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THE M1 AMMONIA CRACKER

With ICI Catalyst

Installation & Operating 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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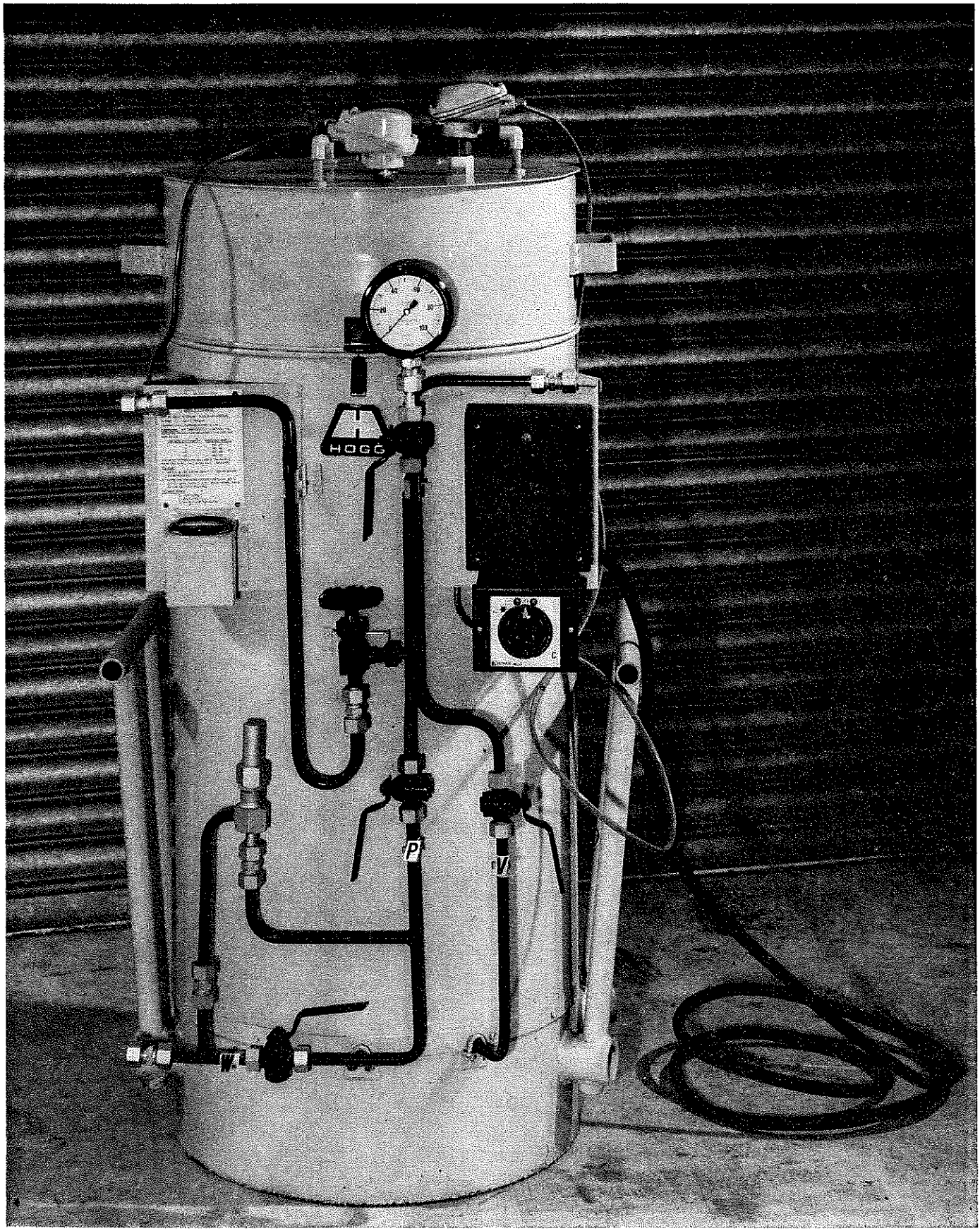
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DESCRIPTION

The ammonia cracker M.1, illustrated in Figures 1 and 2, is arranged to operate from a gaseous ammonia supply at a pressure of 15 p.s.i.g. (1·03 Bar).

The catalyst is held in a detachable container (M.15) made from a nickel alloy, and it is heated to a temperature of 610°-670°C by an electric heater (C.16) which is governed by a controller (C.240) with a relay operated switch (C.71). Figure 4 illustrates the wiring arrangement.

A thermocouple (C.149) enclosed in a sheath (C.178) fitted with a thermocouple head (C.177) measures the temperature, which is indicated on a millivoltmeter (C.176).

