

**P9005****TWO SHAFT GAS TURBINE UNIT****INTRODUCTION**

Gas turbines are becoming increasingly used as power plants for a wide variety of applications around the world. Originally they were developed solely for aircraft propulsion where their inherent low specific weight (i.e. mass/unit power) made them essential for high speed flight. For this particular purpose they have been developed to a high degree of efficiency both thermodynamically and mechanically.

Due partly to the impetus from the aircraft engine field and also to other significant operational advantages, industrial gas turbines have been and are being developed for such diverse applications as electrical power peak lopping stations, firefighting pump sets, natural gas pumping and compressor units, factory power and process heating plants, heavy lorry propulsion, rail and ship propulsion.

Cussons have designed and manufactured educational gas turbines since 1970 and the latest version incorporates many improvements.

Cussons P9005 Gas Turbine Unit is now offered as a full two shaft machine with built in starting equipment, power absorption system and data logging option (P9008). It provides the means for carrying out an extensive programme of experiments in gas turbine technology using only the instrumentation provided.

Particular features of the Two Shaft Gas Turbine Unit are its versatility, ease of operation, safety and low noise level. All instrumentation and controls are carried on the panel which displays the flow diagram with a clear indication of all measurements identified by symbols and illuminated tell-tales. Measurement of power turbine torque is by calibrated electrical dynamometer.

EXPERIMENTAL CAPABILITY

Allows an extensive programme of experiments in Gas Turbine technology including:

- Performance of a simulated single shaft unit
- Performance of a single shaft unit with nozzle simulated load (with thrust nozzle option - availability on request).
- Performance of a two shaft unit
- Characteristics of individual components
 - Gas generator compressor
 - Combustion chamber characteristics
 - Power turbine characteristics
 - Gas Generator Turbine Efficiency
 - Overall Plant Efficiency

**FEATURES**

- Self-contained complete teaching facility
- Designed for safe easy operation with low noise levels
- Data logging option available for all measured variables
- Comprehensive controls and instrumentation displayed in multi-colour flow diagram

GENERAL DESIGN

The Two Shaft Gas Turbine employs a centrifugal compressor and a radial turbine, arranged back to back on a common shaft which together with a gas-fuelled combustion chamber operating on propane or butane, form the gas generator.

ASSEMBLY

The complete unit is built on a robust steel chassis mounted on castors, carrying a melamine laminate instrument panel and steel clad panels.

The overall dimensions permit the unit to pass through any normal doorway and special attention has been paid to the requirements of easy installation, low noise level,



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FUEL SYSTEM

In temperate climates propane and in tropical climates butane, or mixtures of the two supplied in bottles, form the fuel supply to the unit. The use of bottled gas is particularly convenient and also is a significant safety feature as large quantities of fuel cannot build up in the system in the event of non-light up. Stable combustion conditions are reached very quickly, and due to the small pressure excess necessary to inject the fuel, any over speeding of the unit will cause drop in fuel mass flow and provide worthwhile governing action.

- A - Inlet Air Silencer
- B - Compressor
- C - Combustion Chamber
- D - Gas Generator Turbine
- E - Power Turbine
- F - Exhaust Silencer
- G - Starting Air Compressor
- H - Dynamometer
- I - Oil Reservoir
- J - Oil Pump
- K - Oil Cooler
- L - Mains Electrical Input

