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ASME 3977-1—2000
(Identical to ISO 3977-1: 1997)

GAS TURBINES: PROCUREMENT

Part 1: General Introduction and Definitions

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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This Standard will be revised when the Society approves the issuance of a new edition. There will be no addenda issued to this edition.

ASME will issue written replies to inquiries concerning interpretations of technical aspects of this Standard.

The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

FOREWORD

The purpose of the ASME 3977 standards is to facilitate preparation of, and response to, gas turbine procurement specifications. They are generally applicable to gas turbines for electrical power generation and industrial generator and mechanical drive service.

Commencing in 1977, the B133 Standards Committee of ASME produced a set of gas turbine procurement specifications, covering all aspects of the process from specification preparation to maintenance and safety. In 1988 the International Standards Organization (ISO) established Technical Committee TC 192, Gas Turbines, which proceeded to develop a set of procurement specifications documented as ISO 3977. In view of the international nature of the gas turbine marketplace, the B133 Committee elected to support the ISO effort, and a Technical Advisory Group (TAG) under B133 was formed to coordinate this support.

Through the participation of the US TAG in the preparation of the ISO 3977 documents, the intent is to adopt the various parts of ISO 3977 as ASME standards.

The purpose of this Standard, Part 1: General Introduction and Definitions, is to provide a comprehensive, alphabetical list of technical terms pertinent to the ASME 3977 series of gas turbine standards.

ASME 3977-1–2000 is an identical national adoption of ISO 3977-1: 1997 and was approved as an American National Standard on June 7, 2000.

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Gas Turbine Procurement

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Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Interpretations. Upon request, the B133 Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the B133 Standards Committee.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his/her request in the following format:

Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings, which are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in this format will be rewritten in this format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

Attending Committee Meetings. The B133 Standards Committee regularly holds meetings, which are open to the public. Persons wishing to attend any meeting should contact the Secretary of the B133 Standards Committee.

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INTRODUCTION

ASME 3977 provides technical information to be used for the procurement of gas turbine systems, including combined-cycle systems and their auxiliaries, by a purchaser from a manufacturer.

NOTE: Where the term "manufacturer" is used in this Standard, it is deemed to mean the gas turbine manufacturer or the appropriate responsible contractor.

This Standard provides a basis for the submission of proposals in line with the different environmental and safety requirements. It also specifies, wherever possible, criteria to establish whether these are met. It does not attempt to deal with local or national legal requirements to which the installation may be required to conform.

Because of the very widely varying operating modes for gas turbines in practice, distinct categories of operating modes are specified with which a "standard" rating can be associated. These ratings are made on the basis of the ISO standard ambient reference conditions.

The various parts of ASME 3977 define a standard framework for dealing with questions of fuel and other matters, such as the minimum information to be provided by both the purchaser and the manufacturer. They do not, however, purport to include all necessary information for a contract and each gas turbine installation should be considered in its entirety. Attention is drawn to the need for technical consultation between the manufacturer and the purchaser to ensure compatibility of equipment being supplied, particularly where the responsibility for supply is divided.

ASME 3977 is applicable to open-cycle gas turbine power plant using combustion systems, and to closed-cycle, semiclosed-cycle, and combined-cycle gas turbine power plants. In the case of turbines using free piston gas generators or special heat sources (e.g., chemical process, nuclear reactors, furnaces for super-charged boilers), it may be used as a basis but will need to be suitably modified.

This Standard is not applicable to gas turbines used to propel aircraft, road construction and earth-moving machines, agricultural and industrial types of tractors, and road vehicles.

GAS TURBINES: PROCUREMENT

PART 1: GENERAL INTRODUCTION AND DEFINITIONS

1 SCOPE

This Part of ASME 3977 groups together the terms and definitions given in ISO 11086 that are relevant to the procurement of gas turbine systems, and defines additional terms.

2 DEFINITIONS

For the purposes of all parts of ASME 3977, the following definitions apply.

