COGENERATION TOTAL ENERGY MODULE

- TOTEM ® -

AdvanceD

BASE 15 kW

USE AND MAINTENANCE MANUAL

revised 21/12/1999

TemEnergy®

Cogeneration Systems

INDEX

TemEnergy®

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Fabrication on FIAT AUTO S.p.a. Licence

USE AND MAINTENANCE MANUAL

Machine:

COGENERATION TOTAL ENERGY MODULE

TOTEM ® AdvanceD

BASE 15 kW

CONFORMITY DECLARATION IN COMPLIANCE WITH THE EEC Directive 89/392/ EEC.

We declare

that this machine has been manufactured to comply with the following European Communities Council Directives concerning the harmonisation of the member states legislation:

89/392 EEC - Machines Security

89/336 EEC - Electromagnetic compatibility

73/23 EEC - Low voltage Directive

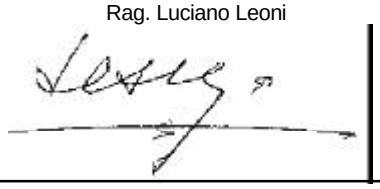
We declare that

TemEnergy® S.r.l. has drawn up the Technical Manufacture Brochure as foreseen by the EEC Directive 89/392 and that as of today's date all machines of the same series will be manufactured in compliance with this Technical Construction Brochure, as prescribed by the EEC Directive 89/392, Enclosure V°, point 3.

Date 01/02/99

the legal representative of the Firm

Rag. Luciano Leoni



GENERAL FEATURES

TOTEM STRUCTURE

Totem (Total Energy Module) is a cogeneration unit, producing electric and thermal energy at the same time, by using more than 95% of the fuel energy potential.

The main TOTEM components are:

a) FIAT 100 GL engine (903 cm3) expressly converted for TOTEM.

The mechanical base structure of the engine has remained the same.

The most important changes were made on the oil pan, on the additional oil tank, the distribution, the feeding, the cooling circuit and the transmission through a flexible coupling.fsdgf

b) Electric Generator

The electric energy is produced by a three-phase asynchronous generator with a pressure die-cast aluminium ...rotor and a cast iron liner and cooling interspace.

c) Primary Hydraulic Circuit.

This is a closed circuit containing a coolant, exchanging heat at various temperatures, due to the three heat exchangers; connected to the engine oil pan, on the water bedplate + head and on the exhaust.

d) Gas feed System.

Comprises a combined gas block with a modulating gas valve.

IDENTIFICATION OF THE MANUFACTURER

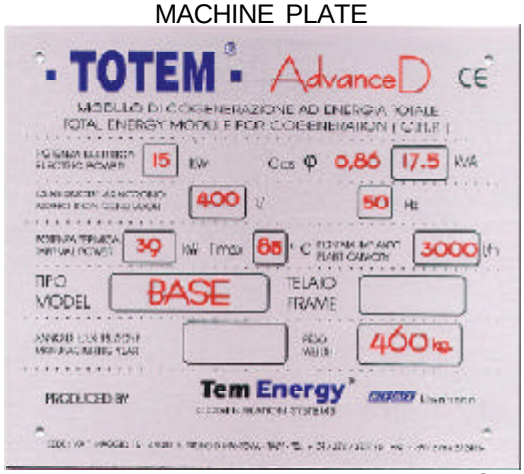
Manufacturer: TemEnergy®
registered office, administrative offices and production plant: via I° Maggio 15
46030 San Giorgio (Mantova)
Telephone: +39 376 - 373070 / Fax: +39 376 - 372426
Registration in The Chamber of Commerce in Mantova, Firms Register N°179496
V.A.T. No. 01756230205 - Authorisation by the Court of Mantova No. 18443

IDENTIFICATION OF THE MACHINE SERIES AND TYPE

FEEDING	
ENGINE SERIAL NUMBER	
GENERATOR SERIAL NUMBER	
MICROPROCESSOR CONTROLE S.N.	

A precise description of **" Model"** and **"Chassis Number"** enables our Technical Staff to give you quicker and better answers. We would advise you to write down your machine data in the panel above. Please do not forget to mention the **"Model"** and the **"Chassis Number"** every time you contact our technical staff.

MACHINE PLATE



Removing the machine ID plate is strictly forbidden

Fig. 1

RECOMMENDATIONS AND GENERAL INFORMATION REGARDING THE MANUAL

INTRODUCTION

GENERAL RECOMMENDATIONS

1. This handbook must be read by the operator and the person in charge of maintenance before installing the machine.
2. The correct and safe running of TOTEM depends on the TOTEM operators' work. Therefore it is necessary for them to have a detailed knowledge about the machine running, its use and maintenance.
3. This handbook's goal is to show the operator and the person in charge of maintenance, using written texts and pictures, the basic norms and criteria which MUST be followed when using and maintaining the system.
4. Keep this handbook within reach.
5. Do not use the machine when the security devices are off.
6. The security devices used for TOTEM are planned for a normal use of the machine, they should avoid accidents during normal work processes.
7. Do not open the movable and unmovable doors of the machine. They can be opened only by authorized operators, after switching off the general switch and closing the gas feed.

ACCIDENT-PREVENTION RECOMMENDATIONS

1. Read carefully the manual before starting, using, maintaning and repairing the machine.
2. Do not allow unauthorized persons to work on the machine.
3. Use accident-prevention clothes during your work.
4. Speak with the employer about the security measures in force and the accident-prevention devices you should adopt.
5. Do not stand in the range of action of the machine.
6. Do not start the machine if there has been a failure.
7. Before using the machine make sure that all dangerous conditions have been removed.
8. Inform the person in charge of maintenance of any operation irregularity.
9. Make sure that all security devices and guards are in the right place and in good conditions.
10. Take care of the place where the maintenance takes place. keep it clean and dry.
11. All repairs must be done when the machine is turned off, and not connected to the electric or gas supply.
12. Do not repair parts of the machine without being authorized.
13. Follow the explained procedures for maintenance and technical service.
14. Do not make use of petrol, solvents or other inflammable fluids such as detergents. Use advised commercial non inflammable and non toxic solvents.
15. When you use compressed air to clean the single parts, do not forget to use safety glasses. the air pressure should not excede 2 bar.
16. Do not use naked flame for lightning when you are making tests on the machine, or looking for leaks.
17. Do not change the setting of the security devices and avoid repairing them.
18. Do not remove the safety gratings, set on the rotating parts.
19. Do not lift the machine without the correct tools Follow the recommendations in chapter.5.

IMPORTANT MESSAGES FOR THE USER

IF THE CUSTOMER DOES NOT USE THE ASSISTANCE OF OUR TECHNICAL STAFF DURING THE COMMISSIONING OF THE SYSTEM, THE FIRM TEMENERGY DECLINES ALL RESPONSIBILITY FOR DAMAGES TO THINGS OR PERSONS, CAUSED BY THE NON-OBSERVANCE OF THE NORMS AND INSTRUCTIONS CONTAINED IN THIS MANUAL.

ATTENTION!

- pay attention to the recommendations contained in the rating plates.
- injures, heavy damages or death can be the result of their non-observance.
- make sure that the rating plates are at the right place and that the written words are legible; do not remove or change them.

IMPORTANT!

THE USER HAS TO ENSURE THAT THE INSTALLATION HAS BEEN MADE IN COMPLIANCE WITH THE NORMS IN FORCE AT THE TIME OF THE COMMISSIONING.

THE MACHINE MUST BE INSTALLED ONLY BY QUALIFIED PERSONNEL, AFTER THEY HAVE READ THIS INSTALLATION AND MAINTENANCE MANUAL.

1 - PRESENTATION OF THE MACHINE

TOTEM ® AdvanceD

WHAT IS TOTEM?

TOTEM is a high efficiency cogenerator, producing simultaneously **15 kW** electric energy and **39 kW** (33,500 KCAL/H) thermal energy, by using more than 95% of the fuel energy potential.

The principal **TOTEM** components are:

- **FIAT 903 cubic centimetre engine**
- **electric generator**
- **a series of heat exchangers**
- **an electric / electronic regulation and control system.**

All these components are contained in a small enclosure, internally insulated with sound retention material, preventing the system from the loss of heat, and reducing at the same time the noise of the engine.

The TOTEM can be fed with a wide range of gases (natural gas, L.P.G., biogas).

TOTEM COMPONENTS

The most important components of TOTEM are the following ones:

a. Thermal engine FIAT 100 GL (903 cm3 power) especially adapted for TOTEM.

The base mechanical structure of the thermal engine has remained the same. The principal changes are related to the oil pan, to the additional oil tank, the feeding, the cooling circuit and the movement transmission through a flexible coupling.

b. Electric generator. The electric energy is produced by a three phase asynchronous generator with pressure die -cast aluminium rotor and cooling cast iron interspace.

c. Primary water circuit. This is a closed circuit containing a coolant exchanging heat at different temperatures, it is set, on the crankcase, on the bedplate and on the smoke exhaust. If the produced heat isn't used, the primary circuit gives the heat to an external convector, to get rid of the excess heat

d. Secondary water circuit: This is a closed circuit containing the external plant water the electric generator and the water/water exchanger

e. Gas feed system. The gas feed system is made of a combined gas block with a modulating valve,.. The engine can be fed with different gas types (natural gas, L.P.G., biogas, etc.). On the flexible coupling has been assembled a particular plate, which makes possible to change the angle of lead according to the used gas.

f. Regulation and Control System: In the TOTEM base model the regulation and the control are based on electric and electromechanical parts with dedicated components. Failure is displayed on the control panel. There is also a min/max power and single phase protection, set inside a three phase system with neutral. This device can give an alarm (drop-out), if for some cycles the current of one of the three phases is not in accordance with the standard values.

g. Minimum and maximum tension and DMA 400 frequency control. This device inside a three-phase system with neutral can give an alarm (drop-out), if frequency or tension of one of the three phases are not in accordance with the fixed values. The relay becomes re sets again automatically, as soon as frequency and tension reach the standard values again.

h. The frame . All TOTEM components are assembled on a chassis and externally isolated by non conducting panels equipped with a series of gaskets. In this way we avoid losing heat externally, and reduce the noise produced by the thermal engine to less than 70 dB at 1metre distance from TOTEM.

TYPICAL DATA AND USE LIMITATIONS

The characteristic data of the different Totem versions can be found in the table (pag.11)

Remember that:

- if TOTEM is placed in unheated rooms, the electronic parts have an operation limit working at a temperature of 0°.
- if TOTEM is placed in very hot rooms the electronic parts have an operation limit at a maximum temperature of 40°.
- the relative humidity rate cannot be over 95%.
- if TOTEM is placed in very hot rooms or in altitude over 1500 m its efficiency decreases.
- if TOTEM remains inactive for a long time in a cold room, the non-freezing limit of the coolant is -10°, while the electronic parts, not connected to electricity can resist till -20°C. By mixing water and the fluid Paraflu11 we will MUST raise the normal 10% Fiat Paraflu percentage to 20%, in order to have anti-

2 - SPECIFICATIONS

TABLE 1: TOTEM - TABLE SUMMARISING TECHNICAL DATA

MODEL	UNIT	STANDARD BASE
Function		**cogeneration module**
Length x height x width	mm	850 x 1075 x 1050
Approximate weight	kg	460
POWER		
min-max inlet power	kW	56,2
Nominal electrical power	kW	15
min-max outlet thermal power	kW	39
Efficiency at maximum power	%	93 ÷ 97
SPECIFIC CONSUMPTION		
Natural gas (CH_4 35,5 MJ/Nm^3)	Nm^3/hour	5,7
LPG (50MJ/kg)	kg/h	4,2
Biogas (60% HC_4 22,6MJ/Nm^3)	Nm^3	8,4
SECONDARY HYDRAULIC CIRCUIT		maximum power data
Maximum inlet water temperature	°C	70
Nominal water flow rate	l/h	3.000
Loss of load at nominal flow rate	kPa	30
Maximum water hardness ($CaCO_3$)/m^3	°F	13
ELECTRICAL GENERATOR		**self-energised, three-phase asynchronous**
Three-phase line voltage	V/Hz	400/50 415/50
start up		D.C. starter motor
Connection to the user		star with accessible neutral
USER CHARACTERISTICS		
Maximum load/minimum cosφ	kW	national grid power
max. single-phase load	kW	national grid power
Maximum admissible starting inductive load (star/delta start-up)	kW	national grid power
Environmental conditions	°C (%UR)	0 ÷ 40 (0 ÷ 95)

3 - APPLICATIONS

freezing effects till -16° C.

TOTEM was developed to be used in cogeneration systems for CIVIL, INDUSTRIAL and AGRICULTURAL plants. Because of the many different possible uses it can be applied to a wide range of plants. (See the examples in the attached plants schemes).

For applications, which are different from the ones shown, we would advice you to contact the TemEnergy Technical Staff.

TOTEM was developed to work in all operation conditions, with the advised gas, with nominal network voltage values .

4 - RESIDUAL RISKS

RECOMMENDATIONS FOR THE OPERATORS

When running, Totem produces heat; Inside Totem there are high pressure and/ or high-temperature points, which could cause burns.

During maintenance, with covers removed, always wear protection, type-approved, accident prevention gloves and glasses.

As the machine is gas -powered you need to pay attention to:

- **Never use naked flames**
- **Do not smoke**

5 - TRANSPORT, MOVEMENT, STORAGE

Since the machine is connected to the electricity supply during the operation it is necessary to use the foreseen isolated protection devices.

TESTING OF THE EQUIPMENT

All TOTEM units are carefully checked, by qualified technicians, before delivery. We make tests, simulating normal operating conditions.

The test operation before delivery enables to verify:

1. The unit produces the require output and complies with the required criteria.
2. The setting of the security devices;
3. The setting of the regulation and control systems;
4. The absence of vibrations or irregular noises;
5. Satisfactory operation of the unit

DELIVERY OF THE MACHINE

All Totem parts are carefully checked before delivery.

The machine is supplied ex-works warehouse TemEnergy Mantova Italy

Note In case of accidents during the transports, badly damaging the machine or causing visible damages, please contact TemEnergy as follows:

· Write a note on the "packing list" accompanying the goods.

· Write a telegram or a registered letter to TemEnergy and to the carrier within 24 hours from the delivery, communicating the damage occurred. After 24 hours, TemEnergy will decline any responsibility on the received damages.

MACHINE PACKING

TOTEM is packed in a wooden container mounted on a pallet for transport with normal fork-lift trucks.

ATTENTION!

Lift the machine with an adequate truck. Totem and the package weight about 550kg; ensure that the load is stable and well set on the forks.

Keep the load as low as possible during the movement, in order to have more stability and control the operation better.

If you bind Totem with chains or ropes:

- **remove the side panels**
- **use hooks and insert them in the lifting**

points positioned in the internal corners of the engine frame as indicated in the particular of the Fig.2

- **be careful**
- **use adequate ropes and chains**
- **use the correct tools**
- **Be careful.**
- **Use adequate ropes and chains.**
- **Use the correct tools.**

STORAGE

The still packed TOTEM UNIT, if not being installed immediately, must be placed indoors

EXAMPLE OF HOISTING THE TOTEM UNIT

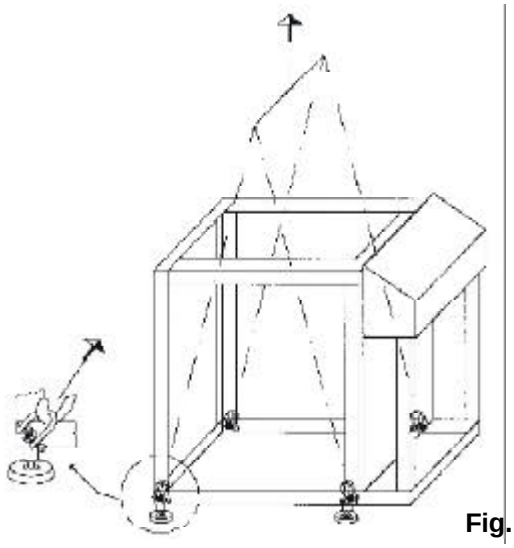
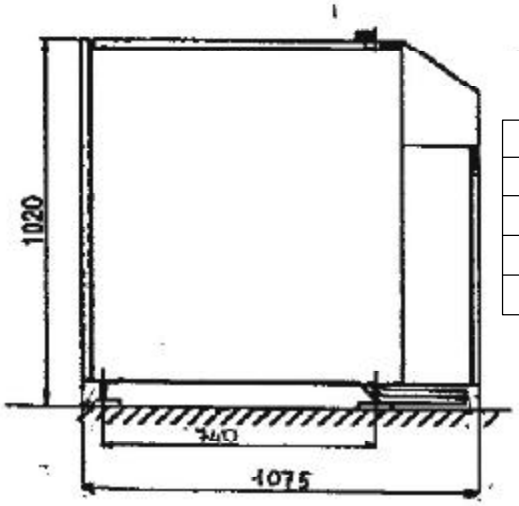


Fig. 2

DIMENSIONS AND WEIGHT



Foot	Weight
P1	160
P2	160
P3	90
P4	90

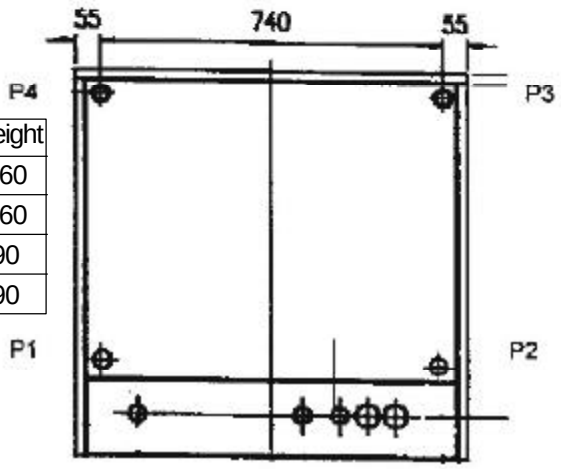


Fig. 3

6 - MACHINE PLACEMENT

and protected from bad weather in dry room.

Do not forget that leaving the machine for long inactivity periods in inadequate places can cause damages to it.

Leaving the machine on wharves for long periods of time is very dangerous.

MACHINE ROOMS

In this chapter we will supply you with all necessary information for the TOTEM installation, and show you the best room features for good operation of the machine.

The most important room features are reported in fig.4.

Remember that:

- The distance between floor and ceiling must not be less than to 2,5 m and 1 m between TOTEM and the ceiling (fig.4) in case of overlapped
- The machine has to be sufficiently distant from the wall to allow maintenance.

The room you chose has to have the following features:

STRUCTURES. Both the horizontal and vertical structures must be 120 minutes fire- resistant

DIMENSIONS. The height from the floor to the ceiling cannot be less than 2.5m, and the distance on three sides between the wall and the machine cannot be under 0,6 (we advise at least a 1 metre distance to permit easy maintenance operations).

ACCESS. The access to the room must be:

- direct from outside
- it is necessary:
  - the room access door width cannot be less than 1,20 m. wide
  - the room cannot communicate directly with other rooms, used for different use.
  - The rooms doors must open from the outside, they must be fireproofing and equipped with a non blocking device. The doors opening on to closed spaces must be smoke proof.

VENTILATION The ventilation openings must have a surface not less than 1/30 of the room surface, and not less than 0,5 m2 (0,5 x 1 m). If you want to use isolated rooms, use fireproofing materials or class1 fireproofing materials; the possible common wall must be 120 minute fireproof. In the free space installations they cannot be at a distance less than 3 m from combustible substances. The installation must be enclosed in order to prevent the system from weather damage.

SERVICES AND GENERAL AMBIENT CONDITIONS

SERVICES. In the Totem plant room you should have the following services to facilitate the safe operation and maintenance of the machine:

- outlet (or more than one) for the inspection light
- service water outlet

ROOM FEATURES

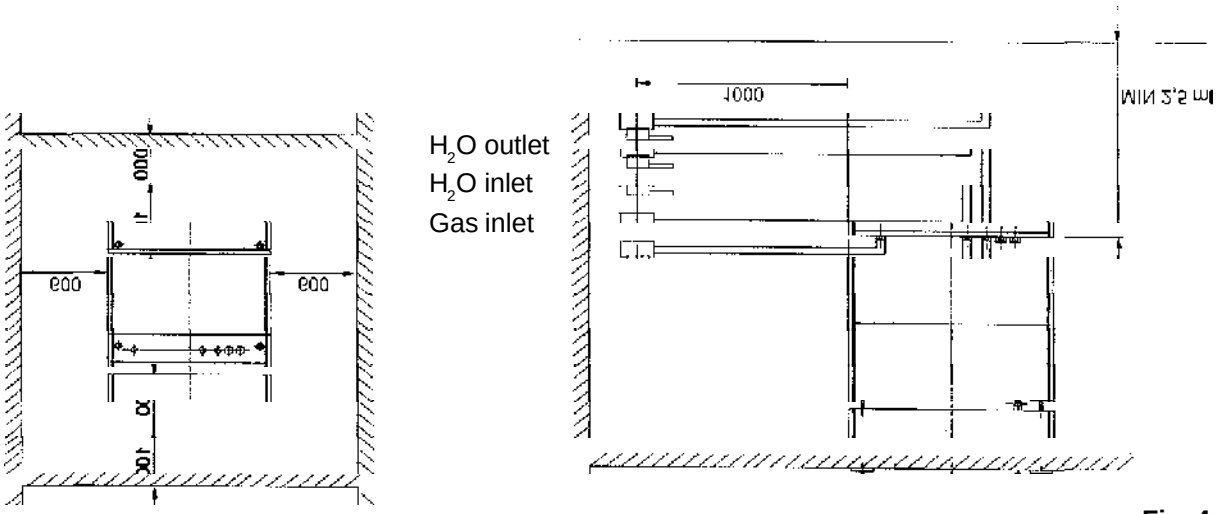


Fig. 4

- drain at floor level.

VENTILATION AND TEMPERATURE

The machine room should have a temperature between -5C° and 45C° with a maximum relative humidity rate of 95%.

When it's not possible to guarantee the above mentioned minimum temperature, it's avisable to empty the primary circuit and to remove the electronic control card from the electric panel

If the system is used in hot climates it is necessary to have a good ventilation system, reducing the humidity and regulating temperature in order not to exceed the machine limits (0+ 40°C 0-95% U.R.)

EXHAUST GAS SYSTEM

The connection of Totem and exhaust pipes is done using a flexible coupling, which the Firm TemEnergy can supply at the customer's request.

SIZING

The exhaust system must not excede a maximum counter pressure of 0,5 KPa (50mm of H2O) and the complete elimination of condensate.

The exhaust pipe diameter depends on the number of installed Totems. We would recommend the following diameters.

For a safer and more efficient operation of the stack, the exhaust pipes should be well isolated.

The condensate exhaust pipe must be of acid proof material, with a diameter not less than 2" 1/2.

