

Oct. 21, 1941.

R. FICHTNER

2,260,015

HYDRAULIC DEVICE FOR TRANSMITTING POWER

Filed July 8, 1938

2 Sheets-Sheet 1

Fig. 1.

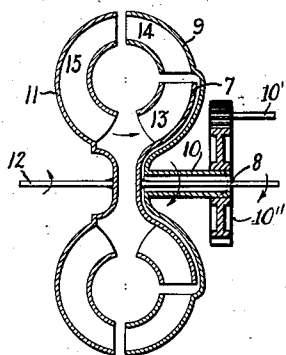


Fig. 3.

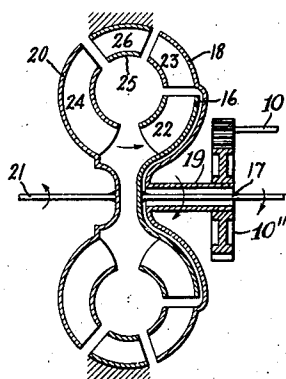


Fig. 2.

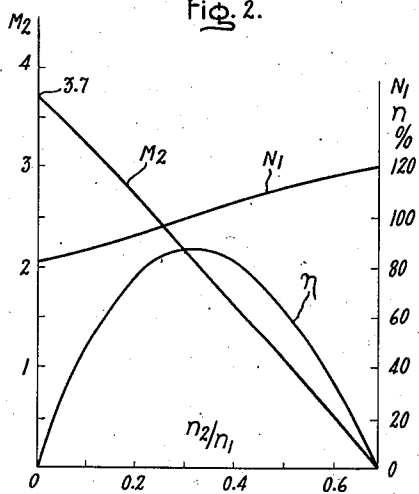
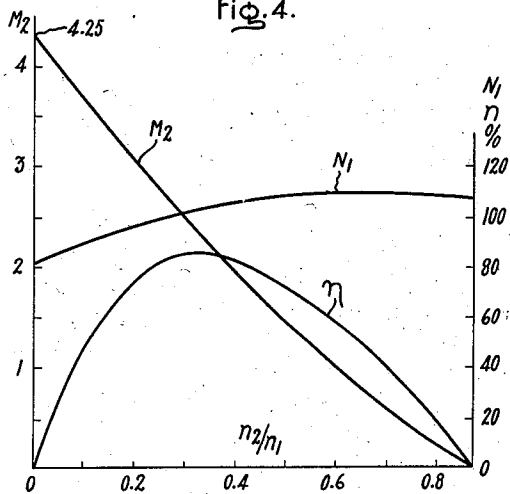


Fig. 4.



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Fig. 5.

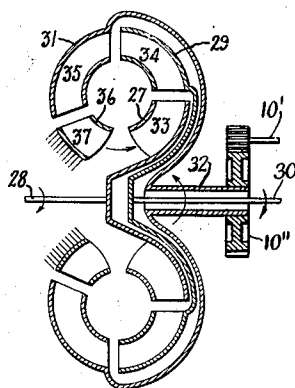


Fig. 7a.

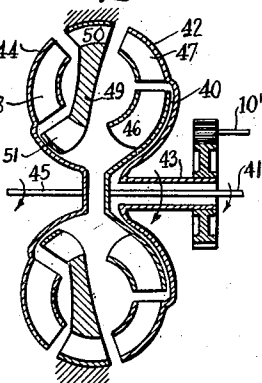


Fig. 7.

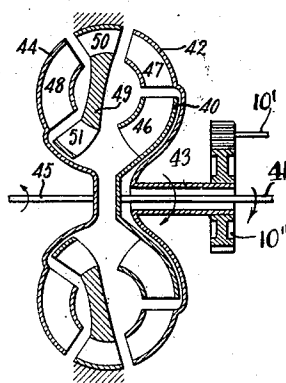


Fig. 6.

