Nov. 8, 1932. W. PROFITLICH 1,886,975

SYNCHRONIZING TWO INTERNAL COMBUSTION ENGINES

Filed Sept. 6, 1930

Fig. 1

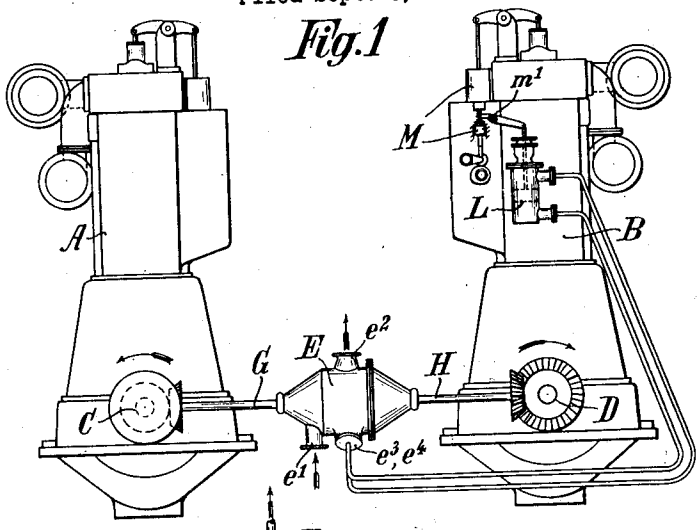


Fig. 4.

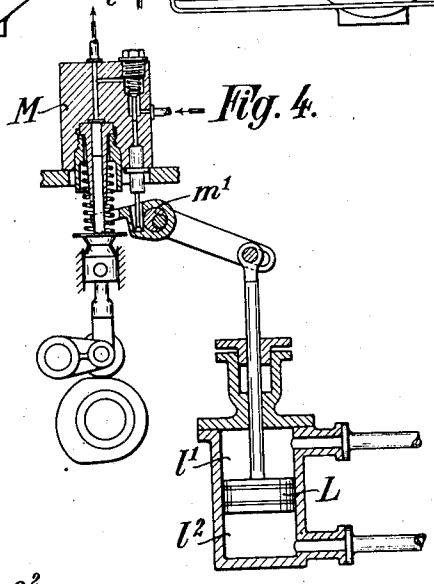


Fig. 2.

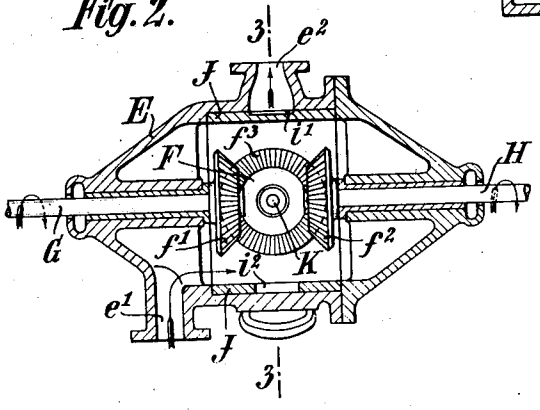
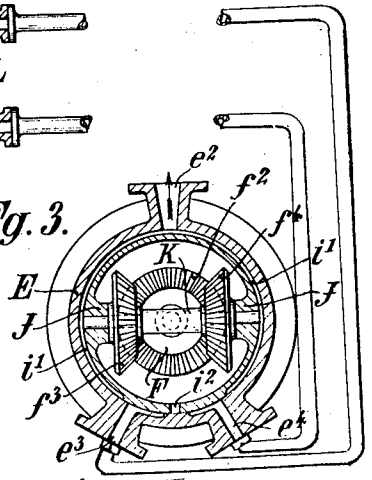


Fig. 3.



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UNITED STATES PATENT OFFICE

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SYNCHRONIZING TWO INTERNAL COMBUSTION ENGINES

Application filed September 6, 1930, Serial No. 480,219, and in Germany September 27, 1929.

The invention has for its object an apparatus intended for synchronizing two internal combustion engines, more particularly marine engines. The invention is based upon the observation that the vibrations of the vessel caused by the driving engines disappear or are damped to a notable extent, if during operation, an equal speed of the engines and a determined mutual position of their cranks is maintained, that is, if the engines run synchronously.

To this end the invention consists in the fact that an equalizing gear is provided which is acted upon by the two crank shafts of the engines, and the equalizing motion of which, upon one of the crank shafts leading or lagging, acts upon the governor and thereby on one or both of the engines until the two crank shafts will have reached again their mutual original position.

In order that the invention can be more readily understood, an embodiment of the apparatus is illustrated by way of example in the accompanying drawing in which

Figure 1 is an end view of two marine internal combustion engines equipped with the equalizing gear according to the invention,

Figure 2 is a longitudinal section through the equalizing gear, on an enlarged scale,

Figure 3 is a cross section on line 3—3 of Figure 2, and

Figure 4 is a sectional view through a hydraulic piston gear acted upon by the equalizer and in turn acting on the governing device of the engines.

