OXFORD LASERS LIMITED

WARNING : BRITISH, NORTH AMERICAN AND OTHER WORLD WIDE PATENTS HAVE BEEN APPLIED FOR TO PROTECT THE DESIGN OF THIS INSTRUMENT

Serial Number

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HYWEL'S — COPY

GP2000 GAS PURIFIER

OPERATION MANUAL

OXFORD LASERS LIMITED

GP2000 GAS PURIFIER

PREDELIVERY TEST AND CHECKLIST

SERIAL NUMBER:..................

Calibration at LN_2:............K

Leak Tested: YES / NO

COMPRESSOR:

Serial No.:............

Type No.:..............

W/O No.:...............

Voltage: 240V / 110V

COMPONENT CHECKLIST:

1. Power Cable..YES/NO
2. Inner plastic lid and stopper..........................YES/NO
3. Outer lid and handle...................................YES/NO
4. PTFE temperature control nut...........................YES/NO
5. Complimentary Spares Kit:
   - (a) Fuses 240V,50Hz (110V,60Hz) - 2 off 10A (15A).....YES/NO
     1 off 250mA.........YES/NO
   - (b) Spare Panel Screws...............................YES/NO
   - (c) Compressor diaphragm.............................YES/NO
   - (d) Peg Spanner......................................YES/NO
   - (e) *Snoop* leak detection fluid.....................YES/NO
   - (f) Light bulbs - 3 off 24V..........................YES/NO
   - (g) Latching 3-way DIN plug - 1 off..................YES/NO
   - (h) 1/4" *Swagelok* nuts - 3 off.....................YES/NO
   - (i) 1/4" *Swagelok* ferrule pairs - 3 off............YES/NO

COMMENTS:...
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CHECKED BY:

......................(signature)......................(name)

......................(date)

SERVICING & GUARANTEE

Servicing

If this instrument requires servicing please contact OXFORD LASERS directly - U.K. customers - or its overseas distributor from whom the instrument was purchased. If an overseas customer has been unable to gain satisfactory answers to his enquiries from our distributor, Oxford Lasers should be contacted directly.

OXFORD LASERS LIMITED as a company is constantly striving to improve its products to best serve the needs of its customers. The company will gladly accept any suggestions from customers for improvements to its products or comments regarding features already installed which a customer has found to be useful.

ADDRESSES

Oxford Lasers Limited,
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Oxford,
UNITED KINGDOM OX4 1RD

Telephone: U.K.: (0865)251479
International: (44-865)251479

Telex: 837897 *OXLASE G*
Telefax: (0865)726753

Guarantee

OXFORD LASERS WARRANTY 1 JANUARY 1985

1) In the case of goods of our own manufacture, we shall replace or repair free of charge any components or parts of any goods supplied which fail within twelve months of the date of despatch, solely as a result of faulty materials or bad workmanship, provided always that the defective parts are despatched by the buyer at his expense to Oxford Lasers Ltd., Oxford, U. K. within 30 days of the discovery of the defect, unless otherwise arranged. Any labour costs involved in refitting into the equipment will not be our responsibility.

2) In the case of goods or components such as capacitors or thyratrons not of our manufacture any guarantees shall be limited to that given by the manufacturer/supplier of the goods.

3) Certain parts, as specified elsewhere in this manual, are regarded as consumable components/materials and are not covered by any warranty.

4) The company shall not be under any liability in respect of defects in goods delivered or for any injury damage or loss resulting from such defects.

5) See our Terms and Conditions of Sale for complete details.

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FIGURES AND TABLES

GP2000 FULL ENGINEERING SPECIFICATION

DIMENSIONS:	340mm (W) x 632mm (D) x 592mm (H) 13.4" 24.8" 23.3"
WEIGHT:	44kg 97lb
POWER REQUIREMENTS:	2.5kW (max) single phase 220-240V, 50Hz or 110-120V, 60Hz
OPERATING GAS PRESSURE:	3.4 bar (4.4 bar absolute) (50 psig) 3.0 bar (44 psig) continuous
LN_2 DEWAR CAPACITY:	~7 litres
LN_2 CONSUMPTION:	~1 litre/hour (at 100 K)
TEMPERATURE RANGE:	~80K to ~150K
TEMPERATURE STABILITY:	±1K
GAS FLOW RATE:	~18 litres/minute at 1 ~~4 bar~~ bar absolute

REF: 0985
11/93

IMPORTANT NOTE:

The life of the compressor diaphragm may be severely limited if the unit is not fitted with an in-line dust filter. Oxford Lasers uses a sealed, disposable filter manufactured by Millipore Inc., Bedford, Ma., USA. The type number of the filter is WGGB06WS1. The filters can be obtained through Oxford Lasers Ltd. or its distributor or directly from millipore. The compressor diaphragm is considered a consumable item.

OPERATION SUMMARY

This set of brief instructions is provided as an aide memoire to the experienced GP2000 user. Ensure you have read and fully understood this manual (particularly the section on safety) before operating this equipment.

START UP

1. Ensure IN and OUT taps are closed then open PUMP OUT and evacuate GP2000
2. Close PUMP OUT
3. Switch POWER ON
4. Fill Dewar with LN_2 (see section 4.4)
5. Set TEMPERATURE CONTROLLER to desired temperature (see section 4.2)
6. Activate TEMPERATURE CONTROLLER (see section 4.2)
7. Open OUT tap
8. Open IN tap
9. Switch on CIRCULATING PUMP

SHUT DOWN

1. Turn off CIRCULATING PUMP
2. Close IN tap
3. Close OUT tap
4. (For impurities removal see section 4.9)
5. Turn off TEMPERATURE CONTROLLER
6. Turn off POWER

SAFETY

Excimer laser gas mixtures invariably contain components which are corrosive, toxic and oxidising. The user is recommended to refer to the gas supplier for necessary safety information.

Liquid Nitrogen LN_2 should be handled with care and splash-proof eye protection should be worn.

Investigation of the electrical circuitry should be undertaken by qualified personnel only.

The GP2000 is manufactured to meet British Standards BS 5772, 5000, 4937, 1904, CEE 10 parts 1 and 2,and international standards IEC 512, 715 and DIN 7174.

1. INTRODUCTION

The GP2000 is a cryogenic trap which significantly increases the single gas-fill lifetime of excimer lasers by the selective removal of impurities from the laser gas mixture. When used in conjunction with periodic halogen donor replenishment, the GP2000 enables the output of the laser to remain constant for greatly extended periods. The device is designed to be used with any excimer laser system and all the commonly used excimer laser gas mixtures, i.e. *KrF, ArF, XeCl and XeF.*

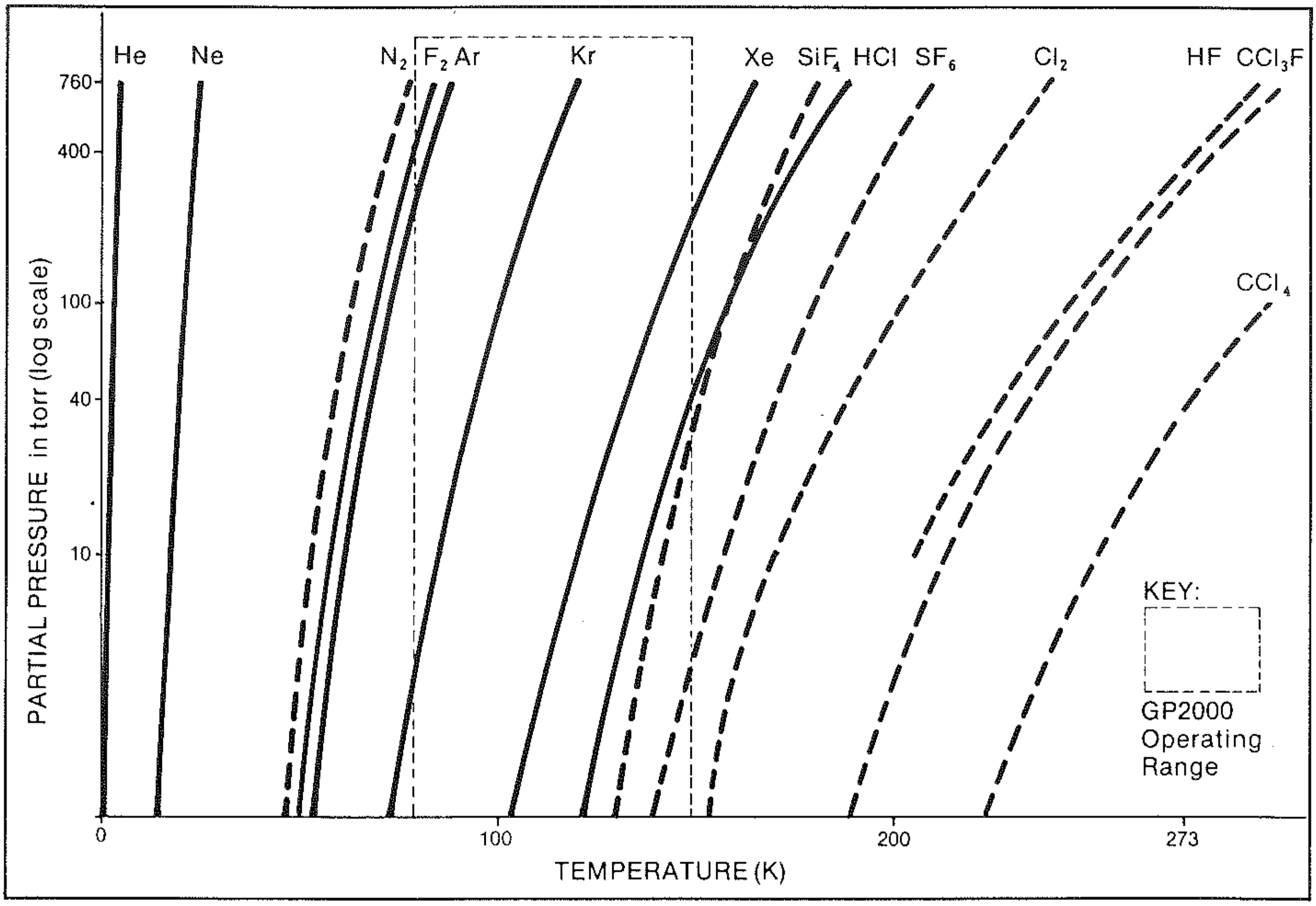


Figure 1: Partial Pressures of excimer laser gases and common impurities as a function of temperature

In normal operation, the gradual decrease in output from excimer lasers is caused by the increasing concentration of contaminant molecular species in the gas mixture. To overcome this problem the GP2000 and the laser head are connected in a closed loop configuration in which both the halogen donor and the rare gas are retained and only impurities are removed from the system. Once the impurities have been trapped by the GP2000 they may then be purged from the laser/purifier system. This ensures that the purifier is able to continue operating with maximum efficiency. Figure 1 shows the partial pressures of excimer laser gases and common impurities as a function of temperature.

Most *home-made* and some commercial excimer laser systems suffer from a further problem: that of dust creation within the laser volume. This dust, apart from reducing laser output, can also cause failure of the diaphragm of the compressor within the GP2000. It is recommended that a dust filter unit is installed before the inlet to the GP2000 to overcome this problem. Oxford Lasers markets an appropriate unit as an accessory.

2. PRINCIPLE OF OPERATION

In order to achieve the temperature required for effective trapping operation, the GP2000 gas purifier uses liquid nitrogen as the cryogenic medium. However, since the vapour pressures of *Xe* and *Kr* are too low at liquid nitrogen temperatures *(−196°C = 77K)* to allow these gases to partake efficiently in the excimer laser reactions, it is necessary to maintain the trap at temperatures above *77K* (see table 1). The temperature setting at which the GP2000 is operated in a particular applications is chosen to be high enough to maintain the required partial pressure of the rare gas *(Xe, Kr or Ar)* in the system, but low enough to remove those contaminant species which impair laser performance. Recommended temperature settings are given in section 4.2

Temperature control is achieved by means of a patented regulator system and fine temperature stability is maintained electrically by a proportionally controlled heater. The GP2000 incorporates a stainless steel/PTFE diaphragm pump which circulates the gas within the system in a closed-loop configuration. Contaminated gas is removed from the laser head, pumped through the purifier and returned to the discharge region in a clean condition.