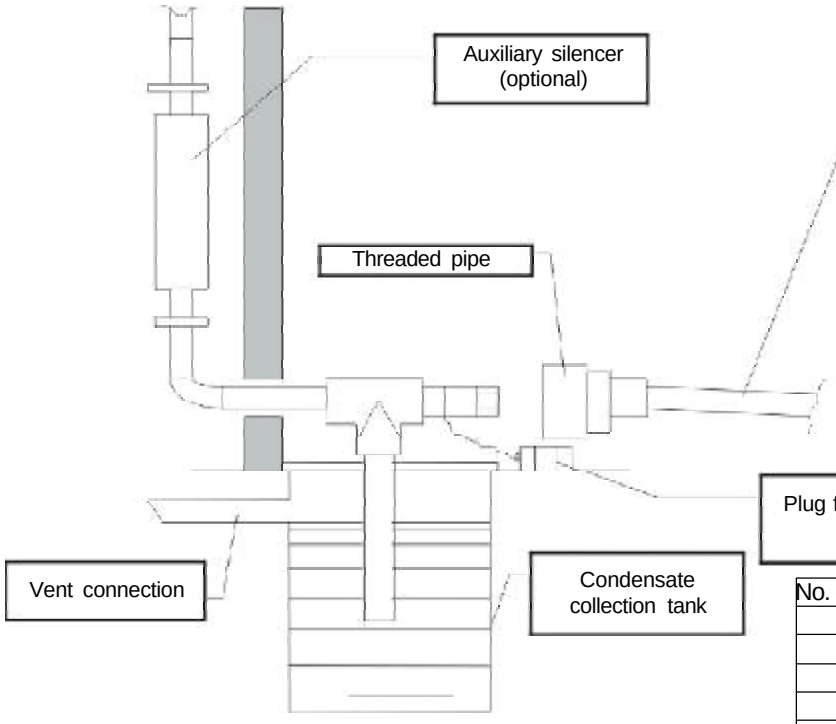
The TOTEM delivers every hour about 70 m3 of exhaust gas at 90°C.

The condensate exhaust pipes must be placed, directly or through a stack, outside, so that the warm gas and the sparks cannot cause any damage. The exhaust pipe end must be placed about 1.5m from doors, windows or air passage ways not higher than 3m on the practicable floor.

Every time the TOTEM is stopped, you must to insert the exhaust pipes locking tap.

If you have more than one Totem, you can use

EXHAUST SYSTEM



No. of TOTEM units	Pipe diameter
1	60 mm
2	120 mm
3	130 mm
4	160 mm
5	170 mm
6	190 mm
7	210 mm
8	230 mm

Fig. 5

7 - MACHINE INSTALLATION

a unique pipe as manifold, in case it is installed over a stack or a lye (draft activator) producing a continuous pressure. It prevents the re circulation of exhaust gases on non working Totems, causing heavy damages to the engine.

The TOTEM must be installed in a dust free room, far from dangerous substances, such as inflammable fluid or material storehouses, or processing equipment where there is dust and aggressive or acid atmosphere.

FOUNDATIONS

TOTEM does not need particular foundations since it is equipped with anti-vibration mounts.

TOTEM weighs about 500 kg. The floor must be able to sustain its weight, the equipment and the maintenance operators. Totem cannot be installed on a bed, higher than the floor, as the operators would not be able to insert the TOTEM internal parts elevating trucks.

LOCATION

The units can be installed outdoors (protected from rain, wind and snow), in isolated rooms, or in rooms belonging to bigger buildings. The ambient temperature can never be less than 0°C.

In case they are installed in bigger buildings,

8 - PREPARATION FOR STARTING THE MACHINE

they cannot be located in underground rooms.

For groups of Totem using gas fuel with inferior density 0.8 Kg/Nm3 it is possible to locate in underground rooms.

For groups of Totem using LPG or gas with a density above 0.8 Kg/Nm3 it is only possible to install above ground

If the building is designated for use as a Public Place the equipment must be installed in a purpose built room and must not be ventilated to the public area.

LOCATION

Make sure that the machine is located on a perfectly flat surface and that the floor is resistant enough to sustain the TOTEM weight (550kg plus operators' weight).

Place the machine where you have enough room for maintenance operations.

The machine has four feet with vibration-

TOTEM FEET

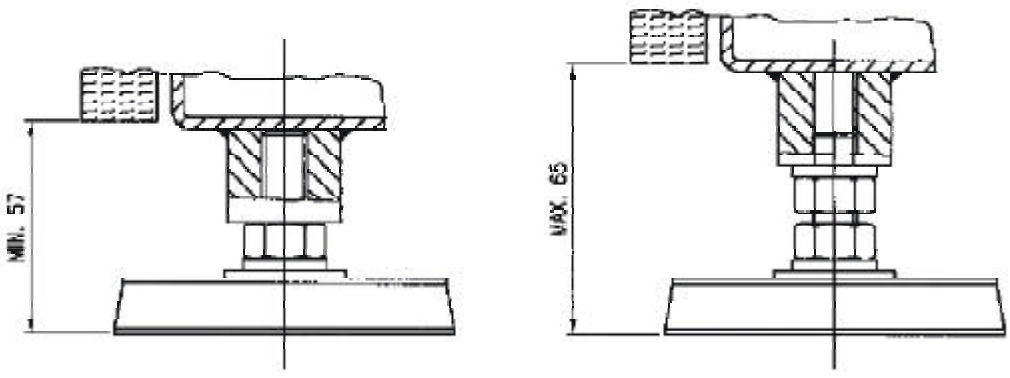
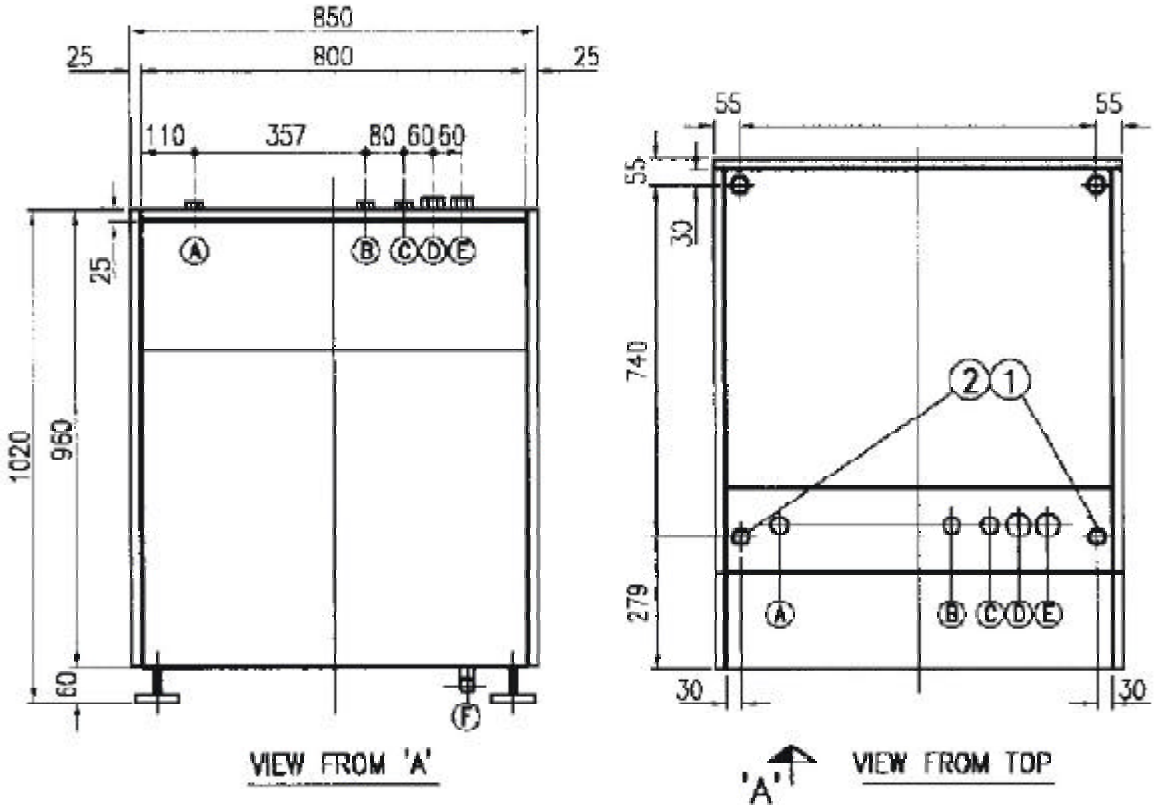


Fig. 6

CONNECTING THE MACHINE TO THE ENERGY SOURCES

CONNECTIONS TO THE ENERGY SOURCES



A) Gas inlet pipe connection ¾"
B) Secondary circuit water inlet 1"
C) Secondary circuit Water outlet 1"
D) Electric connector
E) Electric connector
F) Exhaust gas outlet
1, 2; Feet

Fig. 7

dumping material bottoms, which can be regulated for height and must be adjusted using a spirit level.

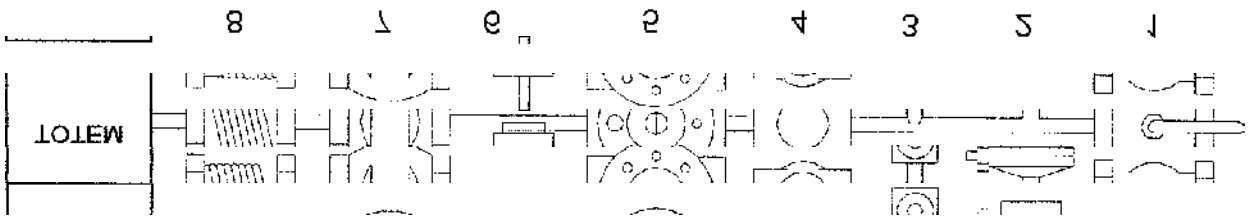
To level the machine:

1. **Place** the machine in its final position.
2. **Adjust** the distance from the floor by screwing and unscrewing the movable feet with a key, adjust it using a spirit level and block it by screwing down the lock nuts.
3. **Ensure** that the machine weight is equally distributed on all the feet.

TABLE 2: FUELS CHARACTERISTICS

FUEL	AVERAGE NET HEAT VALUE	AVERAGE COMPOSITION (% in volume)
Natural gas *	37 MJ/m³	$CH_4^{(95)}+N_2^{(3)}$
biogas *	26 MJ/m³	$CH_4^{(66)}+CO_2^{(25)}+N_2^{(8)}$
LPG	113 MJ/kg	$C_3H_8^{(31)}+C_4H_{10}^{(68)}$
city gas *	20 MJ/m³	$CH_4^{(37)}+H_2^{(28)}+NO_2^{(20)}+CO^{(9)}$
ethyl alcohol/methane	27MJ/kg	$C_2H_5OH^{(95)}+H_2O$
* a 0 °C e 101,3 kPa		1 MJ/M³ = 238,9 kCal/m³

INSTALLATION DIAGRAMS: GAS FEED NETWORK



1. Manual cock
2. Pressure switch
3. Breather valve
4. Filter
5. Pressure reducer (for pressures above standard pressure)
6. Breather valve
7. Safety valve
8. Vibration damper

Fig. 8

GAS CHARACTERISTICS:

For the correct operation of the system the gas has to have following characteristics:

1. **Feed pressure at the TOTEM 2 kPa (200 ± 10% mmH20).**
2. **99,9% filtering of dusts with diameter over 50 micron (for all gas tipes).**
3. **Humidity rate: absent fluid, or dry saturated steam (for all gas types).**
4. **Maximum H2S possible percentage: 0,10% in volume (biogas).**

NECESSARY DATA FOR SIZING

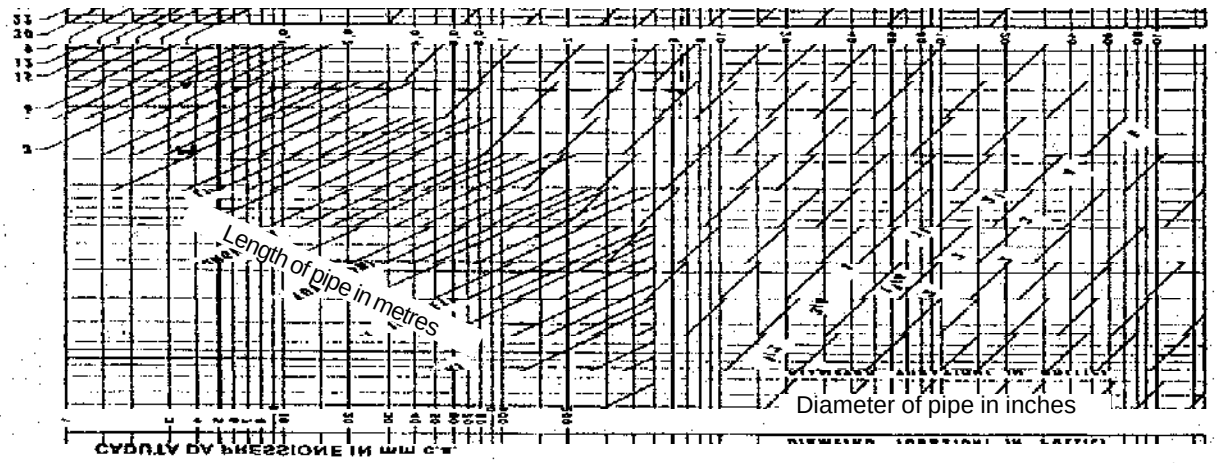
1. Pipes length :

- The virtual length of the pipes can be obtained by adding up the real length and the length resulting from the calculation of the direction variations x 0,5m.

2. Pipes loss of pressure: in accordance with

SIZING DIAGRAM FOR NATURAL GAS FEED PIPING

Gas flow rate in m3/h (natural gas: relative density 0.6)



Drop in pressure in mm H_2O

Drop in pressure in mm H_2O
(Maximum Δp permitted by law: 5 mm H_2O)

Specific weight	multiplication coefficient
0,6	1,00
0,65	1,04
0,7	1,08
0,75	1,12
0,8	1,16
0,85	1,20

*To obtain the equivalent flow rate with which to calculate the loss of load

Fig. 9

MORE TOTEM UNITS FED BY THE SAME PIPE

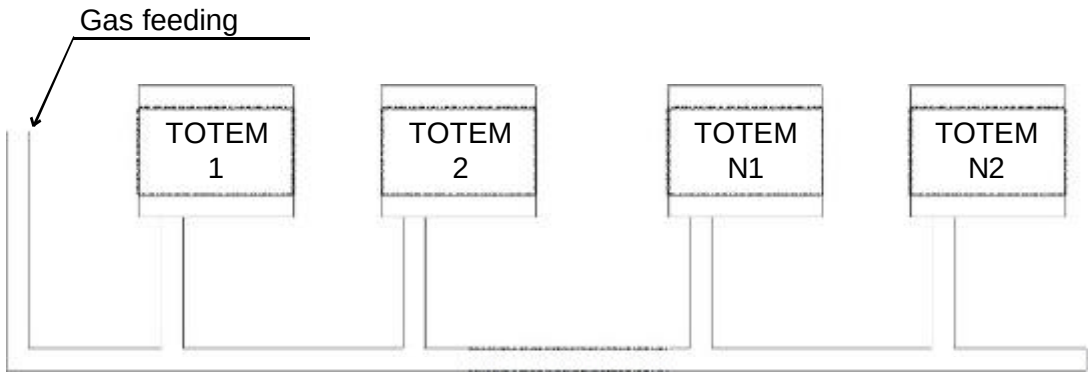


Fig. 10

the norm the maximum pipe DP is 1 mbar.

3. Capacity, expressed in m3/h , corrected through a multiplying factor, for gases with a density different from 0,6 kg/Nm3, to which the diagram is referred.

EXAMPLE

You have a natural gas-fed TOTEM with a density of 0,8; for the installation you need a 20m long pipe with three elbows.

The length is therefore of about 22 m. The TOTEM consumption is of 5,7 Nm3/h: the diagram shows that 0,8 density gases have a 1,16 multiplying factor and the right capacity value is 6,612 m3/h. By inserting these values in the diagram you obtain point A, the intersection of the maximum possible load losses (about 5mm) and the virtual length line. From the intersection of the point A, and the 6,612 m3/h capacity load line origins a point; the nearest line to that point shows the pipe dimension we wanted to obtain. In this case 1"1/4. We advice you to increase the pipe dimensions, as on this line will be set a pressure stabiliser, solenoid valves, filters, etc. We will MUST limit the load losses as much as possible, in order not to reduce the feed pressure. In case you have more TOTEM units fed by the same pipe, it is advisable to keep the first pipe dimensions till the last unit in the series, we can therefore create a sort of plenum chamber, enabling the right TOTEM gas pipe sizing for different operating conditions.

As we have already said about the gases characteristics, we should have in case of biogas an adequate filter for dusts, tars, gas cooling and a H20 separator.

CONNECTION TO A VIBRATION-DUMPING TOTEM GAS FEEDING COUPLING

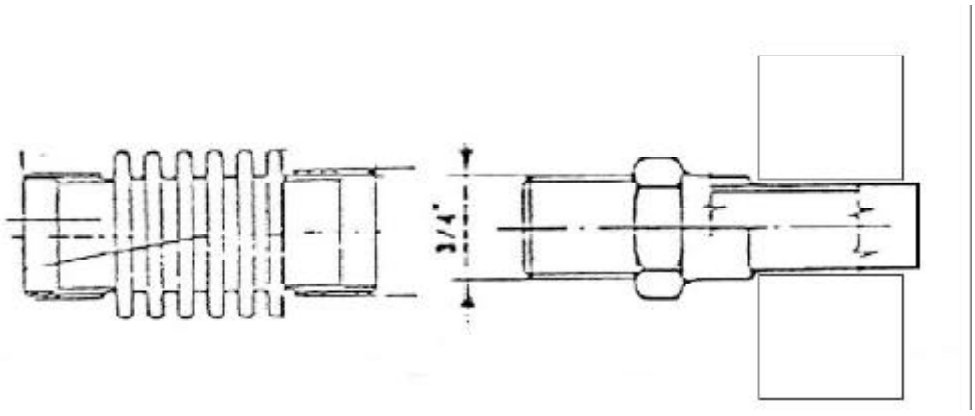


Fig. 11

In systems with a balloon it is advisable to install a minimal level/ pressure system to stop the TOTEM units in case of gas exhaustion. The efficiency of TOTEM depends on the heat value of the used gas. The lower the heat value is, the lower the delivered power will be.

ATTENTION!

The machine has been planned, manufactured and equipped in order to avoid all risks connected to residual gases, fluids and steam produced.

In case gas leaks should originate inside the machine, they would be sensed and burnt by the air of the motor suction device.

CONNECTION TO THE WATER SYSTEM

WATER SYSTEMS CONTROL AND MAINTENANCE

The systems equipped with TOTEM units are not different from those equipped with other thermal generators:

The controls which MUST be taken are related to the current use.

You MUST pay particular attention to system water flow rate

the installation of a single water re circulating pump on all TOTEM units, set on the return, in order to have a 10°C thermal head.

We advice you to install thermometers and thermometer pockets both on the delivery and on the return; it will be possible to verify possible operation anomalies.

1. Water hardness control . The system feeding water values should be between 5 and 7 French hardness degrees, the circulating water hardness cannot be over 13F. Therefore it is advisable to install a ion exchange resin water softener, in case the water quality should not comply with the standards required.
2. Control of the exchangers stoppage. It is very important to control this aspect: the stoppage of an exchanger can be verified thanks to the DT variation between delivery and return. This value should be reported on the station booklet every time you work on the machine; in this way you will be able to clean the machine before a total exchanger stoppage occurs.
3. Regular control of the check valves to avoid their stoppage or blockages.
4. System and automatic load operation control. The insertion of the water flow measurer enables to see the right calibration of the pressure reducer displayed (automatic load).

ELECTRIC SYSTEM CONNECTION

ATTENTION

IMPORTANT INFORMATION FOR THE TOTEM INSTALLERS

You MUST use protections for the totem version with parallel of an generator, asynchronous to the public electric network (both in MT and LT)

MAKE SURE EVERY TIME THERE IS ELECTRICITY, THAT THE GENERATOR IS NOT IN A SELF- EXCITATION STATE WHEN IT IS CONNECTED TO THE NETWORK, AS

TO AVOID OPERATIONS ON A DISCONNECTED NETWORK.

read carefully the chapter about the protections to adopt.

CONNECTION TO THE ELECTRIC NETWORK

IMPORTANT

- **All maintenance operations on the electric components MUST be done by skilled personnel**
- **Make sure that the feeder line corresponds to the tension and frequency values written on the rating plate.**
- **It is necessary to connect the machine to an electric feeder line with serviceable earth plate.**

ELECTRICAL INSTALLATIONS SCHEMES

In this paragraph you will find the explanation of the electric systems schemes for a correct TOTEM installation

IMPORTANT!

The electric system sizing and installation criteria are reported in the chapter 2.14 of the Technical Documents.

The operation rules contained in the following TOTEM electric schemes are not to modify without the written authorisation of TemEnergy.

CAPTION

A) Frequency and voltage protection device

B) Parallel remote control switch

C) Power connection terminal board

D) Auxiliary connections terminal board

E) Public electric network

F) Feed connections terminal board

F2) Overload cut-outs for each TOTEM unit

F3) General switch

FA) Feed protection fuses.

