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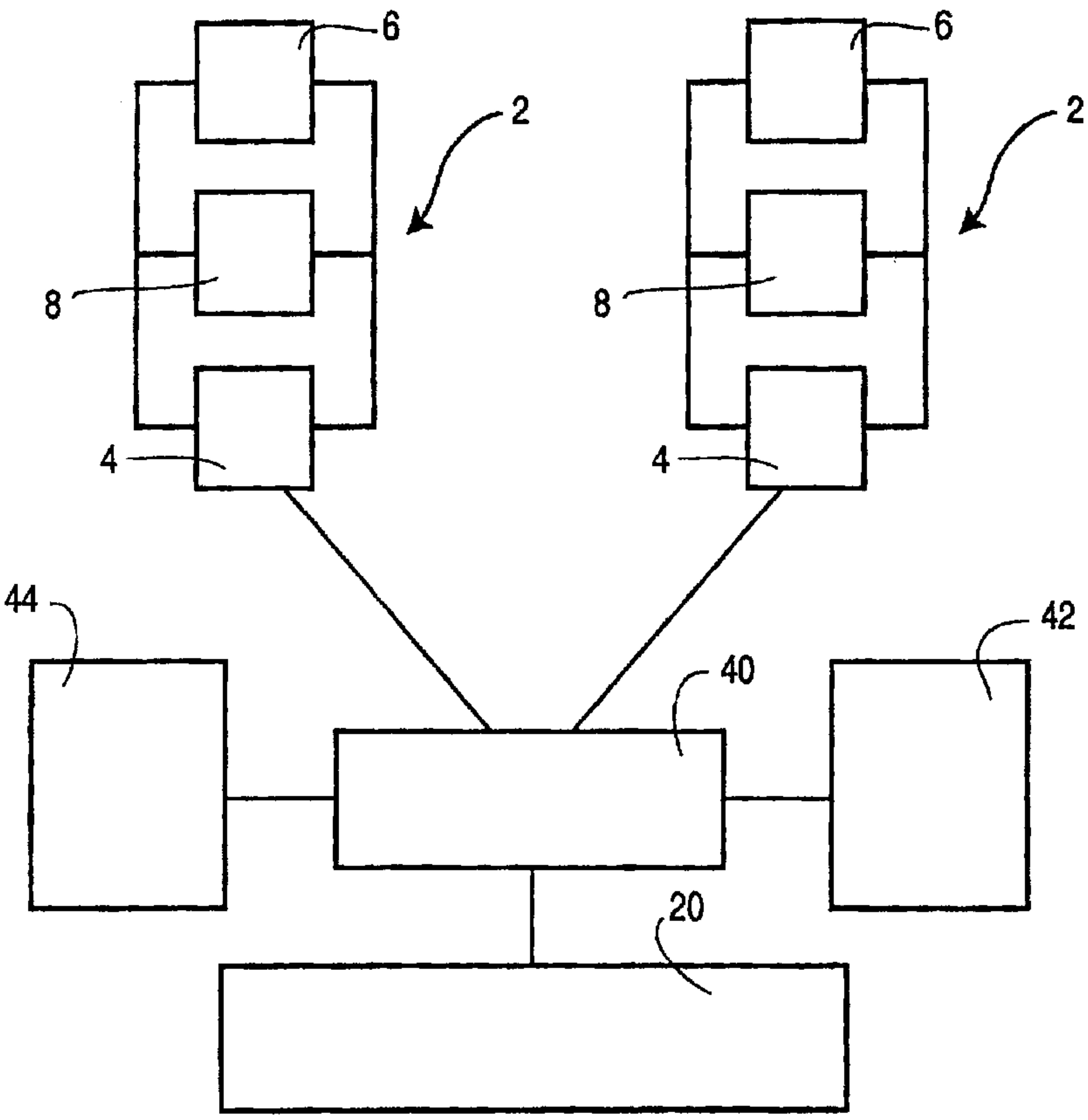
(54) Title: ALL WHEEL DRIVE FOR MOTOR GRADER



(57) Abrégé/Abstract:
A full hydrostatic transmission is used as part of an all wheel drive system of a motorgrader. Each front wheel includes its own drive system comprising a pump, a hydraulic motor and a bypass valve. The bypass valve protects the motor automatically from cavitation conditions and allows the hydrostatic transmission avoid hydrostatic braking.

ABSTRACT OF THE DISCLOSURE

A full hydrostatic transmission is used as part of an all wheel drive system of a motorgrader. Each front wheel includes its own drive system comprising a pump, a hydraulic motor and a bypass valve. The bypass valve protects the motor automatically from cavitation conditions and allows the hydrostatic transmission avoid hydrostatic braking.

TITLE: ALL WHEEL DRIVE FOR MOTOR GRADER

BACKGROUND OF THE INVENTION

The present invention relates to drive control arrangements for motor graders and in particular, relates to an all wheel drive arrangement for motor graders and other vehicles.

All wheel drive arrangements for motor graders have the advantage that the front drive wheels can compensate for poor traction conditions experienced by the tandem drive. The front wheel drive can operate in a passive mode where the front wheels only form part of the primary drive when there is slippage of the tandem drive. This passive mode basically allows the front wheel drive to respond when slippage has occurred on the tandem drive while in good traction conditions, the grader acts as if it is only driven by the tandem drive.

All wheel drive systems allow a variation in the level of aggression of the front wheel drive and the front wheel drive can be set to be faster than the tandem drive. This aggressive mode is not the most cost efficient manner of operating the grader but it is desirable for certain applications.

Existing front wheel drive arrangements for motor graders use a hydraulic motor which is supplied with hydraulic fluid under pressure for providing the necessary drive of the front wheels. There is a common hydraulic pump that supplies hydraulic fluid to each of the hydraulic motors and a flow control valve distributes the amount of hydraulic fluid to each motor. Control between the two motors is based on control of the distributing valve. Various sensors are used for sensing the speed of the front wheels, rear wheels, ground speed and other parameters which sensors are connected to a controller which controls the speed of the pump as well as the position of the distribution valve. With this arrangement, fine adjustment between the drive of the front wheels is difficult to achieve.

The present invention uses a different drive arrangement where each front wheel has its own hydraulic circuit and is hydraulically separated from the hydraulic circuit of the other drive. This drive arrangement provides increased control and sensitivity in adjustment of the system.

In a preferred embodiment a bypass valve is used to control the switching of the hydraulic circuit from an open circuit to a closed circuit. This by-pass valve automatically adjusts to changing conditions and appropriately switches the conditions of the drive arrangement.

The present invention allows an all wheel drive which additional works in a creep mode where only the front wheels are driven.

The particular drive arrangement for each front wheel drive allows simplified control logic due to the automatic response of the by-pass valve to changing hydraulic conditions as opposed to electrically driving such a by-pass valve to respond to changing conditions. The particular hydraulic circuit automatically responds to the changing conditions and causes the hydraulic circuit to appropriately respond.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are shown in the drawings, wherein:

Figure 1 is a perspective view of a motor grader;

Figure 2 is a top view of a motor grader showing the tandem and front wheel drives and various sensors;

Figure 3 is a simplified schematic view of the hydraulic circuit of one of the front wheel drives;

Figure 4 is a schematic view showing the tandem drive and two separate drives for the front wheel of the grader and a control arrangement;

Figure 5 is a perspective view of a variable displacement motor;

Figure 6 is a sectional view of a variable displacement pump;

Figures 7 and 8 are schematic views of a particular hydraulic motor for the front wheels;

Figure 9 is a control logic chart for the all wheel drive controller;

Figures 10A, 10B and 10C show details of the hydraulic circuit of the two front wheel drive systems;

Figures 11 through 15 show various conditions of the bypass valve;

Figure 16 shows the overall all wheel drive logic flow chart;

Figures 17A and 17B show the logic associated with the calibration mode of the system;

Figures 18A and 18B show the control logic associated with the creep mode; and

Figures 19A, 19B and 19C show the control logic associated with the normal all wheel drive mode.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 schematically illustrates a motor grader 1 having a frame 3, an operator's cab 7, and a motor 9 which drives a tandem drive 20. The grader has a mold board 5 suspended beneath the frame and includes front wheel drive arrangements to either side of the grader.

The top view of the motor grader as illustrated in Figure 2 has additional components used to control the all wheel drive arrangement of the grader. Each front wheel drive system 2 includes a variable output pump 4, a hydraulic motor 8, which is driven by the pump and drives the front wheels of the grader, and a condition sensing by-pass valve 6 associated with the hydraulic motor 8. Brake and clutch sensing mechanism 28 is shown as well as the all wheel drive control panel 24 and the transmission control all wheel drive control module 26.

Each of the front wheel drive systems 2 include their own accumulating tanks 7 for excess hydraulic fluid. The grader frame is articulated generally about a point 23 in front of the motor 9. The front wheel drive system 2 is duplicated to either side of the motor grader. Each drive system works independently and one such drive system is schematically shown in Figure 3. The variable output pump 4 is connected to the hydraulic motor 8 and the automatic condition sensing bypass valve 6 separates the pump from the motor. The pump 4 and the hydraulic motor 8 is shown in greater detail in Figures 5 and 6 respectively.

The controller 34 of the pump receives a current input signal and based on the current, provides adjustment output of the pump. The pump is by-directional and therefore allows the motor to operate in either a forward or reverse direction. The pump can also be in a neutral position where it does not pump any hydraulic fluid. The hydraulic motor 8 has an operating position where the pistons of the motor are connected to an output drive member and a free wheel position where the pistons are separated from the drive member. In this free wheel position, the pistons of the motor are biased to a clear position and the motor can free wheel.

The automatic sensing bypass valve 6 either renders the hydraulic circuit to the motor open or closed. In the closed position, the motor is driven by the pump as a typical hydrostatic drive, whereas in the open position, the hydraulic fluid by-passes the motor (to avoid hydrostatic braking) or supplies hydraulic oil being outputted by the motor back to the inlet of the motor to avoid cavitation in an overdrive condition.

As shown in Figure 4, the all wheel drive arrangement of the motor grader has two separate front wheel drive systems 2 which work independently of one another hydraulically, yet are controlled by the controller 40. The controller 40 effectively coordinates the front wheel drive systems with the tandem drive system of the grader. The controller receives a number of inputs including inputs from the sensors generally shown as 42 and from the operator controller 44. The coordination of the drive arrangement between the front wheel drive system and the tandem drive system is simplified due to the automatic condition sensing by-pass valves 6. In addition if steering angle and/or articulation angle are sensed, each pump can be adjusted to provide appropriate aggressive front wheel drive during cornering.

These bypass valves cause the hydraulic circuit of each motor 8 to assume a bypass condition when the front wheels are being driven by the pump at a lesser rate than necessary to keep up with the drive of the wheels of the tandem drive arrangement 20. This is often referred to as a passive mode for the front wheel drive. Basically the front wheels are being driven by each pump 4, however, the front wheels are overdriving the motors 8 to keep up with the movement caused by the tandem drive arrangement.

This is a motor cavitation condition that is corrected by the bypass valve. The automatic condition sensing by-pass valves 6 produce an open circuit and thus protect the motors 8. Basically the motor can overrun as if connected to an overrunning clutch which is accomplished hydraulically. In the event that the tandem drive wheels start to slip, due to a lose of traction, the overdrive arrangement of the front wheels will cease and the automatic condition sensing by-pass valves 6 close due to a drop in pressure caused by the fact that the motors are not being overdriven, rendering the hydraulic circuits closed. The front wheels are then driven by the respective motors and the front wheels become the dominant traction component of the grader until such time as the tandem wheels cease to experience the slip condition. The bypass valves 6 sense these conditions hydraulically and as the pump is being operated it already has the necessary flow of hydraulic fluid to drive the motors and it is merely the closing of the circuit which is accomplished by the bypass valve. Thus the system rapidly switches from passive to aggressive front wheel drive while the drive system is a full hydrostatic system.

The all wheel drive system is also capable of being driven in an aggressive mode where the front wheels are over driven relative to the tandem drive. In this condition, which is a setting inputted by the operator using controller 44, the bypass valves are closed and the front drive wheels are active. Basically the pump is driven to produce a pressure that renders the circuit closed. The bypass valves still function to help protect the hydraulic motors 8 even in the aggressive mode. For example, when the grader is being turned and the motor speeds are such that one motor is overdriven. This condition is sensed by the by-pass valve and again, it operates to protect the motor from cavitation.

Figure 6 shows a cross section of the variable output pump of which is an axial piston pump manufactured by Sauer-Sundstrand. The pump includes a barrel and piston rotation arrangement where the pistons slide on a swashplate. The swashplate is adjustable and angled to vary the displacement of the pump. An electric displacement control unit 34 varies the position of the swashplate. This allows the output of the pump to be tailored to the needs of that particular front wheel.

Figure 7 and 8 illustrate a radial piston pump manufactured by Valmet Hydraulics. Figure 7 shows the hydraulic motor schematically in closed hydraulic circuit condition. This is a low speed high torque radial piston cam/lobe type motor. Oil ported to the pistons force the pistons against the cam, forcing the cam to rotate. The motor housing and wheel rotate with the cam.

Figure 8 shows the motor in a free wheeling mode where the pistons are not in contact with the cam. The cam housing and wheel rotate freely. This is the condition when the front wheel drive is off. The hydraulic oil which is normally in contact with the pistons that drive the pistons has been drained and is essentially not acting on the pistons. Spring arrangements and hydraulic pressure can be used to drive the pistons to the non contacting position of Figure 8.

The bypass valve 6 automatically senses a cavitation condition of the motor (overdrive condition) and opens the bypass valve to feed additional hydraulic fluid to the inlet of the motor. During actual braking or clutching the bypass valve is opened (by movement of the solenoids) such that hydrostatic braking is avoided.

The front wheel drive systems define a full hydrostatic drive that operates in a passive or aggressive mode and is actually driven in these modes to be available if slippage of tandem drive occurs and the front systems are in passive mode. In such a condition the motors of the front systems prior to slippage are driven by the respective motors and additional fluid is provided by the bypass valves to avoid cavitation. Slippage of the tandem drive results in a change in hydraulic pressures and closing of the bypass valves resulting in front wheel drive. The pumps are always pumping and the pistons of the motor are in contact with theses drive components. Therefore, the transition is accomplished smoothly and quickly.

Hydrostatic braking is avoided by opening the bypass valve whereby normal braking using the tandem braking continues. A further advantage of the front wheel drive system is the protection of the hydraulic motors. The bypass valve automatically senses cavitation conditions and opens to supply the necessary additional fluid while continuing to be driven

A full hydrostatic front wheel drive system is used which recognizes that pump adjustment to compensate for many changing conditions is impractical. The bypass valve provides an automatic clutch like function, provides a differential function for cornering, provides cavitation protection, provides passive and aggressive modes in a full hydrostatic drive, allows the systems to avoid hydrostatic braking, and maintains the pump and motor in a full function condition for fast return to an aggressive drive condition. The bypass valve also allows greater flexibility in changing drive settings on the fly.

In creep mode the bypass valve is preferably closed by adjustment of the solenoids such that a full hydrostatic drive with hydrostatic braking is provided. The operator uses the throttle position to accelerate or decelerate. The tandem braking system remains active and can open the bypass valve when actuated.

Figure 9 shows details of the control logic used for the all wheel drive arrangement. Each of the pumps are initially driven to a nominal start value to provide hydraulic fluid to the motors. Input is received regarding the desired front wheel target speed and a comparison is made between the actual front wheel speed of each drive wheel system and its own target. If the wheel speed is within a very tight tolerance, the process is repeated. If the wheel speed is outside this close tolerance and is within a somewhat less demanding tolerance, then a decision is made to produce a small size signal correction which is fed to the controller of the pump.

If it is outside this close tolerance, a fuller decision is made whether the pump signal is within upper and lower limits, and if it is within the upper and lower limits which define normal operating ranges then a large signal correction is made. In contrast, if the pump is outside the upper and lower limits then a decision is made to hold the signal at the limit. In this way, upper and lower limits are set for each pump and different incremental adjustments are made to the pump signal in accordance with the condition sensed.

