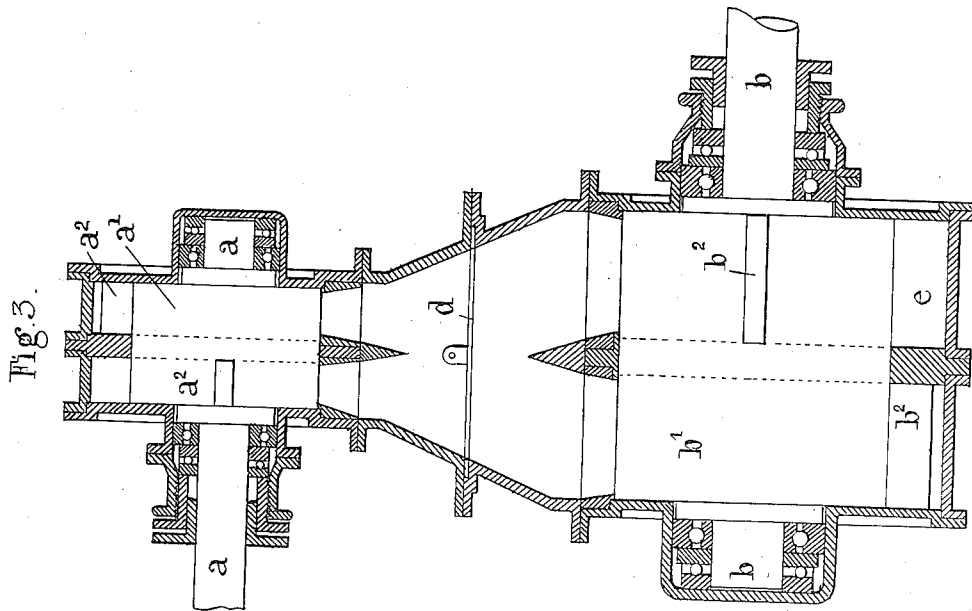
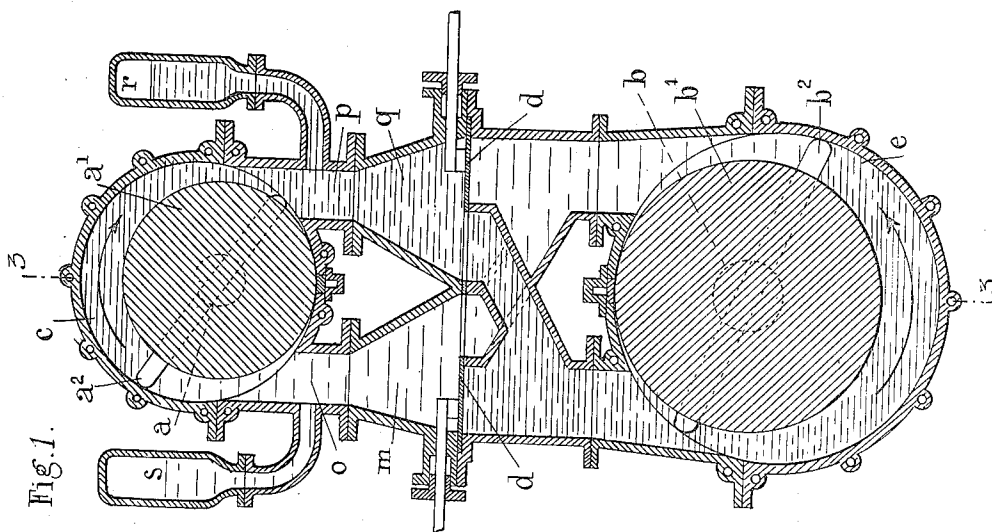


M. TOURREIL.
VARIABLE SPEED APPARATUS.
APPLICATION FILED MAR. 7, 1913.

1,269,338.

Patented June 11, 1918.
3 SHEETS—SHEET 1.



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3 SHEETS—SHEET 2.