A control valve (C.14) controls the flow of ammonia, and the pressure at the inlet to the catalyst is indicated by the pressure gauge (C.21). A relief valve (C.18) is fitted in the exit gas line, which is provided with a branch to atmosphere. Isolation cocks are provided on the inlet, exit, and atmosphere lines (C.28b, V, P, and W, respectively.

The catalyst container and heater are enclosed in a refractory tube (C.10) with a detachable brick (C.11) at the top. The inlet (C.7) and exit (C.8) coils are arranged around the refractory tube, and the whole is packed with heat insulating material and enclosed in a metal casing which supports the various pipes and controls. 'Ermeto' couplings are fitted to the inlet, exit, and atmosphere pipe terminals, and only $\frac{17}{32}$ in o.d. tubing is suitable for connecting to these.

The wiring of the cracker is completed before despatch, and a 3-core cable, approximately 12 ft long, is supplied with each plant, each lead being clearly labelled:

E = earth (green or green & yellow)

P = phase (red or brown)

N = neutral (black or blue)

INSTALLATION

Ammonia crackers are delivered with the heaters disconnected and packed inside the cracker. The top brick is separately packed. Attached to the cracker is the millivoltmeter and the thermocouple sheath with thermocouple compensating lead and dust cap.

Also attached to the cracker is a bag containing the following spares:

2 copper ferrules (C.56) for catalyst container joints,

2 nose pads (C.18a) for relief valve.

Wherever possible, any equipment for the ammonia supply (e.g. cylinder connections, headers, pressure control units, etc.) and catalyst containers which are to be used with the cracker, will be delivered with the cracker plant, but they may be packed separately. The catalyst container is always fitted with a header protector and with caps to protect the threads on the elbows of the containers.

UNPACKING

1 Examine the equipment immediately it is received. In the event of damage or loss, inform James Hogg (Chemical Engineering) Ltd. Complaints regarding damage or loss must be made within three days of receipt of goods.

2 Return all container header protectors, and sealing plugs, as soon as possible to James Hogg (Chemical Engineering) Ltd.

ASSEMBLY OF PLANT

It is assumed that a supply of ammonia gas at a pressure of 15 p.s.i.g. (1·03 Bar) is available before assembly of the cracker is commenced.

Pipework

Arrange the position of the cracker and pipework so that the cracker cover can be removed easily and so that at least 8 ft headroom is available. Provide sufficient working room on each side of the plant.

Connect *(a)* the inlet to the ammonia supply line;

(b) the cracked gas outlet to the point of usage;

(c) the pipe from the relief valve to atmosphere.

These pipe terminals are clearly shown in Figure I. For the ammonia supply, use only weldless steel tubing. Copper or copper alloy fittings must not be used.

Figure 9 shows the correct assembly of the couplings.

Pass compressed air through the pipework, after erection and before coupling up to the cracker, to remove any dirt or loose scale.

For the cracker gas and atmosphere lines, any good-quality mild steel or wrought iron tubing may be used; weldless tubing is not essential. Slope the atmosphere pipe down to a point outside the building.

Test the joints on the ammonia lines as far as the inlet isolation cock (C.28b V), with that cock closed and with ammonia at a pressure of 15 p.s.i.g. (1·03 Bar), and hold a burning sulphur taper below each joint under test. Dense white fumes will appear at any leaking joint. Isolate and release any pressure before tightening a leaking joint.

Fitting the Catalyst Container

Remove the cover from the cracker and take out the heater; remove any packing material, etc., from the heater space. Unpack the top brick (C.11).

Remove the asbestos tape and bolts (C.54a) which form the heater connections.

Remove the bolts from the flanges on the inlet and outlet coils, releasing the screwed conical bushes (C.62) and flanges (C.69) for use on the catalyst container.

Remove the header protector from the catalyst container, and note the two guide strips which are welded to the container, one at the bottom and the other to the stiffening rings near the top. The strips are to prevent the thermocouple sheaths from fouling the heater winding; they indicate the spaces into which these items are later fitted. *Mark with chalk or pencil the tops of the legs at each side of each guide strip.*

Place the catalyst container into the cracker with the terminal elbows opposite to the joints on the inlet and outlet coils, inserting a small block of wood about 2 in square under the header to prevent the container going fully home. It is convenient to use a crane or hoist for handling the catalyst container, which weighs approximately 150 lb (68·2 kgs).

Remove the caps from the elbows on the catalyst container, pass one of the flanges over the threaded portion of each elbow with the smaller diameter of the tapered hole nearest to the container, smear the threads on the elbows with graphite compound ('Foliac' is recommended), and screw on the conical bushes so that the outer face of the elbow is flush with that of the bush. The elbow must not protrude from the bush, as this may cause the elbow to "spread", with subsequent difficulty in removing the conical bush.

