if the predetermined value of degree of vacuum (Vo) is greater than the said value (V) minus the first predetermined quantity (K1), to verify that the delivery (CLV) of the variable volume pump (PVV) relative to the variable speed power transmissions (TV) which drive the vacuum pump (PV) is lower than 100%, before increasing it by a predetermined quantity (dc), waiting for a predetermined time t2, and passing to manage the engine (M) and the pressure pump (PP); otherwise to verify that the number of revolutions (GM) of the engine (M) is lower than a predetermined maximum volume (GMmax), and that the number of revolutions (GPV) of the vacuum pump (PV) is lower than a predetermined maximum value (GPVmax) before increasing the number of revolutions (GM) of the engine (M) by a predetermined quantity dg, waiting for a predetermined time t1 and passing to manage the engine (M) and the pressure pump (PP);
- if the number of revolutions (GM) of the engine

(M) is not lower than the predetermined maximum value (GMmax) and/or if the number of revolutions (GPV) of the vacuum pump (PV) is not lower than the predetermined maximum value (GPVmax), to verify that the predetermined value of the degree of vacuum (Vo) is not lower than said value (V) plus the second predetermined quantity (K2) before passing to manage the engine (M) and the pressure pump (PP);

- if the predetermined value of degree of vacuum (Vo) is lower than said predetermined value (V) plus the second predetermined quantity (K2), to verify that the number of revolutions (GM) of the engine (M) is not greater than the predetermined minimum value (GMmin) before reducing by the predetermined quantity dc the delivery (CLV) of the variable volume pump (PVV) relative to the variable speed power transmission means (TV) which drive the vacuum pump (PV), waiting for a predetermined time t3 and passing to manage the engine (M) and the pressure pump (PP);
- if the number of revolutions (GM) of the engine (M) is greater than the predetermined minimum value (GMmin), to verify that the pressure pump (PP) is activated and that the delivery (CLP) of the variable volume pump (PVP) relative to the variable speed power transmission means (TP) which drive the pressure pump (PP) is greater than 99% before reducing by the predetermined quantity dc the delivery (CLV) of the variable volume pump (PVV) relative to the variable speed power transmission means (TV) which drive the vacuum pump (PV), waiting for a predetermined time t5 and passing to manage the engine (M) and the pressure pump (PP); otherwise to reduce the number of revolutions (GM) of the engine (M) by the predetermined value dg and waiting for a predetermined time t4 before passing to manage the engine (M) and the pressure pump (PP).

8. Suction equipment as in claim 7, in which the pressure pump (PP) is directly driven by the engine (M), characterized in that the logic unit (UL) carries out the following sequence of functional steps: to verify that the number of revolutions (GM) of the engine (M) is greater than the predetermined minimum value (GMmin) and to verify that the pressure pump (PP) is activated before reducing by the predetermined quantity dc the delivery (CLV) of the variable volume pump (PVV) relative to the variable speed power transmission means (TV) which drive the vacuum pump (PV), waiting for a predetermined time t5 and passing to manage the engine (M) and the pressure pump (PP); otherwise to reduce the number of revolutions (GM) of the engine (M) by the predetermined quantity dg, and waiting for a predetermined time t4, before passing to manage the engine (M) and the pressure pump (PP).

9. Suction equipment as in claim 7, in which the vacuum pump (PV) is directly driven by the engine (M), characterized in that the logic unit (UL) manages the engine (M) through the following sequence of functional steps:

- following a initialisation step, if any, to verify if the vacuum pump (PV) is activated: if the vacuum pump (PV) is not activated, to verify if the pressure pump (PP) is activated;
- if the pressure pump (PP) is activated, to pass to manage the engine (M) and the pressure pump (PP), otherwise to bring the number of revolutions (GM) of the engine (M) to a predetermined minimum volume (GMmin) before returning to stand by condition;
- if the vacuum pump (PV) is activated, to verify that the predetermined value of degree of vacuum (Vo) is greater than value (V) measured by a first sensor (SV) minus a first predetermined quantity (K1), but lower than said value (V) plus a second predetermined quantity (K2) and wait for a predetermined time t6 before passing to manage the engine (M) and the pressure pump (PP); otherwise, to verify that the predetermined value of the degree of vacuum (Vo) is not greater than the said value (V) minus the first predetermined quantity (K1), to verify that the predetermined value of degree of vacuum (Vo) is not lower than said value (V) plus the second predetermined quantity (K2) and to pass to manage the engine (M) and the pressure pump (PP);
- if the predetermined value of degree of vacuum (Vo) is greater than the said value (V) minus the first predetermined quantity (K1), to verify that the number of revolutions (GM) of the engine (M) is lower than a predetermined maximum value (GMmax) and that the number of revolutions (GPV) of the vacuum pump (PV) is lower than a predetermined maximum value (GPVmax), to increase by a predetermined quantity dg the number of revolutions (GM) of the engine (M), to wait for a predetermined time t1 and to pass to manage the engine (M) and the pressure pump (PP);
- if the number of revolutions (GM) of the engine (M) is not lower than the predetermined maximum value (GMmax) and/or if the number of revolutions (GPV) of the vacuum pump (PV) is not lower than the predetermined maximum value (GPVmax), to verify that the predetermined value of degree of vacuum (Vo) is not

lower than said value (V) plus the second predetermined quantity (K2) before passing on to manage the engine (M) and the pressure pump (PP);

- if the predetermined value of degree of vacuum (Vo) is lower than said value (V) plus the second predetermined quantity (K2), to verify that the number of revolutions (GM) of the engine (M) is not greater than the predetermined minimum value (GMmin) before waiting for a predetermined time t3 and passing to manage the engine (M) and the pressure pump (PP);
- if the number of revolutions (GM) of the engine (M) is greater than the predetermined minimum value (GMmin), to verify that the pressure pump (PP) is activated and that the delivery (CLP) of the variable volume pump (PVP) relative to the variable speed power transmission means (TP) which drive the pressure pump (PP) is greater than 99% before waiting for a predetermined time t5 and passing to manage the engine (M) and the pressure pump (PP); otherwise to reduce the number of revolutions (GM) of the engine (M) by the predetermined quantity dg and waiting for a predetermined time t4 before passing to manage the engine (M) and the pressure pump (PP).