2.1

gas turbine: machine which converts thermal energy into mechanical work; it consists of one or several rotating compressors, a thermal device(s) which heats the working fluid, one or several turbines, a control system, and essential auxiliary equipment. Any heat exchangers (excluding waste exhaust heat recovery exchangers) in the main working fluid circuit are considered to be part of the gas turbine.

NOTE: Examples of gas turbine systems are shown in Figs. 1 through 9.

2.2

gas turbine power plant: gas turbine engine and all essential equipment necessary for the production of power in a useful form (e.g., electrical, mechanical, or thermal). [ISO 11086]

2.3

open cycle: thermodynamic cycle in which the working fluid enters the gas turbine from the atmosphere and is discharged into the atmosphere. [ISO 11086]

2.4

closed cycle: thermodynamic cycle having a recirculating working fluid independent of the atmosphere. [ISO 11086]

2.5

semiclosed cycle: thermodynamic cycle utilizing combustion in a working fluid that is partially recirculated and partially exchanged with atmospheric air. [ISO 11086]

2.6

simple cycle: thermodynamic cycle consisting only of successive compression, combustion, and expansion. [ISO 11086]

2.7

regenerative cycle: thermodynamic cycle employing exhaust heat recovery, consisting of successive compression, regenerative heating, combustion, expansion, and regenerative cooling (heat transfer from the exhaust to the compressor discharge fluid) of the working fluid. [ISO 11086]

2.8

intercooled cycle: thermodynamic cycle employing cooling of the working fluid between stages of successive compression. [ISO 11086]

2.9

reheat cycle: thermodynamic cycle employing the addition of thermal energy to the working fluid between stages of expansion.

2.10

combined cycle: thermodynamic cycle employing the combination of a gas turbine cycle with a steam or other fluid Rankine cycle.

NOTES:

(1) In a common example, the gas turbine exhaust heat is used to generate steam for the Rankine cycle.

(2) The superior thermal performance of this cycle is due to a combination of the best thermodynamic attributes of each cycle,

namely the addition of thermal energy at higher temperatures in the gas turbine cycle and the rejection of thermal energy at lower temperatures in the Rankine cycle. [ISO 11086]

2.11

single-shaft gas turbine: gas turbine in which the compressor and turbine rotors are mechanically coupled and the power output is taken either directly or through gearing.

2.12

multishaft gas turbine: gas turbine combination including at least two turbines working on independent shafts.

NOTE: The term includes cases referred to as compound and split-shaft gas turbines.

2.13

bled gas turbine: gas turbine which has, for external use, extraction of compressed air between compressor stages and/or at the discharge of the compressor, or extraction of hot gas at the inlet of the turbine and/or between turbine stages.

2.14

gas generator: assembly of gas turbine components that produces heated pressurized gas to a process or to a power turbine.

NOTE: It consists of one or more rotating compressor(s), thermal device(s) associated with the working fluid, and one or more compressor-driving turbine(s), a control system and essential auxiliary equipment. [ISO 11086]

2.15

compressor: that component of a gas turbine which increases the pressure of the working fluid.

2.16

turbine: term which when used alone refers to the turbine action only. It is that component of the gas turbine which produces power from expansion of the working fluid.

2.17

power turbine: turbine having a separate shaft from which output is derived.

2.18

combustion chamber (primary or reheat): heat source in which the fuel reacts to increase directly the temperature of the working fluid.

2.19

working fluid (gas or air) heater: heat source in which the temperature of the working fluid is increased indirectly.

2.20

regenerator/recuperator: different types of heat-exchanger, transferring heat from the exhaust gas to the working fluid before it enters the combustion chamber.

2.21

precooler: heat-exchanger or evaporative cooler which reduces the temperature of the working fluid prior to its initial compression. [ISO 11086]

2.22

intercooler: heat-exchanger or evaporative cooler (spray intercooler) that reduces the temperature of the working fluid between stages of compression. [ISO 11086]

2.23

overspeed trip: control or trip element which immediately activates the overspeed protection system when the rotor speed reaches a preset value. [ISO 11086]

2.24

control system: general system used to control, protect, monitor, and report the condition of the gas turbine in all of its modes of operation.