Fig. 4

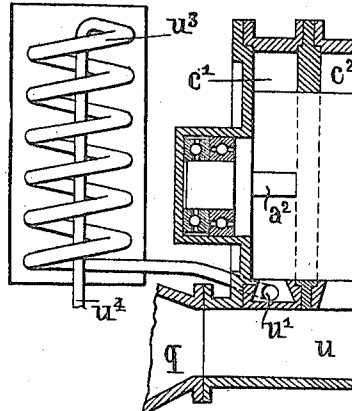


Fig. 5 a

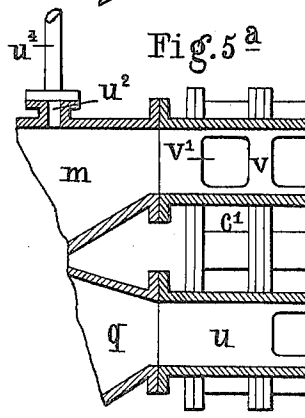
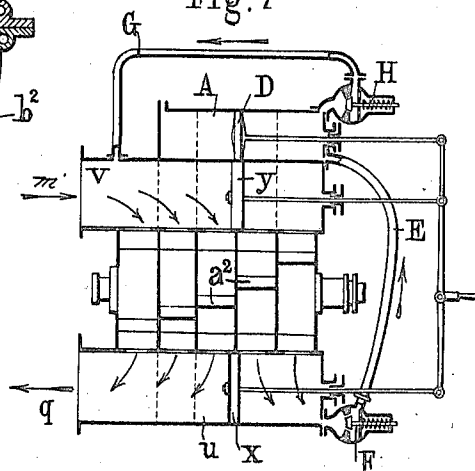
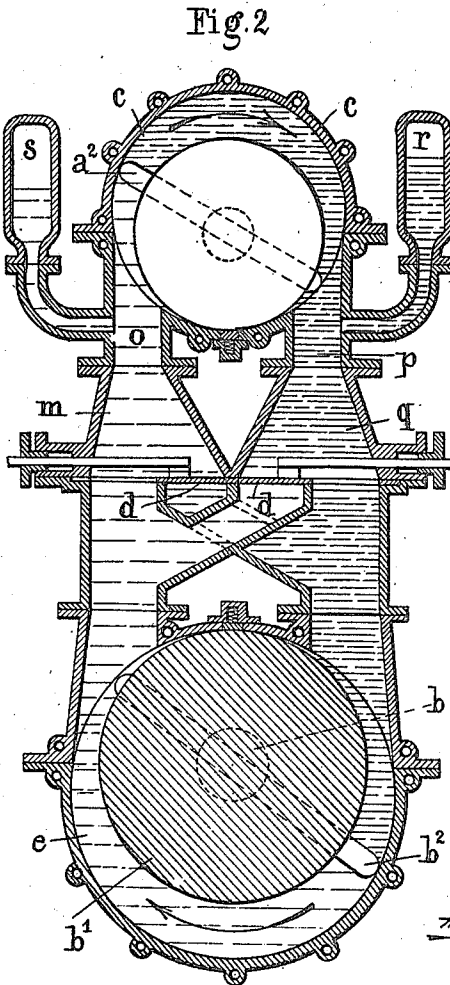


Fig. 7



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3 SHEETS—SHEET 3.

Fig 4.

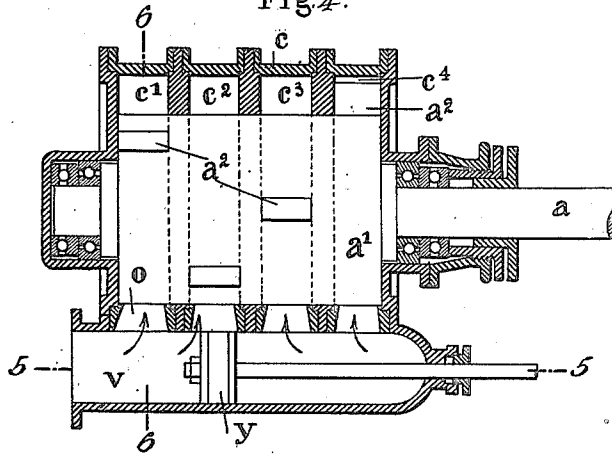


Fig 5.

