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HYDRAULIC DYNAMO-METER WITH FREE-FLOATING ROTORS

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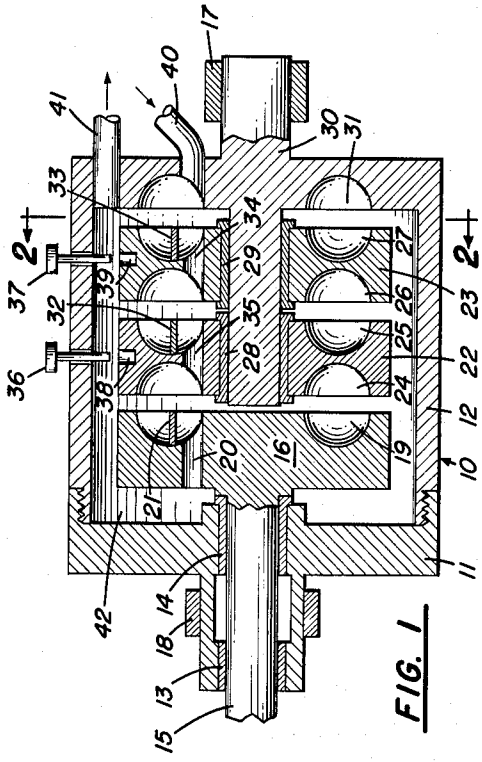


FIG. 1

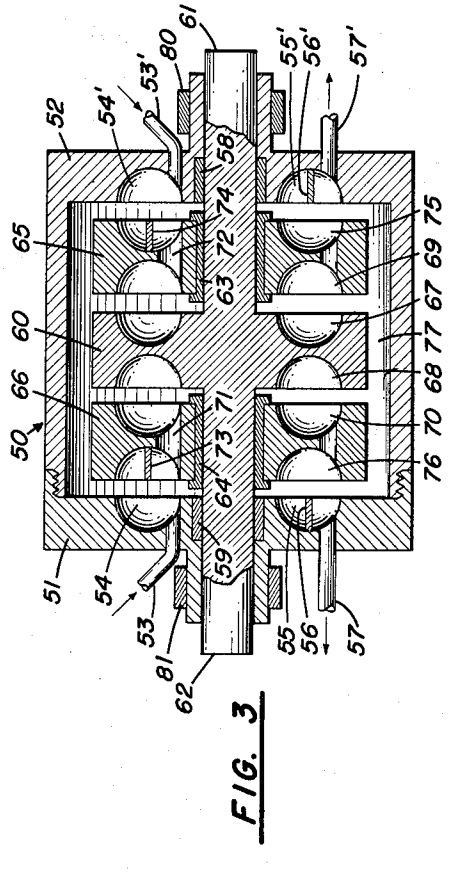


FIG. 3

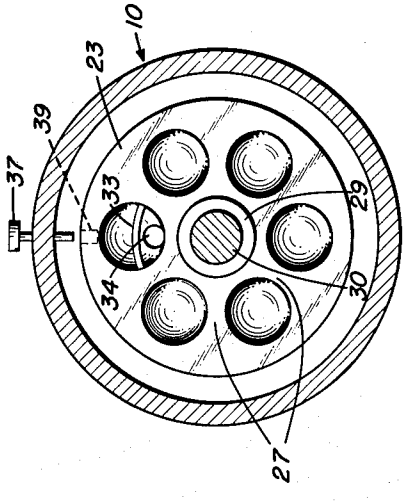


FIG. 2

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HYDRAULIC DYNAMO-METER WITH FREE-FLOATING ROTORS

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14 Claims. (Cl. 188—90)

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This invention relates to hydraulic dynamometers which may be constructed in large horsepower sizes and in which cavitation is virtually eliminated.

More specifically the invention is directed to high speed paddle wheel absorption dynamometers comprising a cylindrical stator within which is coaxially mounted a radially vaned input rotor, and a freely rotatable vaned rotor or rotors which rotate at lesser speeds than the main or input rotor. The freely rotatable rotors are positioned between the input rotor and a stator. When a plurality of such free rotors are used in series they rotate at successively decreasing speeds in their order of spacing from the input rotor to the stator.

