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Section 29

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Patents Act 1990 656269

PATENT REQUEST : STANDARD PATENT

I/We, being the person/s identified below as the Applicant, request the grant of a patent to the person/s indicated below as the Nominated Person/s, for an invention described in the accompanying standard complete specification.

Full application details follow.

[71] [70] Applicant/s and Nominated Person/s:
Deere & Company, a Delaware corporation,
of John Deere Road, MOLINE, Illinois, 61265, UNITED STATES OF AMERICA

[54] Invention Title:
Calibration method for transmission control clutches

[72] Name/s of actual inventor/s: (optional)

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BASIC CONVENTION APPLICATION/S DETAILS:

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Deere & Company
By Patent Attorneys
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NOTICE OF ENTITLEMENT

DEERE & COMPANY, of John Deere Road, Moline, Illinois, 61265, United States of America being the applicant/Nominated Person in respect of the Application No. 40091/93 state the following :

The Nominated Person is entitled to the grant of the patent because the Nominated Person derives title to the invention from the inventors, PETER LESLIE FALCK, DENNIS LEE JEFFRIES and DAVID EUGENE BRANDON by assignment.

The Nominated Person is entitled to claim priority from the basic application listed on the patent request form because the Nominated Person has entitlement from the applicants of the basic application listed on the patent request form, and because the basic application is the first application made in a Convention country in respect of the invention.

Dated this 4th day of November, 1994

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a member of the firm of
DAVIES COLLISON CAVE
for and on behalf of
the applicant(s).

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(54) Title
CALIBRATION METHOD FOR TRANSMISSION CONTROL CLUTCHES

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(56) Prior Art Documents
US 5138906
US 4989471

(57) Claim

1. In a control system for a vehicle powershift transmission in a power train having an engine for driving the transmission, a disconnect device for connecting and disconnecting an output shaft of the transmission from a vehicle drive shaft and a plurality of hydraulic pressure operated control elements for shifting the transmission, at least one of which is operated by an electrohydraulic proportional control valve, a method of determining a hydraulic parameter associated with the control element controlled by the proportional control valve, comprising the following steps:

disengaging the disconnect device so that the transmission output shaft is free to rotate;

controlling engagement of certain ones of the plurality of the control elements other than the control element being calibrated in order to cause relative rotation between parts of the control element being calibrated;

operating the engine in a predetermined speed range;

modifying a signal applied to the proportional control valve to gradually modify the hydraulic parameter associated with the control element being calibrated while monitoring engine speed; and

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when the monitored engine speed changes by predetermined amount, saving a value of the signal applied to the proportional control valve as the hydraulic parameter calibration value.

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ORIGINAL
COMPLETE SPECIFICATION
STANDARD PATENT

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Invention Title: Calibration method for transmission control clutches

The following statement is a full description of this invention, including the best method of performing it known to me:-

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CALIBRATION METHOD FOR TRANSMISSION CONTROL CLUTCHES

Background of the Invention

This invention relates to a vehicle transmission control system, in particular a microprocessor-based electronic control system for a powershift transmission having solenoid valve operated transmission control elements, such as brakes and clutches, and more particularly to a calibrating method which is a method of determining key parameters relating to the operation and control of the brake or clutch elements.

Some manufacturers have used versions of electrohydraulic transmission controls with some success. Some such control systems have utilized proportionally controlled valves, but most such systems have used mostly simple on-off valves, with just one or two transmission control clutches controlled by proportional valves. For example, a powershift transmission sold by Ford New Holland, Ltd. has two modulating valves which control three different transmission control clutches. These valves are in turn controlled by an electronic controller. Such a proportional control allows a clutch element to be modulated during engagement and release of that element, and the controller provides the ability to vary the modulation for a particular element for each unique shift. Another system which includes on-off valves and at least one proportional control valve is described in US patent No. 4,855,913, issued 8 Aug. 1989 to Brekkestran et al.

In such systems with proportional control valves it is possible and desirable to accurately control the torque capacities of the clutches during engagement. While the electrical command supplied to the control valve may be very precise, manufacturing tolerances in the valves and transmission cause large variations on an actual vehicle. If it is known what electrical command corresponds to the initial clutch engagement pressure which causes a clutch to just begin carrying torque, then this command could be used to modify the shift command for that clutch during shifting to provide optimized control.

It is also useful to determine the clutch fill time, which corresponds to volume of oil required to fill and engage a transmission control clutch. This is because manufacturing tolerances may cause variations from one transmission to the next. Also, the clutch fill time will change as a result of normal component wear as the transmission ages. If this variation can be measured, then the shift commands can be modified to compensate for such variations.

For example, the Brekkestran reference discloses that the key parameters in the control system include the initial clutch engagement pressure (represented by DC-MAX) and the fast-fill clutch delay (represented by T1). The Brekkestran reference further states that DC-MAX and T1 must be determined by laboratory or field tests. However, the Brekkestran reference does not disclose any method for determining these values.

A calibrating method or a method of determining the pressure necessary to achieve clutch engagement in a microprocessor-based transmission control system is described in US Patent No. 4,989,471, issued on 5 February 1991 to Bulgrien. The Bulgrien method includes braking the transmission output shaft, then gradually increasing the clutch pressure and saving a value corresponding to the clutch pressure at which the engine speed begins to decrease. However, this method requires use of the vehicle brakes to prevent rotation of the transmission output shaft. Such a procedure could be dangerous if the vehicle brakes are not applied or if the brakes fail, because then undesired vehicle motion could result during calibration. The Bulgrien patent also illustrates an alternate method of calibrating a clutch by sensing when the clutch transmits sufficient torque to move the vehicle. This alternate method requires that the vehicle be placed in a position where vehicle motion is not a safety concern, and the results of such a method will vary depending upon the terrain on which the vehicle is placed. The Bulgrien reference does not disclose any method for determining a clutch fill time value.

US Patent No. 5,082,097, issued on 21 January 1992 to Goeckner et al. relates to a transmission controller for a transmission which includes a solenoid valve operated clutch and a solenoid valve for operating the clutch. The Goeckner et al. system also discloses a calibrating system or a system for determining a current signal corresponding to the point at which the clutch begins to transmit torque. This system includes a vehicle monitor for producing a threshold signal when the clutch begins to carry a predetermined amount of torque and a memory for storing a calibration value corresponding to the value of the current at which the clutch carries the predetermined amount of torque. However, this system requires a controller which generates a controlled current signal and a current monitoring circuit which generates a signal which corresponds to the current flow to the solenoid valve. Furthermore, the threshold signal in this system is either vehicle movement or engine droop, and the calibration procedure does not appear to involve disconnecting an output shaft of the transmission from a vehicle drive shaft. As a result, the calibration procedure described in Goeckner et al. would appear to be similar to the methods described in the Bulgrien patent, and would appear to have to involve allowing vehicle movement during calibration, or applying the vehicle brakes during calibration.

Summary of the Invention

An object of the present invention is to provide a method of determining key parameters for the control of proportional control valves for a powershift transmission.

Another object of the invention is to provide a such method which can be used at the time the powershift transmission is first built or installed in the vehicle and which can be used as the powershift transmission ages or is repaired.

Another object of the invention is to provide such a method which can be used without application of the vehicle brakes and without requiring that the vehicle move during operation of the method.

These and other objects are achieved by the present invention wherein a control system for a vehicle powershift transmission is calibrated. First, the transmission output shaft is disconnected from the drive wheels and the engine is run at a predetermined speed. Depending upon which transmission control element is to be calibrated, certain ones of the plurality of the control clutches, other than the control clutch being calibrated, are engaged in order to prevent rotation of a part of the control clutch being calibrated. Then the duty cycle of a pulse-width-modulated voltage signal applied to the proportional control valve is gradually modified to increase the pressure applied to the control clutch being calibrated while the engine speed is monitored. When the monitored engine speed droops by a predetermined amount, a value corresponding to the pressure applied to the proportional control valve is stored as the clutch calibration pressure value. In order to determine the fill volume of an element, the element is fully pressurised while the engine speed is monitored. The time required for this pressurisation to cause a decrease in engine speed will represent the volume of fluid required to fill the element so that it begins to carry torque.

In one broad form, the present invention provides, a control system for vehicle powershift transmission in a power train having an engine for driving the transmission, a disconnect device for connecting and disconnecting an output shaft of the transmission from a vehicle drive shaft and a plurality of hydraulic pressure operated control elements for shifting the transmission, at least one of which is operated by an electrohydraulic proportional control valve, a method of determining a hydraulic parameter associated with the control element controlled by the proportional valve, comprising the following steps:

disengaging the disconnect device so that the transmission output shaft is free to rotate;

controlling engagement of certain ones of the plurality of the control elements other than the control element being calibrated in order to cause relative rotation between parts of the control element being calibrated;

operating the engine in a predetermined speed range;

modifying a signal applied to the proportional control valve to gradually modify the hydraulic parameter associated with the control element being calibrated while monitoring engine speed; and

when the monitored engine speed changes by predetermined amount, saving a value of the signal applied to the proportional control valve as the hydraulic parameter

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vehicle powershift transmission in a power train having an engine for driving the transmission, a disconnect device for connecting and disconnecting an output shaft of the transmission from a drive shaft and a plurality of hydraulic pressure operated control elements for shifting the transmission, at least one of which is operated by an electrohydraulic proportional control valve, a method of determining the pressure required to initially engage the control element controlled by the proportional control valve, comprising the following steps:

controlling engagement of certain ones of the plurality of the control elements other than the control element being calibrated in order to cause relative rotation between parts of the control element being calibrated;

operating the engine in a predetermined speed range;

modifying a signal applied to the proportional control valve to gradually increase the pressure applied to the control element being calibrated while monitoring engine speed;

when the monitored engine speed droops by predetermined amount, saving a value of the signal applied to the proportional control valve as the element calibration pressure; and

automatically shifting the transmission to neutral if vehicle motion is sensed.

In yet a further broad form, the present invention provides a control system for a vehicle powershift transmission in a power train having an engine for driving the transmission, a disconnect device for connecting and disconnecting an output shaft of the transmission from a drive shaft and a plurality of hydraulic pressure operated control elements for shifting the transmission, at least one of which is operated by an electrohydraulic proportional control valve, a method of determining the pressure required to initially engage the control element controlled by the proportional control valve, comprising the following steps:

disengaging the disconnect device so that the transmission output shaft is free to rotate;

operating the engine in a predetermined speed range;

modifying a signal applied to the proportional control valve to gradually increase the pressure applied to the control element being calibrated while monitoring engine

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and,

when the monitored engine speed droops by predetermined amount, saving a value of the signal applied to the proportional control valve as the element calibration pressure.

In still a further broad form, the present invention provides a control system for a vehicle powershift transmission in a power train having an engine for driving the transmission, a disconnect device for connecting and disconnecting an output shaft of the transmission from a drive shaft and a plurality of hydraulic pressure operated control elements for shifting the transmission, at least one of which is operated by an electrohydraulic proportional control valve, a method of determining the time required to initially engage the control element controlled by the proportional control valve, comprising the following steps:

disengaging the disconnect device so that the transmission output shaft is free to rotate;

operating the engine in a predetermined speed range;

sensing and storing an initial engine speed;

applying a predetermined pressure to the control element to be calibrated for a predetermined time period;

sensing the current engine speed;

increasing the predetermined time period by an increment and repeating the applying and sensing steps until the sensed engine speed droops by a predetermined amount when compared with the initial engine speed; and

when the sensed engine speed has drooped by a predetermined amount indicating that the control element is being loaded, storing a time value.

Brief Description of the Drawings

Fig. 1 is a schematic block diagram of a microprocessor based transmission control system to which the present invention is applicable;

Fig. 2a is a schematic representation of a transmission to which the present invention is applicable;

Fig. 2b illustrates in greater detail a portion of the transmission of Fig. 2a;

Fig. 3 is a simplified logic flow diagram of a motion detection interrupt algorithm which is performed by the method of the present invention;

Figs. 4a and 4b are simplified logic flow diagrams of a main loop algorithm which is performed by the method of the present invention.

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FIG. 4c is simplified logic flow diagram of a clutch engagement checking algorithm which is performed by the method of the present invention.

FIG. 5 is a simplified logic flow diagram of a stabilization algorithm which is performed by the main loop algorithm of the present invention.

Figs. 6a and 6b form a simplified logic flow diagram of a pressure calibration algorithm which is performed by the main loop algorithm of the present invention.

Figs. 7a and 7b form a simplified logic flow diagram of a volume calibration algorithm which is performed by the main loop algorithm of the present invention.

Detailed Description

As shown in FIG. 1, a vehicle power train includes an engine 10 which drives a power shift transmission 12, which has an output shaft 13, which, via a conventional tow disconnect mechanism 14, drives an output drive shaft 16 which is connected to drive wheels (not shown). The power shift transmission 12 includes a transmission 18 which is operated by a set of pressure operated control elements or clutches 20 which are controlled by a corresponding set of solenoid operated proportional control valves 22. The transmission 18 may be a transmission such as described in US Patent No. 5,011,465, issued 30 April 1991 to Jeffries et al., and assigned to the assignee of this application. The valves 22 may be two-stage electrohydraulic valves as described in U.S. Patent No. 4,741,364, issued 3 May 1988 to Stoss et al. and assigned to applicant's assignee.

The power shift transmission control system includes a transmission control unit 30, a chassis computer 32 and a dash display 34. The transmission control unit 30 and the chassis computer 32 are preferably microprocessor-based electronic control units. Manual control is achieved via a gearshift lever 36. A gearshift switches and encoder unit 38 provides signals representing the position of the lever 36 to the transmission control unit 30. A clutch engagement switch 40 and a clutch disengagement switch 42 provide signals

representing the position of a clutch pedal 44. The transmission control unit 30 also receives signal from a ground speed sensor 48. The chassis computer 32 also receives signals from an engine speed sensor 46 and a transmission oil temperature sensor 50. The chassis computer sends information from these sensors to the transmission control unit 30.

The transmission control unit 30 includes a commercially available microprocessor (not shown) which, in response to an operator generated signal, executes a computer program which implements operation of the calibration methods described hereinafter. The transmission control unit 30 also includes valve drivers (not shown) which provide variable duty cycle pulse-width-modulated voltage control signals to the valves 22. The transmission control unit 30 and the valve drivers (not shown) will generate such control signals as a function of various sensed and operator determined inputs in order to achieve a desired pressure in the clutches and to thereby control the shifting of the transmission 12 in a desired manner. However, the present invention is not concerned with the control of the shifting of the transmission 12, the transmission itself, or the valves 22, since the present invention is concerned only with calibration of certain parameters. The method of the present invention is implemented by the control unit 30 which executes the computer program which is listed in the microfiche appendix. The computer program listing is in Motorola 68HC11 assembly language.

Referring to Fig. 2a and 2b, the control elements of transmission 12 include a set of brake elements B1, B2, B3, B4 and B5, and a set of clutch elements C1, C2, C3 and CLO. The input shaft 52 is connected by splines 54 to the clutch drum 56 of clutch C1 and of clutch C2 (not shown in Fig. 2b). The drum 56 in turn is splined to the clutch separators 58 of clutch C1. The clutch disks 60 of clutch C1 are splined to the clutch hub 62 of clutch C1. The clutch hub 62 is splined to a first intermediate shaft 64. The first clutch C1 is provided with a piston 66 for activating the clutch C1 by

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compressing the clutch separators and disks 58, 60. A spring 68 is provided to bias clutch C1 out of engagement. For further information regarding the details of such a transmission reference is made to US Patent No. 5,011,465, which is incorporated by reference herein.

The clutch piston 66, as well as the pressure operated elements of the other clutches and brakes, are each provided with hydraulic fluid from a pump (not shown) under the control of a corresponding one of the valves 22, in the usual fashion which is well-known to one of ordinary skill in the art, and therefore will not be described further herein.