Fit a copper ferrule into each elbow, lower the container into position, and make the joints. Set the flanges at an angle of approximately 60° to horizontal to ensure that they do not foul the insulating block (C.13) in the cover. Figure 5 shows the arrangement of the joint, and Figure 2 the angle at which the flanges should be set.

Test the joints on the catalyst container with ammonia at a pressure of 15 p.s.i.g. (1·03 Bar) by opening the control valve (C.14) and inlet isolation cock (C.28b V), and holding a burning sulphur taper below the joints under test. Make sure that the exit isolation and atmosphere cocks (C.28b P and C.28b W) are closed before carrying out this test.

Replace the heater and top brick so that the short tongues on the top brick fit between the marks previously made on the legs of the container. The correct position is clearly shown on Figure 3. See that the bottom of the heater (C.16) sits in the recess made to receive it in C.12, and that the recess in the top brick (C.11) rests firmly on the top of the heater. Make the heater connections with the bolts (C.54a) and wrap with the asbestos tape to prevent any possibility of a short circuit. These nuts must be tight to ensure a sound electrical connection.

Replace the cover, making sure that the location marks on the cover and body are in line.

Wiring

Remove the cover from the relay switch (C.71), make sure that the mercury switch is intact and that nothing is interfering with its free movement. Replace the cover.

Pass a pilot rod approximately $\frac{1}{2}$ in diameter and 2 ft 6 in long through the right hand socket and, if necessary, re-adjust the position of the cracker cover until the rod can be entered quite freely and without the slightest obstruction.

Place the thermocouple sheaths, with couples, thermocouple heads, and compensating leads, in position in the cracker. *Make sure that the bottom of the sheath is outside the guide strip welded to the container.*

Remove the shorting wires from the millivoltmeter, which should be placed temporarily into its bracket on the cracker. While the instrument is in a horizontal position, adjust the pointer to a 20°C zero on the scale by means of the small slotted screw on the dial.

Connect the cable to the power supply through a switch fuse of 30-amp capacity. The phase, neutral, and earth wires are clearly labelled, and it is important that they are correctly connected.

A complete wiring diagram is shown in Figure 4.

Preliminary Adjustment

Nearly close the control valve (C.14), and in the case of single cracker installations, reduce the inlet ammonia pressure to about 3 p.s.i.g. (0·2 Bar). Release the pressure in the cracker by opening the atmosphere cock (C.28b W). Allow a small flow of ammonia to pass to atmosphere for a moment or two to sweep out any air. Close the atmosphere cock. Follow the same procedure when starting all the crackers in a multi-cracker installation.

On a multi-cracker installation where other crackers are in use, blow a little ammonia to atmosphere to drive out any air as described above, and then close the inlet cock (C.28b V) and open the exit cock (C.28b P).

Switch in the heater and observe the indicator lamp, which, being operated from a current transformer, will only light when current is passing through the cracker heater.

In about 30 minutes, the rising temperature of the cracker will be indicated on the millivoltmeter (C.176).

After being switched in for about 4 - 5 hours, the temperature of the cracker should be about 610°-620°C. If necessary, re-adjust the dial of the controller so that the relay switch opens as shown by the indicator lamp when the temperature of the cracker reaches 610°C.

The temperature of the cracker should now be maintained automatically at 610°-620°C, but the controller will need re-adjustment from time to time until the cracker is thoroughly heated up.

On any cracker with the inlet cock (C.28b V) open and the exit cock (C.28b P) closed, the pressure indicated by the gauge (C.21) will increase as the temperature rises. The relief valve should start to pass gas when the pressure is approximately 35 p.s.i.g. (2·4 Bar), but the pressure may rise further as the flow of gas through the valve increases. Should the pressure tend to rise above 50 p.s.i.g. (3·5 Bar) release it by momentarily lifting by hand the spindle A (Figure 8). When the temperature is being maintained at 610°-620°C with the atmosphere cock (C.286W) open and the exit isolation cock (C.286P) closed, allow ammonia to enter the cracker at a low rate. The gas escaping from the atmosphere connection of the cracker during the first 30 minutes will mainly consist of nitrogen, steam and water and will not burn. After this period, the gas should be ignited at a suitable burn-off point from the atmosphere connection, and the ammonia rate adjusted to give a flame 6 to 8 inches long. Condensed water vapour should be drained from the burn-off line. After 4 hours the residual ammonia in the cracker gas will have dropped to about 0·1% v/v and the cracked gas can then be directed to the point of usage. Adjust the gas rate by means of the control valve (C.14), if necessary re-adjusting the inlet pressure to 15 p.s.i.g. (1·03 Bar).