TABLE ONE
VAPOUR PRESSURE DATA FOR RARE GASES AND HALOGEN DONORS

Vapour Pressure	*1.3mbar*	*13mbar*	*50mbar*	*130mbar*	*525mbar*	*1000mbar*
He	0.3	1.7	2.3	2.7	3.7	4.4
Ar	54.8	62.1	68.1	72.5	82.4	87.4
Kr	73.7	85.8	94.6	101.2	114.0	121.0
Xe	104.5	120.2	131.8	140.2	155.9	165.0
F_2	50.0	58.9	65.3	70.3	79.8	85.1
NF_3	-	102.3	112.8	120.7	135.6	144.0
HCI	122.2	137.4	149.2	159.0	177.7	188.2

The table gives temperatures in Kelvin corresponding to the chosen equilibrium vapour pressures of each gas.

3.INSTALLATION

3.1 INSTALLATION:

In order for the GP2000 to operate efficiently it is necessary to establish a loop which contains the gas purifier and the laser head or main gas envelope (figure 2).

OXFORD LASERS KX series excimer lasers are provided with input and output ports which allow quick and convenient installation of the GP2000 gas purifier. Lasers manufactured by other companies may require some modifications in order to connect the GP2000 in a configuration which ensures the most efficient gas flow path. Briefly, the requirement is that the gas path should be along the length of the laser tube. A laser which has its gas feed into the laser volume on one end flange and the gas feed out of the laser on the other end flange would satisfy this requirement. Lasers which have the *GAS IN* in close proximity to the *GAS OUT* will need to be modified to increase the flow path. However, if the laser system is fitted with an internal gas-mixing fan, it may not be necessary to do this. The newer models of most manufacturer's excimer lasers will already be fitted with connection ports for the GP2000.

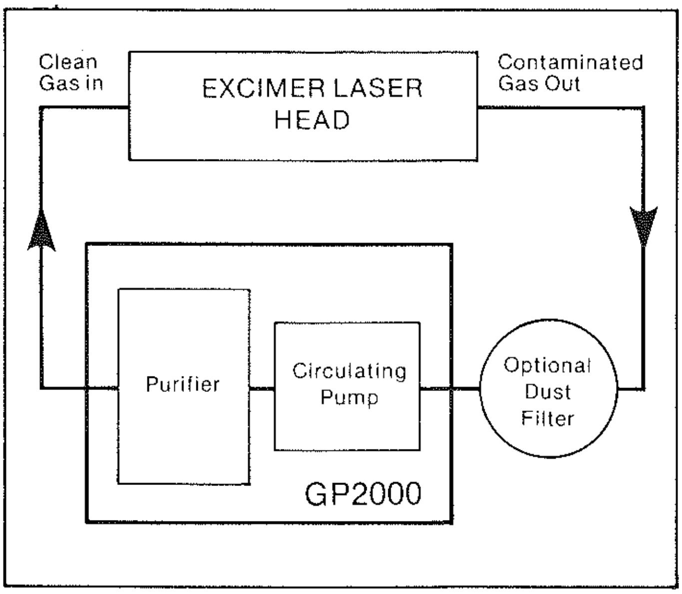


Figure 2: Connection of the GP2000 to an excimer laser

The GAS IN and GAS OUT ports are stainless steel 1/4" *Swagelok* connectors. Connections to these should be made using 1/4" outside diameter tube of some suitable material e.g. stainless steel, PTFE, copper or nickel (instructions in appendix 6.1).

The PUMP OUT port is also a 1/4" *Swagelok* connector and should be connectied via suitable tubing to a vacuum pump or line. (The most convenient vacuum line is probably that from the laser head itself, and a branch of this vacuum line may be connected to the PUMP OUT port).

3.2 TESTING THE INSTALLATION

N.B. Before filling the GP2000 with liquid nitrogen check that the installation is leaktight.

With both GAS IN and GAS OUT valves on the GP2000 fully open, the purifier/laser system should be pumped down to *0.1 mbar* or less. Owing to residual outgassing of some materials in the GP2000 it is advisable to continue this initial pump down for an hour or more. If, after such time, the system is unable to maintain a pressure less than or equal to *0.1 mbar*, all new connections should be thoroughly checked. Similarly if the vacuum pump is shut off and the pressure rises at a steady rate towards atmospheric pressure these connections should again be checked.

If these tests indicate the presence of leaks somewhere in the system, a simple procedure for locating them is the following:

1. Fill the laser/purifier system with helium to a pressure of approximately *0.5 Bar* over atmospheric pressure.

2. Apply the *Snoop* leak detector fluid -contained in complimentary spares kit - to each connection or union at which leaking may occur.

3. Immediate and vigourous bubbling of the *Snoop* fluid indicates the presence of a leak.

4. In this case the connection should be tightened or re-made.

It should be noted that when using piping made from non-metallic materials that it may be necessary to tighten *Swagelok* joints beyond the number of turns recommended by the manufacturer in order to obtain a good vacuum seal.

IMPORTANT

Do not attempt to bring the GP2000 into operation until the entire laser/purifier system is free from leaks.

Access to GP2000. Although every effort is made to ensure that the internal gas connections of the GP2000 are leak-tight on despatch from the factory, it may be felt necessary to gain access to these connections at this stage. The procedure relating to servicing of the GP2000 is detailed in chapter 5.

3.3 *PASSIVATION*

3.3.1 Initial Passivation

Like any new excimer laser installation, the GP2000/laser system will require passivation. Passivation is the process by which the halogen in a rare gas halide laser gas mixture reacts with the materials of the system and forms more or less chemically stable layers on the surfaces of the materials.

Passivation is best effected using a mixture of the halogen in helium (a rare gas halide laser gas mixture without the expensive rare gas). This mixture should then be circulated in the system using the circulation pump in the GP2000. The passivation procedure should be carried out before the GP2000 is filled with liquid nitrogen. After ten minutes circulating this passivation gas mixture, the laser/purifier system should be pumped down and the passiviation mix discarded. The system is now ready for normal operation.

3.3.2 Repasssivation

A similar passivation procedure to that described above should be followed when the laser is changed from *KrF, ArF or XeF* operation to *XeCl* operation or vice versa.

4. OPERATING INSTRUCTIONS

4.1 THE CONTROLS

4.1.1 General

The GP2000 has four controls: a *POWER ON* switch; a *GAS CIRCULATING PUMP* switch; a *TEMPERATURE CONTROLLER* switch; and a combined temperature readout and control unit.

The *POWER ON* switch controls the mains power input to the entire unit and will be illuminated when switched on. The *GAS CIRCULATING PUMP* switch controls the operation of the compressor within the unit. It should be noted that the compressor cannot normally be switched on if the unit is *at pressure.* The *TEMPERATURE CONTROLLER* switch enables operation of the heater circuit for controlled temperature operation. ACTIVE temperature control (see below) is only possible when the light in the temperature control switch is illuminated.

4.1.2 The Temperature Control Unit

The temperature control unit fulfils a number of functions. At the most basic level it merely provides a reading of the temperature of the liquid nitrogen trap. Unless the *alarm* feature is to be used this is the only use that the control unit will be put to when operating on *ArF or* F_2. When the GP2000 is to be used for other excimer gas mixtures the control unit continuously monitors the actual or real temperature against a user-selectable preset value. If the temperature should fall below the preset value the controller switches the heater circuit into operation (provided the temperature controller switch is on) to bring the temperature back to the preset level. If the temperature should rise more than 10K above the set temperature an *alarm* mode is activated.

A full description of the unit is provided in the manufacturer's operation manual attached to this manual. Basically, to set the temperature either of the *UP* or *DOWN* buttons on the unit is depressed. A flashing light will be seen which indicates that the *set* temperature is being observed rather than the *real* temperature. The appropriate *UP or DOWN* button is held down for a period of about five seconds before the set temperature will begin to change. The button is held down until the desired temperature is reached. When the button is released the set temperature will continue to show for a further period of about five seconds then the display will revert to the real temperature. This new value of the set temperature is now stored in the unit and will be there even after the unit has been switched off.

The *OUTPUT 1* lamp becomes illuminated when the heater circuit is activated. *OUTPUT 2* is not used. The *ALARM 1* lamp becomes illuminated when the real temperature is in excess of 10K above the set temperature. *ALARM 2* is not used.

4.1.3 The ALARM out port

The output of the alarm from the temperature control unit is transferred to a latching 3-way DIN socket located on the bottom panel of the GP2000. Pin 1 of this socket is common. Pin 2 provides 24V DC when the alarm is on, and pin 3 provides 24V DC output when the alarm is off. These outputs are only suitable for driving loads which draw between 20mA and 120mA.

Posssible uses for the *ALARM* out port include an extra flashing light to warn of exhaustion of the liquid nitrogen or the initiation of an automatic liquid nitrogen refilling apparatus.

4.2 TEMPERATURE CONTROL

The temperature of the purifier is indicated in Kelvin. The temperature control unit has its own internal reference and so the reading of the temperature will always reflect that of the trap.

The operating temperature of the GP2000 is controlled either *passively* or *actively.* The *passive* control mode is normally employed when the purifier is being used with *ArF* or F_2 gas mixtures. The *active* control mode is employed when gas mixtures such as *KrF*, *XeCl* or *XeF* are to be purified.

4.2.1 Passive Temperature Control (ArF and F_2 operation)

The design of the GP2000 is such that without the integral heater circuit operational the temperature will stabilise around 90K-100K when a gas mixture is being circulated. This temperature is ideal for operation of *ArF* and F_2 lasers. When the GP2000 is operated in this mode (*TEMPERATURE CONTROLLER* switch in the off position), the controls on the control unit have no effect on the temperature - the operating temperature is merely that indicated on the display.

4.2.2 Active Temperature Control (KrF, XeCl and XeF operation)

When the GP2000 is operated in the *active* temperature control mode, the working temperature of the GP2000 is selected by adjusting the set temperature of the temperature controller unit as described above. However, for the controller to switch power through to the heater circuits the *TEMPERATURE CONTROLLER* switch must be operated. The heater circuit is protected by an alarm circuit such that the heater can only operate up to temperatures of ~310K and, additionally, only if the real temperature is less than 10K above the set temperature.

4.3 OPERATING TEMPERATURES

4.3.1 ArF, KrF and F_2 Operation

The optimum operating temperature for *ArF* and F_2 laser gas mixtures is between 90K and *100K.* In most types of excimer laser a temperature of ~100K ±5K is found to give the best results for *KrF.* However, it should be kept in mind that it is preferable to operate the GP2000 at the lowest possible temperature which still maintains the required partial pressure of rare gas in the laser head. Some degree of experimentation with the temperature may give better results since the exact gas mixture requirements will depend on which company manufactured the laser. However, experimentation is only possible when using *active* temperature control.

4.3.2 XeCl Operation

For *XeCl* laser gas mixtures the operating temperature is selected according to the required partial pressures of *Xe* and/or the halogen donor. The actual temperature is calculated by considering the required pressures of *Xe* and halogen donor (obtained from the laser manufacturer's handbook) in conjunction with the vapour pressure data given in Table 1. For example, if *XeCl* gas mixture is to consist of *3 mbar HCl* and *40 mbar Xe* the correct operating temperature of the GP2000 is *131K*. (This would allow *3 mbar* of *HCl* and *47 mbar* of *Xe* to be present in the gas mixture - if partial pressures equal to or in excess of these values had been put in the gas mixture).

4.3.3 XeF Operation

For *XeF* operation a slightly different approach is required to remove contaminants. The considerations outlined for *XeCl* operation apply in this case also but there is an added complication - formation of stable compounds containing xenon and fluorine at low temperatures. The formation of these compounds reduces the partial pressure of xenon in the laser gas mixture. This can have a worse effect on laser output energy than any benefit gained by the removal of impurities.

It has been found that the best way to operate the GP2000 on *XeF* gas mixtures is in an intermittent mode. It appears that the various xenon (multi-)fluorides take longer to form than it takes to remove impurities. Operation of the GP2000 for five minutes in every hour has been found to produce significant increases in lifetime when operating at pulse repetition frequencies of 1-2Hz. The times required for higher pulse repetition frequencies will have to be determined for particular systems. The user is advised to contact the manufacturer of the excimer laser for further information on this point.

