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Raetiger

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[54] **DEVICE FOR EXAMINING THE PISTON RINGS IN FREE-FLOATING PISTON ENGINES**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.**.....**F15b 7/00**

[58] **Field of Search** .....60/54.5 R; 123/46 R, 46 A, 123/46 B, 46 SC, 46 E, 197 R

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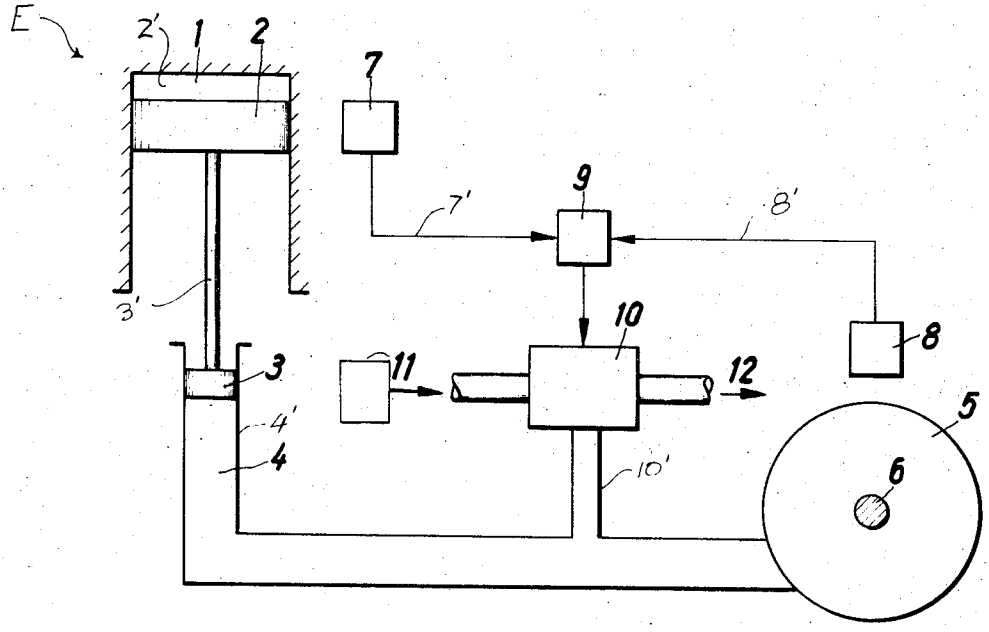
[57] **ABSTRACT**

A device is provided for use in examining the piston rings of free-floating piston engines wherein power from the pistons is transmitted to the engine's power output shaft through a hydrostatic motion converter system. The device includes piston detector means associated with each of the pistons in the engine for respectively producing a continuous output signal corresponding to the momentary or instantaneous position of their associated piston. A shaft detector is located adjacent the engine's output shaft and is adapted to produce an output signal corresponding to the momentary or instantaneous angular position of the shaft. Independent comparator means are operatively connected between each of the piston detectors and the shaft detector for comparing the signals produced thereby and generating separate synchronization error signals for each of the pistons. Fluid control means is operatively connected to the comparator means for selectively adding liquid to or removing liquid from the hydrostatic converter system in response to the synchronizing signal so that the synchronization error between the pistons and the shaft is reduced. An adjustable signal generator for selectively producing output signals corresponding to predetermined output shaft positions, is selectively connected to the comparator means by a switch so that when the signal generator is connected to the comparators, the latter generate predetermined synchronization error signals to operate the fluid control means and thereby move the pistons to predetermined positions independently of the actual position of the engine's output shaft.

