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THE HT1 AMMONIA CRACKER

With ICI Catalyst

Installation, Operating & Maintenance Instructions

Manufacturers of Ammonia Crackers & Vaporisers
Part of the Surface Finishing Equipment Group
Reg. No. 6348827 Vat No. GB 917 7059 05

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Note:

METRICATION

The government target date for metrication is 1975, and in preparation for this the values and measurements in this book are printed in British units with the equivalent values for International System (S I) units in brackets.

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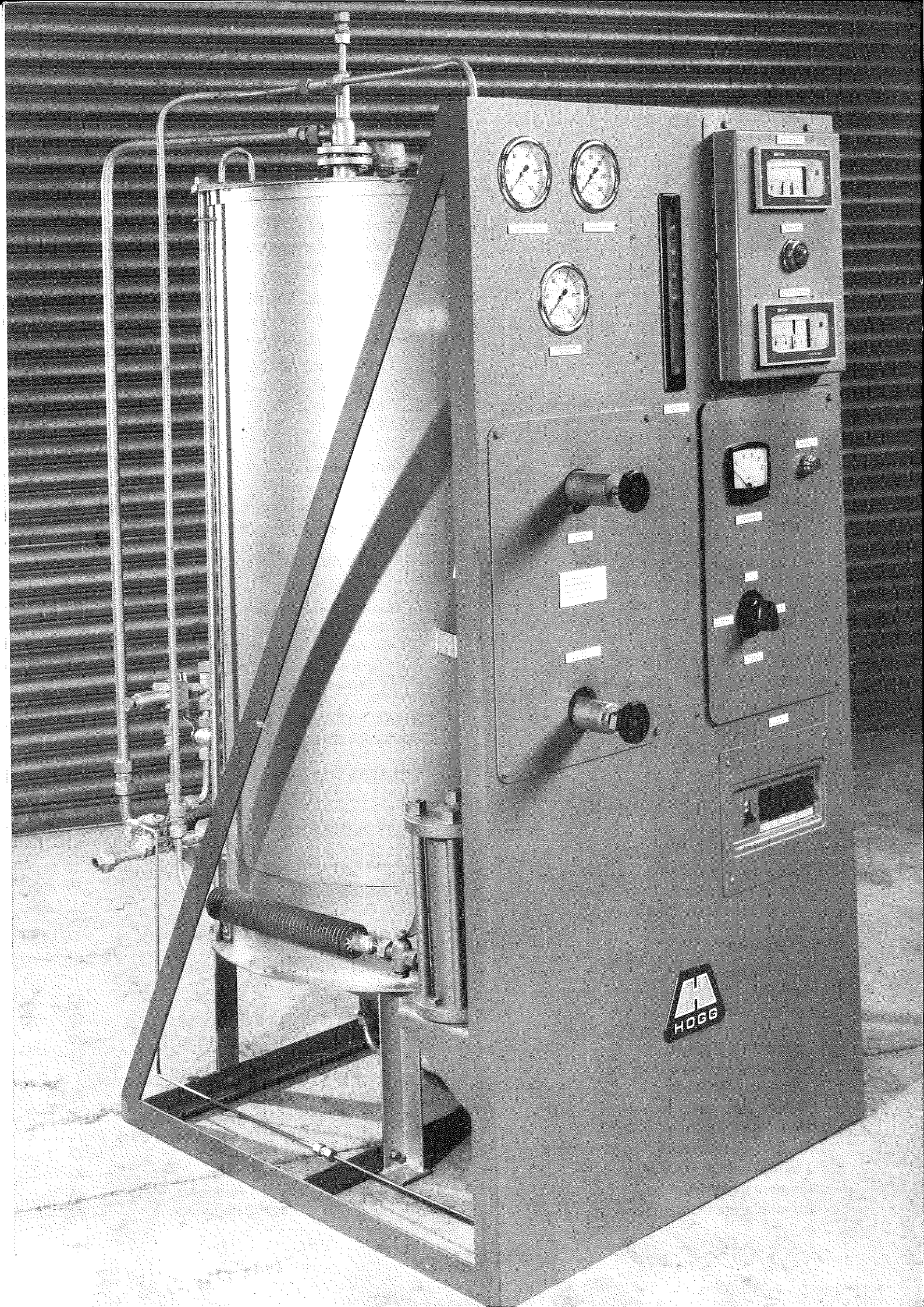
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DESCRIPTION OF MARK VII HT 1 AMMONIA CRACKER

The high temperature ammonia cracker (Code M 7) is designed to operate from a liquid anhydrous ammonia supply at a pressure of not less than 35 lb/in² gauge (2·4 bar gauge). The cracker is essentially in two parts:

1 The body, consisting of an electric furnace holding the catalyst container

2 A panel on which are mounted the pressure and temperature controls and instruments.

The body consists of a thermally insulated vertical tube furnace with refractory brick closures at either end holding a spirally wound catalyst container of 'Inconel' tube and a tubular electric heater. The four feet on which the body stands are bolted to cross members on the panel framework, thus holding the two parts together. On the panel are mounted the gas pressure controls, flowmeter, temperature control and alarm instruments, and the electrical relays and transformer.

GAS CONTROL SYSTEM *(See Fig 1)*

Liquid anhydrous ammonia is fed into a small cylindrical vaporiser mounted within the outlet branch of the catalyst container. The heat for vaporisation comes partly by conduction from the furnace and partly from the hot cracker gas flowing over the outside of the vaporiser. Gaseous ammonia from the vaporiser passes through a finned cooler, an isolation cock and a gas filter to a pressure reducer. The pressure reducer is set to maintain the ammonia at 25 lb/in² gauge (1·72 bar gauge) —the calibration pressure of the flowmeter. From the flowmeter, the gas passes through an ammonia pressure regulator and a restrictor before reaching the catalyst container. The ammonia pressure regulator consists of a reducing valve where the manually loaded control spring setting is altered by variations in cracker gas delivery pressure. This valve, together with the restrictor, limits the ammonia pressure entering the catalyst container to the minimum necessary to maintain the required flow. The ammonia pressure regulator may be adjusted to limit the available flow from the cracker to any desired rate up to a maximum of 300 scfh (8·5 m³/h).