10. Suction equipment as in claims 7,8 or 9, characterized in that the first and second predetermined quantities (K1,K2) are between 0 and 0,3 bar, about, the waiting times (t1-t6) are between 0 and 60 seconds, about, and the maximum number of revolutions (GPVmax) of the vacuum pump (PV) is between 500 and 5000 rpm, about.

11. Suction equipment as in claim 10, characterized in that the first predetermined quantity (K1) is of about 0.01 bar, the second predetermined quantity (K2) is of about 0.08 bar, waiting times t1 and t2 are of about 0.4 seconds, waiting times t3,t4,t5 are of about 0.3 seconds, waiting time t6 is of about 0.5 seconds and the maximum number of revolutions (GPVmax) of the vacuum pump (PV) is of about 1100 rpm. ca.

12. Suction equipment as in claim 3, characterized in that the logic unit (UL) manages the engine (M) and the pressure pump (PP) through the following sequence of functional steps:

- following an initialisation step, if any, to verify that the pressure pump (PP) is activated: if the pressure pump (PP) is not activated, to verify if the vacuum pump (PV) is activated;
- if the vacuum pump (PV) is activated, to lower to zero the delivery (CLP) of the variable volume pump (PVP) relative to the variable speed power transmission means (TP) which drive the pressure pump (PP) and to pass to manage the engine (M) and the vacuum pump (PV); otherwise to lower to zero the delivery (CLP) of the variable volume pump (PVP) relative to the variable speed power transmission means (TP) which drive the pressure pump (PP) and bringing the number of revolutions (GM) of the engine (M) to a predetermined minimum value (GMmin) before returning to stand by condition;
- if the pressure pump (PP) is activated, to verify that the predetermined value of delivery pressure (Po) of the pressure pump (PP) is greater than value (P) measured by second sensor (SP) minus a third predetermined quantity (K3), but lower than said value (P) plus a fourth predetermined quantity (K4), and wait for a predetermined time t12 before passing to manage the engine (M) and the vacuum pump (PV); otherwise, to verify that the predetermined value (Po) of delivery pressure of the pressure pump (PP) is not greater than the said value (P) minus the third predetermined quantity (K3) before verifying that the predetermined value of delivery pressure (Po) of the pressure pump (PP) is lower than said value (P) plus the fourth predetermined quantity (K4);
- if the predetermined value of delivery pressure (Po) of the pressure pump (PP) is greater than the said value (P) minus the third predetermined quantity (K3), to verify that the delivery (CLP) of the variable volume pump (PVP) relative to the variable speed power transmission means (TP) which drive the vacuum pump (PV) is lower than 100% before increasing it by a predetermined quantity (dc), waiting for a predetermined time t8 and passing to manage the engine (M) and the vacuum pump (PV); otherwise, to verify that the number of revolutions (GM) of the engine (M) is lower than the predetermined maximum value (GMmax), and that the number of revolutions (GPP) of the pressure pump (PP) is lower than a predetermined maximum value (GPPmax) before increasing by a predetermined quantity dg the number of revolutions (GM) of the engine (M), waiting for a predetermined time t7 and passing to manage the engine (M) and the vacuum pump (PV);
- if the number of revolutions (GM) of the engine (M) is not lower than the predetermined maximum value (GMmax), and/or if the number of revolutions (GPP) of the pressure pump (PP) is not lower than the predetermined maximum value (GPPmax), to verify that the predetermined value (Po) of delivery pressure of the pressure pump (PP) is not lower than said value (P) plus the fourth predetermined quantity (K4) before passing to manage the engine

(M) and the vacuum pump (PV):

- if the said value (Po) of delivery pressure of the pressure pump (PP) is lower than said value (P) plus the fourth predetermined quantity (K4), to verify that the number of revolutions (GM) of the engine (M) is not greater than the predetermined minimum value (GMmin) before reducing by the predetermined quantity dc the delivery (CLP) of the variable volume pump (PVP) relative to the variable speed power transmission means (TP) which drive the pressure pump (PP) and wait for a predetermined time t9 before passing to manage the engine (M) and the vacuum pump (PV);
- if the number of revolutions (GM) of the engine (M) is greater than the predetermined minimum value (GMmin), to verify that the vacuum pump (PV) is activated and that the delivery (CLV) of the variable volume pump (PVV) relative to the variable speed power transmission means (TV) which drive the vacuum pump (PV) is greater than 99%, before reducing by the predetermined quantity do the delivery (CLP) of the variable volume pump (PVP) relative to the variable speed power transmission means (TP) which drive the pressure pump (PP), and wait for a predetermined time t11 before passing to manage the engine (M) and the vacuum pump (PV); otherwise, to reduce the number of revolutions (GM) of the engine (M) by the predetermined quantity dg and wait for a predetermined time t10 before passing to manage the engine (M) and the vacuum pump (PV).

13. Suction equipment as in claim 12 in which the pressure pump (PP) is directly driven by the engine (M), characterized in that the logic unit (UL) manages the engine (M) through the following sequence of functional steps:

- following an initialisation step, if any, to verify if the pressure pump (PP) is activated: if the pressure pump (PP) is not activated, to verify if the vacuum pump (PV) is activated;
- if the vacuum pump (PV) is activated, to pass to manage the engine (M) and the vacuum pump (PV); otherwise, to bring the number of revolutions (GM) of the engine (M) to the predetermined minimum value (GMmin) before returning to stand by condition;
- if the pressure pump (PP) is activated, to verify that the predetermined value (Po) of delivery pressure of the pressure pump (PP) is greater than the value (P) measured by a second sensor (SP) minus a third predetermined quantity (K3), but lower than said value (P) plus a fourth predetermined quantity (K4) and wait for a predetermined time t12 before passing to manage the engine (M) and the vacuum pump (PV); otherwise, to verify that the predetermined value (Po) of delivery pressure of the pressure pump (PP) is not greater than the said value (P) minus the third predetermined quantity (K3) before verifying if the predetermined value (Po) of delivery pressure of the pressure pump (PP) is lower than the said value (P) plus the fourth predetermined quantity (K4);
- if the predetermined value (Po) of delivery pressure of the pressure pump (PP) is greater than the said value (P) minus the third predetermined quantity (K3), to verify that the number of revolutions (GM) of the engine (M) is lower than the predetermined maximum value (GMmax) and that the number of revolutions (GPP) of the pressure pump (PP) is lower than the predetermined maximum value (GPPmax) before increasing the number of revolutions (GM) of the engine (M) by a predetermined quantity dg and wait for a predetermined time t7 before passing to manage the engine (M) and the vacuum pump (PV);
- if the number of revolutions (GM) of the engine (M) is not lower than the predetermined maximum value (GMmax) and/or if the number of revolutions (GPP) of the pressure pump (PP) is not lower than the predetermined maximum value (GPPmax), to verify that the predetermined value (Po) of delivery pressure of the pressure pump (PP) is not lower than said value (V) plus the fourth predetermined quantity (K4) before passing to manage the engine (M) and the vacuum pump (PV);
- if the predetermined value (Po) of delivery pressure of the pressure pump (PP) is lower than said value (P) plus the fourth predetermined quantity (K4), to verify that the number of revolutions (GM) of the engine (M) is not greater than the predetermined minimum value (GMmin) before waiting for a predetermined time t9 and passing to manage the engine (M) and the vacuum pump (PV);
- if the number of revolutions (GM) of the engine (M) is greater than the predetermined minimum value (GMmin), to verify that the vacuum pump (PV) is activated and that the delivery (CLV) of the variable volume pump (PVV) relative to the variable speed power transmission means (TV) which drive the vacuum pump (PV) is greater than 99%, before waiting for a predetermined time t11 and passing to manage the engine (M) and the vacuum pump (PV); otherwise, to reduce the number of revolutions (GM) of the engine (M) by the predetermined quantity dg and wait for a predetermined time t10 before passing to manage the engine (M) and the vacuum pump (PV).

14. Suction equipment as in claim 12, in which the vacuum pump (PV) is directly driven by the engine (M), characterized in that the logic unit (UL) carries out the following sequence of functional steps: to verify that the number of revolutions (GM) of the engine (M) is greater than the predetermined minimum value (GMmin), to verify that the vacuum pump (PV) is activated, to reduce by the predetermined quantity dc the delivery (CLP) of the variable volume pump (PVP) relative to the variable speed power transmission means (TP) which drive the pressure pump (PP) and to wait for a predetermined time t11 before passing to manage the engine (M) and the pressure pump (PP); otherwise, to reduce the number of revolutions (GM) of the engine (M) by the predetermined quantity dg and to wait for a predetermined time t10 before passing to manage the engine (M) and the pressure pump (PP).

15. Suction equipment as in claims 12, 13 or 14, characterized in that the third and fourth predetermined quantities (K3, K4) are between 0 and 50 bar about, the waiting times (t7-t12) are between 0 and 60 seconds about and the maximum number of revolutions (GPPmax) of the pressure pump (PP) is between 400 and 2500 rpm. about.

16. Suction equipment as in claim 15, characterized in that the third predetermined quantity (K3) is of about 5 bar, the fourth predetermined quantity (K4) is of about 12 bar, the waiting times t7 and t8 are of about 0.8 seconds, the waiting times t9, t10 and t11 are of about 0.4 seconds, the waiting time t12 is of about 0.5 seconds and the maximum number of revolutions (GPPmax) of the pressure pump (PP) is of about 1450 rpm.

17. Suction equipment as in claim 9 or 13, characterized in that during the initialisation step the logic unit (UL) acquires a predetermined value of output speed of the variable speed power transmission means (respectively TV and TP) which drive respectively the vacuum pump (PV) and the pressure pump (PP).

18. Suction equipment as in claim 17, characterized in that during the initialisation step the logic unit (UL) acquires a predetermined value of delivery (respectively CLV and CLP) of the variable volume oil pump (respectively PPV and PVP) relative to the variable speed power transmission means (respectively TV and TP) which drive respectively the vacuum pump (PV) and the pressure pump (PP).

19. Suction equipment as in claims 7 to 9 or from 13 to 15, characterized in that the minimum number of revolutions (GMmin) of the engine (M) is between 100 and 1500 rpm. about, the maximum number of revolutions (GMmax) of the engine (M) is between 500 and 4000 rpm. about, the increasing/decreasing step dg of the number of revolutions (GM) of the engine (M) is between 1 and 250 rpm. about and the increasing/decreasing step dc of the delivery (respectively CLV and CLP) of each of the variable volume pumps (respectively PVV and PVP) is between 0.1% and 50% about.

20. Suction equipment as in claim 19, characterised in that the minimum number of revolutions (GMmin) of the engine (M) is of about 650 rpm., the maximum number of revolutions (GMmax) of the engine (M) is of about 1050 rpm., the increasing/decreasing step dg of the number of revolutions (GM) of the engine (M) is of about 30 rpm. and the increasing/decreasing step dc of the delivery (respectively CLV and CLP) of each of the variable volume pumps (respectively PVV and PVP) is of about 2%.