The detailed hydraulic circuit of Figures 10A, 10B and 10C illustrate various controls of the front wheel drive systems. On the right hand side of the drawing, a right pump 4A and a left pump 4B are shown. Right pump 4A is connected to a right side free wheeling valve 31A and a left free wheeling valve 31B is connected to left pump 4B. These valves cause each of the respective motors 8A and 8B to operate in the free wheeling position as shown in figure 8. Each circuit also has the bypass valve 6A and 6B respectively. The circuits include a common charged pump which provides a minimum pressure to the systems.

The automatic condition sensing by-pass valves 6 can be better understood from a review of figures 11 through 15. Each by-pass assembly consists of two solenoid operated two position three-way valves, one pilot operated logic element and one shuttle valve. The logic element (bypass) shifts to either the open or close position depending upon pressure acting on three differential areas. The solenoids are controlled to determine whether the device operates in a forward or reverse direction. In addition, DCV3 and DVC4 will be de-energized when a clutch or brake is actuated and/or when the all-wheel drive on/off switch is in the on position and the grader is in neutral or in 8th gear. The 8th gear is the highest gear and the all wheel drive is not in use in this position. Similarly, when the grader is in neutral this system is off. The bypass valve is open in 8th gear but the pump and motor are operating should a shift to 7th gear be made. The operating parameters of 8th gear cause the valve to open.

Activating the brake or clutch stops the direct drive of the front wheels. When oil flows in the motor through the B port, this defines the forward operation whereas when oil is provided through the A port, this defines the reverse operation. Basically, the forward bypass solenoid and the reverse bypass solenoid are set by the operator and similarly the input regarding the brake and clutch merely de-activate the system. The bypass valve generally forms the hydraulic equivalent of a sensitive over running clutch in function.

In a passive mode, the bypass valve receives input from the motor causing a hydraulic pressure which is higher than the pressure being provided by the pump. The bypass valve operates to bypass fluid either side of the motor and the wheels can merely react to the drive of the tandem drive without damaging the motor. In contrast, when the tandem drive starts to slip the front wheels are no longer over driven causing a reduction in pressure, causing the pump pressure to be higher and the bypass valve automatically closes and the pump drives the front wheels. This is accomplished automatically and quickly.

Figure 12 shows the bypass valve where the all-wheel drive is switched on and a grader is in neutral. The bypass valve is shifted to a bypass position due to the fact the grader is in neutral and the pump pressure is low.

Figure 13 shows the all-wheel drive on with the grader moving forward. The bypass valve is closed and oil flow is directed to the motor.

Figure 14 shows the position of a valve when the operator actuates the clutch or brake. This results in the bypass valve being shifted to the open circuit condition.

Figure 15 illustrates the position of the bypass valve when the operator makes a right turn. In such a case, the left wheel is driven faster by the grader and the full rate of oil supplied by the pump does not increase as the wheel speed increases. Drive pressure drops off eventually to the charged pressure. Oil flow returning from the motor increases as motor speed increases and this increase in braking pressure causes the bypass valve to open once the braking pressure is higher than the bypass valve spring pressure. This allows the left wheel to assume the correct speed as the output of the motor is connected to the motor input and then provides the necessary additional fluid and avoids cavitation. The pistons remain in contact with the cam and are ready when the condition is removed.

Figure 16 shows the overall all-wheel drive logic flow chart. In this case when the controller is powered up, it looks to see whether there are abnormal conditions and also checks whether calibration has been performed or should be performed. It then checks to see whether the all-wheel drive is on or off and further checks whether it has been placed in creep mode. In creep mode, the tandem drive is disconnected and the grader is driven merely by the front wheels. The maximum creep mode speed is less than 3 m.p.h. and preferably 2 m.p.h. or less.

Figures 17A and 17B show detail of the logic associated with the calibration mode. Figures 18A and 18B show control logic associated with the creep mode of operation and Figures 19A-19C show detail associated with normal all-wheel drive mode.

In the creep mode, the current provided to the hydraulic pump of each drive system 2 is a function of the engine RPM. Creep mode is used for very fine finishing grading. With such grading it is desirable to disconnect the tandem drive to avoid any scuffing or damage caused by turning. A large engine RPM range is used to allow the operator fine control with respect to the particular creep speed.

The present all-wheel drive arrangement has recognized that there are vary significant control logic advantages to having separate drive systems for each front wheel of the grader. The actual hydraulic flow to each hydraulic motor can be more precisely controlled by varying the output of the particular pump. In addition the condition sensing bypass valve allows rapid opening and closing or switching of the hydraulic circuit between an opened and a closed configuration. This allows the drive wheels to assume an active mode when they are in a passive condition and slippage of the tandem drive occurs. The automatic bypass valve simplifies the control logic. Electric control arrangements which operate valves are not as fast and the sophistication of the control logic is significantly greater particular in the light of many different modes and speeds in which the system operates.

Although various preferred embodiments of the present invention have been described herein in detail, it will be appreciated by those skilled in the art, that variations may be made thereto without departing from the spirit of the invention or the scope of the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An all wheel drive arrangement for a motorgrader comprising a tandem drive for rear wheels of the grader in combination with independent front wheel drives for each front wheel, each front wheel drive comprising a variable output hydraulic pump powering an hydraulic motor which drives the front wheel of the vehicle, said hydraulic motor being connected to said hydraulic pump via a hydraulic circuit, said hydraulic circuit including a bypass valve which in one position defines a closed circuit between said pump and motor and in a second position defines an open circuit where said motor is isolated from said hydraulic pump, said pump including a controller for adjusting the output of the pump in accordance with input signal; said all wheel drive arrangement being selectively operable in a passive mode where said front wheel drives are overdriven by said tandem drive or an aggressive mode where said front wheel drives tend to overdrive said tandem drive; each front wheel drive, when said all wheel drive arrangement is in a passive mode, being normally overdriven by said tandem drive and said bypass valve compensates by alternating between said open and closed circuit, said bypass valve automatically assuming a closed circuit position in the event of slippage condition of said tandem drive resulting in the temporary stoppage of the overdrive condition of said front wheel drives and the active drive of each front wheel drive until slippage condition ceases.

2. An all wheel drive arrangement for a motorgrader as claimed in claim 1 wherein said bypass valve of each front wheel drive automatically assumes said closed circuit based on changes in hydraulic fluid pressure of said hydraulic circuit.

3. An all wheel drive arrangement for a motorgrader as claimed in claim 2 wherein said arrangement includes an

arrangement for setting different levels of passive and aggressive modes.

4. An all wheel drive arrangement for a motorgrader as claimed in claim 2 wherein said drive arrangement includes a creep mode where only said front wheel drives are operative.

5. An all wheel drive arrangement for a motorgrader as claimed in claim 4 wherein said creep mode has a top speed of less than 3 miles per hour.

6. An all wheel drive arrangement for a motorgrader as claimed in claim 2 wherein said front wheel drives when turned off cause said motors to assume a free wheel condition.

7. An all wheel drive arrangement for a motorgrader as claimed in claim 1 wherein said drive arrangement includes an electrical controller which cooperates with a series of sensors to assess speed parameters of the drives of the grader and adjust each input signal to each pump as a function of sensed conditions.

8. An all wheel drive arrangement for a motorgrader as claimed in claim 7 wherein said controller receives operator instruction signals which determine a desired drive condition and said controller adjusts each input signal based on said desired drive condition and said assessed speed parameters.

9. An all wheel drive arrangement for a motorgrader as claimed in claim 8 wherein said assessed speed parameters include sensed front wheel speeds.

10. An all wheel drive arrangement for a motorgrader as claimed in claim 1 wherein said bypass valve of each front wheel drive senses actual hydraulic conditions of said hydraulic circuit and responds thereto to determine and produce the open or closed circuit condition.

11. An all wheel drive arrangement for a motorgrader as claimed in claim 10 each front wheel drive includes its own input signal which determines the output of the respective pump.

12. An all wheel drive arrangement for a motorgrader as claimed in claim 11 wherein each bypass valve allows the motor to be overdriven without cavitation to form the hydraulic equivalent of an overrunning clutch.