From the regulator the ammonia passes into the bottom of the catalyst container where it is dissociated into a 75% hydrogen/25% nitrogen by volume gas mixture—'cracker gas'. The hot cracker gas passes over the ammonia vaporiser and then leaves the catalyst container to pass through a finned cooler and a ½ in. isolation valve to the cracker gas distribution main.

Relief valves are fitted immediately after the vaporiser, between the flowmeter and the ammonia pressure regulator, and on the cracker gas line before the ½ in. isolation valve.

ELECTRICAL SYSTEM *(See Figs 2 and 3)*

The electric furnace holding the catalyst container is maintained at 850°C. Temperature sensing is by two 'Chromel/Alumel' thermocouples mounted in the centre of the tubular heater and regulation is effected by a control instrument in conjunction with a relay. An alarm instrument operates an alarm light and Klaxon horn to give warning of either high or low temperature.

Because the heater is designed to operate at 250 V ac, a 'step-up' transformer is provided to adjust the mains voltage to the correct value. This transformer also has a series of reduced voltage tappings providing a limited power output to keep the cracker hot while there is no gas requirement. The changeover from 'operating' to 'stand-by' is effected by a manually operated rotary switch. In the 'stand-by' condition, the cracker will hold a temperature of 750°–850°C and, as the control and alarm circuits are by-passed, no supervision is necessary.

INSTALLATION

The ammonia cracker arrives in two crates, one containing the body of the cracker with pipework and the other containing the panel with wiring and pipework.

Wherever possible any ancillary equipment ordered will be delivered with the cracker but may be packed separately.

UNPACKING

Examine the equipment immediately it is received. To minimise any risk of breaking the electric heater in the cracker, the refractory top cap which fits over the top of the heater *(See photographs 5 and 6, 'Dismantling of Cracker Body', page 10)* is packed separately in the crate containing the cracker panel. A bag of thermal insulation is also packed in this crate.

Complaints regarding damage or loss must be made within three days of receipt of the equipment.

When the cracker has been unpacked, replace the refractory top cap and thermal insulation as follows:

1 Dismantle the cracker body up to and including step 6 of 'Removing and Replacing the Heater from the Cracker' *(page 11)*.

2 If necessary, level off the thermal insulation.

3 Remove the stainless steel cover section. A disc of cushioning material will be exposed and this should be removed (it may stick to the underside of the stainless steel cover section).

4 Remove the four cushioning strips placed between the outside of the heater and the inside of the catalyst container and also the four strips placed between the outside of the catalyst container and the inside of the refractory tube.

5 Remove the top cap from the box (the cap is formed from brittle material and the box must be opened carefully).

6 Re-assemble the cracker body as detailed on page 11 'Removing and Replacing the Heater from the Cracker', steps 1–9 in reverse order (it will be found that the loose thermal insulation provided will 'top-up' the existing insulation without the need for any slag wool in this case).

ASSEMBLY OF UNIT

It is assumed that a supply of liquid ammonia at cylinder pressure is available. Details of the pipework arrangement for a supply from cylinders are shown in the booklet 'Anhydrous Ammonia—Gas and Liquid Supplies from Cylinders'. Provide adequate working room around the unit and, if possible, at least 6 ft (2 m) headroom. A beam or gantry capable of taking a 10 cwt (0·5 t) chain block will be useful during erection and maintenance.

1 Check that the serial number of the unit is the same on both panel and body.

2 Place the body of the cracker in position, match the panel to it and secure the body to the bottom angles of the panel with the 4 bolts provided.

3 Make the pipe joints at points AA, BB, CC and DD. These joints are identified on installation drawing Fig. 4.

4 Run a 1 in. mild steel stack pipe from the union on top of the purge pot to atmosphere at some point above roof level and remote from access by personnel. The top of this pipe should be bent over through 180° to prevent ingress of rain.

5 Run a separate ¼ in. mild steel vent pipe from the cracker gas relief valve to atmosphere outside the building. This pipe should terminate away from any means of ignition.

6 Connect the cracker gas outlet at GG into the cracker gas main using ½ in. mild steel pipe.

7 Connect the liquid ammonia supply line to the top connection on the cracker vaporiser using ¼ in. n.b. steel tubing (Code C 42). For maintenance purposes it is essential that this supply line should be fitted with a 'Klinger' sleeve packed cock (Code C 28b) close to the cracker but not positioned above the body. This cock enables the ammonia supply to the cracker to be isolated and a section of pipe above the cracker to be removed so that access may be obtained to the heater and catalyst container.

WIRING THE UNIT *(See Figs 2 and 3)*

1 Isolate the mains electrical supply to the cracker.

2 Connect one thermocouple to each instrument. The positive wire of the compensating lead is identified by red insulation:
Note: After step 5 of the section on checking the electrical system (below) has been reached and the cracker has been wired up and the current switched on, remove the thermocouple

head, complete with the two couples, from the thermocouple sheath. Move the red set-points to the top of the instrument scale, hold a lighted match under the end of each thermocouple and check that the indicator pointer of each instrument moves up the scale.

3 Connect the output leads from the transformer to the heater terminals in the junction box beneath the cracker body.

4 Connect up the transformer input terminal, the neutral and the earth terminals to the corresponding terminals on the isolation switch. The phase wire should be connected to the transformer terminal corresponding to the main voltage obtaining in the factory. Note that the mains supply cable used must be capable of carrying at least 40 amps per cracker.

CHECKING THE ELECTRICAL SYSTEM

1 Replace all fuses and switch on the mains supply to the cracker and check that the circuit breakers on the cracker are in the 'on' position.

2 Set the set-points on the instruments to about a mid-scale reading.

3 Switch on the cracker and turn the rotary switch to 'operating'. The alarm light will come on and the Klaxon buzzer will sound.

4 Press the 'cancel alarm' button on the front of the cracker panel. This will cut out the alarm circuit.

5 Check that the ammeter reading lies between 30 and 32 amps.

6 Turn the rotary switch to 'stand-by' and check that the ammeter reading lies between 15 and 16 amps.

7 If either the 'operating' or 'stand-by' current is outside these limits, make the cracker electrically safe and adjust the input phase wire to a more suitable terminal for operating current and the half-volt output wire for 'stand-by' current. The 'stand-by' voltage can only be adjusted accurately by observing the cracker temperature over a considerable period under 'stand-by' conditions. The reduced voltage should be adjusted to maintain the temperature of the cracker at 750–850°C with no gas passing through the cracker.