NOTE: This includes starting control systems, governor and fuel control systems, speed indicator(s), gauges, electrical supply controls and other controls necessary for the orderly startup, stable operation, shutdown, tripping and/or shutdown for abnormal conditions, and standby operation. [ISO 11086]

2.25

governing system: control elements and devices for the control of critical parameters such as speed, temperature, pressure, power output, etc.

2.26

fuel governor valve: valve or any other device operating as a final fuel-metering element controlling the fuel input to the gas turbine.

NOTE: Other means of controlling the fuel flow to the turbine are possible.

2.27

fuel stop valve: device which, when actuated, shuts off all fuel flow to the combustion system.

2.28

dead band: total range through which an input can be varied with no resulting measurable corrective action of the fuel flow controller. In the case of speed, dead band is expressed in percent of rated speed.

2.29

governor droop: steady-state speed changes produced by the change of output from zero to the rated output, expressed as a percentage of the rated speed.

2.30

overtemperature detector: primary sensing element that is directly responsive to temperature and which immediately activates, through suitable amplifiers or converters, the overtemperature protection system when the temperature reaches a preset value. [ISO 11086]

2.31

fuel specific energy (calorific value): gross specific energy is the total heat released per unit mass of fuel burned, expressed in kilojoules per kilogram. The net specific energy is the gross specific energy less the heat absorbed by the vaporized water formed during combustion. It is expressed in kilojoules per kilogram.

2.32

heat rate: ratio of the net fuel energy supplied per unit time to the net power produced in kilojoules per kilowatt hour [kJ/(kW·h)]. [ISO 11086]

NOTE: The rate is based on the net specific energy of the fuel including the sensible heat above 15°C (59°F) (see also ISO 2314: 1989, 8.2.3).

2.33

specific fuel consumption: ratio of the mass flow of fuel to the net power output in kilograms per kilowatt hour [kg/(kW·h)] of the specified fuel. [ISO 11086]

2.34

thermal efficiency: ratio of the net power output to the heat consumption based on the net specific energy of the fuel.

NOTE: See also ISO 2314: 1989, 8.2.2 and 8.3.3e.

2.35

reference turbine inlet temperature: mean temperature of the working fluid immediately upstream of the first stage stator vanes.

NOTE: For method of determination, see ISO 2314: 1989, 8.6.

2.36

self-sustaining speed: minimum speed at which the gas turbine operates, without using the power of the starting device, under the most unfavorable ambient conditions.

2.37

idling speed: speed designated by the manufacturer at which the turbine will run in a stable condition and from which loading or shutdown may take place.

2.38

maximum continuous speed: upper limit of the continuous operating speed of the gas turbine output shaft.

2.39

rated speed: speed of the gas turbine output shaft at which the rated power is developed.

2.40

turbine trip speed: speed at which the independent emergency overspeed device operates to shut off fuel to the gas turbine. [ISO 11086]

2.41

steam and/or water injection: Steam and/or water injected into the working fluid to increase the power output and/or to reduce the content of oxides of nitrogen (NO_x) in the exhaust.

2.42

mass-to-power ratio (mobile applications): ratio of the total dry mass of the gas turbine elements (in accordance with 2.1) to the power of the gas turbine, expressed in kilograms per kilowatt.

NOTE: See also ASME 3977-2.

2.43

compressor surge: an unstable condition characterized by low-frequency fluctuations in mass flow of the working fluid in the compressor and in the connecting ducts.

3 REFERENCES

The following is a list of publications referenced in this Standard.