Figure 1

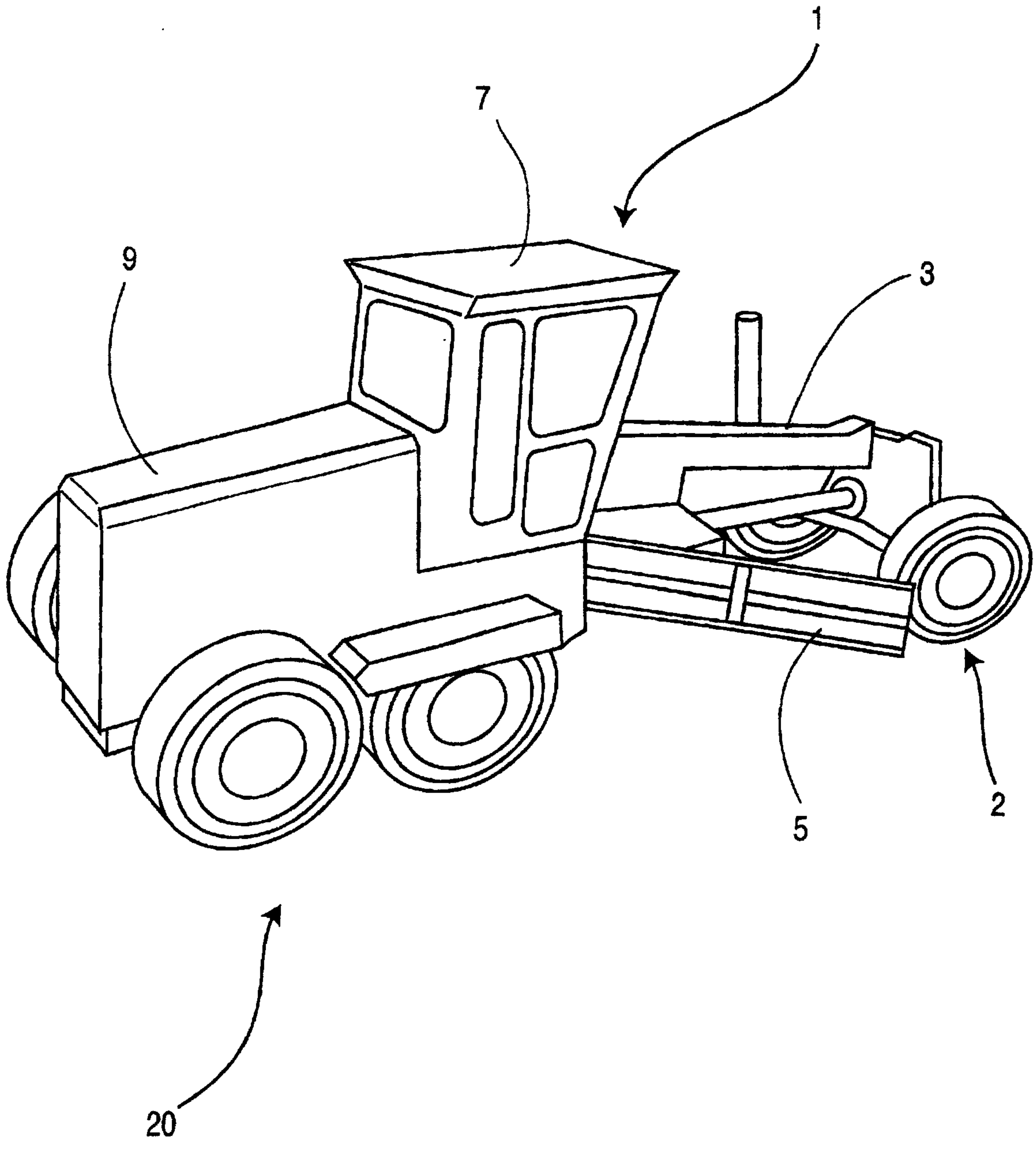


Figure 2

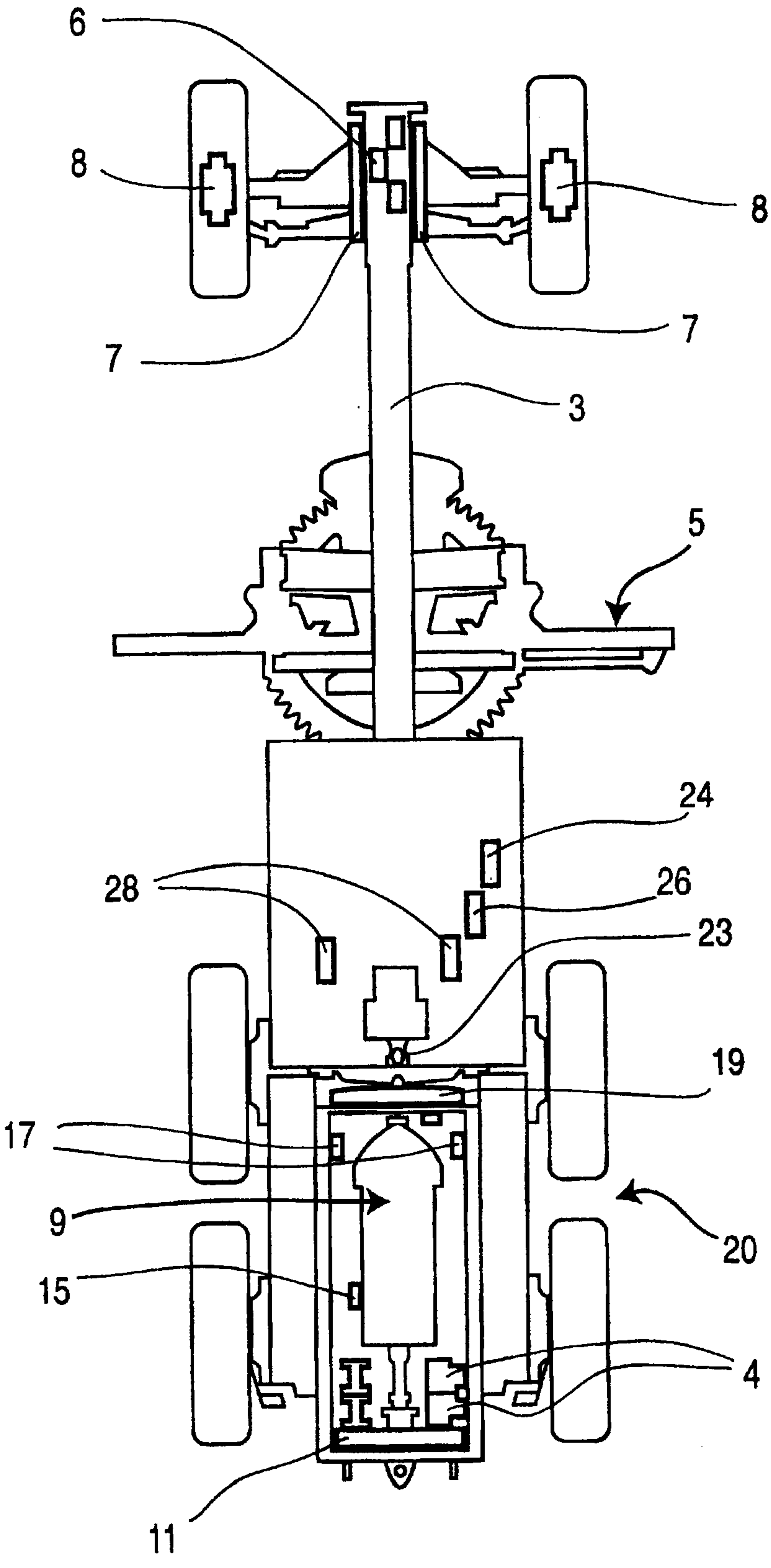


Figure 3

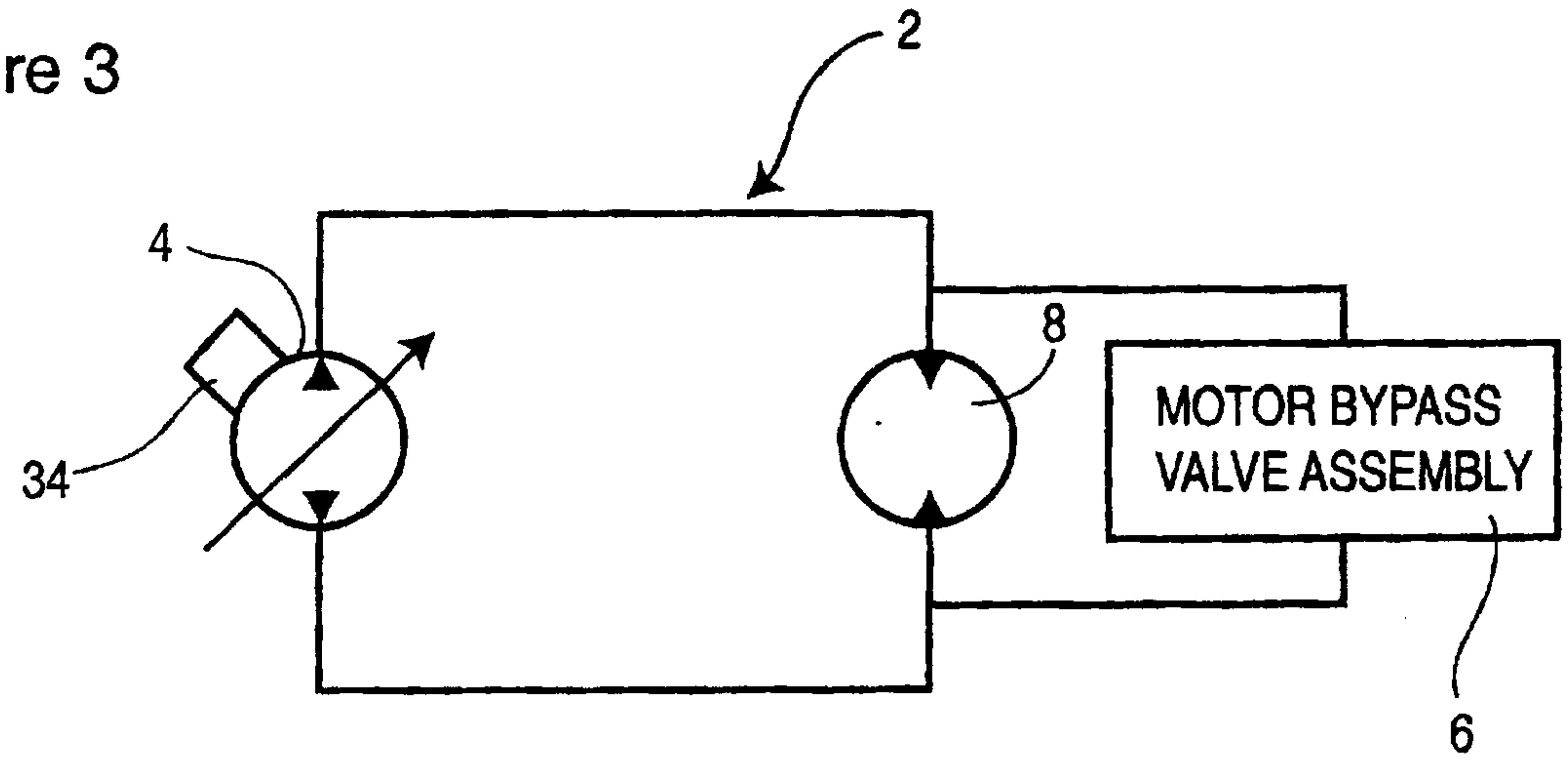
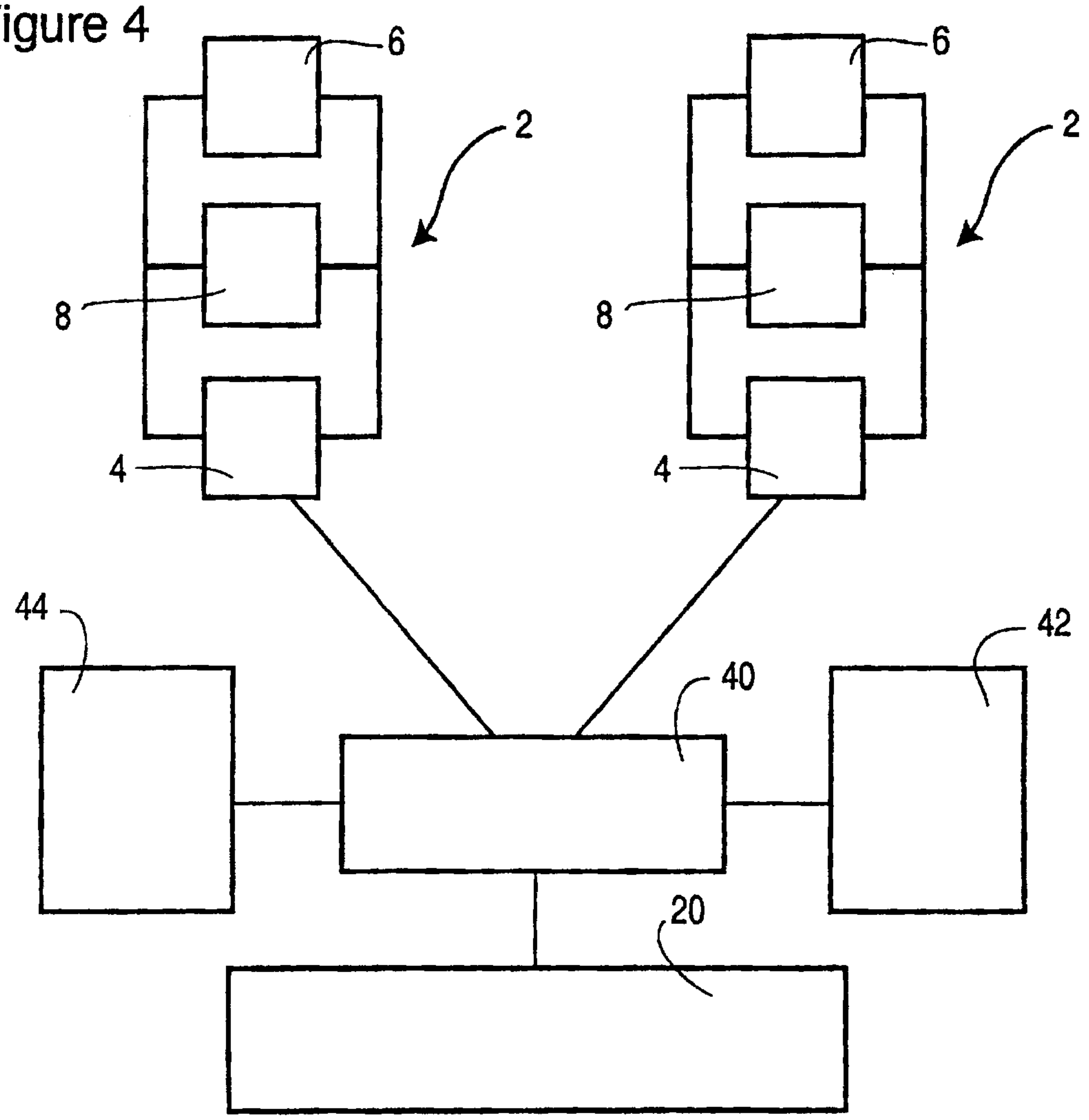