On multi-cracker installations with the inlet cock shut and the exit cock open, the indicated pressure will not increase, and the flow of gas is started by opening the inlet cock and controlling the rate by means of the control valve (C.14).

It will be found that, although the temperature of the cracker is 610°-620°C with no gas passing through the plant, it will rise after gas has been passed through for 2 - 3 hours, the precise temperature being dependent on the gas rate in use.

When the preliminary adjustments have been made and the plant is delivering the required gas rate with the temperature governed by the controller at 610°-670°C according to gas output (see the note on the nameplate of the cracker), the installation can be considered complete.

Shut down procedure is detailed on page 6.

OPERATING INSTRUCTIONS

STARTING UP

1 Switch in the heater about 4 - 5 hours before cracker gas is required.

2 It will be apparent by the operation of the relay switch when the controller has taken over control of the temperature; this should occur when the indicated temperature is 610°-620°C—

(a) on single cracker installations or when starting all crackers of a multi-cracker installation, momentarily open the atmosphere cock (C.28b W) and slowly open the exit cock (C.28b P), re-adjusting the inlet ammonia pressure to 15 p.s.i.g. (1·03 Bar).

(b) On multi-cracker installations where other crackers are in operation, slowly open the inlet cock (C.28b V).

3 Adjust the control valve (C.14) to obtain the required gas rate, if necessary re-adjusting the inlet ammonia pressure to 15 p.s.i.g. (1·03 Bar).

4 During the first hour or two of running, the temperature indicated by the millivoltmeter will slowly rise from 610°-620°C to the temperature at which the controller was set during the preliminary adjustment, when the normal gas rate was passing through the plant, i.e. 610°-670°C according to the gas output (see the note on the nameplate of the cracker).

Experience has shown that it is of great advantage to record the major operating conditions at regular intervals, and the slight inconvenience is amply repaid.

RUNNING

During normal running, the plant is entirely automatic in operation, the only attention necessary being to check the temperature and gas rate.

Temperature

It is not necessary to adjust the temperature controller frequently.

Turning the dial of the controller in an anti-clockwise direction will raise the controlled temperature, and vice versa.

Gas Flow

To ensure that the ammonia content of the cracker gas is at a minimum, it is essential that the pressure over the catalyst is also at a minimum, and for this reason, control is effected by the control valve (C.14) at the inlet side of the cracker.

SHUTTING DOWN

Single cracker installation and when all crackers of a multi-cracker installation are being shut down

(a) reduce the gas rate to about 20 ft³/hr (0·56 M³/hr) by adjusting the control valve (C.14);

(b) reduce the inlet ammonia pressure to about 3 p.s.i.g. (·207 Bar), on the external pressure reducer;

(c) shut the exit cock (C.28b P) and switch out the heater.

Multi-cracker installation where other crackers are in operation

To keep one or more crackers in operation, it is necessary to maintain the inlet ammonia pressure at 15 p.s.i.g. (1·03 Bar) and in these circumstances the closing of the exit cock on a cracker being shut down is not recommended, as there is a possibility of loss of ammonia through the relief valve. For all crackers, excluding the last one, the procedure is—

(a) reduce the gas rate to about 20 ft³/hr (0·56 M³/hr) by adjusting the control valve (C.14);

(b) close the inlet isolation cock (C.28b V), and switch out the heater. When the last cracker is being shut down, the procedure is—

(c) reduce the gas rate to about 20 ft³/hr (0·56 M³/hr) by adjusting the control valve (C.14);

(d) reduce the inlet ammonia pressure to about 3 p.s.i.g. (·207 Bar);

(e) close the exit cocks (C.28b P) and open the inlet cocks (C.28b V) on all the crackers previously shut down;

(f) close the exit cock on the last cracker, and switch out the heater.

When a cracker has been shut down by closing the exit cock (C.28b P), the pressure in the plant indicated by the pressure gauge (C.21) will rise during the first hour or two of cooling. This is due to the expansion and cracking of the entrapped ammonia and any excess pressure will be relieved to atmosphere via the relief valve (C.18).

MAINTENANCE

As there are no moving parts in the ammonia cracker, the maintenance required is exceedingly small, and apart from the changing of the catalyst containers from time to time, is confined to a routine checking of various components.

The various spares and services available are described in TECHNICAL SERVICE page 9. Each component can be identified by reference to the sketches in this book, and it is important that the code number of each part is quoted on orders or correspondence.

It is recommended that a supply of copper ferrules (C.56), graphite jointing compound (C.60), and sulphur tapers (C.61), together with a thermocouple (C.149), be always held on site.