DIAGRAM OF CONNECTIONS FOR SINGLE TOTEM

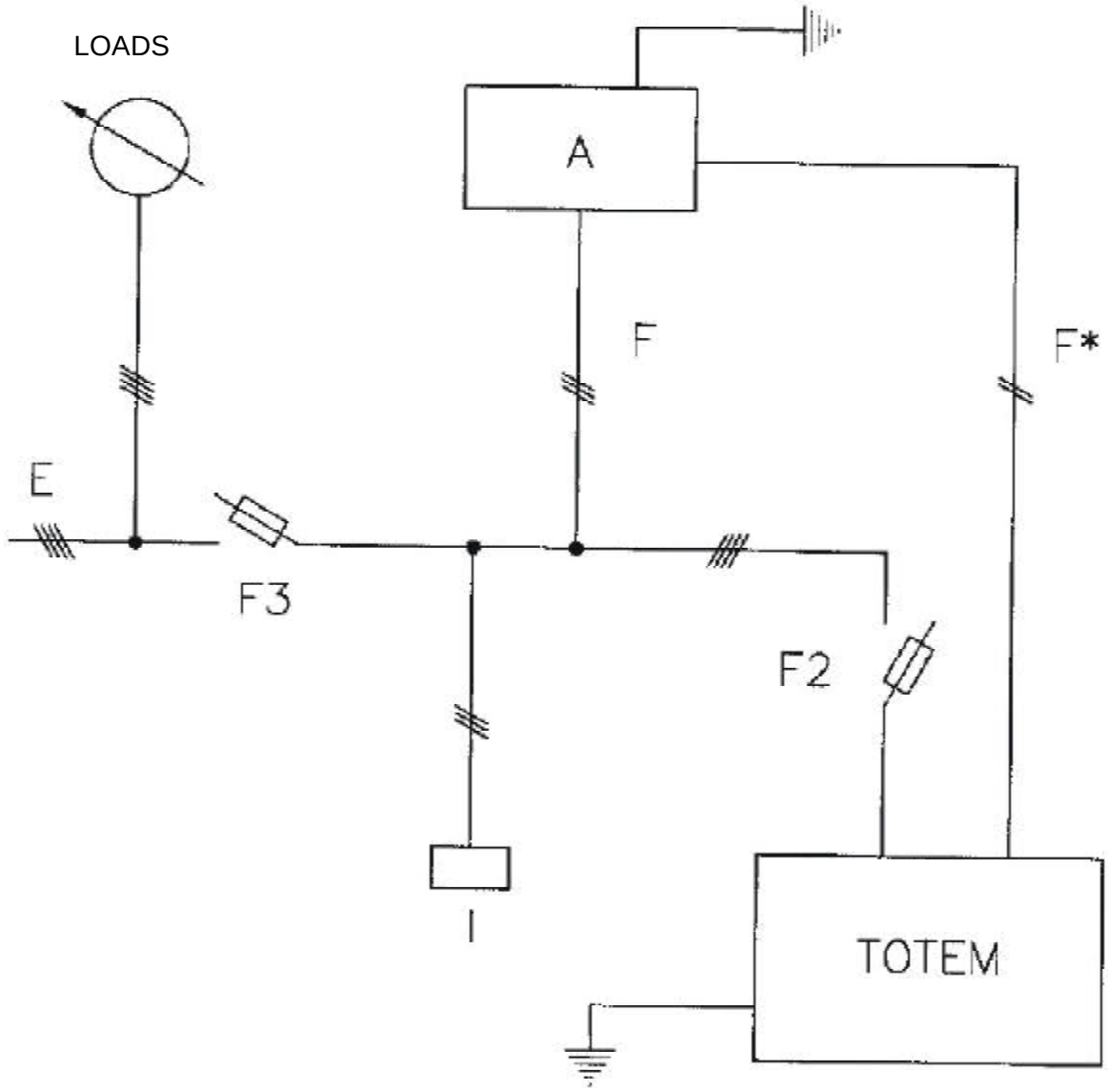


Fig. 12

DIAGRAM OF ELECTRIC GENERAL CONNECTIONS FOR SINGLE TOTEM

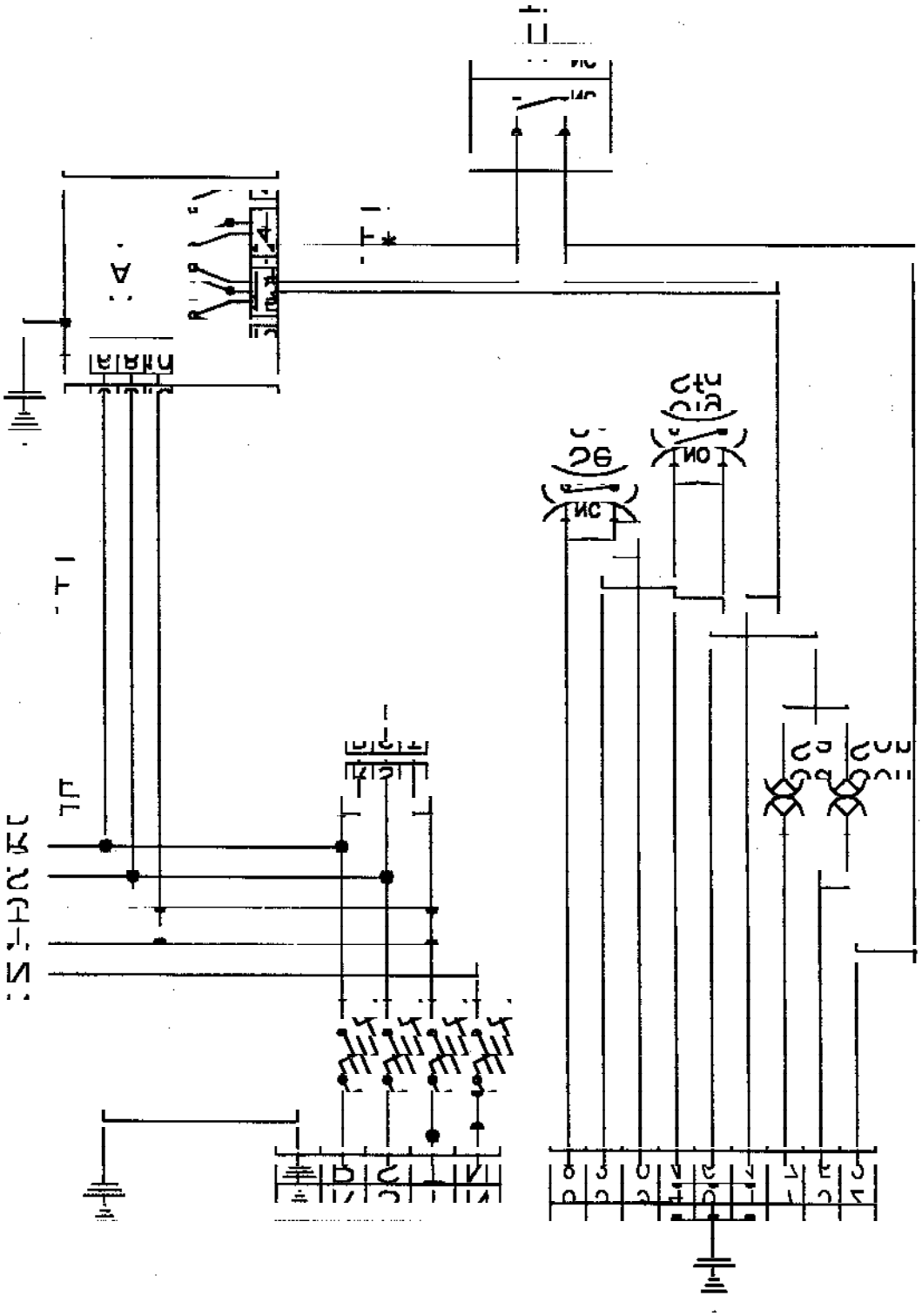


Fig. 13

DIAGRAM OF CONNECTIONS FOR MULTIPLE TOTEM

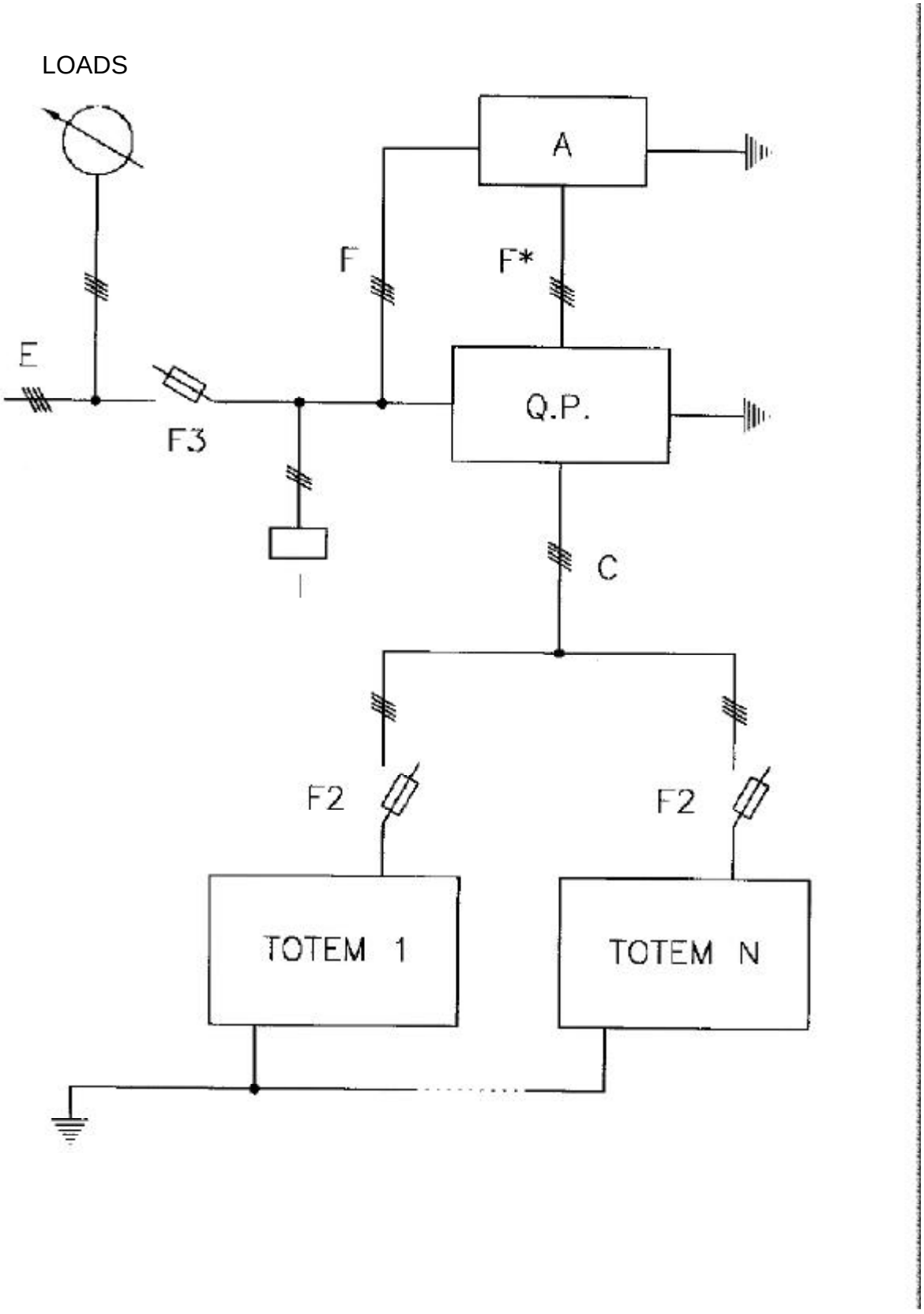


Fig. 14

PARALLEL BOARD FOR TOTEM MULTIPLE INSTALLATION

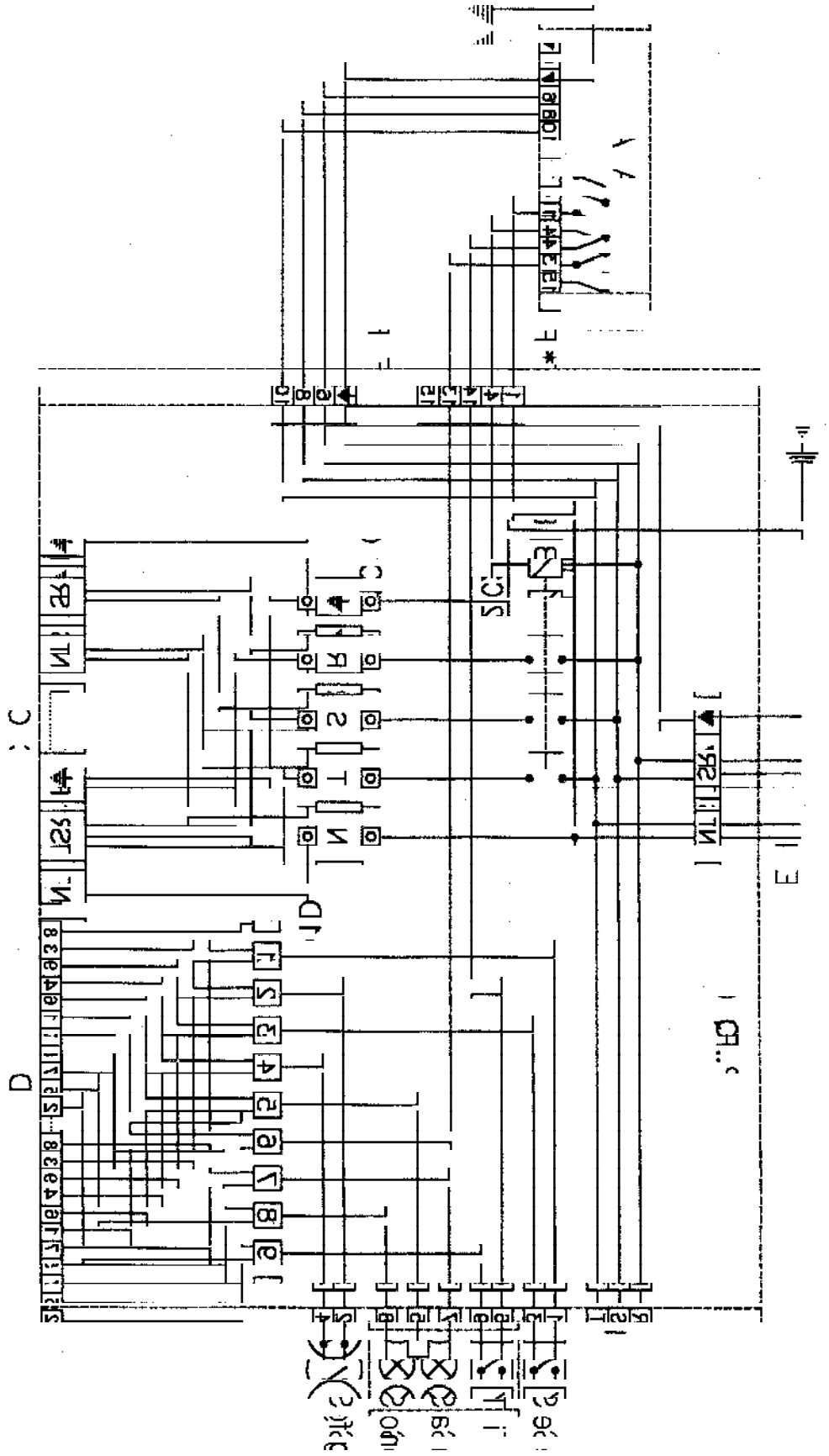


Fig. 15

DIAGRAM OF ELECTRIC GENERAL CONNECTIONS FOR MULTIPLE TOTEM

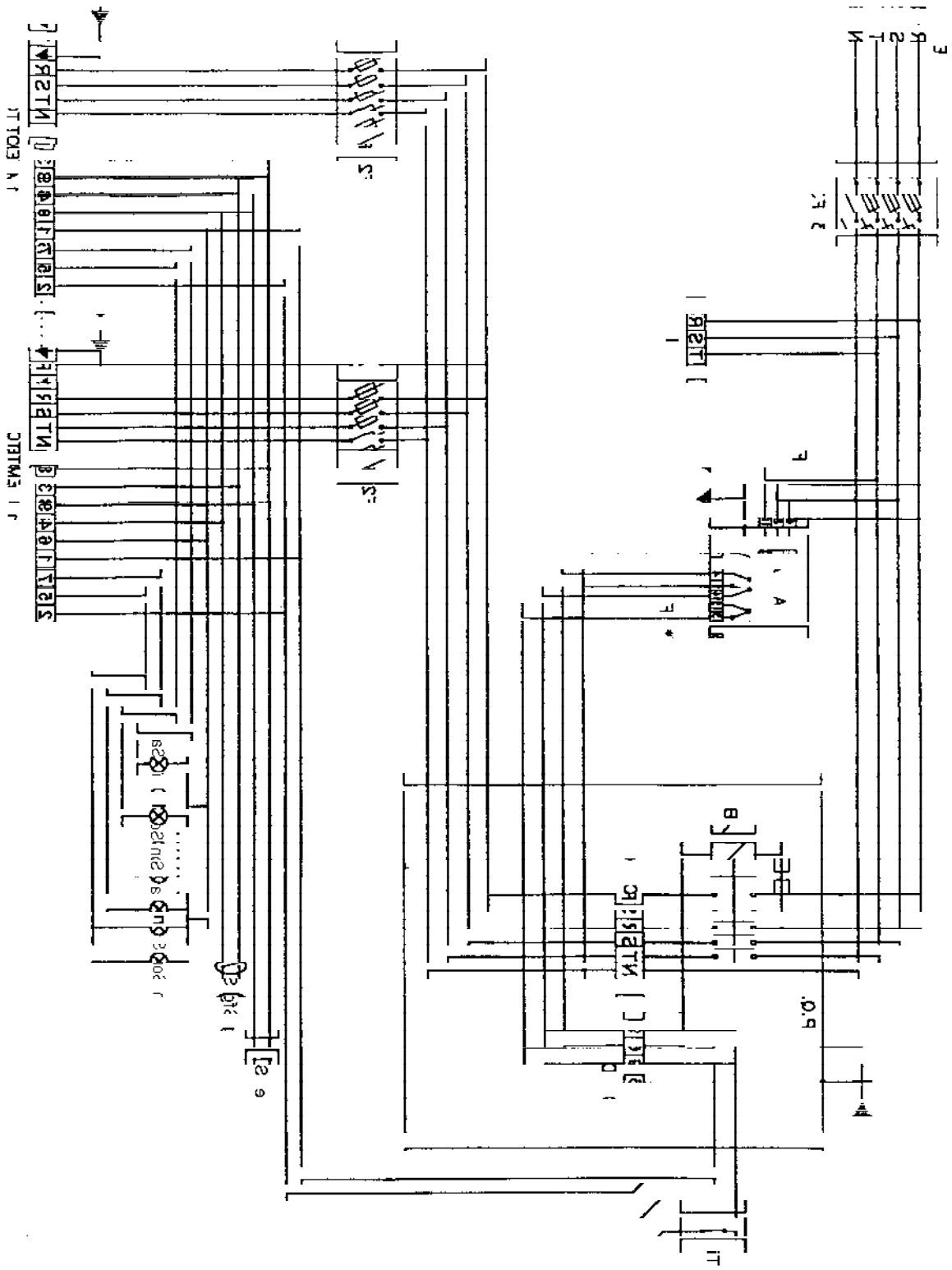


Fig. 16

9 - REGULATION AND ADJUSTMENT

FT) Parallel remote control switch protection fuses

H) Parallel remote control switch command relay

I) Power factor improvement battery connection terminal board

L) Remote control switch

Q) Priority loads terminal board

QP) Parallel switchboard

Sa) outside alarm (not supplied)

Se) Emergency stop (not supplied)

Sfg) Gas sensor (not supplied)

Son) TOTEM state signal (not supplied)

Ti) Plant thermostat (not supplied)

PRELIMINARY CONTROLS

Before the starting make sure that:

1. the gas circuit is ready and connected, as explained in the specifications
2. the connection to the electric network has already been established
3. the hydraulic connection has already been established
4. the exhaust pipe is connected and the condensation water sump pit is full, as stated in the specifications
5. skilled personnel for the system inspection is available (electric and hydraulic system)

INSPECTION BEFORE STARTING

1. Examine TOTEM from outside and write in the system starting report whether damages have occurred during transport.
2. Remove the isolating panels and control that the data reported on the equipment card are the same reported on the generator and on the motor rating plate (control all retrofits required by the Technical Assistance).
3. Check with an electrician all electric connections, the phase-phase and phase-neutral tensions and the right network connection (correspondence among the RST phases).
4. Check the effectiveness of the TOTEM plant's earthing.
5. Make sure that there is a fuse protection device (for the sizing see the installation scheme) or the magneto-thermal.
6. Sectionalize the network tension and the TOTEM network connections.
7. Check the presence of the gas filter and of the possible traps for biogas condensate.
8. Verify that all sectioning valves work.
9. Connect the feed gas pipe by inserting a manometer and keeping the sectioning valve closed.
10. Connect the following circuits on the terminal board (in case they have not already been connected):

- (Son) TOTEM ON signal (12V) at the terminal boards 5 - 6
- (Sa) alarm signal (12V) at the terminal boards 6 - 7

connection to the general switchboard:

- (Ti) plant thermostat at the terminal boards 1 - 2
- (Se) emergency stop at the terminal boards 8 - 9
- (Sfg) gas sensor at the terminal boards 3 - 4
- note: since the remote control and the machine thermostat are N.C. contacts during the unit's working It's necessary to connect the relative terminal boards if they aren't inserted in the system.

11. Check that oil and water level are as required

- note: In case the system is new, verify the hydraulic system filter efficiency, and decide how often the operators MUST check the filter, until it is completely clean.
- disconnect the line switch
- unscrew the sparking-plugs
- start the group with the gas circuit closed and with the secondary circuit open, by pass bond for minimal
- let it run for about 10 minutes
- stop the electric motor
- screw the sparking-plugs and remove the by pass

CONTROL AFTER THE IGNITION

1. Start the group and bring it to its conditions of normal operation

2. Verify that with all TOTEM operating, the connection of whatever load (i.e. burners) on the gas plant does not determine variations out of tolerance as regards the gas pressure to the TOTEM.
3. Check that the gas pressure at the TOTEM inlet be constant within the field, first with all TOTEM connected and than with all TOTEM disconnected
4. For the biogas installation, it is necessary to analyse the gas quality (humidity less than 17 gr/m3, corresponding to steam dry mixture at a temperature of 20 °C; H2S content less than 0,10%; dusts of dimensions less than 5 micron)
5. Check that the counter-pressure at the exhaust be less than 0,5 kPa (50 mm H2O) with all TOTEM connected.
6. In case of two or more TOTEM, verify the absence of eventual exhaust gas returns from operating TOTEM to stopped TOTEM. If necessary, act on the exhaust installation, pre-arranging the situation in such a way that gases be conveyed towards the outlet
7. Check the plant condensate discharge

10 - MACHINE STARTING AND USE

8. Adjust the maximum power with verification of CO less than 0,2% (more or less 0,1%)
9. Record the power obtained and eventually the consumption on the starting ratio.
10. Check the correct operation of the external thermostat
11. Whit TOTEM operating, verify the connection of whatever hydraulic load (three-way valve) and/or pump on the plant, controlling that no variations out of tolerance of the water capacity to the TOTEM arise.
12. With the TOTEM stopped, bring the water and oil reserve to the maximum level.
13. Record the number indicated on the hours-counter.
14. Disassemble the instruments employed.
15. Assemble the isolating panels

ATTENTION!

- **UNAUTHORIZED PERSONNEL CANNOT WORK ON THE MACHINE**
- **THE OPERATOR HAS TO MAKE SURE THAT ALL PROTECTIONS ARE IN THE RIGHT PLACE AND THAT THE SECURITY DEVICES ARE PRESENT AND SERVICEABLE.**
- **ALL MAINTENANCE OPERATIONS ON THE ELECTRICAL PARTS MUST BE CARRIED OUT BY SKILLED PERSONNEL**
- **THE MACHINE MUST BE CONNECTED TO AN ELECTRICAL FEED LINE, WITH AN EFFICIENT EARTH SWITCH**
- **DURING ITS OPERATION TOTEM IS LIVE: DO NOT OPEN THE SIDE, FRONT AND BACK PANELS.**
- **IF THE MACHINE NEEDS TO STOP IMMEDIATELY AFTER STARTING, PRESS THE SELECTOR, FUNCTIONING ALSO AS EMERGENCY STOP, WHICH IS A ROTARY RED LEVER ON A YELLOW BACKGROUND (FIG.17)**

CONTROL PANEL DESCRIPTION (PLC VERSION)

In standard conditions, both PLC module and EXOR module keyboard + display on the machine, are normally running. Therefore, to switch the machine off completely it is necessary to open the switch disconnecting the main input of these two components.

In any case, when the switch is closed, both display module (through the special 220 V AC/ 24 V DC feeder) and PLC are operating, even if the remaining machine is disconnected (machine OFF). With machine OFF it is possible to carry out the setup procedure or to set all the machine at ON condition, ready for operating in normal service conditions.

Setup procedure

By pressing HELP and CLEAR keys at the same time for two seconds at least, you enter the main setup menu.

The first setup item is the language selection. The display will show the following message:*

SELECTOR

Fig. 17

CONTROL PANEL

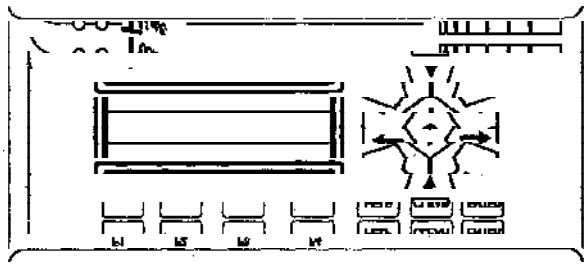


Fig. 18

Setup mode

OIT 1EN 2FR 3DE 4SP

Using the (⇑) and (⇓) keys it is possible to look through the setup menu lines which will appear as following:

Setup Mode

OIT 1EN 2FR 3DE 4SP

Language selection

Initial waiting time

Start waiting time

Catalyzed (1 = YES)

Min. power value

Min. power time

Max. power value

Max. power time

Working hours

Press HELP to exit

Hour-counter set

From any line of the set up page, it is possible to exit from the configuration modus pressing HELP key, provided that the cursor is not active (blinking).

* The quoted messages refer to English language. In accordance to the selected language, the corresponding messages will be shown.

Let's analyse single setup menu items.

Language selection: from this line it is possible to select the language for the displayed messages. Pressing the (⇐) key, the cursor will start blinking , select the language required by using the (⇑) or (⇓) keys.

0 Italian

1 English

2 French

3 German

4 Spanish

Press the ENTER key when you have selected the required language, all menu items will be in the selected language.