Figure 4



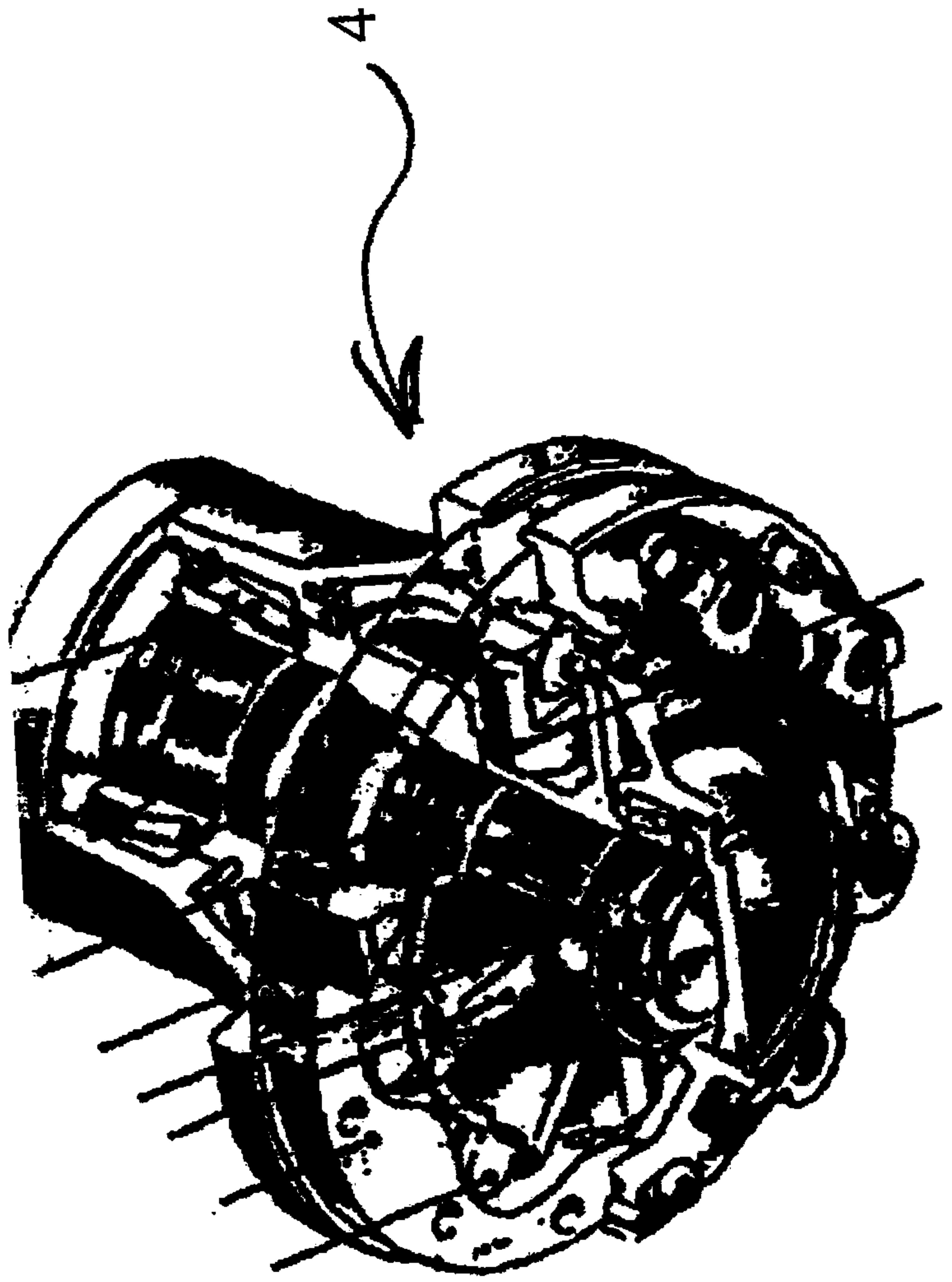


Figure 5

Figure 6

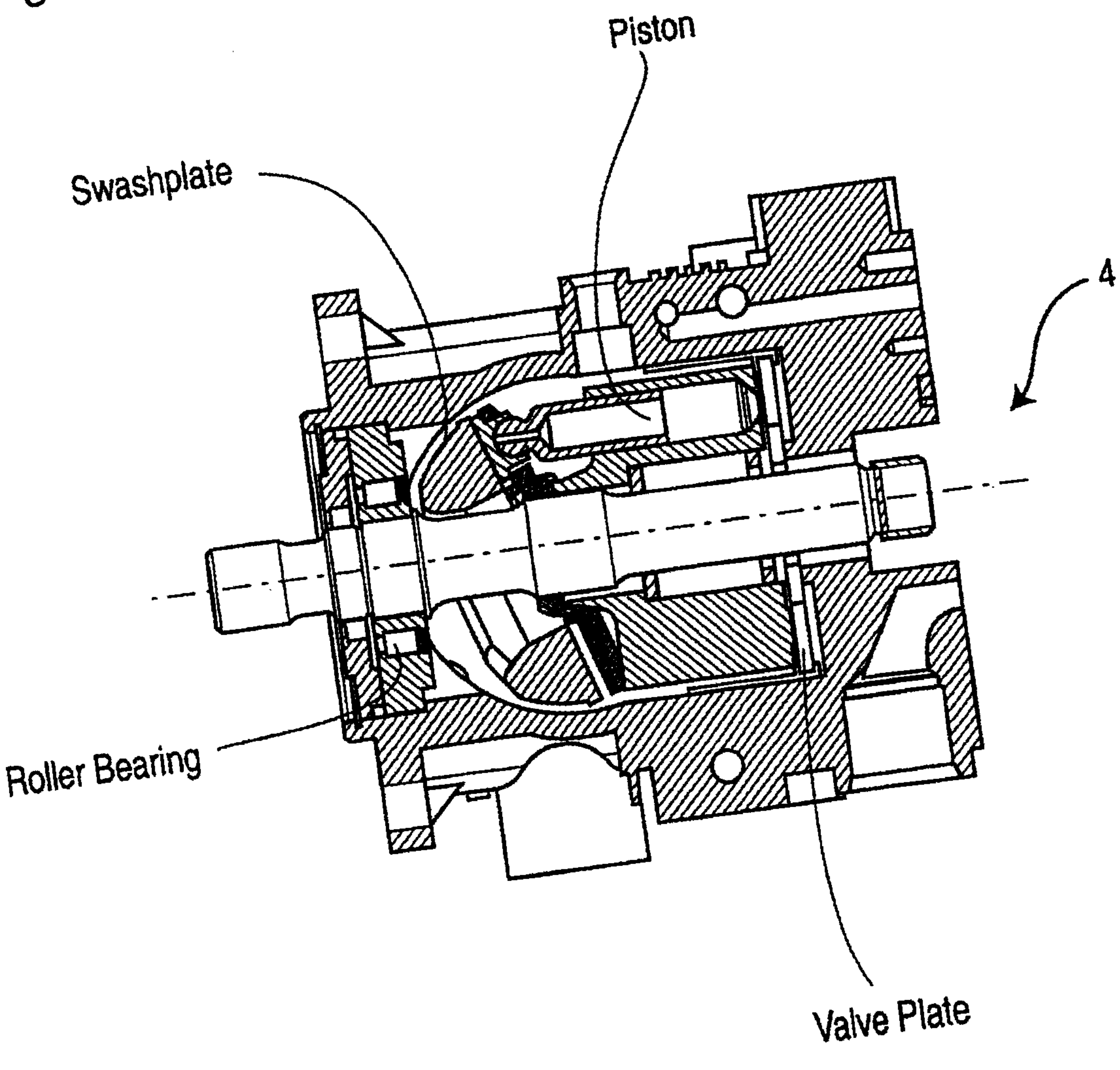


Figure 7

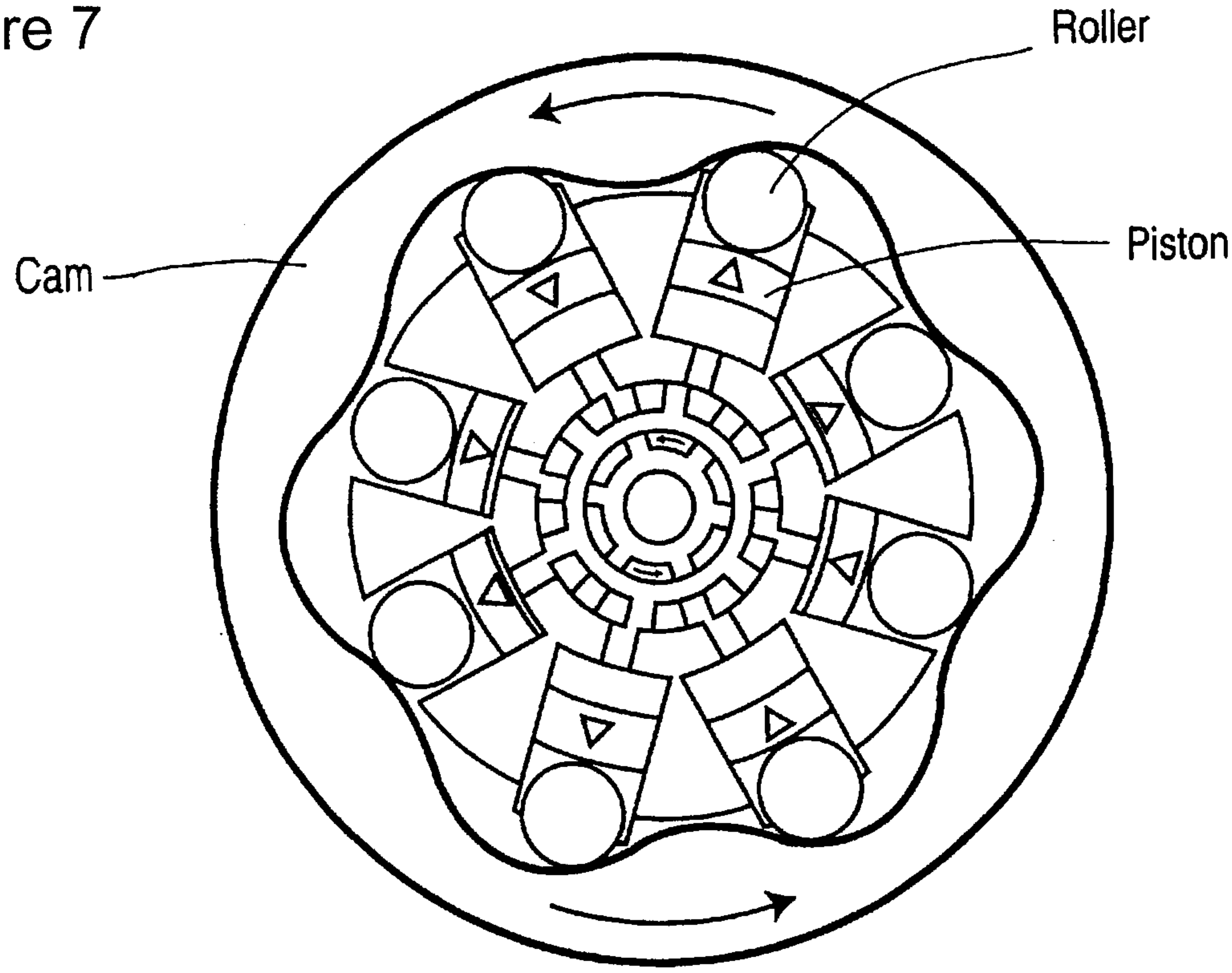


Figure 8

Free Wheeling Mode

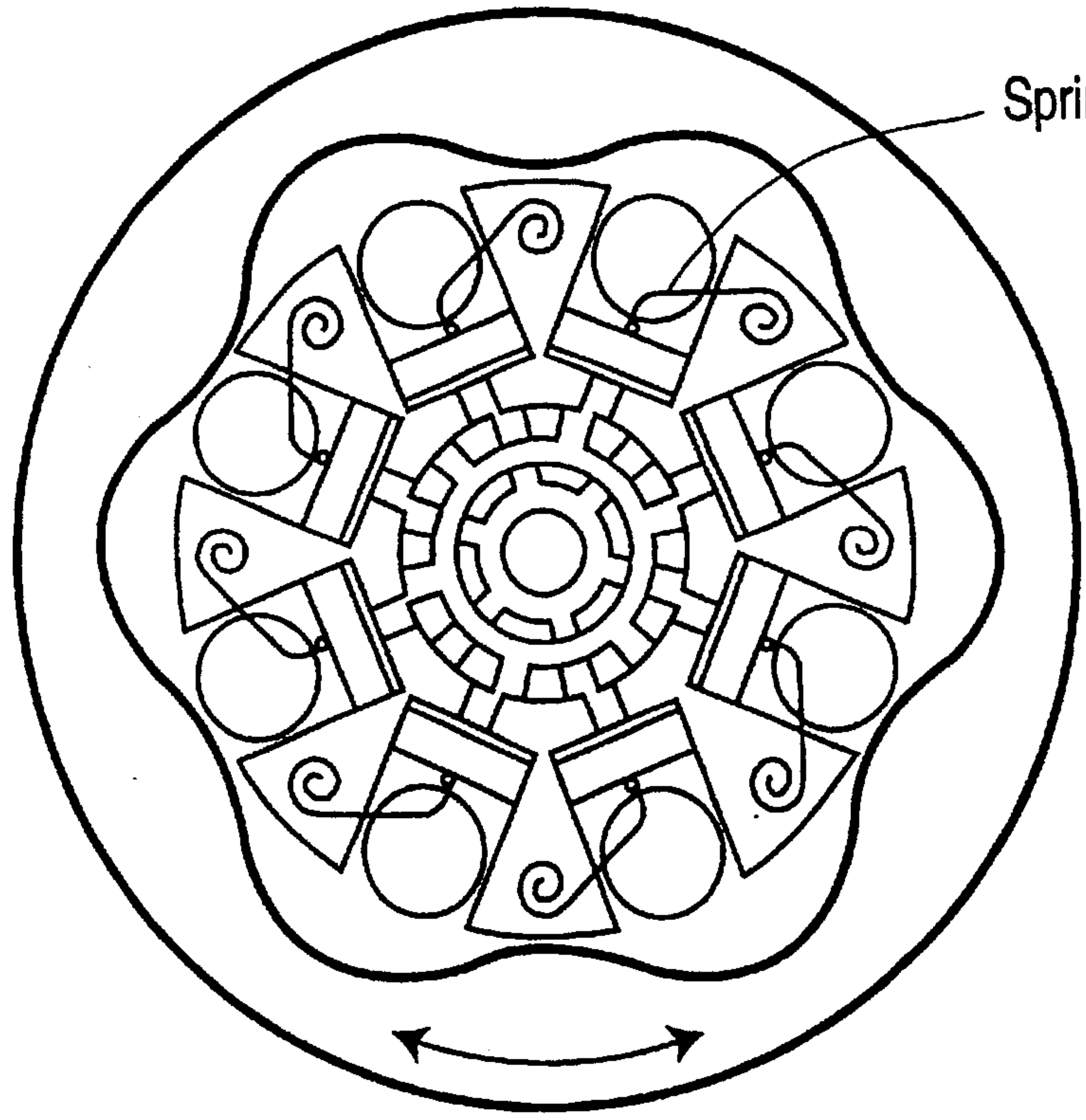


Figure 9

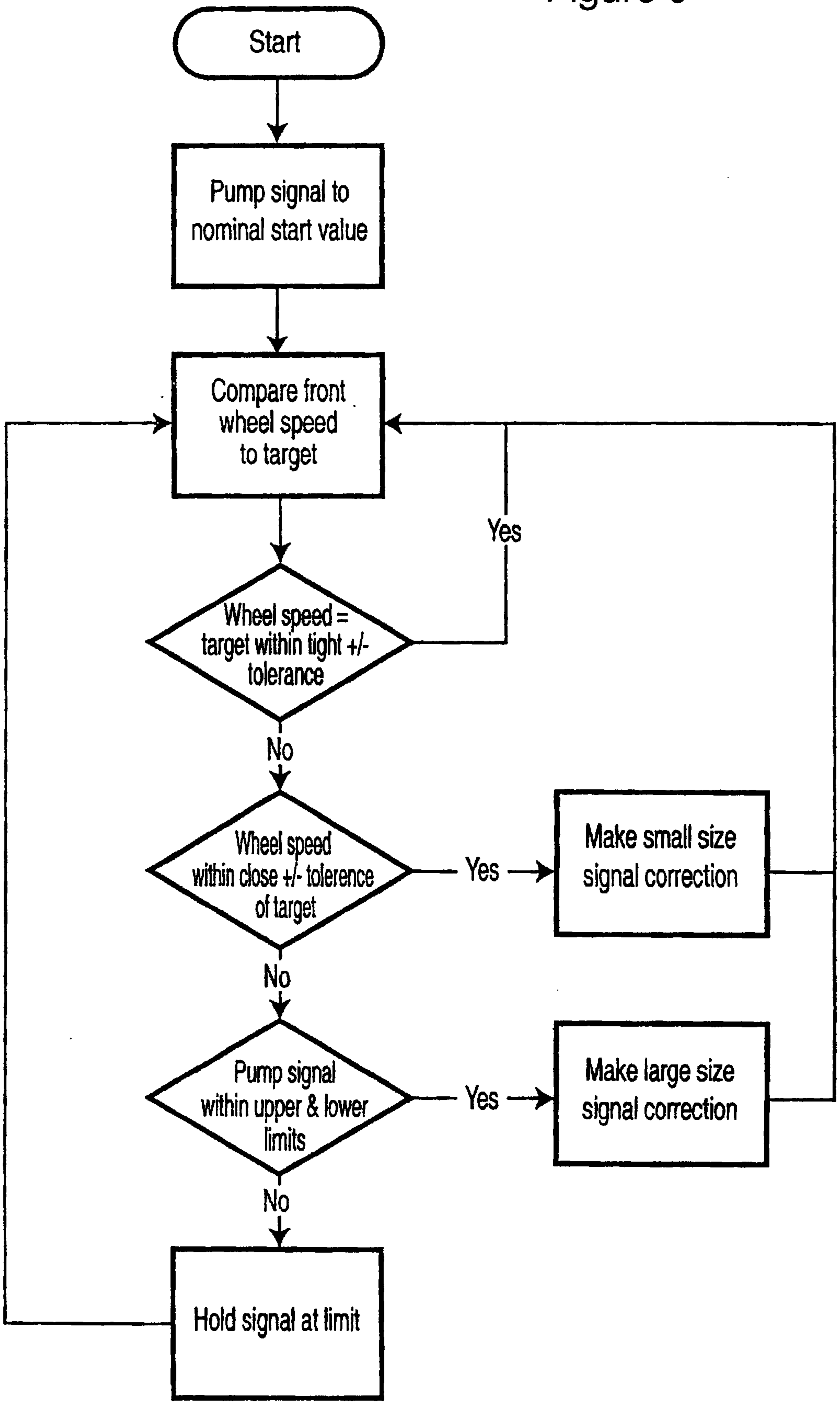
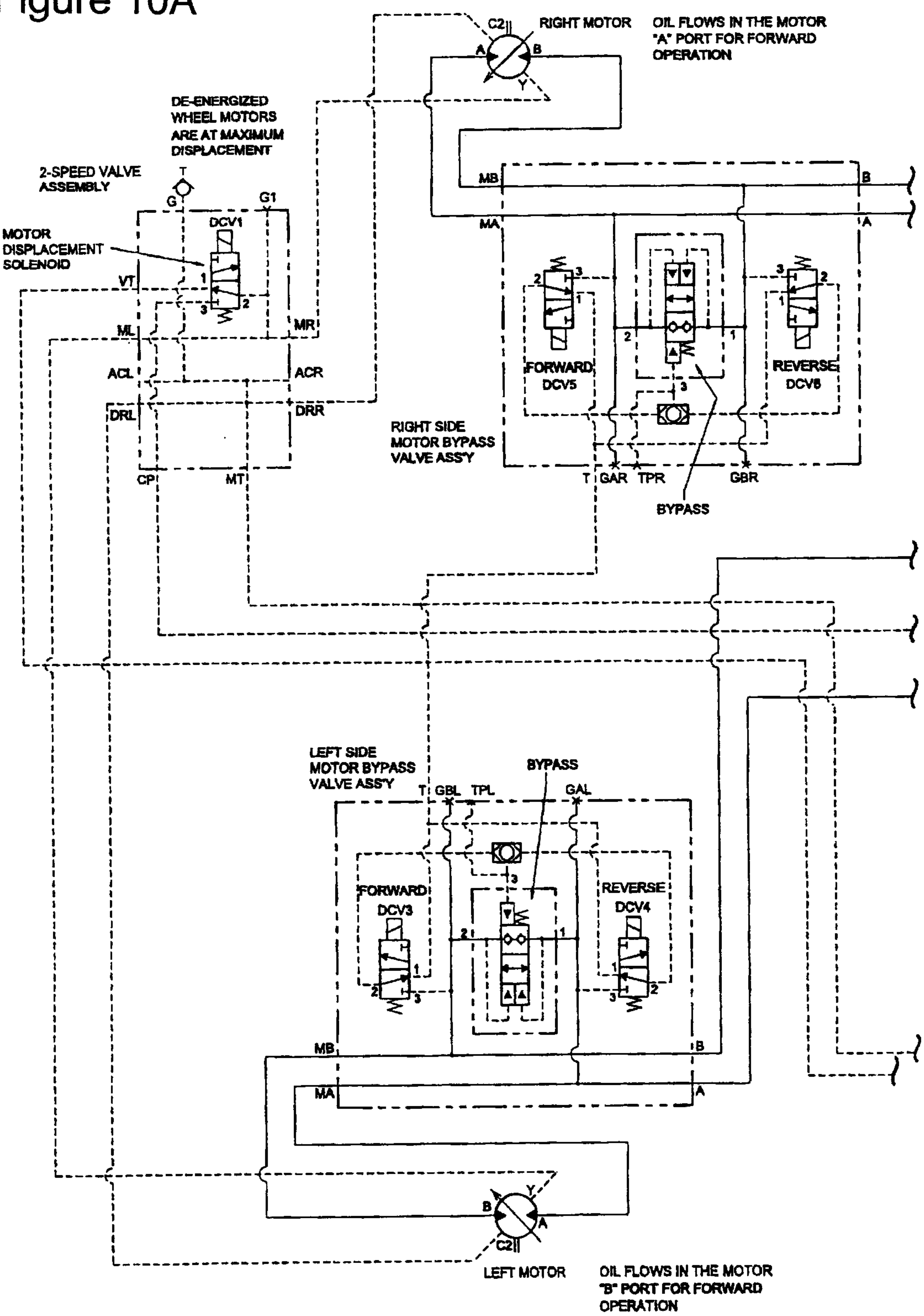

Start
Pump signal to nominal start value
Compare front wheel speed to target
Wheel speed = target within tight +/- tolerance
Yes
No
Wheel speed within close +/- tolerence of target
Yes
Make small size signal correction
No
Pump signal within upper & lower limits
Yes
Make large size signal correction
No
Hold signal at limit

Figure 10A



FORWARD BYPASS SOLENOID LH (DCV3)
REVERSE BYPASS SOLENOID LH (DCV4)
FORWARD BYPASS SOLENOID RH (DCV5)
REVERSE BYPASS SOLENOID RH (DCV6)