CATALYST CONTAINER REPLACEMENT

Switch out the heater, withdraw the fuses, and after allowing the plant to cool, shut off the ammonia supply and close the exit cock (C.28b P). Release any pressure in the plant by opening the atmosphere cock (C.28b W). Disconnect the compensating leads from the thermocouples and lift out the couples and sheaths.

After removing the cover, remove the asbestos tape from the heater connections, and disconnect the connector bolts (C.54a).

Lift out the heater and top brick—it is not necessary to separate them.

Break the inlet and outlet joints on the catalyst container and lift out.

When fitting the replacement catalyst container, proceed as described under INSTALLATION page 3, Preliminary Adjustment.

Fit the caps and header protector from the freshly-charged catalyst container to the spent one, and return it to James Hogg (Chemical Engineering) Ltd.

Advice of despatch of all containers should be sent to James Hogg (Chemical Engineering) Ltd., and in addition, where a catalyst replacement is required in the buyers' container, an order should be sent to James Hogg (Chemical Engineering) Ltd., quoting the number of the container. See TECHNICAL SERVICE page 9. Under no circumstances should catalyst containers be despatched unless a header protector is fitted. If a protector is not available on site, one can be obtained by applying to James Hogg (Chemical Engineering) Ltd.

RELIEF VALVE

Figure 8, Sketch 4, shows a sectional arrangement of the relief valve. The correct functioning of the valve is dependent on the freedom of movement of the spindle (A), and it is recommended that a little oil or grease be applied occasionally.

The valve may be manually operated by lifting the spindle (A) after removing the screwed protective cover (G).

To renew the nose pad (C.18a) (B):

1 close the inlet and exit isolating cocks (C.28b V and P);

2 open cock (C.28b W), and allow the gas in the cracker to pass to atmosphere;

3 release the locking nut (C), and remove the spring-retaining thimble (D);

4 remove the spindle (A) together with the guide (F) and spring (E); renew the nose pad (B) and see that it is not deformed at all. Assemble in the reverse order; replace the spring-retaining thimble (D) as far as possible in its original position. Reset the valve so that it begins to blow at 35 p.s.i.g. (2·4 Bar).

To set the relief valve (this should be done after the plant has been running for some time):

1 disconnect the pipe to atmosphere at the coupling near the cracker;

2 close the control valve (C.14) and the exit cock (C.28b P);

3 adjust the spring-retaining thimble (D) so that gas begins to pass the valve when the pressure gauge (C.21) indicates 35 p.s.i.g. (2·4 Bar); at this setting the valve will not pass the full flow of gas, and the plant pressure may continue to rise until the flow is at the maximum; the flow of gas may be noted at the broken joint in the atmosphere line;

4 lock the spring-retaining thimble (D) by means of the locking nut (C).

SLEEVE PACKED COCK

Figure 6, Sketch 2, shows the construction of the cocks used on M.1 ammonia crackers. Any tendency to leak either externally or through the port when closed can be overcome by tightening the sleeve compression screw (B).

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

1 isolate the cock concerned from the source of gas which it controls;

2 remove the cock handle (A);

3 remove the sleeve compression screw (B);

4 remove the plug (C) by carefully tapping out with a light hammer;

5 remove the sleeve (C.28a) (D) by carefully tapping the distance piece (E) through the body of the cock; replace (E);

6 fit the new sleeve, making sure that the "feather" on the side engages correctly with the recess cut 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 should be taken that it is not damaged in any way;

8 replace the sleeve compression screw (B), tightening it until the cock is gastight;

9 replace the handle (A), so that it is in line with the mark on the end of the plug (C).

CONTROLLER

This requires no maintenance at all. If any trouble is experienced, do not attempt to dismantle the instrument. This is a specialised operation, and the mechanism can be very easily damaged. Controllers which are faulty or suspected of being faulty should be replaced by new ones and returned for examination and credit.

RELAY WITH MERCURY SWITCH

Incorporated with the relay-operated mercury switch is a current transformer and low-voltage indicator lamp. The lamp used is suitable for a voltage approximately 30 per cent higher than that obtained from the current transformer, and should have a life of several years. The armature of the relay is not heavy, and is balanced so that the operating current is small, and very little wear takes place on the pivots.

A routine maintenance inspection of the relay should be carried out every month, when the mercury switch should be examined to ensure that it swings quite freely. It should be noted that the flexible leads to the mercury switch must be correctly supported if they are not to interfere with freedom of movement. Spare mercury switches are available, and great care is necessary when fitting. The position of the switch in the spring clips should be carefully adjusted so that the switch swings freely and is correctly balanced.

MILLIVOLTMETER

The mechanical zero of the instrument should be checked and reset if necessary at least every month. Check by disconnecting the compensating lead, and adjust the pointer to the 20°C mark on the scale by means of the slotted pin situated below the dial.