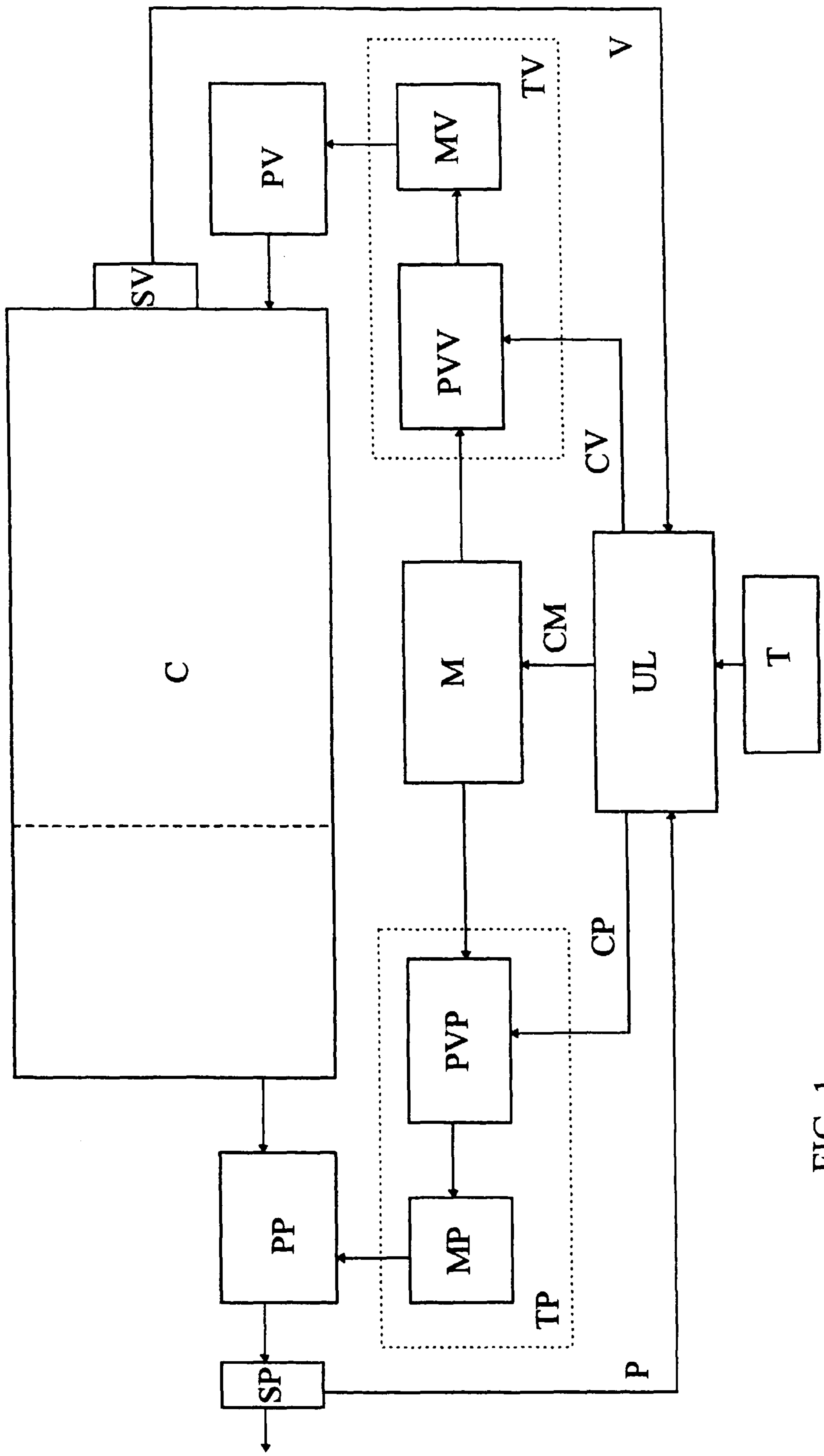

FIG. 1

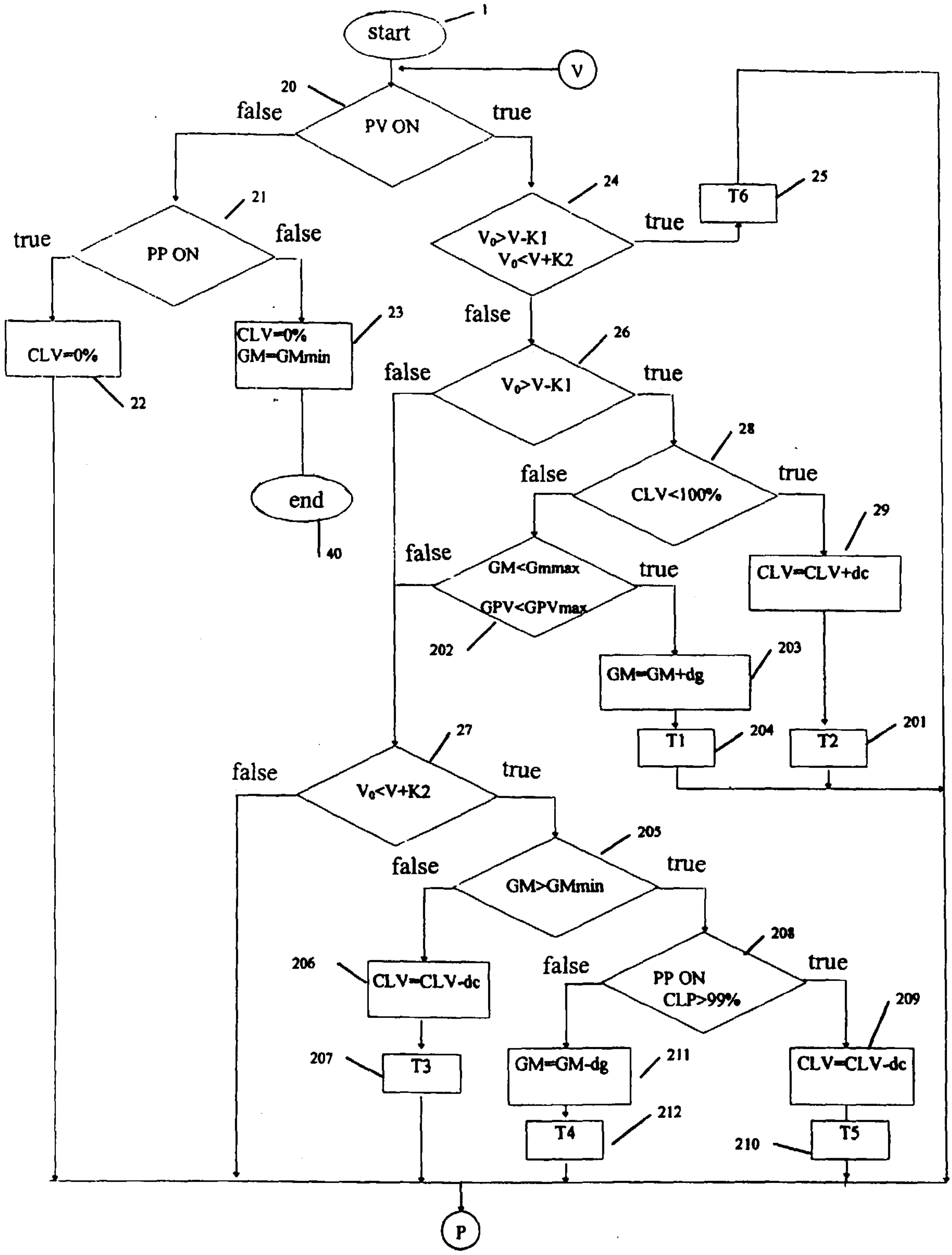
start
1
V
20
PV ON
false
true
21
PP ON
true
false
CLV=0%
22
CLV=0%
GM=GMmin
23
end
40
24
V0>V-K1
V0<V+K2
true
false
T6
25
26
V0>V-K1
false
true
28
CLV<100%
false
true
29
CLV=CLV+dc
GM<Gmmax
GPV<GPVmax
202
false
true
GM=GM+dg
203
T1
204
T2
201
27
V0<V+K2
false
true
205
GM>GMmin
false
true
206
CLV=CLV-dc
207
T3
208
PP ON
CLP>99%
false
true
GM=GM-dg
211
T4
212
209
CLV=CLV-dc
T5
210
P

