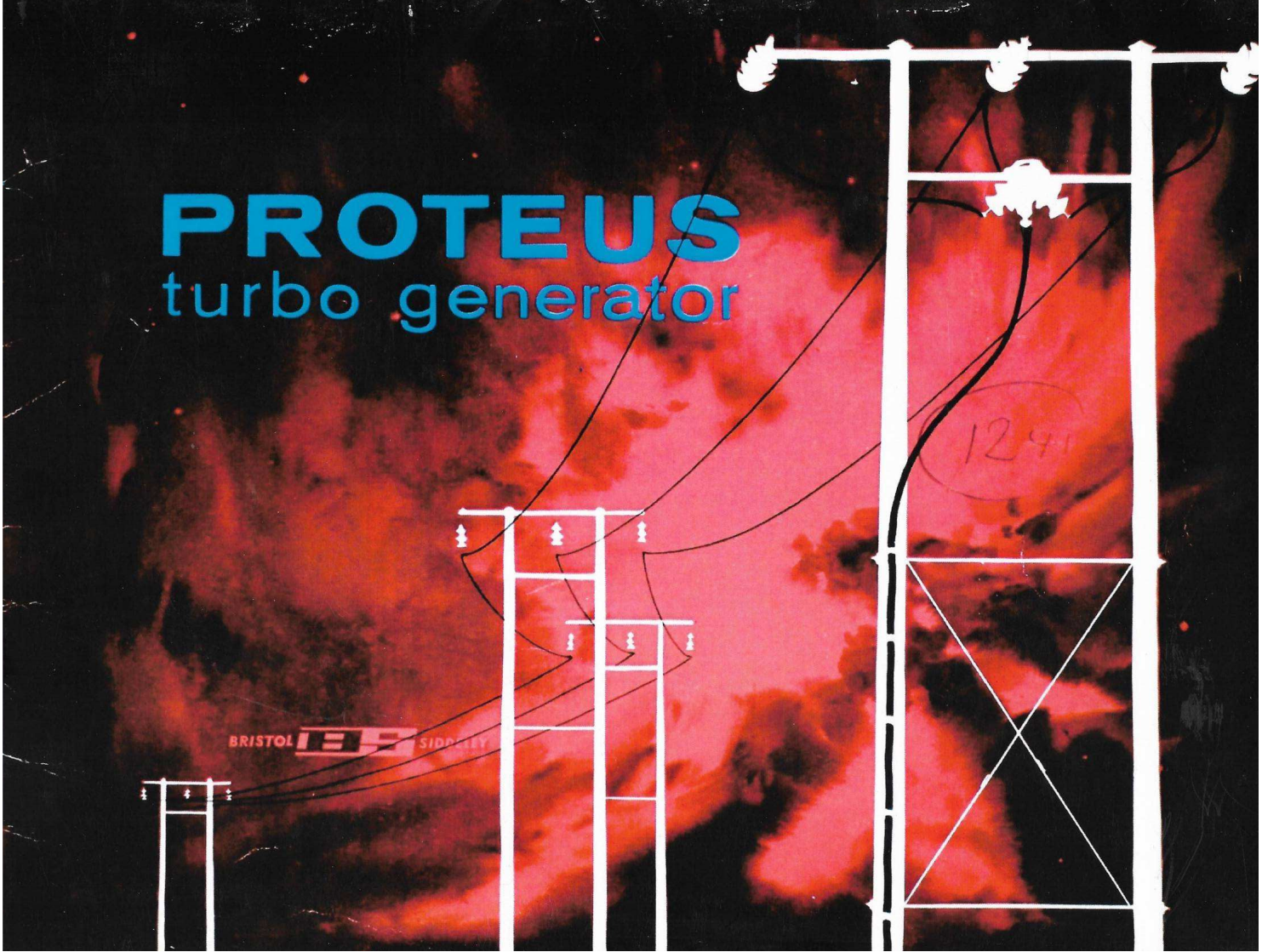
PROTEUS
turbo generator

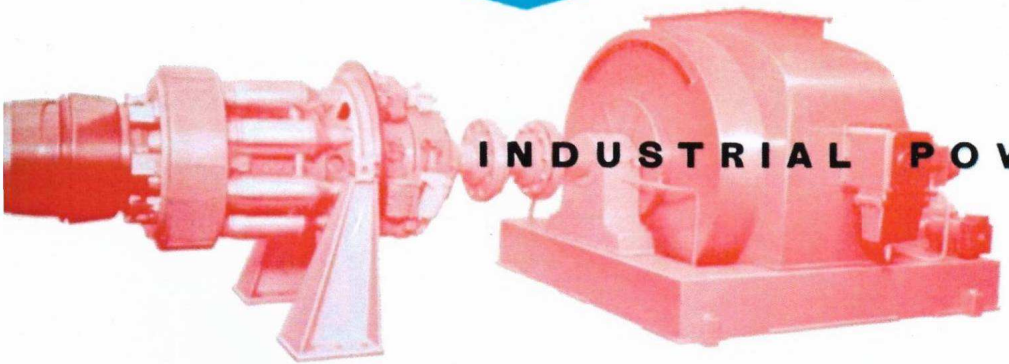


BRISTOL SIDDELEY

brings

AUTOMATION

to



INDUSTRIAL POWER SUPPLY

A small unmanned power station, capable of supplying electricity to a town of 10,000 people; generating power at the required load within two minutes of dialling a telephone number 100 miles away, and shutting itself down automatically by a similar operation; built for the South Western Electricity Board, it is claimed as the World's First 3000 k w unmanned, remote controlled gas turbine power station.

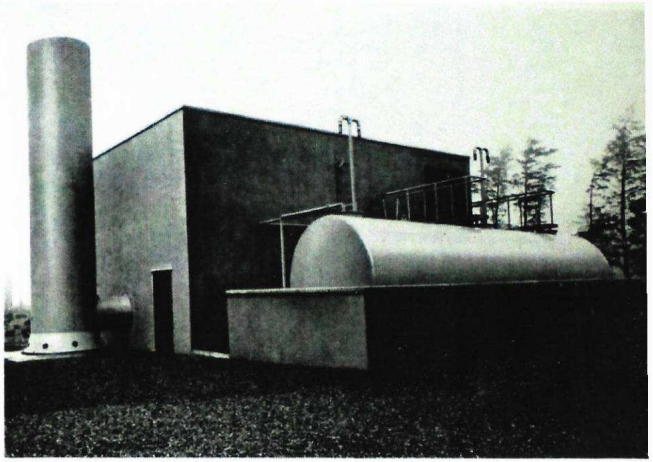
BRISTOL SIDDELEY

PROTEUS 3 Megawatt turbo generator set

This historical achievement has been made possible by the adaptability and unique performance of the Bristol Siddeley Proteus 3 Megawatt turbo-generator set; it is an example of automation in this field which will lead to new conceptions in the application of industrial power, and to the fulfillment of many projects hitherto restricted by problems of power supply and manning.

This compact generating set which is very light in weight for its high power output — the gas turbine weighs only 1½ tons (1500 kg) for a shaft power output of 4400 h.p. (4463 c.v.) with an overall length of 25 ft. (7620 mm) — has been designed for intermittent use, and is particularly suitable for:—

- Peak load power generation.
- Maintaining power supply in emergency.
- Supplying power during main plant overhaul.
- Mobile power source.