Referring to this drawing, A and B denote the two engines of a vessel, and C and D denote their crank shafts. E denotes the casing of the equalizing or differential gear F comprising four bevel wheels f^1, f^2, f^3, f^4. The bevel wheels f^1 and f^2 are driven through their shafts G and H by the crank shafts C and D, respectively, while the bevel wheels f^3 and f^4 run on a common shaft K mounted within a hollow rotary slide J. This slide J rests oil-tightly in the cylindrical portion of the casing E and serves to control a quantity of oil under pressure which enters the casing E through inlet e^1 and leaves it at e^2. The slide J has an annular passage i^1 extending on the greater portion of its periphery, and a radial bore i^2 disposed between the ends of passage i^1. These ducts serve to control the oil under pressure contained in the casing E. Upon slide J being turned out of its middle position the ducts i^1, i^2 connect passages e^3, e^4 of the casing E in a determined manner to the inlet e^1 and outlet e^2 thereof. These passages e^3, e^4 respectively, communicate through pipes with the upper space l^1 and the lower space l^2 of a cylinder, Figure 4, in which a piston L may rise or lower, which acts upon the governing shaft m^1 of the fuel pump M.

The described apparatus operates as follows:

The crank shafts C and D are rigidly coupled, according to the experiences of the service or on the basis of calculations of the vibrations, with the shafts G and H in a position in which during run the vibrations of the vessel are reduced to a minimum or no vibration at all exist. With this position of the crank shafts the slide J of the equalizing gear is in the middle position illustrated in Figure 3 and obturates the passage e^3 and e^4 leading to the controlling piston L. Consequently piston L cannot shift in any direction.

The ratio of transmission between the crank shafts C and D and the bevel wheels f^1 and f^2 driven by them is 2:1. Now, upon one of the two crank shafts making one revolution so as to assume again its initial position, the slide J executes likewise one revolution and again assumes its original middle position. It results therefrom that if slide J is in middle position the crank shafts C and D take always their determined relative position.

It is further to be seen from the figures that if the two engines run at the same rate, slide J is at rest and that if the relative position of the cranks of the engines does not correspond to the determined one, the slide is out of its middle position.

It may be assumed for instance that the crank shaft D has some lead with regard to crank shaft C, then slide J has turned out of its middle position in clockwise direction so

that its passage i^2 communicates with the casing passage e^3 while its annular passage i^1 communicates with passage e^4. Consequently the oil under pressure entering the casing E at e^1 flows through passage i^2 and passage e^3 to the space l^1 above piston L and lowers the latter, since the oil in space l^2 can escape through passage e^4, annular passage i^1 and outlet e^2. The downward motion of piston L causes a turning motion of the governing shaft m^1 in such a manner that the suction valves of the fuel pump M are opened earlier and the run of engine B is retarded due to the reduced fuel supply, so that slide J returns to middle position. When, for instance, in turning over the rudder of the vessel, the engine B runs more quickly than engine A, slide J turns again in clockwise direction. As soon as it has turned an amplitude corresponding to this surplus speed, the controlling piston L acts in the above described manner upon the fuel pump M whereby the run of engine B is retarded. Consequently slide J returns to middle position. When a state of stability is reached, slide J remains in middle position, if not so, it turns until piston L moves in opposite direction and anew accelerates the run of engine B. Probably the slide J and thus the engines A and B will oscillate about the desired crank position.

The apparatus illustrated in the drawing works only if the two crank shafts C and D revolve in the direction of the arrows corresponding to the forward run of the vessel. In working the vessel for reverse operation the apparatus must be thrown out of operation which is effected by releasing the pressure exerted upon the oil. When for reverse operation the apparatus is not thrown out, then the equalizing gear J acts in opposite sense, that is, any differences in the rates of revolution and in the mutual position of the cranks are not eliminated but increased.

In the service of the engines the apparatus is thrown into operation, after the engines have been set to approximately equal rate by hand regulation, at that moment where the disappearance of the vibrations of the vessel indicates that the crank shafts of the two engines are in the desired relative position.

The arrangement as described may be modified in so far as the controlling piston L may act upon the governing shafts of both engines, or another controlling piston L may be provided for the governing shaft of engine A which piston acts upon the fuel pump in a sense opposite to that of engine B.

What I claim, is:—

1. In combination with a power plant comprising two internal combustion engines, crank shafts in said engines, means for synchronizing said engines comprising an equalizing gear connected between said crank shafts, a governing device for modifying the relative speeds of said engines, and hydraulic pressure means for operating said governing device controlled by said equalizing gear to maintain a synchronous relationship between said engines.

2. In combination with a power plant comprising two internal combustion engines, crank shafts in said engines, a chamber containing a fluid under pressure, transmission elements extending from said crank shafts to said chamber, a rotatable element in said chamber adapted to be actuated by a differential movement of said transmission elements, a governing device for modifying the speed of one of said engines with respect to the other, a member operated by a fluid under pressure connected between said governing device and said chamber, and valve means in said chamber for controlling said member and governing device by the movement of said rotatable element.

3. In combination with a power plant comprising two internal combustion engines, crank shafts in said engines, a chamber containing a fluid under pressure, transmisison elements extending from said crank shafts to said chamber, a rotatable element in said chamber adapted to be actuated by a differential movement of said transmission elements, a governing device for modifying the speed of one of said engines with respect to the other, a fluid pressure controlled piston connected to said governing device, a chamber for said piston having ports for a fluid under pressure above and below said piston, communicating conduits between said ports and said chamber, a normally obturated channel in said chamber associated with an intake pressure adapted to register alternatively with one of said conduits responsive to the direction of actuation of said rotatable element, and another normally obturated channel associated with an exhaust pressure adapted to respectively register with the other of said conduits responsive to said actuation.

The foregoing specification signed at Hamburg, Germany, this 23rd day of August, 1930.

WILHELM PROFITLICH.