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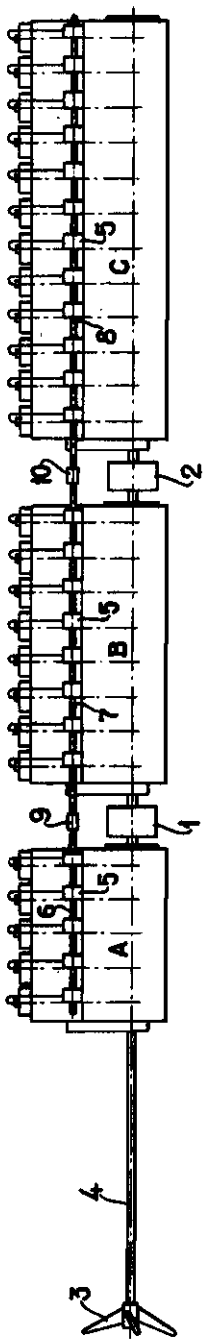

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ALIEN PROPERTY CUSTODIAN

COMBUSTION ENGINES

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The invention refers to an internal combustion motor installation, composed of two or more motor-units; this installation must be able to run during a long period besides with a normal and a maximum load also with lower and eventually even with extremely low load, whereby it is of the greatest importance that also at certain definite low loads, eventually also at certain definite extremely low loads the consumption of fuel and lubrication oil is exceptionally low.

Such installation e. g. is of interest for the propulsion of such seagoing vessels which, besides having to cover long distances at normal speed, are for a long period employed in the costal service, running at small speed or of passenger vessels which in making cruises run at half power or even less during the whole voyages, and it is of still greater interest to war vessels which, besides at normal and maximum speed of 30 to 40 knots, also have to run long time at convoying speed of about 22 knots and at cruising speed of 12 to 15 knots.

Methods are known by which the purpose described above can be approximately attained. All these methods, however, make use of the socalled indirect transmission of the output of various motor-units to the propellershaft either by mechanical, electric or pneumatic means.

The invention is, however, confined to the direct transmission of the output of various motor-units to the propellershaft, so that transmission losses are avoided, and whereby simplification and as a rule saving of space, more particularly in the direction of breadth, and in many cases saving of weight and saving of expenses may be realised.

The inventor proceeds from an arrangement whereby the crankshafts of all motor-units have been placed directly in line with the propellershaft, the hindmost motor-unit has been coupled directly to that shaft, and two successive motor-units may be coupled directly by means of couplings fitted on their crankshafts so that the output of each motor-unit is transmitted to the propellershaft through the crankshafts of the motor-units situated behind. For each main service speed a certain definite output is required; this required output can be obtained at every time by uncoupling or coupling the various motor-units.

According to the invention the numbers of cylinders of the various motor-units are chosen in such a way that for each main service speed such a number of cylinders can be coupled to the propellershaft that, particularly in regard of the oil consumption, in each case the required output of the cylinders is developed under the most favourable conditions.

The relations between the different numbers of cylinders which may be put in operation simultaneously, are preferably so chosen that the different outputs, corresponding to the different speeds desired, may be obtained by substantially uniform load of the cylinders in the different cases.

The different numbers of cylinders which may be put in operation simultaneously, can e. g. be determined by the formula

$$c = \left(\frac{v}{V}\right)^3 \cdot C$$

in which C is the total number of cylinders in the motor plant, V the maximum speed (knots) at normal load, v one of the desired lower speeds, and c the number of cylinders corresponding to the lower speed in question.

The drawing illustrates the arrangement of a ship's motor installation with direct driving. The motor installation consists of three separate motor-units A, B and C, of which A has been coupled directly to the shaft or shafts **4**. The ship's propeller **3** has been fitted to shaft **4**. The crankshafts of the three motor-units A, B and C can be coupled one to the other by means of the couplings **1** and **2**.

It may be assumed that the three principal speeds, at which the vessel should be run with the exceptionally utmost economy, are e. g. 30, 22 and 13.5 knots respectively, the speed 30 knots corresponding to 100% of the normal output of the installation, while the speeds 22 and 13.5 knots will correspond to about 40% and 10% respectively of said normal output.