DCV3 AND DCV5 ARE ENERGIZED DURING FORWARD OPERATION
DCV4 AND DCV6 ARE ENERGIZED DURING REVERSE OPERATION

Figure 10B

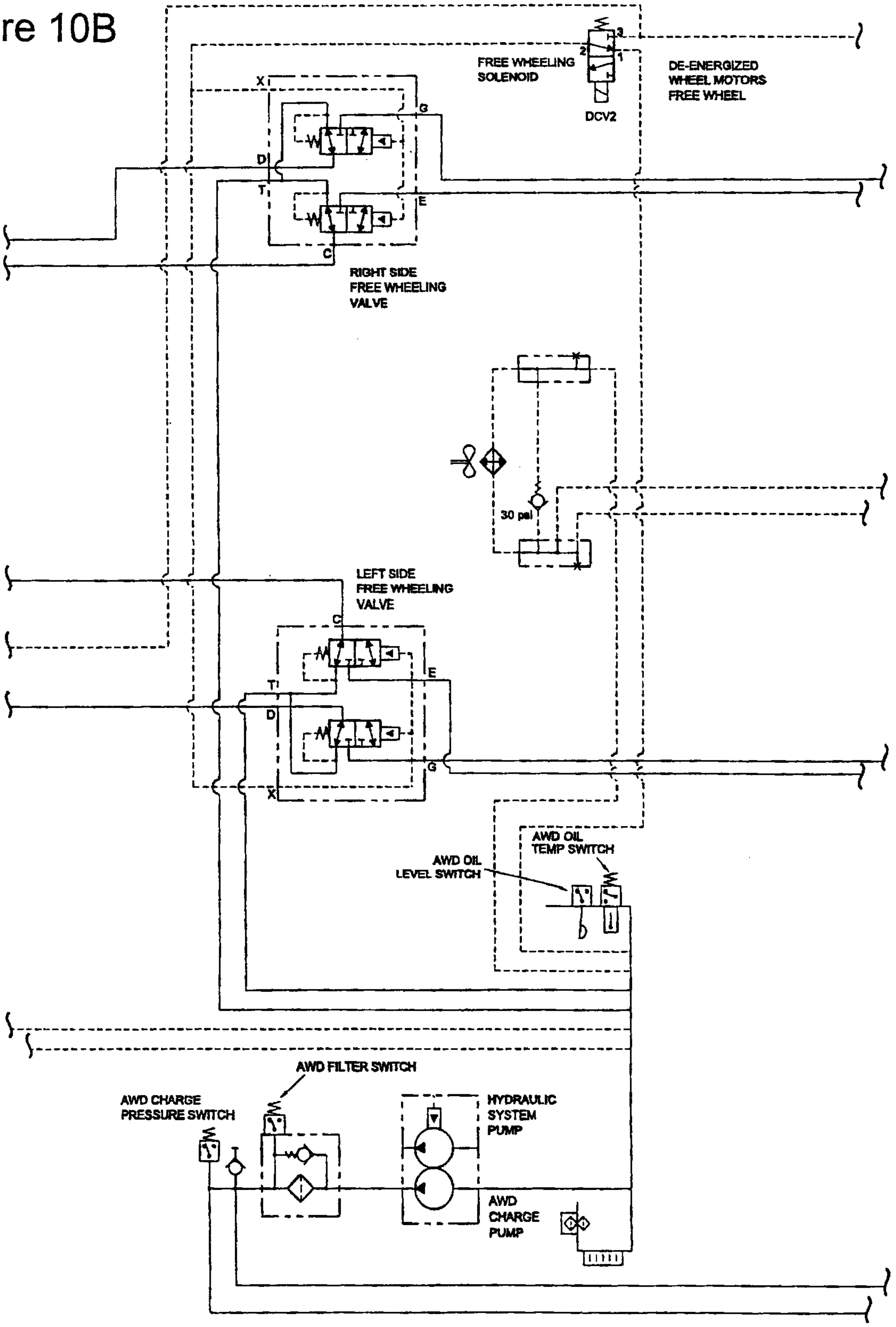
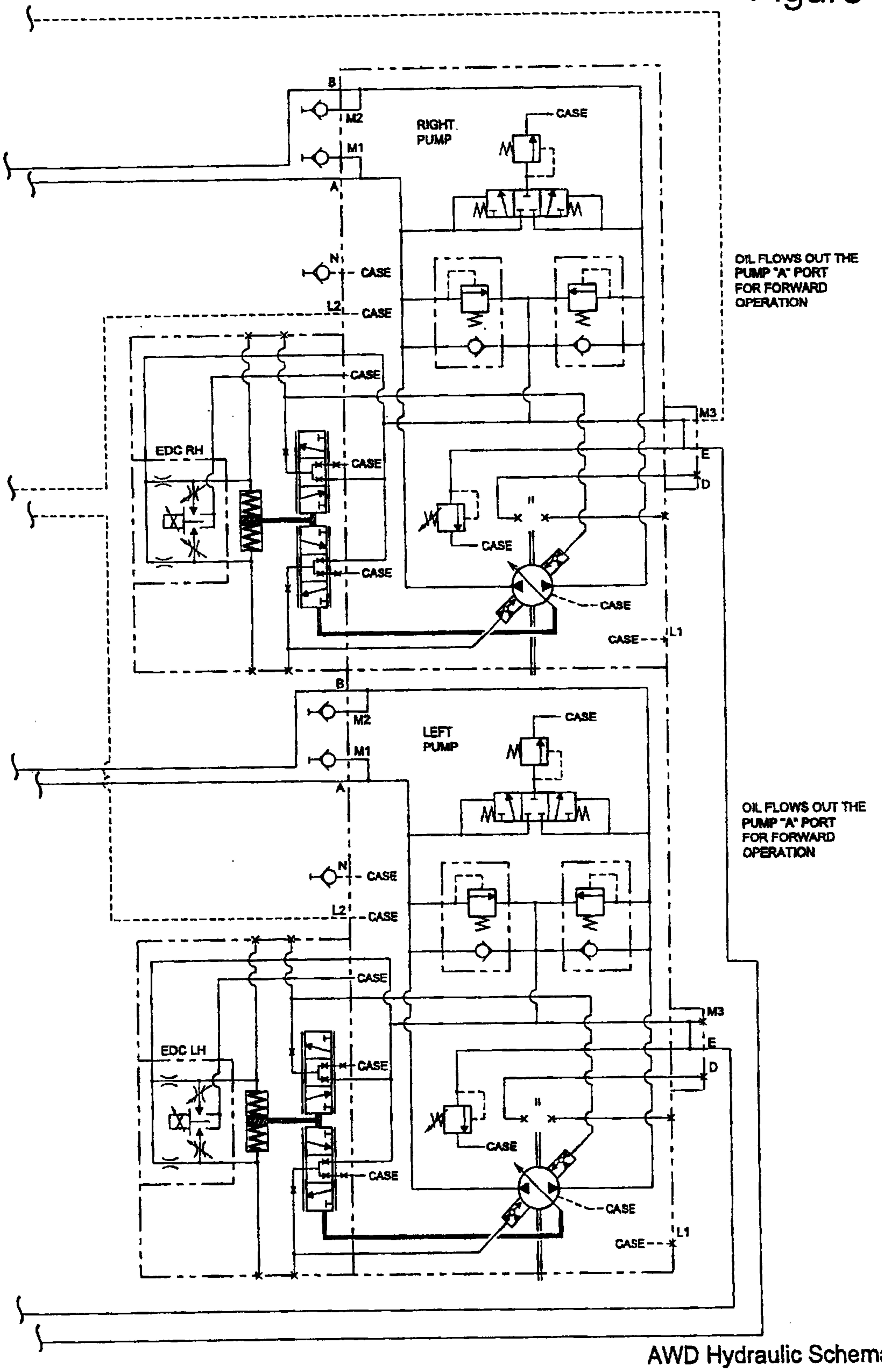

FREE WHEELING
SOLENOID
DCV2
DE-ENERGIZED
WHEEL MOTORS
FREE WHEEL
X
G
D
T
E
C
RIGHT SIDE
FREE WHEELING
VALVE
30 psi
LEFT SIDE
FREE WHEELING
VALVE
C
T
E
D
G
X
AWD OIL
TEMP SWITCH
AWD OIL
LEVEL SWITCH
AWD FILTER SWITCH
AWD CHARGE
PRESSURE SWITCH
HYDRAULIC
SYSTEM
PUMP
AWD
CHARGE
PUMP

Figure 10C



AWD Hydraulic Schematic

Figure 11

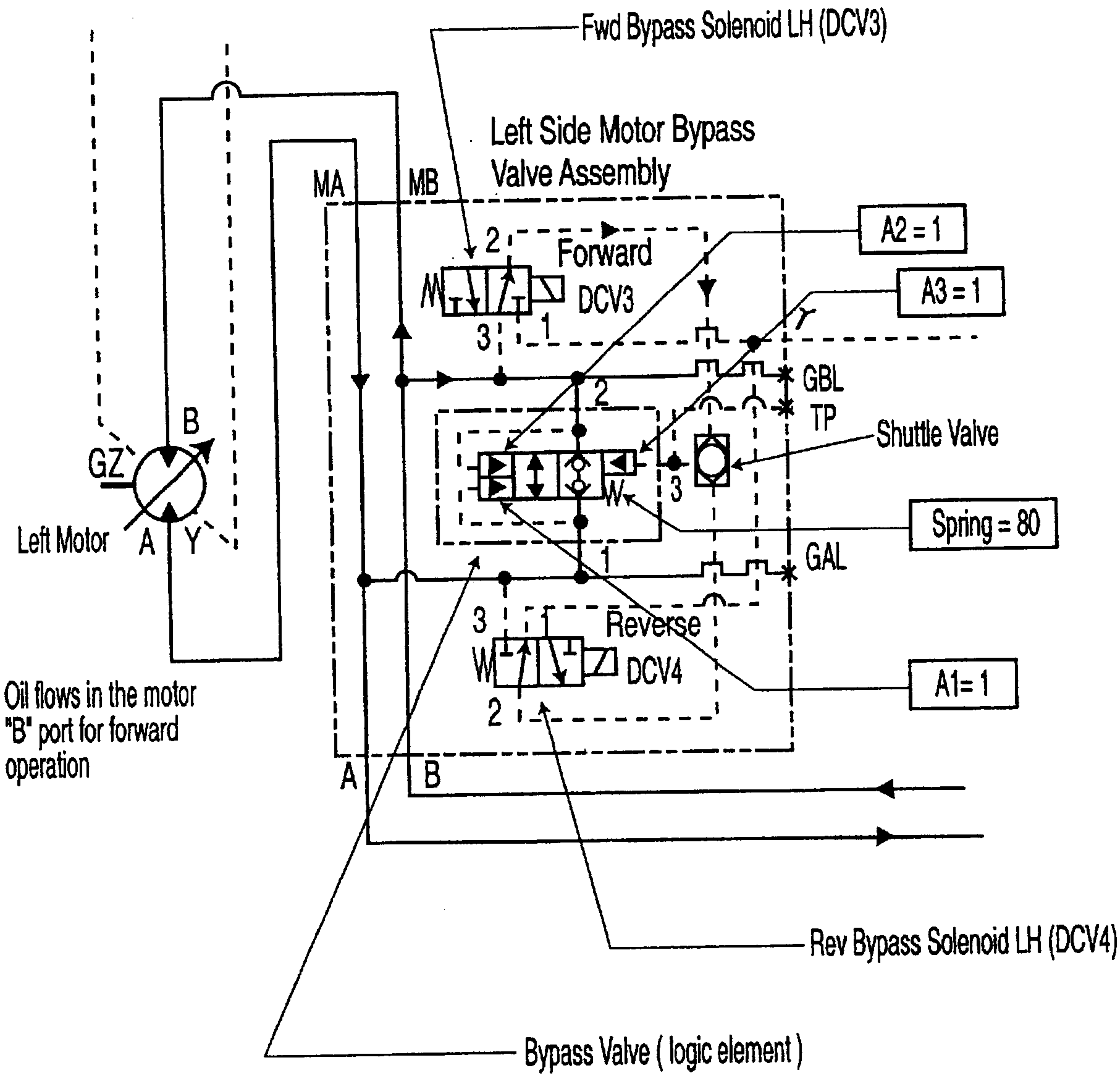

Fwd Bypass Solenoid LH (DCV3)
Left Side Motor Bypass
Valve Assembly
MA
MB
2
Forward
DCV3
3
1
A2 = 1
A3 = 1
GBL
TP
Shuttle Valve
2
3
Spring = 80
GZ
B
Left Motor
A
Y
1
GAL
3
Reverse
DCV4
2
A1= 1
Oil flows in the motor
"B" port for forward
operation
A
B
Rev Bypass Solenoid LH (DCV4)
Bypass Valve (logic element)

Figure 12

1) AWD Switch is "ON" and the grader is in neutral
- Fwd Bypass Solenoid LH (DCV3) is de-energized
- Rev Bypass Solenoid LH (DCV4) is de-energized
- The Bypass valve is shifted to the "bypass", position

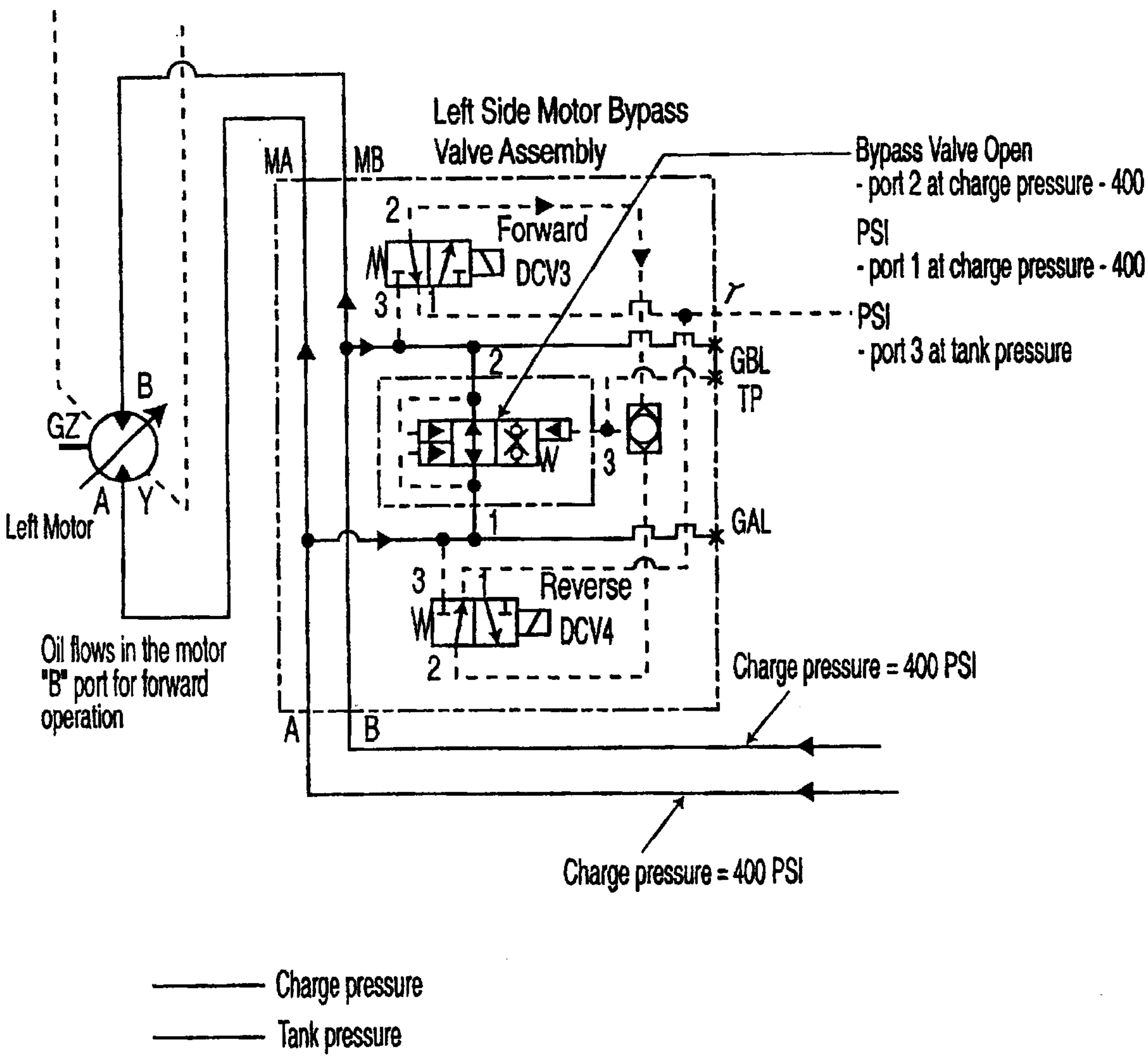


Figure 13

2) Machine driving forward with the AWD "ON"
- Fwd Bypass Solenoid LH (DCV3) is energized and shifted
- Rev Bypass Solenoid LH (DCV4) is de-energized
- The bypass valve will be closed and oil flow will be directed to the motor