Initial waiting time: it shows the initial waiting time, i.e.: the time between start control and the actual start. It is mainly used in the case of multiple machines running in parallel to avoid excessive take-off during possible simultaneous start. This value can be fixed in a field between 0 and 25 seconds. After positioning this line, press the (⇐) key to activate the cursor, which starts blinking in correspondence of the relevant 2-digit field. Select the required value through (⇑) or (⇓) keys, and confirm by pressing ENTER which will return you to the menu.

Start waiting time: it shows the time required between an outside consent lock, remote control or plant thermostat, and real start cycle beginning (initial waiting and real start): it can change in 0-800 seconds. After positioning on this line, press the (⇐) key to operate the cursor which will start blinking. After selecting the required value with (⇑) or (⇓) key, confirm by pressing ENTER which will return you to the menu lines.

Catalyzed: it must be specified if the machine is a Base standard or a Base Catalyst, so that the software caninterpret signals coming from the devices existing on the catalyzed machine only (lambda feeler, k feeler).

Press the (⇐) key to operate the cursor, which will start blinking, it is only possible to give the value "0" (standard machine) or "1" (catalyzed machine) using the arrow keys. After confirming the value by ENTER, you will enter the main setup menu again.

Min. power value: it shows the lower limit of delivered power, (expressed in kW), under which the minimum power alarm releases. Operate the cursor with (⇐) key to set a value between 0 and 24 kW. Confirm with ENTER key.

Min. power time: the min. power alarm releases when the measuring transducer measures a delivered value under the limit consecutively pre-set, for a time to be determined in this menu item. If the value of the measured power exceeds the minimum limit, even for a split second, the counting restarts from zero. This value can be set in a time interval 0-30 seconds. Confirm with ENTER to enter setup menu.

Max. power value: it shows the max. limit over which the max. power alarm is released. Its value can be set in a range between 0-24 kW, but if it is not compatible with the previously set value as minimum limit, it will not be accepted. The procedure to operate the cursor and to modify the settings is the same as above.

Max power time: it is the time in which the system consecutively measures a value over the limit to release the alarm. It is between 0 and 30 seconds according to the usual procedure. Confirm with ENTER to enter setup menu.

Service hours: it shows the corresponding hours to single scheduled maintenance times to be carried out on the working machine; during the normal operation of the machine these hours diminish progressively and when the time interval on the display is zero, the message "Service operation" is periodically shown. To set the value for the service hours required, operate the cursor by pressing the (⇐) key, changing the number with the (⇑) or (⇓) keys, to increase or to decrease. Press ENTER to confirm.

Hour meter set: by running along the setup page you will get the line of the machine service hours. The hour meter shows the real working hours of the TOTEM and is set with the above procedure by operating the cursor, modifying the numbers and confirming with ENTER. It is possible to view the hour meter at any time during the machine operation by pressing HELP key. In PLC memory a second hour meter 15 is available: it cannot be modified or displayed and it reads from the computer all the modifications made to the hour meter on the display.

To exit from the setup mode press HELP key with disabled cursor (i.e.: when you are not modifying a parameter).

DESCRIPTION OF NORMAL OPERATION CYCLE

To enter the normal operation cycle of the machine, set the machine ON by pressing F1 key on the keyboard.

In this way the primary of the main feeder is fed and the 12V and 300 V CC tensions for the components input are generated (starting, gas solenoid valve, auxiliary circuits). The last alarm message will be displayed where a previous error has not been rectified. In normal condition the following messages will be displayed:

"Ready to start"

It shows the machine is ready for starting cycle, unless an outside constraint such as remote control or plant thermostat exists: in this case a waiting message is displayed.

Once ready for start, the machine is started by the start control (button F3). The machine then carries out an inside test cycle to check that there are no existing alarm conditions; if all tests are positive, the start procedure will begin.

"Start procedure"

Once start consent is obtained (absence of outside blocks or alarm conditions), the machine waits for a time equal to the initial waiting time set during the setup procedure, and then, provided that in the meantime no conditions prevent it from starting,(such as alarms, outside blocks or by pressing STOP key) then the signals for the closing of line remote control switch and for the operation of soft start are sent.

The TOTEM starts slowly in order to allow the engine to run at a slow speed for the first few seconds. If the line remote control switch does not close after a few seconds, the machine stops and the following message will be displayed:

"Line remote control switch not closed"

Once the slow start procedure has finished, the soft start sends a closing order to the by-pass control switch that short-circuits and deactivates it. If the remote control switch does not close, the machine stops after a few seconds and the following messages will be displayed:

"By pass remote control switch not closed"

Closing the by-pass remote control switch will activate the running cycle of the machine.

Normal operation

On finishing the soft start cycle, the machine starts a normal operation cycle, during which 15 kW approx. of electric power and 39 kW of thermal power are produced. Following messages will be displayed:

"Operation OK"

"kW power xx.x"

The second line shows the electric power momentary value in kW delivered by the machine, it changes every 200 ms on the display. This signal comes from the power transducer which sends a 4-20 mA signal to the PLC analogue input.

During the steady state operation of the machine it is possible to display on the first line (instead of "operation OK") the hour meter by pressing the HELP key. The second line shows the power.

Service conditions

By "service conditions" we usually mean operations carried out by the machine involving special conditions not comparable with alarms. If a service condition occurs, the machine stops and waits for the return of the consent signal. Once the signal is received, the system waits for a time equal to the start waiting time set in setup and subsequently, if the OK conditions persist, the above mentioned start procedure is automatically re-started.

In the TOTEM there are two service conditions:

- Remote control: this signal is normally closed, connected in the terminal board with terminals 1 and 2; it can be used to control the machine according to requirements (timer, programmable logic, by outside switch). When opening the contact the TOTEM stops and the display shows "Remote stop". When the contact is closed again, the machine waits for a few seconds and the display shows "Start waiting", then the start procedure is carried out (initial waiting + soft start + operation OK). If this control is not used, do not forget to bridge terminals 1 and 2.
- Plant thermostat: this signal is usually closed, connected with the terminal box (8 and 9), generally controlled by a thermostat placed on the secondary hydraulic circuit. This signal is in series with the temperature sensor bar placed on the electric generator. Opening one of the two thermostats the machine will stop and will display "plant temperature", remaining in this condition until the contact 15 is closed. Closing the machine will perform restart procedure as above mentioned. Even in this case it is necessary to bridge terminals 8 and 9 in case the outside thermostat is not used.

Alarms

Unlike the service functions, when an alarm condition occurs, the TOTEM is stopped and the cause of the defect will be displayed; the TOTEM cannot start again until the alarm is reset by F4 key. The alarm condition will remain also in case of black out.

After having pressed F4 key as alarm reset, the machine checks again if the cause of the trouble is still persisting, if not the machine is reset in "Ready for start", otherwise an error message will be displayed and the machine will be disabled. In case of more alarm conditions occurring at the same time, the TOTEM will stop and the first display line will show the total number of alarms occurred, while the second line will show the relevant messages, that can be read by use of the arrow key (Ý) or (ß). The display will be updated as each condition changes. The machine is blocked until the reset key is pressed.

In the TOTEM base the existing alarm messages are the following:

engine temperature

min. oil level

oil pressure

gas leak

min. water level

catalyst temperature

min. power

max. power

line remote control switch not closed

by-pass remote control switch not closed

Engine temperature: this signal is normally closed (NC) and comes from the two bar sensors placed on the cylinder head and on the gas-water exchanger connected in series by passing through terminal 10 in the branch box to the PLC input 0 (wire 20). Opening the contact (by one only thermostat or both) the machine will stop; it can restart again only by closing the contact and pressing F4 key (reset).

Min oil level: this signal is normally closed and comes from the level indicator on the oil tank, passing through the terminal 11 to PLC 1 input (wire 21). If the oil level is under the pre-set limit, the contact opens and the machine stops. To restart the machine reset oil level and press F4 key.

Oil pressure: this signal comes from the oil pressure switch placed on the lower part of the engine, passing through terminal 12, arriving at the PLC input 2 (wire 22). The pressure switch is normally open and closes at 180+220 kPa, therefore when the machine is stopped it is open and it closes after a few seconds of operation. This is one of the alarms not considered during the inside tests before starting; during the soft start cycle it is not considered, therefore it can close before the steady state operation. In this case the contact is open and the TOTEM stops.It can be restarted by pressing F4 key.

Gas leak: this signal is normally open (NA) and comes from an outside gas detector (option) connected in the terminal box to terminal 3 and 4 brought to the PLC at input 5. Closing this contact stops the machine working in any condition (steady state, start, waiting). To restart, the contact must be open and the reset key (F4) pressed.

Min. water level: this signal is normally closed (NC), it comes from the water level sensor placed on the liquid tank of the catalyzed machines. It passes through the terminal 14 in the junction box to the input 8 of the PLC. The software will recognise the signal only if the

machine has been defined as catalyzed when the TOTEM was initially set up. The opening of the contact will stop the machine and sound an alarm and the TOTEM will only restart when the contact closes again (resetting the correct level) and pressing reset key (F4).

Catalyst time: this signal is normally open (NA), it comes from pin 1 of the title and temperature control card of the catalyst arriving at input 9 of the PLC. The signal is present only on catalyzed TOTEM. Excessive temperature on the catalyst (598° C approx.) causes the signal at equivalent tension brought by the K feeler to the card, operates a relay which closes to earth the signal coming from its pin 1.

The PLC stops the machine and the restart procedure can be carried out only when the cause is removed and the alarm reset.

Min. Power: when TOTEM is outputting power which is under the pre-set minimum level, the machine stops. The 4-20 mA current signal is transmitted to the analogic input on PLC side from outputs 9 and 10 (wires 87 and 88) of the UNIDATA power transducer, which gives a proportionate value to the measured active power. To restart the machine press F4 key (reset).

Max. Power: once the max. power limit and time are set, the machine reads the value at the PLC analogic input and should the measured power exceed the maximum level for the required time, the machine stops. Reset to restart.

Line remote control switch not closed: this signal comes from an auxiliary contact of the line remote control switch. When the machine closes the contact input A of the PLC (wire 30) receives confirmation that the contact is closed.

If it does not close the machine does not start and an alarm message is displayed. Close the switch and press F4 key to restart the machine.

By-pass remote control switch not closed: this signal comes from an auxiliary contact of the by-pass remote control switch.

Once the soft start has accomplished its task, it sends a signal directly to the coil of the by-pass remote control switch that closes also the contact arriving at the PLC input B (wire 31). If within a certain time after starting this signal does not arrive to the logic, the machine is stopped with the relevant message on the display. Close the switch and reset the alarm to restart.

DESCRIPTION OF THE SOFT START SET UP ROUTINE

A top view of the soft start shows 2 adjustment trimmers. Their positions are shown in the figure below:

Trimmer A is relative to soft start time. It is the time in which the starter acts before being bypassed.

Clockwise rotation is calibrated to 13+/-15 seconds during test.

Be sure this time is not too long or the main switch may cut out (overload).

Trimmer B is relative to the reference speed for the adjustment of the soft start operation. The speed is increased by turning the screw clockwise.

It is usually recommended to start from the

SOFT START

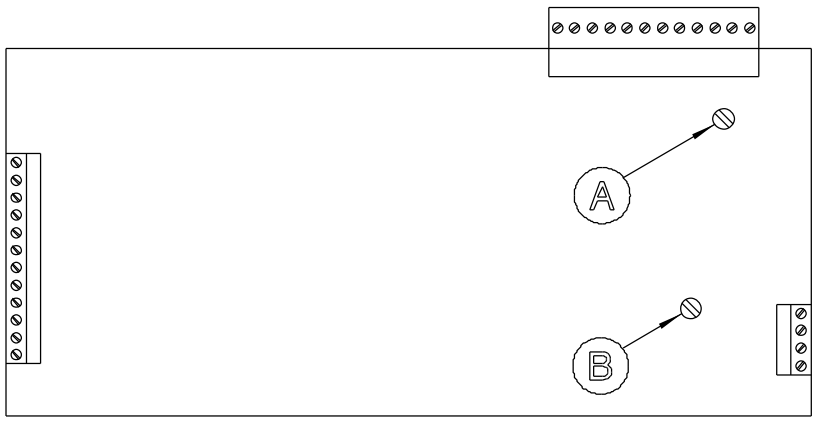


Fig. 19

maximum adjustable speed and to decrease progressively until the optimum point.

Starting from minimum you risk excessive absorption which may cause the opening of the main switch for overcurrent (the lowest is the reference speed, the highest the absorbed current).

DESCRIPTION OF OPERATING MODES

MAINS PROTECTION DEVICES

As for the safety of an asynchronous public network generator parallel (MT and LT) you MUST:

"MAKE SURE IN ANY ELECTRICITY CONNECTION STATE THAT THE GENERATOR IS NOT WORKING IN THE SELF-START MODE WHEN CONNECTED TO THE NETWORK, TO AVOID ANY OPERATION ON A DISCONNECTED LINE".

We would like to underline that the asynchronous generator working in parallel to the public electric network delivers electricity to the tension and frequency values imposed by the network, giving the machine the reactive power it needs (power factor = 0,86 in the max power conditions in case there is no external power factor improvement system).

When the network to which TOTEM is connected or part of it is disconnected (line or black-out maintenance), Totem can go on working if the network is particularly capacitive. The operation point depends on the network equivalent parameters (resistance, efficiency, and inductance.) fixing the voltage and the frequency values, which keep the system in balance. Experimental self-start measurements have shown that the balance points have voltages between 300-600V and frequency values between 42 and 59Hz.

CHARACTERISTICS OF PROTECTION DEVICES

The purpose of protection devices is to monitor the three-phase voltages and the mains frequency by generating a signal when al least one of the factors being controlled falls outside the permitted limits.

The maximum voltage threshold has been determined on the basis of voltage excursions on LT mains. The minimum voltage threshold has been determined considering that possible mains failures (due, for example, to a short circuit on LT mains) should not interfere with TOTEM operation as TOTEM may, in this case, support the mains with its own power contribution, even if limited.

PARALLEL AND NON PARALLEL OPERATION

Because of its internal characteristics TOTEM base can work only if it is parallel to the network. Where an anomaly is found, it stops immediately.

The stop takes place at three levels:

- line remote control switch opening
- gas sensor solenoid valve closure
- engine electronic injection stopped

After it has stopped Totem base can restart only through the network (asynchronous machine used as group starting motor). It means that Totem cannot restart until the network is present again, since there would not be sufficient energy for the asynchronous motor.

If tension and frequency protection devices remove the alarm signal, Totem restarts and the network parallel mode re-establishes automatically: in the asynchronous machine, already connected to the network as motor, there is a shaft torque reversal, a change of the electricity sign, and then it operates as generator without electrical interruptions.

During operation the neutral generator is not connected to the network neutral, since it is

TYPE OF INTERVENTION	THRESHOLD VALUE	TIME OF INTERVENTION
max voltage (Vn = 380V)	1,20 Vn	100 ÷150 ms
min voltage (Vn = 380V)	0,80 Vn	100 ÷150 ms
max frequency fn = 50Hz	1,02 fn	< 100 ms
min frequency fn = 50Hz	0,98 fn	< 100 ms

wound up as a "triangle".

AUTOMATIC HANDLING OF ON/OFF SEQUENCES

Before starting the machine make sure that:

- the circulation pumps of the hydraulic circuit are preset for starting;
- the water temperature control thermostats are set to the value the system requires;
- all the hydraulic circuit and gas feed system manual gate valves are open;
- check that the general system remote control command and the thermostat are closed, and that there are no anomalies;

The TOTEM Base has to work in parallel to the public network as on/off cogenerator.

Tension and frequency are imposed by the network, also delivering the necessary energy to start the machine; it guarantees safety, since disconnected lines cannot be activated.

In case of electrical black-outs TOTEM cannot go on working; when electricity is delivered again TOTEM restarts automatically after a pause, programmed by the sequential timer.

TOTEM will start only if the system remote general control or thermostat are closed and if no mains malfunctions are present (voltage and frequency, minimum oil level and gas leak).

The machine will start, connecting the asynchronous to the network, through a "soft-start" static starter. The acceleration to about 3000 rpm goes through an asynchronous motor/ generator, working initially as electric motor. In this case we can guarantee the engine starting in all ambient conditions; the asynchronous exceeds the synchronous speed, becoming an electric generator.

Since the engine feed cannot regulate itself automatically, the generator delivers the maximum available power.

The group stop command can be:

- manual (selector OFF or STOP key or selector on 0)
- automatic (plant temperature signal or general system remote control command signal)
- automatic (group failure or safety thermostat)

In these cases the control:

- closes the gas solenoid valve
- opens the starting feed contact
- opens the line and by pass remote control switch

The system state is displayed (rest or failure). In case of anomaly the "alarm" led lights up.

11 - MACHINE START-UP AND USE

The restart of TOTEM depends on the stop procedure we have chosen:

- In case of manual STOP a manual START is required;
- In case of stop caused by the external thermostatic command, the closure of the output contact will initiate new automatic restart;
- in the case of a failure a maintenance operation is required; Afterwards the machine can be restarted manually, following the sequence STOP/RESET/START;

If the machine is disconnected for long periods of time the on/off selector has to be set at off; all leds must be off as well, and the last information displayed is memorized.

ATTENTION!

If the machine stop is caused by the emergency KEY, the machine resets to the initial starting conditions. To restart it, it is necessary to reset the same initial conditions.

MULTI-TOTEM MANAGEMENT

TOTEM base is pre-set for the MULTI-TOTEM operation, the connection of different machines is possible.

For the right TOTEM operation during the starting phase the sequential timers of the single TOTEM units - must be calibrated as required.

The sequential timer of a single TOTEM has to be calibrated to at least 9 seconds and the other possible auxiliary TOTEM units MUST be calibrated to intervals of 10 seconds or more.

CHAPTER OBJECTIVE

In this chapter we will describe the electric and electronic subsets and the TOTEM operation mode. The maintenance operator should read this chapter in cases of difficulty or for a better understanding of the maintenance procedures.

ELECTRONIC CONTROL

The TOTEM maintenance and control go through an electronic system, made of a microprocessor, A/D converters and analogical transducers. The TOTEM transducer analogical signals (pressure, temperature, level, etc.) are digitally converted and sent to the microprocessor.

If the controlled values exceed the threshold ones, the microprocessor blocks the TOTEM operation, and the error causing the stop is displayed (min. pressure, gas leak, runaway speed rate).

The electronic components control the start/ triangle starting for the Stand-by and island versions, and soft start for the base version and the self-protection TOTEM system for errors in the engine, the hydraulic circuit and electricity delivery.

This operation in particular is done by the EMI-

ELECTRONIC IGNITION BLOCKS SCHEME

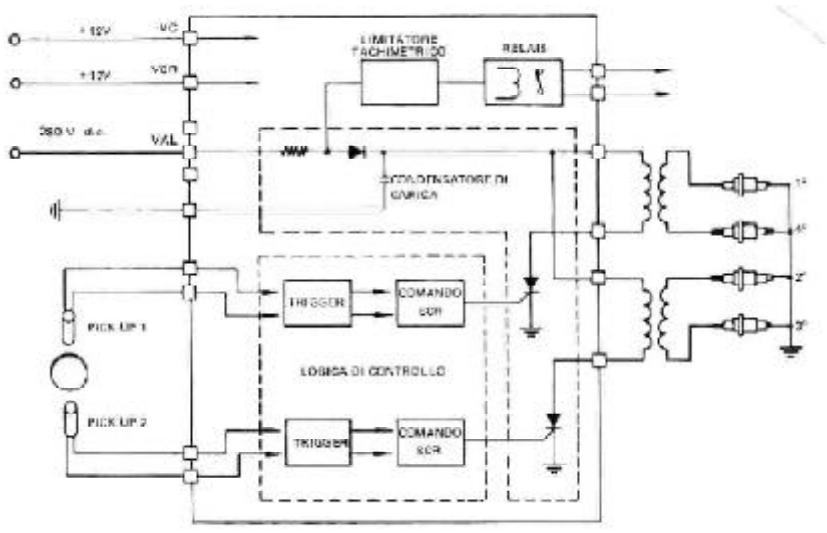


Fig. 20

GENERATOR DIRECTION OF ROTATION			
GAS TYPE	GPL	METANO	BIOGAS
TOOTH POSITION OF REFERENCE TOOTH ON THE TRANSMISSION			
ANGLE OF LEAD	25	35	45

027 FT, equipped with three amperometric transducers. There is also the external protection device DMA400 Tytronic, verifying the network characteristics. The operating electric scheme is shown in the figure.

For the island operation mode the network frequency control and the electric power modulation, related to the users request depends on the feed ducting throttle.

This is a control loop, eliminating the network frequency variations, acting on the linear motor command. This command starts the throttle on the ducting. With an electric load variation, the asynchronous generator varies its own sliding and the frequency varies as well (the instantaneous speed rate does not vary). The control registers this frequency change and gives a command to the throttle actuator. The frequency goes back to the nominal value and the engine rectifies its operation point to adapt to the different power value required. As the system reacts very quickly, the control is accurate and precise.

ELECTRONIC CAPACITIVE DISCHARGE IGNITION

The electronic ignition has a capacitive discharge with static high tension distribution, which is foreseen as TOTEM motor equipment.

It works at the same speed and therefore with constant angle of lead. It consists of:

a) Electronic control module

b) Two electromagnetic pick-ups

c) Two double H.T. output bobbins

The ignition system (Fig. 21) was designed to be assembled on the motor-generator group of TOTEM, and more precisely:

- The picks up are inserted directly on the

ELECTRONIC IGNITION

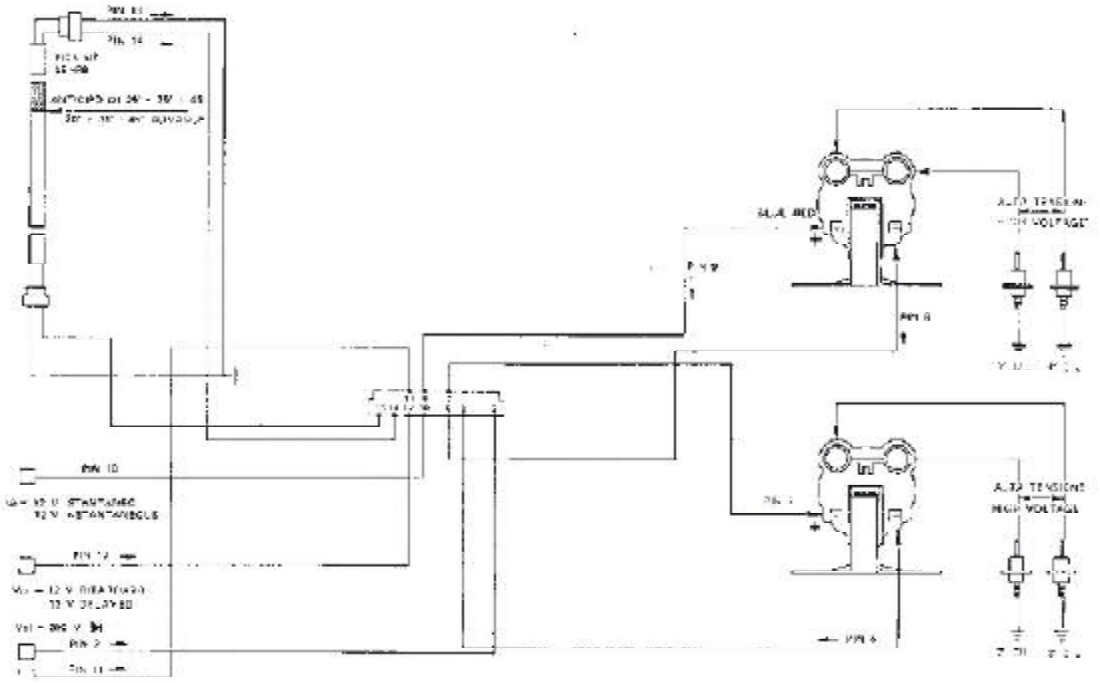


Fig. 21

generator, facing the reference tooth with defined timing of the required ignition lead (35° for natural gas, 25° for L.P.G., 45° for biogas);

As the engine starting is controlled by the soft start, there is no change in spark advance. It is possible to select an angle of lead among the three possible tooth reference assembly positions (on the transmission disk) switching on the magnetic ignition rectification boosters. The right angle of lead is selected as a consequence of the used gas.