ISO 2314: 1989, Gas Turbines — Acceptance Tests
ISO 11086: 1996, Gas Turbines — Vocabulary
Publisher: International Organization for Standardization (ISO), 1 rue de Varembé, Case Postale 56 CH-1211, Genève 20, Switzerland/Suisse

ASME 3977-2-2000, Gas Turbines: Procurement, Part 2: Standard Reference Conditions and Ratings
Publisher: The American Society of Mechanical Engineers (ASME International), Three Park Avenue, New York, NY 10016

Key
1 Compressor
2 Combustion chamber
3 Turbine
4 Load

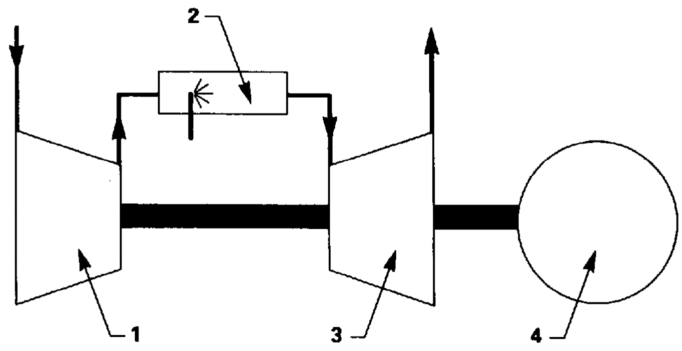


FIG. 1 SIMPLE CYCLE, SINGLE-SHAFT GAS TURBINE

Key
1 Regenerator or recuperator
2 Combustion chamber
3 Compressor
4 Turbine
5 Load

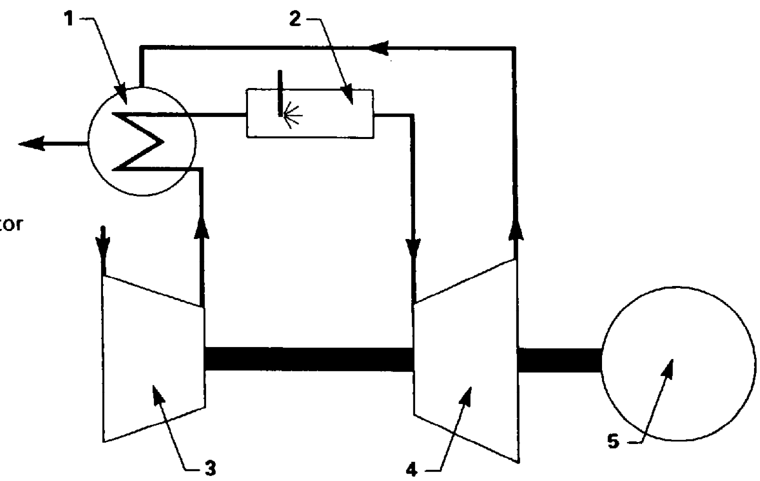
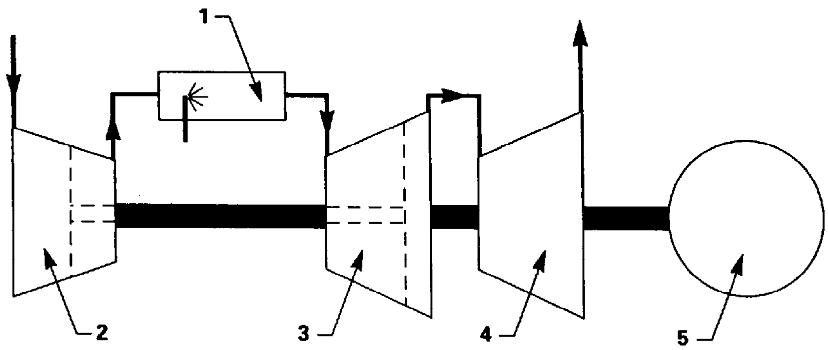