8 Every time the cracker is switched off and on or from 'stand-by' to 'operating', the alarm system will operate. Cancel this each time.

9 With the rotary switch set to 'operating' move the set-point of the control instrument down scale. As this set-point passes the indicator pointer on the instrument, the heater should switch out.

10 Move the set-point of the control instrument up scale until it is just above the indicator pointer. The alarm system will now operate.

11 Move the two set-points of the alarm instrument down scale until the indicator pointer lies between them. The alarm system will now switch off.

12 Move the set-points of the alarm instrument further down scale until they are both well below the indicator pointer. The alarm system will sound.

13 Set the control instrument set-point to 850°C and the two alarm instrument set-points to 800°C and 900°C respectively. Cancel the alarm system and leave the cracker to heat up to operating temperature.

LEAK TESTING THE PIPEWORK

1 Ensure that the ½in. n b isolation valve on the outlet of the cracker and the by-pass cock across the cracker gas relief valve are shut.

2 Open the 'Klinger' isolation cock in the ammonia supply line; close the cock at the inlet to the ammonia gas filter; fully release the spring of the ammonia pressure reducer (turn the handwheel anti-clockwise) and close the pressure regulator (turn the handwheel clockwise).

3 Crack open the isolation valve on the ammonia cylinder and then shut it. Using a burning sulphur taper (Code C 61) test all joints from the cylinder to the cock at the inlet to the gas filter. Stop all leaks.

4 Open the isolation cock at the gas filter and test all joints up to the pressure reducer.
Note: The pressure in the ammonia cylinder is registered on the right hand side pressure gauge labelled 'cylinder pressure'. If there is no pressure indicated, ensure that the isolation valve to the pressure gauge is open. This is situated on the block of the pressure reducer behind the panel. If there is still no pressure indicated, crack open the valve on the ammonia cylinder, then shut it as before and repeat the leakage test up to the pressure reducer.

5 Turn the handwheel on the pressure reducer clockwise until a pressure of 25 lb/in^2 gauge (1·72 bar gauge) is indicated on the left hand pressure gauge labelled 'rotameter pressure' and test all joints up to the ammonia pressure regulator.

6 Turn the handwheel on the pressure regulator anti-clockwise until a pressure of 10 lb/in^2

gauge (0·7 bar gauge) is indicated on the pressure gauge labelled 'ammonia before catalyst'. Test all joints up to the ½ in. n b isolation valve at the outlet of the cracker. When all joints are free from leaks, close the pressure regulator and vent all pressure from the catalyst container by opening the by-pass cock across the cracker gas relief valve. When the pressure gauge labelled 'ammonia before catalyst' indicates zero, shut the by-pass cock.

REDUCTION OF THE CATALYST

The catalyst in the container as supplied is in an oxidised condition and it must be reduced before it will effectively dissociate ammonia.

Reduction is achieved by passing ammonia over the heated catalyst. Proceed as follows:

1 Check that the set-point on the 'Control Instrument' is at 850°C and that the two set-points on the 'Alarm Instrument' are at 800°C and 900°C.

2 Check that the circuit breakers are all in the 'on' position and switch on the cracker.

3 Turn the rotary switch to the 'operating' position. The alarm light and Klaxon will then be operative.

4 Press the button labelled 'cancel alarm' and the alarm system will be rendered inoperative until the set-point of 850°C is reached.

5 Allow the temperature of the cracker to rise to 850°C, which will take approximately 3–4 hours.

Note: i The cracker must be at a temperature of 850°C before cracker gas is taken off.

ii When starting from room temperature, do not attempt to take gas from the cracker until approximately two hours after the temperature of 850°C has been reached.

6 Ensure that the ½ in. n b isolation valve at the outlet of the cracker and the by-pass cock across the cracker gas relief valve are closed.

7 Open *slowly* the isolation valve on the ammonia cylinder (or the isolation cock at the cracker, having already opened the valve on the ammonia cylinder).

8 Open fully the by-pass cock across the cracker gas relief valve.

9 Adjust the pressure reducer to obtain 25 lb/in² gauge (1·72 bar gauge) on the pressure gauge labelled 'rotameter pressure'.

10 Adjust the ammonia pressure regulator to give a flow of 25 s c f h (0·7 m³/h) on the flowmeter.

11 Maintain the gas rate as above for about four hours. Initially, a mixture of steam and water will be emitted as water is produced during the reduction of the catalyst. At the end of the period of reduction, readjust the pressure regulator to give a flow rate of 150 scfh (4·25 m³/h) on the flowmeter for a few minutes, and any water which has been held up in the pipework will be blown out.

Note: The catalyst is now reduced and should deliver gas to specification (i e better than 0·05% residual ammonia). The catalyst will continue to improve for several days after this initial reduction as impurities in the catalyst substrata are removed.

SETTING THE RELIEF VALVES

There are two relief valves connected into the purge pot at the back of the panel. One is set to lift at 180 lb/in² gauge (12·43 bar gauge) and locked and must not be touched. The other should be set to lift at 35 lb/in² gauge (2·4 bar gauge) in the following manner:

1 Readjust the pressure reducer to indicate a pressure of 35 lb/in² gauge (2·4 bar gauge).

2 Slowly turn the knurled knob on the relief valve anti-clockwise until the float in the ammonia flowmeter just starts to lift. The valve is now set and the locking ring should be tightened.

3 Reset the ammonia pressure reducer to control at 25 lb/in² gauge (1·72 bar gauge).

A third relief valve is situated on the outlet of the cracker and is set as follows:

1 With the ½ in. cracker gas isolation cock and the cracker gas relief by-pass valve both shut, adjust the pressure regulator until the pressure gauge labelled 'ammonia before catalyst' indicates 25 lb/in² gauge (1·72 bar gauge).

2 Slowly turn the knurled knob on the relief valve as in 2 above.

During the above operations, it will be found easier if a second person observes the float in the flowmeter.

