Title: HYDRAULIC FLUID SUPPLY SYSTEMS

Abstract: A tractor has an engine (11) which drives the tractor via a transmission (14) whose operative ratio is controlled electronically. The tractor also has an auxiliary hydraulic fluid supply system with an engine driven hydraulic pump (17) which provides pressurised fluid to one or more auxiliary outlets (18-21) on the tractor. A driver operated control means (22, 23) is provided for selecting the oil flow rate to be delivered to the outlets, and a control system (25) adjusts the speed of the engine to the minimum required to provide the selected oil flow rate and changes the operative ratio of the tractor transmission so that the speed of the tractor remains substantially unchanged despite any change in engine speed required to deliver the selected oil flow rate. The transmission may be a CVT or powershift transmission.
HYDRAULIC FLUID SUPPLY SYSTEM

The invention relates to tractors and in particular to hydraulic fluid supply systems for tractors which supply pressurised fluid from an engine driven pump to auxiliary outlets such as spool valves used to control auxiliary equipment on the tractor such as a front loader.

Problems arise with such auxiliary equipment when high flow rates are demanded which the pump may not be able to deliver at the current engine speed.

Thus according to the present invention there is provided a tractor having an engine which drives the tractor via a transmission whose operative ratio is controlled electronically, the tractor having an auxiliary hydraulic fluid supply system with an engine driven hydraulic pump which provides pressurised fluid to one or more auxiliary outlets on the tractor, a driver operated control means for selecting the oil flow rate to be delivered to the outlets, and a control system which adjusts the speed of the engine to the minimum required to provide the selected oil flow rate and changes the operative ratio of the tractor transmission so that the speed of the tractor remains substantially unchanged despite any change in engine speed required to deliver the selected oil flow rate.

Preferably the driver operated control means comprises one or more control levers or dials for selecting the flow rate to the or each auxiliary outlet.

The control system adds the flow rates selected for each outlet to give the total flow rate selected and adjusts the engine speed and transmission ratio accordingly.

When the transmission is a CVT, exactly the appropriate transmission can be selected.

If the transmission has a range of discrete ratios, the control system selects a transmission ratio which is closest to but above the ratio required to deliver the required oil flow rate and tractor speed

The present invention will now be described with reference to the accompanying Figure 1 which shows diagrammatically a tractor having a hydraulic fluid supply system embodying the present invention.
Referring to the drawing, the tractor 10 has an engine 11 which drives the wheels 12 and 13 of the tractor via a transmission 14 and front wheel transfer drive 14a. The operative ratio of the transmission is controlled either manually by a driver operated control 15 or automatically in accordance with various operating parameters of the tractor by a transmission control unit 16.

Engine 11 is controlled by an electronic control unit 11a in response to movement of an accelerator pedal lib and other well known tractor operating parameters. Engine 11 also drives an oil pump 17 (which may be either fixed volume per revolution or a variable displacement pump) via a fixed ratio drive. Pump 17 supplies pressurised fluid via line 17a to a number of auxiliary outlet valves 18 to 21 whose outlet flow rate is controlled by two levers, a first joystick lever 22 and a second simple pivoting control lever 23. In the arrangement shown valves 18 to 20 are controlled by joystick 22 and valve 21 is controlled by control lever 23.

Pivoting movement of the joystick about axis XX controls valve 18 and pivoting movement about axis YY at right angles to the axis XX controls valve 19. Joystick carries buttons 24a and 24b the depression of which operates the control valve 20. The pivoting of the control lever 23 in the direction ZZ controls the outlet of valve 21. These auxiliary outlet valves 18 to 21 are of the solenoid operated spool valve type and receive their solenoid commands from electronic valve control system 25 via lines 18a to 21a. System 25 in turn receives the tractor operator’s commands from joystick 22 via line 22a and from control lever 23 via line 23a.

Additionally, in accordance with the present invention, the valve control system 25 is connected with the transmission 14 (in this case via the control unit 16) via line 25a to effect changes in the operative ratio of the transmission as will be described below.

If, for example, the tractor is being used to operate a front loader, valve 18 can be used to operate the loader arm raise and lower cylinders, valve 19 to operate the bucket angle control cylinder and the push buttons 24a and 24b can be used to open and close a clam shell fitted to the bucket. Thus the arms of the loader can be raised and lowered by pivoting of the joystick 22 about axis XX, the bucket angle can be adjusted by moving the joystick sideways about axis YY. Any clam shell fitted to the bucket can be open and closed by operating buttons 24a and 24b.

In accordance with the present invention, valve control system 25 calculates or estimates the total oil flow rate requested at any moment by operation of the joystick 22 (and the control
lever 23 of this also is being used to operate valve 21). The control system then calculates the engine speed required to deliver this oil flow rate knowing the fixed gear ratio which connects the pump 17 to the engine 11 and the pump volume per revolution. This engine speed is then selected by engine controller 11a as instructed via line 25b and the transmission ratio provided by transmission 14 is adjusted to ensure that the forward speed of the tractor remains substantially that previously requested by the tractor driver or control unit 16.