4.4 FILLING WITH LIQUID NITROGEN

4.4.1 Operation with ArF, KrF and F_2

The liquid nitrogen filling port is located under the aluminium cover on the top of the GP2000. For ArF, KrF and F_2 operation the PTFE nut supplied with the GP2000 should be unscrewed from the base of the stainless steel column and removed.

(a) Initial Filling with LN_2

Procedure (Cooling down from room temperature)

1. Remove the aluminium cover and the red PVC stopper.

2. Fill with liquid nitrogen until the top of the stopper hole. This ensures that liquid nitrogen enters the central column.

3. Replace PVC stopper and aluminium cover.

4. Depress the *POWER* switch on the top front panel.

(b) Refilling with LN_2

1. Remove the aluminium cover, the red PVC stopper and the white cover.

2. Fill with liquid nitrogen until a level just below the top of the central stainless steel column is reached - take care not to let liquid nitrogen down the central stainless steel column.

3. Replace the white cover, the red PVC stopper and the aluminium cover.

4.4.2 Operation with XeCl and XeF

(a) Initial filling with LN2

For *XeCl* and *XeF* operation a higher purifier head temperature is required, hence a slightly different procedure is followed. Before filling with liquid nitrogen and while the trap is at room temperature, the PTFE nut which is provided separately with the GP2000 should be screwed into position firmly at the bottom of the stainless steel column inside the liquid nitrogen dewar.

Procedure

1. Remove the aluminium cover and the red PVC stopper.

2. Remove the white cover. Access is now gained to the liquid nitrogen dewar.

3. The PTFE nut which is located at the top of the threaded section of the central stem is screwed into hard contact with the base of the liquid nitrogen dewar.

4. Replace white cover.

5. Fill with liquid nitrogen until the top of the stopper hole. This ensures that liquid nitrogen enters the central column.

6. Replace PVC stopper and aluminium cover.

7. Depress the *POWER* switch on the top front panel.

(b) Refilling with LN2

1. Remove the aluminium cover, the red PVC stopper and the white cover.

2. Fill with liquid nitrogen until a level just below the top

of the central stainless steel column is reached - take care not to let liquid nitrogen down the central stainless steel column.

3. Replace the white cover, the red PVC stopper and the aluminium cover.

4.5 COOL-DOWN TIME

A temperature of between *77K* and *85K* should be attained after approximately five minutes. However, if after ten minutes the temperature appears to have more or less stabilised at some point significantly above the desired operating temperature, it may be necessary to add more liquid nitrogen. In this case the procedure described in section 4.2.1(a) or 4.2.2(a) above, is repeated and more liquid nitrogen is allowed to enter the central column. This time however the operation is a *topping up* measure and the amount of liquid nitrogen involved will be small (~1 litre).

4.6 INTRODUCING THE LASER GAS MIXTURE

Provided that the GP2000 is isolated from the laser head or main gas envelope - that is the GAS IN, GAS OUT and PUMP OUT valves are closed - the laser can be filled with the required excimer laser gas mixture at any point during the cooling down phase of the GP2000 gas purifier. It is important to keep in mind that if the purifier head is not isolated from the laser during the introduction of the laser gases, and if the temperature is too low, the device will act as a *sink* (by cryogenic pumping action) for *Xe* and *Kr*. Consequently, an inaccurately prepared laser gas mixture may result.

4.7 NORMAL OPERATION - GAS CIRCULATION

Once the laser is filled with the desired gas mixture and the temperature of the purifier head has reached the required value, the *GAS OUT* tap and then the *GAS IN* tap should be fully opened and the *GAS CIRCULATING PUMP* switch on the top front pannel switched on.

Once gas flow is established in the laser/purifier loop, the temperature of the purifier head can be expected to rise by several degrees. The exact amount of the rise is determined by a number of factors including the working pressure of the laser system and the flow rate of the laser gas in the laser/purifier loop.

The GP2000 is designed so that with gas circulation and subsequent temperature rise, the temperature at which the purifier stabilizes is that required for normal operation on a F_2 or *ArF* system. This temperature is between *90K* and *100K*.

If the *GAS CIRCULATING PUMP* is switched off whilst the gas lines in the GP2000 are above atmospheric pressure it is possible that the compressor motor will not have sufficient torque to restart the piston. It is also possible that an attempt to start the unit under load in this way will cause the mains fuse to *blow*. If the compressor is turned off for any reason the *GAS IN* and *GAS OUT* ports should be closed, the pressure released via the impurity pump out port, the *GAS OUT* and then the *GAS IN* port reopened and the compressor restarted.

4.8 HALOGEN DONOR REPLENISHMENT

For most purposes, it is desirable that the output energy of the laser remains constant over the period of time during which the experimental data is being accumulated. To achieve this the GP2000 is used in conjunction with halogen replenishment. Two methods of halogen replenishment are possible: the first method involves manual, periodic *topping-up* and the second gives automatic replenishment.

4.8.1 Manual Replenishment

The manual technique is recommended for *ArF* and *KrF* laser gas mixtures, that is, those RGH laser gas mixtures whose halogen donor is molecular fluorine. The output energy of the laser is monitored and when it has fallen below some specified level more fluorine is added to the laser purifier system. From figure 3, it is clear that more frequent additions of fluorine result in more nearly constant output power. However, it should be borne in mind that the addition of too much fluorine will result in decreased laser output. The actual frequency of this fluorine *topping-up* process will be determined by the maximum

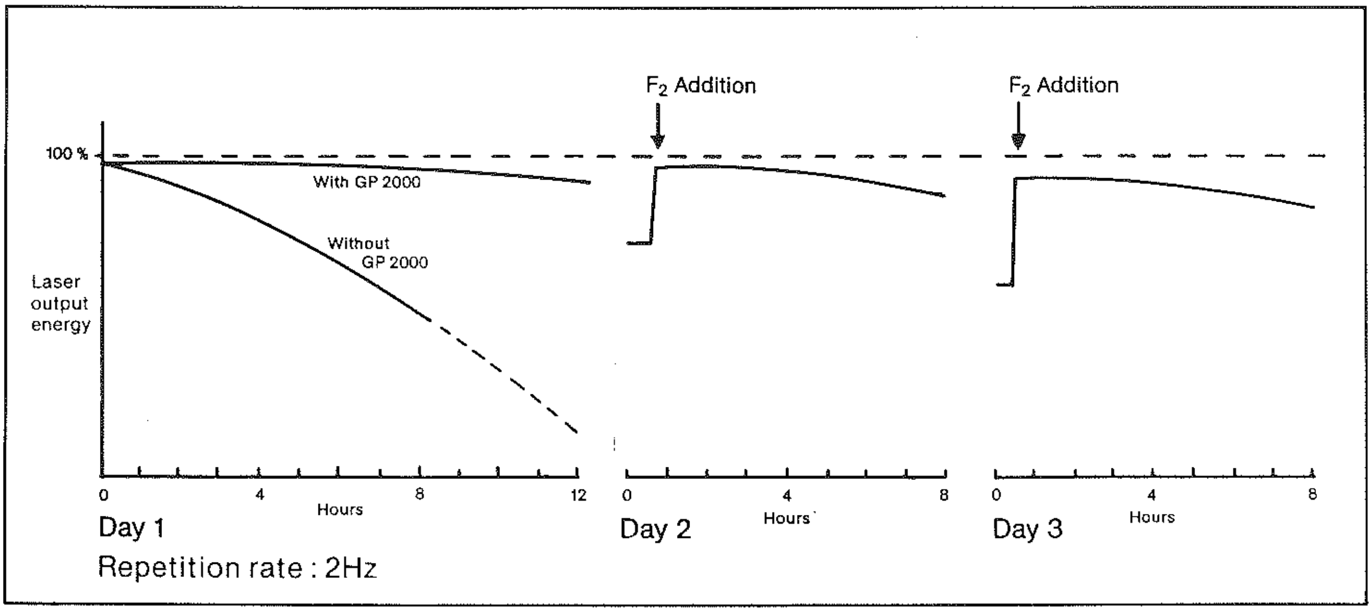


Figure 3: GP2000 typical results on single fill KrF

tolerated fall-off in laser output, which in turn is related to the repetition rate of the laser and the fluorine compatibility of the materials in the system.

Since the most common source of fluorine for *ArF* and *KrF* laser gas mixtures derives from a dilute mixture of fluorine in helium, it is inevitable that introducing additional fluorine into the laser leads to an increase in the overall working pressure of the system. However, most rare gas halide lasers will operate fairly efficiently over a moderately wide range of operating pressures (refer to laser manufacturer's handbook). Thus, if the initial working pressure of the laser/purifier system is chosen to be near the lower end of the operating range, additional fluorine in helium can subsequently be added until the working pressure of the laser reaches its given maximum.

When this condition is reached it is possible to reduce the pressure in the system to some point near the lower end of the operating pressure range. If laser action is impaired after this (or subsequent) reductions in pressure it may be beneficial to replenish the *Ar* and *Kr* components in their respective gas mixtures, since some of these gases will have been lost in pumping down. The actual amount needed can be easily calculated by considering the initial *Ar* and *Kr* concentrations and that in the gas fill remaining after reducing the pressure.

Alternatively the rare gas (*Xe or Kr only*) can be held in the purifier before the reduction in pressure in the manner detailed in section 4.9.3 below.

4.8.2 Automatic Replenishment

A technique for the automatic replenishment of the *HCl* component in *XeCl* laser gas mixtures is made possible by the GP2000. An excess of *HCl* is introduced in the initial filling of the laser. The resulting *HCl/Xe*/buffer gas mixture (containing far too high a concentration of *HCl* for optimum laser performance) is circulated in the laser/GP2000 system, and a temperature is chosen such that only the required concentration of *HCl* is present in gaseous form (refer to Table 1). The remainder of the *HCl* is stored in the purifier head and when equilibrium is reached the GP2000 will maintain a constant temperature and consequently a constant *HCl* partial pressure in the laser, even though there may be gross *HCl* depletion in the laser/purifier system.

IMPORTANT NOTE

Do not attempt to store more than 1 litre-atmosphere of *HCl* in the GP2000 as this may cause blockages.

4.9 PUMPING OUT THE LASER/PURIFIER SYSTEM

4.9.1 Cleaning the Purifier Head

Since the impurities which are removed from the laser gas mixture are held in the GP2000 purifier head it will be necessary from time to time to discard this residue. It is recommended that this purging procedure be carried out at regular intervals e.g. on a daily basis. The method is described below

While the GP2000 is still cold (i.e. at its selected working temperature) isolate the unit from the laser by switching off the circulating pump and closing the GAS IN and then GAS OUT valve. The PUMP OUT valve is opened and, when the liquid nitrogen in the dewar is exhausted (or emptied), the GP2000 is allowed to warm up for a suitable period of time (e.g. overnight) thus releasing the trapped impurities. The PUMP OUT valve is then closed and the GP2000 is again ready for normal operation.

It is possible to bring the purifier to room temperature more quickly by putting the set temperature up to 300K and then activating the temperature control circuit. Defrosting of the trap in this way should take about half an hour - providing that the dewar was empty of liquid nitrogen. **It is not advisable to leave the GP2000 in this mode overnight as any malfunction may cause considerable damage to the trap.**

4.9.2 Refilling

The GP2000 removes the greater part of those impurities whose presence in the laser gas mixtures impair laser performance. However there will be a gradual increase in species not removed by the GP2000 purifier and at some stage it will become necessary to pump out and refill the laser system in order to maintain optimum laser performance.

The simplest refilling technique is to allow the GP2000 to warm up and then discard the entire gas mixture in the laser/purifier system. The GP2000/laser system is then returned to normal operation.

4.9.3 Rare Gas Retrieval

An alternative refilling procedure, which allows the *Kr* and *Xe* component of the gas mixture to be retained in the system, is made possible using the GP2000.

The GP2000 should be filled with liquid nitrogen (Section 4.3) until the minimum attainable temperature is reached. This may require one or more liquid nitrogen *topping-up* operations. The laser/purifier loop is held intact during this operation and the circulating pump is switched on for a short period. Switch off the circulating pump and wait a further five minutes. The GP2000 should then be isolated by closing the GAS IN and GAS OUT valves. The laser system is then pumped out in the usual way.