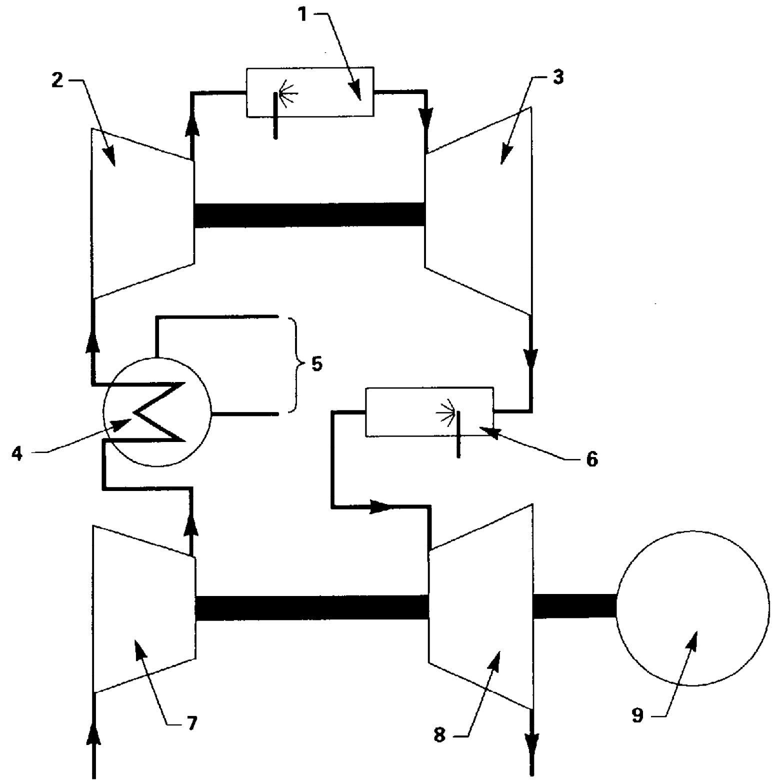
FIG. 2 REGENERATIVE CYCLE, SINGLE-SHAFT GAS TURBINE

Key
1 Combustion chamber
2 Compressor
3 Compressor turbine
4 Power turbine
5 Load



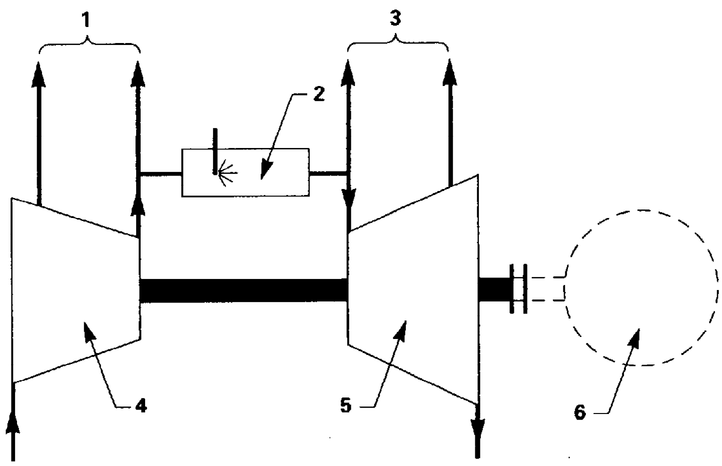
GENERAL NOTE: Alternative twin-spool arrangement is shown in dotted lines.

FIG. 3 SIMPLE CYCLE, SPLIT-SHAFT GAS TURBINE (i.e., WITH SEPARATE POWER TURBINE)