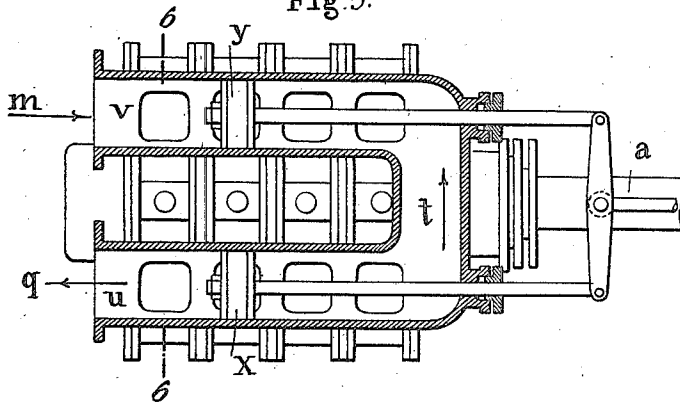
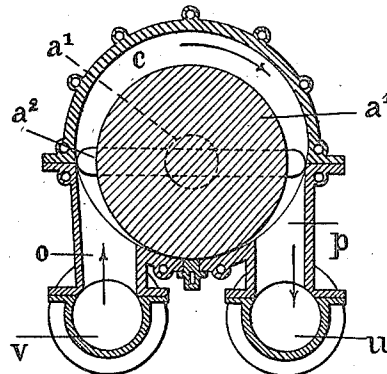


Fig 6.



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MAURICE TOURREIL, OF NANTES, FRANCE.

VARIABLE-SPEED APPARATUS.

1,269,338.

Specification of Letters Patent. Patented June 11, 1918.

Application filed March 7, 1913. Serial No. 752,667.

To all whom it may concern:

Be it known that I, MAURICE TOURREIL, a citizen of the Republic of France, and a resident of 15 Grande Avenue Bouchaud, Nantes, Loire-Inférieure, France, have invented a new and useful Variable-Speed Apparatus, of which the following is a specification.

The present invention relates to variable speed apparatus, comprising rotary pumps of which the pump body, in cross section, has a slightly elliptical form, in which the rotary member (disk) lies in such position that all the chords passing through its axis are approximately equal to the small axis of the ellipse.

The invention relates in particular to an apparatus of this character in which the pump and the motor may, at will, turn simultaneously in either direction or one in one direction and the other in the opposite direction.

In the accompanying drawings,

Figure 1 is a vertical section through an apparatus in which my invention is embodied and showing the parts in a position such that the rotors turn in opposite directions;

Fig. 2 is a similar view showing the same apparatus with the parts in a position such that the direction of the rotors is reversed from that shown in Fig. 1;

Fig. 3 is a section on the line 3—3, Fig. 1;

Fig. 4 is a section through a modified construction of the pump body;

Fig. 5 is a section on the line 5—5, Fig. 4;

Fig. 6 is a section on the line 6—6, Fig. 4;

Fig. 7 is a diagrammatic view of an arrangement for automatically emptying non-working compartments of the pumps;

Fig. 4^a is a partial section corresponding to Fig. 4 but showing one compartment of the pump as a circulating pump for the cooling of the fluid; and

Fig. 5^a is a view thereof similar to Fig. 5.

Referring to Figs. 1, 2, and 3 the two engines *c* and *e* are placed one above the other and in such a manner that the shafts *a* and *b* shall be parallel. *a*¹ and *b*¹ are the disks, *a*² and *b*² are the corresponding flat pistons. The engine *c* acts as a pump and the engine *e* as a motor. The pump bodies are shaped in the form of an ellipse of slight eccentricity. The axes *a* and *b* of the pump *c* and motor *e* are placed in such position that all the chords passing through these axes are

respectively substantially equal to the short axis of the ellipse of the respective pump bodies. In order to recover as static pressure the live pressure of the liquid on its emergence from the small pump body without loss of charge and in order to communicate the necessary velocity thereto on its emergence from the large pump body to enter the small pump body and fill it, the connecting pipes between the large and small pump bodies are given the form of conveniently arranged nozzles *m* and *g*. In order to reduce as much as possible the losses of charge of the fluid these pipes are connected to pipes of constant section which are as short as possible. All internal projections and roughnesses are eliminated as well as variations of section or too rapid changes of direction.