Each bobbin controls two sparking-plugs, those of the cylinders 1 and 4 and of the cylinders 2 and 3.

The high tension has to feed the sparking-plugs; because of the particular closure of the secondary circuit (series sparking-plugs) its intensity will be different.

One of the two sparking-plugs will be periodically in the compression phase, the originating spark will be bigger, in the other phase it will be smaller.

The feed comes directly from the power line, after the uncoupling with a transformer, and the rectification through a diode bridge and the filtering with a condenser.

The principle is based on the partialization of the wave form applied so as to supply a peak current for starting the engine to overcome inertia.

Thereafter it regulates the efficient value of the voltage for proceeding with a slow start that reduces stresses to the minimum. After the start, following the controls on the machine, the soft start is by-passed and is electronically deactivated, in order to be ready for the next operation.

To limit the engine rpm during the start phase in a most economical way from the operative conditions, the new release of soft start has been equipped with a tachometric feedback which checks the signal of the pick-ups present on the alternator

COMPOSITION:

The soft start is composed of:

TABLE 3: ELECTRIC GENERATOR CHARACTERISTICS	
TYPE (EUROPE)	Asynchronous three-phase generator
CONNECTION	triangle
SYNCHRONISATION RATE	3000 rpm
FREQUENCY	50 Hz
VOLTAGE	400 V (phase-phase)
MAXIMUM NOMINAL POWER	15 kW
MINIMUM USER POWER FACTOR	0,85
ELECTRIC DELIVERY	0,90 (under nominal conditions)
DELIVERED CURRENT	26,5A (without power factor improvement)
DELIVERED POWER	22,8A (with power factor improvement)

- module at controlled diodes
- control card code 000155
- synchronism transformers card code 000157
- tachometric reaction card code 000182 (if foreseen)

TEST PROCEDURES AND SET UP

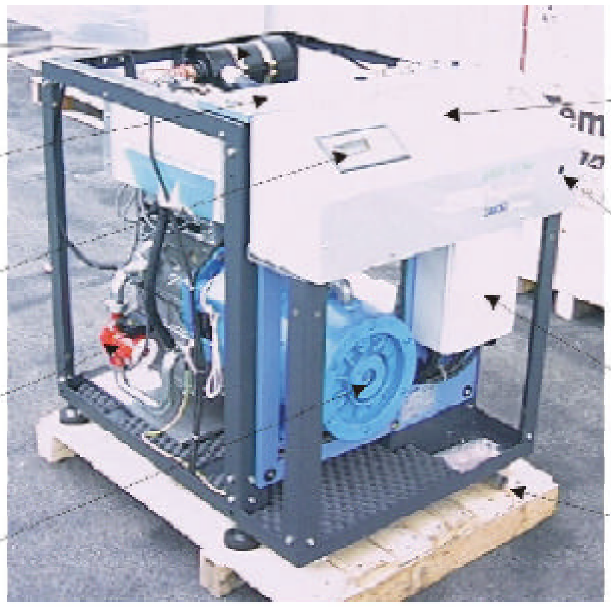
The soft start is supplied with the following regulation trimmers

- PT4 initial current for moving the alternator
- PT2 total start time
- PT1 Regulation of minimum speed (if foreseen)

Switch on the machine and verify that the start

12 - MAINTENANCE

LOCALIZZAZIONE PARTICOLARI TOTEM



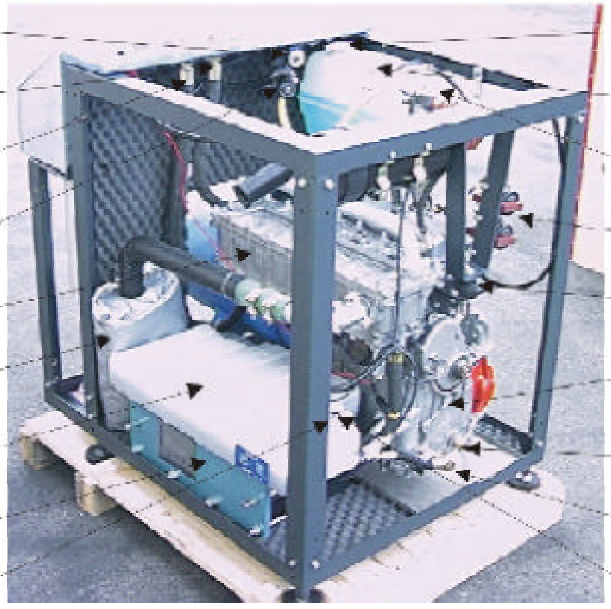


Fig. 22

occurs without difficulties and without uncertainties.

In case of misfire or an erratic start turn off and rotate PT4 1 revolution anticlockwise. If a longer total time is required, rotate the trimmer PT2 anticlockwise.

On the machines on which is installed the tachometric feedback, regulate the rotation speed during the phase of soft start acting on PT1

ELECTRIC GENERATOR

Electric energy is delivered by an asynchronous three-phase machine with rotor and water cooling liner.

This structure has a lot of advantages making it competitive, as for power, in comparison to the synchronous generator.

- lower starting costs
- a rotor (easier and more resistant)
- no separate excitation (CC generator)
- very simple protection and control devices
- no synchronisation device (parallel connector)
- no harmonics
- impossibility to feed short-circuits
- minimal maintenance costs

ELECTRIC GENERATOR AND POWER FACTOR IMPROVEMENT SYSTEM

Table 1 contains the main characteristics of the asynchronous generator used (for high tensions see technical data characteristics).

In the table you can see a 0,86 power factor, corresponding to a 8,9 kVa reactive power consumption. The current necessary for its operation is taken from the public electric network, without it no power delivery is possible.

In case of tariffs problems with the electric companies it is possible to assemble a power factor Improvement condensers group, which can overcomel the reactive power of the network and bring the generator power value to a value next to 1.

THERMAL ENGINE MAINTENANCE PROCEDURE (GROUP A)

SPARKING-PLUGS REPLACEMENT

- Unscrew and remove the four cornet head sparking-plug
- Replace the spark plugs ensuring the gap between the electrodes is 0,4mm; in case of biogas 0,5 mm
- Screw the spark lugs tight again

Note: After completing this operation make sure that the connections on spark plugs and bobbins, starting bobbins, pick up and starter are stable and not oxidised

OIL TOPPING UP AND COOLANT

- Unscrew the service plug and fill the oil tank, until it is 10-15 mm under the border limit.
- Unscrew the water tank service plug and fill the water expansion tank with a mixture of 10% water, 11% Fiat Paraflu until the tank is 7/8 full.

OIL PRESSURE CONTROL

- Remove the oil pressure transmitter, set on the motor bed, on the cartridge oil filter side.
- Assemble the manometer with scale end 8 kg/cm2 (800 kPa).
- During operation the pressure cannot be under 3,5 kg/cm2 (350 kPa) with hot oil.

TABLE 4: WATER PUMP REPLACEMENT - TECHNICAL CHARACTERISTICS	
MAX OPERATING PRESSURE	10 bar
TEMPERATURE RANGE	-20° to +110 °C
AMBIENT TEMPERATURE	+ 40 °C Maximum
WATER + GLYCOL MIXTURE	up to 15%
SALMSON CLX 80-25	+1° a 110 °C (option -20 °C to +110 °C)
ATTENTION! Never run the circulating pump dry.	

MOTOR OIL AND OIL FILTER REPLACEMENT

- When the motor is warmed up stop the group and place the driving shaft on the top dead centre;
- Let the pan and auxiliary tank oil drain though the manual cock
- Remove the auxiliary tank and empty it after the auxiliary tank has been detached
- Unscrew the oil filter;
- Lubricate the new filter seal with motor oil;
- Manually screw the filter and the corresponding support;
- After the seal has reached the base, screw it manually for ¼ turn;
- Mount the auxiliary tank again and reconnect the pan coupling;
- Remove the oil filler plug from the auxiliary tank and from the tappet cover.

Pour3 kg of oil through the tappet cover and 13 kg in the auxiliary tank (fill it to the Maximum limit);

Screw the plugs on the tappet cover and on the auxiliary tank again.

Note: to facilitate the oil and a possible slag outlet from the oil pan, unscrew the connection screw located between engine support and frame (Fig.22)

ATTENTION!

Dispose of the oil and cartridge according to the ecological laws in force.

WATER PUMP MAINTENANCE

The circulating pump does not require a particular maintenance during operation. The motor bearings are self-lubricating. At the beginning of all heating phases or after a long inactivity period make sure that the circulating pump turns freely.

OPERATION PROBLEMS

ATTENTION!

Before any maintenance operation disconnect THE CIRCULATING PUMP.

1. The pump is noisy

- presence of air : bleed the pump as follows. Unscrew the back plug, until there are no air bubbles anymore, then screw the plug up again.
- the suction pressure is too low : increase the circuit pressure.
- foreign matters in the impeller: disassemble the motor and clean the impeller

2. The circulating pump does not start

- shaft block caused by stoppage after a long inactivity period; to remove the shaft stoppage: remove the back plug. Use a flat screwdriver, let the motor shaft turn, screw the back plug again.
- no electric feed : control the motor connection and / or the system fuses
- The motor is disabled : disassemble it and replace it with a motor block of the same type (characteristics on the plaque)
- foreign matters in the impeller

CYLINDER HEAD CLOSURE

ORDER IN WHICH SCREWS ARE TO BE TIGHTENED TO SECURE THE HEAD TO THE ENGINE BLOCK

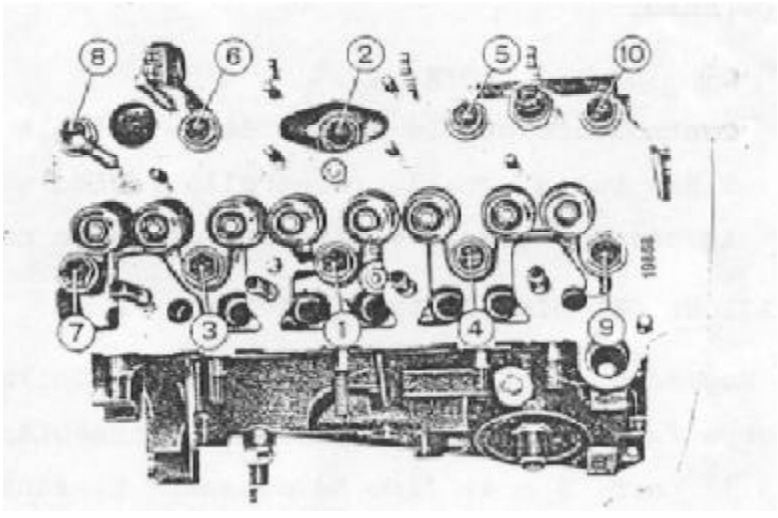


Fig. 23

- Unscrew the tappet cover (T key for 10 mm);
- Remove the air and gas tube;
- Remove the rocker holder;

Close them following the procedure shown in Fig.23 (not greased screws).

As for the assembly repeat the same operations in the opposite order and adjust the tappet as described below.

TAPPET ADJUSTMENT

- remove the tappet cover (10mm key);
- turn manually the driving shaft clockwise, using the 36 mm key on the hub fixing nut;
- reach the balancing (by opening and closing the first cylinder valves);
- adjust the clearance between the valves and the rocker of the fourth cylinder at 0,30 mm, unloose the blocking nut and use the adjust nut, while inserting a feeler gauge between valve and rocker (the feeler gauge cannot be free or spot weld);
- block the adjustment nut of the fixing screws;
- turn the drive shaft until the valves of the third cylinder are balanced and control the clearance between valves and rockers of the second cylinder;
- Repeat the same operations for the first and the third cylinder;
- replace the tappet cover gaskets and mount the cover again;

ADJUSTMENT OF THE MAXIMUM POWER

- Insert a 40 A scale end amperometric pliers on a one- phase, or a three-phase watt-hour metre (scale end 20 kW);
- turn the screw, set on the solenoid valve unit (Fig. 34), till the system reaches the Maximum delivered power. Control that the delivered power corresponds to the one foreseen for the used gas, using the same method applied to verify the efficiency;
- the position reached delivers the Maximum

ELECTRIC POWER	* kW (from the watt-hour metre)
	* read current (A) x Read Tension (V) x 1,47/1000= kW
THERMAL POWER	* kcal/h (from the calorimeter)
	* (T2 output- T1 input)(°C) x capacity(1/h)= kcal/h
INPUT POWER	consumed gas (m3/h)x net heat value(kcal/m3)= (kcal/h)

GAS TYPE		NETWORK METHAN	CITY G110	BIOGAS TYPE 1	BIOGAS TYPE 2
Gas consumption	Nm3/h	5,70	13,04	7,30	8,33
Input power	KW	56,19	52,35	53,04	52,23
Electric power	KW	15,02	14,20	14,40	13,80
Thermal power	KW	39,26	35,82	36,65	36,82
Electric efficiency		0,27	0,27	0,27	0,27
Thermal efficiency		0,70	0,69	0,69	0,69
Global efficiency		0,97	0,96	0,96	0,97
CO emissions	%V	0,06	0,06	0,06	0,06
P.C.I. 0°C-101,3kPa)	MJ/m3	35,30	14,50	26,20	22,60

power, which normally does not correspond to the minimal emissions or to the Maximum efficiency;

- the Maximum efficiency position can be obtained adjusting the carbon monoxide emissions, reducing the obtained maximum power of a few percentage points.

RATTLE ABSENCE CONTROL

Adjust the Maximum TOTEM power. Make sure that the base does not produce the typical rattle noises (rough motor). In case of rattle reduce the selected angle of lead.

ADJUSTMENT OF THE CARBON MONOXIDE EMISSIONS

- On the exhaust pipe insert the plug for the CO portable analyzer;
- make sure that the CO test has been used following the instructions;
- measure using the lowest available (5% CO; in case the instrument is well calibrated, the measure is important);
- adjust the gas delivery and bring the concentration value to 0,1 ¸0,2% (1000 ¸2000 ppm). The power will be in this case lightly inferior to the Maximum possible power.

EFFICIENCY CONTROL

The following control has to be done when TOTEM is working and when the temperature has been steady for about 3 hours. To compare them to the plate values you need very good measure instruments with a 0,5% precision. The gas heat power has to be measures exactly as well.

To have a general evaluation rule you can do following calculations.

EFFICIENCY CALCULATION

h={(860X electric power (kW)+ thermal power (kcal/h)/ consumption (m3/h) x8000} x 100

Note: using this procedure the efficiency calculation can have a 10% failure possibility; this mistake does not only depend on the instruments but also on the method used.

PERFORMANCE SUMMARY

In the table 1 are reported the general performance values of TOTEM; they were obtained in the Italgas laboratories in Asti during the homologation of different test gases.

These data can be used for comparisons only for measurements made with adequate instruments.

DETACHMENT AND REATTACHMENT OF CYLINDER HEAD WITH GAS/WATER EXCHANGER

- Remove the plug, set on the water tank and discharge the circuit, let the coolant flow in the specially provided container;
- detach the connecting gas/water exchanger and coolant tank tube, remove the coolant in Totem after disconnecting the two remaining pipes;
- detach the exhaust pipe from the gas/water exchanger;
- detach the tube, connecting gas/water exchanger and motor head;
- remove all electric connections;
- place under the cup, disconnect the motor from the motor support on the frame;
- remove the tappet cover and the throttle;
- remove the balancing carrier and extract the rod;
- place the truck under the gas/water exchanger and unscrew the fixing screws from the head to the motor base;
- extract the gas/water general cornet head exchanger from the TOTEM internal part;
- detach the gas/water exchanger from the motor head, by using the 13 mm key;
- for the reattachment repeat all these operations but in the opposite order and use some new gaskets, wash old screws or replace them with new ones.

note: to close the cylinder head follow the instructions on page 42. After assembling rods and rockers under frame the adjust tappets as described on page 42.

ENGINE WITH GAS/WATER EXCHANGER DETACHMENT AND REATTACHMENT

- place the specially provided A99013 support under the electric motor;
- remove the water tank plug and the coolant from the primary hydraulic circuit of the exchanger cup, using the special container;
- disconnect the oil auxiliary tank and remove it from inside totem;
- detach the exhaust pipe from the gas/water exchanger;
- remove all electric and feed connections;
- detach the four connection tubes, set on

exchanger and oil cup;

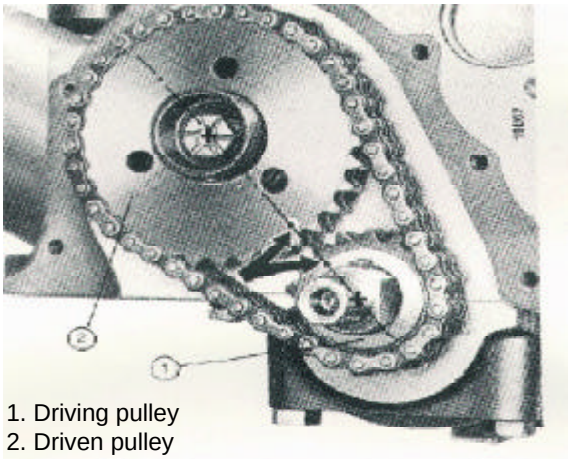
- place the A99022 support under the cup;
- disconnect the engine from the electric motor, by unscrewing the four connection bolts;
- disconnect the motor from the motor support, set on the frame using a 13 mm T key;
- place the truck fork with the engine specially provided A99024 support in the right position and extract the engine and the gas/water exchanger from the TOTEM internal part;
- detach the tube between engine and gas/ water exchanger
- Detach the gas/water exchanger from the cornet head using a 13mm combined key.

To reassemble the thermal group you need to invert the disassembly operations sequence, blocking the engine generator fixing bolts, to an 8 kgm coupling using a dynamometric key with a 19 mm bush using extensions and a 19 mm combined key.

CHAIN AND DISTRIBUTION GEARS REPLACEMENT

- block the conducting pulley using the specially provided A99017 tool;
- unloose and remove the hub fixing nut, set on the driving shaft (36 mm bush key);
- remove hub
- remove the cup fixing screws on the distribution cover (10 mm articulated key);
- remove the base distribution cover fixing screws (10 mm key);

REFERENCE GATES FOR THE DISTRIBUTION TIMING



1. Driving pulley
2. Driven pulley

Fig. 24

Note: the screws have different length, respect their position.

- remove the distribution cover;
- block the flywheel using a screwdriver between flywheel and generator chassis, unscrew the gears fixing bolt;
- remove the driven gear, the chain and extract the driving gear from the driving shaft using an extractor;
- reassemble the new driving gear on the shaft front end;
- insert the chain on the driven gear: either the small stretching levers will be directed inside or the clear fastener will look outside;
- insert the chain on the driving gear and the driven gear on the distribution shaft, pay attention that the reference signs are the same and that the centre grain on the camshaft inserts in its seat on the driven gear;
- Screw the fixing screw on the camshaft using the relative washer; if you keep the driving shaft still, close that screw using a 5 kgm torque (dynamometric key and 17mm bush).

To reassemble the other parts follow the disassembly operations but in the opposite order.

As for reassembly use a new gasket and a new oil ring, centre the cover unit and gas ring, inserting temporarily the driving pulley.

In case the distribution cover should interfere with the cup top border, loosen the cup using the cup- base fixing screws.

Note: By assembling the driving wheel on the driving shift using a small key, make sure that there is not too much slack between the small key and its seat.

Otherwise use a different key. The pulley fixing nut has to be closed using a dynamometric key with a 36mm bush to the 12 kgm torque.

Note: The arrows in the picture show that the sign designed on the driven gear periphery has to be the same as the one reported on the driving gear gate, if you want the distribution to be in phase. The two gates MUST be on the line

connecting the driving shaft centre and the cam axis.

PRIMARY AND SECONDARY HYDRAULIC CIRCUIT MAINTENANCE PROCEDURES (GROUP C).

HYDRAULIC CIRCUIT AND FUNCTIONAL DIAGRAM DESCRIPTION

It consists of a closed primary circuit, containing a coolant (water + antifreeze glicole Paraflu 11), activated from the C pump.

The project data and the operation conditions of the analyzed circuit are reported in the chapter 15

The secondary circuit contains a fluid warming itself through the S2 exchanger.

During the start-up the pump is controlled by the double thermostat based on the head of the engine, giving a speed according to the temperature.

To optimise the heat exchange in the two highest circuit parts (gas/water exchanger and electric generator), which the presence of air bubbles can make more difficult, there are two direct drains to the water tank.

The H pressurised cup compensates the fluid volume variations, keeping the pressure, in to the circuit from the G calibrated plug, at the source of the water pump. The L plug is used for the filling the topping ups.

At the steady state the circuit stabilizes on temperature values depending on the used thermal power and on the users' circuit temperature.

PRIMARY AND SECONDARY HYDRAULIC CIRCUIT OPERATION INSPECTION

The goal of the inspection is to make sure that the coolant and the exhaust gas temperature are the right ones, in relation to the TOTEM operation conditions.

As these conditions depend on the water flyback temperature to the users' TOTEM circuit, the picture 5 enables comparison of the read temperatures (following the procedure explained) to the foreseen ones.

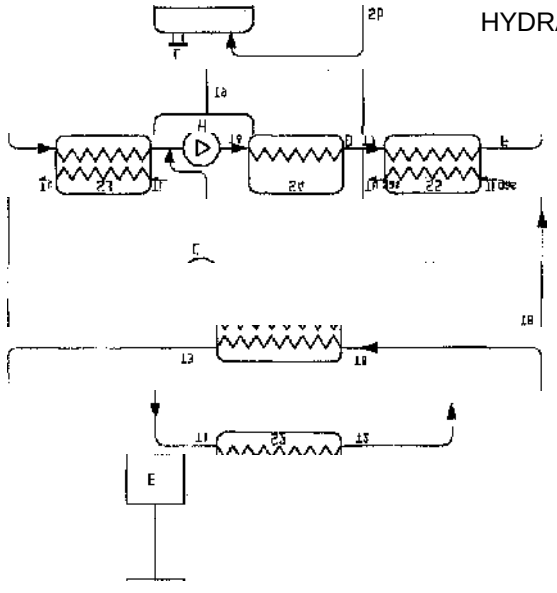
In case this comparison should show an operation temperature over the foreseen one, the control has to be repeated after an exact circuit setting up, this is to say:

- cup fluids level control;
- primary and secondary circuit seal inspection;
- primary and secondary circuit load losses control;
- gas/water exchanger stoppage control.

TEMPERATURES MEASUREMENT

- use a portable contact, digital or analogic thermometer calibrated in °C with a 150°C scale end;
- follow the FIG.25 and 26 instructions to measure the temperatures corresponding to the following abbreviation and note the following values:

1. T1 TOTEM input water temperature (the lower temperature point of the secondary circuit) (*);
2. T2 TOTEM output water temperature (hottest point of the secondary circuit) (*);



HYDRAULIC CIRCUIT

LEGEND

E) Electric generator jacket of windings
S2) Water/water exchanger
S3) Oil/water heat exchanger sump
S4) Cylinder head and block
S5) Gas/water exchanger
C) Circulation pump
D) Thermoresistor
F) Operating heat shield
H) Water tank
L) Plug
Sb) Bleed

Fig. 25

3. T3 water exchanger output temperature (the lower temperature point than the primary one);
4. T7 cornet head output water temperature;
5. T8 output water temperature from the gas/ water exchanger (warmer point than the primary);

(*) In case the system is instrumentated read the values on the instruments.

note: The measurements MUST be done making sure that the thermal probe is in contact with the metal parts and that the indicator is stabilized.