A replacement service is available for instruments which give trouble during the first six months of operation (see Section 5). Repairs to these components cannot be undertaken.

THERMOCOUPLES

Occasionally check and clean the various connections on the thermocouples, compensating leads and millivoltmeter.

The thermocouples used are of the chromel-alumel type, and the wire deteriorates over a period of time. It is recommended that the thermocouples be renewed annually.

To renew the thermocouples, first unscrew the three screws on the top of thermocouple head and after unscrewing the screw on the side of the head pull out the thermocouple head with the thermocouple. Loosen the screws on the brass terminal blocks in the thermocouple head and the thermocouple will drop out. The tags on the thermocouple are staggered so that the thermocouple cannot be connected with the wrong polarity.

TECHNICAL SERVICE

Technical representatives are available to discuss and advise on the uses to which the cracked ammonia is or may be put. Arrangements for such discussions should be made with the nearest ICI Sales Office or James Hogg (Chemical Engineering) Ltd.

REPLACEMENT AND SPARE PARTS SERVICE

Catalyst Replacement

Under the correct operating conditions, the minimum life of a catalyst should be six months. No guarantee is given, but a credit will be considered should a catalyst life of less than six months be obtained, provided that James Hogg (Chemical Engineering) Ltd., is informed.

Replacement of catalyst in buyers' containers is given priority. Each container is examined before recharging, and where its condition does not warrant a further charge of catalyst, customers are informed. No guarantee is given as to the future life of the container after each examination, but a credit for the remaining catalyst life will be considered should the container fail within six months of being recharged. When ordering catalyst replacements in buyers' containers, it is essential to quote the serial number, which is stamped on the terminal elbows of every container.

Charges of catalyst may be obtained ex stock in containers, which are supplied on hire. Details of costs, etc., are available from James Hogg (Chemical Engineering) Ltd. Charges of catalyst can be obtained under this scheme irrespective of whether the customer has purchased spare containers or not.

When ordering catalyst replacements, it is essential that the correct code number be quoted on the order.

All catalyst replacements must be fitted with caps and container header protectors before return, to prevent any damage in transit.

Catalyst containers should be returned carriage paid and addressed to James Hogg (Chemical Engineering) Ltd., Collingwood House, Lawson Street, North Shields, Tyne and Wear.

Instruments under Guarantee—Replacement Service

Most of the instruments of proprietary manufacture used on M.1 ammonia crackers are guaranteed by the makers for six months against faulty material or workmanship.

With the "Instruments under Guarantee-Replacement Service", a credit, pro rata to the time of use, is available for any instrument which fails during normal service within the guarantee period and is returned suitably packed to James Hogg (Chemical Engineering) Ltd.

Should any proprietary instrument fail during the first six months of use, an order for a new one should be placed in the normal way. The faulty instrument should be suitably packed and returned to James Hogg (Chemical Engineering) Ltd., who must be informed of the date of despatch and the serial number of the instrument concerned, and that credit is being claimed.

No credit is available for instruments failing outside the guarantee period.

Spare Parts and Ancillary Equipment Service

Every endeavour is made to maintain adequate stocks of spare parts, delivery of the items in the following lists normally being ex stock. Details and quotations for items not covered in the lists can be obtained from James Hogg (Chemical Engineering) Ltd., to whom all enquiries should be addressed.

It is essential that the code number and description of the items required should appear on the official order. No difficulty should be experienced in quoting these essential details, as the code numbers are shown in this book.