In the force and suction mains *m* and *g* are arranged two gate valves *d* which are conjugated and which act as a reversing cock. By their operation the exhaust and supply pipes for the liquid under pressure to the motor *e* are reversed and the movement of this engine is reversed. A crossing of the current of liquid in motion is produced which is similar to the crossing of an ordinary belt for the purpose of reversing the motion of a transmitting shaft. If the reversing valves be opened together a shunt of the liquid is produced between the suction and the force and the receiving motor *e* then rotates at a reduced speed which becomes more reduced the greater the shunt is. It is an action which may be likened to the slipping of an ordinary belt.

If the reversing valves are placed in the central position the receiving motor *e* remains stationary while the pump *c* continues to rotate being carried around by its driving connection.

If while the motor *e* is working in one direction the reversing valves are operated to produce the reversal of its working a braking action will be applied to the shaft *b* which slows down and stops. A suitably loaded safety valve permits this braking action to be so limited that the pressure of the liquid never acquires a dangerous value in the apparatus.

Upon the pipes *g* and *m* are placed two compressed air reservoirs *r* and *s* which act as dash pots.

Before starting there is created in these reservoirs by the aid of small hand pump a

pressure of air P_0 . As soon as the engine is charged, the air of the reservoir r is compressed to a pressure $P_1 > P_0$. The air in the reservoir s consequently expands to a pressure $P_2 < P_0$. P_0 must be so selected that P_2 is still sufficient to insure the complete filling of the small pump body.

This action presents a new analogy with that of the ordinary belt the initial tension T_0 of which is regulated before starting and which assumes during working a tension $T_1 > T_0$ upon the driving pulley and a tension $T_2 < T_0$ upon the driven pulley.

As has been seen the variable speeds of the shaft b are obtained by the aid of shunt of a portion of the liquid. They consequently bring about a loss of power and lower the efficiency of the transmission. The apparatus shown in Figs. 4 to 6 is designed to remedy the inconvenience and permits the different compartments $c^1 c^2 c^3 c^4$ of the pump c to be short-circuited upon each other successively by causing their suction and force sides to communicate with each other. The compartments which are not isolated continue to supply the active liquid to the pipes of the reversing motor. The transmission can therefore be effected with as many ratios of speed or different variations as can be carried out by the different ratios between the volume of the compartments of the engine c which are not isolated and the volume of the receiving engine.

For this purpose the various force pipes p of the various compartments open into a cylindrical collecting pipe u in which a piston x works. According to the position occupied by the piston the liquid is forced toward one or the other end of the pipe u .

The various suction pipes o of the various compartments open into another cylindrical collecting pipe v identical with the first one and arranged parallel thereto. In the pipe v works a piston y . According to the position occupied by the piston y the liquid entering the pump compartments must come either from one end or the other of the collecting pipe v . The two pistons are conjugated in such a manner that they always remain together at the same height and that they consequently uncover at the same time the suction and force orifices of one and the same compartment.

If therefore the left hand ends (for example) of the cylindrical pipes u and v respectively be caused to communicate with the collecting pipes q and m of the pump, and if their right hand ends be connected together by a pipe of curved form t , all the compartments placed on the left of the pistons will work effectively while the compartments placed on the right will be short-circuited on each other.

Instead of dividing the pump c into several compartments the receiving motor e

may be divided and the various compartments short-circuited on each other by the aid of an exactly similar arrangement. If necessary the two apparatus may also be combined, that is to say the short-circuiting of the compartments of two engines may be utilized simultaneously. For example if the two engines each have four compartments it is possible in this way to obtain for one and the same speed n of the shaft a 16 different speeds of the shaft b .

The simultaneous use of several compartments capable of being short-circuited and the shunting of a portion of the liquid by the aid of gate valves for reversing it permits of a transmission being obtained by the apparatus which imparts to the shaft b for one and the same speed of the shaft a all the speeds either forward or backward comprised between zero and a certain maximum speed.