The result of this technique is that the greater part of the original volume of *Xe* and *Kr* will be retained in the GP2000. Fresh halogen and buffer gases can be introduced into the laser which is then reconnected to the GP2000 operating in its normal mode. The resulting gas mixture will contain more or less the correct amount of rare gas and operation of the laser may recommence. It may, however, be found necessary to add a small amount of the rare gas component to the above mixture to make up for any loss which may have occurred during this procedure.

IMPORTANT NOTE

Do not allow the GP2000 to warm up above 100K with the rare gas stored within as this can lead to dangerous overpressure in the system.

4.10 INTERMITTENT OPERATION

An alternative to the normal, continuous mode of operation is to use the GP2000 in an intermittent mode. Although such non-continuous operation often produces more startling results the overall laser performance is generally poorer than that obtained when the GP2000 is used continuously. However there may be some applications where intermittent operation is preferable in which case the following procedure should be adopted.

While the laser is operating the GP2000 should be kept isolated from the laser (GAS IN and GAS OUT valves closed) until gas clean-up is required. The interval between these clean-up periods will be determined by the cleanliness of the laser system and the repetition rate at which the laser is operated. The length of the clean-up period depends on the volume of the laser system and must be determined by the user.

It is important that immediately prior to and during the clean-up period operating temperature of the GP2000 be maintained at that required for the relevant gas mixture.

5.SERVICING

In normal operation the GP2000 purifier should require little or no maintenance. However should servicing be required, the following section should be read carefully before commencing.

5.1 ACCESS

CAUTION: MAINS VOLTAGES ARE PRESENT

Access to the mechanical and electrical components of the GP2000 is via the front panels. It is not advisable to attempt to remove the top, rear, or bottom panels.

For most purposes it will be sufficient to remove only the upper front panel (that is the control panel) which gives access to all the control circuitry and all gas connections. This panel may be completely removed by disconnecting the cables from the terminal block and the thermocouple inputs.

Alternatively the upper panel may be lifted out and, using the lower edge as the pivot, swung forward and secured in this position with a length of wire joining the holes in the upper side of the panel to those in the frame.

The lower panel is removed by first removing the upper panel and disconnecting the gas lines from the valves.

5.2 MECHANICAL

Mechanical failure is manifested in two modes: gas leakage and failure of the gas to circulate.

5.2.1 Gas Leakage

The source of the leak should be identified (see procedure section 3.2). If the leak is in the *Swagelok* connectors these may be further tightened or, if necessary, the ferrules may be replaced. If the leak appears to be in the compressor head then the procedure outlined in part (b) of the following section should be followed.

5.2.2 Failure of the gas to circulate

There are two possible reasons why the gas may fail to circulate: either a blockage has occurred, or there is a failure in the circulating pump.

Blockages are usually the result of an excess of trapped species within the purifier head. Blockages can be removed by following the procedure described in section 4.9.1.

The circulating pump has two possible failure modes:

(a) the motor is not working. In this case all electrical fuses, connections, etc. should be thoroughly checked before informing Oxford Lasers Ltd. or its distributor.

(b) the pump appears to be operating but is not circulating gas. In this case the top of the compressor head may be taken off. This can be done without removing the compressor from the case provided that the two front panels are opened and the right hand side panel is removed. However, it may be found to be easier to remove the compressor entirely if difficulty is had removing the locking nuts which are located on the reverse side of the compressor head. It is necessary to disconnect the gas lines from the valves on the lower front panel and this panel may then be swung down thus allowing access to the pump without breaking any electrical connections.

Failure of the gas to circulate, despite the pump motor running, is the result of two modes:

1. The valves in the pump head are not operating correctly

2. The diaphragm is damaged. This will usually cause a gas leak in the system. Short diaphragm life is caused by excessive dust creation in the laser. Should this be a problem, a dust filter should be installed.

To rectify (1) above, the socket head cap screws (#542 on manufacturers' drawing) are removed and the cover plate (#336) lifted out to give access to the valve strips (#29 & #506). The valves can then be cleaned and reinstalled. Beford the pump head is reassembled the O-rings (#540 & #541) and their grooves should be thoroughly cleaned.

To rectify (2) above the spare diaphragm and PTFE cover supplied with each GP2000 unit should be fitted. To gain access to the diaphragm, the screws (#32S) and their associated locknuts(#39) are removed and the valve plate (#335) can be lifted out. The diaphragm and cover are held under the top washer (#413) which must be unscrewed to release them. A special tool is provided for the removal of the top washer. It is best to remove the two front panels and the right hand side panel, and possibly remove the compressor entirely, in order to carry out this operation.

Other mechanical damage or failure in the pump is not user servicable and in this case Oxford Lasers Ltd. or its distributor should be notified.

5.3 ELECTRICAL

The electrical system of the GP2000 incorporates temperature readout and control circuitry, switches for these circuits and for the gas circulating pump and fan.

Failure of the temperature controller to elevate the temperature of the GP2000 may be due to two causes:

(a) The heater element is broken. The room temperature resistance of the heater looking between terminals 11 and 12 of the terminal block should be 15Ω - 25Ω. (This test should be carried out with the other side of terminals 11 and 12 disconnected from the terminal block). A fault in the heater element is not user-servicable and the GP2000 must be returned to Oxford Lasers or its distributor.

(b) Temperature controller unit not working. Refer to manufacturer's handbook (included with this manual) or to Oxford Lasers Ltd. or its distributor.

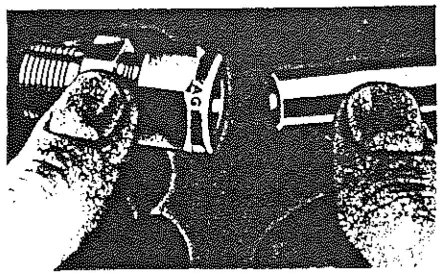
Any other electrical fault should be investigated using the circuit diagrams accompanying this manual.

SWAGELOK Tube Fittings come to you completely assembled, finger-tight. They are ready for immediate use.

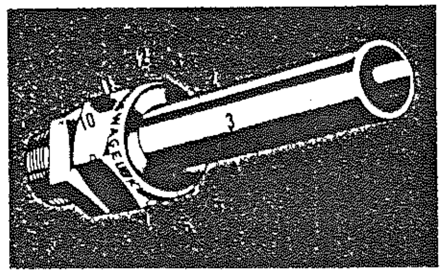
Disassembly before use can result in dirt or foreign material getting into the fitting and causing leaks.

INSTALLATION INSTRUCTIONS

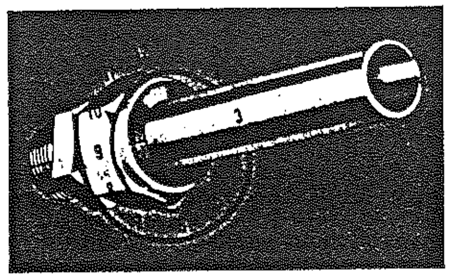
SWAGELOK Tube Fittings are installed in three easy steps.



STEP 1
Simply insert the tubing into the SWAGELOK tube fitting. ***Make sure that the tubing rests firmly on the shoulder of the fitting and that the nut is finger-tight.***



STEP 2
Before tightening the SWAGELOK nut, scribe the nut at the 6 o'clock position.



STEP 3
Now while holding the fitting body steady with a backup wrench, tighten the nut 1-1/4 turns.* Watch the scribe mark, make one complete revolution and continue to the 9 o'clock position.

By scribing the nut at the 6 o'clock position as it appears to you, there will be no doubt as to the starting position. When tightened 1-1/4 turns* to the 9 o'clock position you can easily see that the fitting has been properly installed.

Use the Gap Inspection Gage (1-1/4 turns from finger-tight to assure sufficient pull-up).

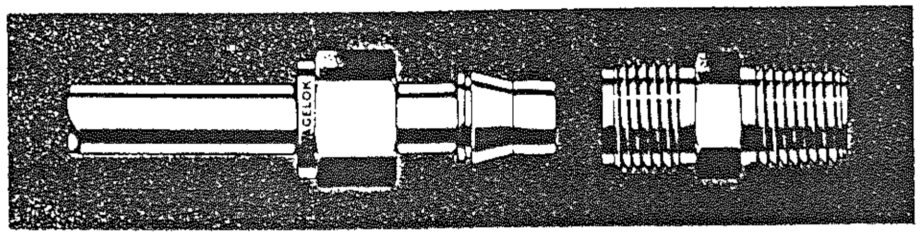
HIGH PRESSURE APPLICATIONS, HIGH SAFETY FACTOR SYSTEMS

Due to the variation of tubing diameters, a common starting point is desirable. Therefore, use a wrench to snug up the nut until the tubing will not turn (by hand) in the fitting. At this point, scribe the nut and body of the fitting. Now tighten the nut 1-1/4 turns and the fitting is ready to hold pressures well above the working pressure of the tubing.

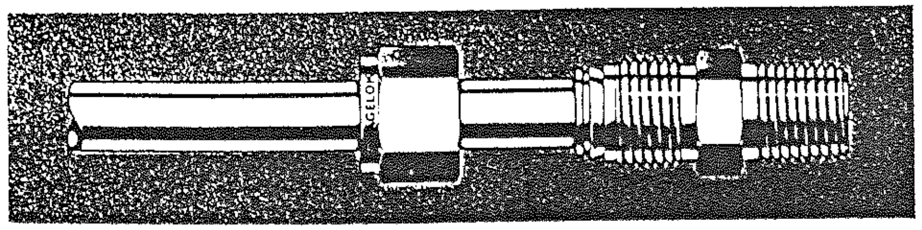
Use the Gap Inspection Gage (1-1/4 turns from snug) to assure sufficient pull-up.

RE-TIGHTENING INSTRUCTIONS

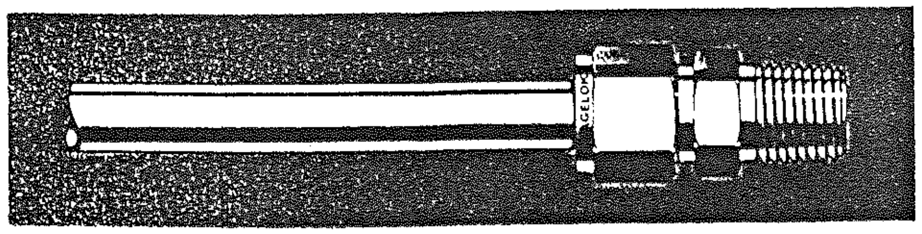
Connections can be disconnected and re-tightened many, many times and the same reliable, leak-proof seal obtained every time the reconnection is made.



Fitting shown in disconnected position.



Tubing with pre-swaged ferrules inserted into the fitting until front ferrule seats in fitting.



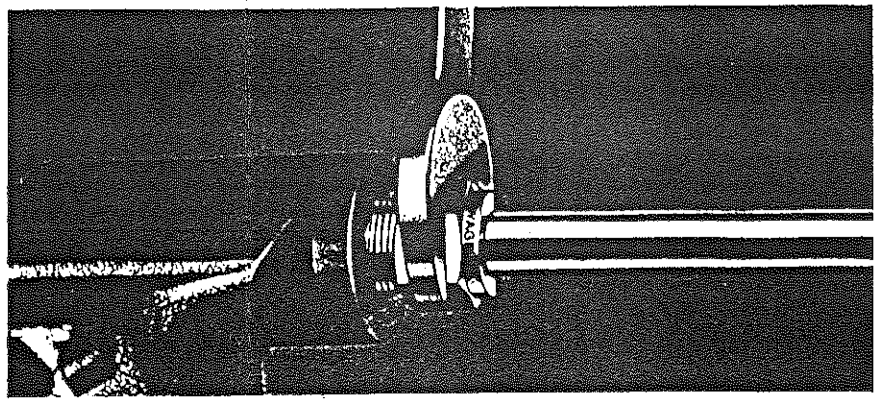
Tighten nut by hand. Rotate nut about 1/4 turn with wrench (or to original 1-1/4 tight position). Then snug slightly with wrench.

*For 1/16," 1/8," 3/16," 2, 3 & 4mm size tube fittings, only 3/4 turns from finger-tight is necessary.