FIG. 2

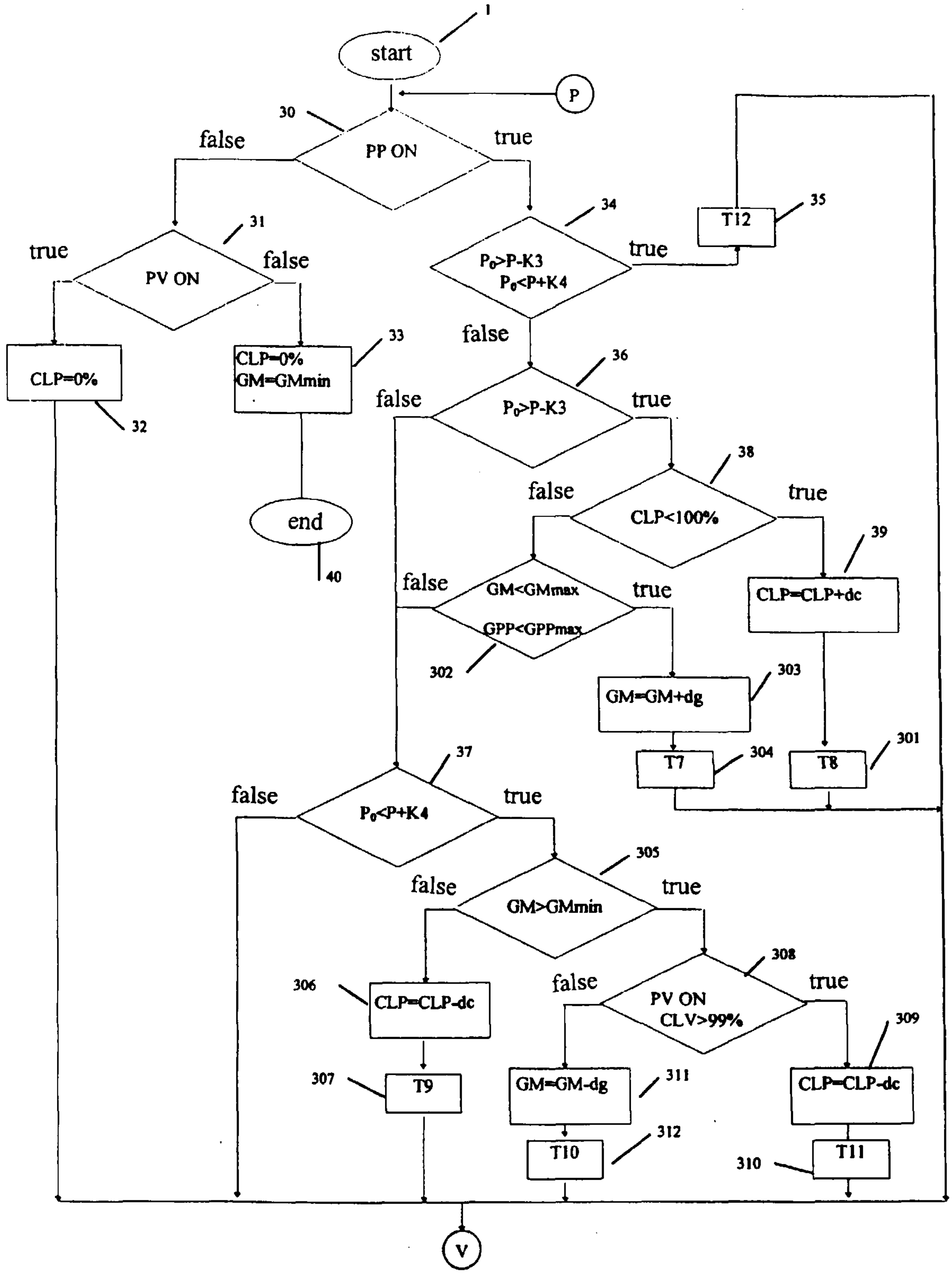
start
1
P
30
PP ON
false
true
31
PV ON
true
false
34
P0>P-K3
P0<P+K4
true
T12
35
CLP=0%
32
CLP=0%
GM=GMmin
33
false
36
P0>P-K3
false
true
end
40
38
CLP<100%
false
true
39
CLP=CLP+dc
GM<GMmax
GPP<GPPmax
false
true
302
GM=GM+dg
303
T7
304
T8
301
37
P0<P+K4
false
true
305
GM>GMmin
false
true
306
CLP=CLP-dc
308
PV ON
CLV>99%
false
true
309
307
T9
GM=GM-dg
311
CLP=CLP-dc
T10
312
T11
310
V