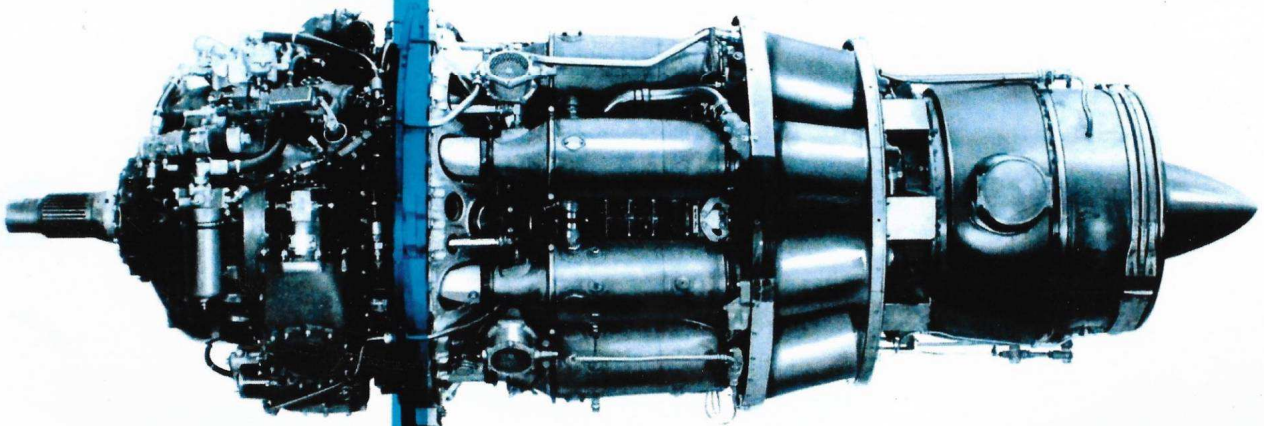


unique combination of advantages offered to Industry by the Proteus 3 megawatt set

- High power at low capital cost.
- No manning problems.
- Completely automatic operation, — starting and stopping by remote control.
- Reliability of the highest order.
- On load within two minutes of initiating the start.
- Negligible maintenance costs for 'standby' duty.
- Small size — readily transportable — occupies the minimum of floor space.
- Can be sited close to the area requiring power supply — avoiding the high costs of cabling and cable laying.
- No cooling water required — wide choice of installation sites.
- Low weight and virtually no vibration — light foundations.
- Quiet operation — suitable for residential area.