7 Claims, 3 Drawing Figures



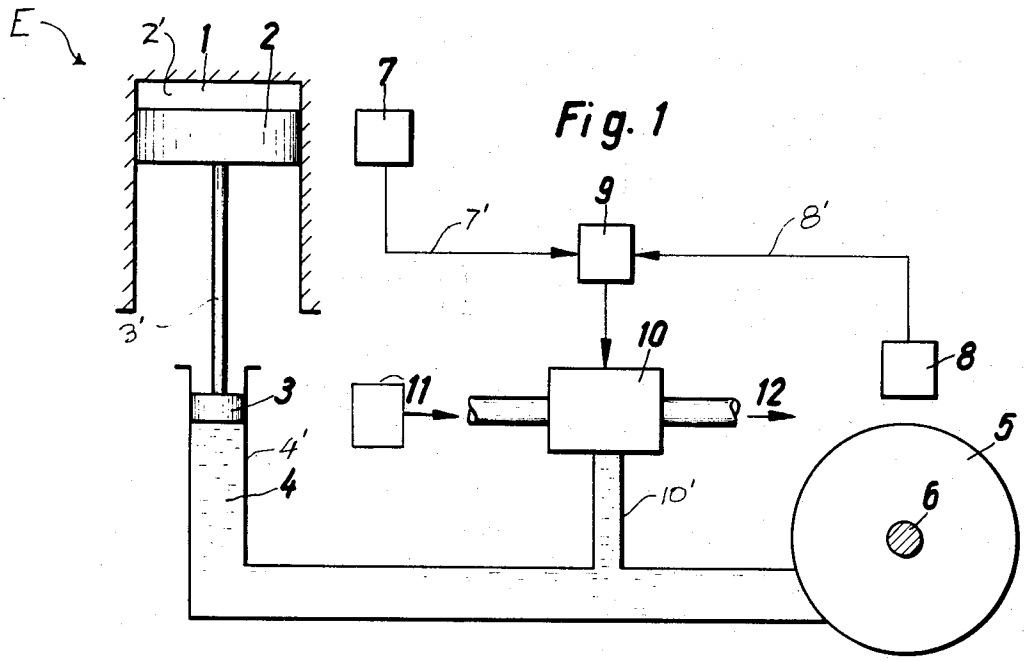


Fig. 1

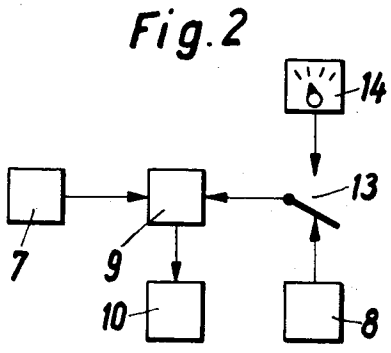


Fig. 2

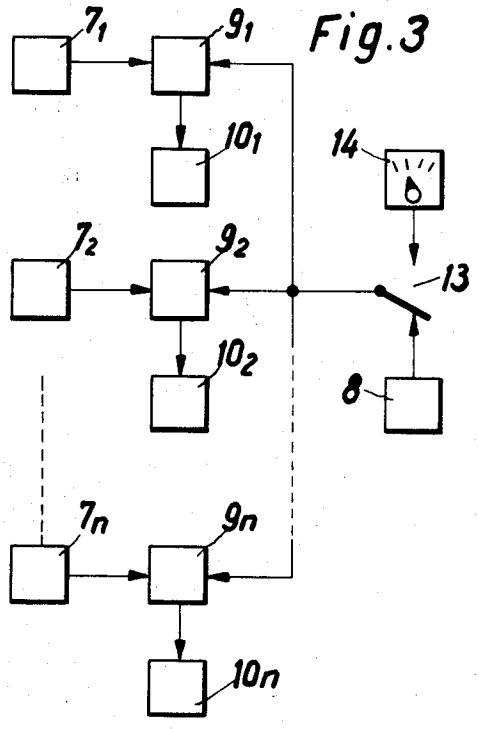


Fig. 3

DEVICE FOR EXAMINING THE PISTON RINGS IN FREE-FLOATING PISTON ENGINES

The present invention relates to apparatus for use in examining piston engines and in particular to a device for examining the piston rings of a free-floating piston engine.

In free-floating piston engines, the power between the driving piston and the driven or power output shaft of the engine is transmitted through hydrostatic motion converters with the correct position of each piston relative to the angular position of the output shaft maintained by synchronizing control systems which effect the quantity of pressured liquid in the hydrostatic system in order to reduce any existing synchronizing errors.