Calibration Method

The following calibration method will determine the valve pressure command signal Pfill(el) required to just engage each clutch or brake element, and it will determine the fill volume times twake(el) required to nearly fill the corresponding clutch and brake elements.

Before the automatic calibration procedure of the control unit 30 is enabled, the operator should disengage the tow disconnect device 14 so that the transmission output shaft 13 is free to rotate, the shift lever 36 must be in neutral, the oil temperature must be above a threshold, and the engine speed must be set to a certain level (within a range).

Referring to FIG. 3, the control unit 30 continuously performs a motion detection interrupt algorithm 300 which is in the background while other functions are being performed. This algorithm 300 monitors the signal from speed sensor 48 to detect motion of the vehicle. If vehicle motion is detected, any other functions are interrupted and the transmission 18 is automatically shifted to neutral to prevent further vehicle motion.

Main Calibration Loop

In the main calibration loop 400 (Figs. 4a and 4b) the control unit 30 performs the following calibration procedure. First, step 399 checks to make sure the shift lever 36 is in neutral before starting the calibration procedure. If the shift lever 36 is not in neutral, step 401 displays a message

or symbol on the display 34 until the shift lever 36 is in neutral. If the shift lever 36 is in neutral, the calibration procedure continues to step 402. This is important because it prevents unexpected motion if the calibration procedure is activated by mistake with the shift lever in gear. Without this step, if the oil is warm and the lever 36 is in forward and the engine speed is 2100 rpm, first gear will be engaged every time calibration procedure is selected.

Step 402 monitors the oil temperature signal from sensor 50 and, if the oil temperature is less than Tcal, step 405 displays a message or symbol on the display 34 until the oil temperature is greater than or equal to Tcal. If the oil temperature is greater than or equal to a threshold temperature "TcalOil", the calibration procedure continues to step 404.

Step 404 checks if the shift lever 36 is placed in a forward gear position by monitoring the condition of "Forward" and "Not Neutral" lever position switches (not shown), and if not, then step 407 displays a message or symbol on the display 34 to prompt the operator to place the shift lever 36 in a forward position until lever 36 is placed in a forward position.

Next, step 406 monitors the engine speed signal from sensor 46 and, if the engine speed is outside of the desired range, step 408 displays a message or symbol on the display 34 until the engine speed is within the desired range. If the engine speed is within the desired range, the calibration procedure continues to step 410.

For each element to be calibrated, step 410 applies full pressure to a certain set of the clutch and/or brake elements in order to create an internal fight between the different parts of the element to be calibrated when that element is pressurised, in other words, to cause relative rotation between the different parts of the element to be calibrated. For example, with respect to clutch C1 and referring to Fig. 2b, the clutch drum 56 will be rotating with the input shaft 52. When brakes B1 and B2 are pressurised, this prevents

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rotation of hub 62 so that there is relative rotation between parts 56 and 62 of clutch C1.

The following table sets forth one possible order in which the elements are to be calibrated, and for each element being calibrated, the set of the other elements which are fully pressurized to create the appropriate internal fight, it being understood that other orders are possible and that other combinations of elements can be pressurized to create the desired internal fight. This table applies to the particular transmission described in US Patent No. 5,011,465. However, one skilled in the art would be able to determine similar combinations of elements for other powershift transmissions.

Calibration Table

Element to be Calibrated	Elements to be Fully Pressurized
Tow Test	C1, B1 and C3
C2	B1, B2
B2	C1, C2, CLO, B5
C3	C2, B2, B3
B3	C1, C2, CLO, B5
C1	B1, B2
B1	C1, C2, CLO, B5
B5	C2, B2, B3
B4	C2, B2, B3

Next, step 500 calls a "Stabiliz" subprocedure shown in FIG. 5. This subprocedure (steps 504-520) pauses for a length of time sufficient for the hydraulic system and the engine to stabilize before proceeding. A check is made (step 508) to determine that the lever 36 remains in the forward position. If not, an error message is displayed (step 506) until the lever 36 is placed in a forward position.

After the prescribed time has elapsed, the engine speed is checked (step 512) to make sure it is within tolerance for the procedure. If not, a message is displayed (step 514) to indicate that the calibration method is waiting for the system to stabilize. If the engine speed becomes correct (step 516), control returns to the beginning of this "Stabiliz" subprocedure (step 504). When step 512 determines that the engine speed is within the proper speed range then step 518

checks to see if the clutch pedal is engaged. If not, a message is displayed by step 520, the algorithm returns to the main loop 400 and the calibration procedure is aborted without executing the Calibrate subprocedure 600. If the clutch pedal is engaged, then step 518 causes a return to step 600 of the main loop 400. It should be noted that if the clutch is not engaged when tested in step 518, the algorithm not only returns to the main loop 400, but the algorithm also does not execute step 600 (or 700) before aborting.

Fill Pressure Calibration

The "Press. Cal" subprocedure 600 for fill pressure calibration is performed to determine the calibration pressure "Pfill(el)" value for each transmission control element. If an element cannot be calibrated for any reason, the previously stored Pfill(el) for that element shall not be altered. Also, if Pfill(el) is determined for an element during the calibration and then the calibration procedure crashes later for some other element, the elements which were calibrated correctly shall retain their correct values for Pfill(el).

Referring now to Figs. 6a-6b, step 602 of this subprocedure displays a message or symbol to indicate which element is being calibrated. As shown in the preceding table, at the beginning of the automatic calibration procedure elements C1, B1 and C3 are automatically fully pressurized (engaging gear 1F). If the tow disconnect device 14 is engaged this will cause the motion detect algorithm 300 to detect vehicle motion, whereupon the calibration method is interrupted and the transmission 12 is automatically shifted to neutral. This operates as a check on whether or not the tow disconnect device 14 is disengaged.

If the tow disconnect device 14 is disengaged, no motion will be detected whereupon the system exits procedure 600, returns to the main calibration loop at step 410 and automatically determines the pressure command required to just engage each clutch or brake by continued execution of the main calibration loop. In step 604 the engine speed from sensor 46 is read and stored. Next, for the element being calibrated, a

low starting pressure Pstrt(el) which corresponds to that element is commanded by step 606. If the element is C1 or C2, this Pstrt(el) is modified or reduced by an amount which depends upon the engine speed in order to compensate for centrifugal head which is the pressure created by the spinning of the element itself (compensating for pressure generated centrifugally in a rotating hydraulic cylinder is known from US Patent No. 4,718,306, issued 12 January 1988 to Shigematsu et al.). These adjustment pressures are illustrated in the following table and are stored in a "lookup" table in the memory of the control unit 30. Table locations are in increments of 128 revolutions per minute beginning with the first table location. For engine speeds above 2176 revolutions per minute, the controller shall use 0 kPa as the compensation value.

Centrifugal Head Compensation Table

Engine Speed (r/min)	Compensation Value (Kpa)
640	133
768	127
896	120
1024	113
1152	107
1280	100
1408	93
1536	80
1664	67
1792	60
1920	47
2048	33
2176	13

This starting pressure is held while steps 608 and 610 operate to compare the engine speed (or engine speed reduction) to a threshold value NeFull for a time t32. If the droop does not exceed the threshold NeFull, then control passes to the step 612. If the droop does exceed the threshold, then steps 624-632 operate to display a certain character and turn off or depressurise all elements. Step 628 prevents further operation until switch 40 is toggled (off then on). Then, once switch 40 has detected that the clutch pedal 44 is depressed and released, step 630 causes the

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controller to leave the current element without storing a Pfill(el) value and to set up for calibrating the next element.

Next, in step 612 the pressure command applied to the element being calibrated is increased by an increment "Pinc". If in step 614 the new pressure command is greater than Plimit(el) for the corresponding element, then in steps 634-640 a certain character is displayed (step 634) and all elements are turned off (step 635). Step 636 prevents further operation until Clutch Engaged switch 40 is toggled, then step 638 causes the controller to leave the current element without storing a fill pressure and set up to calibrate the next element. If in step 614 the new pressure does not exceed Plimit(el), then control proceeds to step 616.

Then, in step 616 the engine droop is again calculated and compared to the threshold NeFull and the increased pressure command is held for time t33 by step 618.

If the droop is greater than or equal to NeFull, then the element is considered to be "full" and the currently commanded pressure (minus any centrifugal head compensation pressure, if applicable) is the fill pressure Pfill(el). This Pfill(el) value is stored in step 642 and the drivers for all elements are turned off by step 644. Then step 646 delays for a period of time, step 648 sets up for the next element and step 650 causes a return to the main loop.

If in step 616 the droop is less than NeFull, then control is returned to step 612 and the algorithm continues in this manner until the droop has reached threshold NeFull in step 616 or until the pressure command has exceeded a predetermined limit for that element (Plimit(el)) in step 614, whereupon control is returned to step 412 of the main loop.

Returning now to Figs. 4a and 4b, step 412 returns the algorithm to step 402 if either of the stabilization or the calibration procedures is aborted because the lever 36 was in neutral or because the clutch pedal 44 was depressed. Steps 410, 500 600 and 412 are repeated until step 414 determines that the last element has been calibrated, whereupon the

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algorithm proceeds to step 416 which prepares for start of fill volume calibration then to step 418 which applies partial pressure to the element set for the element to be calibrated. Then the Stabiliz subroutine 500 is executed and then a fill volume calibration procedure 700 is performed. Step 424 returns the algorithm to step 416 if the calibration procedure is aborted, otherwise the algorithm proceeds to step 426. Steps 418, 500, 700 and 424 are repeated until step 426 determines that the last element has been calibrated, whereupon the algorithm is exited.

The values determined by this calibration procedure are also preferably adjusted to compensate for variations in oil temperature, battery voltage, etc.

With this system and method, all transmission brake and/or clutch elements may be calibrated in turn without any further input from the operator. This virtually eliminates any chance of operator induced error (such as not calibrating one or more elements) in the procedure.

Because the tow disconnect device 14 is disengaged and internal fights between transmission elements are used to determine when engagement occurs, the output shaft 13 is not restrained from rotation and no vehicle motion can occur. Therefore, with this calibration method it is not necessary to rely on the vehicle brakes to prevent dangerous vehicle movement. As an additional safety feature, this calibration routine also continually checks for vehicle motion (by monitoring the output of ground speed sensor 48), and stops the process and places the transmission 18 in neutral (all valves 22 off) if motion is sensed. In particular, a forward gear of the transmission is engaged during the initial stages of the calibration method so that if the tow disconnect device 14 is not disengaged, the vehicle will move only a very short distance before the transmission 18 is automatically shifted to neutral.

It should be noted that, during steps 600 and 700, the controller continually monitors the clutch pedal 44 to make sure it remains fully engaged during calibration. If during

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calibration the clutch pedal 44 is not engaged", the controller exits the routine and aborts the calibration procedure as shown in steps 412 and 424.

It should be noted that in subprocedure 600, this clutch pedal check is active until execution reaches step 624 or 634. After that, the clutch pedal is required for acknowledging the fault so that operation can continue to the next element to be calibrated. In subprocedure 700, the clutch pedal 44 is similarly checked until step 718 or 732, and may even be checked until step 752. In other words, the check is required during the actual calibration of the element. This checking procedure is illustrated by the flow chart of FIG. 4c.

Fill Volume Calibration

The "Vol. Cal." subprocedure 700 for fill volume calibration is performed to determine the fill volume calibration value for each transmission control element. The fill volume calibration method is similar to the fill pressure calibration method. Each element will be calibrated individually, and preferably in the same order as in the fill pressure calibration method. As before, the tow disconnect device 14 must be disengaged to prevent unexpected motion, and any vehicle movement during the calibration cycle will cause the transmission 18 to be automatically placed in neutral. This calibration cycle is automatically entered upon completion of the fill pressure calibration procedure. Again, the cycle proceeds without the need for any operator input.

Each individual element is fill volume calibrated by engaging the same combination of elements for the element being calibrated as used in fill pressure calibration method. However, all of these elements will only be partially pressurized.

Referring now to Figs. 7a-7b, step 702 of this subprocedure displays a message or symbol to indicate which element is being calibrated. The procedure begins with element C2 of the Calibration Table. Then, the system proceeds to step 704 where the engine speed from sensor 46 is read and stored. Next, in step 706, for the element being

calibrated, a "wakeup" pulse is applied to the element being calibrated. This means that the element will be commanded to full system pressure for an initial time period. This time period is variable, depending upon which element is being calibrated. Steps 708-710 operate to calculate the engine speed droop and compare the droop to a threshold value Ne2Ful during the time the wakeup pulse is applied.

If the wakeup pulse terminates and the droop has not exceeded the threshold NeFull, then control passes to the step 712. If the droop does exceed the threshold, then steps 718-726 operate to display a certain character and turn off or depressurize all elements. Step 722 prevents further operation until switch 40 is toggled (off then on). Then, once switch 40 has detected that the clutch pedal 44 has been depressed and is now released, step 724 causes the controller to leave the current element without storing a volume calibration value twake(el) and to set up for calibrating the next element.

In step 712 the wakeup pulse is terminated and steps 714-716 operate to calculate the engine speed droop and compare the droop to a threshold value Ne2Ful during a time t35 after the start of the wakeup pulse is applied. If the droop does exceed the threshold, then step 714 directs control to previously described steps 718-726. If the droop does not exceed the threshold, then at the end of time t35 step 716 directs control to step 728.

Step 728 increases the duration of the wakeup pulse by one time interval. If in step 730 the new duration is greater than tlimit(el) for the corresponding element, then in steps 732-733 a message is added to the display in the right-most display digit and all elements are turned off. Step 734 prevents further operation until Clutch Engaged switch 40 is toggled, then step 736 causes the controller to leave the current element without storing a fill volume value and set up to calibrate the next element. If in step 730 the new duration does not exceed tlimit(el), then control proceeds to step 740.

Steps 742-744 operate to calculate the engine speed droop and compare the droop to the threshold value Ne2Ful during the new duration of the wakeup pulse. If the droop does exceed the threshold, then the element is considered to be "full" and step 742 directs control to step 752-760. Step 752 stores the last wakeup pulse time twake(el) as the volume calibration value and all drivers are turned off by step 754. Step 756 delays for a time period, step 758 sets up for the next element and step 760 causes a return to the main loop. If the droop does not exceed the threshold, then at the end of the new duration of the wakeup pulse step 744 directs control to step 746 which turns off the wakeup pulse at the end of the new duration.

Then steps 748-750 operate to calculate the engine speed droop and compare the droop to a threshold value Ne2Ful during a time t35 after the start of the new wakeup pulse. If the droop does exceed the threshold, then step 748 directs control to previously described steps 752-760. If the droop does not exceed the threshold, then at the end of time t35 step 750 directs control to back to step 728.

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While the invention has been described in conjunction with a specific embodiment, it is to be understood that many alternatives, modifications and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, this invention is intended to embrace all such alternatives, modifications and variations which fall within the spirit and scope of the appended claims.

However, the 'best method' of performing the invention is described in the 'program listing' attached and marked 'Appendix A'.

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The Claims defining the invention are as follows:

1. In a control system for a vehicle powershift transmission in a power train having an engine for driving the transmission, a disconnect device for connecting and disconnecting an output shaft of the transmission from a vehicle drive shaft and a plurality of hydraulic pressure operated control elements for shifting the transmission, at least one of which is operated by an electrohydraulic proportional control valve, a method of determining a hydraulic parameter associated with the control element controlled by the proportional control valve, comprising the following steps:

disengaging the disconnect device so that the transmission output shaft is free to rotate;

controlling engagement of certain ones of the plurality of the control elements other than the control element being calibrated in order to cause relative rotation between parts of the control element being calibrated;

operating the engine in a predetermined speed range;

modifying a signal applied to the proportional control valve to gradually modify the hydraulic parameter associated with the control element being calibrated while monitoring engine speed; and

when the monitored engine speed changes by predetermined amount, saving a value of the signal applied to the proportional control valve as the hydraulic parameter calibration value.