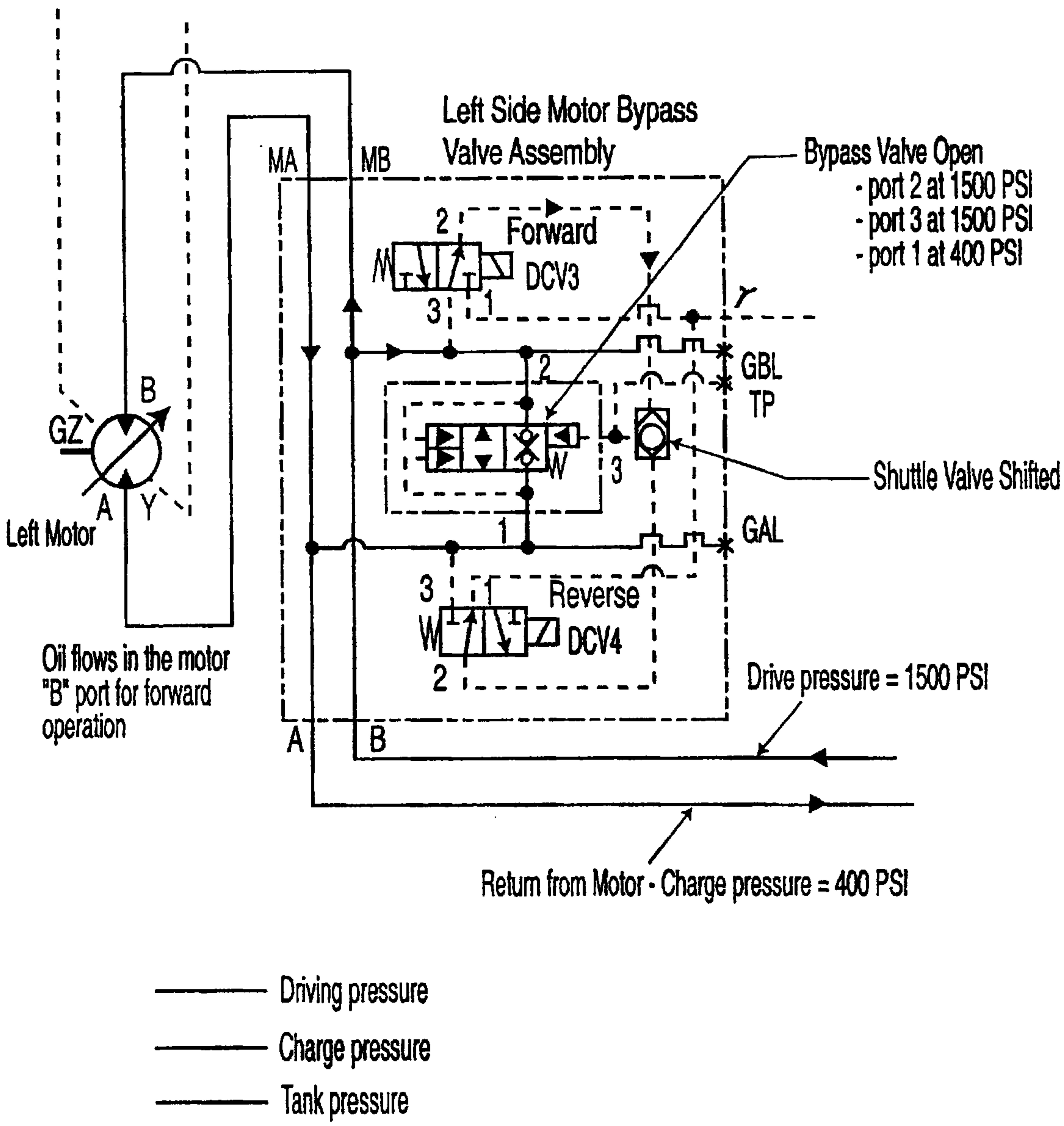


Figure 14

3) Grader is driving forward and the operator actuates the clutch or brake:

- Fwd Bypass Solenoid LH (DCV3) is de-energized
- Rev Bypass Solenoid LH (DCV4) remains de-energized
- The Bypass valve is shifted to the "bypass", position

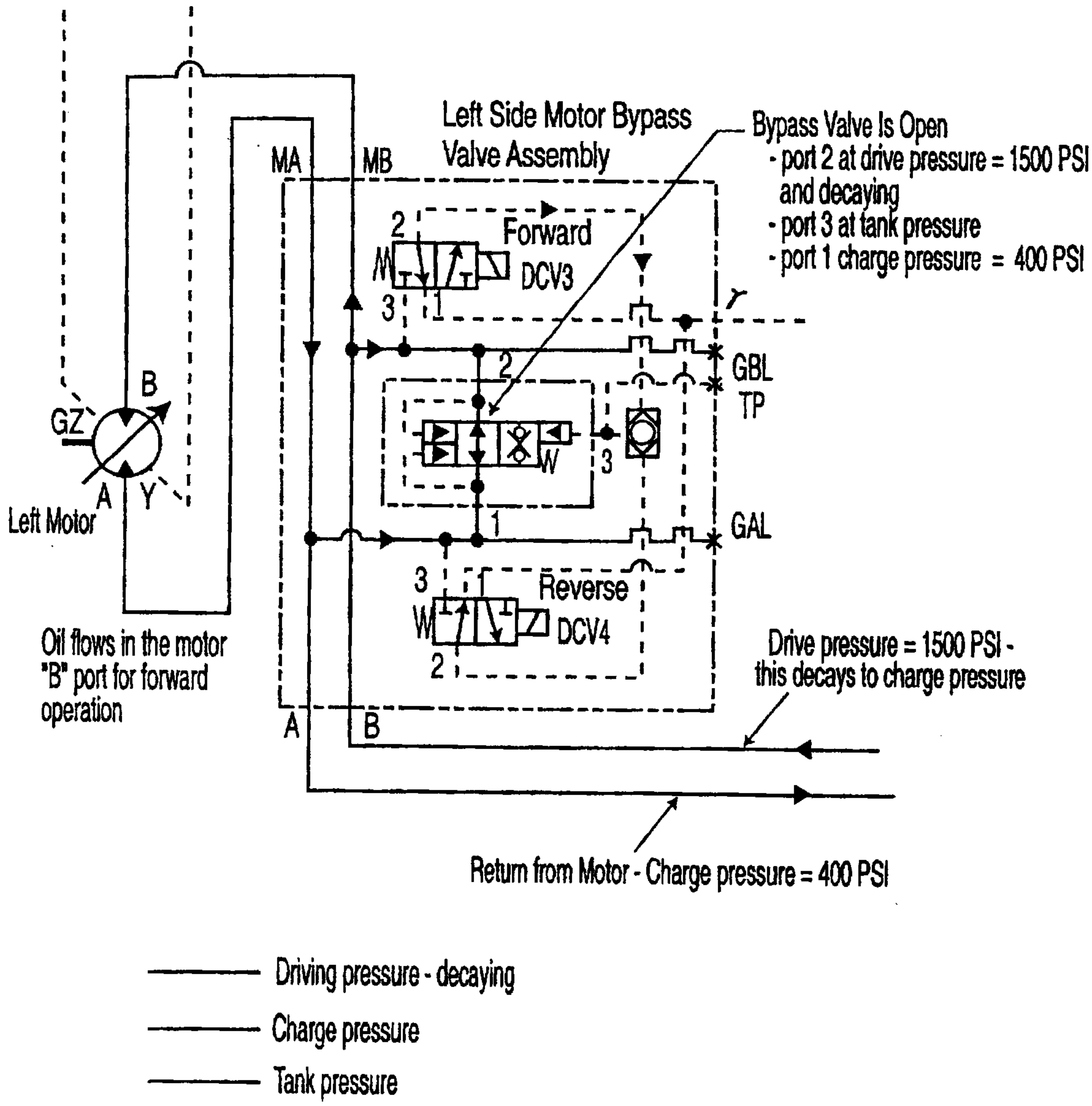


Figure 15

4) Grader is driving forward and the operator makes a right turn :

- Fwd Bypass Solenoid LH (DCV3) is energized
- Rev Bypass Solenoid LH (DCV4) remains de-energized
- Left wheel is driven faster by the grader - the flow rate of oil supplied by the pump does not increase as wheel speed increases - drive pressure drops off (eventually to charge pressure) - Oil flow "returning from the motor increases as motor speed increases - this increases " braking " pressure. - the bypass valve will open once " braking " pressure is higher than the bypass valve " spring " pressure.