For certain of these speeds obtained by the short-circuiting of compartments and without any shunt of the fluid there is no loss of power and the efficiency assumes its maximum value. For intermediate speeds between the preceding ones, it is necessary to have recourse to the shunt. The efficiency is then lowered but this does not present any great inconvenience in practice if care be taken to so select the volumes of the compartments that the speeds obtained without any shunt shall be the speeds of the ordinary kind required, the intermediate speeds, that is to say those which are obtained by the use of the shunt, being then speeds called working speeds.

When a large number of compartments are short-circuited on each other, the agitation of the liquid they contain uselessly absorbs a large amount of work which is the cause of the lowering of the efficiency of the apparatus for high ratios of transmission.

This disadvantage can be avoided by insuring the automatic emptying and filling of the compartments which cease to work or those which it is desired to throw into action again by the aid of an arrangement such as that shown in Fig. 7.

The curved pipe t which establishes communication between the two cylindrical collecting pipes u and v is dispensed with. A third cylinder A is connected to the cylinders u and v . In this cylinder works a piston D the stroke of which is equal to that of the pistons x and y and the rod of which is worked in the same time as those of the pistons x and y .

The section of the cylinder A is determined in such a manner that the piston D produces, for each movement corresponding to the cutting out of circuit of a compartment of the engine c , a volume equal to that of this compartment and the dead spaces which depend thereon.

A pipe E puts the right hand end of the cylindrical pipe *u* into communication with the right hand end of the cylinder A. A spring valve F, which opens outward, is placed at the beginning of the pipe E upon the cylinder *u*. A second pipe G puts the right hand end of the cylinder A into communication with the left hand end of the cylindrical pipe *v*. A spring valve H, which opens outward, is placed at the beginning of the pipe G upon the cylinder A.

When the operating lever is worked to short-circuit a compartment of the machine *c*, the liquid which fills this compartment and its dead spaces is forced by the flat piston *a*² through the cylindrical pipe *u*; the valve F and the pipe E and fills the empty space which the piston D has produced in the cylinder A.

When the operating lever is worked to throw a compartment of the engine *c* into operation again, the piston D forces through the valve H, the pipe G and the cylindrical pipe *v*, a volume of liquid sufficient to fill the next compartment put into operation.

Experience has shown that in order to insure a sufficient cooling of the liquid it is necessary to cause it to circulate in a refrigerator cooled by water or air at a low temperature. This circulation may be obtained by the aid of a small independent rotary pump. One of the compartments of the engine *c* may with advantage be used as a circulating pump. This is illustrated in Figs. 4^a and 5^a. The compartment *c*¹ is so constructed that the fluid is circulated when the remaining compartments *c*²—*c*⁴ are short-circuited. The orifice establishing communication between the compartment *c*¹ and the delivery passage *u* is omitted, while the orifice *v*¹ which connects *c*¹ with the suction passage *v* is retained (Fig. 5^a). The fluid enters *c*¹ through *v*¹ and is delivered to the port *u*¹ leading to a cooling coil *u*³ of any suitable character, whence it is led back through pipe *u*⁴ and port *u*² into the suction pipe *m*.

It will be understood that it is possible by a suitable change of form and very slight extension of the suction and force pipes, to place the motive and receiver parts so that the two shafts *a* and *b* occupy any relative position.

Finally in the same way as the fluid under pressure forced up by the motive part can be utilized in two or more receivers, one and the same receiver may receive the motive fluid under pressure forced up by two or more motor pumps driven by different motors.

The apparatus according to this invention consequently permits of the distribution over two or more receiving shafts of

the motive power furnished by one and the same motor shaft or of the concentration upon one and the same receiving shaft of the power furnished by two or more motor shafts.

What I claim and desire to secure by Letters Patent of the United States is:

1. A variable speed transmission apparatus comprising a plurality of geometrically similar rotary pumps, conduits connecting said pumps, valves controlling the reversal of direction of flow through said conduits, the rotary elements of said pumps moving in harmony with the movement of liquid therethrough and operating indifferently as pump or motor and in either direction of rotation, the body of at least one of said pumps comprising a plurality of compartments, intake and discharge collecting chambers common to said compartments and communicating with each other at one end and with the intake and discharge conduits connecting the pumps at their other ends, in combination with valves working in harmony in said collecting chambers to short circuit said collecting chambers or to open the same to the circulating conduits connecting the pumps.