PRE-SWAGING INSTRUCTIONS

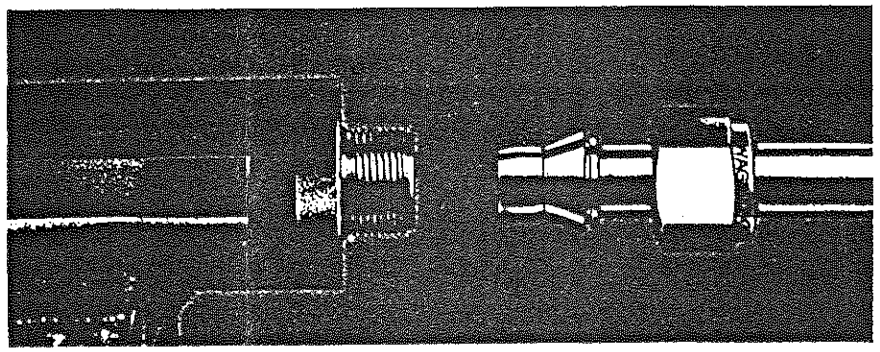
When installing SWAGELOK Tube Fittings in cramped quarters or where ladders must be used, it may be advantageous to use a pre-swaging tool. This will allow you to pre-swage the ferrules onto the tube in a more open or safe area. After using the tool, tubing can be easily attached to a fitting by simply following the re-tightening instructions.

Oversized or very soft tubing may occasionally stick in the tool after pull-up. If this happens, remove the tube by gently rocking it back and forth. DO NOT TURN the tube with pliers or other tools as this may damage sealing surfaces.

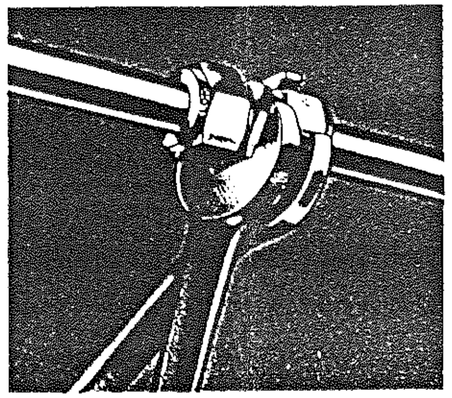


1. Assemble SWAGELOK nut and ferrules to pre-swaging tool. Insert tubing until it bottoms in the fitting body, and tighten nut 1-1/4 turns.*

While pre-swaging tools can be used many times, they do have a finite life. After frequent use, ask your local Sales and Service Representative to have them checked.



2. The nut is loosened and the tubing with pre-swaged ferrules is removed from the pre-swaging tool.



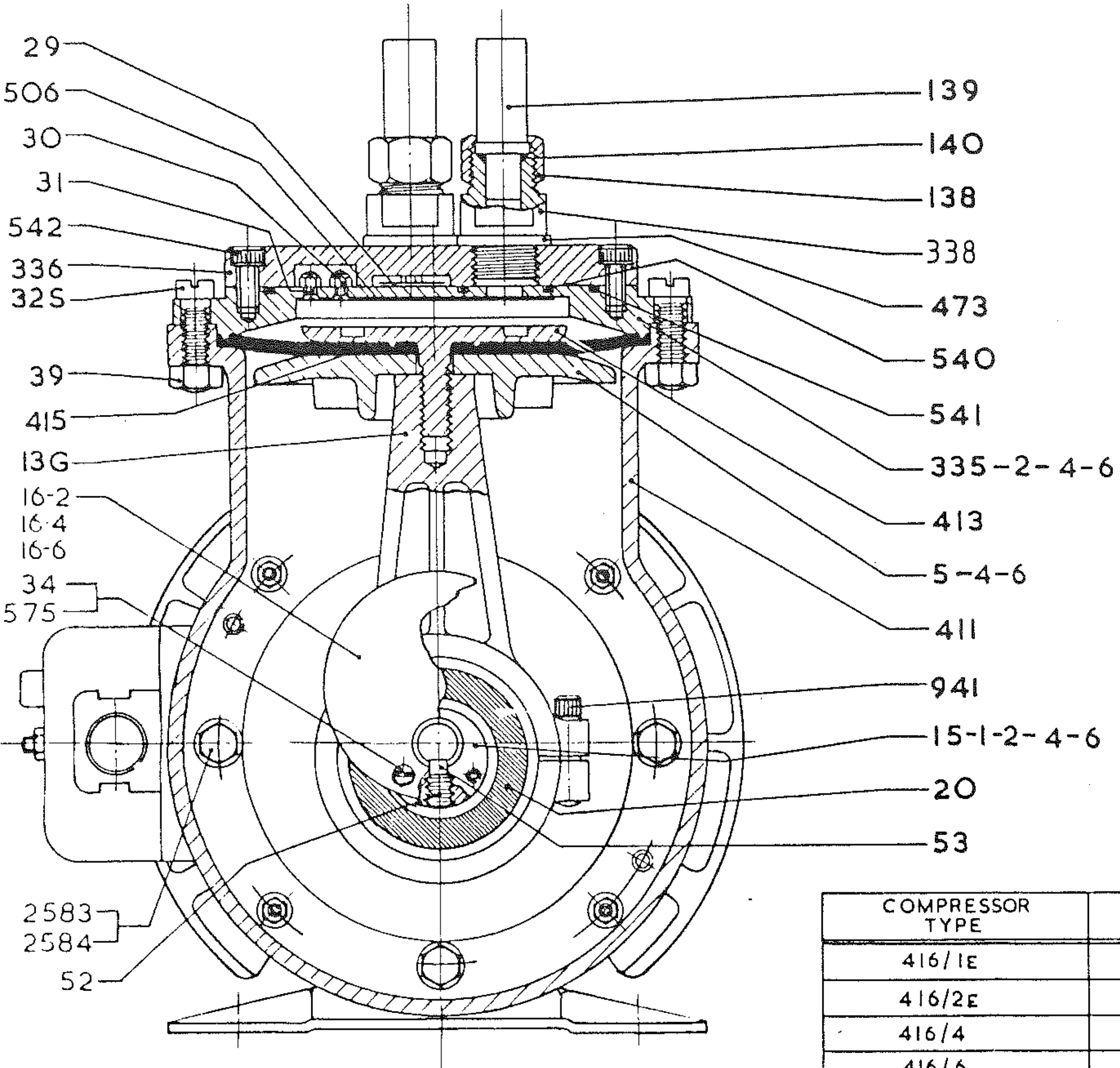
3. The connection can now be made by merely snugging up the nut as described in the *re-tightening instructions*.

Hydraulic swaging units are now available in 1/2", 5/8", 3/4" and 1" sizes. For further information consult your local SWAGELOK Sales and Service Representative.

*For 1/16," 1/8," 3/16," 2, 3 & 4mm size tube fittings, only 3/4 turns from finger-tight is necessary.

ISSUE 2	NO.941 2BA SCREW WAS NO.35 1/4"BSF SCREW	25-11-68
ISSUE 3	NO.39 NUT WAS NO.33	20-5-69
ISSUE 4	NO.2583, 2584 & 575 ADDED. NO.124 & 125 REMOVED.	7-10-74

DAWSON MCDONALD & DAWSON LTD. ASHBOURNE



COMPONENT PARTS

PART NO.	DESCRIPTION
13G	CONNECTING ROD.
14	PLASTIC COVER. NOT SHOWN.
20	BIG-END BALL BEARING.
29	VALVE STRIP FOR OUTLET.
30	6BA SIMMONDS LOCKNUT. (4)
31	6BA SCREW. (4)
32S	5/16" BSF SCREW. (6)
39	5/16" BSF NUT. (6)
34	2BA SCREW FOR BALANCE WEIGHT. (2)
941	CLAMPING SCREW FOR CONNECTING ROD.
52	5/16" BSF GRUB SCREW.
53	KEY FOR ECCENTRIC.
2583	1/4" BSF SET SCREW (4)
2584	1/4" STEEL WASHER (4)
138	NUT FOR CLOSED CIRCUIT CONNECTION. (2)
139	NIPPLE FOR CLOSED CIRCUIT CONNECTION. (2)
140	"O" RING. (2)
338	1/2" BSP ADAPTOR FOR CLOSED CIRCUIT CONNECTION (2)
336	COVER PLATE.
411	CP ECCENTRIC HOUSING.
413	TOP WASHER.
415	CP DIAPHRAGM.
473	DOWTY SEAL TYPE PP45-D (2)
506	VALVE STRIP FOR INLET.
540	"O" RING, DOWTY NO. PP 49B9.
541	"O" RING, DOWTY NO. PP 49B 38.
542	1/4" BSF SOCKET HEAD CAP SCREW. (6)
478	2BA SCREW FOR PLASTIC COVER. NOT SHOWN. (2)
575	2BA SHAKEPROOF WASHER. (4)

COMPRESSOR TYPE	BOTTOM WASHER *	ECCENTRIC	BALANCE WEIGHT	CP VALVE PLATE
416/1E	5-4	15-1	16-2	335-2
416/2E	5-4	15-2	16-2	335-2
416/4	5-4	15-4	16-4	335-4
416/6	5-6	15-6	16-6 (2)	335-6

* ON PUMPS WITH PTFE COVERED DIAPHRAGM THE BOTTOM WASHER TYPE REF. MUST HAVE THE SUFFIX PTFE

SPARES FOR 416 COMPRESSORS WITH STAINLESS STEEL HEADS

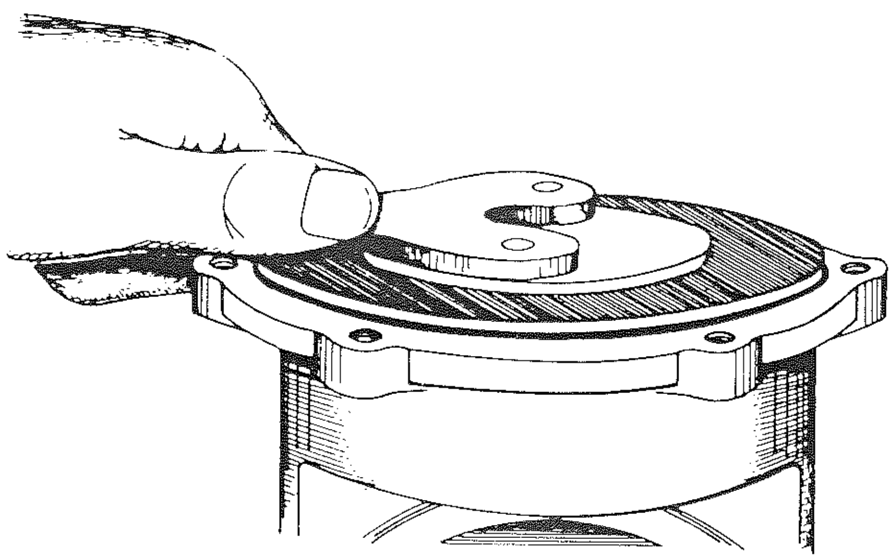


Fig.4

Fig. 4 shows a diaphragm assembly as used in gas circulating pumps or gas compressors.

The fixing method is somewhat different as the top washer and 3/8" Whitworth screw are combined into one component. A special peg spanner must be used when removing or replacing the diaphragm assembly. This spanner is available from our works, the part number is 442.

The diaphragm used with this kind of fastening is a special type being manufactured to a very fine limit on thickness. Its part number is 415CP and it is important to use this particular reference when ordering spare diaphragms for pumps with the type of fastening shown in Fig. 4.

All machines using this special type of fastening and diaphragm have the figure 416 or 296 as part of their type reference, e.g. D/416—4, or D/296—4.