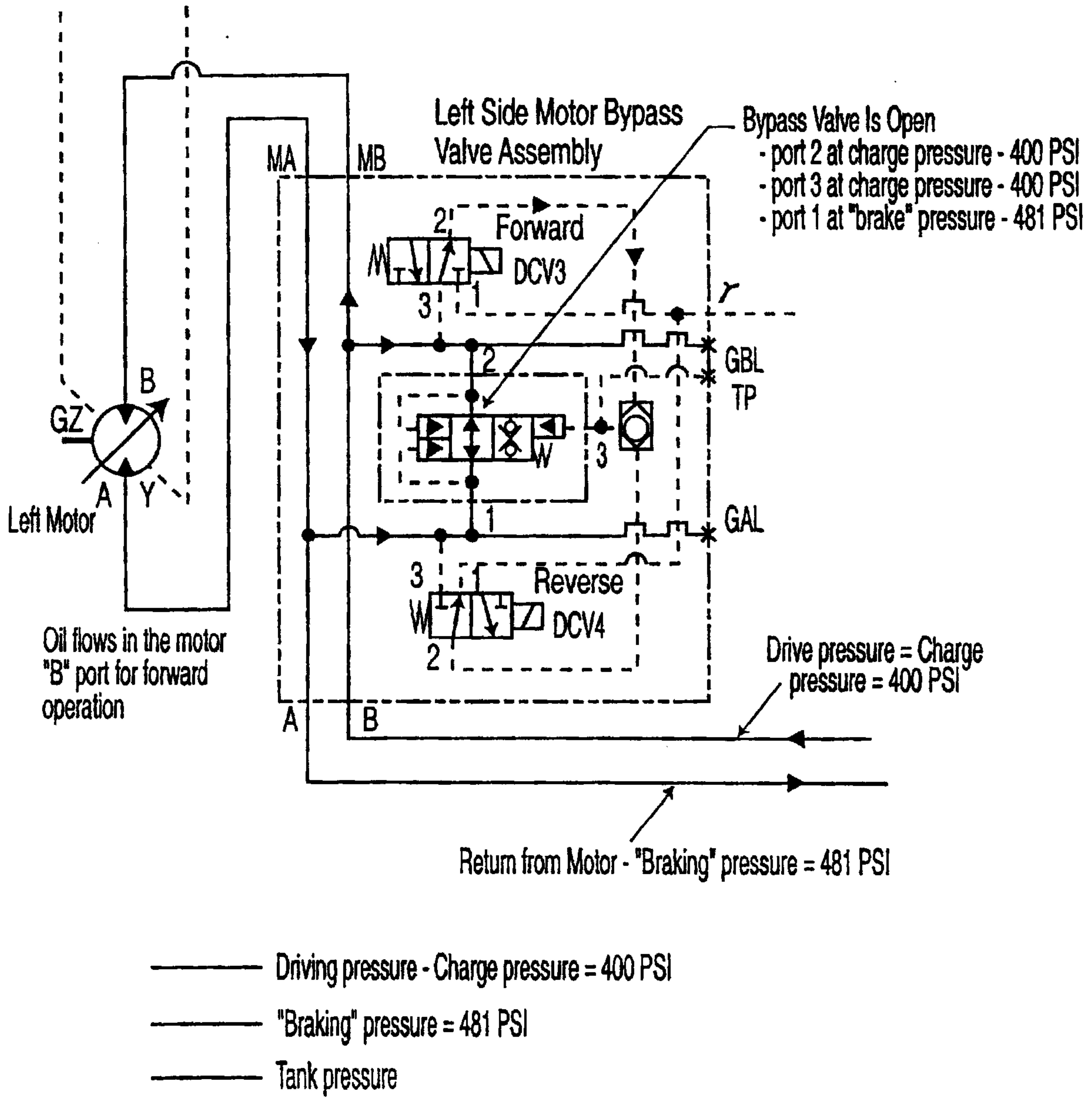


Figure 16

OVERALL AWD LOGIC FLOW CHART

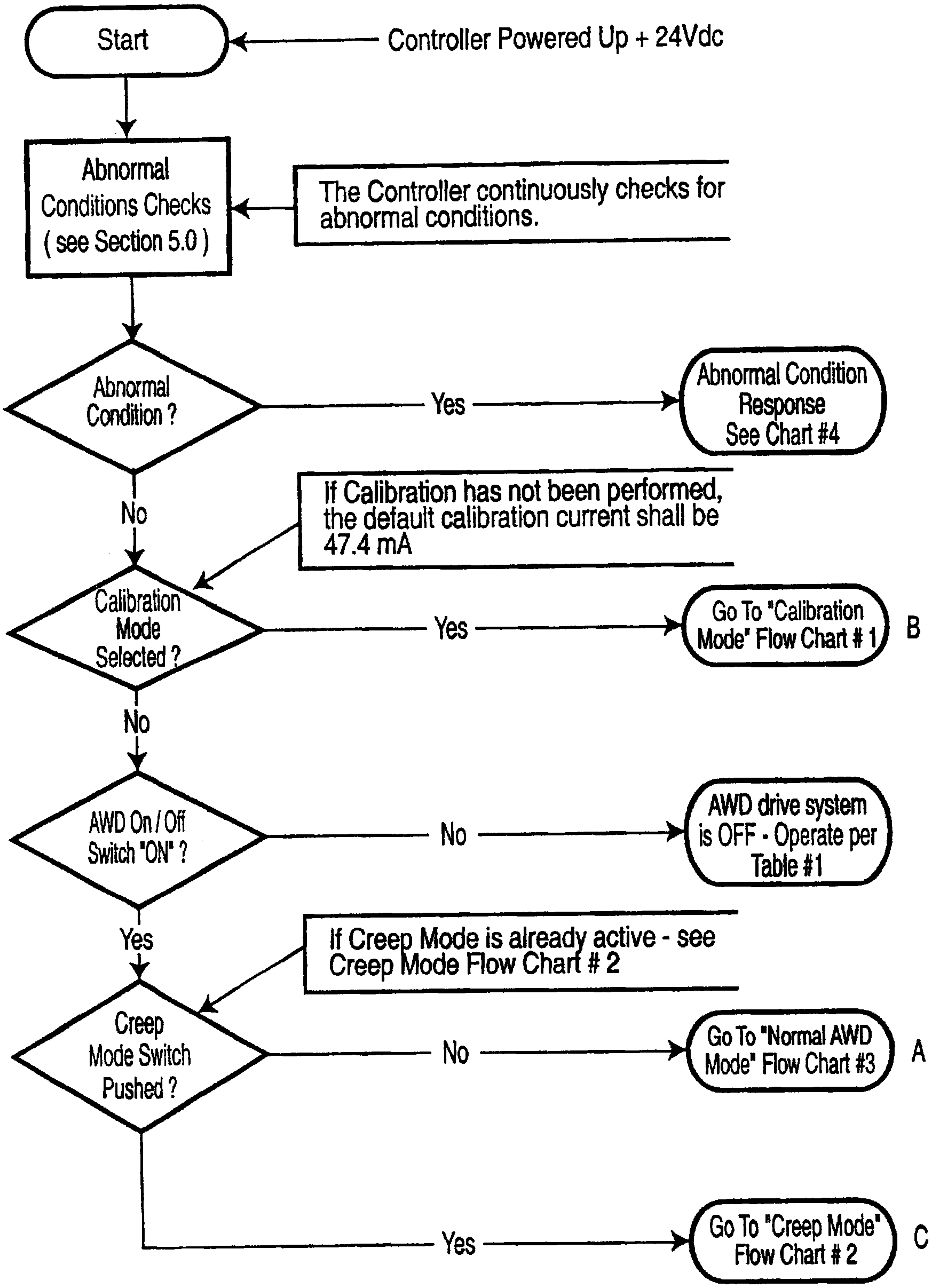


Figure 17A

CHART # 1 CALIBRATION MODE

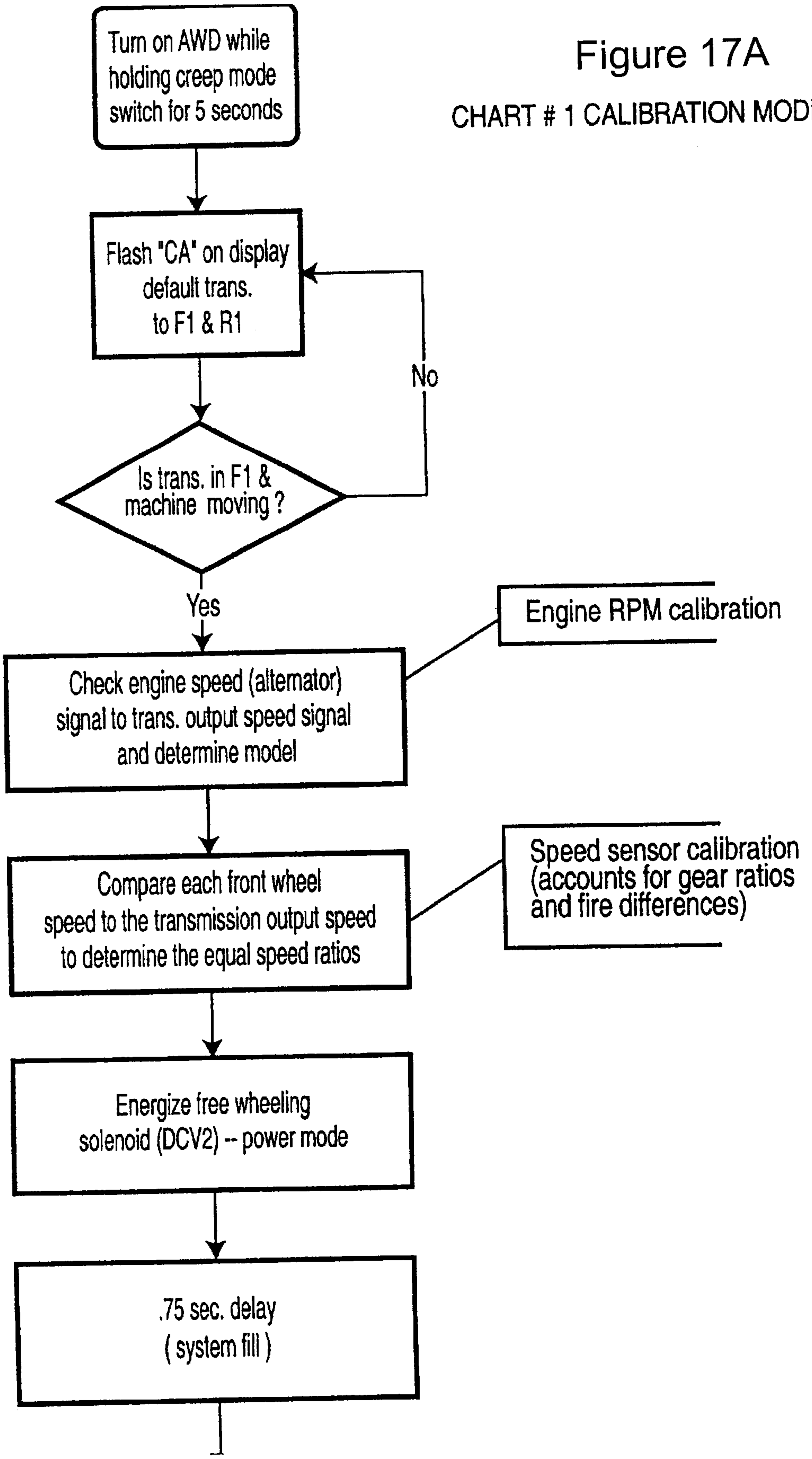
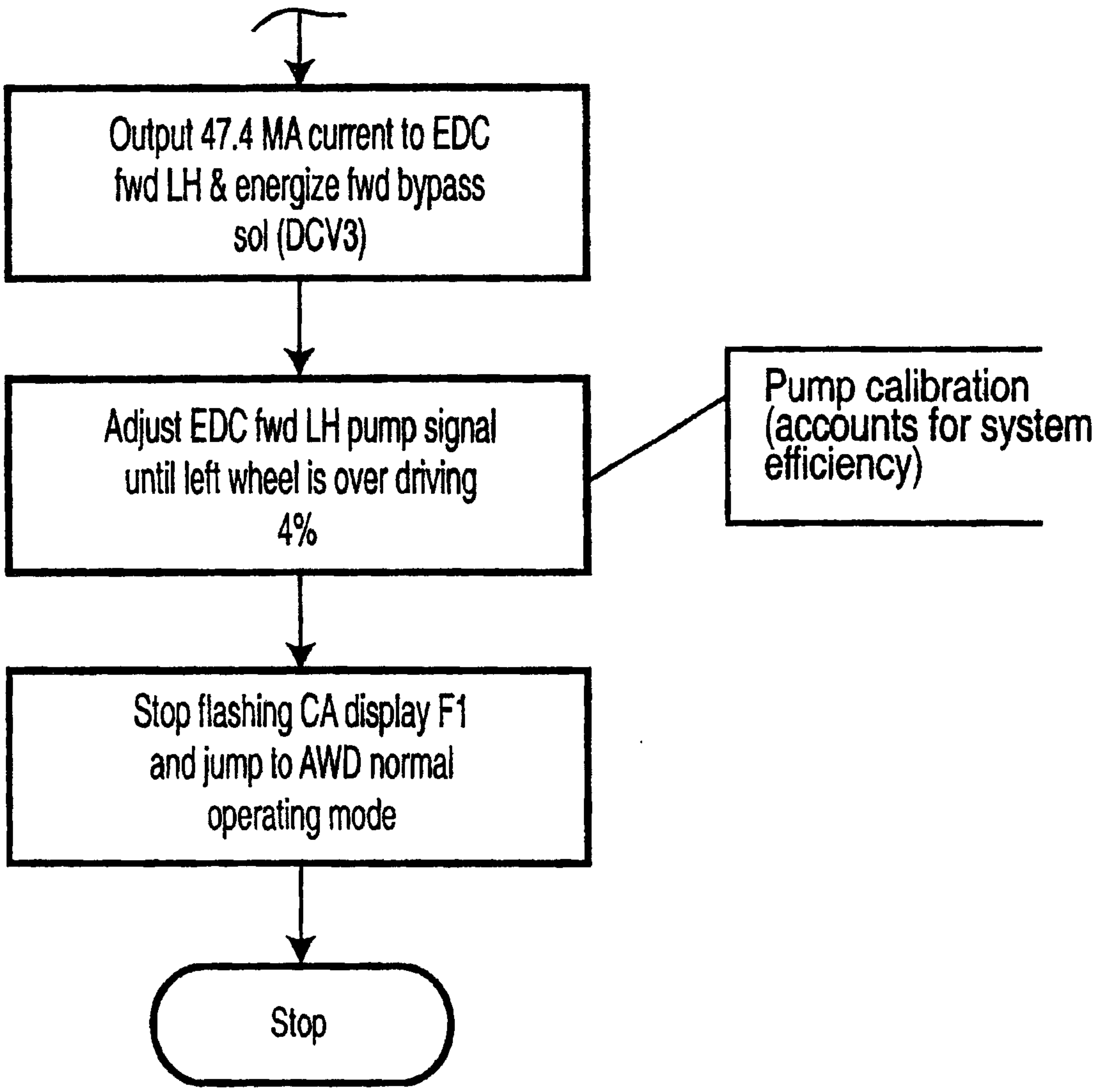


Figure 17B


Output 47.4 MA current to EDC fwd LH & energize fwd bypass sol (DCV3)
Adjust EDC fwd LH pump signal until left wheel is over driving 4%
Pump calibration (accounts for system efficiency)
Stop flashing CA display F1 and jump to AWD normal operating mode
Stop

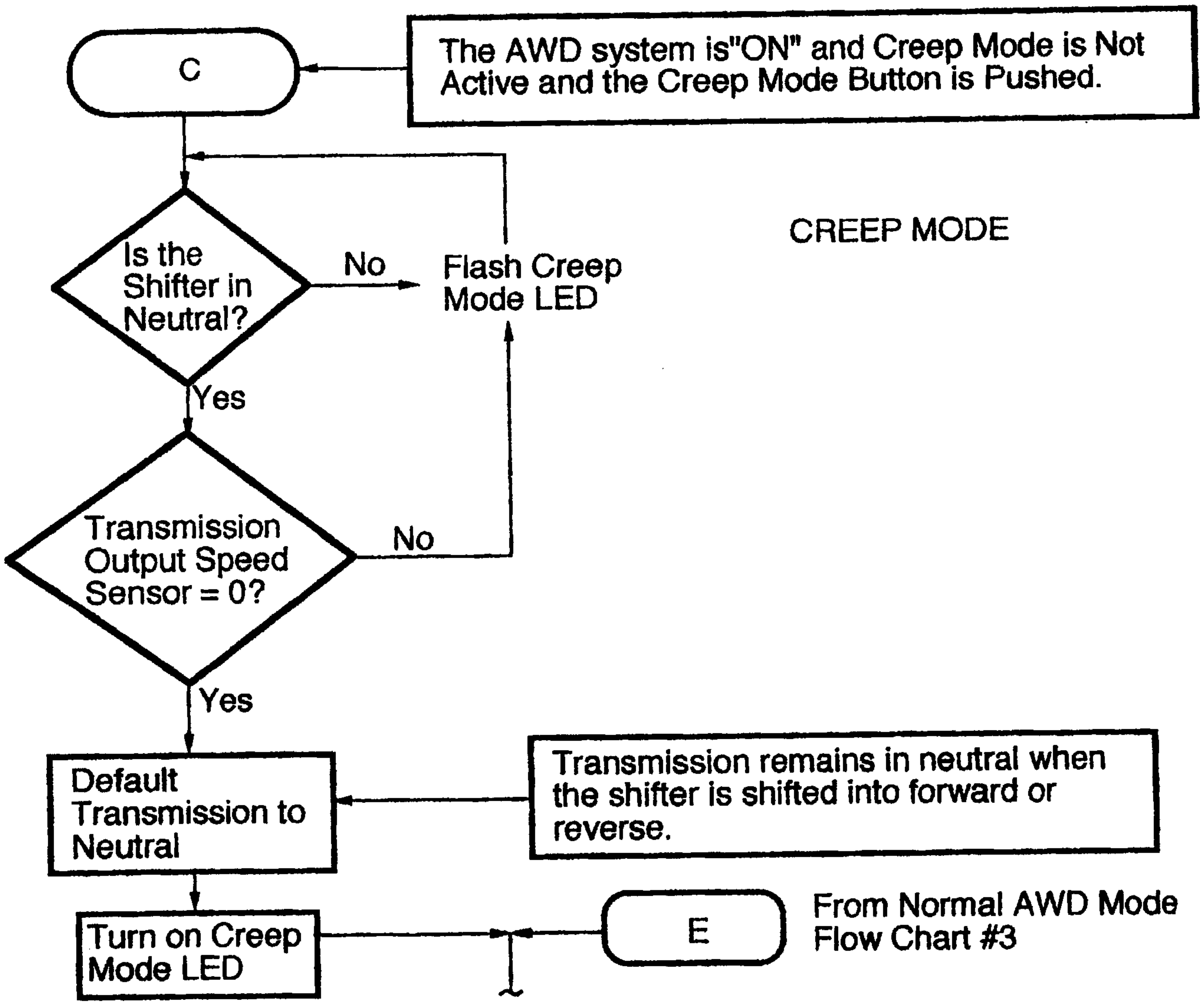
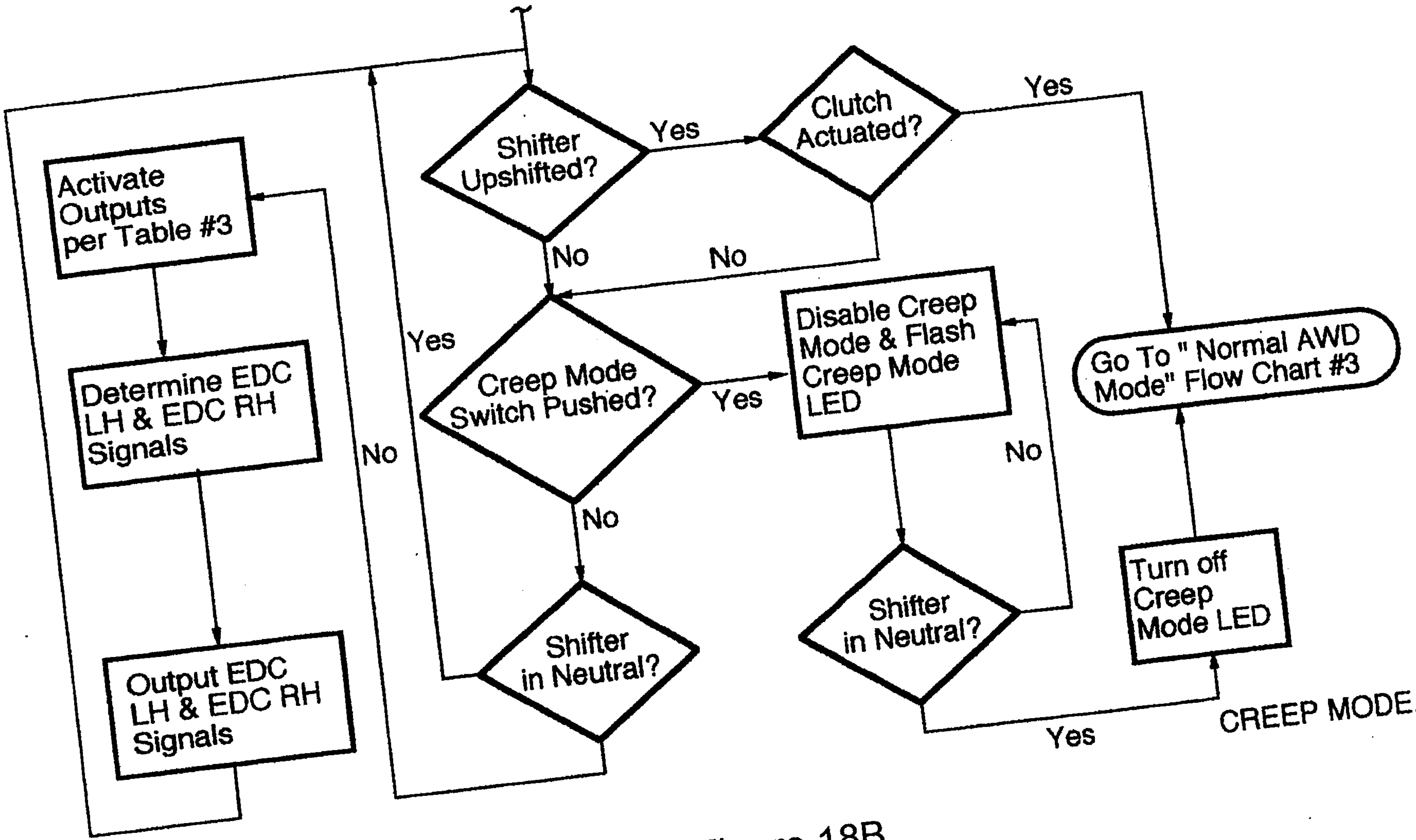

The AWD system is"ON" and Creep Mode is Not Active and the Creep Mode Button is Pushed.
C
CREEP MODE
Is the Shifter in Neutral?
No
Flash Creep Mode LED
Yes
Transmission Output Speed Sensor = 0?
No
Yes
Default Transmission to Neutral
Transmission remains in neutral when the shifter is shifted into forward or reverse.
Turn on Creep Mode LED
E
From Normal AWD Mode Flow Chart #3