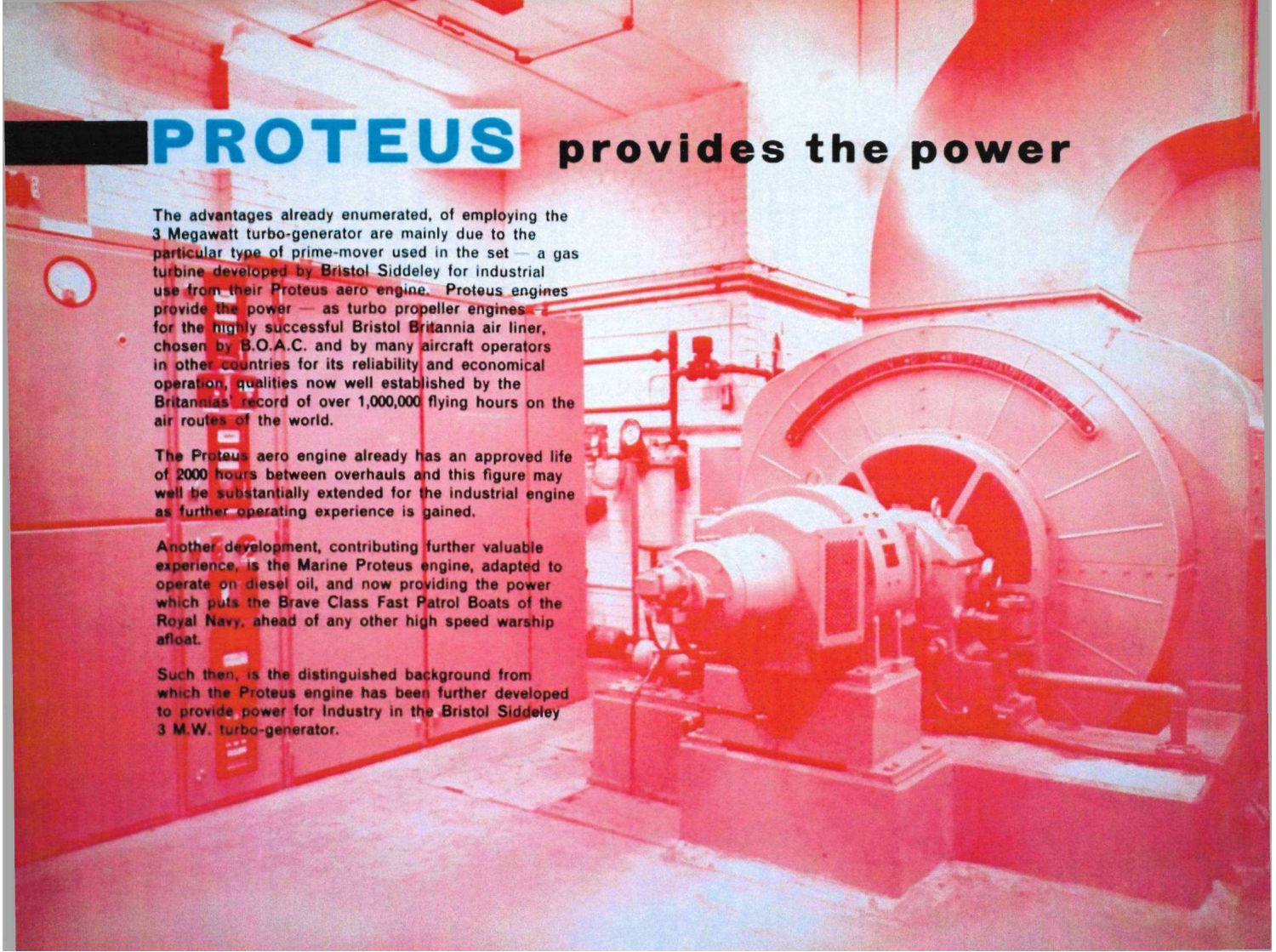
SPECIFICATION

LENGTH	106″ (269 cm)
DIAMETER	39·5″ (100 cm)
WEIGHT	3360 lb (1500 kg.)
POWER OUTPUT	4400 s.h.p. (4463 C.V.) maximum
REDUCTION GEAR RATIO	0·0863 : 1 power output shaft to power turbine
OUTPUT SHAFT SPEED	1000 r.p.m. for 6 pole, 50 cycle alternator or 900 r.p.m. for 8 pole, 60 cycle alternator
FUEL CONSUMPTION	2570 lb/hr. (1166 kg/hr) at max. output
FUEL CONSUMPTION (SPECIFIC)	0·575 lb/s.h.p./hr. (0·257 kg/cv/hr) at Standard temp. and pressure
FUEL SPECIFICATION	Diesel fuel to B.S.S. 2869 Class A
OIL CONSUMPTION	1 - 2 pt/hr. (0·57 to 1·14 Litre/hr)
OIL SPECIFICATION	D.E.R.D. 2479/1



PROTEUS INDUSTRIAL GAS TURBINE

PROTEUS provides the power



The advantages already enumerated, of employing the 3 Megawatt turbo-generator are mainly due to the particular type of prime-mover used in the set — a gas turbine developed by Bristol Siddeley for industrial use from their Proteus aero engine. Proteus engines provide the power — as turbo