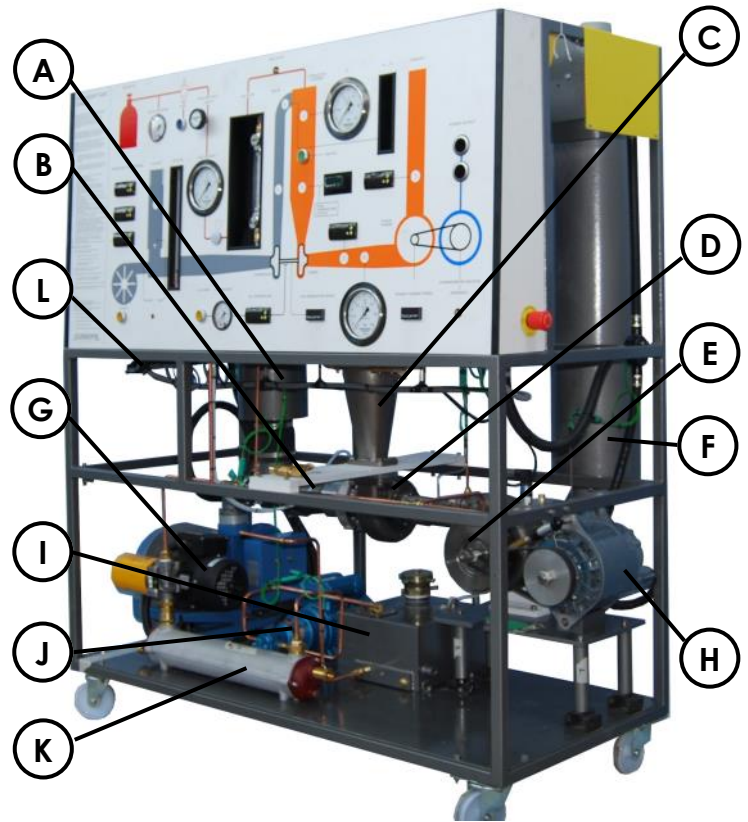


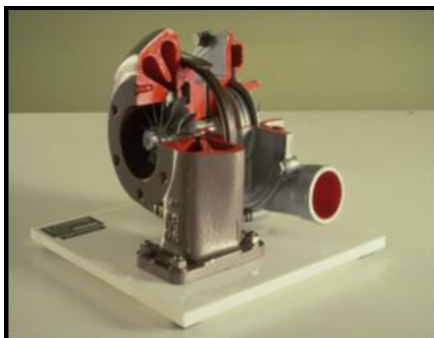
Figure: Front View Of Two Shaft Gas Turbine Unit

COMPRESSOR/TURBINE SYSTEM

The compressor is formed in light alloy and operates at a pressure ratio of approximately 2:1. The combustion chamber operates at high efficiency and permits stable operation over a wide range of mass flows with an even temperature distribution. The gas generator turbine operates over the speed range of 600 to 1400 rev/second according to fuelling with the power turbine operating over the range 170 to 590 rev/second and developing a maximum power of about 4 kW.

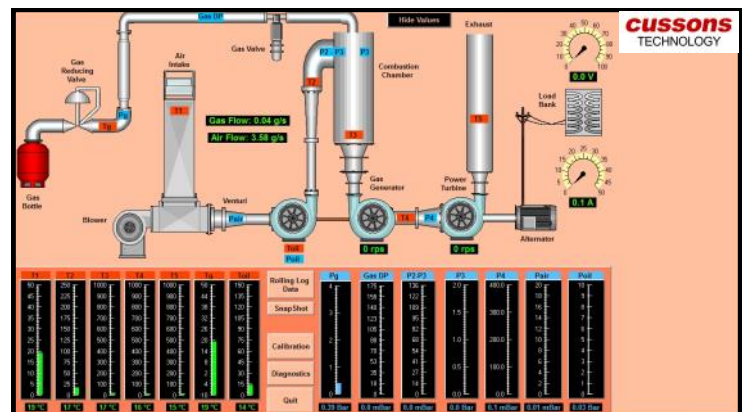
P9007 SECTIONED COMPRESSOR/TURBINE UNIT

Compressor/Turbine Unit similar to Gas Generator supplied on P9005 sectioned to show all functions and mounted on base.



P9008 DATA LOGGING OPTION INCLUDING SIGNAL CONDITIONING, PC AND SOFTWARE

Factory-fitted option for P9005 to provide signals for 15 measured variables comprising additional dc power supply, 4 pressure transducers, 3 differential pressure transducers, fuel orifice, rms voltage and current sensing modules and an additional printed circuit board, plus all necessary wiring, piping and connections.