According to a preferred form of the invention, the stator is provided with an axial inlet and a circumferential outlet port for fluid. The rotor discs have fluid ports therein to provide for circulation of the flow. Baffles may be used on the free rotors to aid the flow altho their use is not considered essential to the broader concept disclosed herein.

Prior to the present improvements single rotor hydraulic dynamometers for absorbing power by rotating the rotor in a fluid in a casing were known. This type is however limited in horsepower capacity and cavitates. Electric induction dynamometers are subject to magnetic leakage difficulties, are expensive and are limited in horsepower. Variable frequency electric dynamometers are also limited in horsepower and require elaborate accessory equipment.

An object of the present improvements is to provide a dynamometer having increased horsepower absorption at any given R. P. M.

Another object is to provide hydraulic dynamometers having reduced cavitation and erosion tendencies and which may operate at higher speeds than prior forms.

Another object is to provide hydraulic dynamometers having free floating intermediate rotors.

Another object is to provide for the flow of operating fluid progressively from lower speed to higher speed rotors.

Another object is to provide for the positive flow of fluid through all rotors and through all clearances.

Another object is to provide for the entry and exit of fluid through the lowest speed rotor.

Another object is to provide floating rotors on both sides of the main driving rotor so as to balance the thrust on the main rotor.

Another object is to provide for the selective locking of the floating or free rotors so as to obtain larger torque at lower speeds when this is desired.

Another object is to provide baffles to force flow through the rotors.

These and other objects will be manifest from a consideration of the following description, claims and drawings in which:

Fig. 1 is a sectional view of a preferred form of the invention in which a driven rotor and vaned stator are

separated by two rotors mounted for free turning during operation.

Fig. 2 is a view, partly in section, taken on the line 2—2 of Fig. 1 and, as viewed from the right, showing the general relationship of vanes and the baffled openings through the solid intermediate rotors.

Fig. 3 is a sectional view of a modification of Fig. 1 in which the driven rotor is intermediate free turning rotors so as to balance the thrust on the main rotor and its drive shaft.

Referring to Fig. 1, there is illustrated a casing 10 formed by securing end portion 11 to body portion 12. The casing may be formed in any suitable manner. Casing 10 has an outboard bearing 13 and an inboard thrust bearing 14 for supporting the input rotor drive shaft 15 and its fixed input rotor 16. Bearings 17 and 18 are for cradling the dynamometer unit for use in measuring and transmitting load as will be understood.

The input rotor 16 has vanes 19 which may be formed by suitably removing material from a solid blank from which the rotor may be formed. An opening passing though the rotor as shown at 20 is provided in one or more of the spaces between the vanes 19. The vanes 19 may be varied as to shape and depth within the scope of the present improvements.

In line with the driven input rotor 16 are free turning or floating rotors 22, 23, which are provided with matching vanes 24, 25, 26, 27 for cooperation in fluid circulation with the input rotor vanes and each other.

The rotors 22, 23 and bearings 28, 29 are supported on short shaft 30. Matching the radial vanes 27 of rotor 23 are the stationary vanes 31 forming a stator connected with casing 10.

Baffles 32, 33 similar to baffle 21 are positioned on the rotors 22, 23 to cooperate with the openings at 34, 35 in facilitating circulation of fluid during operation. Locks or latches 36, 37 movable thru the casing 10 may be used when it is desired to selectively lock one or both the rotors 22, 23 to the casing 10. The latches 36, 37 secure the rotors 22, 23 against turning by entering into the small recesses 38, 39 of the rotors. As will be understood, the latches 36, 37 may be varied in design so as to operate as screws or may be wholly removed and plugs substituted according to requirements. The casing 10 has a fluid inlet as at 40 and an outlet at 41.