In large diesel engines, particularly those engines which are utilized to power ships or ocean-going vessels, the piston rings must be examined for wear or looseness in mounting after approximately every 1,000 hours of operation. For this purpose the engine typically is turned over slowly, by means of a highly geared down motor connected to the engine drive shaft, until a piston ring of one of the pistons appears before the intake or exhaust slot adjacent the piston. After the piston ring has been checked, the engine must again be turned over until the next ring appears. Accordingly, only one ring can be examined at a time and the maneuver must be repeated until all of the piston rings of all of the pistons have been examined. Since it usually takes up to 20 minutes to rotate the crank shaft of a large ship's diesel engine during examination of the piston rings in this manner, and since there are up to four (4) rings on each piston, the total examining time adds up to a considerable period which is particularly undesirable when the ship is at sea and is, as a result, unable to maneuver during the extended examination period. Moreover, since the ship's drive shaft must be operated during the examination of the pistons, the shaft and the propeller cannot be checked independently of the examination of the piston rings and, as a result, the amount of time spent in examining the drive system of the ship's engine is substantially increased.

Accordingly, it is an object of the present invention to examine the piston rings of free-floating piston engines independently of the position of the power output shaft of the engine.

Another object of the present invention is to examine the piston rings of free-floating piston engines by a method which is relatively rapid and inexpensive.

Yet another object of the present invention is to examine the piston rings of free-floating piston engines by a method and apparatus which is relatively simple and accurate in operation.

In accordance with an aspect of the present invention, the piston rings of a free-floating piston engine, wherein power from the piston is transmitted to the engine's power output shaft through a hydrostatic motion converter, are examined by a device which avoids the above-mentioned drawbacks of conventional examining systems and substantially shortens the examination period. In general, a piston detector is associated with each of the pistons in the engine for producing a continuous output signal corresponding to the momentary or instantaneous position of its associated piston as it passes through its cycle. A single shaft detector is

located adjacent the engine's output shaft to detect the instantaneous angular position of the shaft and produce an output signal representative of that position.

Independent comparator means are operatively connected between each of the piston detectors and the shaft detector for comparing the output signals produced thereby and generating a synchronizing error signal for each of the pistons, which signals are supplied to independent fluid control means. The latter are adapted to selectively add liquid to or remove liquid from the hydrostatic converter system between its associated piston and the output shaft in response to the synchronizing signals, so that the synchronization errors between the respective pistons and the shaft are reduced.

In accordance with a feature of the present invention, an adjustable signal generator, which is adapted to selectively produce output signals corresponding to predetermined output shaft positions is selectively connected to the comparator means, through a switch, to cause the comparator means to generate predetermined synchronization error signals. These signals activate the fluid control means in a predetermined manner and thereby cause the pistons to move to predetermined positions in accordance with the selected output signals of the signal generator. Accordingly, by adjusting the signal generator means, liquid can be supplied or removed from the hydrostatic system in order to raise or lower the pistons independently of the position of the engine's output shaft, in order to present the piston rings adjacent the examining port. As a result, the examination of the piston rings can be performed without regard to the angular position of the output shaft of the engine. Rather, the examination is conducted by the application of predetermined signals to the system which signals can be preselected on the signal generator to correspond to those positions of the output shaft when the desired piston rings are in position for examination.

In accordance with one embodiment of the present invention a single signal generator is utilized and connected to all of the comparator means associated with the various pistons in the engine, so that all of the pistons will move simultaneously and in parallel relationship into their examining positions.

The above, and other objects, features and advantages of this invention, will be apparent in the following detailed description of an illustrative embodiment thereof which is to be read in connection with the accompanying drawings, wherein:

FIG. 1 is a schematic illustration of a synchronizer control system for a free-floating piston engine with a hydrostatic motion converter in accordance with an embodiment of the present invention;

FIG. 2 is a schematic block diagram of the control arrangement for a free-floating piston engine having a single piston; and

FIG. 3 is a schematic block diagram of the examining control arrangement for a free-floating piston engine having a plurality of pistons controlled by a single signal generator.

Referring to the drawings in detail, and initially to FIG. 1 thereof, it will be seen that a free-floating piston engine E of generally conventional construction has a working cylinder 1 in which a driving piston 2 is

received to define a combustion chamber 2' wherein the fuel for driving the engine is combusted with air in the well known manner.

