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L. L. SALTER
TURBINE DRIVE

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2 Sheets-Sheet 1

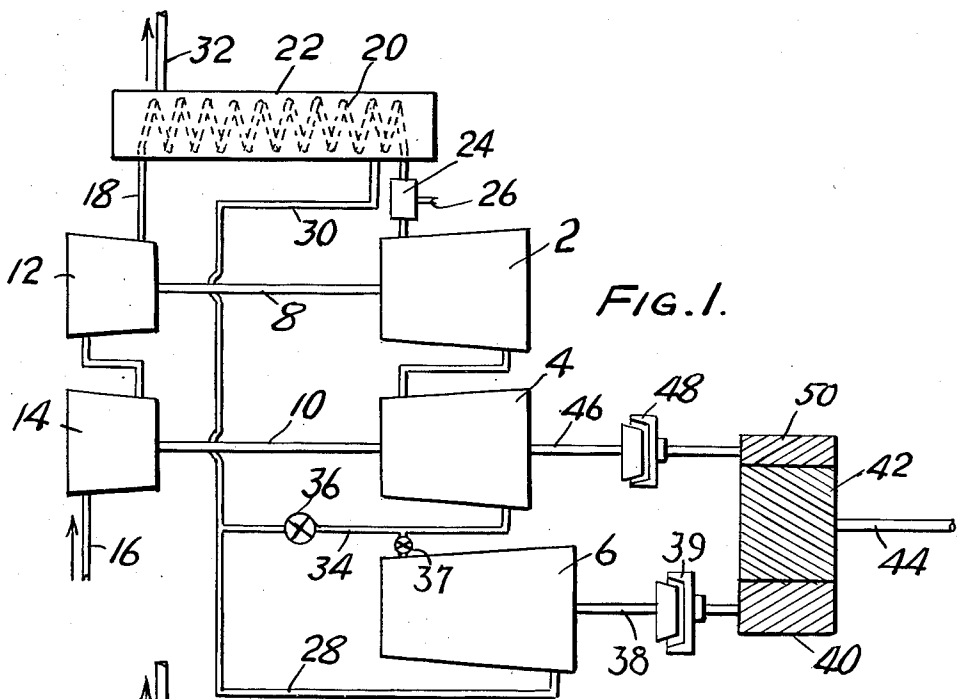


FIG. 1.

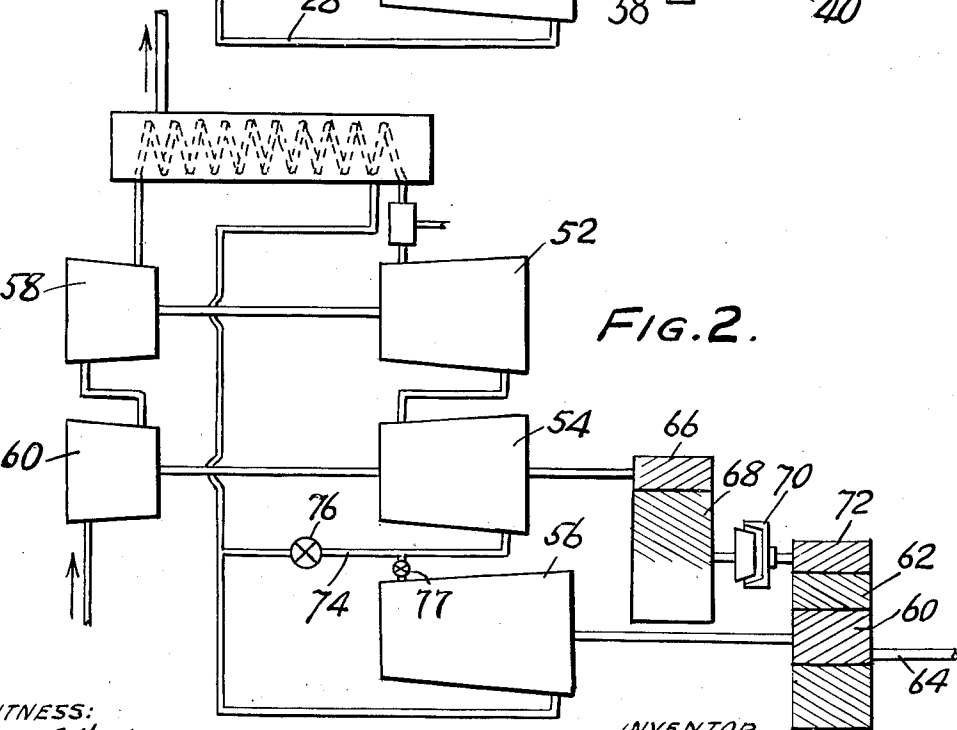


FIG. 2.