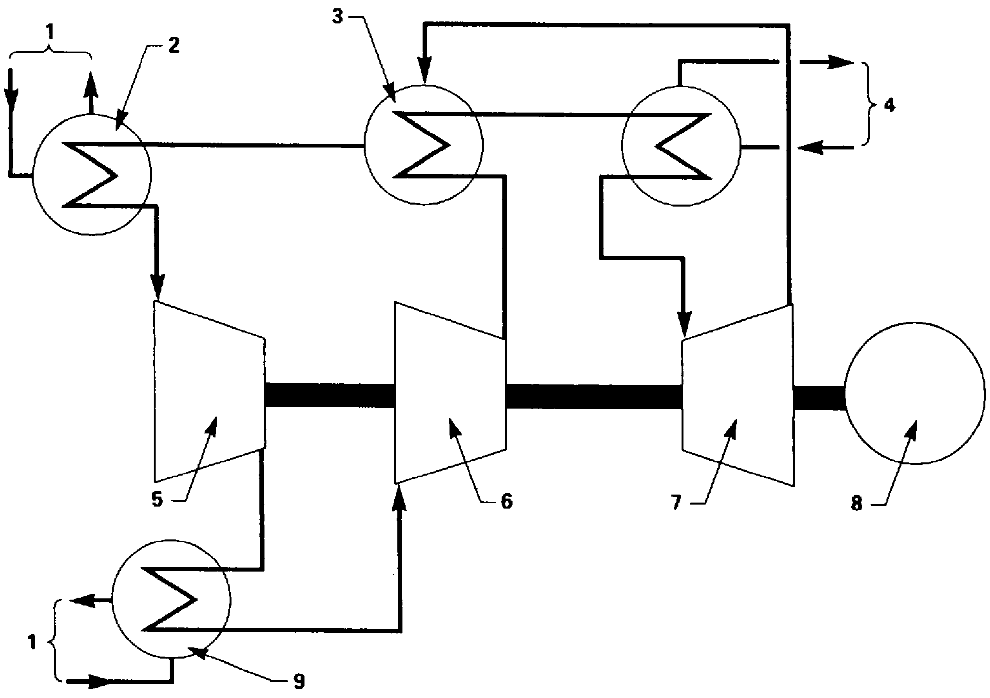
Key
1 Combustion chamber
2 H.P. compressor
3 H.P. turbine
4 Intercooler
5 Coolant
6 Reheat combustion chamber
7 L.P. compressor
8 L.P. turbine
9 Load

FIG. 4 INTERCOOLED AND REHEAT CYCLE (COMPOUND TYPE), MULTISHAFT GAS TURBINE WITH LOAD COUPLED TO LOW-PRESSURE SHAFT



Key
1 Air bleed
2 Combustion chamber
3 Hot gas bleed
4 Compressor
5 Turbine
6 Load

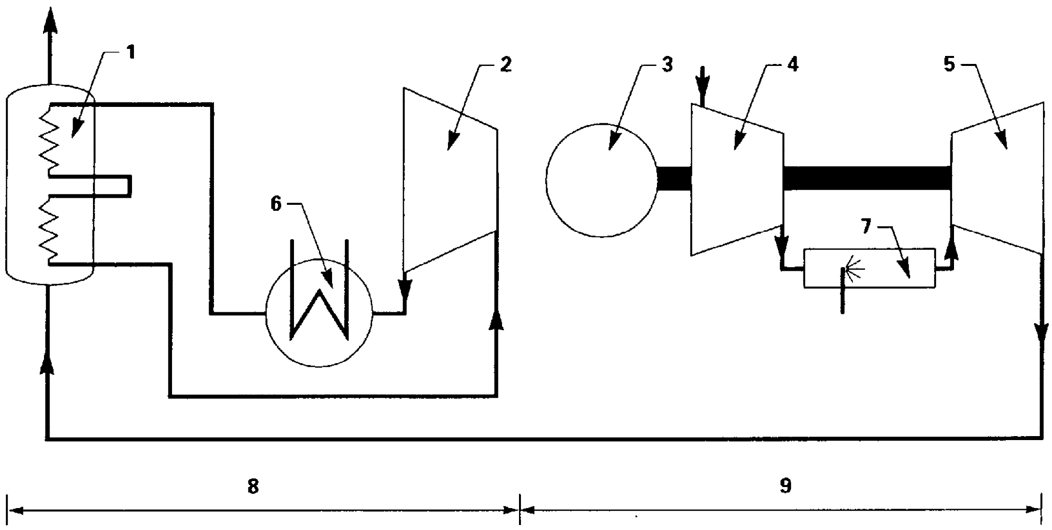
FIG. 5 SINGLE-SHAFT GAS TURBINE WITH AIR BLEED AND HOT GAS BLEED



Key

1 Coolant
2 Precooler
3 Working fluid heaters
4 Heat source
5 L.P. compressor
6 H.P. compressor
7 Turbine
8 Load
9 Intercooler