The operation of the embodiment illustrated in Fig. 1 is as follows. Fresh hydraulic fluid, such as water, is introduced at 40 and circulates radially outward between vanes 27 on free rotor 23 and radially inward between vanes 31 in the stationary casing 10 while the rotor 23 turns. Part of the fluid circulating between vanes 27 and 31 passes through the opening 34 in the rotor 23 and circulates between the vanes 25, 26 on rotors 22, 23. In turn part of the fluid circulating between the vanes 25, 26 passes through the opening 35 on rotor 22 and circulates between vanes 19 and 24 on rotors 16 and 22. In like manner part of the fluid circulating between vanes 19 and 24 moves through opening 20 of the main rotor 16 and thence into the clearance portion 42 surrounding the rotors as it moves out through discharge opening 41 while positively scavenging all hot liquid from said clearance 42.

When the main or driven input rotor 16 is turning, fluid flows radially outward between the vanes 19 and leaves the space between the vanes with a high velocity tangential to the axis of rotation of shaft 15. As this fluid leaves the outer parts of vanes 19 it enters the openings between vanes 24 on rotor 22. It will be seen that if 22 is rotating slower than 16 the fluid entering the openings between vanes 24 will exert a torque on rotor 22 about its rotational axis. In a similar manner liquid leaves the vanes 25 on rotor 22 and enters between vanes 26 on rotor 23

exerting a torque on rotor 23 if rotor 23 is rotating slower than rotor 22.

When rotor 23 is turning, fluid leaves the outer part of the opening between vanes 27 with a velocity tangential to the axis of rotation of 23. This liquid leaving rotor 23 enters between the stationary vanes 31 on casing 10 and exerts a torque on the casing 10.

It will be seen from the above that the input rotor 16 cannot exert a torque on free rotor 22 without rotor 22 exerting a torque on free rotor 23; and rotor 22 cannot exert a torque on rotor 23 without rotor 23 exerting a torque on casing 10. Also since 16 must turn faster than 22 to exert torque on this free rotor, and 22 must turn faster than 23 to exert a torque on 23 and 23 must rotate relative to vanes 31 to exert a torque on the casing 10 it is seen that the velocity of the vanes of the free rotors are successively less according to their position than is the series away from the input rotor. The result is that there is less tendency for cavitations or erosion of vanes 19 when free floating rotors 22, 23 are interposed between vanes 19 and 31, than would exist if rotors 22, and 23 were not used and vanes 19 where moving adjacent to stationary vanes 31 as is the case in prior dynamometers.

The use of the free floating rotors permits the use of a large input rotor 16 which may be rotated rapidly so as to produce a very high actual vane velocity, without the velocity of the vanes on rotor 16 being excessively high relative to the velocity of the vanes of the next adjacent rotor. The rotor 16 can be large in horsepower and absorb very large values of horsepower and still rotate at very high speeds. Prior high speed hydraulic dynamometers were necessarily small in diameter and lower in horsepower.

As explained above the use of locks or latches such as 36, 37 is optional. They may be selectively used to prevent rotation of rotors 23 or 22 so as to obtain higher torque at low speed. Additionally structural and operative changes are contemplated. Oil, water, or other hydraulic fluids may be used. The number of free rotors and the shape and depth of the vanes may be varied within the basic concept. The baffles are very useful but are not considered essential to the invention.

The position of the fluid inlet and outlet ports may be changed while maintaining the flow of circulating fluid from the inlet through lower speed rotors as it moves to the highest speed rotor and then toward the outlet.

A modification illustrative of some of the above variations and in which the dynamometer may be driven from either end is shown in Fig. 3. Fig. 3 shows a free rotor positioned on each side of the input rotor 60 so as to balance the thrust on the input rotor shaft. The basic principle of operation is the same as that of Fig. 1 in that a rotor which operates at a lower rate than the input rotor 60 is positioned between a stator and the input rotor. It differs from the structure of Fig. 1 in that two inlets and outlets are used. Other differences will be obvious from inspection and the following brief description.

Casing 50 may be formed in two parts in the same manner as casing 10. The end portions 51 and 52 each have an inlet 53, or 53' and vanes 54, 54', 55, 55'. A baffle 56, 56', may be used in vanes 55, 55' near the outlets 57, 57'.