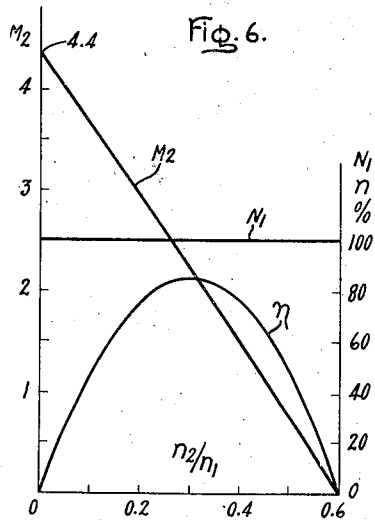
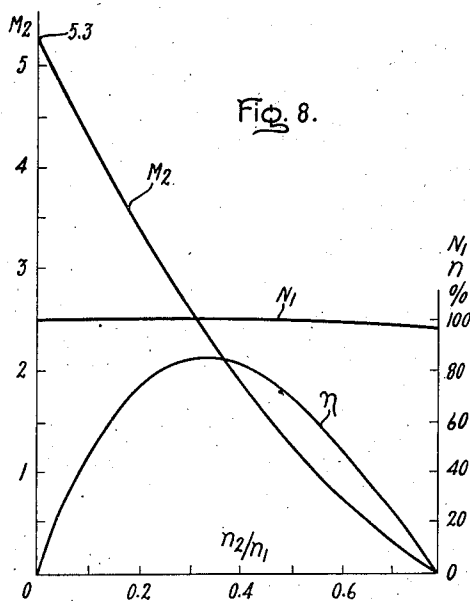


Fig. 8.



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UNITED STATES PATENT OFFICE

2,260,015

HYDRAULIC DEVICE FOR TRANSMITTING POWER

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General Electric Company, a corporation of
New York

Application July 8, 1938, Serial No. 218,252
In Germany July 16, 1937

1 Claim. (Cl. 60—54)

My invention relates to hydraulic devices for transmitting power, and more particularly to torque converters of the Föttinger type, consisting primarily of an impeller wheel and one or more fluid impelled wheels mounted in a common casing in which a fluid is circulated to transmit power between the wheels.

Torque converters of the above mentioned type, described in detail in U. S. Patent 1,199,359, require a series of stationary guide vanes for the purpose of producing a difference between the input and output torques. In multi-stage devices, several of these guide vanes are required, and more specifically the required number of such vanes is equal to one less than the number of stages in the devices.

An exception to the above stated rule is in devices wherein several impelled turbine wheels run in opposite directions, such operation being obtained partly by repulsion between the two pairs of oppositely running wheels. While in such devices the algebraic sum of the output torque is equal to the input torque, it is possible for the absolute values of these torques to vary from each other substantially.

In both types of converters; that is, the impulse type in which both input and all output wheels run in the same direction, and the repulsion type, in which the output wheels run in opposite directions, the fluid returns from the turbine, or impelled wheel, directly to the intake side of the impeller wheel. The circulation of this fluid entering the impeller wheel (entry whirl) is substantially affected by the speed of rotation of the last turbine wheel. As a result of this characteristic, the impulse type of device develops a substantially increased performance when the turbine wheel is stationary as is the case during the starting period, and in the case of the repulsion type, this characteristic results in a substantially reduced performance. Both of these changes in performance effect an inefficient use of the prime mover.

In the repulsion type of device, furthermore, the starting torque is greatly affected by fluid impact losses between the oppositely running turbine wheels. At standstill, that is at the starting period when the turbine wheel is at rest, the speed of this fluid impact is equal to the sum of the peripheral speeds of the oppositely running wheels during impact-free operation whereby the loss due to this impact is approximately proportional to the square of the impact speed.

One object of my invention is to reduce the impact losses and thereby increase the efficiency of hydraulic couplings of the above described type.

For a better understanding of my invention together with other and further objects thereof, reference is had to the following description taken

in connection with the accompanying drawings, and its scope will be pointed out in the appended claim.