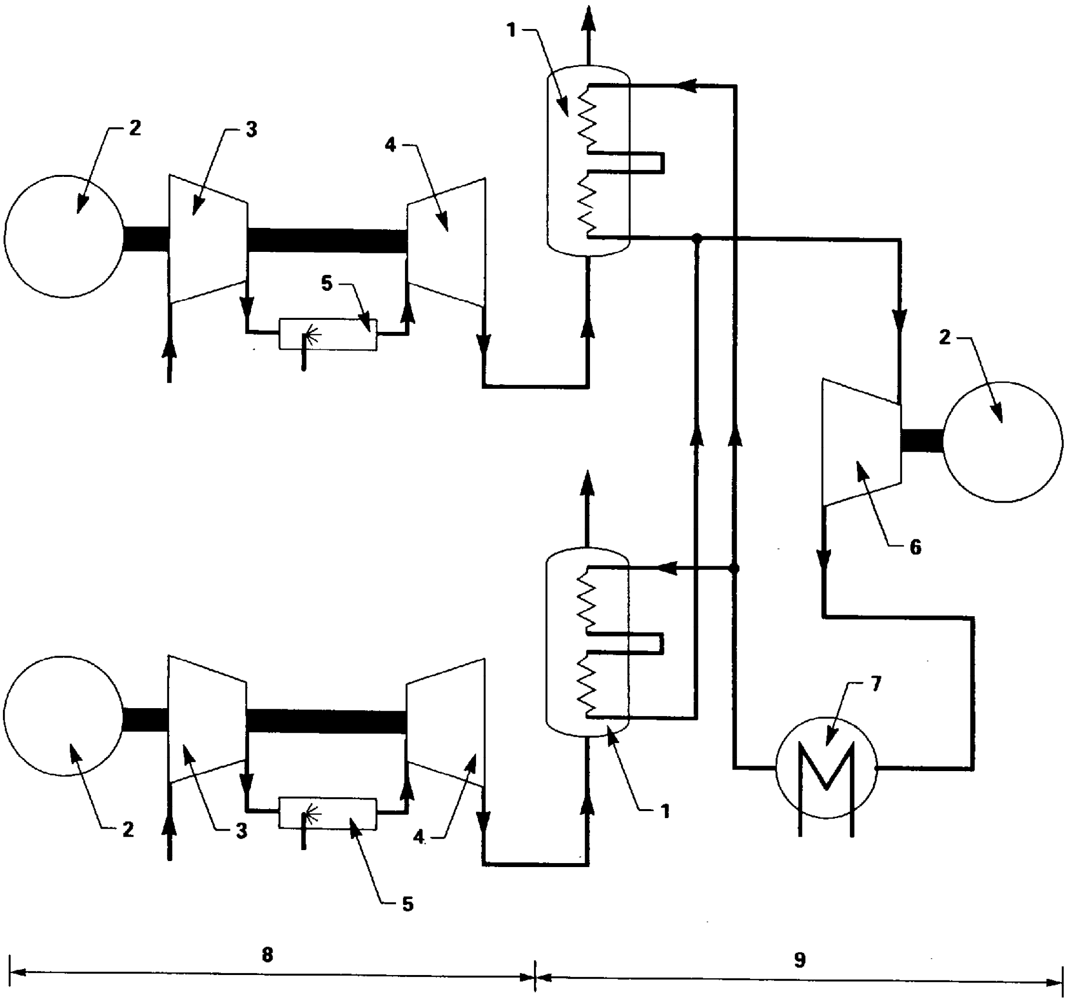
FIG. 6 SINGLE-SHAFT CLOSED-CYCLE GAS TURBINE



Key

1 Waste heat recovery boiler
2 Steam turbine
3 Load
4 Compressor
5 Turbine
6 Condenser
7 Combustion chamber
8 Steam turbine section
9 Gas turbine section