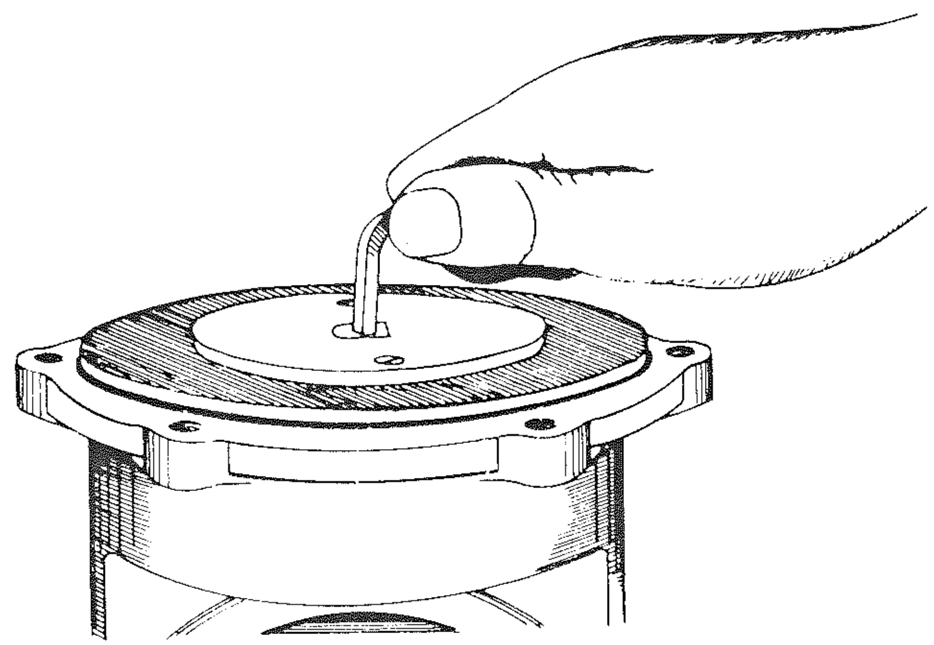


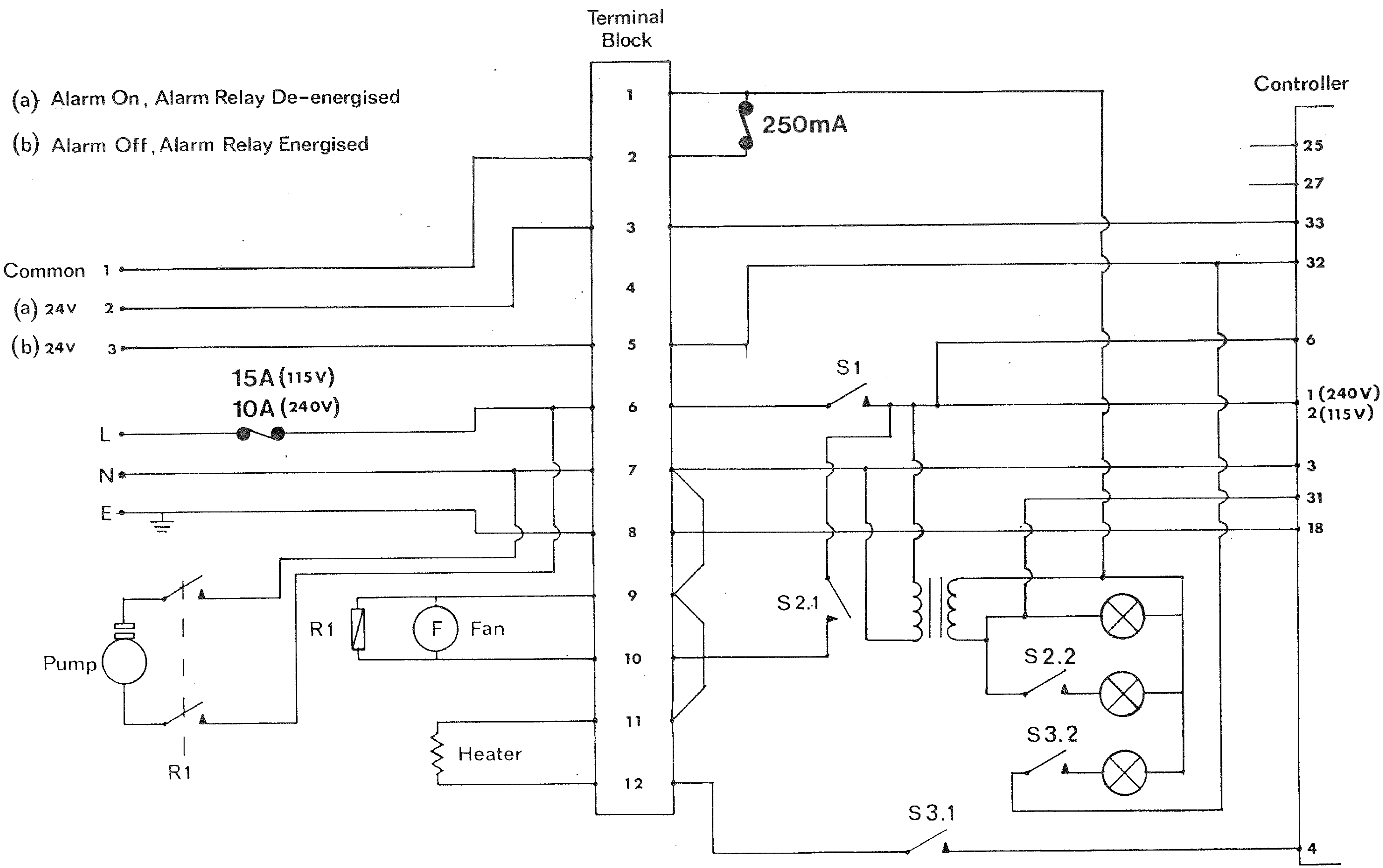
Fig. 5

Fig. 5 shows the diaphragm assembly being retightened. Make sure that the edges of the diaphragm are clear of the recess as shown (i.e. have the eccentric turned to its highest point) before attempting to tighten the screw. Also it is important to see that the 3/8" Whitworth screw is properly in its countersink with the locking flat fitting the flat in the top washer.

Tighten the assembly firmly into place. The 2BA screws and nuts where used should be fitted and tightened before the diaphragm assembly is presented to the connecting rod.

PART OF DO NOT SCALE SHEET OF

DRG. No.



ISSUE	DESCRIPTION	APPD.	DATE

OXFORD LASERS

TITLE
GP2000
WIRING DIAGRAM

DRAWN	TRACED	CHECKED	APPROVED	DATE
				10/84

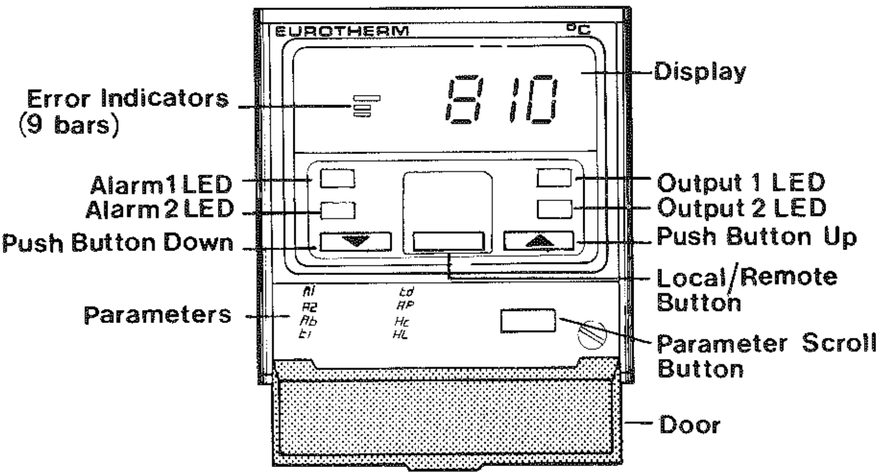
DRAWING No. 02

RS 558-717 420 x 297mm A3

EUROTHERM

MICROPROCESSOR BASED 3-TERM CONTROLLER TYPE 810

INSTALLATION AND OPERATING INSTRUCTIONS



Part No. HA016938

810W-5

CONTENTS Page

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Telex 484791. EUROT D.
Also regional offices.

Figure 3. The 2A relay output drives a contactor for heating and the 1A triac output operates a solenoid valve for cooling. A thermocouple is used as the input sensor.

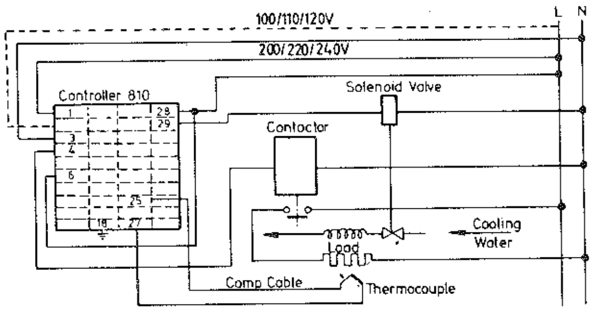
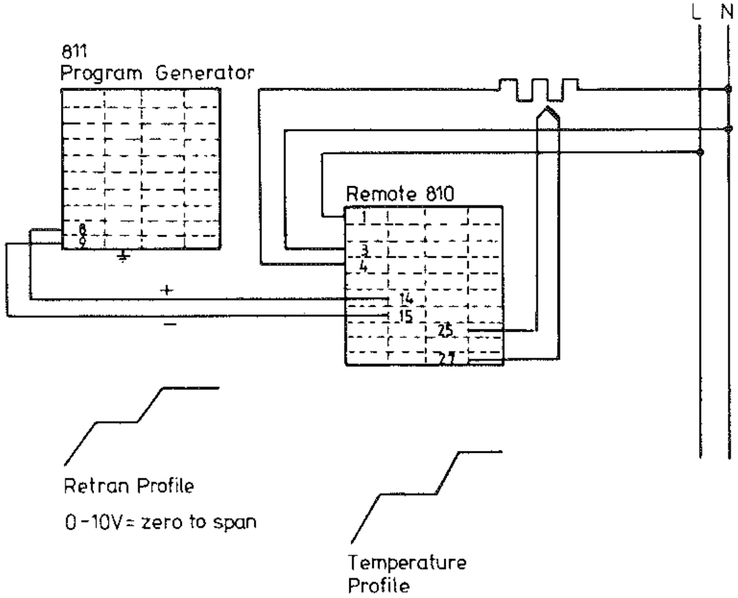
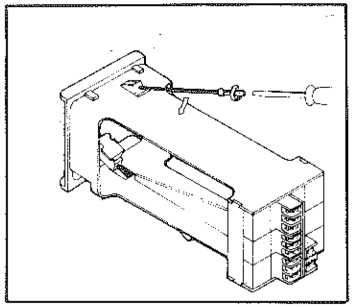


Figure 4. A remote input 810 controller whose setpoint is controlled by an 811 Setpoint Generator.



INSTALLATION

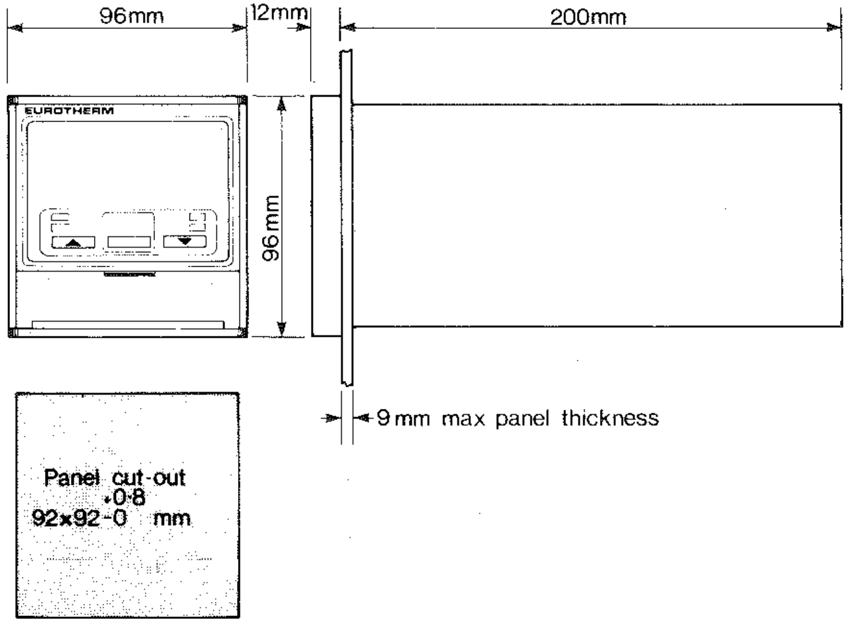


The instrument plugs into a panel-mounting sleeve which requires a DIN size 92 by 92mm cut-out as illustrated. Remove the instrument from the sleeve by opening the front panel door and with a screwdriver turn the screw, in the bottom-hand corner, counter clockwise. The instrument will start to withdraw from the sleeve and once the screw has been turned to its furthest extent the instrument can be withdrawn by hand. Remove the top and bottom mounting clamps from the sleeve by gently levering outwards and easing downwards inside the sleeve. Insert the sleeve through the cut-out via the front of the panel. Fit the mounting clamps in the slots from inside the sleeve and from the rear of the mounting panel tighten with a screwdriver.