FIG. 3

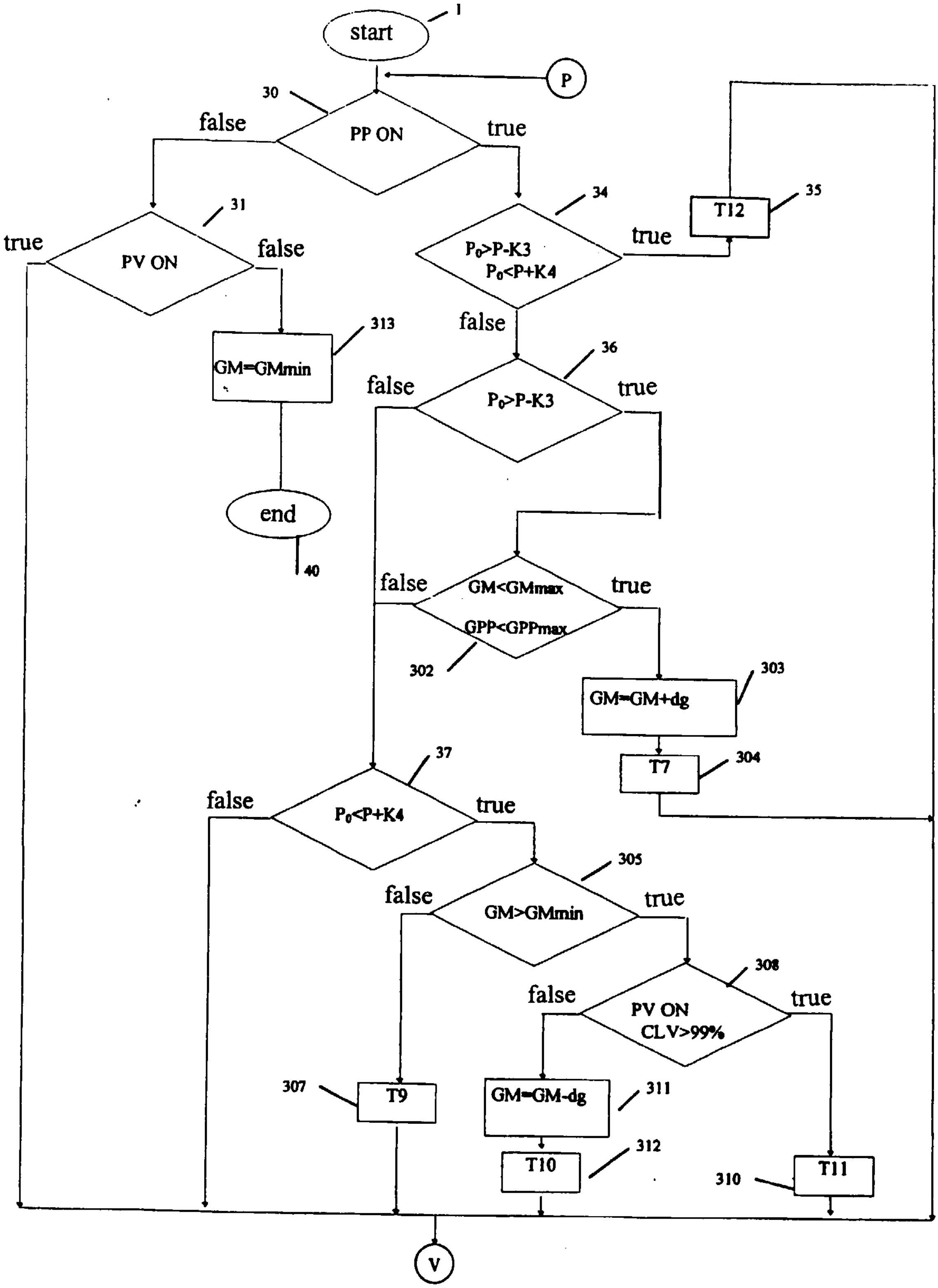
start
1
P
30
PP ON
false
true
31
PV ON
true
false
34
P_0>P-K3
P_0<P+K4
true
T12
35
false
313
GM=GMmin
end
40
36
P_0>P-K3
false
true
GM<GMmax
GPP<GPPmax
false
true
302
GM=GM+dg
303
T7
304
37
P_0<P+K4
false
true
305
GM>GMmin
false
true
308
PV ON
CLV>99%
false
true
307
T9
GM=GM-dg
311
T10
312
310
T11
V