OPERATING INSTRUCTIONS (single or multi-cracker installation)

STARTING FROM ROOM TEMPERATURE

1 Check that the set-point on the 'Control Instrument' is at 850°C and that the two set points on the 'Alarm Instrument' are at 800°C and 900°C.

2 Check that the circuit breakers are all in the 'on' position and switch on the cracker.

3 Turn the rotary switch to the 'operating' position. The alarm light and Klaxon will then be operative.

4 Press the button labelled 'cancel alarm' and the alarm system will be rendered inoperative until the set-point of 850°C is reached.

5 Allow the temperature of the cracker to rise to 850°C, which will take approximately 3-4 hours.

Note: When starting from room temperature, do not attempt to take gas from the cracker until approximately two hours after the temperature of 850°C has been reached.

6 Ensure that the ½ in. n b isolation valve at the outlet of the cracker and the by-pass cock across the cracker gas relief valve are closed.

7 Open the isolation valve on the ammonia cylinder *slowly* (or the isolation cock at the cracker).

8 Open slowly and fully the ½ in. n b isolation valve at the outlet from the cracker.

9 Adjust the pressure reducer to obtain 25 lb/in² gauge (1·72 bar gauge) on the pressure gauge labelled 'rotameter pressure'. To increase the pressure rotate the handwheel clockwise.

Note: If the installation incorporates a Fisher cracker gas governor, refer to section on Fisher cracker gas governor — setting the control, page 8, at this point in the operation.

The pressure regulator must now be adjusted so that the output of the cracker is limited to 300 s c f h (8·5 m³/h) of cracker gas as follows:

10 Open fully the valve at the point of consumption (this assumes that the consuming process is fit to receive cracker gas, i e the furnace is at its operating temperature and has been purged with nitrogen). Alternatively, if the consuming process has not been prepared, a branch with a valved burn-off pipe can be installed.

11 Open the pressure regulator until the flowmeter indicates a flow of 150 s c f h (4·25 m³/h) of ammonia. The pressure regulator is now set.

Steps 10 and 11 are carried out only during the commissioning of the equipment or after maintenance checks of the pressure regulator. Once set the pressure regulator should only require infrequent adjustment.

12 Re-adjust the pressure reducer, if necessary, to maintain the 'rotameter pressure' at 25 lb/in² gauge (1·72 bar gauge).

13 Set the valve at the point of consumption to the desired supply rate.

Note: In the case of a multi-cracker installation, adjustment of the pressure regulators is carried out as above, but it will be necessary to re-adjust the pressure regulators until each cracker delivers a maximum of 300 s c f h (8·5 m³/h) of cracker gas.

During subsequent running of a multi-cracker installation it will be found that when all the crackers are on line, if less than the maximum rate is demanded, some crackers will deliver at maximum rate, some at less than maximum or even nil rate. Providing no one cracker supplies more than 300 s c f h (8·5 m³/h) of cracker gas, equal proportioning of the gas load is unimportant.

SHUTTING DOWN TO STAND-BY

1 Close the valve at the consumption point.

2 Wait for at least five minutes to allow the contents of the ammonia vaporiser to empty back into the ammonia supply system.

3 Shut the isolation cock at the inlet to the vaporiser.

4 Turn the rotary switch from 'operating' to 'stand-by'. The ammeter should indicate 15—16 amps.

STARTING FROM STAND-BY

1 Turn the rotary switch from 'stand-by' to 'operating'. If the temperature during 'stand-by' has been below 800°C the alarm light and Klaxon will operate. Press the button labelled 'cancel alarm'.

2 Ensure that the valve at the point of consumption is closed and wait until the temperature of the cracker is 850°C.

3 Open *slowly* the isolation cock at the inlet to the vaporiser.

4 Open the valve at the point of consumption as required.

SHUTTING DOWN

1 Follow instruction above for shutting down to stand-by but for 4 read—"Switch off the cracker at the isolation switch".

FISHER CRACKER GAS PRESSURE GOVERNOR (CODE A32)

Where there are several points of gas consumption and it is necessary to vary the cracker gas rate at one point without affecting the gas rates at the other points, the use of a 'Fisher' gas governor is strongly recommended. This is a pressure control valve capable of maintaining a substantially constant pressure over a very wide range of gas rates. The governor will take the output of up to six HT1 crackers but should there be more than six crackers in the installation a larger internal orifice can be obtained from the manufacturer.

The governor will control the gas main pressure at any figure between ½ lb/in² gauge (35 mbar gauge) and 3¼ lb/in² gauge (224 mbar gauge). It is supplied fitted with a spring to control the pressure at any figure between 1 and 2 lb/in² gauge (70-140 mbar gauge) and springs covering the ranges 0·5-1·1 lb/in² gauge (35-75 mbar gauge) and 1½-3¼ lb/in² gauge (100-224 mbar gauge) are also supplied with the governor. Fig. 5 shows the sectional arrangement of the governor and the breather.

INSTALLATION OF FISHER GOVERNOR

The governor is supplied with a 0-10 lb/in² gauge pressure gauge to indicate the controlled pressure. It carries union screwed 1 in. BSP female or 1½ in. BSP female if the bushing is removed. Should the governor be mounted horizontally, the diaphragm chamber should be supported by a light structure. If the governor is mounted vertically, the diaphragm chamber can be rotated to a horizontal position by loosening the two bolts on the joint between the diaphragm chamber and the valve body.

An arrow is cast on the valve body of the governor and this must point in the direction of the gas flow otherwise the governor will not function.

SETTING THE CONTROL (See Fig. 5)

The control pressure is set while adjusting the cracker to deliver up to maximum rate. Assuming that the cracker has been prepared for start-up as detailed in 1-9 of 'Starting from Room Temperature' page 7:-

Single Cracker Installation

1 Open fully the ammonia pressure regulator.

2 Crack open a suitable burn-off valve downstream of the gas governor to give a flame about 6 in. (150 mm) high.

3 Remove the closing cap (4) on the governor. Remember that the governor is supplied fitted with a spring for a pressure range of 1-2 lb/in² gauge (70-140 mbar gauge).