The main or input rotor 60 is supported as shown in the casing 50 and by the bearings 58, 59. Either of the extending shaft portions 61, 62 may be connected to a driving means in a known manner. These shaft portions 61, 62 support bearings 63, 64 of the free turning rotors 65, 66.

In this modification the input rotor has two sets of vanes 67, 68, one set on each face. Matching vanes 69, 70 are formed in free rotors 65, 66. The rotors 65, 66 are provided with openings 71, 72 and baffles 73, 74 in a manner similar to those of Fig. 1. Vanes 75, 76 are positioned opposite the stator vanes 55, 55'. Similarly

to the flow of Fig. 1, the fluid entering the inlets 53, 53' is circulated between the stators and the matching faces of the free rotors 65, 66. A part of the fluid moves through the openings 71, 72 to between vanes 67, and 68 on opposite sides of the input rotor 60. After passing to the clearance portion 77 it moves through the outlets 57, 57', such movement being facilitated by baffles 56, 56'. Bearings 80 and 81 may be used in mounting or cradling the dynamometer unit for use in a well known manner.

From the above description it is believed clear that there is herein provided structures in which an input rotor is spaced from a stator or stators by additional rotors which during operation may rotate at a velocity less than that of the input rotor. Also that the path of hydraulic fluid used is from the inlet to and through rotors turning at lesser rates of speed than the main or input rotor.

It will further be understood that a plurality of rotors may be used between the input rotor and a stator in the modification illustrated in Fig. 3 and that locking means for a free rotor of Fig. 3 may be used in a manner similar to that shown by Fig. 1.

The use of free rotors is highly advantageous and is relatively simple in that few parts are required. The locking arrangement adds flexibility and gives a scope of application not found in prior constructions of the type disclosed. Certain of the advantages of these improvements may be obtained by use of reduction gears between the input rotor and intermediate rotors or by making the intermediate rotors partially free as by use of friction drag or brakes. It may be noted that the circulating flow may be similar in these cases and the tendency to erode or cavitage will be lessened. In the case of gears the complexity of the structure will be materially increased however.

The use of free floating motors intermediate an input rotor and stator lessens the tendency for cavitation or erosion of the vanes of the input rotors and the stators. The number of parts are kept to a minimum.

Applicant does not wish to be limited to the above description or to the illustrated embodiments but instead only by the scope of the appended claims and their equivlents.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. An hydraulically-operated absorption-type dynamometer unit comprising a casing having an inlet and an outlet for hydraulic fluid, a stator connected with said casing, an input rotor within said casing, said stator and said input rotor having opposed surfaces provided with vanes for circulating hydraulic fluid, and a freely-rotatable intermediate rotor of the same diameter as said input rotor positioned between said stator and said input rotor, said intermediate rotor having a set of vanes on one side surface opposed to the vanes of the input rotor and a second set of vanes on the other side surface opposed to the vanes of the stator.

2. The combination of claim 1 further defined in that the input rotor and intermediate rotor are mounted coaxially, and that the intermediate rotor has an opening for movement of fluid from between vanes of one set directly to between vanes of the other set.

3. In a hydraulically-operated dynamometer, a casing having an inlet and an outlet for hydraulic fluid, an input rotor enclosed in said casing; a stator connected with said casing; and a freely-rotatable intermediate rotor positioned between the input rotor and the stator, said intermediate rotor having a set of vanes on each side, one set of vanes cooperating with the input rotor and the other set cooperating with the stator in circulating hydraulic fluid; said input rotor, said intermediate rotor and

said stator each rotating at a different rate of speed during operation of the dynamometer.

4. In a hydraulic dynamometer device, a casing having an inlet and an outlet for hydraulic fluid, an input rotor, a drive shaft operatively attached to the input rotor and extending outwardly through the casing, a stator formed integral with the casing, a rotor positioned intermediate the input rotor and the stator, said intermediate rotor being mounted for free turning and having a set of vanes on each of its two sides, said intermediate rotor having a fluid passage between vanes, said passage being located with respect to the inlet so that incoming fluid passes through the passage of said intermediate rotor as the fluid moves toward the input rotor, and a baffle secured to the intermediate rotor near said passage to deflect incoming fluid into said passage, and means for transmitting torque from the input rotor to the stator.