FIG. 4

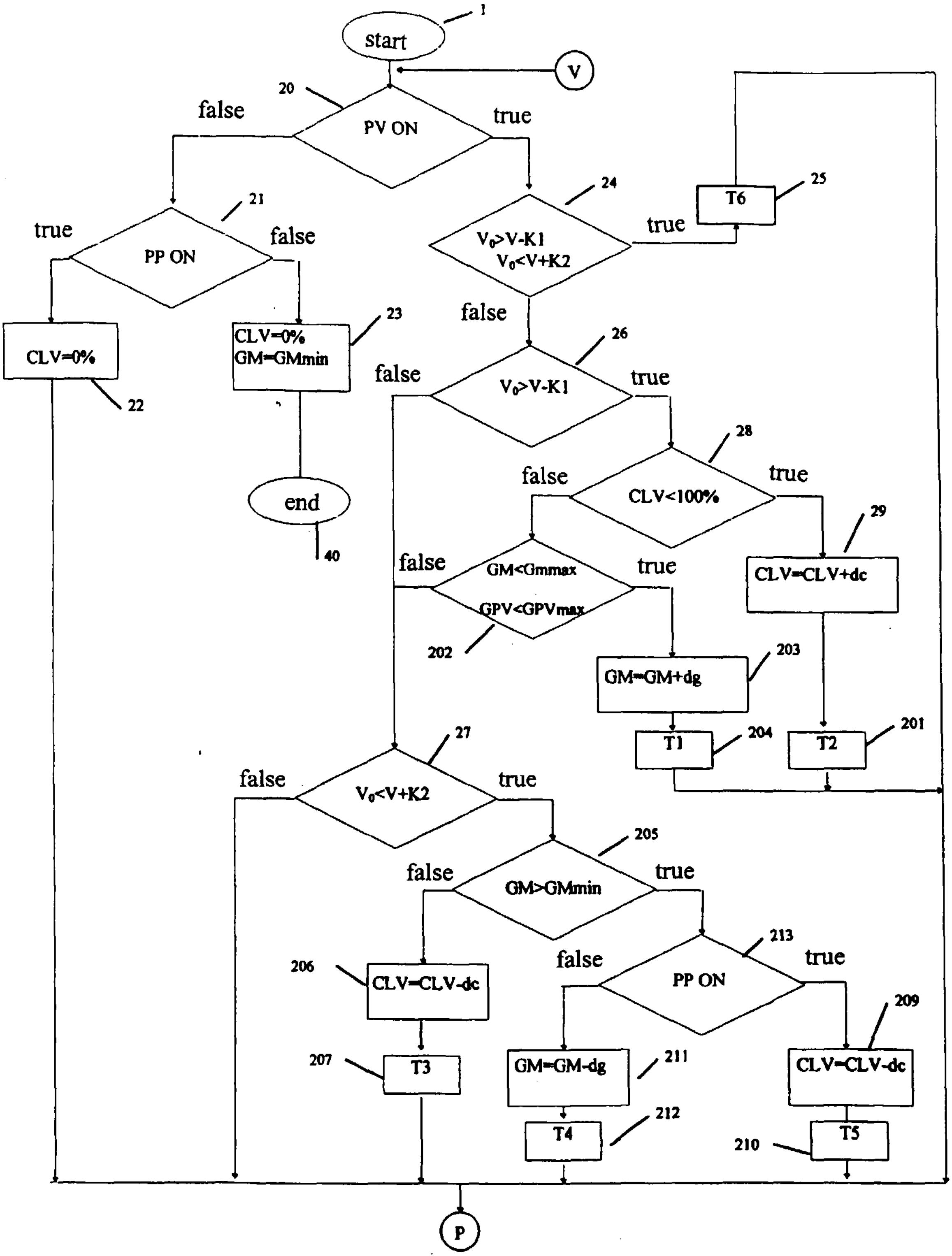
start
1
V
20
PV ON
false
true
21
PP ON
true
false
CLV=0%
22
CLV=0%
GM=GMmin
23
end
40
24
V_0>V-K1
V_0<V+K2
true
T6
25
false
26
V_0>V-K1
false
true
28
CLV<100%
false
true
29
CLV=CLV+dc
GM<Gmmax
GPV<GPVmax
202
false
true
GM=GM+dg
203
T1
204
T2
201
27
V_0<V+K2
false
true
205
GM>GMmin
false
true
206
CLV=CLV-dc
207
T3
213
PP ON
false
true
GM=GM-dg
211
T4
212
209
CLV=CLV-dc
T5
210
P

FIG. 5

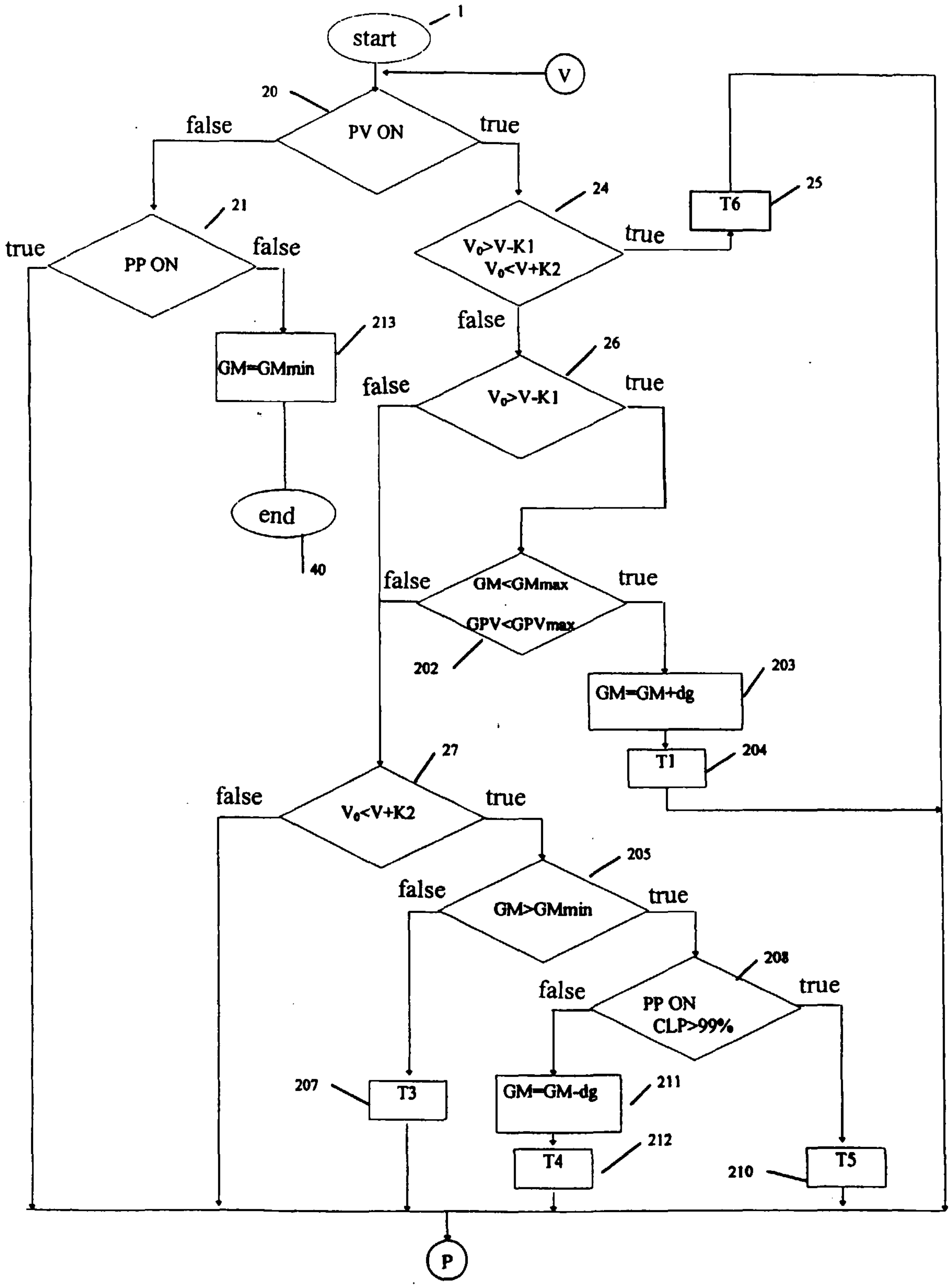
start
1
V
20
PV ON
false
true
21
PP ON
true
false
24
V_0>V-K1
V_0<V+K2
true
T6
25
false
213
GM=GMmin
end
40
26
V_0>V-K1
false
true
GM<GMmax
GPV<GPVmax
false
true
202
GM=GM+dg
203
T1
204
27
V_0<V+K2
false
true
205
GM>GMmin
false
true
208
PP ON
CLP>99%
false
true
207
T3
GM=GM-dg
211
T4
212
T5
210
P