2. The method of claim 1, wherein:

the hydraulic parameter is the pressure required to initially engage the control element controlled by the proportional control valve.

3. The method of claim 1, wherein:

the hydraulic parameter is the volume of hydraulic fluid required to initially engage the control element controlled by the proportional control valve.

4. The method of claim 1, wherein:

the hydraulic parameter is the time required to fill with pressurised hydraulic fluid and initially engage the control element controlled by the proportional control valve.

5. The method of claim 1, further comprising:

automatically shifting the transmission to neutral if vehicle motion is sensed.

6. A vehicle powershift transmission in a power train having an engine for driving the transmission, a disconnect device for connecting and disconnecting an output shaft of the transmission from a drive shaft and a plurality of hydraulic pressure operated control elements for shifting the transmission, at least one of which is operated by an electrohydraulic proportional control valve, a method of determining the pressure required to initially engage the control element controlled by the proportional control valve, comprising the following steps:

controlling engagement of certain ones of the plurality of the control elements other than the control element being calibrated in order to cause relative rotation between parts of the control element being calibrated;

operating the engine in a predetermined speed range;

modifying a signal applied to the proportional control valve to gradually increase the pressure applied to the control element being calibrated while monitoring engine speed;

when the monitored engine speed droops by predetermined amount, saving a value of the signal applied to the proportional control valve as the element calibration pressure; and

automatically shifting the transmission to neutral if vehicle motion is sensed.

7. The method of claim 6, further comprising:

automatically repeating all the above steps for each of the plurality of control elements.

8. The method of claim 7, further comprising:

initially applying a low starting pressure (Pstrt(el)) to the element being calibrated; and

gradually increasing the pressure applied to the control element being calibrated.

9. A control system for a vehicle powershift transmission in a power train having an engine for driving the transmission, a disconnect device for connecting and disconnecting an output shaft of the transmission from a drive shaft and a plurality of hydraulic pressure

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operated control elements for shifting the transmission, at least one of which is operated by an electrohydraulic proportional control valve, a method of determining the pressure required to initially engage the control element controlled by the proportional control valve, comprising the following steps:

disengaging the disconnect device so that the transmission output shaft is free to rotate;

operating the engine in a predetermined speed range;

modifying a signal applied to the proportional control valve to gradually increase the pressure applied to the control element being calibrated while monitoring engine speed; and

when the monitored engine speed droops by predetermined amount, saving a value of the signal applied to the proportional control valve as the element calibration pressure.

10. The method of claim 9, further comprising:

automatically shifting the transmission to neutral if vehicle motion is sensed.

11. The method of claim 9, further comprising:

controlling engagement of certain ones of the plurality of the control elements other than the control element being calibrated in order to cause relative rotation between parts of the control being calibrated.

12. A control system for a vehicle powershift transmission in a power train having an engine for driving the transmission, a disconnect device for connecting and disconnecting an output shaft of the transmission from a drive shaft and a plurality of hydraulic pressure operated control elements for shifting the transmission, at least one of which is operated by an electrohydraulic proportional control valve, a method of determining the time required to initially engage the control element controlled by the proportional control valve, comprising the following steps:

disengaging the disconnect device so that the transmission output shaft is free to rotate;

operating the engine in a predetermined speed range;

sensing and storing an initial engine speed;

applying a predetermined pressure to the control element to be calibrated for a predetermined time period;

sensing the current engine speed;

increasing the predetermined time period by an increment and repeating the

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applying and sensing steps until the sensed engine speed droops by a predetermined amount when compared with the initial engine speed; and

when the sensed engine speed has drooped by a predetermined amount indicating that the control element is being loaded, storing a time value.

13. A control system, substantially as herein described with reference to 'Appendix A' and/or the accompanying drawings.

14. A method of controlling a system, substantially as herein described with reference to 'Appendix A' and/or the accompanying drawings.