5. The combination of claim 4 further defined in that there are a plurality of free turning rotors each of which has two sets of vanes as set forth and a communicating fluid passage between the two sets of vanes on each intermediate rotor.

6. The combination of claim 4 further defined in that there is a stator connected with each end of the casing and an intermediate rotor mounted for free turning between each of said stators and the driven input rotor.

7. In a power absorbing hydraulic type dynamometer unit, a casing having a fluid inlet and a fluid outlet extending therethrough, an input rotor in said casing, a drive shaft operatively attached to said input rotor, a stator connected wtih said casing, a vaned rotor positioned intermediate the said stator and input rotor and mounted for free rotation throughout 360 degrees, said intermediate rotor being of solid construction and having an opening therethrough which provides a passage for the flow of fluid moving from the casing inlet toward the input rotor during operation, said input rotor, said vaned rotor and said stator each rotating at a different rate of speed during operation of the unit.

8. In a power absorbing hydraulic type dynamometer unit, a casing having a fluid inlet at one end and a fluid outlet, a stator connected with the casing, a plurality of coaxial rotors which rotate at progressively higher speeds in their order of spacing from the fluid inlet, all rotors between the inlet and the highest speed rotor having an opening therein to provide a passageway for incoming fluid as it moves progressively from the inlet through a lower speed rotor to a higher speed rotor, and means for transmitting torque from the input rotor to the stator.

9. The combination of claim 8 further defined in that the highest speed rotor has an opening therein to provide a passageway for fluid leaving said rotor and that said opening is in communication with the fluid outlet through a clearance portion, said fluid outlet being on the same end of casing as the inlet.

10. In a power absorbing hydraulic type dynamometer unit, a casing having a fluid inlet and a fluid outlet at each end, a stator connected with each end of the casing, an input rotor, a drive shaft operatively connected to said input rotor, additional rotors being intermediate a stator and said input rotor and being mounted for free rotation, said intermediate rotors and input rotor having an opening for fluid moving from the inlet through the input rotor and a passage for fluid moving from said input rotor toward the outlet which is at the same end of the casing as said last named inlet, and means for transmitting torque from the inlet rotor to the stators.

11. In a power absorbing hydraulic type dynamometer unit, a casing having a fluid inlet and a fluid outlet, a stator connected with each end of the casing, an input rotor and a supporting drive shaft operatively attached thereto, freely rotatable rotors on opposite sides of the input rotor, said rotors all having vanes on their sides for controlling the hydraulic fluid circulation during operation, said free rotors acting to balance the thrust on the input rotor during operation, and means for transmitting torque from the input rotor to the stators.

12. In a power absorbing hydraulic type dynamometer unit, a casing having a fluid inlet and outlet, an input rotor enclosed in said casing, a drive shaft operatively attached to said input rotor, a stator connected with said casing, a rotor positioned intermediate the said stator and input rotor and mounted for free rotation throughout 360 degrees, said intermediate rotor having an opening therethrough constituting a fluid passage, a baffle close to said opening for directing circulating fluid through said rotor in the direction of the input rotor, and means for transmitting torque from the input rotor to the stator.

13. In a power absorbing hydraulic type dynamometer unit, a casing for the operating fluid, an input rotor enclosed in said casing, a drive shaft operatively attached to said input rotor, a stator connected with said casing, a rotor member positioned intermediate the stator and the input rotor, a shaft supporting the rotor member, said rotor member being mounted for free rotation relative to said shaft throughout 360 degrees, means for locking said rotor member to said casing, and means for transmitting torque from the input rotor to the stator.

14. The combination of claim 13 further defined in that the locking means has a portion extending through the casing which may be manually manipulated to lock and unlock the rotor member relative to the casing.

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