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(54) A MOTOR VEHICLE WITH AN INTERNAL COMBUSTION ENGINE

(71) We, LINDE AKTIENGESELLSCHAFT, a German Company, of Abraham-Lincoln-Strasse 21, D—6200 Wiesbaden, Federal Republic of Germany, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to a motor vehicle with an internal combustion engine.

In known vehicles with hydrostatic transmission, the pump of the hydrostatic transmission is always arranged in extension of the engine shaft, the pump either being flange-attached directly to the engine or being attached to it through an intermediate housing and an intermediate shaft; sometimes the pump is arranged separately from the motor of the hydrostatic transmission but in other cases the transmission itself is designed as a compact integral unit so that pump and one or two hydraulic motors are arranged in a common housing. Even in vehicles propelled by an electric motor and hydrostatic transmission, this lay-out has been chosen; for example, in the forklift truck disclosed in United States Patent Specification No. 3,208,222, the pump of the hydrostatic transmission which is an integral type HW 10 unit, is connected through an intermediate shaft to the electric motor and arranged coaxially in relation thereto. The same arrangement using the same hydrostatic transmission, has also been used in the forklift trucks of the same manufacturer, this time with an internal combustion engine, the engine being designed as a flat opposed in-line engine. In the "Linde-Guldner-Hydrocar" diesel transport vehicles, the crankshaft of the internal combustion engine was connected through an intermediate shaft to the pump of the hydrostatic transmission which, depending upon the vehicle model, was either an integral unit with two hydraulic motors, or of non-integral design. In this type H12 and H40 Linde forklift trucks, the pump of the hydrostatic transmission in the vehicle propulsion system, is directly flange-attached to the shaft of the piston-type internal combustion engine, coaxially therewith, and connected through hoses to the hydraulic motor flange-fitted to the mechanical drive axle. In the type H20 Linde forklift truck, the pump of the hydrostatic transmission, this time designed as an integral axle unit, is flange-attached to the shaft of the piston-type internal combustion engine, coaxially therewith, through an intermediate housing so that a compact drive unit consisting of axle transmission and internal combustion engine is created. Again, in the type H40 and H35 NG Linde forklift trucks, the pump is attached to the internal combustion engine by a flange, directly in extension thereof and connected through hoses to the two hydraulically parallel-connected hydraulic motors associated with respective axle drive units. All these arrangements have the drawback that a drive unit of relatively large extent in the direction of the shaft of the internal combustion engine is created. Because, on the other hand, motor vehicles, in particular forklift trucks, must be as manoeuvrable (and therefore as short) as possible and the available vehicle length should be utilized as far as possible for purposes other than that of accommodating the drive unit, this constitutes a drawback. The word Linde mentioned in this paragraph is a Registered Trade Mark.

The object of the present invention is to make the drive unit of a motor vehicle, and particularly of a forklift truck, as short as possible.

Accordingly, the present invention consists of a motor vehicle with an internal combustion engine for the propulsion function, and with a hydrostatic transmission in the propulsion system, wherein a first vertical plane containing the longitudinal axis of the engine lies on one side of a second vertical plane containing the longitudinal axis of the vehicle and wherein a pump which forms a part of the hydrostatic propulsion system is located adjacent the engine on the other side of the said second vertical plane, a third vertical plane containing the axis of rotation of a shaft of said pump being parallel to said first and said second vertical planes.