If the required pressure is outside this range the adjusting screw (3) should be removed and the correct spring (2) fitted. To increase the controlled pressure the adjusting screw (3) should be turned clockwise and for a decrease in pressure it should be turned anti-clockwise. Replace and tighten the closing cap (4).

4 *Slowly* open the valve at the burn-off point to obtain an indicated flow rate on the cracker flowmeter of marginally less than 150 s c f h (4·25 m³/h) of ammonia.

5 Close the ammonia pressure regulator until the flowmeter reading just falls. Open the burn-off valve further and note that the pressure in the cracker gas line falls and that there is no appreciable increase in the gas output from the cracker.

Multi-Cracker Installation

Having set the Fisher gas governor, set each cracker in turn as detailed above in steps 1, 4 and 5. Put all the crackers on to the cracker gas main, and gradually open the cracker gas burn-off valve whilst observing the rate of gas taken from each cracker. If any one cracker exceeds 150 scfh (4·25 m³/h) indicated on the flowmeter, partially close the ammonia pressure regulator on that cracker to stop any further increase. Continue opening the cracker gas burn-off valve until each cracker is indicating a flow of 150 scfh (4·25 m³/h) of ammonia. At this point, further opening of the cracker gas burn-off valve should only result in a pressure drop in the cracker gas main and not in a further appreciable increase in flow from any of the crackers. Partially close the cracker gas burn-off valve until a flame only about 6 in. (150 mm) high is obtained. All crackers should now be delivering well under their maximum output of gas. Now open the burn-off valve while observing the cracker flowmeters and ensure that no cracker exceeds a rate of 150 scfh (4·25 m³/h) of ammonia. At this point the crackers may be considered to be set and it may be advisable to limit access to the crackers to prevent tampering.

MAINTENANCE

Little maintenance is required by the HT 1 ammonia cracker and is virtually confined to the routine checking of various components.

Where reference is made in the text to a part number associated with a drawing, followed by a reference (C - - -) this refers to the code number of the item. A list of available parts and their code numbers appears on page 26 of this booklet. It is essential that code numbers for spare parts should be quoted on all orders or correspondence.

If uncoded spares are required they should be ordered by description and if possible by using a part number from the relevant drawing. Details of the Technical Service for ammonia crackers available to customers are given on page 17.

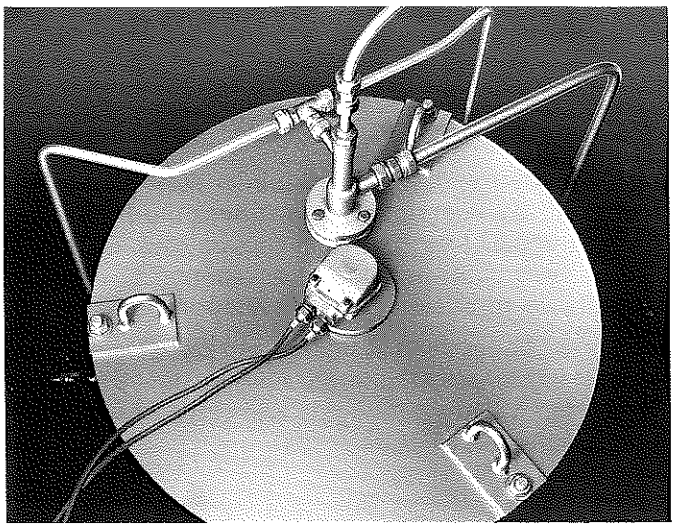
It is recommended that a supply of commonly used spare parts such as sulphur tapers, thermocouples, valve diaphragms and valve nose pads is available on site at all times.

FAULT FINDING

This section illustrates the symptoms and causes of faults which may develop on the cracker.

Symptom	Possible Causes and Rectification
High residual ammonia content in cracker gas	i Low operating temperature—check instruments and thermocouples. ii Leaking ammonia vaporiser—replace. iii Cracker gas rate in excess of 300 scfh (8·5 m³/h) —check flowmeter and reduce rate.
'Hunting' on pressure gauges associated with ammonia pressure reducer	Partial blockage within pressure reducer—strip and clean out reducer.
Appearance of liquid in flowmeter	Carry-over of liquid ammonia from the vaporiser due to overloading. This can occur because: i Any of the three relief valves fitted to the cracker has lifted. ii There has been a violent fluctuation in cracker gas demand. iii The cracker was not up to operating temperature when gas was demanded. N.B.—Liquid ammonia must be cleared from the system by permitting it to evaporate slowly through the cracker before normal operation can be restarted.
Inability to obtain desired cracker gas rate from cracker	Partial or complete blockage in pipes or valves: i Check the 0·070 in. (1·778 mm) restrictor for blockage. ii If the blockage has occurred in the pressure reducer this will be shown up on the pressure gauges, i e lower pressures and/or 'hunting'.
High delivery pressure ex cracker	Poor control on the ammonia pressure regulator probably due to dirt or worn valve head disc—strip down regulator at first opportunity and clean inside and replace valve head disc and small diaphragm.
Alarm klaxon sounding and alarm light operative during normal running N.B.—Check instruments to see whether it is due to low or high temperature conditions.	If high temperature conditions exist: i Check the ammeter and if this is registering it means that the control relay is 'sticking' and/or the control instrument is faulty. ii If the ammeter is indicating zero the alarm instrument may be faulty. If low temperature conditions exist: i Check the thermocouples. ii Check the ammeter and if this is indicating zero it means that the control relay and/or the control instrument is faulty. iii If the ammeter is registering normally, the control instrument may be faulty. iv The electric heater may have failed.
Fisher Cracker Gas Pressure Governor	
Inability to control line pressure setting	Split or punctured diaphragm in governor—replace diaphragm.
Undue rise in line pressure when no cracker gas is flowing	Valve in governor not shutting off due to dirt on valve nose or deformation—clean or replace valve nose.