Piston 2 is connected by a rod 3' to a lifting piston 3 which constitutes part of the hydrostatic motion converter of the system. Piston 3 is received in liquid tight relation within a conduit or chamber 4' which contains liquid 4 under pressure therein. The opposite end of conduit 4' is in fluid communication with a conventional rotary converter 5 so that as piston 2 is reciprocated upon combustion of fuel within chamber 2', the force of combustion is applied, through piston 3, fluid 4 and rotary converter 5 to rotate the output shaft 6 of the engine.

A signal generator or piston detector device 7, is located adjacent work cylinder 1 in order to detect the momentary, i.e., instantaneous position of piston 2 and generate an electrical signal representative of that position, which signal is transmitted through line 7'. Detector 7 may be an electromagnetic detecting device which is adapted to pick up a recorded signal on piston 2, a photoelectric device or other well known position detecting devices as are used in the art.

A second detector and signal generator 8 is located adjacent output shaft 6 of the engine. Detector 8 detects the momentary or instantaneous angular location of the shaft and produces a continuous output signal which is representative of the instantaneous shaft position.

There is a predetermined shaft position with respect to detector 8 for every position of piston 2 so that when engine E is properly synchronized the signals from generators 7 and 8 will also be synchronized. To check and control this synchronization, the signals produced by generators 7 and 8 are transmitted through lines 7', 8', respectively, to a signal comparator means 9 which is adapted to generate an error signal if the signals from detectors 7 and 8 are not in synchronization, i.e., when piston 2 and shaft 6 are out of synchronization. The synchronization signal produced by comparator 9, which is of conventional construction, is utilized to control a liquid control member 10, which may be a slide valve or the like, so that liquid under pressure will either flow in the direction of the arrow, from a source 11 thereof, to conduit 4', or will flow out of the conduit 4', through control member 10, in the direction of arrow 12. Accordingly, the synchronization error signal will add or remove liquid from conduit 4' in order to adjust the position of piston 2 with respect to shaft 6 so that the piston and shaft are in perfect synchronization. Thus, is is seen that the system is adapted to maintain the angular position of the shaft 6 in synchronization with corresponding positions of piston 2.

It is a feature of the invention to locate piston 2 in predetermined positions independently of output shaft 6 in order to permit independent examination of the piston rings of the engine. Referring to FIG. 2 of the drawings, a diagram of the control system of the invention is illustrated, wherein it is seen that a switch 13 is provided between detector or generator 8 and a selectively operative electric signal generator 14. The signal generator is constructed to produce manually selectable signals corresponding to signals generated by detector 8, but it is adapted to develop only as many individual predetermined signals as there are piston rings on the piston. These signals each correspond to the signal generated by detector 8 when shaft 6 is in a synchronized position with the selected piston ring on the piston adjacent the air port or examining hole in the engine. As a result, when it is desired to examine the piston rings of the piston, switch 13 is actuated to connect signal generator 14 to the circuit and render detector 8 inoperative. Generator 14 is then adjusted to generate a signal corresponding to the position of the shaft 6 when one of the piston rings is adjacent the exhaust or inspection opening. Each of the possible selected signals to be generated by generator 14 corresponds to a position of the shaft at which one of the piston rings of piston 2 should be adjacent the inspection opening, if the engine were in operation and synchronized. If piston 2 is not in that position when generator 14 is connected to comparing means 9, the latter will produce a synchronization error signal causing control member 10 to operate until sufficient liquid is added or removed from the system so that piston 2 is brought to its "synchronized" position. At that point the signals produced by generators 7 and 14 will be synchronized and no error signal will be produced so that the piston is held in proper position for inspection. When the next piston is to be inspected, generator 14 is adjusted to produce the next signal and the device operates to move piston 2 to its next synchronized position. It is thus seen that the position of piston 2 can be varied for inspection of the piston rings independently of the location of shaft 6. As a result, shaft 6, and the propeller may be inspected in separate operations while the piston rings are being simultaneously examined. This is a substantial improvement over the inspection procedures which previously have been proposed in which inspection was limited only to sequential inspection of piston rings, the propeller shaft and propeller itself.