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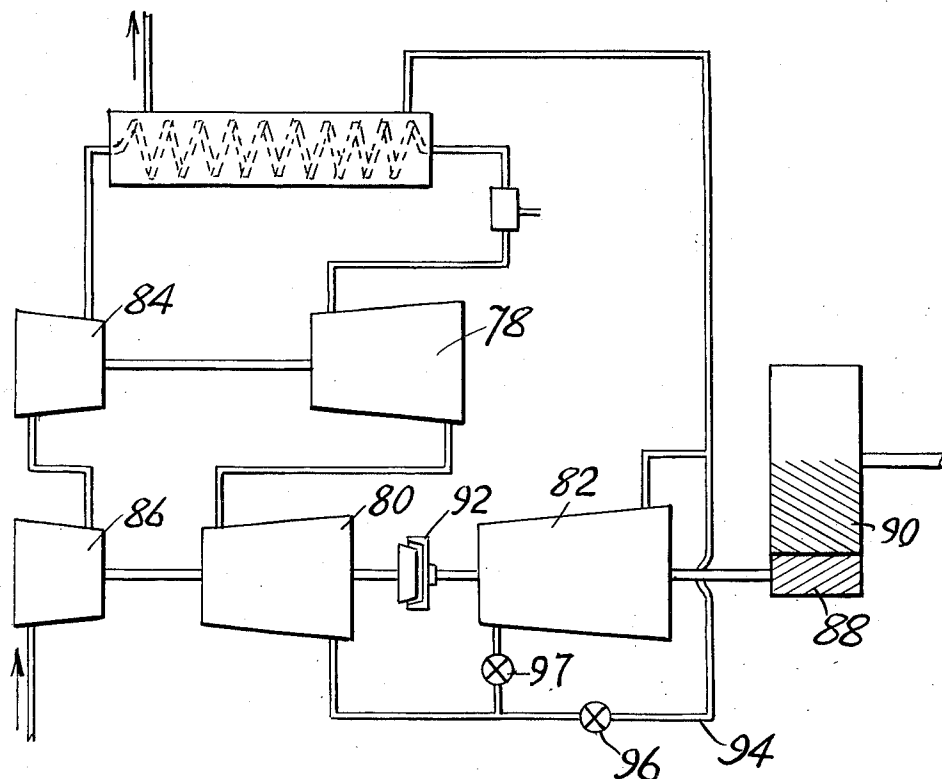


FIG. 3.

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UNITED STATES PATENT OFFICE

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TURBINE DRIVE

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1 Claim. (Cl. 60—39.16)

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This invention relates to a reversible turbine drive, particularly of the type adapted for marine propulsion.

Reversibility of a propeller for maneuvering is one of the requirements of a marine propulsion plant. While this requirement does not call for any special device in the case of piston-type machines, like diesels or steam engines, various means are required for securing reversibility in turbine propulsion units, since turbines are essentially non-reversible machines. Various schemes for reversibility have been used in the past including turbo-electric drive, turbo-hydraulic drive, variable pitch propellers, an astern turbine, astern stages in the forward turbine, and others. Generally speaking, all of these schemes require a considerable amount of additional machinery, and, furthermore, some of them are inherently of low efficiency.

The present invention relates to means for securing reversal of a propeller shaft with only a minimum of additional machinery over the basic propulsion plant and without impairing efficiency either at full or part loads. The invention is applicable to multi-shaft turbine propulsion plants, and particularly to gas turbine plants with direct gear drive. The foregoing general object of the invention, as well as other objects relating particularly to details, will become apparent from the following description read in conjunction with the accompanying drawings, in which:

Figure 1 is a diagram illustrating one embodiment of the invention and

Figures 2 and 3 are similar diagrams illustrating alternative embodiments.

Since the invention is particularly applicable to gas turbine plants, it will be described with reference thereto, though it is to be understood that the invention in its broader aspects is applicable to steam plants.

Referring first to Figure 1, high, intermediate and low pressure turbines are indicated at 2, 4 and 6 arranged in a series of stages. The high pressure turbine 2 drives through a shaft 8 the high pressure compressor 12, while the intermediate pressure turbine 4 drives through a shaft 10 the low pressure compressor 14. These turbines and compressors may be of any conventional type, and, consequently, need not be further described.

Air entering at 16 is compressed by the compressors 14 and 12 and delivered through the passage 18 to a heat exchanger of usual type conventionalized as an air coil 20 within a chamber 22. The compressed air passes from the heat exchanger to combustion chamber 24 to which

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fuel is introduced through a pipe 26. The products of combustion cooled by excess air or otherwise then pass in series to the turbines to drive the same. The exhaust gases from the last turbine flow through the passages 28 and 30 to the heat exchanger where they deliver up their residual heat content to the air and are discharged at 32. To the extent so far described, it will be recognized that there is provided a conventional gas turbine power plant and it may be understood that the simple diagrammed plant may comprise any conventional features of such plants.