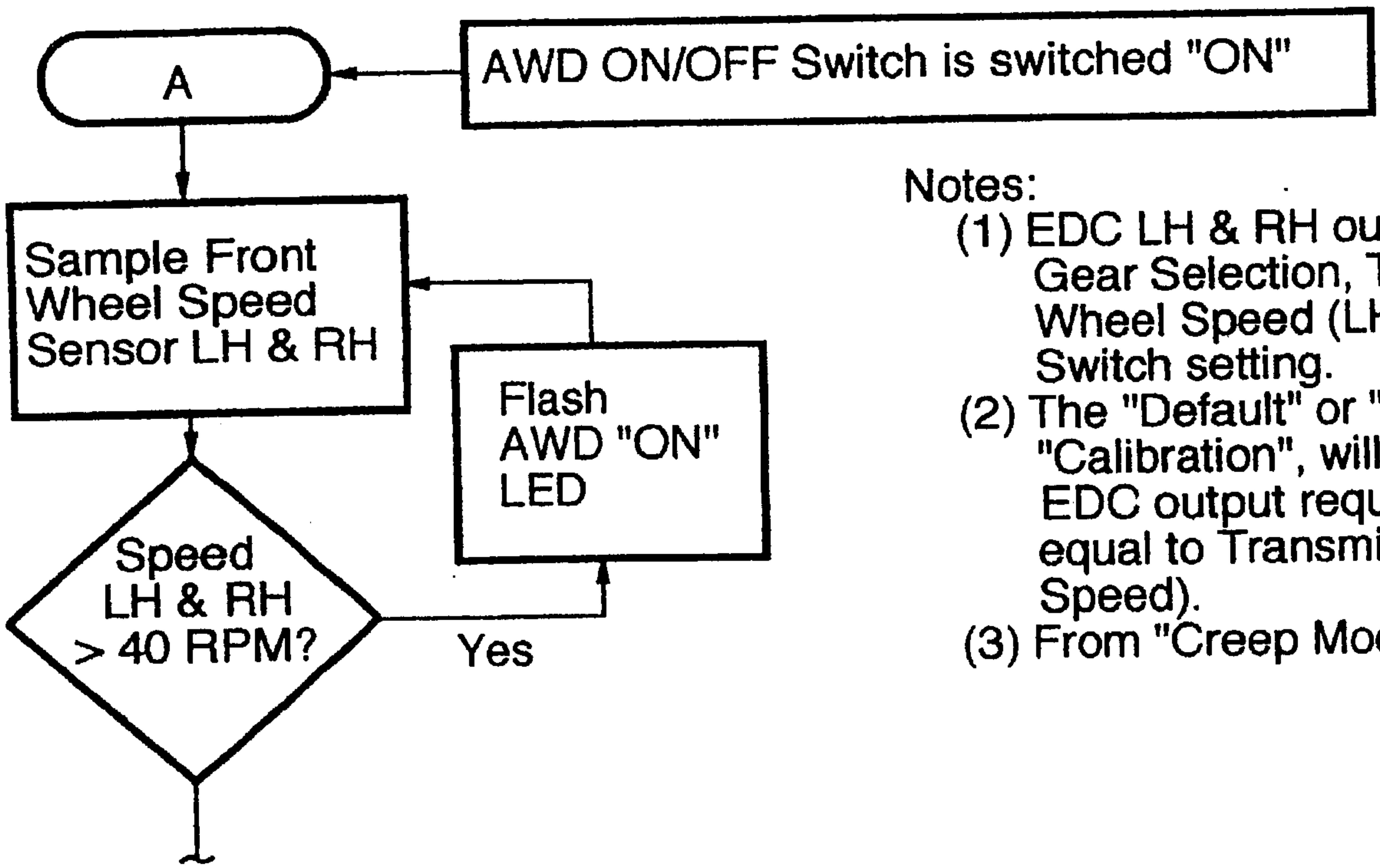
Figure 18A



CREEP MODE. VSD

Figure 18B

Normal AWD Mode



Notes:

(1) EDC LH & RH outputs are a function of Transmission Gear Selection, Transmission Output Speed, Front Wheel Speed (LH & RH), and Aggression Select Switch setting.

(2) The "Default" or "Nominal" setting, determined by "Calibration", will typically be a value close to the EDC output required when Front Wheel Speed is equal to Transmission Output Speed (Rear Wheel Speed).

(3) From "Creep Mode"

Figure 19A

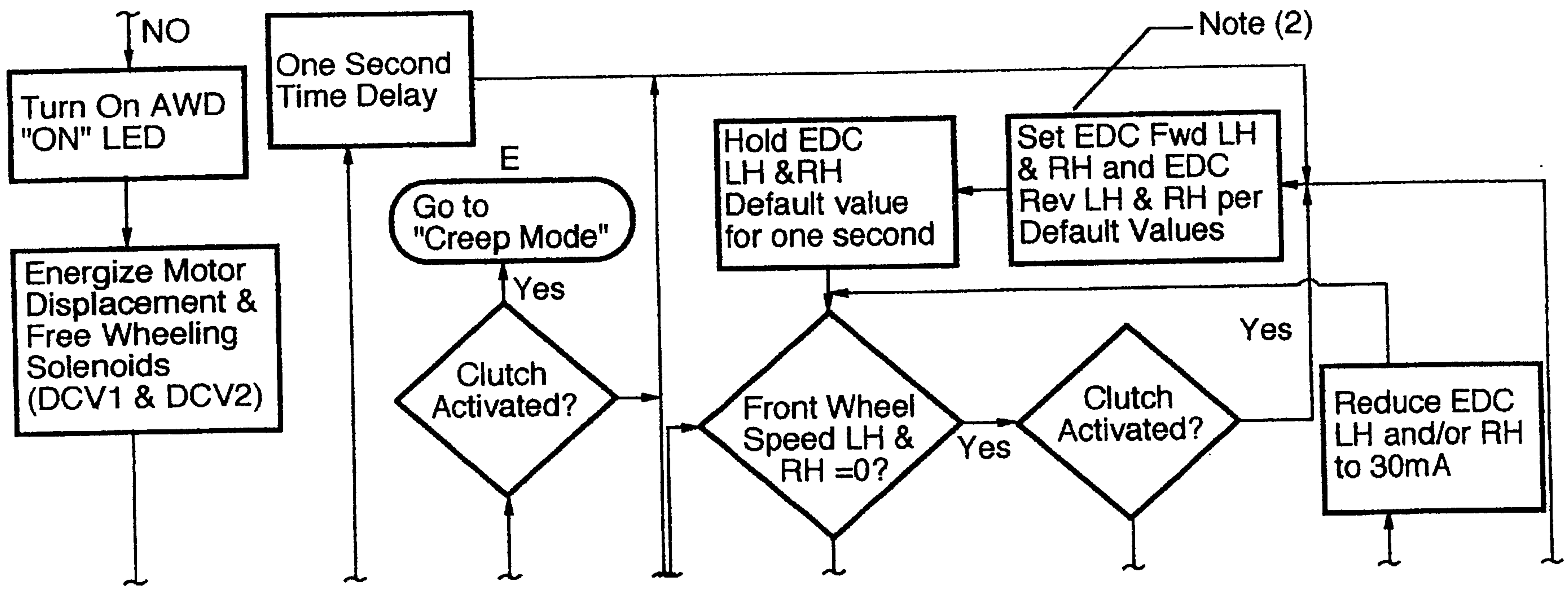

NO
Turn On AWD "ON" LED
Energize Motor Displacement & Free Wheeling Solenoids (DCV1 & DCV2)
One Second Time Delay
E
Go to "Creep Mode"
Yes
Clutch Activated?
Hold EDC LH &RH Default value for one second
Note (2)
Set EDC Fwd LH & RH and EDC Rev LH & RH per Default Values
Front Wheel Speed LH & RH =0?
Yes
Clutch Activated?
Yes
Reduce EDC LH and/or RH to 30mA

Figure 19B

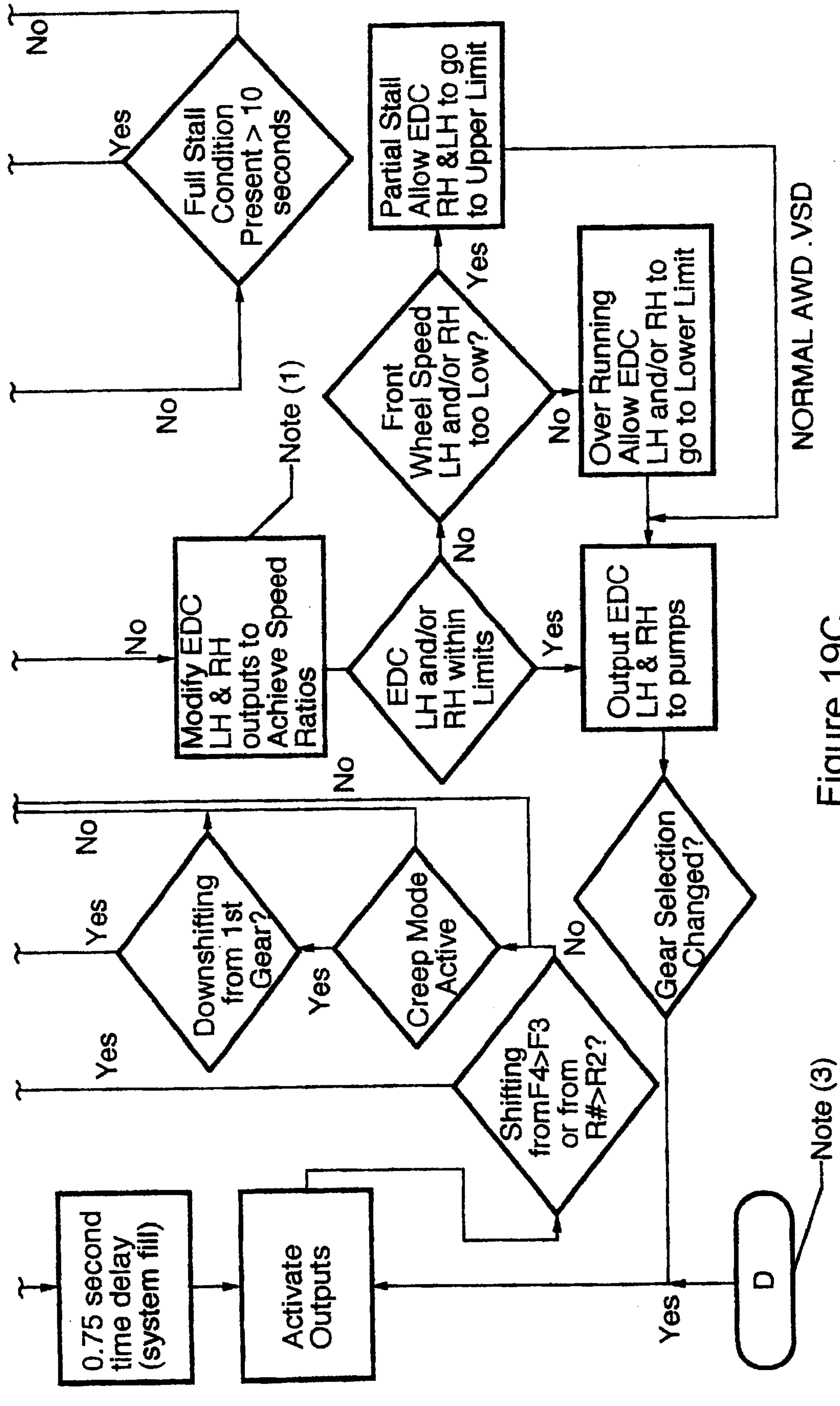
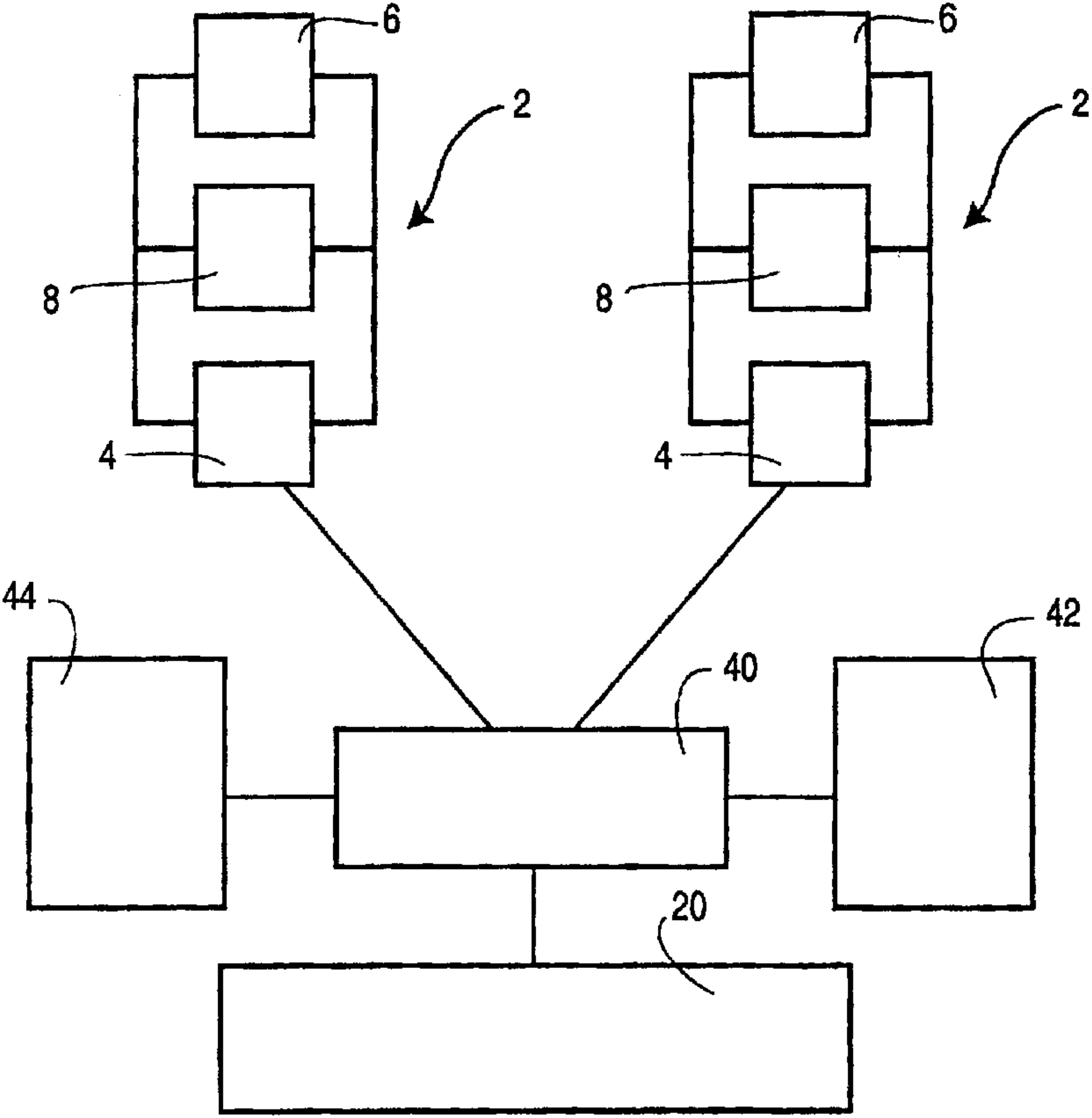

0.75 second time delay (system fill)
Activate Outputs
Shifting fromF4>F3 or from R#>R2?
Yes
No
Creep Mode Active
Yes
No
Downshifting from 1st Gear?
Yes
No
Gear Selection Changed?
Yes
D
Note (3)
Modify EDC LH & RH outputs to Achieve Speed Ratios
No
Note (1)
EDC LH and/or RH within Limits
Yes
No
Output EDC LH & RH to pumps
Front Wheel Speed LH and/or RH too Low?
Yes
No
Partial Stall Allow EDC RH &LH to go to Upper Limit
Over Running Allow EDC LH and/or RH to go to Lower Limit
NORMAL AWD .VSD
Full Stall Condition Present > 10 seconds
Yes
No
No

Figure 19C


6
2
8
4
6
2
8
4
44
42
40
20