Since there are a number of ways in which the output of auxiliary valves 18 to 21 can be controlled there are corresponding number of ways in which the oil flow rate selected by the operator can be calculated or estimated.

For example, if the valves are operated on a flow volume principle and only valves 18 to 20 are being operated by joystick 22 and the selected volumes for valves 18 to 20 are 40, 50 and 60 litres/min respectively, the total volume required will be:

\[ \text{VTOTAL} = 40 + 50 + 60 \text{ litres min} \]
\[ = 150 \text{ litres/min} \]

On the other hand, for example, if a percentage command principle is being used with valves having a flow scaling factor (fs) which is set for each valve so that each valve can only deliver up to a preselected percentage (fs) of its maximum flow then, for example, the require volume for valve 18 would be

\[ \text{V18FLOW} = \text{Fsv} \text{I18 Commanded } \%\text{. Maximum flow rate of valve 18.} \]

If the flow scaling factors of valves V18 to V20 are 100, 50 and 55% respectively and their commanded % flows are 50%, 100% and 100% respectively with respective maximum flow rates of 100L/min, 50L/min and 100L/min then the total flow rate requested will be:

\[ \text{Total flow} = 100\% \times 100 \text{L/min} + 50\% \times 50 \text{L/min} + 55\% \times 100 \text{L/min} \]
\[ \text{Total flow} = 50 \text{L/min} + 25 \text{L/min} + 55 \text{L/min} \]
\[ = 130 \text{L/min} \]

As will be appreciate, whatever method is used to calculate or estimate the requested flow rate through the auxiliary valves 18 to 21 the control unit 25 calculates the required engine speed and also the new operative gear ratio required from transmission 14 in order to maintain the tractor forward speed substantially constant.
If transmission is a CVT then the exact ratio required can be selected. For example, if the tractor has an engine speed of 1000rpm and the currently operative gear ratio of 0.5 and the control system 25 determines that in order to provide the selected flow rate from the valves 18 to 21 an engine speed of 2000rpm is now required this will require the transmission gear ratio to be changed to 1.0 in order to provide the same output wheel speed.

If, for example, the transmission was a powershift transmission and the gear ratios available are 0.9 and 1.10 respectively, the control system will select the ratio 1.10 (i.e. the closest ratio above the required ratio) so that the new output speed will be 2200rpm and this will maintain substantially the same vehicle speed and ensure sufficient engine speed to deliver the require volume flow rate to the hydraulic valves.
CLAIMS

1. A tractor having an engine which drives the tractor via a transmission whose operative ratio is controlled electronically, the tractor having an auxiliary hydraulic fluid supply system with an engine driven hydraulic pump which provides pressurised fluid to one or more auxiliary outlets on the tractor, a driver operated control means for selecting the oil flow rate to be delivered to the outlets, and a control system which adjusts the speed of the engine to the minimum required to provide the selected oil flow rate and changes the operative ratio of the tractor transmission so that the speed of the tractor remains substantially unchanged despite any change in engine speed required to deliver the selected oil flow rate.

2. A tractor according to claim 1 in which the driver operated control means comprises one or more control levers or dials for selecting the flow rate to the or each auxiliary outlet.

3. A tractor according to claim 1 or 2 in which the control system adds the flow rates selected for each outlet to give the total flow rate selected and adjusts the engine speed and transmission ratio accordingly.

4. A tractor according to any one of claims 1 to 3 in which the transmission is a CVT.

5. A tractor according to any one of claims 1 to 3 in which the transmission is a powershift with a range of discrete ratios, and the control system selects a transmission ratio which is closest to but above the ratio required to deliver the required oil flow rate and tractor speed.

6. A tractor constructed and arranged substantially as hereinbefore described with reference to and as shown in the accompanying drawings.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60W30/18 B60W10/06 B60W10/10 E02F9/22

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC.

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B60W E02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of database and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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Further documents are listed in the continuation of Box C. See patent family annex.

Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier document but published on or after the international filing date

“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

“K” document member of the same patent family

Date of the actual completion of the international search: 6 December 2010

Date of mailing of the international search report: 15/12/2010

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Plenk, Rupert

Form PCT/ISA/210 (second sheet) (April 2005)
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Form PCT/ISA/210 (continuation of second sheet) (April 2005)
INTERNATIONAL SEARCH REPORT

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:

2. X Claims Nos.: 6 because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

   see FURTHER INFORMATION sheet PCT/ISA/210

3. □ Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. □ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. □ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. □ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.: 

4. □ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 

Remark on Protest

□ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

□ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

□ No protest accompanied the payment of additional search fees.
Continuation of Box II.2

Claims Nos.: 6

The subject-matter of claim 6 does not include technical features, but a reference to the drawings. It does not comply with Article 6 and Rule 6.2(a) PCT to such an extent that a search for claim 6 is not possible.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.
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