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Multi-row plant hole digger with hydraulic transmission

The system model of a multi-row plant hole digger with hydraulic transmission has been built and tested at Hanoi University of Agriculture. The system model contains two parts for digging hole, that are installed at appropriate distance on a frame connected to tractor's linkage mounting. Transmission diagram is based on kinetic linkage with two parallel hydraulic transmission lines from tractor's engine through a flow dividing valve to working parts. The testing results showed that two hole digging parts with hydraulic transmission ran well at different resistant moments. Owing to flow dividing valve the flow rate kept constant at different load pressures and synchronizing rotation of two hydraulic engines.

Keywords

Multi-row plant hole digger, hole digging machine, plant hole digging machine

Abstract

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In recent years, there have been more and more self-propelled plant hole diggers used in forestry production in Vietnam. Depend on hole size and soil properties, power demand for digging one hole just around 10–14 kW [1], therefore it is unable to get appropriate power using factor for tractors

with engine power ranging from 20–40 kW. In order to increase power using factor for engine as well as increase hole digging capacity, a multi-row plant hole digger with hydraulic transmission has been developed. Two hole digging parts are connected in parallel as a unit linked to four wheels tractor (engine power of 30 kW). With strong point of hydraulic transmission is able to flexibly link between tractor and machine work, and to freely place the components of system in space, a better transmission solution has been obtained for multi-row hole digging machine under heavy working conditions in forestry production.

Following is an introduction of system model has been developed and manufactured with some initial testing results.

Fig. 1

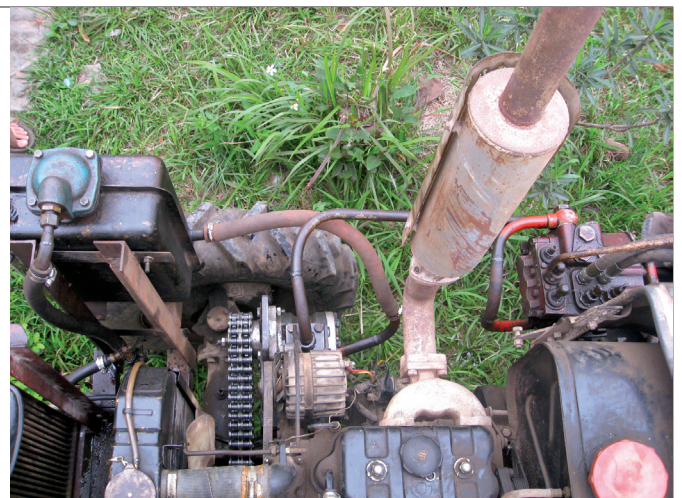
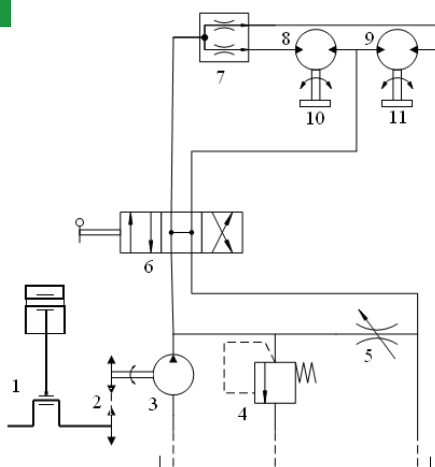


Foto: Bui Viet Duc

Hydraulic transmission diagram for two-row plant hole digger

1: Traktormotor/tractor engine; 2: Kettengertriebe/chain transmission; 3: Hydropumpe/hydraulic pump; 4: Druckbegrenzungsventil/Pressure relief valve; 5: Drosselventil/Flow control valve; 6: Wegeventil/Directional control valve; 7: Stromteilventil/Flow divider valve; 8, 9: Hydromotoren/Hydraulic motor; 10, 11: Pflanzlochmaschinen/plant hole digger

Hydraulic transmission system for two-row plant hole digger

To get synchronic rotary motion of tow hydraulic engines and keep appropriate flow rate even pressure of load varies, one flow dividing valve connected in series in front of hydraulic engines.