Dismantling of Cracker Body



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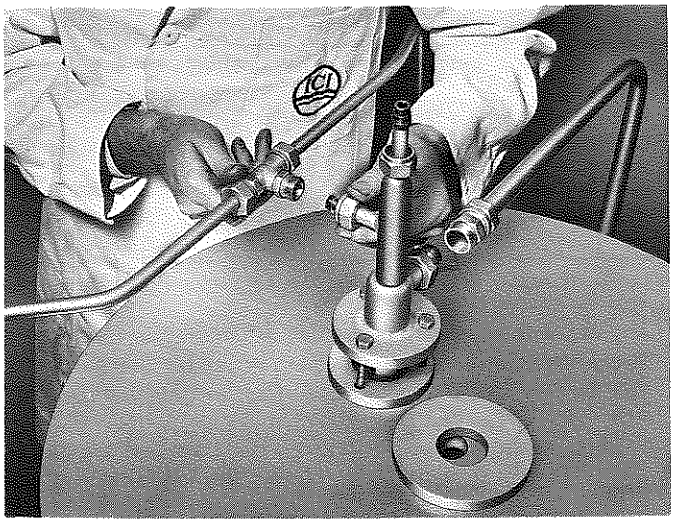

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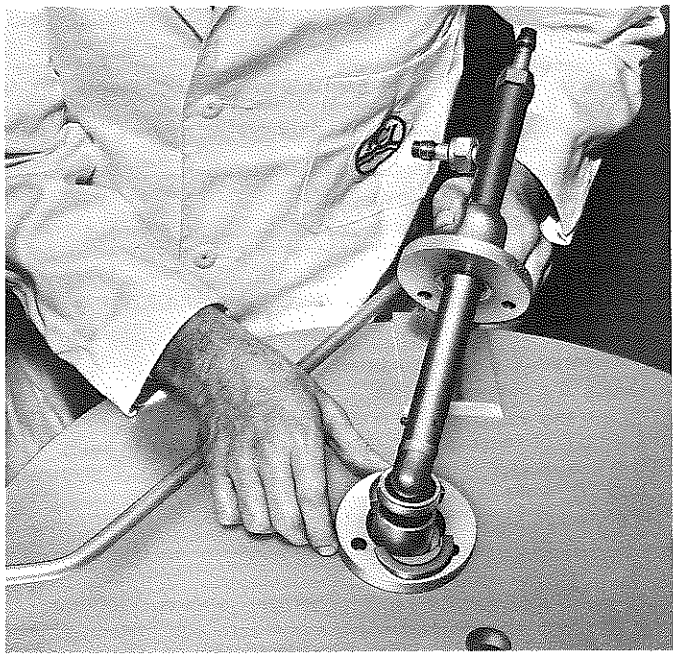

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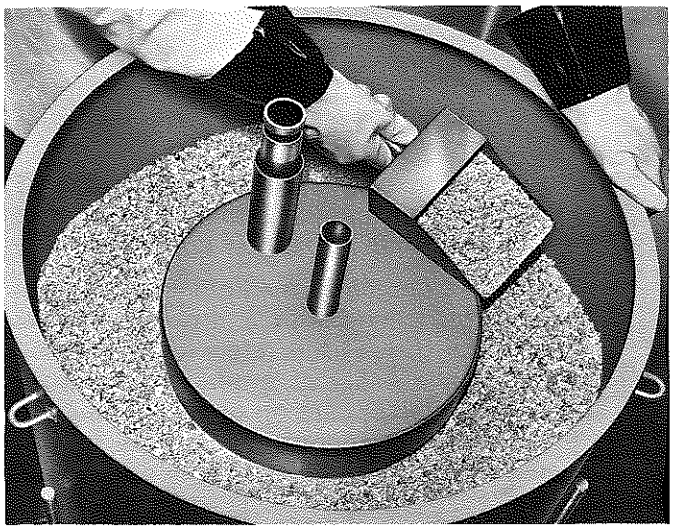

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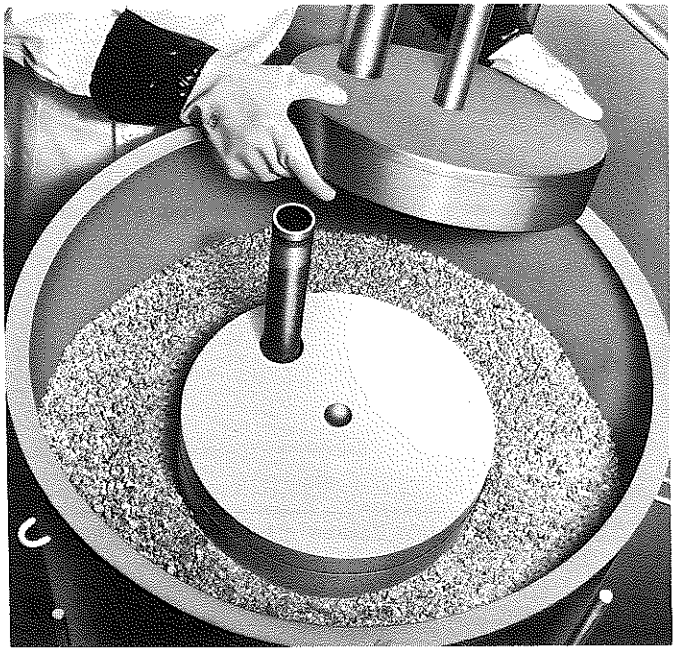

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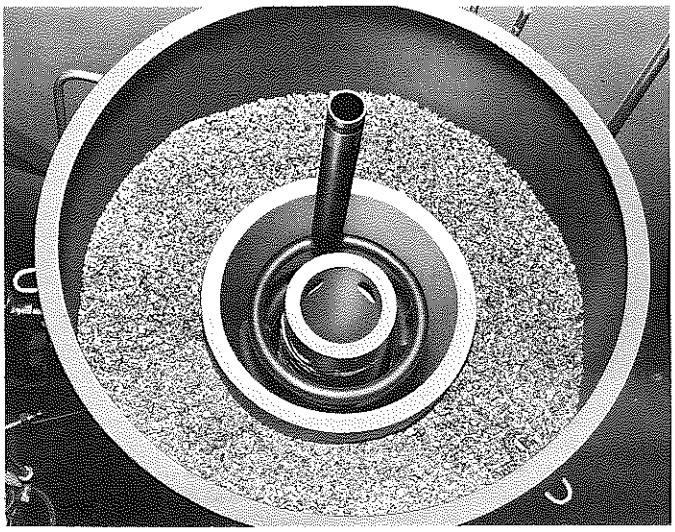

6

REMOVING AND REPLACING THE AMMONIA VAPORISER *(See photographs 1–3 opposite)*

1 Isolate the ammonia supply at the 'Klinger' cock at the cracker, blow off all pressure in the cracker and isolate the cracker electrically.