FIG. 6

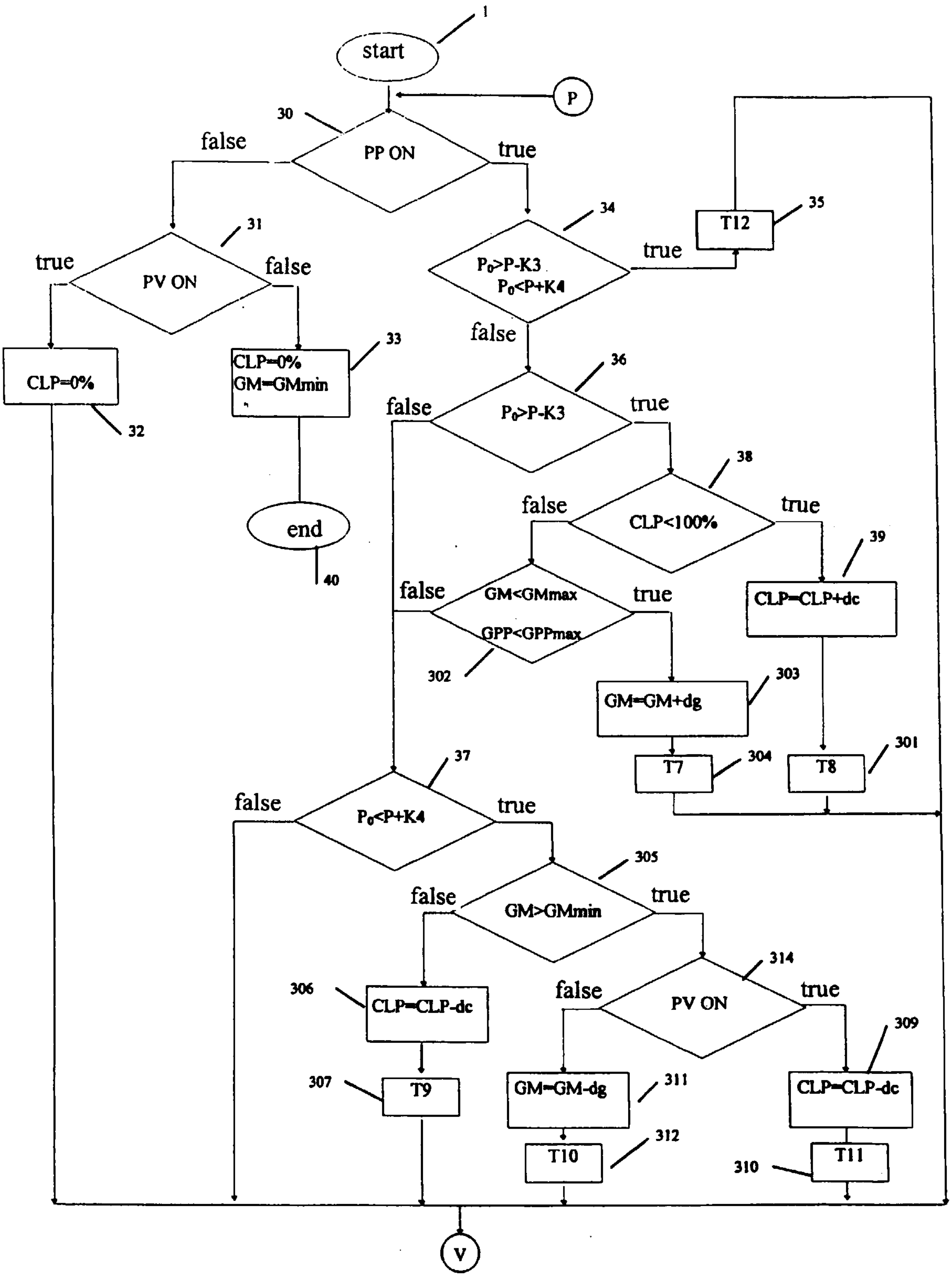
1
start
P
30
PP ON
false
true
31
PV ON
true
false
CLP=0%
32
33
CLP=0%
GM=GMmin
end
40
34
P0>P-K3
P0<P+K4
true
35
T12
false
36
P0>P-K3
false
true
38
CLP<100%
false
true
39
CLP=CLP+dc
GM<GMmax
GPP<GPPmax
false
true
302
303
GM=GM+dg
304
T7
T8
301
37
P0<P+K4
false
true
305
GM>GMmin
false
true
306
CLP=CLP-dc
307
T9
314
PV ON
false
true
309
CLP=CLP-dc
GM=GM-dg
311
312
T10
310
T11
V

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 99 11 9283

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 4 134 174 A (FLYNN ET AL) 16 January 1979 (1979-01-16) * abstract * * column 3, line 47 - column 4, line 28 * * column 4, line 63 - column 5, line 56 * * column 6, line 52 - column 9, line 56; figures *	1-4	E03F7/10 F04B49/00 F04B49/06 //B08B9/02
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	7 December 1999	Van der Zee, W

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