DATED this 4th day of November, 1994

DEERE & COMPANY
By Its Patent Attorneys
DAVIES COLLISON CAVE

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'APPENDIX A'

```
00000100 *        .TTL    'INIT/DIAGNOSTIC' MODE VALVE CALIBRATION RAM - MODE 22
00000200 *M22_CT RMB      1       Counter to keep track of where in mode 22
00000300 *        0 -> Just entered - starting
00000400 *        1 -> Motion fault has occurrec - waiting for neutral to recover
00000500 *        2 -> Storing a clibration datum
00000600 *Note: mode 22 counter = 'storing + 1' -> done storing -> 'delay'
00000700 *        3 -> Waiting for delay following calibration of specific element
00000800 *        4 -> Waiting in Peter's 'Stabiliz' routine for t9 to
00000900 *        5 -> Engine speed wrong during 'Stabiliz' so wait on operator
00001000 *        6 -> calibration of a particular element
00001100 *Note: mode 22 counter = 'stabiliz + 1' -> done waiting -> calibrate
00001200 *        7 -> ramping pressure of a particular element
00001300 *8       Compare to mode 22 low fault while trying to calibrate element
00001400 *9       Compare to mode 22 high fault while trying to calibrate element
00001500 *        10  -> Mode 22 is finished - send 'END' until operator does something
00001600 *        11  -> Mode 22 waiting for clutch pedal to be released - fully engage clutch
00001700 *
00001800 *M22_TR RMB      1       Timer for whatever is happening in Mode 22 ( 20 mSec)
00001900 *BGNENG RMW      1       Engine speed when begin calibrating a given element (word)
00002000 *ElmNum RMB      1       Number of element being calibrated - Table entry
00002100 *        controls which element, picture, etc.
00002200 *M22PRS RMB      1       Pressure being commanded to the element under calibration
00002300 *ElmMax          EQU     9       highest element number
00002400 *         for use as a pointer
00002500          .PAGE
00002600          .TTL    'INIT/DIAGNOSTIC' MODE VALVE CALIBRATION - MODE 22
00002700 *NOTE: ROM can be shortened by using DECB in following test and ordering
00002800 *the tests appropriately but since the oreder is unknown presently (ie
00002900 * at  2-NOV-1991 06:11:40) I will use this technique.
00003000 Mode22   BCLR     FLAGD,#PICDAT   Mode 22 always needs picture display selected
00003100          LDX      #VOFNS  Setup X to cause all elemnts to be Off (needed sometimes)
00003200          JSR      UP_BUF  Update the modulator pressure commands to 0 (")
00003300 *   Setup the X pointer to the element table
00003400          LDX      #ElmTBL Fetch address of the element table
00003500          LDAB     ElmNum  Fetch the element number
00003600          CMPB     #ElmMax Compare to maximum element number
00003700          BLO      77$     IF: Reached past last element
00003800          LDAA     #10   THEN: store mode 22 finished count
00003900          STAA     M22_CT
00004000          JMP      M22END          Finished go send PicEnd until exit
00004100 *                           ELSE: Continue with this element
00004200 77$      ABX              \Offset by 2 times element number (2 byte entries)
00004300          ABX              /
00004400 *  Begin to search for function in mode 22
00004500          LDAB     M22_CT  Fetch the counter for where in Mode 22
00004600          BNE      50$
00004700          JMP      M22SRT  IF: Just starting
00004800 50$      CMPB     #1      Compare to mode 22 motion fault count
00004900          BNE      51$
00005000          JMP      M22MFT  IF: Motion fault then go send error and wait for Neutral
00005100 51$      LDAA     AX10pr  IF:previous 10mSec axle period timer -> motion
00005200          CMPA     >SC_t30  (period lower than t30)
00005300          BHS      49$
00005400          LDAA     AX10ms    THEN: IF:present 10mSec axle period timer -> motion
00005500          CMPA     >SC_t30  (period lower than t30)
00005600          BHS      49$
00005700          JMP      M22MFT       THEN: Goto motion fault handler (sets M22_CT properly)
00005800 49$      CMPB     #10     Compare to mode 22 finished count
00005900          BNE      52$
00006000          JMP      M22END  IF: Finished go send PicEnd until exit
00006100 52$      CMPB     #8      Compare to mode 22 fault while trying to calibrate element
00006200          BNE      53$
```

```
00006300          JMP     M22CLF  IF: Low fault while cailibrating
00006400 53$      CMPB    #9      Compare to mode 22 fault while trying to calibrate element
00006500          BNE     54$
00006600          JMP     M22CHF  IF: High fault while cailibrating
00006700 54$      CMPB    #11     Compare to mode 22 waiting for clutch pedal
00006800          BNE     45$
00006900          JMP     M22_11  IF: waiting for clutch pedal
00007000 45$      CMPB    #3      Compare to mode 22 delay following calibration of element
00007100          BNE     55$
00007200          JMP     M22DLY  IF: delay following a specific element's calibration
00007300 55$
00007400 *        .TTL    MEMORY MAPPING FOR THE ELEMENT CALIBRATRION DATA (Internal EEROM)
00007500 *        ORG     $B620
00007600 *Cal_B3 RMW      1       Calibration data for element on driver on B3
00007700 *Cal_E1 RMW      1       Calibration data for element on driver on E1
00007800 *Cal_F2 RMW      1       Calibration data for element on driver on F2
00007900 *Cal_E3 RMW      1       Calibration data for element on driver on E3
00008000 *Cal_E2 RMW      1       Calibration data for element on driver on E2
00008100 *Cal_A1 RMW      1       Calibration data for element on driver on A1
00008200 *Cal_A2 RMW      1       Calibration data for element on driver on A2
00008300 *Cal_F3 RMW      1       Calibration data for element on driver on F3
00008400 *Cal_A3 RMW      1       Calibration data for element on driver on A3
00008500
00008600          .PAGE
00008700 *  Turn On elements that are to be on
00008800          PSHX            save pointer to the modulator being 'ramped'
00008900          LDAB    #4*ElmMax Preset B to the required offset
00009000          ABX             Setup X as pointer to valves to be on
00009100          JSR     MXTSUB  Preset all the modulators
00009200          JSR     UP_BUF  Update the modulator pressure commands to 0 (")
00009300          PULX            Restore X as pointer to element data
00009400
00009500 *  Test for other conditions as required
00009600          LDAB    M22_CT  Fetch the counter for where in Mode 22
00009700          CMPB    #5      Compare to mode 22 waiting for engine speed adjustment
00009800          BNE     56$
00009900          JMP     M22AD2  IF: Engine speed needs adjustment - go wait on operator
00010000 56$      CMPB    #2      Compare to mode 22 Storing a clibration datum
00010100          BNE     57$
00010200          JMP     M22str  IF: storing then wait till stored
00010300 57$      CMPB    #4      Compare to mode 22 Waiting in PF's 'Stabiliz' routine for t9
to
00010400          BNE     58$
00010500          JMP     STBLIZ  IF: then wait until engine speed ok
00010600 58$
00010700
00010800 *  Verify that NOT Neutral and Clutch fully engaged
00010900          BRCLR   DIGN_1,#NNEUTN,59$ IF: NOT Neutral
00011000          BRCLR   FLAG4,#CL_NEF,60$    THEN: IF: Clutch Not Fully engaged
00011100 59$      CLR     M22_CT                     THEN: Clear mode 22 counter
00011200          JMP     M22SRT                           Start over
00011300
00011400 *  Engage the modulator which is changing
00011500 60$      LDY     2*ElmMax,X Setup Y as pointer to the modulator being 'ramped'
00011600          LDAA    M22PRS  Fetch Pressure being commanded to the element under
calibration
00011700          CLR     1,Y     \Store as command to element under calibration
00011800          STAA    0,Y     /
00011900
00012000 *  Test for the remaining conditions
00012100          CMPB    #6      Compare to mode 22 calibration
00012200          BEQ     M22CAL  IF: calibrating an element
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00012300          CMPB    #7        Compare to mode 22 calibration pressure ramping
00012400          BEQ     M22CPS    IF: ramping the pressure on element under calibration
00012500          JMP     M22END    IF: NOT one of these THEN: send PicEnd  ???
00012600
00012700 *  When ramping pressure on element undergoing calibration
00012800 M22CPS   LDY     8*ElmMax,X Fetch the address of the starting pressure of next element
00012900          LDAA    M22_TR    Fetch the timer
00013000          BNE     Seplx     IF: It is 0 THEN: Time to increment
00013100          LDAB    M22PRS    Fetch Pressure being commanded to the element under
calibration
00013200 *Note: Pinc = 3 presently
00013300          ADDB    >Pinc     Add the pressure increment value
00013400          CMPB    #237      IF: Pressure has reached 237
00013500          BLO     1$          THEN: (go to next element essientially)
00013600          LDAB    #3                \Set mode 22 to delay following store
00013700          STAB    M22_CT            /
00013800          JMP     M22DLY            Godo that as next function
00013900 *                          ELSE: Continue here
00014000 *  ? of whether Pinc will have sufficient resolution?
00014100 1$       CMPB    1,Y       Compare to the limiting pressure (1 above start)
00014200          BLS     Sep1      IF: Pressure now too high
00014300 M22CHF   LDAA    #9          THEN: store mode 22 high fault
00014400          STAA    M22_CT
00014500          LDAA    >PicH             Fetch the 'H' picture
00014600          BRA     Sepic
00014700 M22CLF   LDAA    #8                store mode 22 low fault
00014800          STAA    M22_CT
00014900          LDAA    >PicL             Fetch the 'L' picture
00015000 Sepic
00015100 *        BCLR    FLAGD,#PICDAT     Select picture display - done at beginning
00015200 *  Turn off element under calibration since there was a fault
00015300          LDY     2*ElmMax,X Setup Y as pointer to the modulator being 'ramped'
00015400          CLR     1,Y       \Store 0 as command to element under calibration
00015500          CLR     0,Y       /
00015600          LDX     0,X               Fetch element's picture's address
00015700 *  Check for clutch switch to get out of this mode
00015800          BRCLR   FLAG4,#CL_NEF,2$ IF: Clutch Not Fully engaged
00015900          LDAA    #11         THEN: mode 11 waiting on clutch
00016000          STAA    M22_CT
00016100          JMP     M22Ed2            Goto M22Ed2 which sends picture
00016200 2$
00016300 *  Setup the picture for this fault mode
00016400          ORAA    2,X               'OR' with third byte of current picture
00016500          STAA    DCCDBU+2          Place in third byte of display buffer
00016600          LDD     0,X               Load first 2 bytes of current picture
00016700          STD     DCCDBU            Place in frist 2 bytes of display buffer
00016800          JSR     VALCMP            Convert pressure to duty cycle and compensate
00016900          JMP     ENDDMD            End of this stuff - go send CCD stuff
00017000
00017100 Sep1     STAB    M22PRS    Save as the next pressure to command
00017200 Seplx    INCA              Increment the timing
00017300          STAA    M22_TR    Update the timer also
00017400          CMPA    >SC_t33   Compare to the delay time required at each pressure step
00017500          BLS     2$        IF: Time Elpased
00017600 *                            ELSE: Continue with loop
00017700 *                            THEN: Calculate droop at starting pressure
00017800          CLR     M22_TR    clear timer for next pressure increment
00017900          LDD     BGNENG    Fetch engine speed at beginning of element calibration
00018000          SUBD    ENGSPD+1 Fetch engine speed as received (carry -> speed increased)
00018100          BCS     2$        IF: speed increased then droop ok??
00018200          CPD     >NeFull Compare to the desired droop
00018300          BLO     2$        IF: Droop has been large enough
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```
00018400 *                              ELSE: Continue with loop
00018500          LDAB    M22PRS        THEN: Fetch the ending pressure
00018600          STAB    Offset              Save as the calibration data for storage
00018700          LDAB    #2                  \Set mode 22 to Storing a clibration datum
00018800          STAB    M22_CT              /
00018900 2$       LDX     0,X       Fetch element's picture's address
00019000          JMP     M22Ed2    Goto M22Ed2 which sends picture
00019100
00019200 *  When calibrating an element
00019300 M22CAL   INC     M22_TR    Hold starting pressure for time t32
00019400          LDAA    M22_TR
00019500          CMPA    >SC_t32   Compare to time t32
00019600          BLS     M22c2     IF: Above t32
00019700 *                            ELSE: Exit
00019800 *                            THEN: Calculate droop at starting pressure
00019900          LDD     BGNENG    Fetch engine speed at beginning of element calibration
00020000          SUBD    ENGSPD+1  Fetch engine speed as received (carry -> speed increased)
00020100          BCS     M22c3     IF: speed increased then droop ok??
00020200          CPD     >NeFull   Compare to the desired droop
00020300          BHS     M22CLF    IF: Droop ok ELSE: Low fault
00020400 M22c3    INC     M22_CT      THEN: Goto pressure ramping mode
00020500          CLR     M22_TR    Reset the timer for next function
00020600 M22c2    LDX     0,X       Fetch element's picture's address
00020700          JMP     M22Ed2    Goto M22Ed2 which sends picture
00020800
00020900 *  Delay following a specific element's calibration
00021000 M22DLY   LDX     #ElmTBL   Fetch address of the element table
00021100          LDAB    ElmNum    Fetch the element number
00021200          ABX               \Offset by 2 times element number (2 byte entries)
00021300          ABX               /
00021400          INC     M22_TR
00021500          LDAA    M22_TR
00021600          CMPA    10*ElmMax,X Compare to required delay time
00021700          BLS     1$
00021800          INC     M22_CT    Goto next mode now
00021900          INC     ElmNum    Goto next element now
00022000          CLR     M22_TR    Reset the timer so that stabiliza starts from 0
00022100          BRA     STBLIZ    Goto 'Stabiliz' to continue
00022200 1$       LDX     0,X       Fetch element picture address while waiting
00022300          JMP     M22Ed2    Goto M22Ed2 which sends picture
00022400
00022500 *  When just started
00022600 M22SRT   CLR     ElmNum    Clear the element being calibrated pointer
00022700          CLR     M22PRS    Clear Pressure being commanded to the element under
calibration
00022800          BRCLR   FLAG4,#CL_NEF,3$ IF: Clutch Not Fully engaged
00022900          LDX     #PicClu             THEN: Fetch the clutch pedal picture
00023000          BRA     4$                        Go send the picture
00023100 3$       BRSET   DIGN_1,#FORIN,1$ IF: Forward
00023200 *                                  THEN: send PicNeu
00023300 *        BRSET   DIGN_1,#REVIN,1$       IF: Reverse
00023400 *                                  THEN: send PicNeu
00023500          BRCLR   DIGN_1,#NNEUTN,2$ IF: NOT Neutral
00023600 1$       LDX     #PicNeu           THEN: send PicNeu - will hang until neutral
00023700 4$       JMP     M22Ed2                  Goto M22Ed2 which sends picture
00023800 *                                 ELSE: Continue
00023900 2$       LDAA    OILTEMP Fetch Oil temperature
00024000 * NOTE: Temp is sent as Temp('C)+64
00024100          CMPA    >CalOil Compare to calibration limit
00024200          BHS     STBLIZ  IF: Oil temperature is low
00024300          LDX     #PicOil   THEN: send picOil - will hang until oil temp ok
00024400          JMP     M22Ed2          Goto M22Ed2 which sends picture
```

```
00024500 *                          ELSE: Ok so goto to 'stabiliz' waiting
00024600
00024700 *  While waiting for clutch pedal to be released - clutch fully engaged
00024800 M22_11  BRSET   FLAG4,#CL_NEF,2$ IF: Clutch Fully engaged
00024900         INC     ElmNum     THEN: Goto next element now
00025000         CLR     M22_TR           Reset the timer so that stabilize starts from 0
00025100         JMP     STBLIZ           Goto 'Stabiliz' to continue
00025200 *                           ELSE: Display wait picture until pedal released
00025300 2$      LDX     #PicWat Set pointer to wait picture for engine stabiliz
00025400         JMP     M22Ed2           Goto M22Ed2 which sends picture
00025500
00025600
00025700 *  When operator is required to readjust/adjust the engine speed
00025800 M22ADJ  LDAA    #5       \Set mode 22 to engine speed wrong
00025900         STAA    M22_CT   /
00026000         CLR     M22_TR  Reset the timer for next function
00026100         LDX     #PicSpd Set pointer to speed adjustment picture
00026200         JMP     M22Ed2  Goto M22Ed2 which sends picture
00026300 *  When operator is required to readjust/adjust the engine speed
00026400 M22AD2  CLR     M22_TR  Reset the timer for next function
00026500         LDX     #PicSpd Set pointer to speed adjustment picture
00026600         DEC     M22_CT  Set to stabilize
00026700         JMP     STBLZ2  Check if ok yet
00026800 *  Wait until engine speed ok and stabilised
00026900 STBLIZ  LDAA    #4       \Set mode 22 to waiting in 'stabiliz'
00027000         STAA    M22_CT   /
00027100 *  Verify that we are in forward and NOT neutral
00027200         BRSET   DIGN_1,#FORIN,89$ IF: NOT Forward
00027300 88$     LDX     #PicFor            THEN: Fetch send PicFor (fetch it's address)
00027400         JMP     M22Ed2                 Goto M22Ed2 which sends picture
00027500 89$     BRCLR   DIGN_1,#NNEUTN,88$ ELSE: IF: Neutral
00027600 *                                              THEN: Send PicFor
00027700 *                                              ELSE: Continue with the stabilize routine
00027800         LDX     8*ElmMax,X Fetch the address of the starting pressure
00027900         LDAA    0,X      Fetch the starting pressure
00028000         STAA    M22PRS  Store Pressure to command to element once under calibration
00028100         LDX     #PicWat Set pointer to wait picture for engine stabiliz
00028200         LDAA    M22_TR   Check timer
00028300         CMPA    >SC_t31
00028400         BLO     STBLZ3  IF: t31 has elpased
00028500         INC     M22_CT  Changed to cal mode (from stabilize)
00028600         INC     M22_CT
00028700 STBLZ2  LDD     ENGSPD+1 Fetch engine speed as received
00028800         STD     BGNENG  Save as engine speed at beginning of element calibration
00028900         CPD     >NeCal  Compare highest allowed engine speed (NeCal)
00029000         BHI     M22ADJ  IF: Too High THEN: Set to engine speed wrong
00029100         ADDD    #100      ELSE: Add the 100 rpm range value
00029200         CPD     >NeCal          Compare to lowest speed (NeCal-100)
00029300         BLO     M22ADJ  IF: Too Low THEN: Set to engine speed wrong
00029400         CLR     M22_TR    THEN: Reset the timer for next function
00029500         BRA     M22Ed2          Goto M22Ed2 which sends picture
00029600 *                           ELSE: wait until t31 or engine wrong
00029700 STBLZ3  INC     M22_TR          Increment the timer
00029800         BRA     M22Ed2          Goto M22Ed2 which sends picture
00029900
00030000 *  Determine if memory is currently processing another function (task)
00030100 *  A to contain the new data
00030200 *  X to be pointer to mode 22 data table - base address + 3*element number
00030300 M22str  BRCLR   prgflg,#erreq+aureq,22$ \May NOT Store a new code when
00030400         JMP     M22eps                  /already storing one - stay this function
00030500 *avaliable for storage applications
00030600 22$     PSHX            Save X since eereqs destroys it (also code below)
```

```
00030700          LDX     6*ElmMax,X Setup X as pointer into EEROM calibration storage
00030800 *  Note: The EEROM address is stored in the mode 22 table like everything else
00030900 *  Storage routine may check for 'same' data'
00031000          LDAA    Offset  Fetch the offset from previous calculations
00031100          CMPA    0,X     Compare to the new cal data
00031200          BEQ     M22ep   IF: They are the 'SAME'
00031300 *                           THEN: No need to store
00031400          STX     eraddr          Set request address pointer to wherever
00031500          STAA    erdata          Put the desired data into request data
00031600          BSET    prgflg,#erreq   Set flag that we requested error code programming here
00031700          JSR     eereqs          Call the routine which causes storage to occur
00031800 M22ep    INC     M22_CT  Set mode 22 counter to next mode -> done storing
00031900          PULX            Restore X
00032000 M22eps   LDX     0,X     Set pointer to element's picture's address
00032100          BRA     M22Ed2          Goto M22Ed2 which is same code
00032200
00032300 *  When Motion fault - send error and wait for Neutral
00032400 M22MFT   CLR     M22_CT  \Set function in mode 22 to Motion fault
00032500          INC     M22_CT  /
00032600          BRSET   DIGN_1,#NNEUTN,2$ IF: Neutral
00032700          CLR     ERRMSG                  THEN: Reset the Error
00032800          CLR     M22_CT                        Reset mode 22 to beginning
00032900          JMP     M22SRT                        Restart at beginning of mode 22
00033000 2$       LDAA    >DC_CNV+116/2           IF: Enabled
00033100          BEQ     1$                        THEN: Get that error
00033200 *                                          ELSE: Go on as if that error had NOT
         occurred
00033300          LDAA    #116            Set error to Motion fault
00033400          JSR     CODSTR          Call fault storage routine
00033500          JSR     CCDSDE          Send CCD link error msg if desired
00033600 1$
00033700 *  Send fault picture
00033800          LDX     #PicFlt         Set pointer to Motion fault picture
00033900          BRA     M22Ed2          Goto M22Ed2 which is same code
00034000
00034100 *  When Mode 22 is finished goto Mode 23 woth all timers reset and elment counter
00034200 *at element number 2