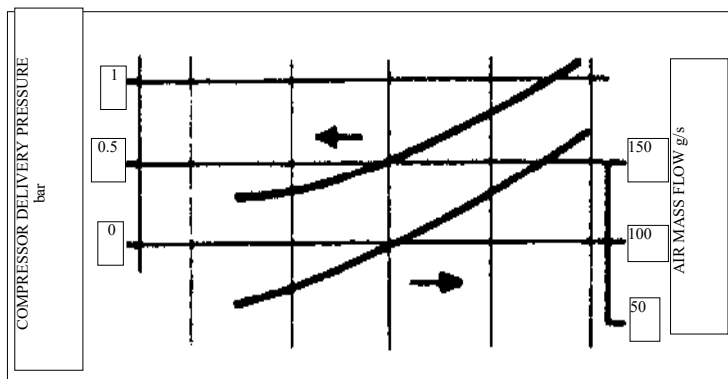
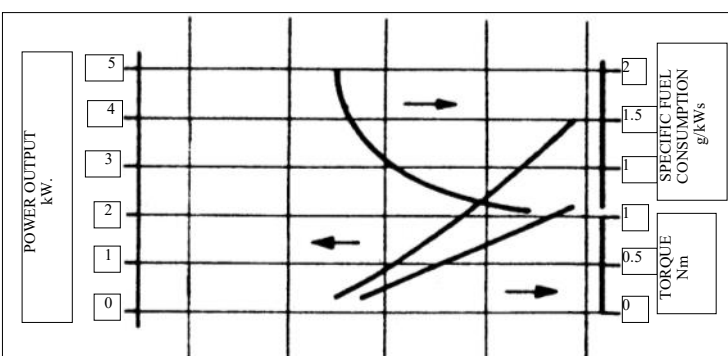
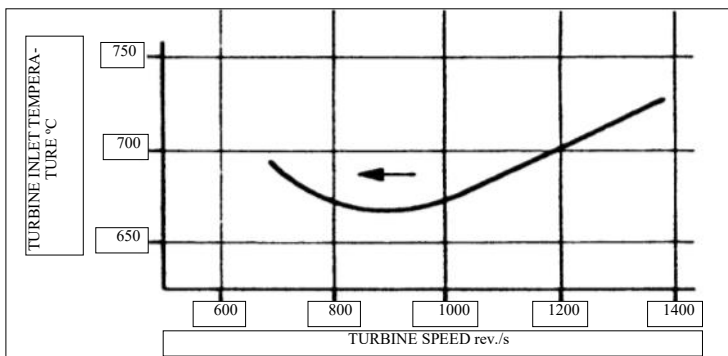
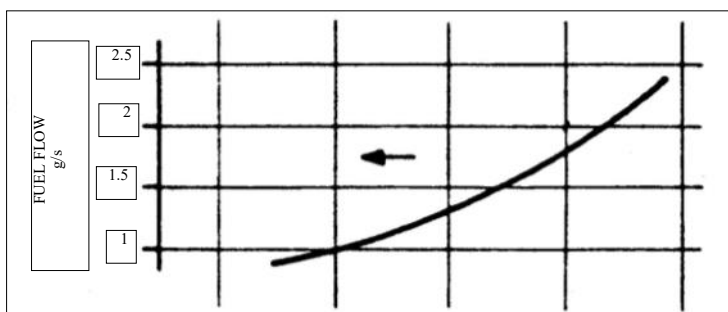


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TWO SHAFT GAS TURBINE UNIT

OPERATING INSTRUCTIONS AND A SUGGESTED PROGRAMME OF EXPERIMENTAL WORK

Complete operating instructions are provided with each unit and a comprehensive test programme is described in Cussons publication 'A First Course in Gas Turbine Technology' by T.H. Frost. Graphs of typical test results are shown in figures below.



TECHNICAL SPECIFICATIONS

P9005 TWO SHAFT GAS TURBINE UNIT

FEATURES

- [1] Self-contained complete teaching facility
- [2] Designed for safe easy operation with low noise levels
- [3] Data logging option available for all measured variables
- [4] Comprehensive controls and instrumentation displayed in multi-colour flow diagram

EXPERIMENTAL CAPACITY / TEACHING OBJECTIVES

- [1] Performance of a simulated single shaft unit
- [2] Performance of a two shaft unit
- [3] Characteristics of individual components: gas generator compressor, combustion chamber characteristics, power turbine characteristics.