propeller engines — for the highly successful Bristol Britannia air liner, chosen by B.O.A.C. and by many aircraft operators in other countries for its reliability and economical operation, qualities now well established by the Britannias' record of over 1,000,000 flying hours on the air routes of the world.

The Proteus aero engine already has an approved life of 2000 hours between overhauls and this figure may well be substantially extended for the industrial engine as further operating experience is gained.

Another development, contributing further valuable experience, is the Marine Proteus engine, adapted to operate on diesel oil, and now providing the power which puts the Brave Class Fast Patrol Boats of the Royal Navy, ahead of any other high speed warship afloat.

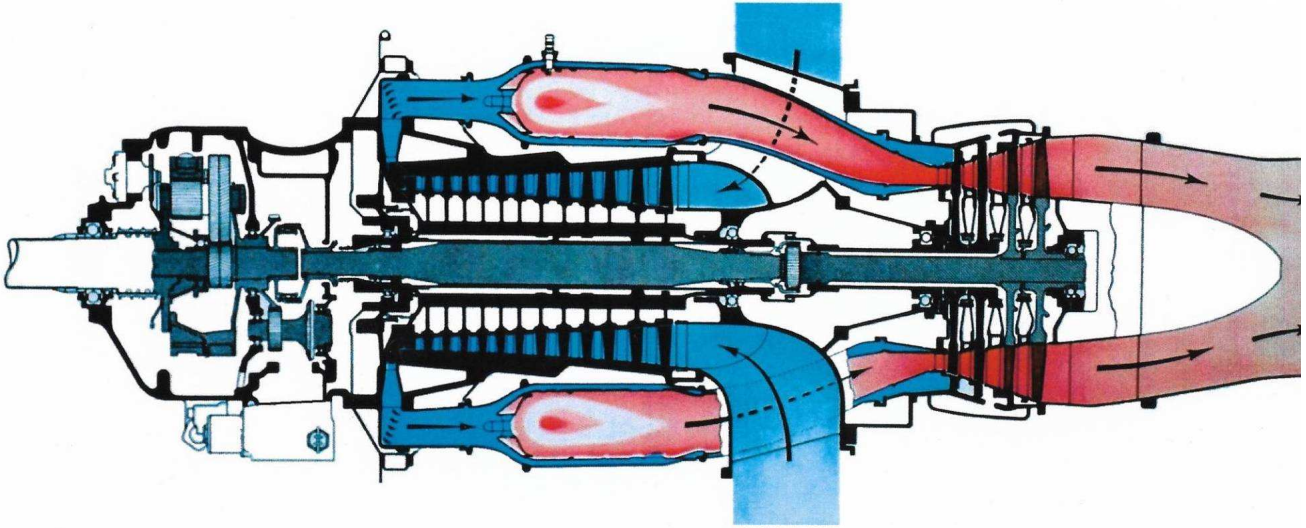
Such then, is the distinguished background from which the Proteus engine has been further developed to provide power for Industry in the Bristol Siddeley 3 M.W. turbo-generator.