COMPARISON TO THE FORESEEN TEMPERATURES

- on the Fig.26 graph locate the temperature corresponding to the read T1 on the horizontal °C graduated scale;
- from T1 plot a vertical straight line, intersecting the curves signalled with T1,T3,T2,T4,T7,T8;
- read the intersection points values referring to the vertical graduated axis (in °C), writing down the values;
- compare the values measured by a thermal probe to those obtained on the diagram, keeping in mind the following diagnosis indications:

Measured T2 higher than diagram T2

It indicates a flow rate on the secondary circuit inferior to the nominal one (3000 litres/h), this causes a general temperatures increase on the primary circuit. The Maximum T2-T1 possible difference is 12°C as shown on the C diagram (Fig.27).

PRIMARY AND SECONDARY CIRCUIT TEMPERATURES

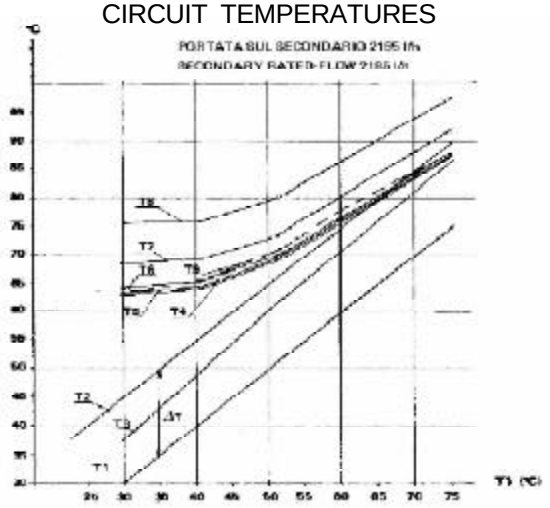


Fig. 26

If T2-T1>12°C the water flow rate of the secondary circuit has to be increased, using the system regulation valves or the circulating pump (give the task to the person in charge of controlling the system).

In such a situation make sure that the secondary circuit load losses correspond to those reported in the diagram A, Fig.27.

Measured T2 inferior to diagram T2

If TOTEM delivers an electric power of about 15 kW, the water flow rate is superior to the nominal one in the secondary, this situation has no consequences for TOTEM. The heat delivered is proportional to the delivered electric power and it does not depend on the reading of a lower thermal head.

Measured T3 higher than the diagram T3

a positive variation of max 10 degrees is allowed;

it indicates a difficult thermal exchange with the water / water exchanger fouling on the secondary side; in case T8 is acceptable do not do anything.

Measured T3 lower than diagram T3

A decrease is allowed, in case the measured value is next to the value T1 the flow rate in the water-water exchanger is low.

The possible causes are:

- the water pump does not give the head required, the measured high T8 values show it; first the T8-T7 temperature difference increases of 5-7°C (normal value) and reaches 10-15°C. This pump defect is normally caused by a wrong circuit filling and a following pump depression at mountain.
- The water level MUST be controlled the trought water tank plug (Fig.25))

Measured T7 higher than diagram T7

The T7 temperature cannot exceed by 5°C the foreseen temperature.

In case T7 is lower than foreseen control the probe efficiency and repeat the measurement when TOTEM has reached a steady state.

Measured T8 higher than diagram T8

The T8 temperature cannot be more than 5°C over the foreseen one, in particular for T1=70°C (in the Maximum foreseen conditions) T8 cannot exceed in any case 100°C, even with secondary loads inferior to the normal one, as we have

already seen when the measured T4 is higher than the T4 diagram value.

In case T8 should be lower than expected, control the thermal sound efficiency and repeat the measurement when TOTEM has reached a steady state.

If the T8 temperature is higher than foreseen and so high that the thermal protection switches on, make following controls in this order :

- T8-T7 thermal head control, as we have already seen
- primary circuit filling
- primary circuit losses control (also inside the gas/water exchanger)
- control and possible replacement of the water / water exchanger (see page 50)

PRIMARY HYDRAULIC CIRCUIT BLEED CONTROL

- disconnect the breather pipe (Fig.25 part. Sb) from the gas/water exchanger, throttling it;
- control that the small hole (Φ = 2mm), on the gas/water exchanger, is free, if not clean it using an iron wire with an adequate diameter;
- check that the breather pipes have no cracks and that they are not stiffened;
- check that the pipes switches on the tank have no cracks and that they are free from calcareous deposits;
- make sure that the fixing flanges for the unions have not incised too much the gasket;
- in case the material is too old replace it with

CHARACTERISTIC CURVE

DIAGRAM A
1 Curve indicating load loss
Asis X Flow rate in m³/h
Asis Y Drop in pressure in m H_2O (kPa)

DIAGRAM B
1 Curve indicating maximum outlet temperature (T3 on the hydraulic diagram)

2 Curve indicating maximum inlet temperature (T1 on the hydraulic diagram)
Asis X Flow rate in m³/h
Asis Y Temperature in °C

DIAGRAM C
1 Curve indicating maximum T3 - T1 temperature differential
Asis X Flow rate in m³/h
Asis Y Temperature in °C

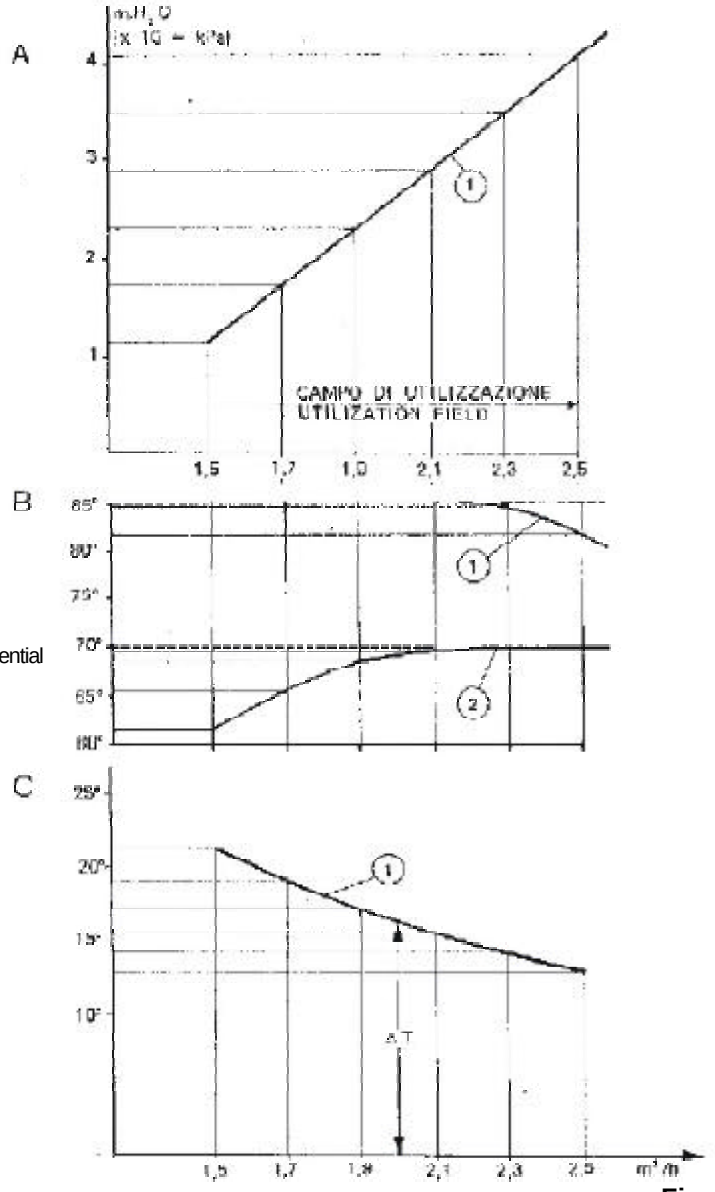
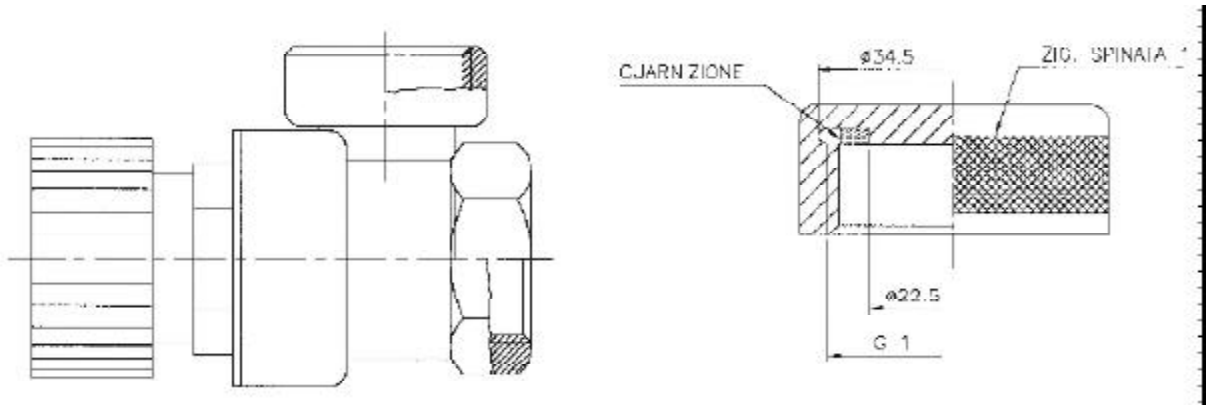


Fig. 27

SAFETY VALVE - PLUG FOR THE HYDRAULIC CIRCUIT TANK



Safety valve

Plug for the hydraulic circuit tank

Fig. 28

new one.

SEAL INSPECTION ON THE PRIMARY CIRCUIT

- Stop the group and when the circuit is cold remove the water tank service plug (Fig.25 part.L);
- use the A95362 device on the tank unit with adapter 1" G
- put the circuit under pressure at 0,6 Kg/cm2 (100kPa);
- check the indicator stability on the tool for about 10 minutes. If the manometer indicates a pressure decrease look for the leak in the couplings; finally discharge pressure;
- screw up the service plug

SEAL INSPECTION ON THE SECONDARY CIRCUIT

The operations are done when TOTEM is working

TABLE 5: AGEING PERCENTAGE

T_{gas} - T_{water} (T8)	< 10°C	30°C	> 50°C
AGING	0%	50%	100%

WATER TANK

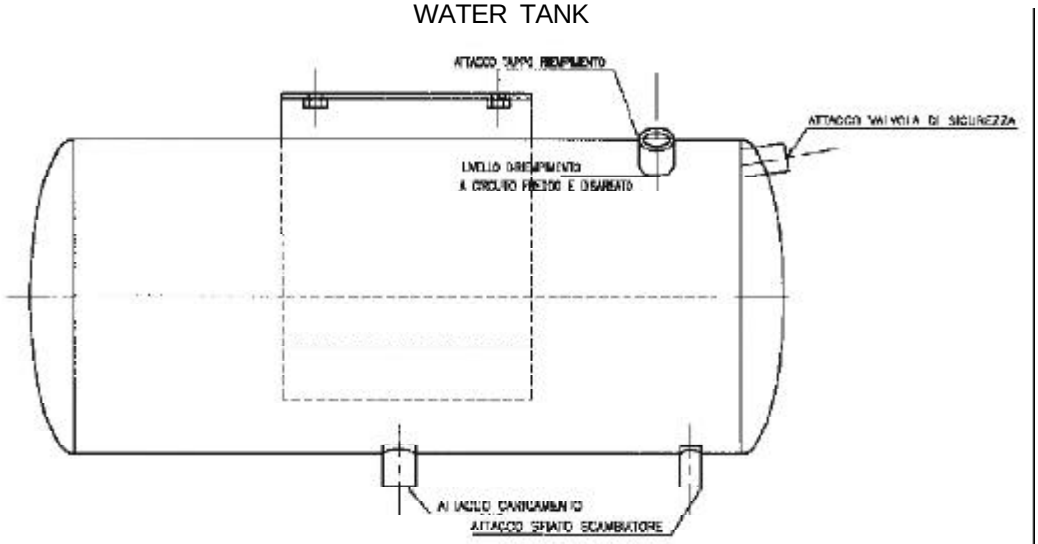


Fig. 29

with disconnected panels. Before starting TOTEM remove the service plug, set on the water tank; when the external secondary circuit pump is working or under pressure make sure that there are no visible external leaks; leaks in the water/water exchanger will be shown by a transfer from the secondary circuit to the primary one, with a following rise of the coolant level in the water tank.

SAFETY VALVE CALIBRATION CONTROL

The safety valve is shown in the figure 28

- remove the service plug from the water tank (Fig.25 part L);
- put the tool using a manometer (A95362) on the tank union
- pressurize until the valve opens.
- the correct value is (0,7 ÷ 0,8 kPa), in case the value is different replace the safety valve and repeat the control operations;
- clean the plug closure beat removing possible calcareous deposits.

GAS/WATER EXCHANGER OPERATION CONTROL

The goal of the control is to identify the contaminating factors and the exhaust pipes stoppage causes. Carbon and oil deposits are originated by blow-by vapours and gas impurities combustion.

This check is necessary in case particular fuels (not purified, not dehumidified or filtered biogas) accelerate the stoppage.

VISUAL CONTROL

- Remove the exhaust elbow from the gas/ water exchanger removing the three fixing nuts, using a 13 mm combined key.
- Make sure that the end inside the exchanger is covered by a soot coat not thicker than 3 mm.

THERMAL CONTROL

Compare the exhaust gas temperature with that of the gas/water exchanger output water. The aging percentage according to the read head is the following one.

EXHAUST GAS TEMPERATURE MEASUREMENT WITH WARMED UP TOTEM AT THE STEADY STATE

- Put the thermal probe in the foreseen slot on the exhaust elbow, set next to the coupling, or use a previously instrumentated exhaust elbow and connect the cable n.10 on the temperature transmitter which has been removed from the exchanger water temperature transmitter;

EXCHANGER OUTPUT WATER TEMPERATURE MEASUREMENT

- Measure the gas/water exchanger temperature with a contact thermometer
- note the difference among the measured temperatures and check the conditions in the table;
- considering that the system does not get dirty in a constant way but increases after 50%, change the exchanger with another already overhauled one, after the system has got dirty over 50%.

GAS/WATER EXCHANGER DETACHMENT, REATTACHMENT

- Remove the water tank filling plug (Fig.25 part.L);
- remove partially the coolant from the cup primary circuit using the specially provided container;
- detach the connection pipes
- disconnect the electric connection from the temperature sensor
- remove the oil filter and , while unscrewing the nuts, detach the exchanger from the cornet head and extract it from TOTEM.

To clean the gas/water exchangers equipped with Al gaskets act as described in "maintenance operations for the gas/water exchangers" on page 50. The replacement can be done using gas/water rotation exchangers.

To remount the gas/water exchanger you just need to change the sequence of the detachment operations, using if necessary a new gasket between cornet head and gas/water exchanger; fill the hydraulic circuit.

DOUBLE THERMOSTAT REPLACEMENT ON ENGINE HEAD

When TOTEM is cold do following operations:

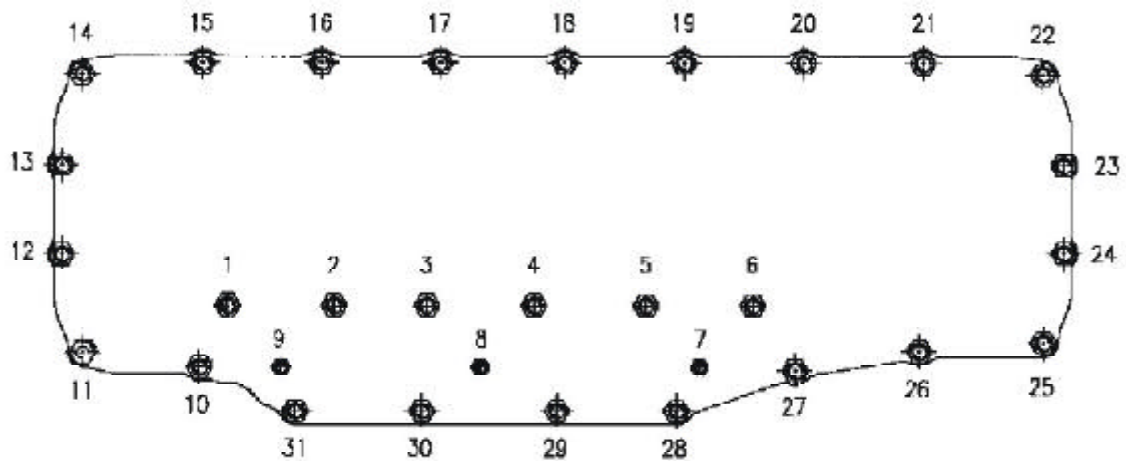
- remove the water tank filling plug (Fig.25 part L);
- empty the primary hydraulic circuit , by opening the cock on the oil cup and recover the coolant
- unscrew the thermostat from the head after detaching the electric plug

- replace the thermostat and reconnect the electric plug
- fill the hydraulic circuit.

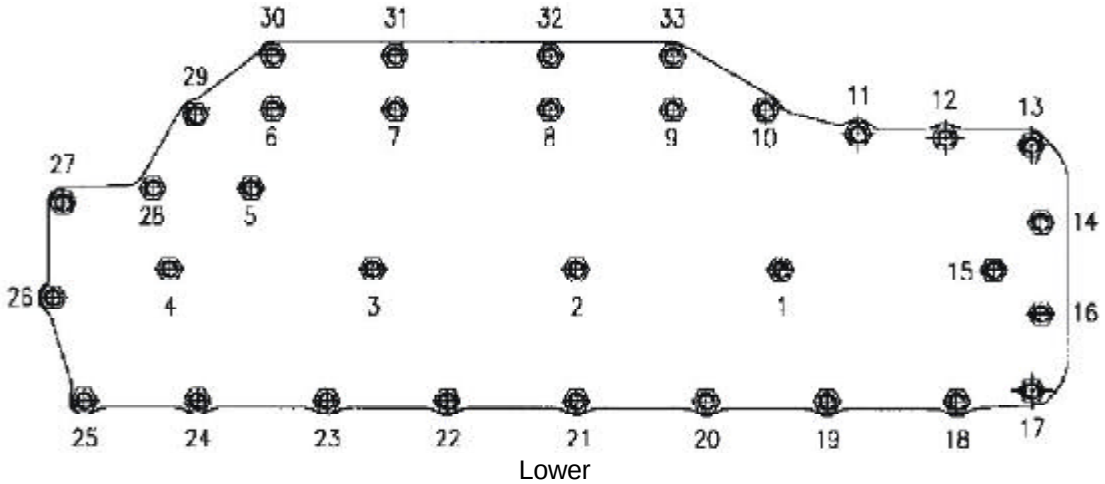
SECONDARY CIRCUIT PRESSURE AND LOAD LOSSES CONTROL

- Install 2 manometers for fluids with a 6 Kg/ cm2 (600 kPa) scale end on the secondary circuit delivery and reversal, in case they are not already provided in the system;
- when the external hydraulic circuit is not working (TOTEM off) read the static pressure, which has to be < 4 kg/cm2 (400 KPa);
- When the external hydraulic circuit is fed with energy, read the TOTEM load loss; knowing the flow rate or the thermal head between delivery and reversal, read on the diagrams in Fig.28 the average acceptable load loss;
- Higher load losses show a possible contamination of the water/ water exchanger caused by insufficient filtering of users' circuit

ORDER IN WHICH THE NUTS ON THE GAS/WATER EXCHANGER COVERS ARE CLOSED



Upper



Lower

Fig. 30

fluid.

WATER / WATER EXCHANGER DETACHMENT-REATTACHMENT

When the TOTEM is cold and disconnected from the external circuit act as follows:

- Remove the additional oil tank (Fig.22)
- Empty the primary circuit
- Disconnect the high pressure secondary circuit and the primary circuit couplings,
- Intercept the secondary circuit
- remove the exchanger

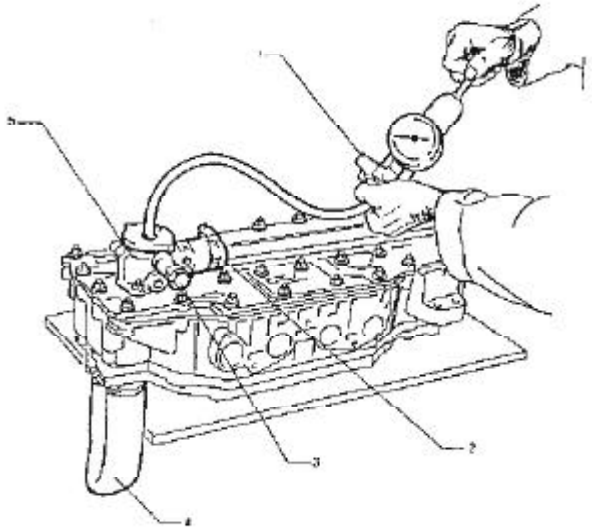
Remount the exchanger repeating these operations in the opposite order.

GAS/WATER EXCHANGERS MAINTENANCE PROCEDURE

- Detach the gas/water exchanger from the head and put it on the worktable
- Unloose and remove the nuts using a top cover exchanger fixing washer
- Remove and extract the cover from the stud bolts using a screw driver on the side plates and not on the coupling surface.
- Remove the coupling surface gasket;
- Turn the exchanger, loosen and remove the nuts and the fixing washers of the inferior cover and of the gas/ water bulkhead.
- Remove and extract the bottom cover and the bulkhead, remove the two gaskets and clean the faces;
- With an apporiate scraper remove the stoppages in the smoke pipe, especially in curves and in the exchanger smokes output
- For a perfect cleaning sandblast the two covers (exchanger and bulkhead). As an alternative you could use a specific cleaning product (like ACITOLS or others), which does not scratch aluminium.
- Make sure that the stud bolts, especially the bottom ones fixing the gas/water bulkhead are inserted in the screw thread. Examine the stud bolts condition and if necessary re-thread using a threading machine or replace the stud bolts after using strong screw brake glue for their base.
- Put new gaskets on the stud bolts; screw up the fixing nuts following the order in the figure 30 until you reach the advised torque
- Top cover nuts 2,5 Kgm (20¸25 Nm)(A,B,C nuts excluded)
- Only A,B,C nuts,: 1 Kgm (10 N.m)
- Bottom cover nuts; 2¸2,5 Kgm (20¸25 Nm)
- Seal test the gas/water exchanger, equipped with a by pass coupling on the water output, using a manometer to test the circuits (see Fig.31). The manometer must have an adequate plug which screws up on the water input union equipped with bleed lights and water input; both MUST be closed. Make sure that after it has pressurized at 2 atm (200 kPa), the pressure inside the exchanger remains stable.
- Reattach the head to the gas/water exchanger

FEEDING GROUP MAINTENANCE PROCEDURES (D GROUP)

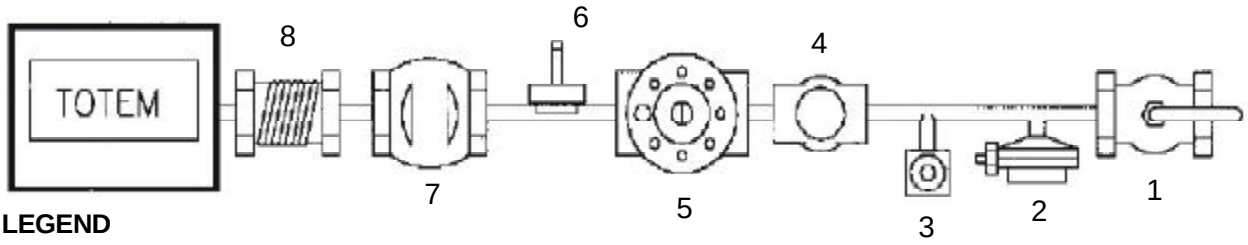
GAS/WATER SEAL TEST EXCHANGER



1. circuits test tools
2. water input plug
3. bleed plug
4. by pass on the water output
5. union

Fig. 31

GENERAL DIAGRAM OF THE GAS FEED CIRCUIT



LEGEND

1. Manual cock
2. Gas pressure switch
3. Breather valve
4. Safety valve
5. Stabiliser (for pressures higher than standard)
6. Pressure intake
7. Filter
8. Vibration damping coupling

Fig. 32

FEEDING CIRCUIT DESCRIPTION

Fig.32 - TOTEM feeding circuit scheme. The fuel is taken from the net system connection by an interception solenoid valve and a membrane pressure stabilizer (5), working between the net pressure (which can vary between 0,5 ÷ 3 kPa) and the Venturi tube depression, caused by the air sucked by the engine.