The low pressure turbine 6 furnishes the drive for forward operation of the propeller; its shaft 38 driving the propeller shaft 44 through the reduction gearing 40 and 42. The shaft 38 may directly connect the turbine 6 and the reduction gearing, or, in some instances, for reasons hereafter stated, there may be interposed a clutch 39. In accordance with the present invention, the turbine 4 drives a gear 50 through a shaft 46 and releasable clutch 48, the direction of rotation of this turbine being such that when the clutch is engaged it will serve to drive the propeller shaft in a reverse direction. In combination with this arrangement, there is provided a by-pass 34 controlled by a valve 36 and directing exhaust gases from the intermediate pressure turbine 4 directly to the exhaust passage 30 by-passing the low pressure turbine 6. A valve 37 is provided to control flow of gas through the low pressure turbine.

During forward operation, the clutch 48 is disengaged so that the power plant operates in the usual fashion, the system operating at high efficiency with the turbine 6 driving the propeller shaft.

When reversal is required, the power turbine is cut out by opening the by-pass valve 36 and by partially closing valve 37 and the clutch is engaged, thus reversing the propeller.

With the power turbine by-passed, an increased enthalpy drop becomes available for the reverse turbine to provide the necessary excess energy from this turbine for astern propulsion. If no clutch is provided at 39, the turbine 6 would then be rotated idly in a direction opposite its usual rotation. In some cases this will be satisfactory, there being little loss involved in this idle rotation. However, in other cases, compression occurring in turbine 6 may involve substantial losses, making desirable the provision of a clutch 39 which, by disengagement, will permit the turbine 6 to remain stationary. The matter of

compression loss is particularly serious since if turbine 6 is permitted to operate in reverse direction, some flow of gas through valve 37 will generally be required to avoid excessive heating, and this flow involves still greater power consumption in the matter of rotation opposing it.

The arrangement illustrated in Figure 2 is fundamentally similar to that of Figure 1 but is applicable to higher speeds of turbine operation for which it would be difficult to provide a clutch directly connected to the turbine shaft. In this case, the turbines are indicated at 52, 54 and 56, and the compressors at 58 and 60. The lower pressure turbine again drives the propeller shaft 64 through the reduction gearing 60 and 62. However, the clutch 70 is interposed between the first reduction gearing 66 and 68 driven by the turbine 54 and the final reduction occurring between 72 and 62. In this case also the turbine 54 is driven so that when the clutch is connected the propeller shaft is reversed.

The by-pass 74 controlled by the valve 76 has the same function as in Figure 1. A valve 77 corresponds to valve 37 of Figure 1. The operation is essentially identical with the exception of the provision for lower speed of operation of the clutch. In this case, also, a clutch may be provided between the low pressure turbine and the reduction gearing to make possible avoidance of reverse operation of the low pressure turbine.

In the case of Figure 3, the turbines are indicated at 78, 80 and 82, and the compressors at 84 and 86. The turbines 80 and 82 are in line with a clutch 92 between them.

The shaft of turbine 82 drives the propeller shaft through the reduction gearing 88 and 90. A by-pass for the low pressure turbine 82 is provided at 94 controlled by the valve 96. A valve 97 controls inflow to the turbine 82.

During forward operation, the by-pass 94 is closed and the clutch is disengaged, the turbines 80 and 82 then rotating in opposite directions. To effect reversal, the by-pass 94 is opened and the clutch is engaged, whereupon the turbine 80 takes over the reverse drive, driving the rotor of

the turbine 82 idly in a reversed direction through the clutch 92.

It will be evident that the same principles may be adopted with other arrangements of the turbines, it being possible to utilize two turbines in the same general fashion with suitable by-pass and clutching arrangements. While the coupling is conventionalized as a cone clutch, it will, of course, be understood that there is desirably used a clutch of a type such as used in marine drive which will permit shockless connection, such as the usual hydraulic clutch.

What I claim and desire to protect by Letters Patent is:

In combination, a pair of turbines arranged in series, a compressor driven by the one of said turbines which is first in series, means for burning fuel in air compressed by said compressor and for directing the combustion gases to said turbines to drive the same, a shaft, connections through which said turbines may drive said shaft respectively in opposite directions, releasable clutches in said connections, one of said clutches being between one of the turbines and the shaft, and the other of said clutches being between the other of the turbines and the shaft, and means for bypassing at least the major portion of the driving gases from the second of said turbines.

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