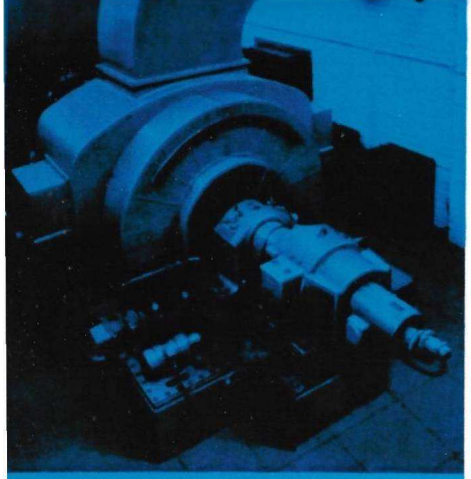
gas flow

Filtered air from the plant's filtering installation enters the compressor duct as shown and travels forward through the twelve axial stages to the single centrifugal stage where it is directed outwards to leave the compressor. The original direction of flow is then reversed towards the combustion chambers, by cascade vanes.

The eight conventionally designed combustion chambers have centrally placed burners at the upstream end, two being equipped with igniter plugs; interconnectors propogate the flame to the other six chambers and maintain the pressure balance between chambers while the engine is running.

The gases of combustion pass to the four turbine stages and are then ducted out of the building.





power output

The four turbine stages are coupled in pairs on the Bristol Siddeley free turbine principle, the first pair driving the compressor, and the second pair the reduction gear and power output shaft through mechanically independent co-axial shafts, this operational independence of the compressor and power turbine systems permits each to run at optimum efficiency. Further advantages of this arrangement are that the starter has only to rotate the compressor system for starting, consequently only a comparatively small starter battery is required, also, the alternator is coupled to a unit of low inertia, this facilitates automatic synchronisation.

The shaft driven by the power turbine system, passes axially through the compressor, and drives the compound epicyclic unit containing the reduction gears and power output shaft.

All engine accessories are arranged around the front gear casing and are driven from either the compressor or power turbine systems.

The engine is coupled by a short cardan shaft to a 3370 k VA alternator which in the set described, has been supplied by the Electric Construction Company of Wolverhampton, but there are other equally suitable alternators available which customers may prefer as an alternative installation.

ALTERNATOR

Selection of the alternator is a matter for the customer, but the unit chosen should be a protected type with two pedestal bearings and direct coupled exciters, all mounted on a common bedplate; the design and construction should be to British Standard 2613 : 1957 or to its equivalent in other countries.

The Electric Construction Company supplied the alternator for the first Bristol Siddeley installation and fully meets the above requirements, the specification is given below.

Power rating: 3370 k VA at 0·89 power factor equal to 3000 k W.

The set is capable of 10% overload in current for 1 hour at rated voltage in ambient air temperatures of 85°F and less.