By hand ease the instrument into the sleeve to its furthest extent. With a screwdriver turn the screw in the bottom right-hand corner clockwise until tight. The instrument will be pulled completely into the sleeve, engaging the rear terminals and be fully secured.

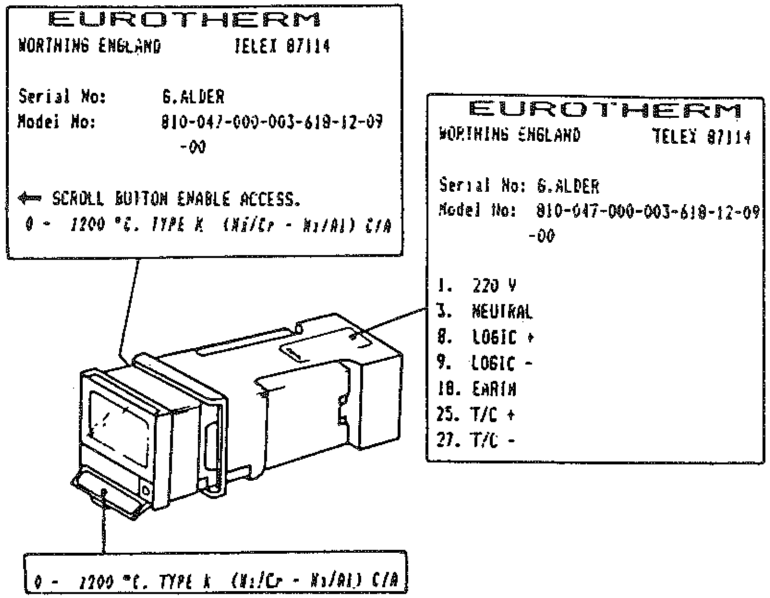
Note: Do not attempt to dismantle the instrument without referring to the Maintenance Manual.

DIMENSIONAL DETAILS

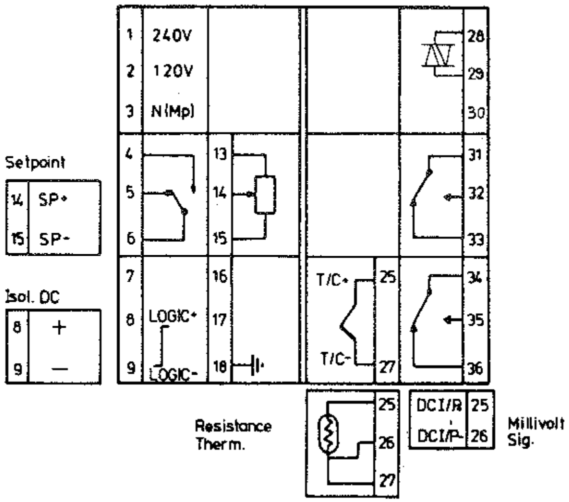


CONNECTIONS AND WIRING

Electrical connections are made via 3-way terminal blocks on the rear of the instrument. All connections are low current and a 16/0.20mm wire size is adequate. Labels on the instrument and sleeve indicate the specific connections for the instrument.



Rear Terminal Connections



Rear Terminals

TYPICAL WIRING SCHEMATICS

Figure 1. Three-phase fast cycling, close delta synchronised system using the logic output from an 810 Controller to drive a pair of Eurotherm 450 series thyristor units with thermocouple sensor. A Eurotherm Alarm Collection unit 603 gives, in this case, an audible warning of partial load failure.

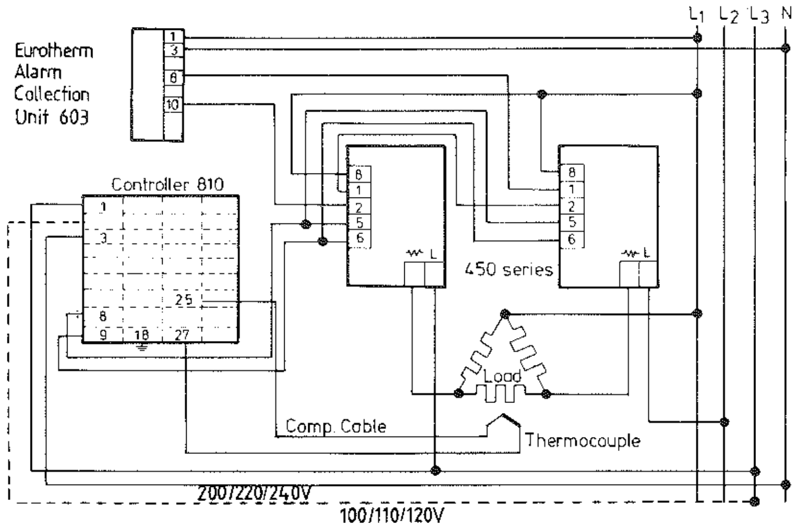
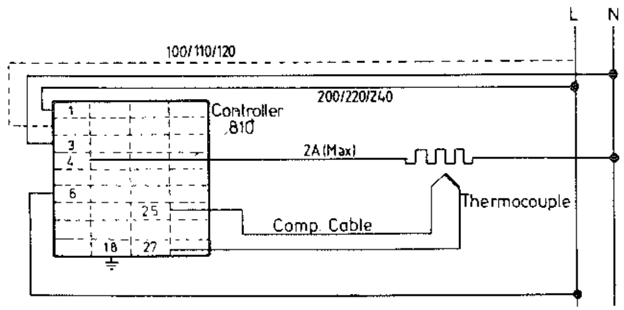
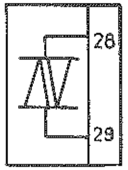


Figure 2. Relay output (heat) directly switching load with thermocouple sensor.





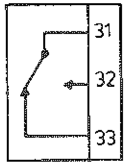
Triac

With controllers provided with triac output, connections are made to terminals 28 and 29 as shown. The triac is connected across the line and load terminals, with a live supply (1A/264V ac max) connected to the line and one side of the load connected to the load terminal. The other side of the load should be connected to the neutral line. During the 'ON' time the circuit between 28 and 29 is closed.

Cool Outputs

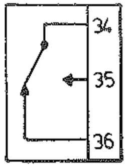
Triac

(see above).



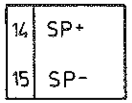
Alarms

Controllers provided with relay alarm outputs are internally connected to terminals 31, 32 and 33 for Alarm 1 and to 34, 35 and 36 for Alarm 2. Terminals 32 and 35 are N/O when the relays are de-energised. When energised the voltages at terminals 31 and 34 are switched through to the output terminals, 32 and 35 respectively. Relay contact rating 1A/264V rms. Contact suppression is provided between the N/C contacts and the wiper with the relay de-energised in alarm (fail safe). Suppression is provided between the N/O contacts and wiper with the relay 'energised in alarm'.



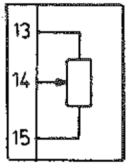
Options

Remote Analogue Setpoint.



Voltage or current input for remote analogue setpoint is applied to terminals 14 and 15 as shown. The remote analogue setpoint can be set by means of an external 10K ohm potentiometer, connect as shown to terminals 13, 14 and 15.

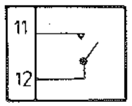
When rear selection of the Local/Remote facility is required an external latching switch should be connected between terminals 11 and 12.



External Power Limit

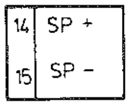
Maximum heat output can be set externally be means of an analogue input or a 10K to 47K ohm potentiometer as shown.

2nd Setpoint



A 2nd setpoint can be selected by a front pushbutton, annotated SETPOINT 2, and/or an external selection button connected to the rear terminals 11 and 12 as shown. When front and rear selection are provided, connected in parallel, closure of either the front or rear contacts selects 2nd setpoint.

Digital Setpoint Trim

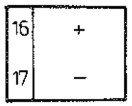


An instrument with a digital setpoint trim accepts a full scale analogue setpoint signal to which is added a ±10% digital setpoint trim. The analogue signal may be a voltage or current input to terminals 14 and 15 or a 10K ohm potentiometer connected between terminals 13, 14 and 15.

Analogue Setpoint Trim

An instrument with an analogue setpoint trim has full scale digital setpoint to which is added a ±10% analogue trim. The analogue trim may be a voltage or current input to terminals 14 and 15 or a 10K ohm potentiometer connected between terminals 13, 14 and 15.

Analogue Retransmission



This unlinearised 0-10V or 0-5V (10mA max) analogue output is available on terminals 16 and 17 as shown.

Three Term Control Parameters

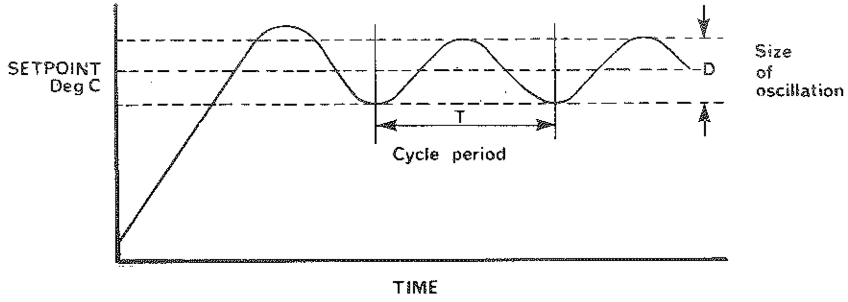
Three term control parameter values for optimum control are a matter of application. If the values are unknown the following method will give acceptable settings which can then be finally adjusted to give the optimum control.

1. The practical approach is to control the load with an on-off system and measure the resulting oscillation and the number of times it occurs per minute.

Set the following conditions:

Proportional band, Pb%	=	0.50	Maximum power, HL%	=	100
Integral time, ti	=	OFF	Approach, AP	=	1.00
Derivative time, td	=	OFF	Setpoint,	=	As required

2. Switch on the process and observe the start-up and running conditions which should appear as shown:

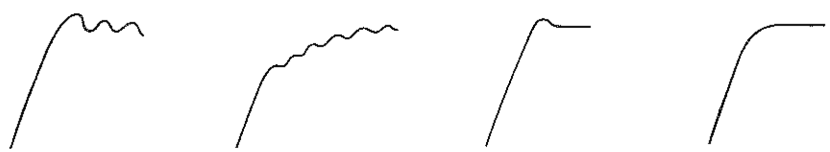


3. From these observations the following initial parameter values can be approximated.

Pb	=	D/Full scale × 100%
		(Set to next higher value if between fixed settings)
ti	=	T seconds
td	=	T/5 seconds
		(Set to next lower value if between fixed settings)

4. Reset instrument with the values calculated in para. 3 and restart the process from cold. If oscillation still results increase proportional band/decrease derivative.

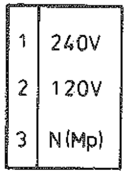
5. Example:-Using a 1200 deg C Muffle furnace with settings as in para. 1, the following waveforms resulted.



Pb = 0.50	Pb = 2	Pb = 3	Pb = 3
ti = Off	ti = 600	ti = 600	ti = 600
td = Off	td = 150	td = 60	td = 60
HL = 100	HL = 100	HL = 100	HL = 100
AP = 1.00	AP = 1.00	AP = 1.00	AP = 2

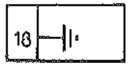
6. The Approach control adjusts the start up characteristics of the furnace by releasing the drivative action at some variable point away from setpoint. This term is expressed as the number of proportional bands away from the setpoint value. Below are shown various waveforms for the same PID settings but with different Approach values.

AP- 0.25 AP-0.50 AP=1.00 AP=2.00 AP=3



Supply

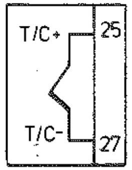
Power supply for the instrument is connected to terminals 1, 2 and 3. Neutral to terminal 3 and either 200/220/240V to terminal 1 or 100/110/120V to terminal 2. The ground connection is made to terminal 18.



Instrument Earth

Inputs

Note: On some instruments a filter module is fitted, above the input terminal block. Ensure that the GREEN lead is connected to terminal 18 and one BLUE lead is connected to terminal 27 for T/C inputs or to terminal 26 for all other inputs, and the other BLUE lead to terminal 17.