Hydraulic pump

The pump is driven from engine’s crankshaft by a chain drive. It is selected so as can convert all tractor engine power into hydraulic power of the system. To get a combined plant hole digging machine that suits to working condition in forestry production with appropriate investment cost, a gear pump was selected. Technical parameters and particular properties of the pump are showed in **figure 2**.

Hydraulic motor

Hydraulic engine is calculated according to power requirement on shaft of digging part. Depend on soil characteristics,

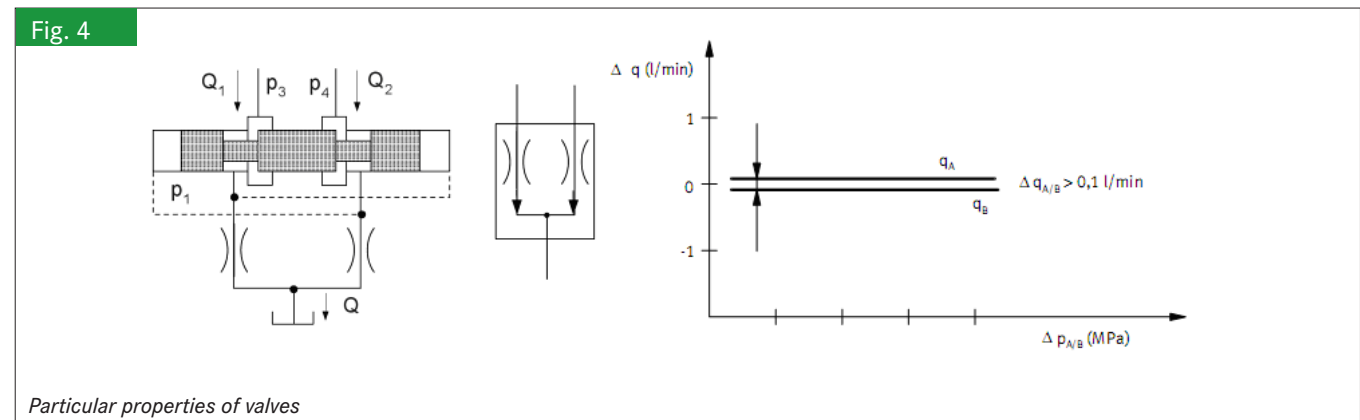
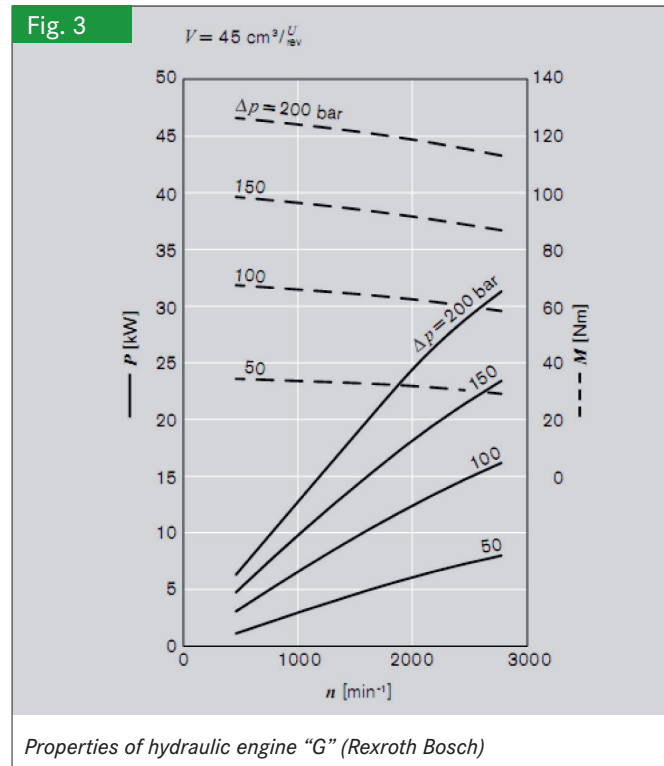
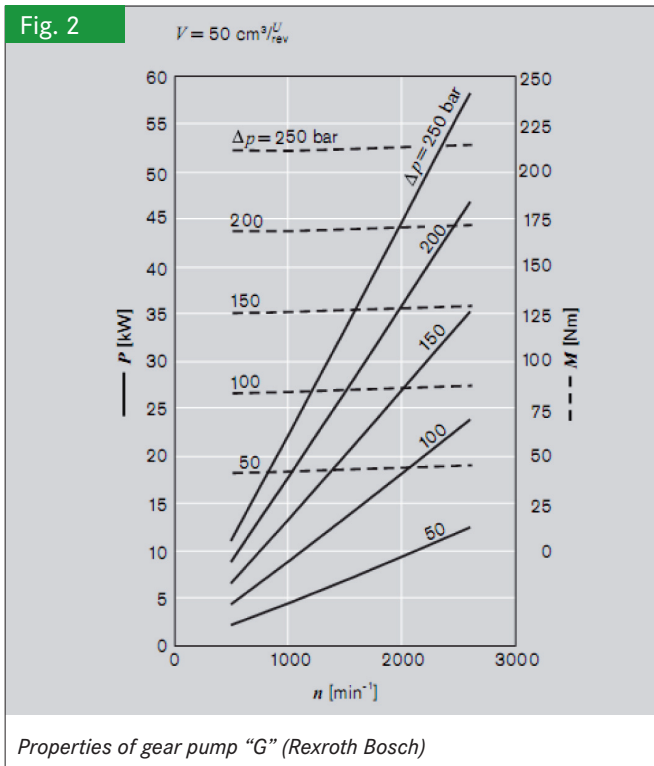
one hole with size of 40 cm × 40 cm needs digging power form 10–14kW, therefore gear wheel “G” Rexroh Bosch was selected. Technical parameters and particular properties of the motor are showed in **figure 3**.