In the accompanying drawings, Fig. 1 is a diagrammatic cross-sectional view of a standard form of hydraulic torque converter; Fig. 2 is a graph illustrating the speed and torque characteristics of this type of converter; Figs. 3, 5, 7 and 7a are diagrammatic cross-sectional views of hydraulic converters which are modifications of the coupling shown in Fig. 1, made in accordance with my invention, and Figs. 4, 6, and 8 are graphs illustrating the speed and torque characteristics of the modified converters illustrated in Figs. 3, 5, and 7 respectively.

Referring to the drawings in detail, Fig. 1 illustrates a coupling comprising an impeller wheel 7 driven by a shaft 8 and operating at a speed of n_1 . The turbine wheel 9 mounted on a hollow shaft 10 and a second turbine wheel 11 mounted on a shaft 12 are driven by a fluid circulated in planes at right angles to the axis of rotation by the arcuate vanes 13 of the impeller wheel. The turbine wheels 9 and 11 are provided with complementary vanes 14 and 15, respectively, to form a single fluid circulating path, and operate in opposite directions to each other; turbine wheel 9 operating in the same direction as the impeller wheel 7, and turbine wheel 11 operating in the opposite direction to the impeller wheel 7. The hollow shaft 10 drives a shaft 10' through a gearing 10''. The speed of the turbine wheel 9 is n_2 and the speed of the turbine wheel 11 is equal to n_2 or varies slightly therefrom.

Fig. 2 discloses a set of curves of which η (eta) indicates the efficiency of the converter, curve N_1 indicates motor load, performance, or utilization; and the line M_2 indicates the output torque at various speed relations between the impeller and impelled wheels. For plotting the output torque the ordinate unit chosen is the torque developed at $\eta = 60\%$. The abscissae unit is the quotient of

$$\frac{n_2}{n_1}$$

and in view of the fact that when

$$\frac{n_2}{n_1} = 0$$

the torque is several times the ordinate unit, a convenient comparison of output torque developed in the various modifications is available.

Upon analyzing the curves of Fig. 2 it becomes evident that in the forms of torque converters heretofore used and built as indicated in Fig. 1, a substantially lower motor performance, or load, is obtained at starting than at normal running conditions. Furthermore, the line M_2 indicates a starting torque which is 3.7 times the chosen

unit which may be called the normal running torque.

In accordance with my invention, stationary guide vanes are provided in the repulsion type devices, in which such vanes are not ordinarily needed for torque conversion, and in the provision of one or more sets of stationary auxiliary guide vanes in torque converters in which such vanes are ordinarily provided.

In all forms of the device; that is, the impulse and the repulsion forms, one set of stationary guide vanes is, in accordance with this invention, preferably placed in front of the impeller inlet. The impeller is thereby freed of the influence of the rotation of the turbine wheel and its performance remains practically independent of the output speed. The power of the prime mover, for example, the motor of a vehicle, is thereby fully utilized. In cases, and specially in the case of the repulsion converters, an increase of the starting torque is thereby obtained.

If in the case of repulsion converters, a set of stationary guide vanes is provided between the oppositely running turbine wheels in addition to, or in place of, the set of stationary vanes at the entrance to the impeller wheel, the above mentioned impact losses between the oppositely running turbine wheels are substantially reduced. This is due to the fact that the impact speed is thereby divided into two parts, and since the total loss at the impact points is proportional to the sum of the squares of its parts, the loss, at equal speeds, is only one-half as great as in the case where no stationary vanes are provided.