The advantages of the present invention are further illustrated in FIG. 3 wherein a schematic diagram of the detecting apparatus and comparators of the present invention are illustrated as they are utilized in a free-floating piston engine having a plurality of n driving pistons with independent piston detectors $7_1 - 7_n$, fluid controls $10_1 - 10_n$, and corresponding comparators $9_1 - 9_n$ connected therebetween, for controlling the slides or valves of liquid controls $10_1 - 10_n$. In this embodiment, the single signal generator 8 associated with driving shaft 6 may be switched over to the single control signal generator 14 so that all of the pistons are brought simultaneously and in parallel into their various positions for examining their piston rings.

Since the control apparatus of the present invention holds each piston in the position set on signal generator 14, regardless of the angular position of driving shaft 6, or of the position to which the shaft is turned in the meantime, any other desired examination can be made on the propulsion aggregate, i.e., the ship's propeller shaft. Accordingly, it is seen that these latter examinations may be performed quite independently of the examination of the piston rings so that unnecessary time is not lost in the examination procedures. Moreover, the pistons are readily and rapidly moved to the desired piston examination positions so that each of the piston rings can be examined sequentially without the necessity of turning over the engine shaft each time a different ring is to be examined.

Although an illustrative embodiment of the present invention has been described herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to that precise embodiment and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope or spirit of this invention.

What is claimed is:

1. A device for use in examining a free-floating piston engine having at least one piston and wherein power from said piston is transmitted to the power output shaft through a hydrostatic motion converter system including a supply of liquid contained between one end of said piston and a rotary converter secured to the output shaft, said device comprising means associated with said piston for producing an output signal in response to the momentary position of said piston, means associated with said output shaft for producing an output signal in response to the momentary angular position of said shaft, means for comparing said output signals and producing a synchronization error signal, fluid control means operatively connected to said comparator means for selectively adding liquid to or removing liquid from said hydrostatic converter system in response to said synchronizing error signal whereby the synchronization error between said piston and said shaft is reduced, an adjustable electric signal generator for selectively producing output signals corresponding to predetermined output shaft positions, and switch means for selectively connecting said comparator means to said signal generator and said output signal producing means associated with the shaft whereby said comparator means generates predetermined synchronization error signals when said signal generator is connected thereto, thereby to operate said fluid control means and move said piston to predetermined positions in accordance with the selected output signal of said signal generator.

2. The device as defined in claim 1 wherein said engine includes a plurality of pistons and said device includes an output signal producing means associated with each of said pistons to produce an output signal in response to the momentary position of its associated piston, and separate comparing means connected between each of said signal producing means associated with said pistons and said output signal producing means associated with said shaft.

3. The device as defined in claim 2 wherein said switch means is operatively connected to each of said comparing means whereby each of said comparing means is simultaneously connected to said signal generator upon operation of said switch.

4. The device as defined in claim 3 wherein the output signals produced by said generator correspond to predetermined positions of said pistons such that at each of said last mentioned positions a different piston ring is presented at a single location for inspection.

5. A device for use in examining the piston rings of free-floating piston engines wherein power from the pistons is transmitted to the power output shaft through a hydrostatic motion converter system, said device comprising, piston detector means associated with each of the pistons in said engine for producing output signals corresponding to the momentary position of its associated piston, shaft detector means for detecting the momentary angular position of said shaft and producing an output signal corresponding to said predetermined angular position; independent comparator means operatively connected to each of said piston detectors and said shaft detector for comparing the signals produced thereby and generating a synchronizing error signal for its associated piston, fluid control means operatively connected to said comparator means for selectively adding liquid to or removing liquid from said hydrostatic converter system in response to said synchronizing signal whereby the synchronization error between said pistons and said shaft is reduced, an adjustable signal generator for selectively producing output signals corresponding to predetermined engine output shaft positions, and switch means for selectively connecting said comparator means to said signal generator and said shaft detecting means, whereby when switched to said adjustable signal generator said comparator means generates predetermined synchronization error signals to operate said fluid control means and thereby move said pistons to predetermined positions in accordance with the selected output signals of said adjustable signal generator.

6. The device as defined in claim 5 wherein said switch means is operatively connected to each of said comparator means whereby each of said comparator means can be simultaneously switched to receive signals from said signal generator.

7. The device as defined in claim 6 wherein the output signals produced by said generator correspond to predetermined positions of said pistons wherein at each of said last mentioned positions a different piston ring is presented at a single location for inspection thereat.

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