Between governor and mixer there is a gas filter.

The air is sucked by the drive through the filter and reaches the Venturi tube where the air-gas mixture takes place. This mixture reaches the motor head through the duct. The mixture is optimized through the adjusting screw .

AIR FILTER STOPPAGE CONTROL

- Mount a barometric liner or a manometer at zero central on the air filter switch (fig.22) and start TOTEM;
- check that the read depression is between 0 and 150 mm H2O (1,5 kPa);
- replace the filtering element if necessary;
- replace the blow-by tube if it no longer works.

INTERNAL FILTER MAINTENANCE

At every maintenance operation check that the air pre-cleaner is well set in its seat, on the back door bottom.

Turn the pre-cleaner 180° on the filter base, after freeing it from dust.

Alternate the rotation to a deeper cleaning using water and soap.

AIR FILTER REPLACEMENT

- Open the filter front cover fastener and remove the filter from its seat;
- replace the filter and close the cover.

STABILIZER AND SOLENOID VALVE OF THE GAS REGULATION

DESCRIPTION

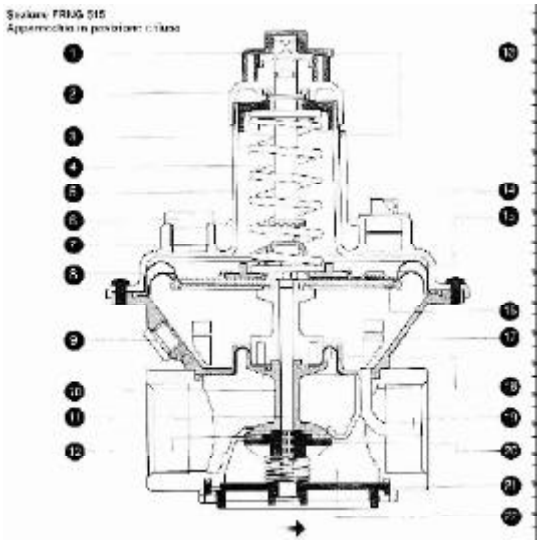
The gas govenor, shown in Fig.33, is a "zero governor" one. It keeps the output pressure stable, under the atmospheric pressure values.

WORKING

The governer works on the principle of forces against forces comparation:

- of the regulating nominal value spring (4)
- of the pre inserted counter spring (22)
- of the differential pressure membrane (8)
- of the gravity force of the negative moving parts

FRNG GAS PRESSURE ADJUSTMENT SYSTEM



LEGEND
1. closure cap
2. adjusting device
3. adjusting pin
4. nominal value spring
5. adjusting turret cover
6. compressed air connection closure screw
7. safety membrane
8. work membrane
9. external pulses connection
10. bottom spacer
11. chuck
12. adjusting gasket
13. splice possibility
14. bleed plug or exhaust line connection
15. membrane washer
16. membrane plate
17. top spacer
18. compensating membrane
19. pulses switch
20. adjusting washer
21. floor cover
22. counteracting spring

Fig. 33

The counter spring counteracts the setting spring and the weight force of the moving parts.

Depending on the pretension of the spring setting and the installation position, the force of the counter spring is compensated

Over compensations take to positive pressure of the governor; partial compensations take to negative pressure of the governor

OVERVERHAULING GAS PRESSURE GOVERNOR

After to have stopped the TOTEM carry out the following operations:

- close the plant gas valve
- disconnect the gas supply tube from the solenoid valve
- disconnect the solenoid valve connector
- disconnect the governor (using a 14 mm allen key and screwdriver) from the chassis and from the gas supply pipe to the valve body
- carry out the service as per the manufactures manual

MOUNTING

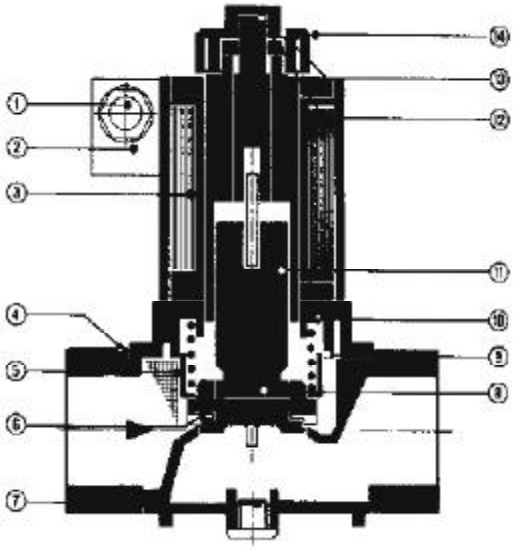
Remove dirt protection caps before mounting. Note flow direction: arrow on housing.

1. tap thread
2. use suitable sealing agent
3. use suitable tool
4. perform leak tests after mounting

ADJUSTMENT OF OUTLET PRESSURE (SET POINT ADJUSTMENT)

FACTORY SETTING

ELECTROMAGNETIC SINGLE ACTION SOLENOID VALVE



LEGEND
1. Grip gland
2. electric terminal board
3. solenoid
4. electric terminal board
5. wire gauze
6. valve seat
7. auxiliary tapping for limit switch k 01
8. spear valve (shutter)
9. dust cover
10. closing pressure spring
11. armature
12. main delivery adjustment
13. lock nut
14. protective cap

Fig. 34

TABLE 6: FOLLOWING PRESSURES

VACUUM	0 ÷ - 1 atm (0 ÷ - 100 kPa)
PRESSURE	0 ÷ +2 atm (0 ÷ +200 kPa)

Standard spring p2 2,5-9 mbar. Sealing force of counter spring in closed position: standard offset 5 mbar

1. Unscrew protective cap.
2. Adjustment (+): setting spindle; turn counter clockwise = increasing outlet pressure (set point) or adjustment (-): setting spindle; turn clockwise = reducing outlet pressure (set point)
3. check set point
4. screw on protective cap
5. attach lead seal

SOLENOID VALVE REPLACEMENT

Check the direction of the arrow on the valve body for the flow direction and fit the valve in the direction of the flow.

When attaching the gas pipe to the valve body, do not use the coil as a lever, but tighten the valve with the adequate tool.

After you have fitted the valve, check for gas leaks and that the valve is working corectly.

SEAL ADJUSTMENT OF THE SOLENOID VALVE

Remove the cover, by loosening the lock nut on the top, you can then adjust the seal regulation. This adjustment is fully open at the moment of supply:

- Turn the screw clockwise to reduce delivery
- Turn the screw anticlockwise to increase delivery

DISCHARGE SILENCER

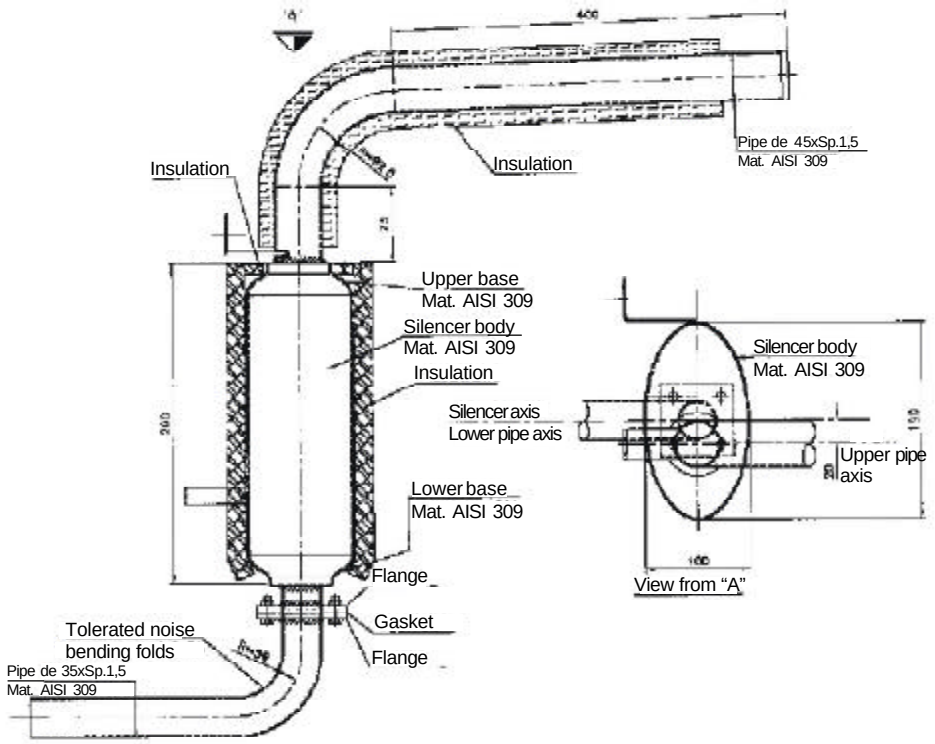


Fig. 35

After you have made the adjustments and regulated the flame at the burner, screw on the lock nut and mount the cover.

CHANGING SOLENOID

Remove the electric connectors, and remove the cover, by loosening the lock nut on the top, you can then remove the solenoid, re fit the cover and re-connect the electrics.

For more information see the DUNGS instructions.

GAS FEED CIRCUIT SEAL INSPECTION

With the TOTEM switched off, brush the parts under pressure where the main gas valve connects, with a soap solution and check that there is good seal.

After the TOTEM has been started, brush with a soap solution the tubes and links on the unions near the principle solenoid valve, on the governor membrane.

If a leak is found, re make the joints and tighten the joints.

GAS FILTER CONTROL AND MAINTENANCE (only TOTEM with biogas)

- Every time you think the engine has bad combustion which could have been caused by a too poor combustible mixture, as a consequence of not normal external intake, adjust the TOTEM internal gas filter.
- Without detaching the frame filter, disconnect the input and outputs pipes and connect them to a test manometer device.
- adjust the filter resistance to the following pressures.
- In case you can not achieve the required pressures, make sure that there are no leaks from the filter in the gas input and output unions welding areas.
- Depending on the amount of gas used, replace the filtering element acting on the lateral cover, blocked on the filter by one clamp. At the same time replace the cover gasket

EXHAUST MAINTENANCE PROCEDURES (GROUP E)

EXHAUST SILENCER STOPPAGE CONTROL

The silencer stoppage can be verified using the apposite tool n.PRVV001, reading the back pressure on the manometer: if it is over 2 m ca (20 kPa) replace the silencer or clean it. You can also verify the caulking of the couplings connecting the exhaust pipes and the silencer by working TOTEM.

EXHAUST SILENCER CLEANING AND DRAINAGE HOLES OPERATION CONTROL

This procedure is necessary particularly for the biogas fed systems.

After detaching the exhaust silencer, clean it mechanically, using gasoline, a strong solvent or another product (caustic soda) removing sludge, incombustible residuals and dusts inside the silencer.

To verify that the drainage holes are clean, insert 0,5 liters water from the top tube; after shaking it in all directions, make sure that water comes out from the bottom tube.

EXHAUST SILENCER REPLACEMENT

- detach the silicone coupling and the lower flange from the exhaust silencer;
- lift and draw the water-water exchanger and the oil tank back a few centimetres to the internal part;

note: this operation has to be done without disconnecting the pipes.

note: In case the silencer is particularly stopped before remounting it verify the gas/water exchanger stoppage following the procedure "gas/water exchanger operation control" on page 48.

FRAME MAINTENANCE (GROUP F)

COMPONENTS LOCATION

The Totem CHP is fitted inside a frame with a casing to isolated it from outside.

On the frame there are five panels (front, top, right side, left side) and a door in the TOTEM back part, visible in Fig.22

The panels are not only isolated, they also have seal gaskets. The gaskets prevent the engine from sucking air.

The group, thermal and electric motor, is fixed to the frame by a front flask on the engine side (Fig.22) and by two supports on the electric generator side (Fig.22). All outside connections such as the gas feed tube, the exhaust pipe, the cold water TOTEM in put and the TOTEM hot water output, the air intake and the electric connections are set in the top part of TOTEM, the air inset and the exhaust pipe are instead in the lower position.

The control central is contained in a specially

provided box set in the top part of the TOTEM front panel. The air intake is set horizontally on the top of the front door. There is a primary filter, cleaning air for the first time. Then air reaches the filter set in the top part of the machine front.

Note: after maintenance do not run TOTEM with open panels.

GENERAL CLEANING OF THE ENGINE COMPARTMENT

At regular service intervals or after oil and coolant have splashed on the system, the mechanical components and surfaces has to be cleaned; in particular the base cup has to cleaned, removing and cleaning it to prevent the creation of fumes.

If any coolant reaches the hollow spaces in the gas/water exchanger, and also the cylinder head fixings, then they should be cleaned carefully.

PRESENCE OF PARTICULAR DUSTS INSIDE TOTEM

On the window created on the electric generator chassis to reach the flexible coupling, you can control the flexible coupling in all its components.

ELECTRIC SYSTEM CALIBRATION AND CONTROL (G GROUP)

ELECTRONIC IGNITION

See on page.36

GENERAL DATA ON THE ASYNCHRONOUS GENERATOR MAINTENANCE

GENERAL ASSEMBLY AND DISASSEMBLY NORMS

Before dismantling the motor or maintaining parts of it under load, make sure that the main switch or the disconnector are open. All these assembly and dismantling operations MUST be done carefully, without damaging the heads and the winding connections.

In case you MUST dismantle a still functioning bearing, which has to be remounted afterwards use a pulley draw to act only on the internal bearing ring. The bearings are assembled using a preloading spring; before you reassemble it, adjust the spring. To fit a new bearing assembly take it out of its package, do not touch it if you have sweaty hands. All surfaces around the bearing MUST be clean, flat and with no flashes. Put a slight stratum of grease on the pin and seat surfaces, where the bearing will be mounted. Heat the bearing in an oven at a 70/80° tempe-

OUTPUT SIGNAL ON 50 HZ PICK-UP

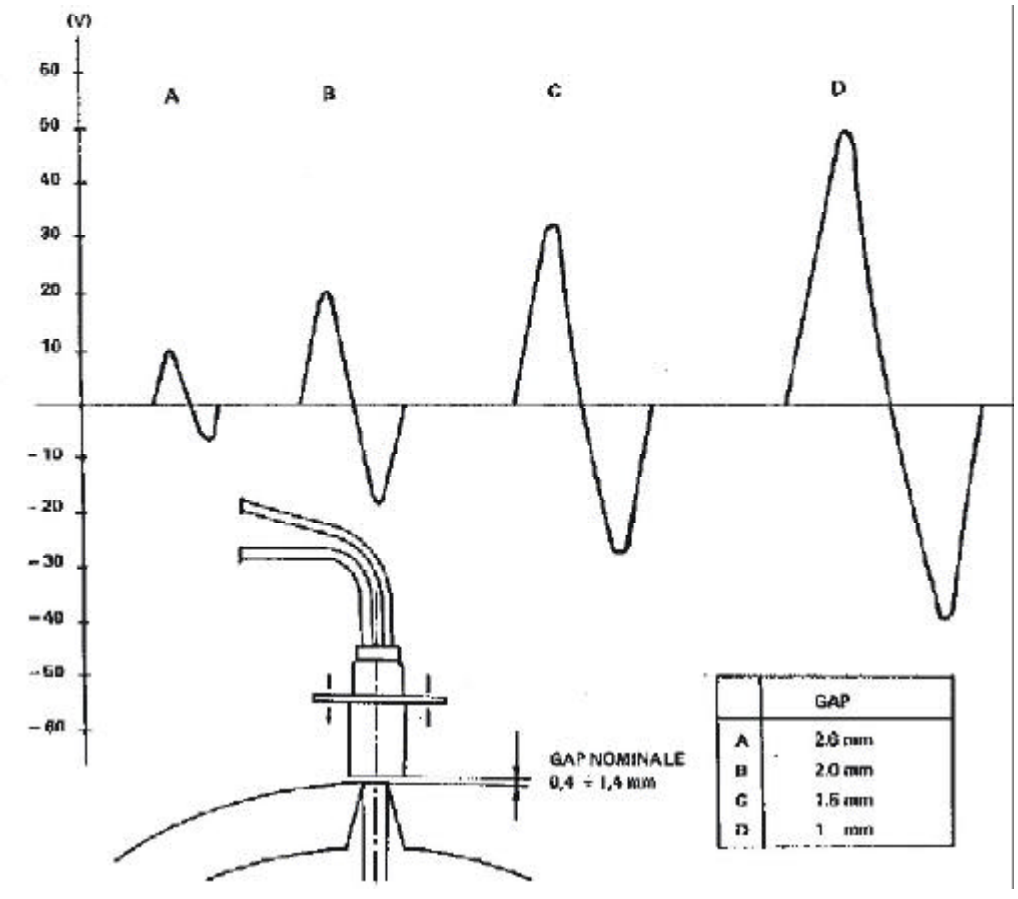


Fig. 36

rature, insert it in the pin and keep it on the shoulder for some minutes. In case you cannot heat the bearing, mount it using the pulley draw, or use a pipe set on the internal ring and push the bearing, beating slightly on the pipe, using a wooden mallet.

INSPECTION AND GENERAL CLEANING

The motor internal and external parts MUST be kept clean. Ensure that there is no oil, grease or dirt deposits. Ensure that the input and output unions and the bleed are neither blocked with no scaling. For a general cleaning you MUST disassemble the motor. Make a note every time the couplings are replaced with new ones. During and after the inspection ensure that the fixing screws are screwed up well and that the alignment with the engine is right, that the coupling is not damaged and that the connection screws are well tight.

CONDENSATE DRAIN

In motors which have absorbed humidity during a long inactivity period, the humidity will condensate inside them at the starting and end in the chassis bottom or in the shield-support.

In many cases this condensated water evaporates during working the heat of the motor and it causes no damages.

As for TOTEM there are two condensate exhausts in the chassis bottom part. Excessive condensates are expelled through them. If you see rust in the exhausts a generator inspection becomes necessary.

ISOLATION AND WINDINGS

If a generator has absorbed humidity either during transport or storage or during a long inactivity period, you should measure the winding isolation resistance using a 500V "Megger". This resistance cannot be less than 25 MW when the system is warmed up (normally it is over 30 MW) and to 1 MW when it is cold, otherwise the winding has to dry, as we will explain in the following parts.

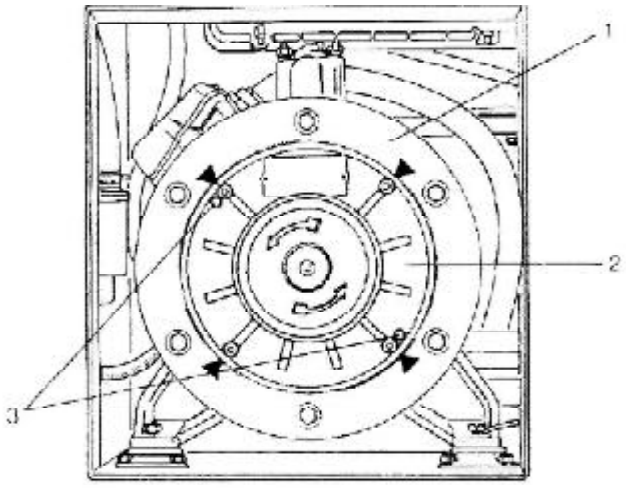
Every time the system is disassembled, control and clean the winding if it is dirty or if the isolation resistance is under the above mentioned value. Act as follows:

- Remove the dust using a soft brush or dry with low pressure air. If it is necessary clean the winding with a cloth or with a brush used with a solvent (e.g a light gasoline), paying attention not to damage or dirty the isolation;
- Put the chassis with stator in a 80-90°C temperature oven, and leave it there until it dries but no more. Spray the winding heads with a good silicon isolation varnish, drying in the air.

STORAGE

If the generator (spare one) or the one assembled on TOTEM has not been used immediately, it

ELECTRIC GENERATOR



◄ Allen screws to remove armature

1. Generator
2. Armature
3. Holes for extractor

Fig. 37

has to be protected during storage. Keep the motor in a covered, clean, dry space. If it remains outside for a long time or in a humid room you MUST dry the winding before starting the motor.

In cold climates in case of storage with risks of freezing, empty the generator chassis, take out the water inside the TOTEM secondary circuit.

As alternative use a Paraflu-water mixture as required for the temperature. The rolling bearings need no maintenance during storage. It is advisable to rotate the shaft a few turns every 1-2 months.

RECEPTION AND TRANSPORT (SPARE PARTS)

The motor is installed on the TOTEM at TemEnergy. We recommend you to examine it carefully on arrival, to make sure that no damages have occurred during transport.

ELECTRIC GENERATOR DETACHMENT AND REATTACHMENT

DETACHMENT

To detach the electric generator act as follows:

- detach the water generator input and output contacts;
- detach the pick-up connector (see general electric scheme);
- use the A99022 support under the engine;
- unscrew and remove the four connection screws of the engine to the electric generator;
- place the A99013 tool under the electric generator;
- remove the two fixing nuts to the generator elastic supports;
- extract the electric generator from TOTEM using the fork lift truck. The forks length must be at least 210 mm.

REATTACHMENT

To reconnect the electric generator act as follows:

- disconnect the coupling from the flywheel ;
- mount the coupling on the rotor splined shaft and fix the distance between the reference tooth and the pick--ups at 0,4 ÷ 1,4 (see fig.36);
- remount the coupling on the flywheel;
- repeat the same operations procedure done when detaching the generator, but in the opposite order and block the engine fixing nuts with a 8 kgm torque.

ELECTRIC GENERATOR ROTOR REPLACEMENT

In case of TOTEM units equipped with generators with an extractable rotor, replace the rotor without disconnecting the TOTEM generator.

- Unscrew the four screws shown in Fig.37.
- Using two extractors, positioned on the two extraction holes (Fig.37 part.3) extract the rotor carefully.
- Block the rotor on the vice equipped with small protective jaws, then disassemble the back fan.
- Replace the couplings (see page 55)
- Remount the entire rotor with couplings on the generator; locate it correctly in the seat; screw and block the four fixing screws.

note: To facilitate the mounting we advice you to use the foreseen cradle tool, which is to fix temporarily on the chassis.

WARNING

During the rotor mounting and demounting sustain it keeping it horizontal till you have ended the operation, in order to avoid rotor crashes with the statoric windings heads.

In case of impacts control the windings surface and if there are small damages re-establish the isolation using proper isolation sprays (F Class).