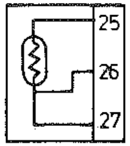


Thermocouple

Thermocouple connections are made to terminal 25 and 27, positive lead to 25 and negative lead to 27. Compensating cable of the correct type must be used between the thermocouple and the instrument and must be connected in the correct polarity. To check compensating lead polarity lift the leads off the thermocouple, twist them together and apply heat to the junction. The digital readout value should increase.

An open circuit thermocouple normally causes the digital value to move upscale and the heat is turned off. For processes where the heat must remain on for open circuit thermocouple, downscale indication (option 24) is specified.

Error indicators show direction of break protection and when the upper/lower limit of scale is reached the display blanks.



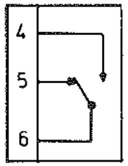
Resistance Thermometer

Platinum resistance three wire thermometers are connected to terminals 25, 26 and 27. Connect the single connection side of the bulb to terminal 25 and the double connection to terminals 26 and 27.

Millivolts Signals

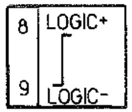
Inputs are connected to terminals 25 and 26 as shown.

Heat Outputs



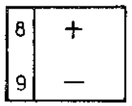
Relay

The controller is fitted with an output relay which has a single changeover contact, connected internally between terminals 4, 5 and 6. With no supply to the instrument the relay is de-energised and terminal 4 is normally open (N/O). The relay is energised to apply power to the load and the voltage at terminal 6 is switched through to terminal 4. The contact is rated at 2A/264V rms and is suitable only for use with low-power loads. Slow cycle time-proportioning or on-off control is available. Contact suppression is provided between the N/O contacts and the wiper.



Logic

A logic output is provided at terminals 8 and 9. This output is an unisolated 10mA at 14Vdc minimum signal with slow or fast cycle time proportioning or on-off. This output is suitable for use only with the Eurotherm Thyristor Units.



Isolated DC

An isolated dc output is provided at terminals 8 and 9, see code for relevant output.

Local/Remote

Indication of a remote facility on local/remote instruments is by the LED in the centre of the fascia. Selection of either the front panel Local/Remote pushbutton or closure of the switch for rear selection causes this LED to illuminate in remote and extinguish in local.

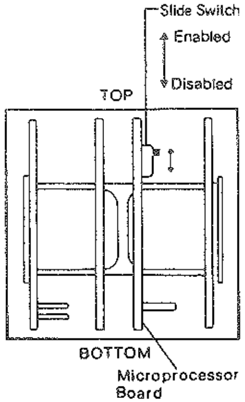
Auto/Manual

Indication of the manual facility on Auto/Manual instruments is by the LED in the centre of the fascia. Selection of either the front panel Auto/Manual pushbutton or closure of the switch for rear selection causes this LED to illuminate in manual and extinguish in auto. If an optional Local/Remote facility is used the remote LED will illuminate when in Remote.

Setting Up

Setting up is achieved by access to the parameters through a scroll button which is located behind the front door panel.

The instrument is supplied with the scroll button disabled. Values of proportional band, integral and derivative times are set to a standard to suit the average application. To modify these values the scroll button has to be enabled. To enable the scroll button, remove the instrument from its sleeve. Locate the switch at the rear of the microprocessor circuit board (as shown). If a slide switch is fitted, slide the switch towards the top of the instrument to enable the scroll button. If a link switch if fitted, press down on the link and engage the hook (as shown). To disable the scroll button slide the switch towards the bottom of the instrument or disengage the link switch as appropriate.



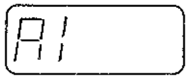
To the left of the scroll button and on the inside of the door panel are listed a series of control parameters, pertinent to that instrument. Each parameter is shown in abbreviated form. Operation of the scroll button causes the abbreviation to appear in the left hand segments of the digital fluorescent indicator panel. After approximately two seconds the abbreviation is replaced by the value of that parameter. NOTE: Until the scroll button is released the first digit of the abbreviation is not displayed. Adjustment of a parameter is achieved by means of the UP/DOWN buttons. Subsequent operation of the scroll button selects the next parameter listed.

NOTE: If no action is taken by the operator within eight seconds of the last action, the display will automatically revert to indicating the measured value.

Parameters

Limit Alarms

When a high or low deviation or band alarm is fitted the alarm setpoint can be adjusted between 0 and a top limit, where the top limit is 20% of the span. The limits for a full scale alarm are the limits of the span of the instrument.



A1 - Alarm 1

To set the limit for one of the alarms depress the scroll button so that 'Al' is displayed. After approximately one second the digital readout will indicate the temperature setting of Alarm 1. To set the limit to the required value depress the respective UP/DOWN buttons until the limit, top or bottom, is reached. This limit will appear in the display.

A2 - Alarm 2

To set the limit of the other alarm depress the scroll button so that 'A2' is now displayed. To set this limit depress the respective UP/DOWN buttons until the required limit is reached.

SP - 2nd Setpoint

For instruments with a 2nd setpoint facility depress the scroll button so that 'SP' is displayed. Depress the UP/DOWN buttons to set the 2nd setpoint to the required value.

St - Digital Setpoint Trim

For instruments with a digital setpoint trim facility depress the scroll button so that 'St' is displayed. Depress the UP/DOWN button to set the degrees of trim, which is adjustable ±10% of the instrument span.

SP - Analogue Setpoint Trim

For instruments with an analogue setpoint trim facility depress the scroll button so that 'SP' is displayed. Depress the UP/DOWN buttons to set the digital setpoint.

AL - Alarm

For instruments fitted with Local/Remote, 2nd setpoint or trim facilities and an alarm channel, depress the scroll button so that 'AL' is displayed. To set the limit of the alarm depress the respective UP/DOWN buttons to set the required limit.

Pb - Proportional Band, On/Off Hysteresis % instrument span

Depress the scroll button so that 'Pb' is displayed. Depress the UP/DOWN buttons to set Pb to required value. The proportional band settings are in 15 steps from 0.5 to 100%. With on/off control instruments Pb sets the ON/OFF hysteresis in % of span.

ti - Integral (Secs)

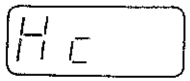
Depress the scroll button so that 'ti' is displayed. Depress the respective UP/DOWN buttons to set the integral time to the required settings in 14 steps from indicating OFF to 1800 seconds.

td - Derivative (Secs)

Depress the scroll button so that 'td' is displayed. Depress the relative UP/DOWN buttons to set the derivative time. The derivative settings are in 13 steps from indicating OFF to 600 seconds.

AP - Approach

Depress the scroll button so that 'AP' is displayed. This control allows adjustment of the rate of change of temperature as setpoint is approached. The approach value is set by the respective UP/DOWN buttons and selectable from 0.25 to 3 in 9 steps.



Hc - Cycle Time (Secs)

Depress the scroll button so that 'Hc' is displayed. Depress the UP/DOWN buttons to set the required cycle time. Cycle times available are 0.3, 1.5, 10, 20, 40 and 80 seconds. For logic outputs it is normally set to 0,3 and for relay outputs to 20 seconds. (Settings below 20 seconds for relay outputs can cause increased contact wear and premature failure). With dc outputs the cycle time is fixed at 0.3 seconds. The cycle time setting is inoperative for ON/OFF control instruments.

HL - Maximum Power (Heat)

Depress the scroll button so that 'HL' is displayed. Depress the UP/DOWN buttons to set the percentage of the required power, normally 100%. Settings available are 0 to 100% in increments of 1%.

HL - External Power Limit

For an instrument with an external power limit facility depress the scroll button until 'HL' is displayed. Depress and hold depressed one of the UP/DOWN buttons and adjust the external power limit potentiometer to the required power setting.

Cc - Cool Cycle (Secs)

Depress the scroll button so that 'Cc' is displayed. Depress the UP/DOWN buttons to set the required cycle time. The cool cycle time is set from 0.3 to 80 seconds and should ideally be set to the highest time possible.

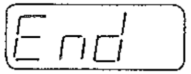
Note: On non-linear cool outputs (code 093) whenever cool is demanded the cycle time is automatically set to 10 seconds, therefore no setting of the cool cycle time is required.

Cr - Relative Cool

Depress the scroll button so that 'Cr' is displayed. Depress the UP/DOWN buttons to set the required cool gain, which is relative to the primary output and adjustable in 9 steps from 0.25 and 3.

CL - Maximum Power (Cool)

Depress the scroll button so that 'CL' is displayed. Depress the UP/DOWN buttons to set the percentages of the required power. Maximum power settings available are 0 to 100% in increments of 1%.



End

Once all parameters have been scrolled the term 'END' is displayed. After eight seconds the 'END' term is automatically replaced by the measured value.

Control Variables (steps)

Standard 810:

Prop band (%) 0.50, 0.75, 1.00, 2, 3, 4, 6, 8, 12, 35, 50, 100
Integral (secs) off, 15, 30, 45, 60, 90, 120, 150, 200, 300, 400, 600, 900, 1200, 1800
Derivative (secs) off, 5, 10, 15, 20, 30, 40, 60, 90, 150, 200, 300, 400, 600
Approach (rel Pb) 0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 2.00, 2.50, 3.00
Cycle Times (secs) 0.3, 1, 5, 10, 20, 40, 80
Maximum Power (%) 0 to 100 in 1% steps
Relative Cool 0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 2.00, 2.50, 3.00

810 Auto/Manual

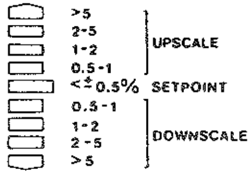
Prop band (%) 0.5, 0.8, 1.1, 1.7, 2.5, 4, 6, 8, 13, 20, 26, 34, 50
Integral (secs) off, 5, 7, 10, 15, 25, 40, 65, 100, 145, 210, 300, 450, 700, 1100, 1700
Derivative (secs) off, 1.5, 2.5, 4, 6, 9, 12, 17, 24, 33, 46, 65, 90, 130, 180
Cycle Times (secs) 0.3, 1, 5, 10, 20, 40, 80
Maximum Power (%) 0 to 100 in steps

OPERATION

Temperature Setting

When power is connected the flourescent indicator panel will display the measured value of the temperature in digital form. Depress and release either the UP or DOWN button and the display will indicate the setpoint value for five seconds and then revert to the measured value.

To alter the setpoint depress the respective UP/DOWN button and after a delay of 3 seconds the setpoint will change in the required direction.



Manual Power Setting

With an Auto/Manual instrument selected to manual the manual power output will be actual power being delivered at the instant of selection. Depress and release either the UP or DOWN button and the display will indicate the current output power in percentage. To alter the power depress the respective UP/DOWN button and the power will change in the required direction.

Indications

The fluorescent indicator panel measured value, setpoint and all parameters particular to the specific instrument. These can include alarms, PID settings approach, heat/cool cycle times, maximum power, 2nd setpoint settings and setpoint trim.

When a parameter other than measured value is displayed, indication is provided by means of a flashing dot at the top of the display.

In the event of a thermocouple break the numeric display goes blank when the maximum scale range is reached.

Error Indications

The nine segment bars situated to the left of the digital readout provide error percentages of measured values of temperature with respect to the set temperature. Illumination of the centre bar only indicates within 0.5% of setpoint.

The bars above and below the centre bar indicate, when illuminated, the upscale and downscale errors respectively, in increasing magnitude. For instruments with a setpoint trim facility operation of the UP/DOWN buttons causes the nett setpoint (setpoint and trim) to be displayed.

Alarms

The respective ALARM LEDs will illuminate whenever an alarm is ON. Optionally, an instrument can have the numeric display flashing in an alarm condition with no alarm boards fitted and therefore the ALARM LEDs are inoperative. (Not applicable to Auto/Manual instruments).

Outputs

The OUTPUT LEDs illuminate when ever an output is operative. Normally OUTPUT 1 LED indicates a heat channel and OUTPUT 2 LED a cool channel output. If a triac heat channel is incorporated OUTPUT LED2 will illuminate for the heat channel and any associated cool channel is indicated by the OUTPUT 1 LED.

2nd Setpoint

Indication of 2nd setpoint, either front or rear selected, is by LED in the centre of the fascia. When illuminated the 2nd setpoint is selected and when extinguished the instrument reverts to its normal setpoint.