From this design, however, in addition numerous special advantages accrue, in particular a reduction in installed height and consequently a more favourable centre of gravity which means that forklift trucks can be operated with a lighter counterweight and therefore with smaller mass to accelerate in the context of the particularly frequent accelerating phases which forklift trucks have, by their very nature, to undergo. Again, the driver's seat height can be reduced because the driver need no longer sit directly above the internal combustion engine but can sit beside it instead. Not only does this facilitate climbing in and out of the truck but gives the driver a greater sense of security and better field of view when lifting loads from floor or road level. Through the arrangement of the pump or pumps, a simply shaped, preferably rectangular engine space is obtained which in particular enables the sound-damping arrangements to be more effectively designed, all the pumps being arranged in the space which is encapsulated by acoustic insulating arrangements. Again, the routing of the hydraulic lines is facilitated if these are all located at one side of the truck, and elements such as filters and valves which may be associated with these hydraulic devices, can also be arranged side by side in a closed system. Through this kind of arrangement, in turn, better access for vehicle care and maintenance is achieved. Also, despite the requisite outlay for a connecting transmission between internal combustion engine and the pump of the transmission, this solution is cheaper over all. This connecting transmission can be a simple pair of gears. Normally, however, a transmission using a traction element, in particular a V-belt, will be chosen. This gives rise to further advantages to the extent that, for a given type, normally a specific pump is chosen which has to operate at a specific drive speed or at any rate at a specific maximum speed, whilst on the other hand different internal combustion engines have to be installed, for one thing engines which differ in accordance with their operating principle, such as diesel engines or gas engines or petrol engines or, again, possibly for economic and political reasons, internal combustion engines which originate from different economic zones. In view of the fact that these internal combustion engines have different operating speeds, adaptation can be achieved very simply by choosing the transmission ratio of the mechanical transmission between internal combustion engine and pump. The pump of the hydrostatic transmission can be screwed directely to the internal combustion engine, for example through the agency of lateral brackets on the engine. Both the engine and the pump, however, can also be mounted in fixed positions in the vehicle chassis. As the engine generates vibrations which must not be transmitted to the chassis, the engine should, if possible, be mounted on elastic mountings but, because the engine must not make any movement in relation to the pump, it has been found to be advantageous for the engine and the pump to be assembled in a common, relatively light, intermediate frame which is supported on the vehicle chassis by way of elastic mountings.

The pump of the hydrostatic transmission for the vehicle propulsion system, is normally designed as a variable-delivery pump. Recent pump designs of this kind are so contrived that at the side opposite the side adjacent the transmission, a further pump can be connected through a flange and, conveniently, this further pump is, in turn, so designed that it, too, can receive a further flange-connected pump. This means that several pumps can be arranged coaxially with one another, these either being directly flange-connected together, or attached commonly to the frame or chassis or to an intermediate frame of the kind discussed in the preceding paragraph and connected with each other through corresponding shaft connections.

The pump of the hydrostatic transmission for the vehicle propulsion system is normally an axial piston pump. It is especially advantageous if a pump in the form of a swash plate is used, firstly, because swash plate pumps take up a small amount of space and, secondly, because swash plate pumps are particularly suitable for having an additional pump connected to the shaft on the reverse side. The subsequently connected pumps can for example be used to drive a load-hoisting mechanism, and in particular in the case of a forklift truck in order to drive the hoist and tilting cylinder of the hoist frame, whilst the further pump can be used to produce the hydraulic pressure for power steering and if required, one or more additional pumps can be provided for other purposes. These additional pumps can either likewise be axial piston pumps or may be radial piston pumps or gear pumps or vane pumps depending upon the desired relationship between delivery flow-rate and maximum delivery pressure. Pumps of different designs can be flange-connected together.

The described arrangement of the drive system, in particular its arrangement on a common, relatively light intermediate frame, is of particular advantage when the hydrostatic transmission is of non-integral (detachable) design and when the pump of the transmission for the vehicle propulsion system is connected to the motor or motors through hoses so that neither free forces nor moments are transmitted from the drive unit to any part connected to the vehicle chassis which are of a kind which react against the drive unit. Instead, it is simply fluid pressures which are transmitted through the hoses.

In relation to the prior art it should also be pointed out that it is known to build forklift trucks with a piston-type internal combustion engine and an electric drive consisting of an electrical generator and an electric motor, the electrical system of generator and motor being used as an infinitely variable transmission. In this case, once again, the drive unit transmits no free moments or forces to any part which is connected to the chassis. Vehicles of this kind are known in the form of forklift trucks with a fourstroke engine having horizontal opposed cylinders in an in-line arrangement, the generator being located beneath the engine in such a fashion that the engine crankshaft and the generator shaft are both located in the longitudinal central plane of the vehicle. This results not only in a relatively high and therefore unfavourable centre of gravity but also has drawbacks from the maintenance point of view because the electrical generator is located directly beneath the engine crankshaft housing. Arrangements of the kind in which the crankshaft is located transversely to the direction of travel, in the manner conventional in motorcycles and in some small motor cars, give rise to fundamentally different conditions as far as installation, location of centre of gravity, accessibility for maintenance and repair, vibrational components in relation to the longitudinal direction of the vehicle, etc., are concerned, so that it is difficult to compare them with arrangements in which the crankshaft is parallel to the vehicle fore-and-aft direction. On the other hand, in vehicles where the crankshaft is arranged parallel to the direction of travel, it has hitherto always been a prerequisite that the crankshaft should be located in the longitudinal central plane of the vehicle.