SPARE PARTS FOR AMMONIA CRACKERS

Code No.	Description	Fig. and Sketch No.	Normal Method of Delivery	Normal Delivery	Remarks
C.15	Slag wool insulation	Fig. 2	Road or Passenger train	Ex Stock	25 kg packs only.
C.16	Heater	Fig. 2	Road or Passenger train	Ex Stock	Suitable for use with 220-250 volts, A.C. single-phase supply.
C.18	Relief valve	Fig. 8	Post	Ex Stock	Inlet $\frac{17}{32}$ in. o.d.; outlet screwed $\frac{1}{4}$ in. B.S.P. and female thread.
C.18a	Nose pad for relief valve	Fig. 8	Post	Ex Stock	
C.19a	Handwheel key	—	Post	Ex Stock	For ammonia cylinder valves.
C.19b	Gland packing for $\frac{5}{16}$ in. control valve	Fig. 7	Post	Ex Stock	
C.176	Millivoltmeter	Fig. 1	Post	Ex Stock	Calibrated 0-800°C for horizontal flush mounting and with chrome-alumel thermocouples only.
C.21	Pressure gauge, 0-100 p.s.i.g.	Fig. 1	Post	Ex Stock	
C.149	Thermocouple	Fig. 1 & 2	Post	Ex Stock	Chrome-alumel. 16 S.W.G. 2 ft. 3 in. long.
C.150	Compensating lead	Fig. 1	Post	Ex Stock	3 ft. long.
C.178	Thermocouple sheath	Fig. 1 & 2	Post	Ex Stock	
C.177	Thermocouple head	Fig. 1 & 2	Post	Ex Stock	
M.15	Catalyst container with charge of catalyst	Fig. 2	Road or Passenger train	Ex Stock	Sealing plugs and header protectors are fitted to all catalyst containers before despatch. They are invoiced at time of despatch and credited in full on return.
C.179	Charge of catalyst in ICI container on hire	—	Road or Passenger train	Ex Stock	
C.180	Catalyst replacement in buyers' container—all types	—	Road or Passenger train	Ex Stock	Order MUST quote the serial number of the container which is stamped on the elbows. Sealing plugs and header protectors should be fitted before despatch.
C.7	Inlet coil	Fig. 2	Road or Passenger train	6-8 weeks	With nipple welded on and fitted with screwed conical bush, two flanges, and two bolts and nuts at one end, for connecting to catalyst container; other end suitable for 'Ermeto' coupling, and to be cut to length on site.
C.8	Outlet coil	Fig. 2	Road or Passenger train	Ex Stock	With nipple welded on and fitted with screwed conical bush, two flanges, and two bolts and nuts at one end, for connecting to catalyst container; other end fitted with two $\frac{17}{32}$ in. o.d. branches for connecting to the relief valve and exit cock.
C.10	Liner tube	Fig. 2	Road or Passenger train	Ex Stock	
C.11	Top brick	Fig. 2	Road or Passenger train	Ex Stock	

Code No.	Description	Fig. and Sketch No.	Normal Method of Delivery	Normal Delivery	Remarks
C.12	Bottom brick	Fig. 2	Road or Passenger train	Ex Stock	
C.14	$\frac{5}{16}$ in. control valve	Fig. 7	Post	Ex Stock	Inlet plain nipple $\frac{17}{32}$ in. o.d. outlet, screwed $\frac{3}{8}$ in. B.S.P. male thread.
C.27	$\frac{1}{4}$ in. 'Ermeto' coupling	Fig. 9	Post	Ex Stock	
C.27a	Spare ring for $\frac{1}{4}$ in. 'Ermeto' coupling	Fig. 9	Post	Ex Stock	
C.27b	Spare nut for $\frac{1}{4}$ in. 'Ermeto' coupling	Fig. 9	Post	Ex Stock	
C.28a	Graphited asbestos sleeve for $\frac{1}{4}$ in. sleeve packed cock	Fig. 6	Post	Ex Stock	
C.28b	$\frac{1}{4}$ in. sleeve packed cock	Fig. 6	Post	Ex Stock	Ends fitted with 'Ermeto' nuts and rings, and suitable for use only with tube $\frac{17}{32}$ in. o.d.
C.40a	Connecting nipple for pressure gauge	Fig. 1	Post	Ex Stock	One end plain for use with 'Ermeto' coupling.
C.41	Union nut for connecting nipple (C.40a)	Fig. 1	Post	Ex Stock	Female thread $\frac{1}{2}$ in. B.S.P. suitable for pressure gauges or ammonia cylinders.
C.44	Joint ring $\frac{23}{32}$ in. x $\frac{3}{8}$ in. x $\frac{1}{16}$ in.	—	Post	Ex Stock	For use with pressure gauge and cylinder connections.
C.51	Fish spine insulating beads, No. 9 size	Fig. 2	Post	Ex Stock	For use on power leads to heater. 2 lb packets, approximately 200 each.
C.52	Asbestos tape 1 in. wide	—	Post	Ex Stock	Available in rolls containing approximately 100 ft. For use on insulator connector bolts. (C 54a).
C.54	Aluminium leads for heater connections	Fig. 3	Post	Ex Stock	Two required per set.
C.54a	Connector bolt and nut for heater lead	Fig. 3	Post	Ex Stock	Two required per set.
C.56	Copper ferrule	Fig. 3	Post	Ex Stock	For catalyst container joints.
C.60	'Foliac' jointing compound	—	Post	Ex Stock	
C.61	Sulphur tapers	—	Post	Ex Stock	Packed in lots of 10.
C.62	Screwed conical bush	Fig. 3	Post	Ex Stock	Two per set. For catalyst container joints.
C.65	Bulb for signal lamp	—	Post	Ex Stock	8-volt M.E.S. cap.
C.69	Flanges for catalyst container joint	Fig. 5	Post	Ex Stock	Two per set.
C.70	Bolts and nuts for catalyst container joint	Fig. 6	Post	Ex Stock	Two per set.
C.71	Relay with mercury switch, current transformer, signal lamp fitting, and 8-volt bulb	Fig. 1	Post	Ex Stock	
C.71a	Mercury switch	—	Post	Ex Stock	Replacement or spare for C.71.
C.71b	Current transformer	—	Post	Ex Stock	Replacement or spare for C.71.
C.71c	Signal lamp fitting	—	Post	Ex Stock	Replacement or spare for C.71.