INSTRUMENTATION

- [1] Measure temperatures and pressures throughout the cycle
- [2] Flow rates of air
- [3] Rotational speeds of the compressor/turbine unit
- [4] Power turbine output torque
- [5] 7 Temperatures measurement NiCr/NiAl thermocouple
- [6] fitted inlet air flow meter
- [7] fuel flow meter
- [8] two tachometers (2)
- [9] multi-point thermocouple instrument
- [10] three sensitive pressure gauges (3)

SPECIFICATIONS

- [1] self-contained moveable stand
- [2] melamine laminate instrument panel and steel clad panels
- [3] single shaft compressor/turbine
- [4] combustion chamber for operation on propane, butane or propane/butane mixtures
- [5] power absorption system and data logging
- [6] calibrated electrical machine for torque and power measurement
- [7] circulating pump
- [8] cooler and filter
- [9] five colour instrument panel with flow diagram
- [10] oil pressure gauge and fuel supply pressure gauge
- [11] air compressor set
- [12] tropicalized for use in conditions up to 40°C ambient and 80% relative humidity
- [13] Consumption at full load approx. 7 kg/hr.



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TECHNICAL DATA

COMPRESSOR/TURBINE SYSTEM

- [1] Compressor is formed in light alloy
- [2] Pressure ratio of 2:1
- [3] Gas generator turbine 600 to 1400 rev/second
- [4] Fuelling power turbine 170 to 590 rev/second
- [5] Maximum power of 4 kW.

SAFETY PROTECTION

- [1] Solenoid valve cuts the fuel supply for malfunction
- [2] Protected against over temperature, lubricating oil pressure failure and mains failure
- [3] The compressor/turbine speed limited
- [4] Components shielded
- [5] Steel front panel or transparent polycarbonate

LUBRICATION SYSTEM

- [1] Continuous circulation lubricating system
- [2] Oil system in an oil tank
- [3] Separated driven gear pump
- [4] Oil filter and water cooled oil heat exchanger
- [5] Low viscosity monograde oil with an anti-oxidant additive
- [6] Operating pressure 400 to 450 Kpa (4 – 4.5 bar)
- [7] Oil cooler temperature maintained at 80°C.

P9008 SYSTEM FOR DATA ACQUISITION

TRANSDUCER AND SIGNAL CONDITIONING FOR DATA LOGGING:

Temperatures (7)

- [1] T1 air inlet
- [2] T2 compressor exit
- [3] T3 combustion chamber exit
- [4] T4 power turbine inlet
- [5] T5 power turbine outlet
- [6] Tg fuel
- [7] To oil

Pressures (5)

- [1] 0 – 1600 KPa (0 – 16 bar) Gas Bottle supply indicator
- [2] 0 – 400 KPa (0 – 4 bar) Combustion chamber inlet gas pressure
- [3] 0 – 250 KPa (0 – 2 bar) Combustion chamber pressure
- [4] 0 – 40 KPa (0 – 0.4 bar) Power Turbine inlet pressure
- [5] 0 – 10 cmHg Combustion chamber pressure loss
- [6] 0 – 1000 KPa (0 – 10 bar) Lubricating oil pressure

Flow rates (2)

- [1] Air 0 – 200 mmH2O
- [2] Fuel 0.4 – 3.3 g/s

Speeds (2)

- [1] Gas generator 0 – 2000 rps
- [2] power turbine 0 – 800 rps

DC Measurement

- [1] Alternator current 0 – 100A
- [2] Alternator voltage 0 – 100V

ADDITIONAL

- [1] DC power supply (0v, 5v, 15v and +24v)
- [2] 4 pressure transducers
- [3] 3 differential pressure transducers
- [4] Fuel orifice
- [5] rms voltage and current sensing modules
- [6] Printed circuit board
- [7] Outputs amplified to 0-10v dc, connected to two D type sockets

INSTALLATION REQUIREMENTS

Electrical supply: 220/240 volt 50 Hz single phase supply. Other voltages and frequency to special order.

Fuel supply: Propane/butane (C3H8) in standard gas take off bottles (45 kg bottles are recommended). N.B. Consumption at full load approx. 7 kg/hr.

Water Supply: Required for cooling oil circuit with 9 mm bore flexible hose and minimum flow rate of 10 litres/min. Exhaust

Provisions: Exhaust is non-toxic and clean but for extended running ducting is required.

DIMENSIONS AND WEIGHTS

	Nett Weight		Length		Width		Height	
	kg	lb	m	in	m	in	m	in
P9005	350	770	1.37	54	0.86	34	1.60	63
P9007	5.5	12	0.30	12	0.30	12	0.25	10
P9008	Included within P9005 above							