The motor-units A, B and C have correspondingly in accordance with the above formula been chosen at 5, 8 and 12 cylinders, in total 25 cylinders, which coupled one to the other develop at normal load the normal output required for the speed 30 knots.

For developing about 40% of this output at the lower number of revolutions of the propeller, appertaining thereto, the 12 cylinder motor-unit C can be uncoupled, and the remaining 5 plus 8=13 cylinders, each at about normal load, and coupled one to the other, will deliver the said output to the propeller for giving the ship a speed of 22 knots.

For developing about 10% of the normal output at the number of revolutions still more greatly reduced, appertaining thereto, the 8 cylinder motor-unit can also be uncoupled, and the remaining 5 cylinders, each almost normally

loaded, will deliver the output required to the propeller for giving a speed of 13.5 knots.

The choice of the numbers of cylinders in the various motor-units has consequently been made so as to obtain the desired different speeds by the most favourable conditions. To be able to regulate the coupled motor-units as a complete unit after having switched on coupling 1 or couplings 1 and 2, the fuel oil regulating shafts 6 and 7, or 6, 7 and 8 respectively, by which the fuel injected by the fuel oil injection pumps 5 into the cylinders is regulated, can be coupled by coupling 9, or couplings 9 and 10 respectively, so as to regulate the fuel oil injection pumps 5 of the coupled motor-units A and B, or A, B and C respectively, simultaneously and in unison.

The coupling or couplings between the motor parts may e. g. consist of a withdrawable clutch coupling, a coupling with withdrawable pins, or a friction coupling, in each case whether or not in combination with an elastic coupling, which may also, if required, be combined with an arrangement to synchronise the motor parts to be coupled before switching in.

Should it be required that coupling and uncoupling is carried out without stopping the motor-unit situated behind, it may be advantageous, in accepting a small transmission loss, to proceed to the application of hydraulic or electric couplings. In this instance, however, fuel regulating continues to be possible, as these couplings have a fixed relation between the number of revolutions, moment to be transmitted and slip incurring.

The inventor originally proceeded from the idea that it must be possible to put out of operation part of a 12 cylinder marine engine not required, when it is desired to run the vessel at a small load during a long period. The remaining cylinders could then continue to operate at their normal mean indicated pressure, that means economically, and the part out of operation need not needlessly be run which would unfavourably affect the mechanic efficiency.

On elaborating the idea, it has proved that this plan could technically be carried out, but it also proved to be possible to put out of operation additional parts of the engine, should one desire to provide additional speed stages for the vessel. It appeared that this would involve splitting the 12 cylinder engine into various independent motor-units which by means of couplings on the crankshafts could be switched on or off, and yet could be attended to as a single unit by one engineer, by coupling the fuel oil regulating shafts.

From a technical point of view there is no objection to enlarging each of these motor-units to a motor having a large number of cylinders and of considerable output, so that in this manner also the problem has been solved to apply an extraordinary large power to the propellershaft, whilst maintaining the advantages of direct drive.

The transmission of the outputs through the aftermost crankshaft does not involve unpractical dimensions of the shaft, because a small increase in diameter of the shaft is sufficient already to permit the transmission of a considerably additional output.

It proves, however, that it is also not necessary that all motor-units are built up of the same cylinders; there may be motor-units with large cylinders and units with small cylinders; even the motor-units may consists of various types, as by the coupling of the regulating shafts it is possible to manoeuver with the whole apparatus as though it were one motor.

The invention may also find application to motor installations driving other machines, whereby extremely variable loads occur during long time, and whereby it is of importance, that at some of these loads, the machine is run with an exceptionally low fuel consumption.

As instances are stated the propellers of an aeroplane, the driving wheels of a locomotive or motor-car, the centrifugal pumps of sewage pumping stations and polder pumping stations, etc.

On each application it will depend on the nature of the service whether the couplings between the crankshafts will be chosen of such construction that the coupling or uncoupling can be carried out whether or not with the engines being in operation.

Cases may present themselves where the motor-crankshafts are in line of and directly coupled to a mainshaft driving one or more machines by means of mechanic or electric transmission.

This e. g. refers to twin-screw motorboats of which the motor installation, driving both propellers, has been placed on the centerline of the boat.

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