2 Remove the ¼ in. n b supply line between the 'Klinger' cock and the ammonia vaporiser and fit a blank into the open end of the 'Klinger' cock.

3 Disconnect the ¼ in. 'Ermeto' tee from the ammonia vaporiser and the ½ in. 'Ermeto' straight coupling.

4 Remove the three nuts and bolts around the flange holding the vaporiser into the top of the catalyst container.

5 The vaporiser may now be lifted out of the top of the catalyst container.

6 To replace or fit a new vaporiser proceed in the reverse order to the above.

REMOVING AND REPLACING THE HEATER FROM THE CRACKER *(See photographs 1–6 opposite)*

1 Isolate the ammonia supply to the cracker, blow off all pressure in the cracker and isolate it electrically.

2 Remove the thermocouples and sheath.

3 Remove the vaporiser as outlined above.

4 Remove the loose vaporiser retaining flange, the two collets and the loose insulating disc from the top of the catalyst container. To do this it may be necessary to lift the catalyst container. This should be done by levering it up with a baulk of timber from the bottom of the cracker body exerting a force on the ammonia inlet pipe at the bend.

5 Remove the retaining nuts around the edge of the cracker lid.

6 Remove such pipework as is necessary and lift off the lid.

7 Remove the layer of slag wool and then scoop out the loose heat insulation from inside the cracker body until the stainless steel cover on top of the furnace is fully exposed.

8 Remove the stainless steel cover section.

9 Remove the refractory lid from the top of the furnace.

10 Disconnect the heater leads in the junction box underneath the cracker body and remove them and their lock nuts from the input leads to the heater.

11 The heater can now be lifted out. The heater former is rather brittle and care should be taken not to damage it.

12 The heater should be replaced in reverse order of the instruction given above.

REMOVING AND REPLACING THE CATALYST CONTAINER *(See photographs 1–6 opposite)*

1 Isolate the ammonia supply to the cracker, blow off all pressure in the cracker and isolate it electrically.

2 Remove the ammonia vaporiser as outlined above.

3 Remove the heater as outlined above.

4 Disconnect the ammonia inlet pipe beneath the cracker.

5 The catalyst container may now be lifted out of the cracker body. The container is heavy and is awkward to lift. It is strongly recommended that a sling and chain block be used to lift it out of the body.

6 Before refitting the catalyst container or fitting a new one, the 'Ermeto' union threads on the ammonia inlet leg of the container should be protected with insulating tape or other suitable material.

7 The container should be lowered into the cracker body very gently as great care is needed to register the ammonia inlet leg with the hole in the bottom brick of the cracker body.

8 Re-assembly of the cracker is completed in reverse order of the instruction given above for removal of the catalyst container, the heater and the ammonia vaporiser.

THE ¼ in. n b RELIEF VALVE (applicable to the relief valve which protects the flowmeter or the relief valve in the cracker gas line)

Fig. 6 shows a sectional arrangement of the relief valve. In this type of valve the only part normally requiring renewal is the diaphragm (C 67).

To renew the diaphragm:

1 Isolate the ammonia supply and blow off all pressure in the cracker.

2 Release the locking ring (2) and remove the spring adjuster (1).

3 Separate the spring cover (5) from the body (9).

4 Remove the spring cap (3), the spring (4) and the diaphragm plate (6).

5 Replace the diaphragm (C 67) with a new one.

6 Re-assemble the valve in reverse order. Tighten the four nuts on the cover only sufficiently to stop any leakage of gas.

7 Re-set the blow-off pressure at the first opportunity, as described on page 6.

'HALE HAMILTON' RELIEF VALVE

This valve is set and locked by the manufacturer and certified to blow off at 180 lb/in^2 gauge (12·43 bar gauge). No maintenance is necessary, and if the valve is ever suspect, a replacement should be ordered (Code C 185) and the suspect valve sent back for reconditioning.

'KLINGER' SLEEVE PACKED ISOLATION COCK *(See Fig 7)*

Any tendency to leak, either externally or through the port when closed, can be overcome by tightening the sleeve compression bush (E).

When sufficient wear of this sleeve has taken place to necessitate its renewal, this should be done as follows:

1 Ensure that all pressure is blown off in the line carrying the cock.

2 Remove the screw (A) and handle (B).

3 Remove the sleeve compression bush (E).

4 Remove the plug (C) by carefully tapping out with a light hammer taking care not to damage the thread.

5 Remove the sleeve D (C28a) from plug (C).

6 Fit a new sleeve, making sure that the 'feather' on the side engages correctly with the recess in the body of the cock; the sleeve must *NOT* rotate with the plug when the cock is operated.

7 Fit the plug very carefully; the bearing surface of this is ground and polished, and care must be taken that it is not damaged in any way.

8 Replace the sleeve compression bush (E) tightening it until the cock is leak-tight.

9 Replace the handle (B) and screw (A).

¼ in. n b ISOLATION VALVE *(See Fig 8)*

These valves are used as pressure gauge isolators on the pressure reducer. Cocks are fitted before the ammonia gas filter and in the by-pass across the cracker gas relief valve.

To renew the sealing rings (C 157) in the nose of the valve:

1 Isolate the ammonia supply and blow off all pressure in the cracker.

2 Remove the handwheel (A).

3 Remove the three screws (B).

4 Replace the handwheel (A) and pull out the valve assembly.

5 Replace the two sealing rings (C 157) situated in the valve nose (C).

6 Re-assemble and ensure that the valve does not leak.

AMMONIA GAS FILTER

The ammonia gas filter is packed with 'Stillite' slag wool and this should be renewed when 5–7 tons (5–7 t) of ammonia have passed through the cracker or when more than half of the filter material has become discoloured. To achieve the correct packing density, 6 oz (170 g) 'Stillite' should be used.

