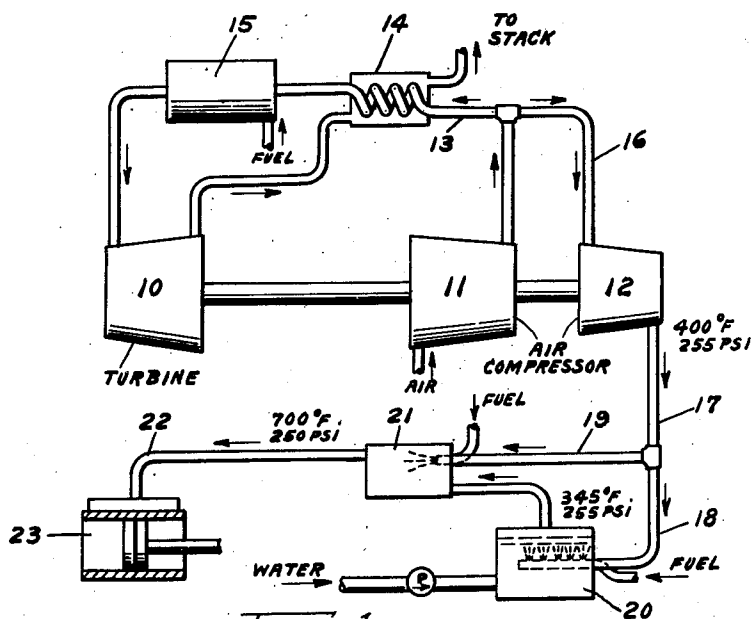
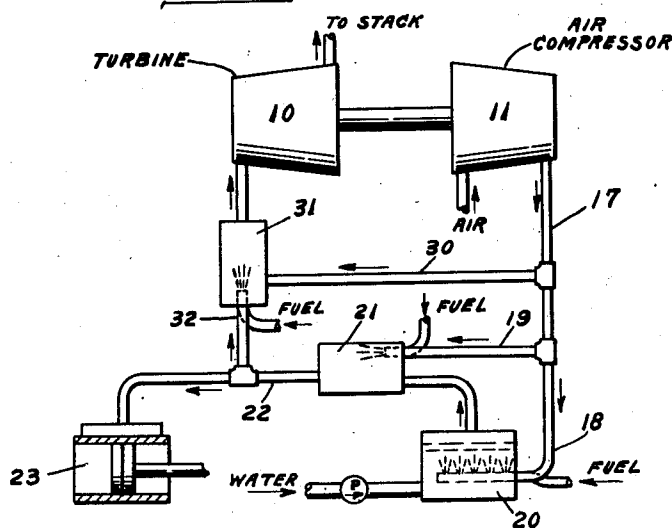


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A. WILLIAMS
RECIPROCATING ENGINE PLANT WITH GAS TURBINE
CYCLE AND SUBMERGED COMBUSTION BOILER
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ARTHUR WILLIAMS
INVENTOR.

BY *James F. Whalen*

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RECIPROCATING ENGINE PLANT WITH GAS
TURBINE CYCLE AND SUBMERGED COM-
BUSTION BOILERArthur Williams, Munster, Ind., assignor to Com-
bustion Engineering-Superheater, Inc., a cor-
poration of Delaware

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3 Claims. (Cl. 60-49)

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The present invention relates to power systems and particularly those in which a gas turbine operates in conjunction with a reciprocating engine.

It has already been proposed to operate a reciprocating engine from part of the gases produced in a gas turbine cycle. The invention contemplates operating such a reciprocating engine at a relatively high rate of efficiency while at the same time reducing the mass of rotating machinery ordinarily required in conventional gas turbine cycles. This is accomplished by employing the air compressed in a gas turbine cycle as primary air for the combustion of fuel in a submerged combustion boiler from which the steam and gas mixture is supplied to a reciprocating engine. The invention will be best understood upon consideration of the following detailed description of illustrative embodiments thereof when read in conjunction with the accompanying drawing in which:

Figure 1 is a diagrammatic view of a gas turbine plant combined with a submerged combustion boiler to operate a reciprocating engine in accordance with the present invention.

Figure 2 is a view similar to Figure 1 of a system utilizing a single stage of air compression instead of two stages as is shown in Figure 1.