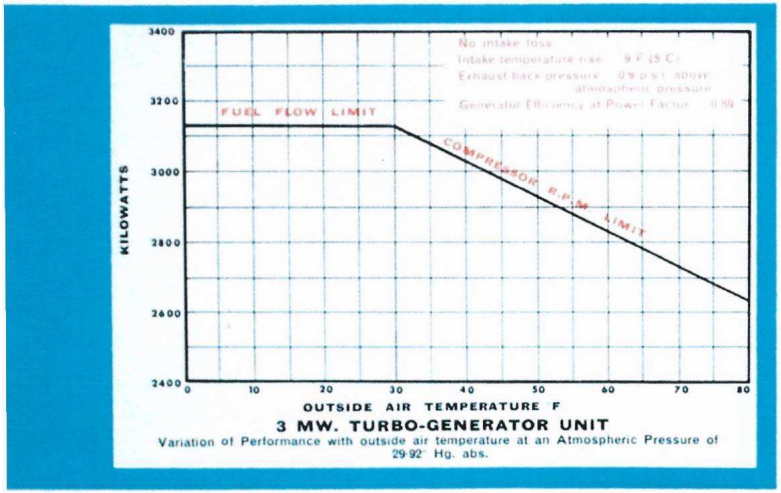
RATED VOLTAGE	NUMBER OF PHASES	FREQUENCY	SPEED	INSULATION	EXCITATION
11,000	3	50 c.p.s.	1,000 rpm	CLASS B	MAIN AND PILOT EXCITERS

VENTILATION

Chimney type air flow, intake air flows axially over windings, exhausts vertically and is ducted out of the building.

PERFORMANCE

Allowance has been made in the performance curve shown for typical electrical efficiencies.



3 MW. TURBO-GENERATOR UNIT

Variation of Performance with outside air temperature at an Atmospheric Pressure of 29·92" Hg. abs.

POWER OUTPUT

Maximum: 3140 k.w. (see performance curve for conditions)

At Standard temp. and pressure: Shaft h.p. = 4250 (4310 CV)

Output shaft speed: 100 r.p.m. for 6 pole 50 cycle alternator or 900 r.p.m. for 8 pole 60 cycle alternator.

Operating in parallel with the grid, the set gives its highest power output in cold weather, when peak load generation is most needed, the curve shows this; the control system being designed to maintain constant fuel flow and power output at temperatures below 30°F — above this temperature the set runs at a constant compressor speed, power output varying with ambient air temperature.

OVERLOADING

No stalling or damage to the gas turbine will result from overloading, there will be a drop in voltage and frequency, but the engine is able to meet an overload by giving a higher torque at reduced speed — this is a basic advantage of the free-turbine principle. The useful margin of automatic load shedding is limited only by the frequency drop permissible and the current capacity of the alternator.

FUEL CONSUMPTION

In the applications proposed for this 3 MW. set, fuel consumption is not of major importance, but the fuel rate per unit of electrical power generator for this simple plant is comparable with that of regenerative base load gas turbines.

OIL CONSUMPTION

When comparing fuel costs with that of diesel plants, a factor favourable to the Bristol Siddeley set is that the cost of used lubricating oil is negligible, whereas with diesel plants the cost of lubricants is commonly up to and sometimes over 10% of the total fuel costs.

AUTOMATIC starting and control

The well proved electric starting system for Proteus engines in aircraft and marine service, is employed with minor modifications to give the Industrial Proteus fully automatic starting by remote push-button control or similar device.

INDEPENDENT OF EXTERNAL SUPPLIES

As the set must be independent of external supplies — one of its functions being to maintain power supplies in emergency such as mains power failure — it is provided with a long-life 110 volt battery having a capacity adequate for the complete starting sequence.

A photo-electric cell facilitates completely automatic operation of the set, by detecting engine light-up and initiating the switching off of the starting fuel pump.

AUTOMATIC CONTROL OF POWER GENERATION

Immediately after starting, a synchroniser motor in phase with the alternator, opens a by-pass fuel valve and the engine accelerates rapidly until close to the synchronous speed when the synchronised motor connects also with the mains current; it detects the instant when mains and alternator current are in phase, and puts the alternator on the line. The engine governor is then reset automatically, giving full throttle at the synchronous speed.

Alternator voltage is maintained approximately equal to the mains during synchronisation, by a voltage regulator.

For applications where the set runs independently, 50 cycle operation is maintained by automatic synchronisation with a slave constant frequency oscillator.