2. A variable speed transmission apparatus comprising a plurality of geometrically similar rotary pumps, conduits connecting said pumps, valves controlling the reversal of direction of flow through said conduits, the rotary elements of said pumps moving in harmony with the movement of liquid therethrough and operating indifferently as pump or motor and in either direction of rotation, the body of at least one of said pumps comprising a plurality of compartments, intake and discharge collecting chambers of cylindrical shape common to said compartments and communicating with each other at one end and with the intake and discharge conduits connecting the pumps at their other ends, in combination with piston valves working in harmony in said collecting chambers to short circuit said collecting chambers or to open the same to the circulating conduits connecting the pumps.

3. A variable speed transmission apparatus comprising a plurality of geometrically similar rotary pumps, conduits connecting said pumps, valves controlling the reversal of direction of flow through said conduits, the rotary elements of said pumps moving in harmony with the movement of liquid therethrough and operating indifferently as pump or motor and in either direction of rotation, the body of at least one of said pumps comprising a plurality of compartments, intake and discharge collecting chambers common to said compartments and communicating with each other at one end and with the intake and discharge con-

duits connecting the pumps at their other ends, in combination with valves working in harmony in said collecting chamber to short circuit said collecting chambers or to
 5 open the same to the circulating conduits connecting the pumps, together with means for automatically emptying the short circuited compartments of the pump.

4. A variable speed transmission apparatus comprising a plurality of geometrically similar rotary pumps, conduits connecting said pumps, valves controlling the reversal of direction of flow through said conduits, the rotary elements of said pumps moving
 10 in harmony with the movement of liquid therethrough and operating indifferently as pump or motor and in either direction of rotation, the body of at least one of said pumps comprising a plurality of compartments, intake and discharge collecting chambers of cylindrical shape common to said compartments and communicating with each other at one end and with the intake and discharge conduits connecting the pumps
 20 at their other ends, in combination with piston valves working in harmony in said collecting chambers to short circuit said collecting chambers or to open the same to the circulating conduits connecting the pumps, together with an auxiliary reservoir cylinder opening to said collecting cylinders, a piston working therein in harmony with the pistons in the collecting cylinders, a valve controlling the connection between said reservoir cylinder and the discharge collecting cylinder, the capacity of said reservoir cylinder being such that its piston opens a space corresponding in volume to the cubic capacity of a pump compartment on the short circuiting of the
 30 latter by the pistons of the collecting cylinders, substantially as described.

5. A variable speed transmission appara-

tus comprising a plurality of geometrically similar rotary pumps one of which serves
 45 as a motor, conduits connecting said pumps, valves controlling the reversal of direction of flow through said conduits, said conduits having a diameter of gradually increasing cross section in the direction of
 50 flow from the pump to the motor and of gradually decreasing cross section from the motor to the pump, whereby the *vis viva* of the fluid from the pump is transformed into static pressure and vice versa, as described.

6. A variable speed transmission apparatus comprising a plurality of geometrically similar rotary pumps, conduits connecting said pumps, valves controlling the reversal
 60 of direction of flow through said conduits, the rotary elements of said pumps moving in harmony with the movement of liquid therethrough and operating indifferently as pump or motor and in either direction
 65 of rotation, the body of at least one of said pumps comprising a plurality of compartments, intake and discharge collecting chambers common to said compartments, and valves in said collecting chamber for
 70 cutting off or opening said compartments to the circulating conduits connecting the pumps, a cooling radiator, means for connecting one of said compartments with said radiator and returning the fluid to
 75 the apparatus, and means for preventing discharge from said compartment save through said pipe, substantially as described.

In testimony whereof I have signed my
 80 name to this specification, in the presence of two subscribing witnesses.

MAURICE TOURREIL.

Witnesses:

RONCHEY,

R. E. LOMGRAN.