The invention therefore also relates to the arrangement of the drive unit in the motor vehicle and, according to a second aspect, the present invention consists in the arrangement of the motor vehicle drive unit consisting of a piston-type internal combustion engine and a hydrostatic transmission for propulsion purposes, together with a frame, wherein the crankshaft of the engine is arranged parallel to and on one side of the longitudinal central plane of the vehicle, wherein the shaft of a pump which forms part of the hydrostatic transmission is arranged parallel to the shaft of the internal combustion engine on the other side of the longitudinal central plane of the vehicle, and wherein said engine and at least one part of said transmission (and possibly further pumps) are located in a single motor space or chamber.

The present invention will now be more particularly described with reference to the exemplary embodiment which is illustrated in the accompanying drawing, in which:—

Figure 1 shows schematically a section through a forklift truck embodying the present invention, the section having been taken perpendicularly to the direction of travel; and

Figure 2 illustrates a plan view of the vehicle illustrated in Figure 1 the bonnet which covers the engine space having been removed.

Referring to the drawing, the vehicle has wheels 1 which are mounted in a chassis 2 in a manner which is not shown. Said vehicle also has an engine 3 which is a piston-type in-line internal combustion engine which is provided (for the purpose of air cooling) with a blower 4 which is driven through a V-belt 5 from a pulley 6, being mounted on the crankshaft of the engine 3. Also mounted on the crankshaft is a belt pulley 7 which, by way of a V-belt 8 which also extends around a pulley 9 which is mounted on the shaft of a variable-delivery axial piston pump 10, is operable to drive said pump. Flange-connected to this pump 10 are three additional pumps 11, 12 and 13; the pump 11 is used to supply the cylinder of a hoist frame 14, the pump 12 is used to generate the hydraulic pressure for a power-steering system which is not shown in the drawing, and the pump 13 is used to supply hydraulic ancillaries which may be added to the vehicle system if required. The pump 10 is connected through hoses (not shown) to hydraulic motors of the propulsion system (also not shown). A counterweight 15 is also attached to the vehicle chassis 2.

The internal combustion engine 3 is screwed through mountings 16 and 17 to an intermediate frame 18 to which the pump 10 is likewise attached through the agency of fixing elements which have not been shown in the drawing. The pumps 11, 12 and 13 are fixed together and the pump 11 is flange-connected directly to the pump 10. The intermediate frame 18 is attached to the vehicle chassis 2 through elastic mounting elements 19 and constitutes a relatively light mounting which is common to all of the engine 3 and the pump 10 and the pumps 11, 12 and 13. In the example shown in the drawing, three such mounting elements 19 have been shown, but, of course, other designs are conceivable with four or some other number of mounting elements.

Also supported upon the vehicle chassis 2 is a bonnet 20 for the engine space, the bonnet containing a depression 21 to the bottom 22 of which a seat (not shown) for the driver can be attached. A large free space at one side of the engine (see Figure 1) is more useful than two narrow ones disposed one at each side of the engine, the latter lay-out being the one obtained when the engine crankshaft lies in the longitudinal central plane of the vehicle.

The overall drive unit comprising the various components indicated by the reference 3 to 13 is thus arranged in a closed space which, as the drawings show, has relatively simple, smooth shape. The intermediate frame 18 is of lightweight construction and connects the engine 3 and the pump 10 to one another in such a manner that relative movement between said engine and said pump is impossible.

WHAT WE CLAIM IS:—

1. A motor vehicle with an internal combustion engine for the propulsion function, and with a hydrostatic transmission in the propulsion system, wherein a first vertical plane containing the longitudinal axis of the engine lies on one side of a second vertical plane containing the longitudinal axis of the vehicle and wherein a pump which forms a part of the hydrostatic propulsion system is located adjacent the engine on the other side of said second vertical plane, a third vehicle plane containing the axis of rotation of a shaft of said pump being parallel to said first and said second vertical planes.

2. A motor vehicle as claimed in Claim 1, wherein the pump is driven by the engine through a traction drive arrangement.

3. A motor vehicle as claimed in Claim 2, wherein said traction drive arrangement comprises pulleys on the engine and on the pump and a V-belt extending around said pulleys.