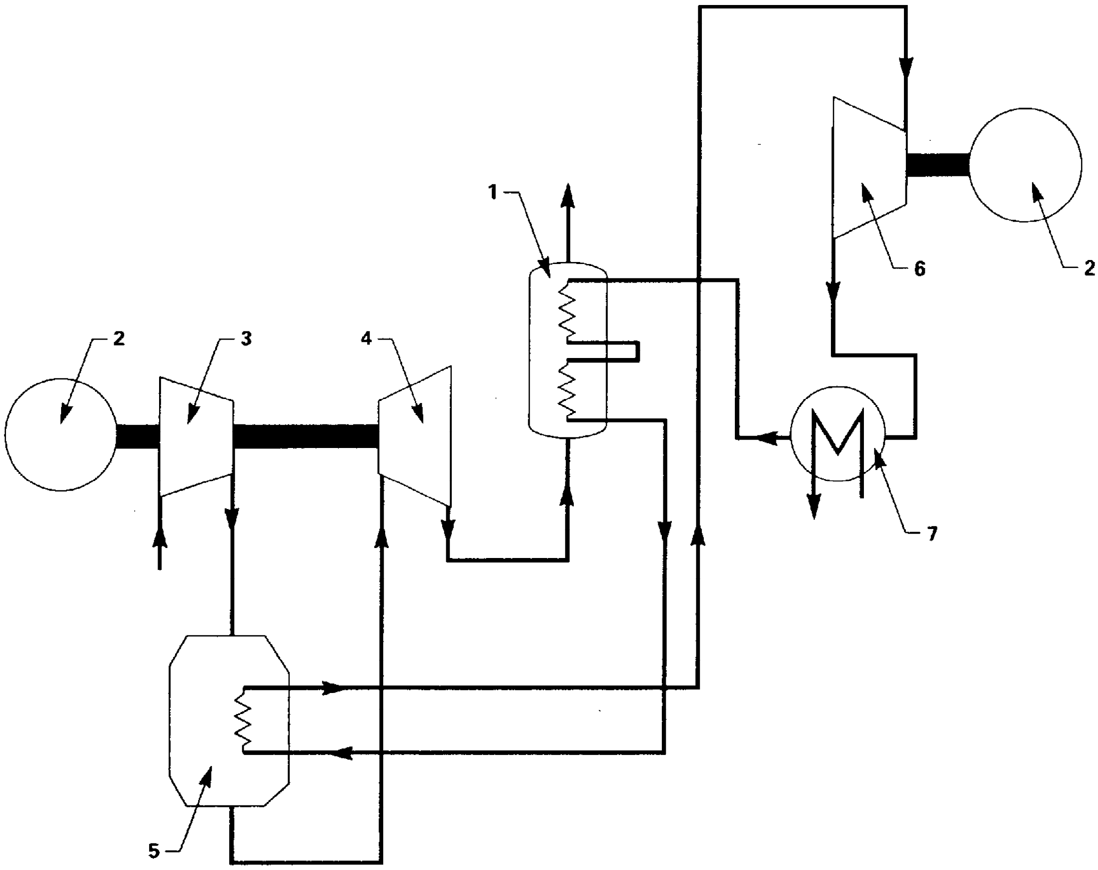
FIG. 7 SINGLE-SHAFT TYPE, COMBINED CYCLE



Key

1 Waste heat recovery boiler
2 Load
3 Compressor
4 Turbine
5 Combustion chamber
6 Steam turbine
7 Condenser
8 Gas turbine section
9 Steam turbine section

FIG. 8 MULTISHAFT TYPE, COMBINED CYCLE (CONFIGURATION WITH TWO GAS TURBINES AND ONE STEAM TURBINE)



Key

1 Waste heat recovery boiler
2 Load
3 Compressor
4 Turbine
5 PFB combustor
6 Steam turbine
7 Condenser

FIG. 9 COMBINED-CYCLE GAS TURBINE WITH PRESSURIZED FLUIDIZED BED (PFB) COMBUSTOR

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