Fig. 3 is a diagrammatic sectional view of a torque converter such as shown in Fig. 1 modified in accordance with my invention. In this modification, the converter includes an impeller wheel 16 mounted on a shaft 17, a turbine wheel 18 mounted on a hollow shaft 19, and a second turbine wheel 20 mounted on a shaft 21 arranged to run in a direction opposite to that of the wheel 18. The impeller wheel and turbine wheels are provided with vanes 22, 23, and 24, respectively, arranged for circulating the fluid between them. In this modification a set of stationary vanes 25 is provided containing a series of vanes 26 which guide the fluid discharged from the vanes 23 of the first turbine wheel into the vanes 24 of the second turbine wheel 20. The turbine shaft 19 is geared to drive a shaft 10' through gearing 10''. Fig. 4 discloses the characteristics of this modified converter. It will be noted that the starting torque has been raised to a value of 4.25 times the normal running torque and the efficiency curve is somewhat improved. This improvement is traceable to the decrease of the fluid impact losses accomplished by the use of the stationary intermediate vanes between the turbine wheels 18 and 20. The performance, or load, curve N_1 does not vary, materially, from that of Fig. 2.

In Fig. 5 another modification of my invention is shown. This figure illustrates in vertical cross-section a converter provided with an impeller wheel 27 mounted on a shaft 28, a turbine wheel 29 mounted on a shaft 30, and a second turbine wheel 31 mounted on a hollow shaft 32 which is geared to shaft 10' by gearing 10''. The impeller wheel and the turbine wheels are provided respectively with vanes 33, 34, and 35, arranged to circulate fluid between them, and the two turbine wheels operate in opposite directions to each other. In the present modification, a set of stationary vanes 36 is provided having a series of

vanes 37 which guide the circulating fluid from the discharge end of the turbine vanes 35 to the intake side of the impeller vanes 33.

Fig. 6 discloses the characteristics of the modification of Fig. 5. The first substantial change is in the performance or load curve N_1 which is substantially constant. This is traceable to the addition of the stationary guide vanes at the entrance to the impeller vanes. The starting torque in this instance has increased to 4.4 times the normal running torque. The efficiency curve remains substantially the same as in the previous modifications.

In Fig. 7 I have illustrated a third modification of the torque converter. In this figure a diagrammatic cross-section of a torque converter is illustrated including an impeller wheel 40 mounted on a shaft 41, a turbine wheel 42 mounted on a hollow shaft 43 and a second turbine wheel 44 mounted on a shaft 45. The impeller and turbine wheels are provided with vanes 46, 47, and 48 respectively and the two turbine wheels are arranged to run in directions opposite to each other. The shaft 43 is geared to a shaft 10' by gearing 10''. In accordance with my invention, this modification is provided with a stationary guide apparatus 49 provided with two sets of guide vanes 50 and 51. The vanes 50 are placed between the discharge side of the first turbine wheel and the entrance to the second turbine wheel, while the second set of stationary vanes 51 is placed between the discharge side of the second turbine wheel 44 and the entrance to the impeller wheel 40. This modification thereby possesses the advantages of the two modifications of Figs. 3 and 5.

Fig. 8 discloses the operating characteristics of this modification. The performance, or load, curve N_1 is substantially constant as in the modification of Fig. 5 and the starting torque is increased to 5.3 times the normal running torque. The efficiency curve η (eta) is also, as in Fig. 4, raised and extends over a larger range of the values

$$\frac{n_2}{n_1}$$

Fig. 7a is a modification of the arrangement shown in Fig. 7, the turbine wheels 42 and 44 being arranged to operate in the same direction, instead of in opposite directions, as shown in Fig. 7. This is indicated by the arrows indicating the direction of rotation of the shafts 43 and 45.

This invention is not limited to repulsion type of converters, but may be used on the impulse type in which two turbine wheels rotate in the same direction with respect to each other and with respect to the impeller wheel.

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

A hydraulic torque converter comprising a fluid containing circuit which consists of an impeller wheel, a pair of turbine wheels coaxially arranged with respect to each other and with respect to the impeller wheel, the vanes of said turbine wheels being so arranged that the said turbine wheels rotate in opposite directions with respect to each other and a set of stationary vanes arranged on the entrance side of said impeller wheel to receive the fluid discharged by said turbine wheels and to return it to said impeller wheel and another set of stationary vanes arranged between the said two oppositely rotating turbine wheels to guide said fluid therebetween.

RUDOLF FICHTNER.