AMMONIA PRESSURE REDUCER *(See Fig 9)*

There are few moving parts in the reducer and little maintenance is required. However, after a period of use, the filter in the reducer may become choked, or the valve head disc and diaphragm may need renewal.

To clean the filter:

1 Isolate ammonia supply, blow off all pressure from the cracker and disconnect at the inlet side of the pressure reducer.

2 Remove 'Ermeto' stud coupling (C215) from the body of the pressure reducer.

3 Remove the "O" ring (A) in front of the filter and the filter gauze (B).

4 Wash filter gauze with petrol or a similar solvent, dry and assemble in reverse order.

To renew valve-head disc (C 18a):

1 Isolate ammonia supply and blow off all pressure from the cracker.

2 Remove nut (K), return spring (M) and valve nose assembly (L) containing valve head disc (C 18a).

3 Remove faulty valve head disc and fit new one.

4 Clean valve seat (P) and re-assemble in reverse order.

To renew diaphragm (C 123):

1 Isolate ammonia supply and blow off all pressure from the cracker.

2 Remove the panel section through which the pressure reducer protrudes.

3 Unscrew spring adjuster (J) until spring pressure is released.

4 Unscrew four nuts (D) and remove spring chamber (E) with spring (F) and diaphragm plate (R).

5 Remove diaphragm (C 123) and tappet (Q).

6 Clean and replace tappet (Q), fit new diaphragm and re-assemble in reverse order, tightening nuts (D) firmly.

It is recommended that all diaphragms be renewed whenever the unit is dismantled, or at least once a year.

To renew the valve seat (P) (this should not be necessary unless accidentally damaged):

1 Proceed as for removing diaphragm, steps 1–5 (above) then unscrew valve seat (P) with a box spanner.

2 Clean up or replace (P) and fit into the valve body with a new joint ring (C 155) under the head of the seat.

3 Re-assemble, following these steps in reverse order.

AMMONIA PRESSURE REGULATOR
(See Fig 10)

As in the case of the ammonia pressure reducer, the only parts requiring occasional maintenance are the diaphragms and the valve head disc. It is recommended that new diaphragms and a valve head disc are fitted whenever the regulator is dismantled, or at least once a year.

To renew valve head disc (C 18a):

1 Isolate the ammonia supply and blow off all pressure from the cracker.

2 Remove nut (A) with joint ring (C 153), return spring (B) and valve nose assembly (C) containing the valve head disc (C 18a).

3 Remove faulty valve head disc and fit new one.

4 Clean valve seat (G) and re-assemble in reverse order.

To renew small diaphragm (C 123):

1 Isolate the ammonia supply and blow off all pressure from the cracker.

2 Remove the panel section through which the pressure regulator protrudes.

3 Disconnect the ¼ in. o d pipe at (D).

4 Unscrew the bolts (E) and remove the diaphragm chamber (M) and take out the worn diaphragm (C 123).

5 Remove, clean and replace tappet (F).

6 Fit a new diaphragm (C 123).

7 Re-assemble in reverse order.

To renew large diaphragm (C 81):

1 Isolate the ammonia supply and blow off all pressure from the cracker.

2 Remove the panel section through which the pressure regulator protrudes and shut the valve.

3 Remove the nuts and bolts (H), remove the spring chamber (L) with spring and diaphragm plate, and the worn diaphragm (C 81).

4 Fit a new diaphragm (C 81).

5 Re-assemble in reverse order.

To remove the valve seat (G) (this should not be necessary unless damaged accidentally):

1 Proceed as for removal of small diaphragm, steps 1–5 above, then unscrew valve seat (G) with a box spanner.

2 Clean up part (G) or fit new one and replace in valve body, fitting a new joint ring (C 128) under the head of the seat.

3 Re-assemble, following these steps in reverse order.

FISHER CRACKER GAS GOVERNOR *(See Fig 5)*

The only items which may need periodic attention are the diaphragm and valve assembly.

To replace diaphragm head assembly (C 235 or C 236):

1 Remove closing cap (A) and turn the adjusting screw (3) out of the spring case.

2 Take the spring (2) out of the governor.

3 Remove the cap screws (14) holding the spring case (1A) and the diaphragm case (9A) together. Lift the spring case off the assembly.

4 The diaphragm (7A) and head assembly (7B) can be removed by unhooking the pusher post (8) from the lever (10).

5 Fit new diaphragm head assembly—should the outlet pressure from the governor be less than 1·1 lb/in^2 gauge (75 mbar gauge) use (C 235); if in excess of 1·1 lb/in^2 gauge (75 mbar gauge) use (C 236).

6 When re-assembling, replace the spring and adjusting screws before tightening the case cap screws. This puts slack in the diaphragm, necessary for good regulation of gas pressure. Renew the closing cap gasket (5) (C 234) if this is damaged.

To replace valve disc assembly (16) (C 237) and/ or orifice :

1 Remove the bolts which hold the two halves of the union ring (9B) together.

2 The governor can now be taken off the valve body which remains in the line. At this time, inspect the body 'O' ring (19) (C 238) and replace if necessary.

3 The valve disc assembly (16) (C 237) is now exposed and can be unscrewed from the valve stem for renewal.

Should renewal of the orifice or the fitting of a different size orifice be required, the orifice unscrews from the body and the male threads should be treated with a jointing compound before replacement.

4 Re-assemble in reverse order.

THERMOCOUPLES

Occasionally clean and check the connections on the thermocouple head and on the instruments. The thermocouples used are of the chromel-alumel type and the wire deteriorates over a period of time. It is recommended that the thermocouples are renewed annually.

To renew a thermocouple :

1 Loosen the three screws on the top of the thermocouple head and remove the head cover.

2 Loosen the screw on the side of the thermocouple head and pull out the thermocouple head with thermocouple from the cracker body.

3 Loosen the two securing screws in the brass terminal block corresponding to the faulty thermocouple and withdraw the thermocouple.

4 Re-assemble (in reverse order) with a new thermocouple.

Note: i If this operation has to be carried out when the cracker is operating, asbestos gloves should be worn.

ii The tags on the thermocouple are staggered so that the thermocouple cannot be connected with the wrong polarity.