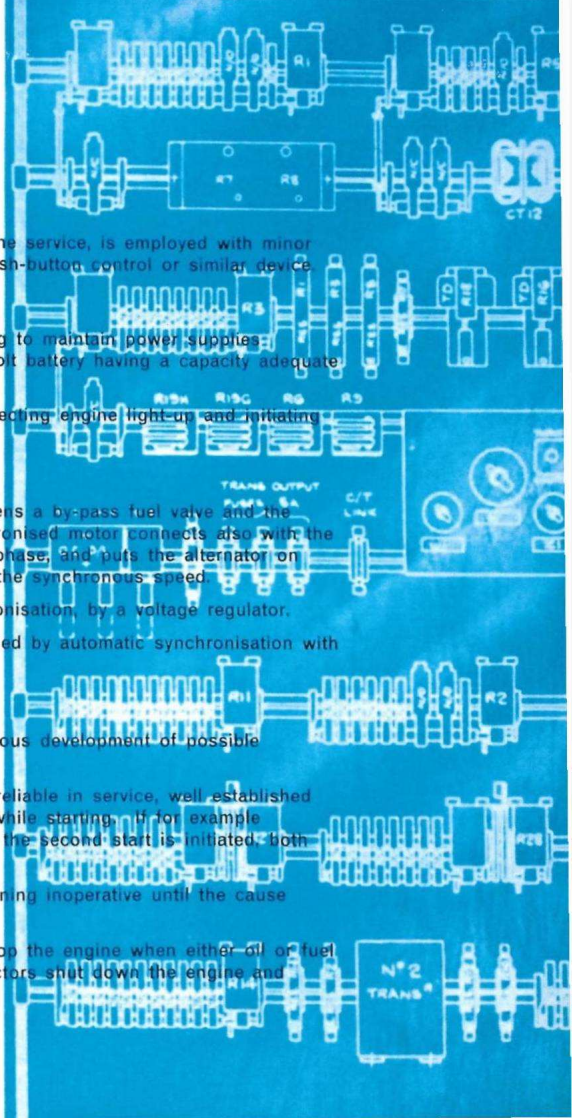
PROTECTION

Devices are provided to ensure the highest degree of protection against the serious development of possible defect occurences.

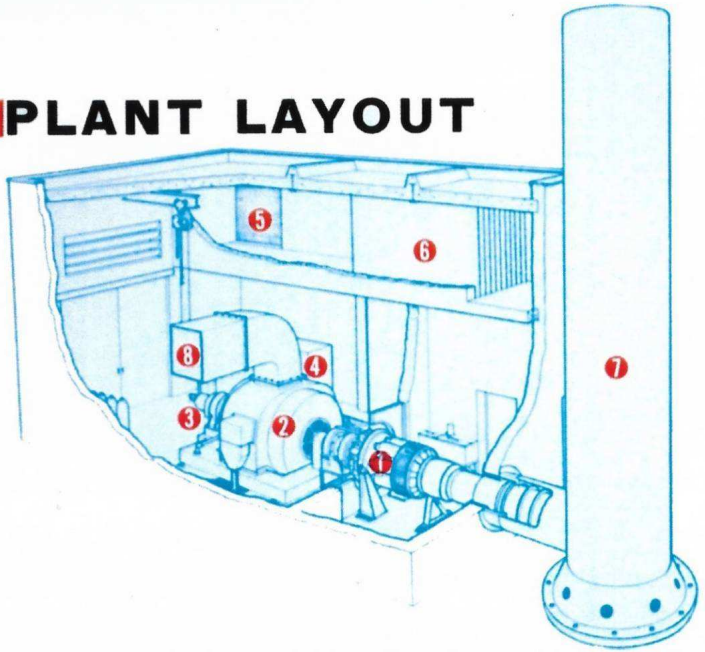
Although engine starting has been proved to be highly efficient and completely reliable in service, well established safeguards completely eliminate any possibility of a dangerous situation arising while starting — if for example the engine fails to light up, the combustion system is completely drained before the second start is initiated, both operations being entirely automatic.

The plant shuts down automatically if the second attempt fails, the engine remaining inoperative until the cause of failure is investigated on the site.

A comprehensive system of devices is provided to prevent overspeeding — to stop the engine when either oil or fuel pressure fails — to guard against excessive exhaust gas temperatures; fire detectors shut down the engine and discharge carbon dioxide extinguishers if fire occurs.



PLANT LAYOUT



1 Proteus Gas Turbine

2 3 MW. Alternator

3 Exciter

4 Control Switchgear

5 Air Intake

6 Filters

7 Exhaust Silencer

8 Alternator Ventilating Air Exhaust

The set can be installed in a comparatively small space, the only major foundation required, being for the Alternator. The overall costs of installation and housing are therefore only a fraction of those incurred by the conventional heavily built industrial plant installation of the same power output.