In Figure 1, the gas turbine 10 drives the air compressors designated 11 and 12 in which air is compressed in two stages. A part of the air from the first stage compressor 11 is taken at say 380° F. and 65 p. s. i. by way of the branch duct 13 through the heat exchanger 14 to a combustion chamber 15 in which fuel is burned with the air to provide gases at say 1200° F. and 65 p. s. i. for operating the turbine 10. The remainder of the air compressed by the first stage compressor 11 passes through the branch duct 16 to the second stage compressor 12 and from the latter at higher pressure of 255 p. s. i. and 400° F. through the duct 17; the greater part of the compressed air is conveyed through duct 18 to serve as primary air for the combustion of fuel in the submerged combustion boiler 20 which may be of any desired form. From the boiler 20 the mixture of steam and gases at say 345° F. and 255 p. s. i. passes through the separately fired superheater 21 to which the remainder of the second stage compressed air at 255 p. s. i. from the compressor 12 is carried through the branch duct 19. From the superheater 21 the steam and gas mixture at a temperature at around 700° and a pressure of about 250 lbs. is carried through conduit 22 to the reciprocating engine 23 in which the

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steam and gas mixture expands to perform the useful work in the system.

In the form shown in Figure 2 a single air compressor 11 is employed; part of the air from the latter being supplied through the conduit 30 as primary air in a second separately fired superheater 31 which receives part of the steam and gas mixture through duct 32 from the superheater 21 and heats it to a still higher temperature in the neighborhood of 1200° for operating the turbine 10.

In both of the systems described above the thermal efficiency may not be quite as high as in a conventional gas turbine plant utilizing a regenerator but on the other hand they possess the advantage of permitting a reduction in the amount of rotating machinery required because the amount of air to be handled in these systems is less than in conventional gas turbine cycles. This is because the submerged combustion boiler and separately fired superheaters require only a relatively small amount of compressed air for use as primary air in burning the fuel while at the same time volume of the gas and steam mixture from the boiler 20 and the high temperatures attained by superheating it permit a greater amount of useful power to be obtained by expansion of the gas and steam mixture in the expansion or reciprocating engine 23, the mixture to the engine being made up of approximately two-thirds air and one-third steam which indicates the substantial reduction in the amount of air required. All of the compressed air is used for burning fuel in the submerged combustion boiler and in the superheaters. The quantity of air furnished need be only about 20% over the theoretical quantity for combustion while in a conventional gas turbine plant the air used is seven or eight times the combustion requirements in order that the gas temperature entering the turbine will not be too high. The reduction in the amount of reciprocating machinery required renders the systems described above practically suitable for use on locomotives or small boats where the space for the power installations is severely limited. Another important advantage of the systems described is that the submerged combustion boilers furnish heat storage in any desired quantity which is a useful quality in the operation of either locomotives or small high speed boats.

The temperatures and pressures indicated in the drawings are approximate and merely illustrative since such factors as pressure drops in

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the piping, have not been taken into consideration in each instance.

What I claim is:

1. In a power system including an air compressor, a combustion chamber, a gas turbine, means coupling said turbine to said compressor, means for branching off a portion of the air and heating it in said combustion chamber, means for admitting said heated air to the gas turbine; an expansion engine; a submerged combustion boiler; a separately fired superheater; fuel burning means for said boiler and superheater; means for supplying the remaining portion of the compressed air to said boiler and superheater as primary air; and means for conveying the steam and gaseous products of combustion from said boiler to said superheater and thence to the expansion engine.

2. In a power system including an air compressor, a combustion chamber, a gas turbine, means coupling said turbine to said compressor, means for branching off a portion of the air and heating it in said combustion chamber, means for admitting said heated air to the gas turbine; a submerged combustion boiler; a separately fired superheater; fuel burning means for said boiler and superheater; means for supplying the remaining portion of the compressed air to said boiler and superheater as primary air; a reciprocating expansion engine, means for admitting the steam and gaseous products of combustion from said boiler to said superheater and thence to the re-

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ciprocating expansion engine; and means for passing part of the superheated gaseous products of combustion and steam to said air heating means for admission to said turbine along with the heated part of said compressed air.

3. In a power system including an air compressor having means for compressing air in two stages, a combustion chamber, a gas turbine, means coupling said turbine to said compressor, means for branching off a portion of the air after the first compression stage, means for heating said branched off air stream in said combustion chamber and for admitting it to the gas turbine; a submerged combustion boiler; a separately fired superheater; fuel burning means for said boiler and superheater; means for supplying, after compression through the second stage, the remaining portion of the air to said boiler and superheater as primary air; a reciprocating expansion engine; and means for conveying the steam and gaseous products of combustion from said boiler to said superheater and thence to the reciprocating expansion engine.

ARTHUR WILLIAMS.

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The following references are of record in the file of this patent:

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