TABLE 7 - LIST OF THE MINIMAL NECESSARY TOOLS REQUIRED FOR SCHEDULED MAINTENANCE (page 1/2) - G = generic, S = Totem specific, F = facultative			
GROUP	G/S/F	TOOLS	Suggested type or Fiat catalogue tool number
Engine	G	Fixed wrench series Ø = 8-38 mm combined	
	G/S	Tappet screwdriver wrench	A50107
	G	Double box wrench Ø = 10-11 mm	
	G	Thickness gauge	A95113 - any
	G	Articulated T wrenches Ø = 10-13-17-19 mm	
	G	Oil filter cartridge wrench	Thin strip type
	G	Screw driver wrench Ø = 6-7-8-10	
	F/S	Engine securing bracket	A99017
	G	Bush wrench series and extension Ø = 13-17-19-36	From ½" (for 36 use the adapter ¾" - ½")
	G	Socket head screw wrenches series 4-6-8 mm	
	S	Special cylinder head closure wrench	A50168
	G	Dynamometric wrench	½" attachment
	G	Stud extractor	From 5, 10 mm A40009
	G	Stud driver	From 6, 8, 10 mm 866-06.08/2, 10/2
	S/G	Compression ratio measurer	A95683
	G	Sparking-plug wrench	A50136
	S/G	Oil pressure manometer	A60162/ full scale 800kPa
Transmission	S G	Long wrench Ø = 19 mm or Bush wrench with extension	 A50173 + A50175 socket head screw reducer
	S	Motor centring pins (n. 2)	A99025
	S	Technical motor supports	A99022
	S	Electric generator support	A99013
Hydraulic circuit	S	Wrench to dismantle gas/water exchanger Ø = 13 mm bent	A50163
	S	Seal tester	A95362
	G	Portable thermometric probe	
	G/F	Container for drained water and oil	A99018
	S	Wrenches to move pipe lead nuts	A50174
Power supply	G	Manometer	Scale end ± 20 kPa
	G	Potentiometer switch punch Ø = 1.3 mm	
		Connector extractor on the actuator (n. 15)	N. N. 150807 AMP. Connector - M.I.
Exhaust	S	Instrumented gas/water exchanger Output connector	Prov. TOTEM - n. 001
Electric motor	G	Insulation measurer (Megger)	500V

TABLE 7 - LIST OF THE MINIMAL NECESSARY TOOLS REQUIRED FOR SCHEDULED MAINTENANCE (page 2/2) - G = generic, S = Totem specific, F = facultative

GRUPPO	G/S/F	TOOLS	Suggested type or Fiat catalogue tool number
Electric motor	G	Pliers power-factor meter	BBC Metrawatt ZP930 (WZC010)
	G	Sequence metre	
	F	Three-phase pliers watt-hour metre	20 kW (BBC Metrawatt ZW920)
Battery charger wiring	G	Complete tester with amperometric pliers	Beckman RMS 3030 digital multimeter with CT-231 amperometric pliers
Relay	G	Connector extractor on the card 1-6	N. 720788/6 - AMP-MIC connector
	G	Connector extractor on circuit 14	P/N458994/1 Conn. AMP UNIV. - MATE-IN-LOK
	G	Cable terminal pliers	
	G	Flat burner pliers	
	G	Wire stripper	
	G	Scissors	
	G	Cutting nippers	
	G	Brush for terminals and poles	A76037
	G	Densimeter	
	G	Battery transport belt	A76038
Ignition	G	Stroboscope lamp + revolution indicator	CZSINCRO MOD DG80
	G	Phase seeker screw driver	
	G	Sparkplug gap gauge	Wire
	S	Generator rotor extractors	
Electronics	F/G	Oscilloscope	Portable remote control equipment
	F/G	Probes (n.2 pairs)	Normal and attenuated x 10
	F	Pliers for integrated	8/14/16/22/24/28/40
	G	Extractor for EPROM	
	F/S	Electronic test kit	UTP 101
	F	Calibration oscillator	Provv. TOTEM with n.003 5.75 KHz ± 2V peak
	G	Plastic screwdrivers	PHILIPS
	G	12V welder + 220/12 transf.	
	G	Flexible isolated bonds	L = 100 mm on 1.5 mm2 with AMP push rod cable terminals
Miscellaneous equipment	S	Truck for engine/generator	Provv. TOTEM n. 002
	F/G	CO test	scale end 1 ÷ 5%
	F/G	Calorie counter	2000 l/h 40 kW
	G	Auxiliary battery connection cables	

13 - TOTEM COMPONENT TECHNICAL DATA

ELECTRIC SYSTEM CHARACTERISTIC DATA

TABLE 1: ELECTRIC GENERATOR

Nation		EUROPE	U.K	U.S.A.	EUROPE	U.K.	U.S.A.
Type		STANDARD			STAND-ALONE/STAND-BY		
Nominal voltage	V	400	415	208	400	415	208
Frequency	Hz	50	50	60	50	50	60
Nominal power	kW	15	15	15	15	15	15
Power factor		0,86	0,86	0,9	0,86	0,86	0,9
Connection		Δ			λ		
Ohmic resistance of windings U_1, U_2, V_1, V_2, W_1, W_2		0,52Ω (a 20°C)			0,175 Ω (a 20°C)		
Nominal current	A	26,5	24,3	46,3	26,5	24,3	46,3
Number of poles		2					
Idle rate	r.p.m.	3000		3600	3000		3600
Service		S1					
Insulation class		F					
Mechanic protection class		IP 44					
Front and back bearings		SKF 6308/2RS/2/C4/S∅/HT51 Permanent lubrication tins					
Rotor		die-cast aluminium squirrel cage					
Cooling		With outside cast-iron jacket for water circulation					
Diameter of bearing housing on drive shaft	mm	$40k5^{+0,013}_{+0,002}$					
Diameter of bearing housing on the side of the drive shaft coupling	mm	$90H6^{+0}_{+0,022}$					
Diameter of bearing housing on the side opposite the drive shaft coupling	mm	$90H6^{+0}_{+0,040}$					
Internal bearing diameter	mm	$40^{+0}_{-0,012}$					
External bearing diameter	mm	$90^{+0}_{-0,020}$					
Screw securing the engine to the shield on the coupling side		N.D.	M10	R80	3,8 ÷ 4 (38 ÷ 40)		
Screw securing the engine to the shield on the side opposite the coupling		N.D.	M10	R80	1,2 ÷ 1,5 (12 ÷ 15)		
Screw securing the generator to the thermal engine		1/55412/21	M12x1,5	R80	9 (90)		
Screw and nut securing the generator to the thermal engine		1/55412/21	M12x1,5	R80	9 (90)		
Allen screw securing the Pick-up		1/3041/21	M5	R80	1		
Allen screw securing the rear FIMET flange		N .D.	M8	R80	1,7 ÷ 2 (17 ÷ 20)		

TABLE 2:ELECTRONIC IGNITION		
Electronic module		
Type		
Bobbins feeding voltage	V dc	300
Instantaneous feeding voltage	V dc	12
Delayed feeding voltage	V dc	12
Bobbins feeding current	mA	380 (massimo)
Instantaneous feeding current	mA	25
Delayed feeding current	mA	60
Running temperature	°C	0 ÷ 50
Spark energy (on 50 pF-1MW)	mJ	6
Spark voltage	kV	13
Spark current	mA	80
Bobins		
Type		M. Marelli BAE 600A
Resistance in primary continuos (L.T.) (t=20°C)	Ω	4,8 ± 4%
Resistance in secondary continuos (H.T.) (t=20°C)	KΩ	9,8 ± 10%
Pick-up		
Type		M.Marelli SEN 8 F
Resistance in continuous	Ω	680 ± 10%
Sparking-plugs		
Type		Champion RN7YCC
Gap	mm	0,4 ÷ 0,5
Thread	mm	14 x 1,25
High tension cable		
Type		Bougie cord
Colour		Grey
Resistance in continuous	Ω	600

TABLE 3: CURRENT TRANSFORMER	
Characteristics	with passing bar
Frequency	50 ÷ 60 Hz
Turn ratio	1 ÷ 100
Load	1 Ω
Work range (I)	8 ÷ 80 A (4 ÷ 40A)
Voltage (with I = 80 A)	V = 800 m Veff ± 2%
Voltage (with I = 40A)	V = 400 m Veff ± 2%

THERMAL ENGINE AND MECHANICS

ENGINE TYPICAL CURVES

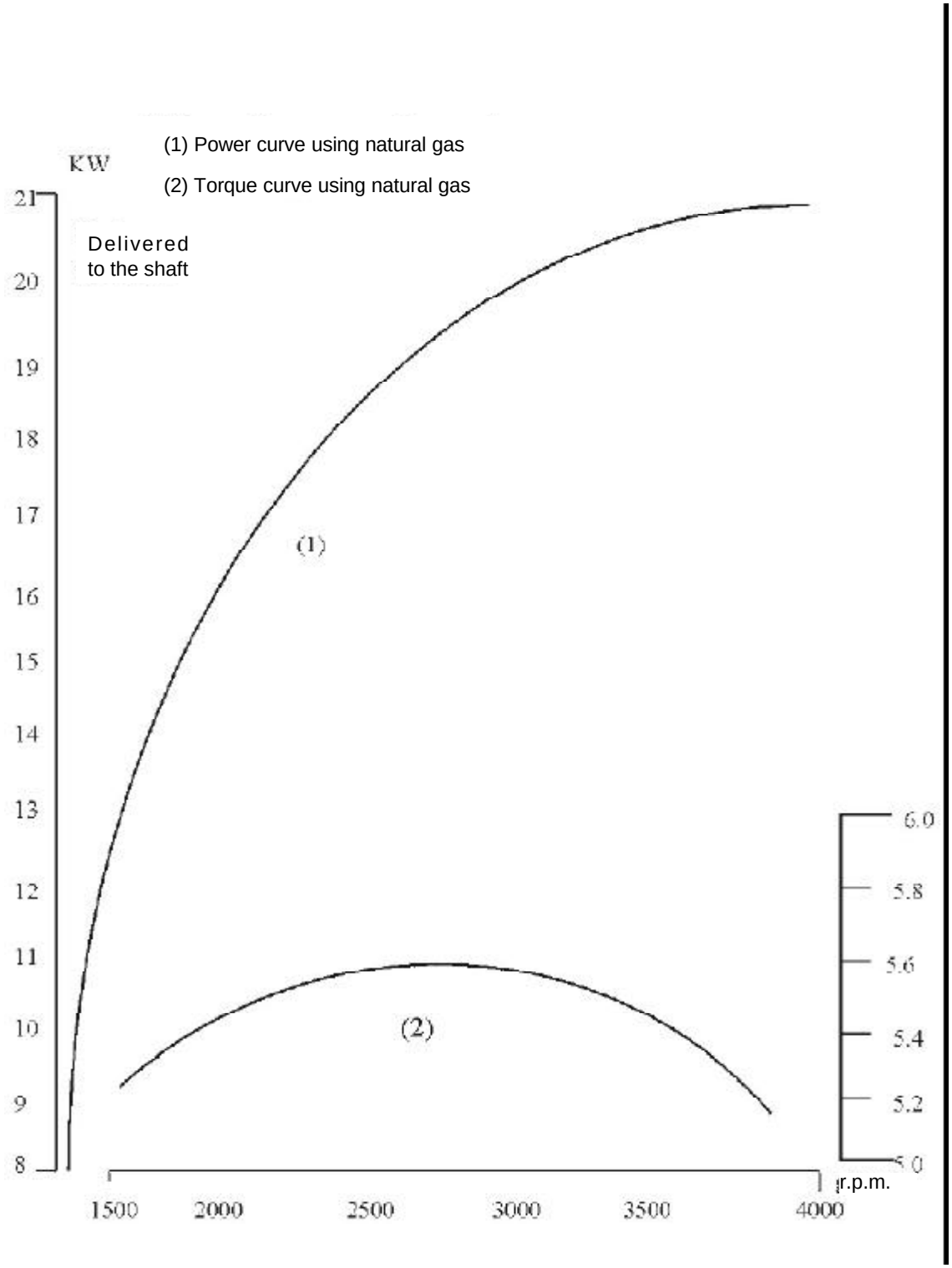


Fig. 49

TABLE 4: CYLINDERS GROUP - CONNECTING RODS	
DENOMINATION	**mm**
Diameter of cylinder barrel (the cylinder barrels are divided in 0.01 mm classes)	65,000 ÷ 65,050
Diameter of normal tappet housing	14,010 ÷ 14,028
Diameter of camshaft bush housing:	
• support on distribution side	
class B	50,500 ÷ 50,510
class C	50,510 ÷ 50,520
class D	50,700 ÷ 50,710
class E	50,710 ÷ 50,720
• central support	46,420 ÷ 46,450
• support on flywheel side	35,921 ÷ 35,951
Diameter of bench driving shaft bearing housing	54,507 ÷ 54,520
Length of the central bench support between the housing for the shoulder half rings	23,240 ÷ 23,300
Diameter of the connecting rod bearing housing	46,657 ÷ 43,670
Diameter of the small end of the connecting rod	19,943 ÷ 19,954
Normal thickness of the connecting rod bearings	1,807 ÷ 1,813
Undersizing scale for connecting rod bearings, spare	0,254-0,508-0,762-1,016
Coupling between piston pin and small end of connecting rod: interference	0,016 ÷ 0,039
Coupling between bearing and small end of connecting rod: assembly clearance	0,026 ÷ 0,071
Maximum misalignment between the head axis and the small end of the connecting rod, measured at 125 mm from the connecting rod stem	±0,10

TABLE 5: PISTONS-PINS-RINGS		
DENOMINATION		mm
Normal spare pistons diameter, measured perpendicularly to the pin axis: 39.5 mm from the piston crown	class A	64,94 ÷ 64,95
	class C	64,96 ÷ 64,97
	class E	64,98 ÷ 64,99
Oversize scale of the spare pistons		0,2 - 0,4 - 0,6
Diameter of piston pin hole	category 1	19,982 ÷ 19,986
	category 2	19,986 ÷ 19,990
	category 3	19,990 ÷ 19,994
Slot height for flexible rings on the piston	1° slot	1,785 ÷ 1,805
	2° slot	2,015 ÷ 2,035
	3° slot	3,957 ÷ 3,977
Diameter of normal piston pins	category 1	19,970 ÷ 19,974
	category 2	19,974 ÷ 19,978
	category 3	19,978 ÷ 19,982
Oversize scale of the spare piston pins		0,2
Thickness of flexible rings:	1st gas ring	1,728 ÷ 1,740
	2nd oil scraper ring	1,978 ÷ 1,990
	3rd oil scraper ring with slit and internal spring	3,925 ÷ 3,937
Coupling between piston and cylinder barrel, measured on the normal pin axis, 39.5 mm from the piston crown	Mounting clearance	0,050 ÷ 0,070
Coupling between pin and hob on the piston:	Mounting clearance	0,008 ÷ 0,016
Coupling between ring and slots on the piston (vertically):	1st mounting clearance gas ring	0,045 ÷ 0,077
	2nd mounting clearance oil scraper ring	0,025 ÷ 0,057
	3rd mounting clearance oil scraper ring	0,020 ÷ 0,052
Opening between the ends of the rings introduced into the cylinder barrel:	1st gas ring	0,20 ÷ 0,35
	2nd oil scraper ring	0,20 ÷ 0,35
	3rd oil scraper ring	0,20v0,35
Oversize scale of the spare flexible rings		0,2 - 0,4 - 0,6

TABLE 6: CYLINDERS HEAD	
DENOMINATION	mm
Diameter of the cylinder head valve guide housing	12,950 ÷ 12,977
External diameter of the valve guide	13,010 ÷ 13,030
Oversize external diameter for spare valve guide	0,2
Internal head valve guide diameter	7,022 ÷ 7,040
Coupling between valve guides and head housing: assembly interference	0,033 ÷ 0,080
Diameter of the valve stem	6,982 ÷ 7,000
Coupling between the valve stem and its guide: assembly clearance	0,022 ÷ 0,058
Housing cylinder head angle of elevation	45° ± 5‘
Valve housing angle of elevation	45° 30’ ± 5’
Diameter of the valve heads * Suction * Exhaust	 29,1 26,1
Maximum valve eccentricity, for one complete revolution of the stem with, indicator resting on the centre of the contact surface	0,03
Width of head valve housing (contact surface): exhaust suction	1,3 ÷ 1,5

TABLE 7: VALVE SPRINGS	unit	spring
Order number		4208869
Check spring height under a 24.5 kg load (mm)	mm	36,5
Check spring height under a 5.5 kg load (mm)	mm	-
Minimal allowed load referred to the above mentioned heights		22

TABLE 8: BEARINGS DRIVING SHAFT	
Denomination	mm
Normal diameter of bench pins	50,785 ÷ 50,805
Diameter of bench bearing housing	54,507 ÷ 54,520
Normal thickness of spare bench bearings	1,831 ÷ 1,837
Undersizing scale for spare bench bearings	0,254 - 0,508 - 0,762 - 1,016
Normal diameter of piston pins	39,985 ÷ 40,005
Couplings for bench pin bearings: assembly clearance	0,028 ÷ 0,073
Length of central bench the two shim adjustment	28,080 ÷ 28,120
Length of central support between the shoulder ring housing	23,240 ÷ 23,300
Thickness of central support shoulder rings	2,310 ÷ 2,360
Thickness of oversized shoulder rings	2,437 ÷ 2,487
Between the driving shaft shim adjustments and the central support with shoulder rings: assembly clearance	0,06 ÷ 0,26
Maximum tolerance for bench pin alignment	0,06 (*)
Maximum tolerance for alignment between piston pins and bench pins	± 0,5
Maximum ovalization of the bench pins after grinding	0,005
Maximum taper of the bench and piston pins after grinding	0,005
Verticality of the flywheel support flange surface vs. the driving shaft axis: Maximum allowed tolerance with a centesimal indicator resting on the side at a 31 mm from the shaft rotation axis	0,025
Engine flywheel: * Parallelism between the support surface of the driven disk and the driving shaft flange attachment surface: Maximum allowance * Verticality of the above mentioned surfaces to the rotation axis: Maximum allowance	 0,1 0,1

TABLE 9: DISTRIBUTION PARTS		
Denomination		mm
Diameter of the bush housing in the base		
- Distribution side support		
	Class B	50,500 ÷ 50,510
	Class C	50,510 ÷ 50,520
	Class D	50,700 ÷ 50,710
	Class E	50,710 ÷ 50,720
- Central support		46,420 ÷ 46,450
- Flywheel side bush		35,921 ÷ 35,951
External diameter of the free bushes		
- Distribution side bush		
	Class B	50,485 ÷ 50,500
	Class C	50,495 ÷ 50,510
	Class D	50,685 ÷ 50,700
	Class E	50,695 ÷ 50,710
- Central bush		46,533 ÷ 46,571
- Flywheel side bush		36,030 ÷ 36,068
Internal diameter of the bushes, finished in the housing		
- Distribution side bush		38,025 ÷ 38,050 (*)
- Central bush		43,404 ÷ 43,424
- Flywheel side bush (*) The internal diameter of the spare for this bush has already been worked and is screw into the housing		31,026 ÷ 31,046
Couplings among the bushes and the housing on the base:		
- Distribution side support	assembly clearance	0 ÷ 0,025
- Central support	assembly interference	0,083 ÷ 0,151
- Flywheel side support	assembly interference	0,079 ÷ 0,147
Couplings between the bushes and the camshaft support pins: Assembly clearance:		
- Distribution side support		0,025 ÷ 0,075
- Central support		0,046 ÷ 0,091
- flywheel side support		0,026 ÷ 0,071
Normal diameter of the base tappet housing		14,010 ÷ 14,028
Normal external diameter of the tappet		13,982 ÷ 14,000
Spare tappets oversize box		0,05 ÷ 0,10
Coupling between tappets and housing: assembly clearance		0,010 ÷ 0,046
Diameter of the support holes for equaliser holder shaft		15,010 ÷ 15,028
Diameter of the equaliser holder shaft		14,978 ÷ 14,990
Coupling between the supports and the equaliser holder shaft: assembly clearance		0,010 ÷ 0,040
Diameter of the equaliser holes		15,010 ÷ 15,030
Coupling between equalisers and their shaft: assembly clearance		0,020 ÷ 0,052

TABLE 10: EXHAUST SILENCER		
TOTEM Type	unit	Already mounted
Diameter of the discharged gas input	mm	45
Diameter of the gas output	mm	45
Initial back pressure	m/H_2O (kPa)	0,1 (1)
Minimum exhaust gas temperature	°C	85
Maximum exhaust gas temperature	°C	140

TABLE 11: LUBRICATING AUXILIARY TANK		
Type		Translucid Plastic PPR
Geometric Volume	dm^3	12
Useful volume	dm^3	10

TABLE 12: GAS PRESSURE REGULATOR			
Type DUNGS FRNG	Zero governor		
Gas type	Biogas	L.P.G.	Gas nat.
Feeding pressure (mm H_2O)	90 ± 10%	280 ± 10%	200 ± 10%
Output pressure	motor depression		
Nominal flow rate (m^3/h)	12	5,5	5,9
Diameter (mm)	1”	¾”	¾”=½”

TABLE 13: SOLENOID VALVE			
Type DUNGS MVD205/5			
Gas type	Biogas	L.P.G.	Gas nat.
Feeding pressure (mmH_2O)	90 ± 10%	280 ± 10%	200 ± 10%
Nominal flow rate (m/h)	12	5,5	5,9
Diameter (mm)	¾”	3/8”	3/8”
Electric power (W)	15		
Solenoid valve feeding tension (V)	12,0 ± 10% DC		

TABLE 14: AIR GAS MIXER	
Type	Venturi
Diffuser diameter (mm)	19
Holes diameter (mm)	6
Number of holes	6

TABLE 15: COOLING		
Water circulation cooling circuit through a pump		Paddle centrifuge
Pump head (3050 r/m)	mm H_2O (kPa)	3,5 ÷ 4 (35 ÷ 40)
Pump flow rate (3050 r/m)	m^3/h	2,5 ÷ 3

TABLE 16: AIR FILTER	
VULKAN Type	tool
Initial charge loss - mm H2O (kPa)	30 ÷ 40 (0,3 ÷ 0,4)
Allowed load loss (on TOTEM) - mm H2O (kPa)	120 ÷ 150 (1,2 ÷ 1,5)

TABLE 17: GAS FILTER (ONLY TOTEM WITH BIOGAS)		
AIAS type		Cylinder cartridge model
Initial load loss	mm H_2O	30 mm H_2O
Allowed load loss	mm H_2O	150 mm H_2O

TABLE 18: OIL PRESSURE REGULATION VALVE SPRING			
Order number		4153891	4225225 (*)
Spring length under a load of			
* Kg 4,61 ± 0,15	mm	22,5	-
* Kg 2,50 ± 0,10	mm	-	36
Minimal allowed load in reference to the housing spring length	Kg	4,3	2,3

TABLE 19: GEARING		
Oil pump: type		Gear model
Pump command		Through the cam shaft
Oil pressure regulation valve		Inside the oil pump
Clearance between the top of gears and the pump cover face	mm	0,020 0,105
Clearance between the periphery of gears and the pump	mm	0,05 0,14
Clearance between the drive shaft control guide and its housing on the base.	mm	There has always to be interference (0,025 0 ,070)
Clearance between the drive shaft and the bed bush	mm	0,025 0,062
Clearance between the driving gearing and the housing on the pump body	mm	0,013 0,050
Clearance between the pin and the driven gearing	mm	0,010 0,050
Clearance between the driving and driven gears	mm	0,08
Clearance between the drive shaft and camshaft gears	mm	0,06
Total flow rate filter with safety valve to cut off filter function		Cartridge model
Low oil pressure signal transmitter		Electric
Gear lubrication pressure at a 100°C	Kg/cm²(KPa)	3,5 ÷ 4,5 (350 ÷ 450)

TABLE 20: WEIGHT - IRRADIATED POWER - ACOUSTIC LEVEL		
Type		decomposable sections
Overload carrier capacity	Kg	> 560
Weight of frame	Kg	100
Weight of panels	Kg	140
Weight of engine	Kg	90
Weight of electric motor	Kg	120
Weight of exchangers	Kg	80
Weight of oil/water supply	Kg	30
Total weight	Kg	560
Radiance	W	300
Acoustic level (1 metre distance)	dBA	64