The simplicity of the plant layout is illustrated in the cutaway example of a sub-power station housing the Proteus 3 MW. generating plant. The ground area occupied by this station is only 900 sq. ft.

Separate alternator and engine rooms are formed by an acoustic bulkhead provided with removable panels to facilitate rapid engine installation and removal in conjunction with the overhead lifting beam which is also used for alternator installation.

Space heating is not required for either the alternator or engine; alternator windings are kept warm and dry by built-in heaters.

The diesel fuel bulk storage plant is mounted on suitable foundations outside the power house.

plant servicing and overhaul

Plant maintenance is confined to fortnightly visits during the winter to read meters, check fuel and oil levels, top up batteries etc.

The fuel and oil filters should be examined after every 100 hours running, and after 1000 hours running a partial dismantling of the engine should be made to inspect main components and bearings.

Complete dismantling will seldom if ever be necessary.

The engine can be removed and a replacement installed within six hours.

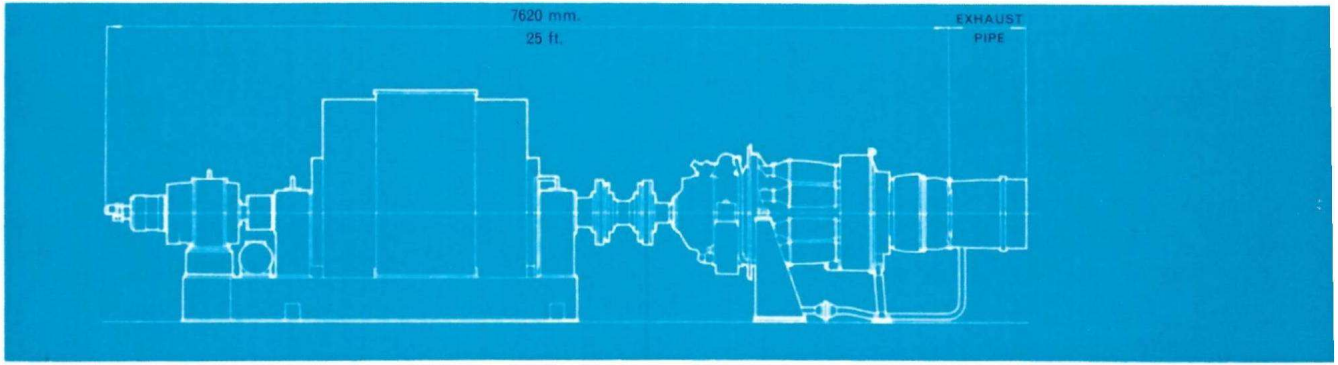
ENGINE SPARES AND SERVICE

Bristol Siddeley have a comprehensive spare parts and service organisation which includes a seven day-week emergency service and special arrangements for the supply of urgently needed spares.

Service engineers are always available to advise and assist customers, and technical publications dealing fully with the relevant equipment are provided.

INSTRUCTIONAL COURSES

Courses of instruction are arranged for customers' engineers at the Bristol Siddeley Gas Turbine School, where every facility exists for obtaining a thorough working knowledge of the Proteus Industrial Engine.



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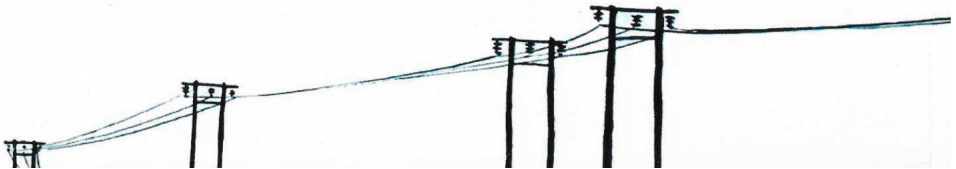
TELEGRAMS: BRISIDAIR COVENTRY
TELEX No: 31556

OTHER PRODUCTS

- GAS TURBINE AERO ENGINES
- PISTON AERO ENGINES
- RAMJETS
- ROCKET ENGINES
- HIGH SPEED DIESELS
- MARINE GAS TURBINES
- QUALITY MOTOR CARS
- BALL SCREWS AND BALL SPLINES
- GAS BEARINGS