00034300 M22END   BRCLR   FLAG4,#CL_NEF,3$ IF: Clutch Not Fully engaged
00034400          LDX     #PicClu           THEN: Fetch the clutch pedal picture
00034500          JMP     M22Ed2                  Goto M22Ed2 which sends picture
00034600 3$       LDAA    #23     \
00034700          STAA    D_MODE  /Set new mode number to 23
00034800          CLR     M23_TR  Reset the Mode 23 timer
00034900          CLR     ElmNum  Reset the Mode 23 element counter to 0 (will be 1 soon)
00035000          LDAA    #3      \Reset the Mode 23 mode counter (to a 3)
00035100          STAA    M23_CT  /to waiting for delay following element cal
00035200          BRA     Mode23  Jump to mode 23 and continue
00035300
00035400 *  When Mode 22 is finished send 'END' until operator does something
00035500 *        LDX     #ENDPIC         Select pointer to ENDPIC
00035600 *  Below is code if need a beep when done
00035700 *        LDAA    CLRTMR          IF: Just sending 'END' for 1st sample
00035800 *        BNE     2$               (ie CLRTMR == 0)
00035900 *        BSET    FLAGD,#BEPIT     THEN: Set for Beep (beep is a single shot)
00036000 *2$
00036100
00036200 M22Ed2
00036300 *        BCLR    FLAGD,#PICDAT   Select picture display - done at beginning
00036400          LDD     0,X             Load fisrt 2 bytes of 'END' from ENDPIC
00036500          STD     DCCDBU          Place in frist 2 bytes of display buffer
00036600          LDAA    2,X             Load third byte from 'END' ENDPIC+2
00036700          STAA    DCCDBU+2        Place in third byte of display buffer
```

```
00036800          JSR     VALCMP          Convert pressure to duty cycle and compensate
00036900          JMP     ENDDMD          End of this stuff - go send CCD stuff
00037000          .PAGE
00037100 *        .TTL    'INIT/DIAGNOSTIC' MODE VALVE CALIBRATION RAM - MODE 23
00037200 *M23_CT RMB      1       Counter to keep track of where in mode 23
00037300 *        0 -> NOT defined
00037400 *        1 -> Motion fault has occurrec - waiting for neutral to recover
00037500 *        2 -> Storing a clibration datum
00037600 *Note: mode 23 counter = 'storing + 1' -> done storing -> 'delay'
00037700 *        3 -> Waiting for delay following calibration of specific element
00037800 *        4 -> Waiting in Peter's 'Stabiliz' routine for t9 to
00037900 *        5 -> Engine speed wrong during 'Stabiliz' so wait on operator
00038000 *        6 -> calibration of a particular element
00038100 *Note: mode 23 counter = 'stabiliz + 1' -> done waiting -> calibrate
00038200 *        7 -> ramping pressure of a particular element
00038300 *        8 -> Compare to mode 23 fast fault while trying to calibrate element
00038400 *        9 -> Compare to mode 23 slow fault while trying to calibrate element
00038500 *        10  -> Mode 23 is finished - send 'END' until operator does something
00038600 *        11  -> Mode 23 waiting for clutch pedal to be released - fully engage clutch
00038700 *
00038800 *M23_TR RMB      1       Timer for whatever is happening in Mode 23 ( 20 mSec)
00038900 *BGNENG RMW      1       Engine speed when begin calibrating a given element (word)
00039000 *ElmNum RMB      1       Number of element being calibrated - Table entry
00039100 *        controls which element, picture, etc.
00039200 *M23PRS RMB      1       Pressure being commanded to the element under calibration
00039300 *ElmMax          EQU     9       highest element number
00039400 *         for use as a pointer
00039500          .PAGE
00039600          .TTL    'INIT/DIAGNOSTIC' MODE VALVE CALIBRATION - MODE 23
00039700 *NOTE: ROM can be shortened by using DECB in following test and ordering
00039800 *the tests appropriately but since the oreder is unknown presently (ie
00039900 * at  2-NOV-1991 06:11:40) I will use this technique.
00040000 Mode23   BCLR    FLAGD,#PICDAT   Mode 23 always needs picture display selected
00040100          LDX     #VOFNS  Setup X to cause all elemnts to be Off (needed sometimes)
00040200          JSR     UP_BUF  Update the modulator pressure commands to 0 (")
00040300 *  Setup the X pointer to the element table
00040400          LDX     #ElmTBL Fetch address of the element table
00040500          LDAB    ElmNum  Fetch the element number
00040600          CMPB    #ElmMax Compare to maximum element number
00040700          BLO     77$     IF: Reached past last element
00040800          LDAA    #10  THEN: store mode 23 finished count
00040900          STAA    M23_CT
00041000          JMP     M23END          Finished go send PicEnd until exit
00041100 *                          ELSE: Continue with this element
00041200 77$      ABX             \Offset by 2 times element number (2 byte entries)
00041300          ABX             /
00041400 *  Begin to search for function in mode 23
00041500          LDAB    M23_CT  Fetch the counter for where in Mode 23
00041600          CMPB    #1      Compare to mode 23 motion fault count
00041700          BNE     51$
00041800          JMP     M23MFT  IF: Motion fault then go send error and wait for Neutral
00041900 51$      LDAA    AX10pr  IF:previous 10mSec axle period timer -> motion
00042000          CMPA    >SC_t30  (period lower than t30)
00042100          BHS     49$
00042200          LDAA    AX10ms    THEN: IF:present 10mSec axle period timer -> motion
00042300          CMPA    >SC_t30  (period lower than t30)
00042400          BHS     49$
00042500          JMP     M23MFT       THEN: Goto motion fault handler (sets M23_CT properly)
00042600 49$      CMPB    #10     Compare to mode 23 finished count
00042700          BNE     52$
00042800          JMP     M23END  IF: Finished go send PicEnd until exit
00042900 52$      CMPB    #8      Compare to mode 23 fault while trying to calibrate element
```

```
00043000          BNE     53$
00043100          JMP     M23CLF  IF: Fast fault while cailibrating
00043200 53$      CMPB    #9      Compare to mode 23 fault while trying to calibrate element
00043300          BNE     54$
00043400          JMP     M23CHF  IF: Slow fault while cailibrating
00043500 54$      CMPB    #11     Compare to mode 23 waiting for clutch pedal
00043600          BNE     45$
00043700          JMP     M23_11  IF: waiting for clutch pedal
00043800 45$      CMPB    #3      Compare to mode 23 delay following calibration of element
00043900          BNE     55$
00044000          JMP     M23DLY  IF: delay following a specific element's calibration
00044100 55$      CMPB    #2      Compare to mode 23 Storing a clibration datum
00044200          BNE     57$
00044300          JMP     M23str  IF: storing then wait till stored
00044400 57$
00044500
00044600 *  Turn On elements that are to be on
00044700          PSHX            save pointer to the modulator being 'ramped'
00044800          LDAB    #4*ElmMax Preset B to the required offset
00044900          ABX             Setup X as pointer to valves to be on
00045000          LDAA    >P_cal  Preset the desired pressure
00045100          JSR     MXTSBS  Preset all the modulators
00045200          JSR     UP_BUF  Update the modulator pressure commands to 0 (")
00045300          JSR     CAL_EL  Cal the calibration subroutine ??? is this correct loc
00045400          PULX            Restore X as pointer to element data
00045500
00045600 *  Test for other conditions as required
00045700          LDAB    M23_CT  Fetch the counter for where in Mode 23
00045800          CMPB    #5      Compare to mode 23 waiting for engine speed adjustment
00045900          BNE     56$
00046000          JMP     M23AD2  IF: Engine speed needs adjustment - go wait on operator
00046100 56$      CMPB    #4      Compare to mode 23 Waiting in PF's 'Stabiliz' routine for t9
to
00046200          BNE     58$
00046300          JMP     STBLZ6  IF: then wait until engine speed ok
00046400 58$
00046500
00046600 *  Verify that NOT Neutral and Clutch fully engaged
00046700          BRCLR   DIGN_1,#NNEUTN,59$ IF: NOT Neutral
00046800          BRCLR   FLAG1,#CL_NEF,60$    THEN: IF: Clutch Not Fully engaged
00046900 59$      DEC     D_MODE                  Reset to mode 22
00047000          LDAB    #10                     Reset to end of mode 22
00047100          STAB    M22_CT
00047200          JMP     M22END                       THEN: Start over @End of Mode 22
00047300
00047400 *  Test for the remaining conditions
00047500 60$      CMPB    #7      Compare to mode 23 calibration wakeup pulse
00047600          BEQ     M23CPS  IF: ramping the pressure on element under calibration
00047700          JMP     M23END  IF: NOT one of these THEN: send PicEnd  ???
00047800
00047900 *  When ramping 'wakeup time' on element undergoing calibration
00048000 M23CPS   LDY     8*ElmMax,X Fetch starting pressure's address (time offset $45)
00048100          LDAA    M23_TR  Fetch the timer
00048200          BNE     Sep3x   IF: It is 0 THEN: Time to increment
00048300          LDAB    M23PRS  Fetch wakeup pulse width currently being used
00048400          ADDB    #1      Add 20mSec to the width of this wakeup pulse
00048500          CMPB    $46,Y   Compare to the limiting time (1 above start time)
00048600          BLS     Sep3    IF: Time now too long
00048700 M23CHF   LDAA    #9        THEN: store mode 23 slow fault
00048800          STAA    M23_CT
00048900          LDAA    >PicS           Fetch the 'S' picture
00049000          BRA     Sepid
```

```
00049100 M23CLF  LDAA    #8              store mode 23 fast fault
00049200         STAA    M23_CT
00049300         LDAA    >PicF           Fetch the 'F' picture
00049400 Sepid
00049500 *       BCLR    FLAGD,#PICDAT   Select picture display - done at beginning
00049600 *  Turn off element under calibration since there was a fault
00049700         LDY     2*ElmMax,X Setup Y as pointer to the modulator being 'ramped'
00049800         CLR     1,Y     \Store 0 as command to element under calibration
00049900         CLR     0,Y     /
00050000         LDX     0,X             Fetch element's picture's address
00050100 *  Check for clutch switch to get out of this mode
00050200         BRCLR   FLAG4,#CL_NEF,2$ IF: Clutch Not Fully engaged
00050300         LDAA    #11       THEN: mode 11 waiting on clutch
00050400         STAA    M23_CT
00050500         JMP     M23Ed2          Goto M23Ed2 which sends picture
00050600 2$
00050700 *  Setup the picture for this fault mode
00050800         ORAA    2,X             'OR' with third byte of current picture
00050900         STAA    DCCDBU+2        Place in third byte of display buffer
00051000         LDD     0,X             Load fisrt 2 bytes of current picture
00051100         STD     DCCDBU          Place in frist 2 bytes of display buffer
00051200         JSR     VALCMP          Convert pressure to duty cycle and compensate
00051300         JMP     ENDDMD          End of this stuff - go send CCD stuff
00051400
00051500 Sep3    STAB    M23PRS  Save as the next time to command
00051600 Sep3x   INCA            Increment the timing
00051700         STAA    M23_TR  Update the timer also
00051800
00051900         CMPA    M23PRS  Compare to the wakeup pulse desired
00052000         BHI     6$      IF: Wakeup pulse has ended
00052100 *                         THEN: Turn the element OFF (should be OFF as default)
00052200 *                         ELSE: Turn the element ON
00052300 *  Engage the modulator which is changing
00052400         LDY     2*ElmMax,X Setup Y as pointer to the modulator being 'ramped'
00052500         LDAB    #239    Fetch wakeup pulse pressure to command - 1600kPa uncomp
00052600         CLR     1,Y     \Store as command to element under calibration
00052700         STAB    0,Y     /
00052800
00052900 6$      CMPA    >SC_t35 Compare to the maximum time between wakeup pulses
00053000         BLO     21$     IF: Time elapsed
00053100 *                         THEN: Start next cycle
00053200         CLR     M23_TR  clear timer for next pressure increment
00053300 *  Save beginning engine speed
00053400         LDD     ENGSPD+1 Fetch engine speed at beginning of this wakeup pulse
00053500         STD     BGNENG  save as the beginning speed for this wakeup pulse
00053600         BRA     22$     Go sned picture for this pass
00053700 *                         ELSE: Continue checking for droop here
00053800 *  Calculate droop at starting pressure
00053900 21$     LDD     BGNENG  Fetch the beginning speed for this wakeup pulse
00054000         SUBD    ENGSPD+1 Fetch engine speed as received (carry -> speed increased)
00054100         BCS     2$      IF: speed increased then droop ok??
00054200         CPD     >Ne2Ful Compare to the desired droop
00054300         BLO     2$      IF: Droop has been large enough
00054400 *                         ELSE: Continue with loop
00054500         LDAB    M23PRS    THEN: Fetch the width of the wakeup pulse chosen
00054600         LDY     8*ElmMax,X Fetch starting pressure's address (time offset $45)
00054700         CMPB    $45,Y           Compare to the starting width
00054800         BEQ     M23CLF          IF: Starting width
00054900 *                                   THEN: Too Fast so fault
00055000         STAB    Offset          Save as the calibration data for storage
00055100         LDAA    #2              \Set mode 23 to Storing a clibration datum
00055200         STAA    M23_CT          /
```

```
00055300 2$       LDX     0,X      Fetch element's picture's address
00055400 22$      JMP     M23Ed2   Goto M23Ed2 which sends picture
00055500
00055600 *  Delay following a specific element's calibration
00055700 M23DLY   LDX     #ElmTBL  Fetch address of the element table
00055800          LDAB    ElmNum   Fetch the element number
00055900          ABX              \Offset by 2 times element number (2 byte entries)
00056000          ABX              /
00056100          INC     M23_TR
00056200          LDAA    M23_TR
00056300          CMPA    10*ElmMax,X Compare to required delay time
00056400          BLS     1$
00056500          INC     M23_CT   Goto next mode now
00056600          INC     ElmNum   Goto next element now
00056700          CLR     M23_TR   Reset the timer so that stabilize starts from 0
00056800          BRA     STBLZ6   Goto 'Stabiliz' to continue
00056900 1$       LDX     0,X      Fetch element picture address while waiting
00057000          JMP     M23Ed2   Goto M23Ed2 which sends picture
00057100
00057200 *  While waiting for clutch pedal to be released - clutch fully engaged
00057300 M23_11   BRSET   FLAG4,#CL_NEF,2$ IF: Clutch Fully engaged
00057400          INC     ElmNum      THEN: Goto next element now
00057500          CLR     M23_TR           Reset the timer so that stabilize starts from 0
00057600          JMP     STBLZ6           Goto 'Stabiliz' to continue
00057700 *                              ELSE: Display wait picture until pedal released
00057800 2$       LDX     #PicWat  Set pointer to wait picture for engine stabiliz
00057900          JMP     M23Ed2           Goto M23Ed2 which sends picture
00058000
00058100
00058200 *  When operator is required to readjust/adjust the engine speed
00058300 M23ADJ   LDAA    #5       \Set mode 23 to engine speed wrong
00058400          STAA    M23_CT   /
00058500          CLR     M23_TR   Reset the timer for next function
00058600          LDX     #PicSpd  Set pointer to speed adjustment picture
00058700          JMP     M23Ed2   Goto M23Ed2 which sends picture
00058800 *  When operator is required to readjust/adjust the engine speed
00058900 M23AD2   CLR     M23_TR   Reset the timer for next function
00059000          LDX     #PicSpd  Set pointer to speed adjustment picture
00059100          DEC     M23_CT   Set to stabilize
00059200          JMP     STBLZ4   Check if ok yet
00059300 *  Wait until engine speed ok and stabilised
00059400 STBLZ6   LDAA    #4       \Set mode 23 to waiting in 'stabiliz'
00059500          STAA    M23_CT   /
00059600 *  Verify that we are in forward and NOT neutral
00059700          BRSET   DIGN_1,#FORIN,89$ IF: NOT Forward
00059800 88$      LDX     #PicFor             THEN: Fetch send PicFor (fetch it's address)
00059900          JMP     M23Ed2                Goto M23Ed2 which sends picture
00060000 89$      BRCLR   DIGN_1,#NNEUTN,88$ ELSE: IF: Neutral
00060100 *                                           THEN: Send PicFor
00060200 *                                           ELSE: Continue with the stabilize routine
00060300          LDX     8*ElmMax,X Fetch the address of the starting pressure
00060400          LDAA    $45,X    Fetch the starting pressure
00060500          DECA             Subtract 20mSec from width to compensate for addition elsewhere
00060600          STAA    M23PRS   Store Pressure to command to element once under calibration
00060700          LDX     #PicWat  Set pointer to wait picture for engine stabiliz
00060800          LDAA    M23_TR    Check timer
00060900          CMPA    >SC_t34
00061000          BLO     STBLZ5   IF: t34 has elpased
00061100          INC     M23_CT   Changed to wakeup pulse cal mode (from stabilize)
00061200          INC     M23_CT
00061300          INC     M23_CT
00061400 STBLZ4   LDD     ENGSPD+1 Fetch engine speed as received
```

```
00061500          STD     BGNENG  Save as engine speed at beginning of element calibration
00061600          CPD     >NeCal  Compare highest allowed engine speed (NeCal)
00061700          BHI     M23ADJ  IF: Too High THEN: Set to engine speed wrong
00061800          ADDD    #100      ELSE: Add the 100 rpm range value
00061900          CPD     >NeCal          Compare to lowest speed (NeCal-100) .
00062000          BLO     M23ADJ  IF: Too Low THEN: Set to engine speed wrong
00062100          CLR     M23_TR    THEN: Reset the timer for next function
00062200          BRA     M23Ed2          Goto M23Ed2 which sends picture
00062300 *                                ELSE: wait until t34 or engine wrong
00062400 STBlZ5   INC     M23_TR          Increment the timer
00062500          BRA     M23Ed2          Goto M23Ed2 which sends picture
00062600
00062700 *  Determine if memory is currently processing another function (task)
00062800 *  A to contain the new data
00062900 *  X to be pointer to mode 23 data table - base address + 3*element number
00063000 M23str   BRCLR   prgflg,#erreq+aureq,22$ \May NOT Store a new code when
00063100          JMP     M23eps                  /already storing one - stay this function
00063200 *avaliable for storage applications
00063300 22$      PSHX            Save X since eereqs destroys it (also code below)
00063400          LDX     6*ElmMax,X Fetch pointer into EEROM calibration storage
00063500 *  Note: The EEROM address is stored in the mode 22 table like everything else
00063600 *therefore must offset by $20 to get to where we are
00063700          XGDX            Setup D for adition
00063800          ADDD    #$20    Offset for mode 23
00063900          XGDX            Setup X as pointer into EEROM calibration storage
00064000 *  Storage routine may check for 'same' data'
00064100          LDAA    Offset  Fetch the offset from previous calculations
00064200          DECA            Remove 20mSec
00064300          DECA            Remove 20mSec for a total of 40mSec reduction
00064400          CMPA    0,X     Compare to the new cal data
00064500          BEQ     M23ep   IF: They are the 'SAME'
00064600 *                           THEN: No need to store
00064700          STX     eraddr          Set request address pointer to wherever
00064800          STAA    erdata          Put the desired data into request data
00064900          BSET    prgflg,#erreq   Set flag that we requested error code programming here
00065000          JSR     eereqs          Call the routine which causes storage to occur
00065100 M23ep    INC     M23_CT  Set mode 23 counter to next mode -> done storing
00065200          CLR     M23_TR  Reset the timer so that delay starts from 0
00065300          PULX            Restore X
00065400 M23eps   LDX     0,X     Set pointer to element's picture's address
00065500          BRA     M23Ed2          Goto M23Ed2 which is same code
00065600
00065700 *  When Motion fault - send error and wait for Neutral
00065800 M23MFT   CLR     M23_CT  \Set function in mode 23 to Motion fault
00065900          INC     M23_CT  /
00066000          BRSET   DIGN_1,#NNEUTN,2$ IF: Neutral
00066100          CLR     ERRMSG                  THEN: Reset the Error
00066200          CLR     M23_CT                        Reset mode 23 to beginning
00066300          JMP     M22END                        Restart at beginning of mode 23
00066400 2$       LDAA    >DC_CNV+116/2           IF: Enabled
00066500          BEQ     1$                        THEN: Get that error
00066600 *                                          ELSE: Go on as if that error had NOT
occurred
00066700          LDAA    #116            Set error to Motion fault
00066800          JSR     CODSTR          Call fault storage routine
00066900          JSR     CCDSDE          Send CCD link error msg if desired
00067000 1$
00067100 *  Neutral recovery of this fault is elswhere and clears M23_CT
00067200 *  Send fault picture
00067300          LDX     #PicFlt         Set pointer to Motion fault picture
00067400          BRA     M23Ed2          Goto M23Ed2 which is same code
00067500
```

```
00067600 *  When Mode 23 is finished send 'END' until operator does something
00067700 M23END  LDX     #ENDPIC          Select pointer to ENDPIC
00067800 *  Below is code if need a beep when done
00067900 *       LDAA    CLRTMR           IF: Just sending 'END' for 1st sample
00068000 *       BNE     2$                (ie CLRTMR == 0)
00068100 *       BSET    FLAGD,#BEPIT       THEN: Set for Beep (beep is a single shot)
00068200 *2$
00068300 M23Ed2
00068400 *       BCLR    FLAGD,#PICDAT    Select picture display - done at beginning
00068500         LDD     0,X              Load fisrt 2 bytes of 'END' from ENDPIC
00068600         STD     DCCDBU           Place in frist 2 bytes of display buffer
00068700         LDAA    2,X              Load third byte from 'END' ENDPIC+2
00068800         STAA    DCCDBU+2         Place in third byte of display buffer
00068900         JSR     VALCMP           Convert pressure to duty cycle and compensate
00069000         JMP     ENDDMD           End of this stuff - go send CCD stuff
00069100
```