Flow dividing valve and flow control valve

Flow dividing valve is selected according to the determined output of two hydraulic motors. The intended dividing flow ratio is 1 : 1 for two loads at the same size.

Flow control valve is used to infinitely change rotary speed of hydraulic engine to get special simple hydraulic circuit with low cost of equipment. The throttle section is varied so as to make both hydraulic engines rotate with synchronizing speed of 1 000 rpm at nominal mode.

Technical parameters and particular properties of the valves are showed in **figure 4**.

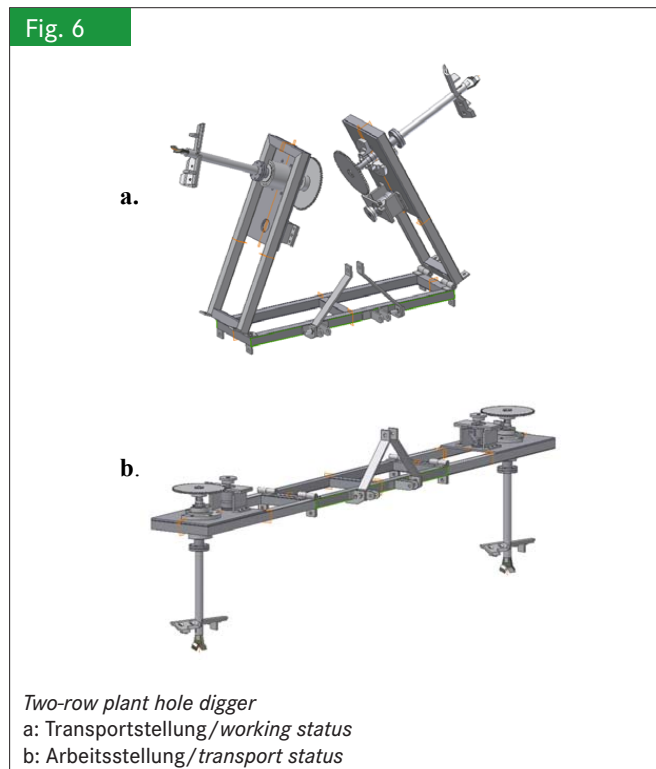
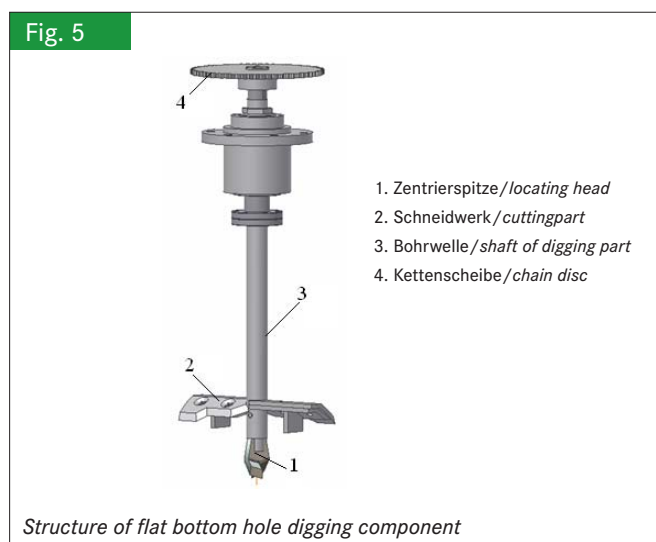


Pressure relief valve

Pressure relief valve used to keep limit of pressure in hydraulic transmission system. Increase of pressure may happen if load of hydraulic motor increased during digging hole. The pressure limit has been selected is 150 bar.

Two-row plant hole digger

After analyzing advantages and disadvantages of different plant hole diggers are used in Vietnam forestry, a flat bottom hole digging component was selected. Then the plant hole digger can only crush soil inside the hole, not toss up soil outside the hole and not make the hole wall compressed. This property of the machine is suitable to forestry requirement while afforesting [3]. One hole digging component consists of the following parts (**figure 5**):



Two digging parts are combined on a frame to make a two-row plant hole digger that can be mounted on linkage of tractor. **Figure 6** introduces two-row plant hole digger in working and transport positions.

The main technical figures are showed in **table 1**.

Table 1

Structure characteristics of two-row plant hole digger

Gesamtmasse Weigh	240 kg
Breite (Arbeitsstellung/Transportstellung) Width (Working/transporting)	4,2 m/2,5m
Höhe (Arbeitsstellung/Transportstellung) Height (Working/transporting)	0,85 m/1,4 m
Reihenweite Distance between two rows	2,7–3 m
Lochdurchmesser Hole diameter	0,4 m
Lochtiefe Hole depth	0,4 m
Bohrwellendrehzahl Rotation of digging shaft	200 min ⁻¹
Hydromotordrehzahl Rotation of hydraulic motor	1 000 min ⁻¹

Table 2

Technical parameters of the two-row plant hole digging machine

Leistung Capacity	200 Loch/h
Kraftstoffverbrauch Fuel consumption	7,5 l/h
Arbeitsdrehzahl Working rotation	200 ± 30 min ⁻¹
Drehzahldifferenz der Lochwellen Rotation difference of digging shaft	20–30 min ⁻¹

Some testing results

The two-row plant hole digging machine was tested at Hanoi University of Agriculture. The testing results showed that both hydraulic transmitted digging parts worked very well (**figure 7**)

Conclusion

The new plant hole digging machine has clear advantages in operation, especially in improving power using ratio and hole digging capacity. The testing results showed two-row plant hole digging machine worked well (no problem) even when resistant moment of two digging parts varied differently. However, it needs to continue researching and development in order to diminish the disadvantages of hydraulic transmission system such as low efficiency, the efficiency depending on hydraulic liquid temperature.



Fig. 7

Testing the two-row plant hole digging machine (foto: Bui Viet Duc)

Literature

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