4. A motor vehicle as claimed in any one of the preceding Claims, wherein said pump and at least one additional pump operable to provide an additional drive system are disposed coaxially and with their shafts connected together.

5. A motor vehicle as claimed in any one of Claims 1 to 3, wherein the engine and the pump are mounted on a common intermediate frame.

6. A motor vehicle as claimed in Claim 4, wherein the engine and said pumps are mounted on a common intermediate frame.

7. A motor vehicle as claimed in Claim 5 or Claim 6, wherein the intermediate frame is mounted on the vehicle chassis through the agency of elastic mounting elements.

8. A motor vehicle as claimed in any one of the preceding Claims, wherein the engine is installed in such a fashion that its longitudinal central plane is inclined with respect to said vertical plane containing the longitudinal axis of said engine.

9. A motor vehicle as claimed in any one of the preceding Claims, wherein the space containing the engine is closed off by a bonnet to which the driver's seat is attached, and wherein the driver's seat, when viewed by looking in the direction of travel of the vehicle, is arranged beside the cylinder head or cylinder heads of said engine, the lowest point of the mounting for the driver's seat being lower than the highest point on the internal combustion engine.

10. A motor vehicle as claimed in any one of the preceding Claims, wherein the hydrostatic transmission is of the non-integral (detachable) type, the pump being connected to the motor by pipelines.

11. A motor vehicle as claimed in any one of the preceding Claims, wherein the internal combustion engine comprises a row of cylinders arranged adjacent to one another in a row.

12. A motor vehicle as claimed in any one of the preceding Claims, wherein the internal combustion engine and at least one part of the hydrostatic transmission, and possibly further pumps, are located in a single motor space or chamber.

13. A motor vehicle as claimed in any one of the preceding Claims, wherein the space accommodating the internal combustion engine and the pump is acoustically insulated.

14. A motor vehicle as claimed in any one of the preceding Claims, wherein the motor vehicle is a forklift truck.

15. The arrangement of a motor vehicle drive unit consisting of a piston-type internal combustion engine and a hydrostatic transmission for propulsion purposes, together with a frame, wherein the crankshaft of the engine is arranged parallel to and on one side of the longitudinal central plane of the vehicle, wherein the shaft of a pump which forms part of the hydrostatic transmission is arranged parallel to the shaft of the internal combustion engine on the other side of the longitudinal central plane of the vehicle, and wherein said engine and at least one part of said transmission, and possibly further pumps, are located in a single motor space or chamber.

16. A motor vehicle constructed, arranged and operable substantially as hereinbefore described with reference to and as illustrated in the accompanying diagrammatic drawing.

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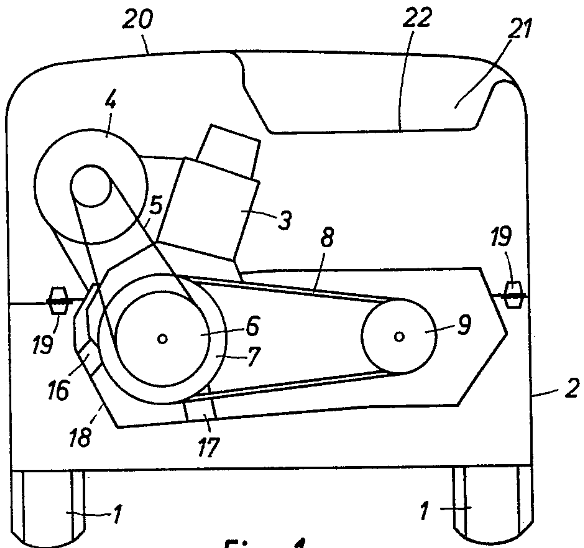
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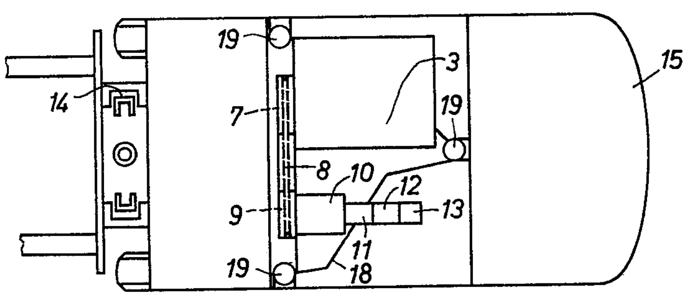
Fig. 1

Fig. 2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