CALIBRATION METHOD FOR TRANSMISSION CONTROL CLUTCHES

ABSTRACT

The hydraulically operated brake and clutch elements (controlled by proportional control valves) of a vehicle powershift transmission have fill pressures which are calibrated by a method wherein the output shaft of the transmission is disconnected from the vehicle drive shaft so that the transmission output shaft is free to rotate and certain ones of the plurality of the control elements other than the control element being calibrated are fully pressurized in order to prevent rotation of a part of the control element being calibrated. The engine is run at a predetermined speed and the pressure applied to the control element being calibrated is gradually increased while engine speed is monitored. When the monitored engine speed changes by predetermined amount, a value is saved corresponding to the calibration pressure. The transmission is automatically shifted to neutral if vehicle motion is sensed. The volume of hydraulic fluid required to initially engage the control element may be calibrated in a similar manner.

07 06 93 40091.

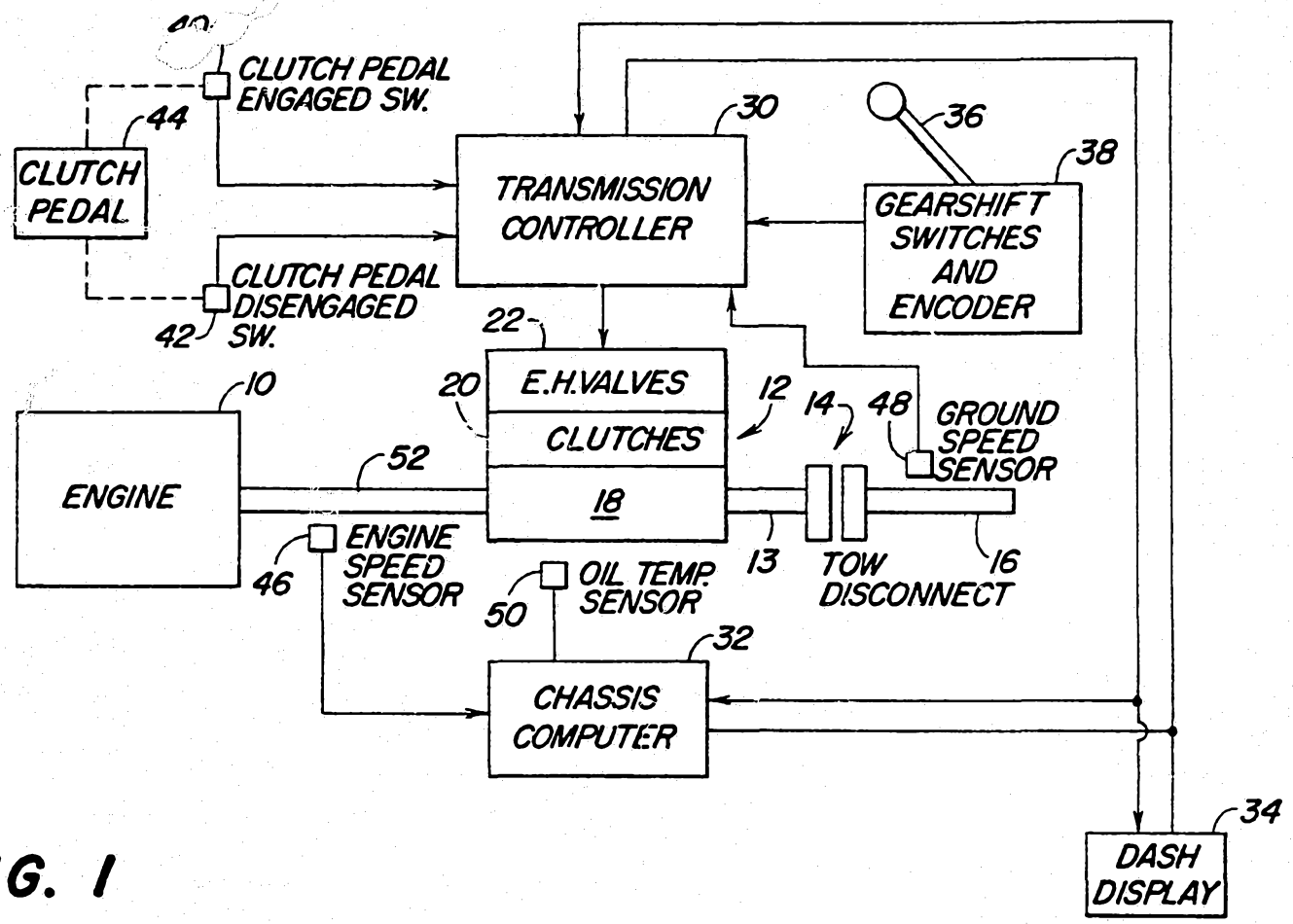


FIG. 1

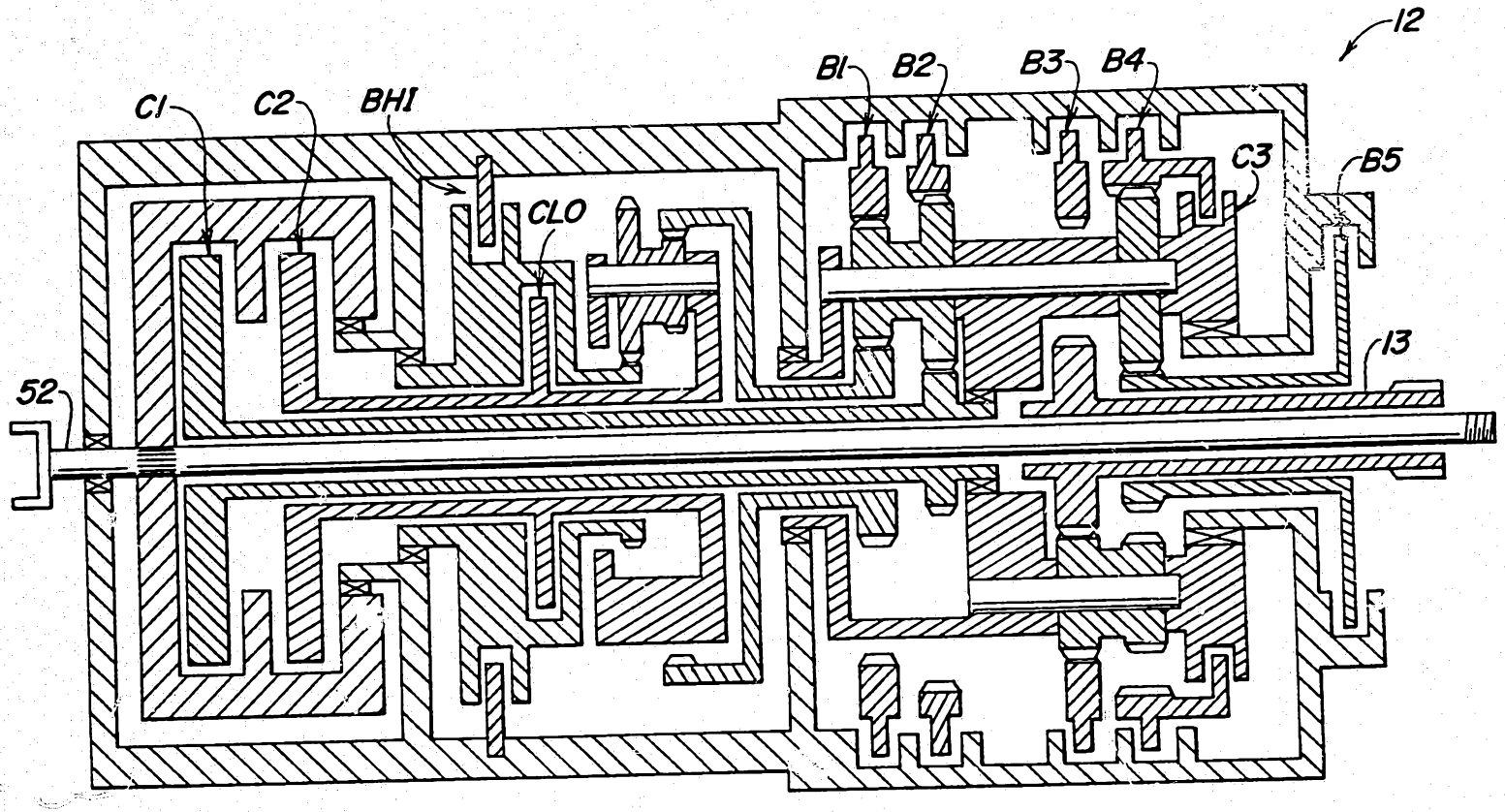


FIG. 2a

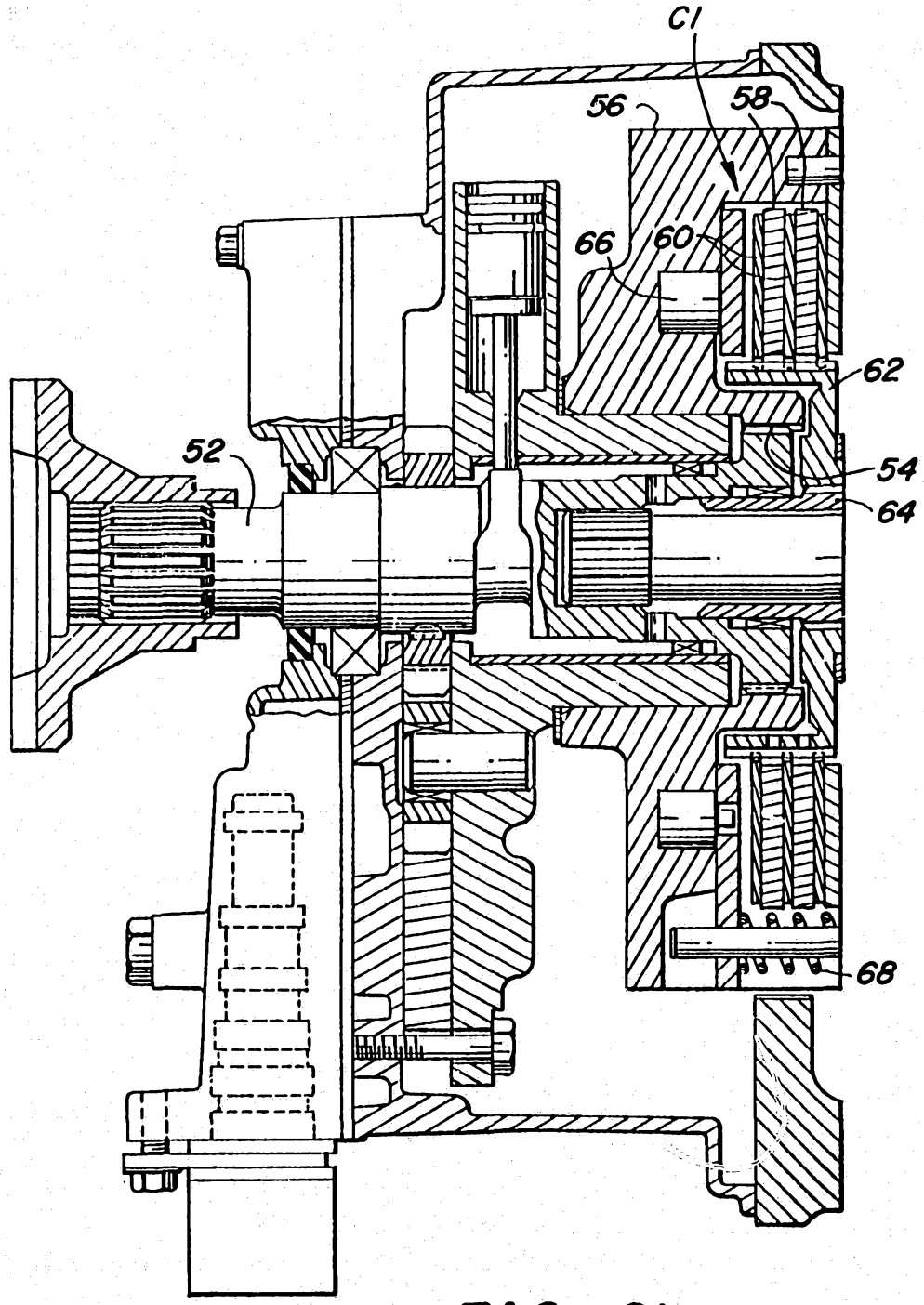


FIG. 2b

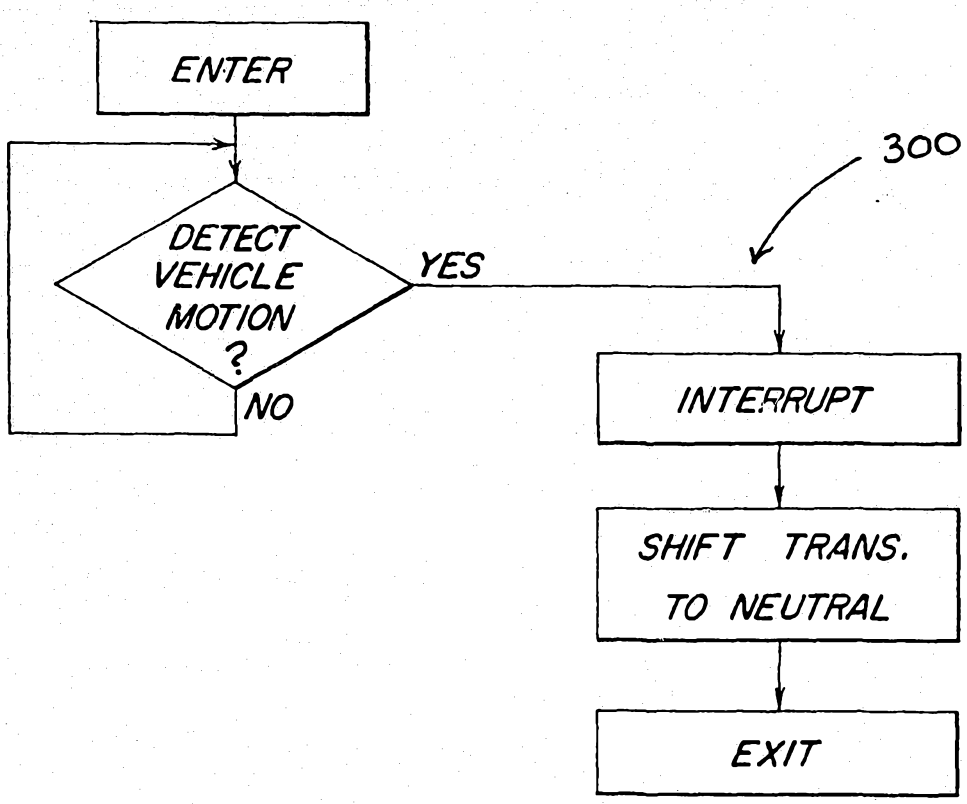

ENTER
DETECT VEHICLE MOTION ?
YES
NO
300
INTERRUPT
SHIFT TRANS. TO NEUTRAL
EXIT

FIG. 3

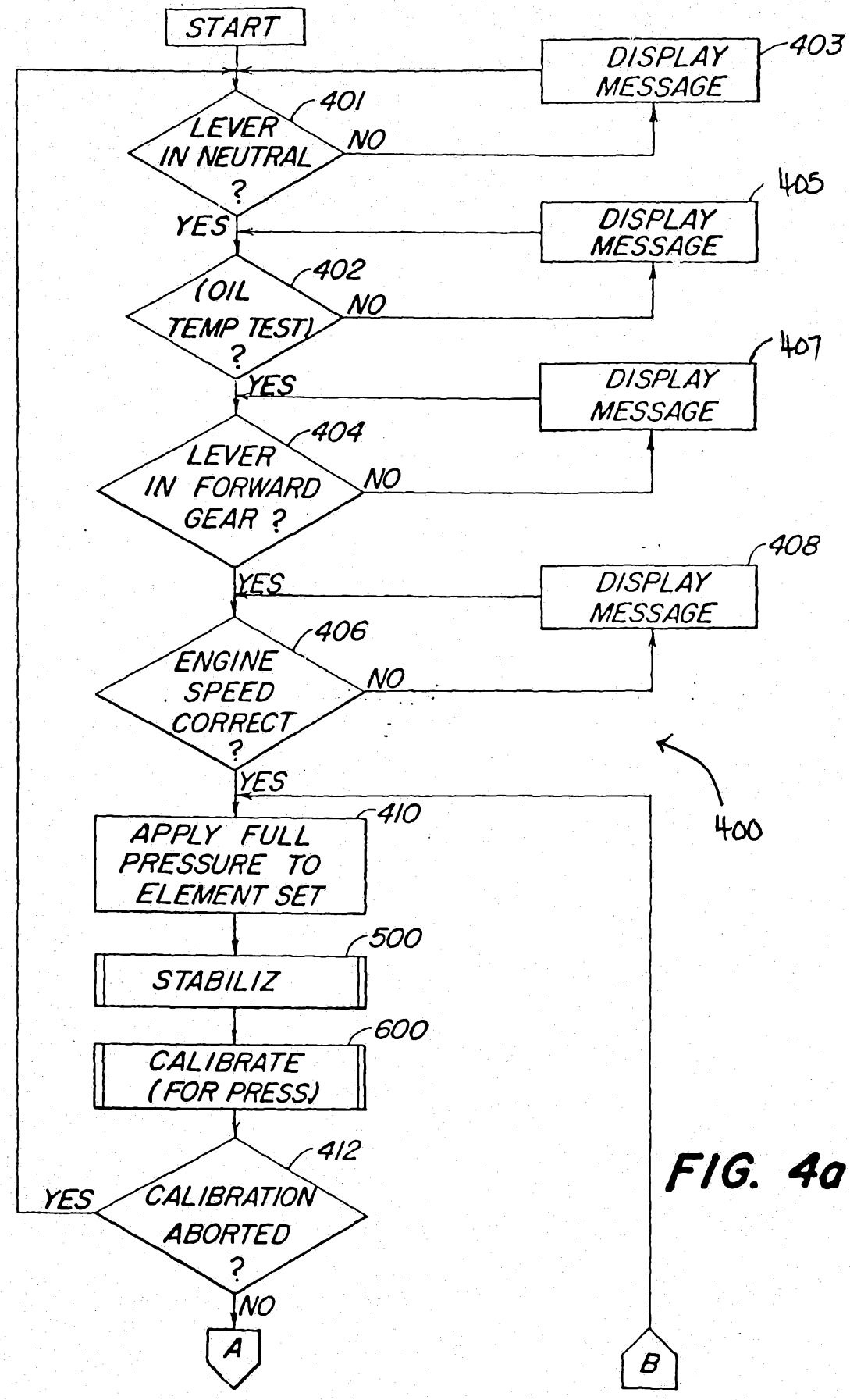

START
DISPLAY MESSAGE
403
401
LEVER IN NEUTRAL ?
NO
YES
405
DISPLAY MESSAGE
402
(OIL TEMP TEST) ?
NO
YES
407
DISPLAY MESSAGE
404
LEVER IN FORWARD GEAR ?
NO
YES
408
DISPLAY MESSAGE
406
ENGINE SPEED CORRECT ?
NO
YES
400
410
APPLY FULL PRESSURE TO ELEMENT SET
500
STABILIZ
600
CALIBRATE (FOR PRESS)
412
YES
CALIBRATION ABORTED ?
NO
A
B

FIG. 4a

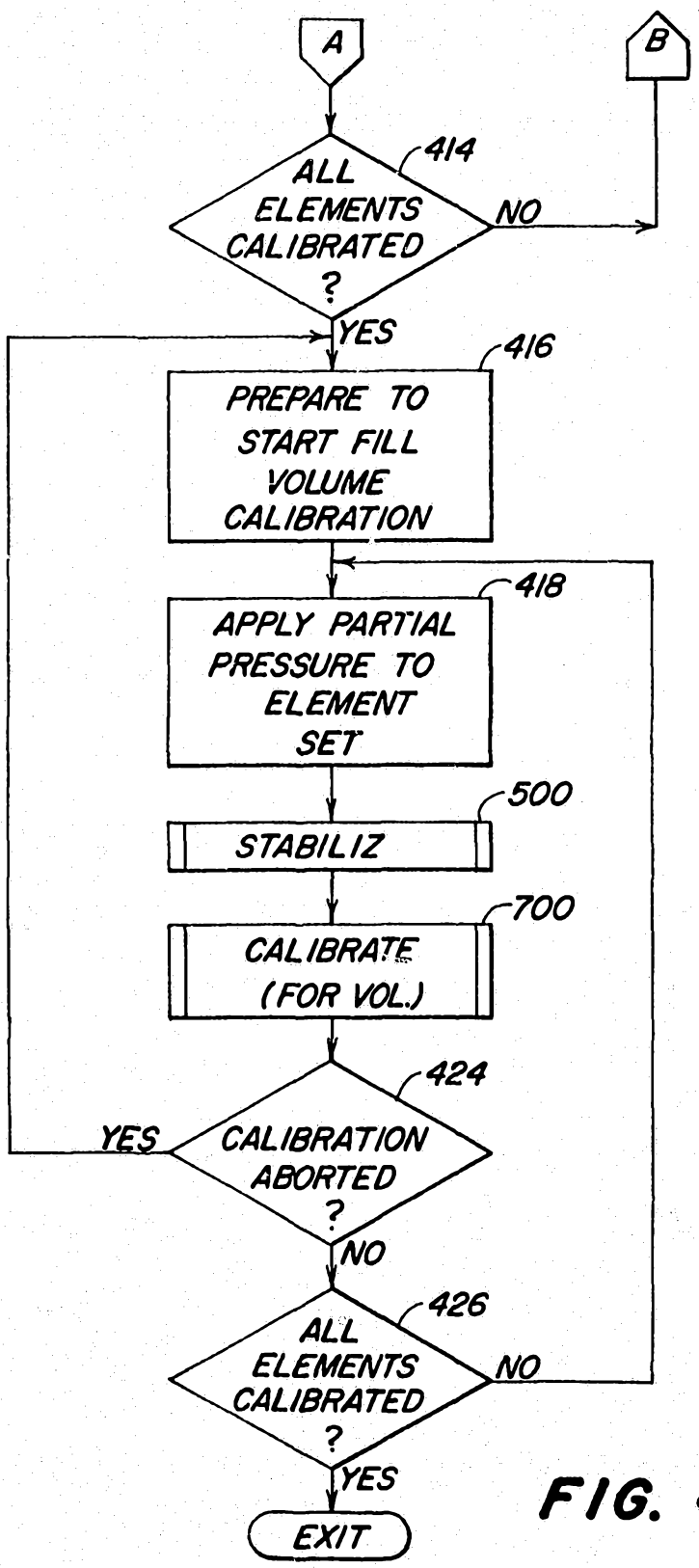

A
B
414
ALL ELEMENTS CALIBRATED ?
NO
YES
416
PREPARE TO START FILL VOLUME CALIBRATION
418
APPLY PARTIAL PRESSURE TO ELEMENT SET
500
STABILIZ
700
CALIBRATE (FOR VOL.)
424
YES
CALIBRATION ABORTED ?
NO
426
ALL ELEMENTS CALIBRATED ?
NO
YES
EXIT

FIG. 4b

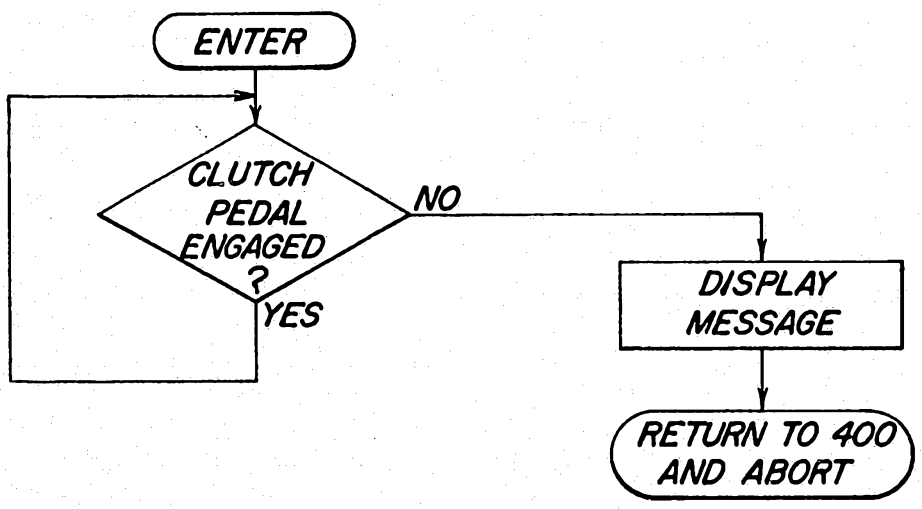

ENTER
CLUTCH PEDAL ENGAGED ?
NO
YES
DISPLAY MESSAGE
RETURN TO 400 AND ABORT

FIG. 4c

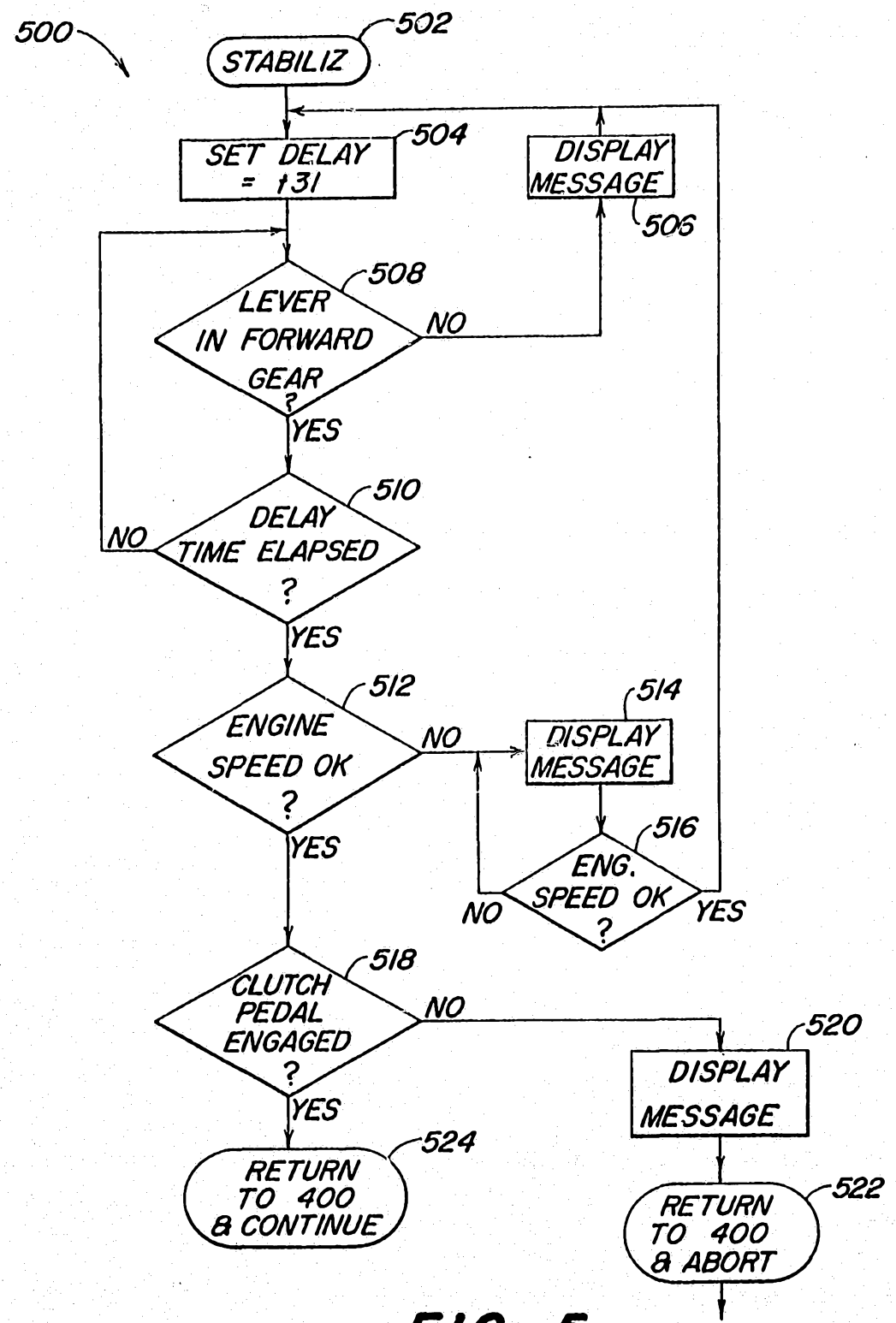

500
502
STABILIZ
504
SET DELAY = t31
DISPLAY MESSAGE
506
508
LEVER IN FORWARD GEAR ?
NO
YES
510
DELAY TIME ELAPSED ?
NO
YES
512
ENGINE SPEED OK ?
NO
514
DISPLAY MESSAGE
516
ENG. SPEED OK ?
NO
YES
YES
518
CLUTCH PEDAL ENGAGED ?
NO
YES
520
DISPLAY MESSAGE
522
RETURN TO 400 & ABORT
524
RETURN TO 400 & CONTINUE

FIG. 5

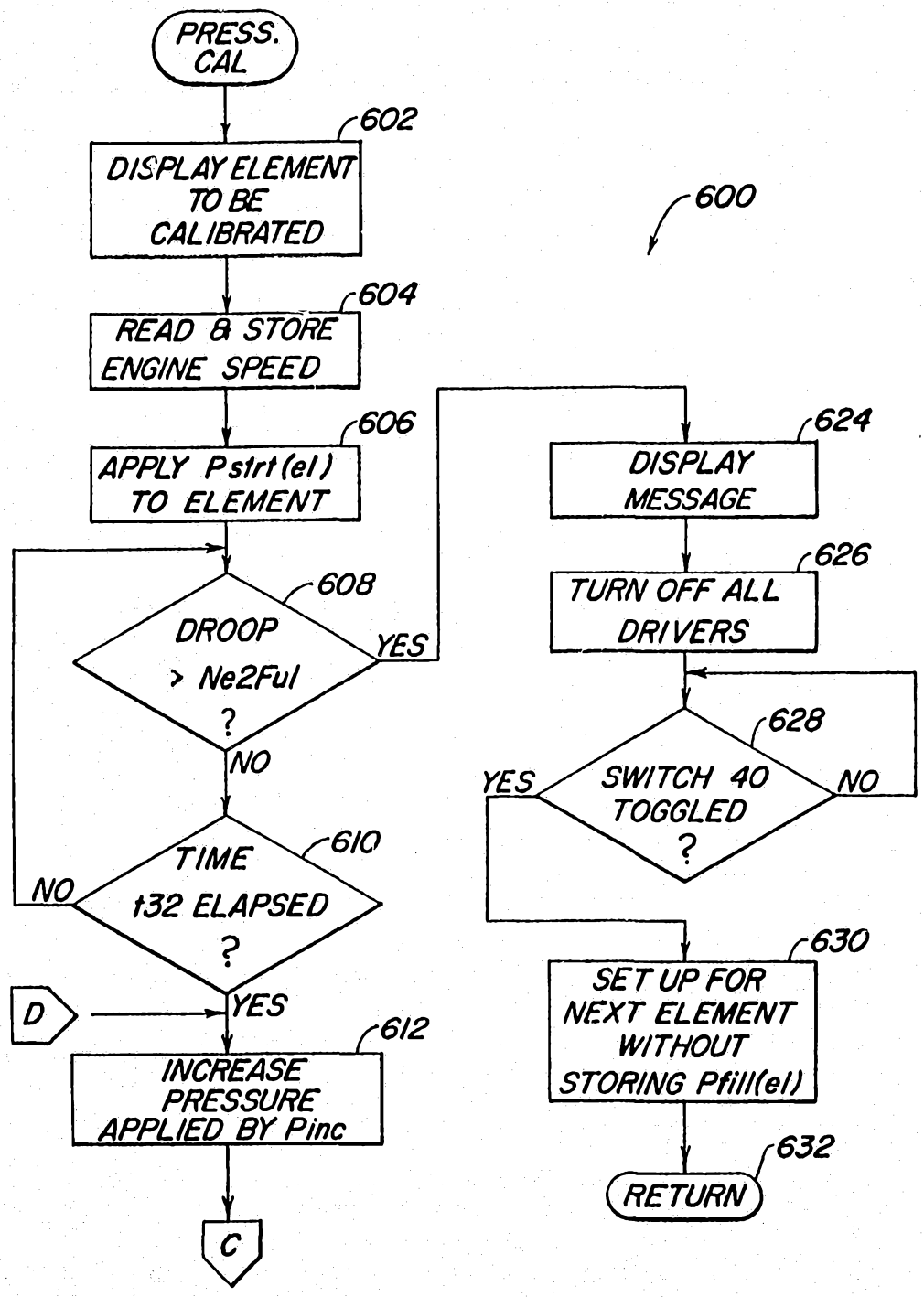

PRESS. CAL
602
DISPLAY ELEMENT TO BE CALIBRATED
600
604
READ & STORE ENGINE SPEED
606
APPLY Pstrt(el) TO ELEMENT
608
DROOP > Ne2Ful ?
YES
NO
610
TIME t32 ELAPSED ?
NO
YES
D
612
INCREASE PRESSURE APPLIED BY Pinc
C
624
DISPLAY MESSAGE
626
TURN OFF ALL DRIVERS
628
SWITCH 40 TOGGLED ?
YES
NO
630
SET UP FOR NEXT ELEMENT WITHOUT STORING Pfill(el)
632
RETURN

FIG. 6a

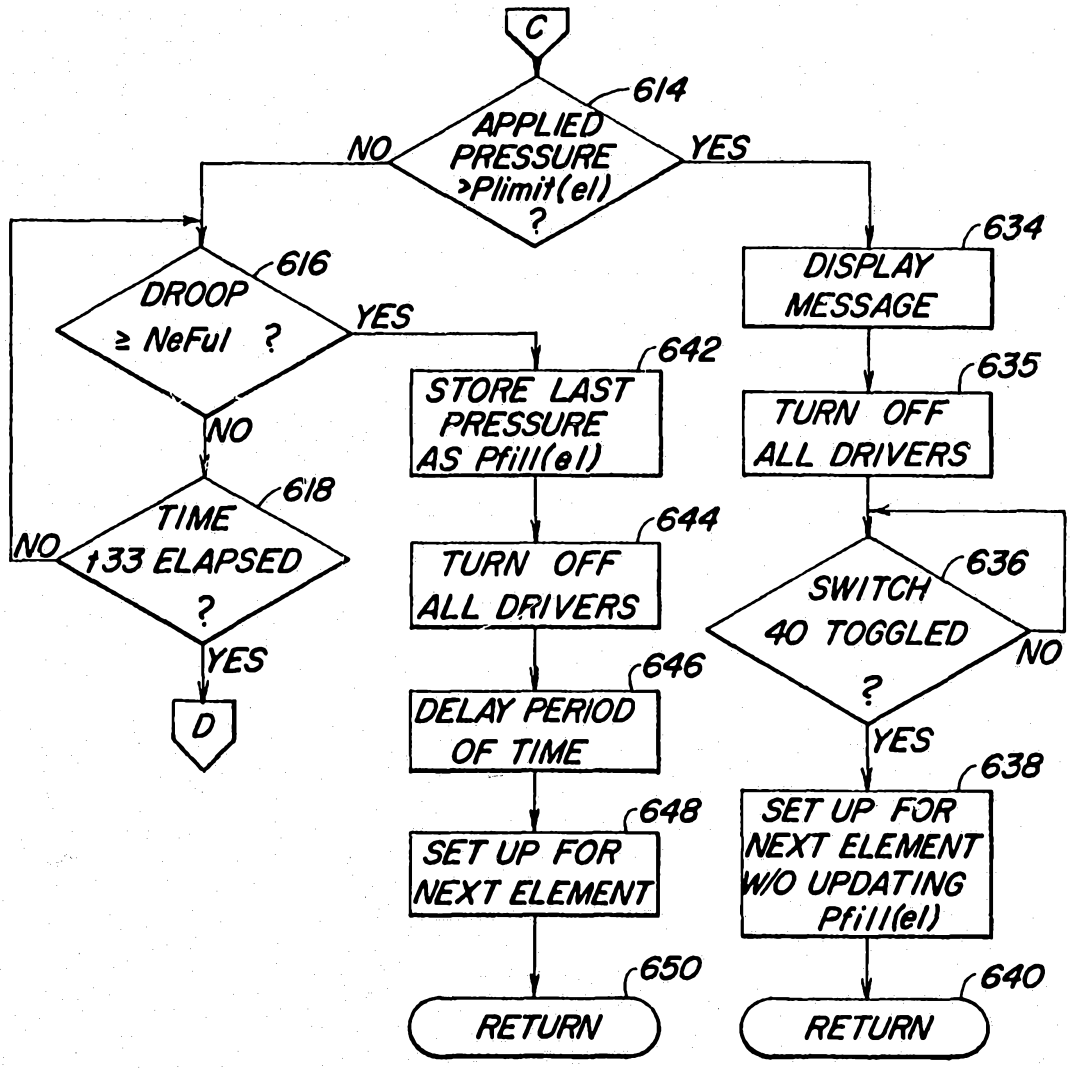

C
614
APPLIED PRESSURE >Plimit(el) ?
NO
YES
616
DROOP ≥ NeFul ?
YES
NO
618
TIME 133 ELAPSED ?
NO
YES
D
642
STORE LAST PRESSURE AS Pfill(el)
644
TURN OFF ALL DRIVERS
646
DELAY PERIOD OF TIME
648
SET UP FOR NEXT ELEMENT
650
RETURN
634
DISPLAY MESSAGE
635
TURN OFF ALL DRIVERS
636
SWITCH 40 TOGGLED ?
NO
YES
638
SET UP FOR NEXT ELEMENT W/O UPDATING Pfill(el)
640
RETURN

FIG. 6b

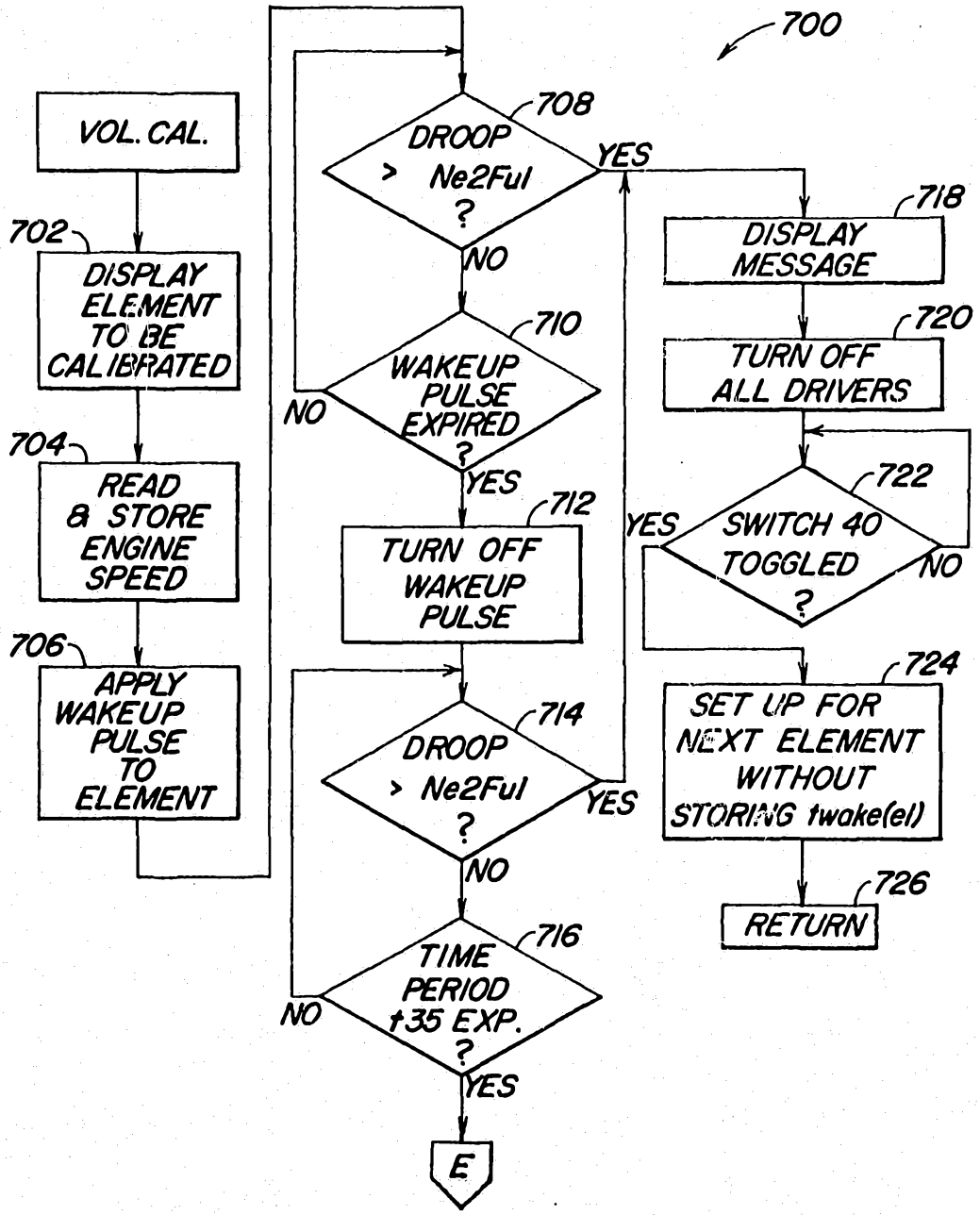

700
VOL. CAL.
702
DISPLAY ELEMENT TO BE CALIBRATED
704
READ & STORE ENGINE SPEED
706
APPLY WAKEUP PULSE TO ELEMENT
708
DROOP > Ne2Ful ?
YES
NO
710
WAKEUP PULSE EXPIRED ?
NO
YES
712
TURN OFF WAKEUP PULSE
714
DROOP > Ne2Ful ?
YES
NO
716
TIME PERIOD t35 EXP. ?
NO
YES
E
718
DISPLAY MESSAGE
720
TURN OFF ALL DRIVERS
722
SWITCH 40 TOGGLED ?
YES
NO
724
SET UP FOR NEXT ELEMENT WITHOUT STORING twake(el)
726
RETURN

FIG. 7a

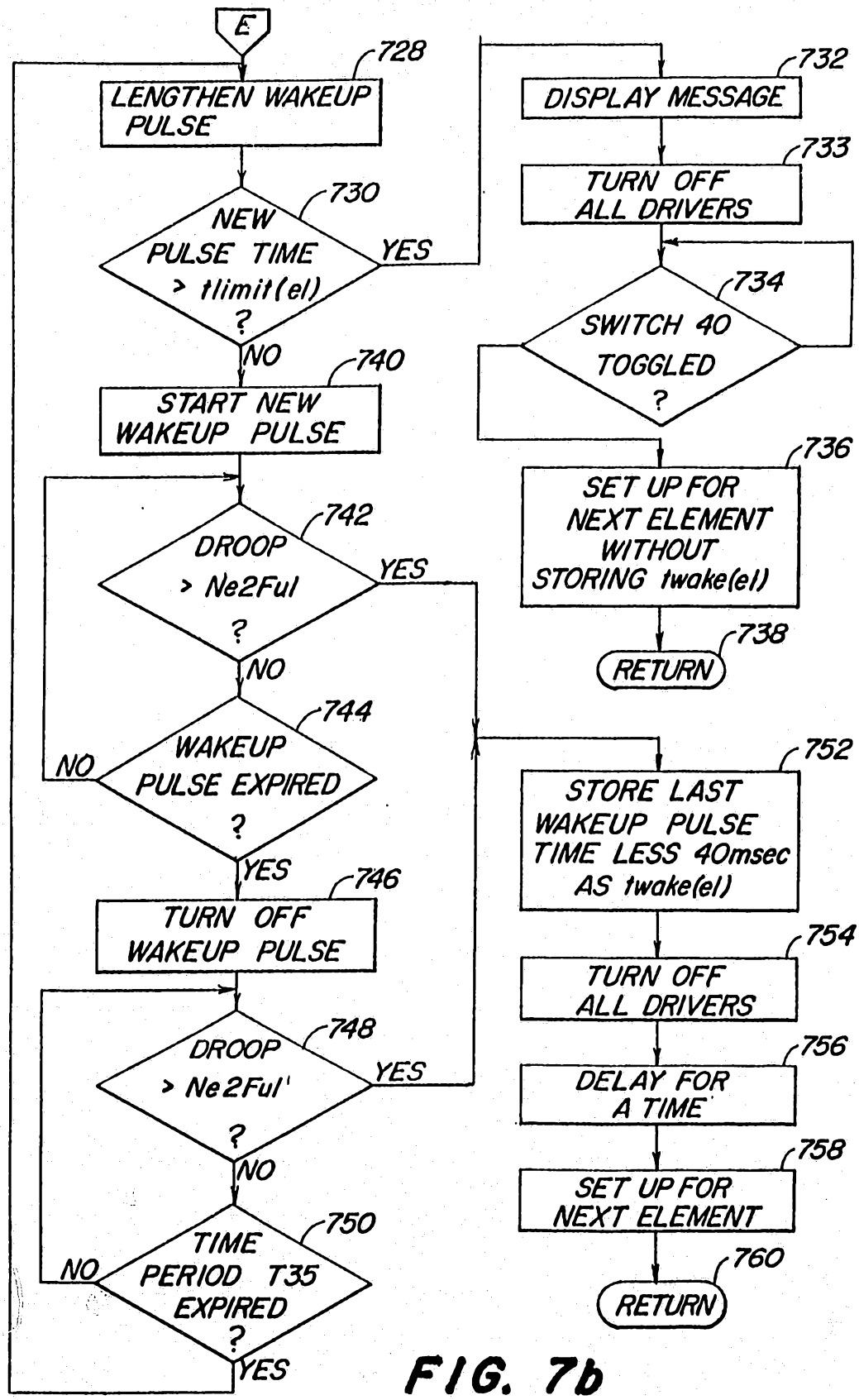

E
728
LENGTHEN WAKEUP PULSE
730
NEW PULSE TIME > tlimit(el) ?
YES
NO
740
START NEW WAKEUP PULSE
742
DROOP > Ne2Ful ?
YES
NO
744
WAKEUP PULSE EXPIRED ?
NO
YES
746
TURN OFF WAKEUP PULSE
748
DROOP > Ne2Ful' ?
YES
NO
750
TIME PERIOD T35 EXPIRED ?
NO
YES
732
DISPLAY MESSAGE
733
TURN OFF ALL DRIVERS
734
SWITCH 40 TOGGLED ?
736
SET UP FOR NEXT ELEMENT WITHOUT STORING twake(el)
738
RETURN
752
STORE LAST WAKEUP PULSE TIME LESS 40msec AS twake(el)
754
TURN OFF ALL DRIVERS
756
DELAY FOR A TIME
758
SET UP FOR NEXT ELEMENT
760
RETURN

FIG. 7b