RECOMMENDED PROCEDURE WHEN HANDLING OR USING ANHYDROUS AMMONIA

At room temperature and pressure, ammonia is a colourless gas with a very powerful characteristic smell, which is so pungent that it is most unpleasant at concentrations much too low to be dangerous. Individuals will move away long before danger threatens. Ammonia concentrations as low as 1 part in 20,000 are easy to detect by smell.

As delivered in cylinders, the ammonia is a liquid under pressure dependent on the temperature of the liquid. The relationship between the temperature of the liquid and the pressure in the cylinder is given below:

TEMPERATURE	CYLINDER PRESSURE
15°C (59°F)	91 lb/in² gauge (6·3 Bar gauge)
20°C (68°F)	110 lb/in² gauge (7·6 Bar gauge)
30°C (86°F)	155 lb/in² gauge (10·7 Bar gauge)

A considerable expansion of liquid ammonia occurs if its temperature is raised. For this reason, stringent precautions are taken when filling ammonia cylinders, to ensure that there is adequate gas space above the liquid to prevent the development of hydraulic pressure.

Small concentrations of gaseous ammonia will irritate the eyes, mouth, and breathing passages; strong concentrations can cause burns.

Liquid ammonia can cause burns if it is allowed to come into contact with the skin.

HANDLING AND STORAGE OF CYLINDERS

Do not allow cylinders to strike each other or other objects violently.

Do not expose cylinders to direct sunlight, or to heat radiating from sources such as furnaces, etc.

On no account use steam or hot water to heat ammonia cylinders.

Store and use ammonia cylinders in well-ventilated places, away from acids, chlorine, and other corrosive materials.

Do not overtighten the valves on empty cylinders, and replace the cap on the valve outlet, and the valve protection covers.

GENERAL PLANT OPERATION

Ammonia can be dangerous: treat it with respect, and never take risks.

Always use protective gloves and goggles when making or breaking joints in pipelines where there is the slightest possibility of liquid ammonia being present.

Never attempt to verify the contents of cylinders by smell.

Whenever there is a smell of ammonia, locate the leak with a burning sulphur taper and have it attended to *immediately.* Never isolate vessels or sections of pipeline containing liquid ammonia in such a way that the liquid is confined without an adequate gas space above it, unless a pressure relief device is fitted. Such action could result in the bursting of the vessel or pipeline, should the temperature of the trapped liquid be increased.

EMERGENCIES

Fire

Ammonia is not an inflammable gas in the accepted sense of the term.

A stream of ammonia gas issuing from a cylinder will not burn in air, but a limited range of ammonia-air mixtures containing 16 - 27 per cent by volume of ammonia can be ignited with difficulty by a flame. It is not possible to breathe such concentrations.

Cylinders should be removed immediately to a safe, cool place should a fire occur which threatens to involve them. If necessary, the cylinders should be kept cool by directing water from a hose at them while this is being done.

Should the fire be of such proportions that it is impossible to approach the cylinders, keep them as cool as possible by directing jets of water at them from fire hoses.

Major Leakages

At least one gas mask or respirator suitable for use in ammonia should be available.

All masks, irrespective of type, should be kept outside the room where leakage can occur, so that they are still available if a hasty exit is necessary.

Respirators having a canister of absorbent material are suitable only for use in low concentrations of ammonia. Helmets of the long breather type or with a self-contained air supply are suitable for use in any concentration of ammonia.

Messrs. Siebe, Gorman & Co. Ltd. supply all types of respirator.

In the event of a major leakage of either liquid or gaseous ammonia, it is most important that the source of ammonia be isolated as soon as possible. If this cannot be done before breathing becomes difficult, the room should be vacated, and all doors leading to other rooms should be closed. Isolation of the ammonia cylinders should then be carried out by an operator wearing a gas mask or respirator and protective clothing, and

the ventilation of the room increased to maximum by opening all doors and windows communicating with the outer air.

If it is not possible to isolate the source of ammonia, or if the ammonia concentration in the air has become great, jets or sprays of water should be directed from the doorway on to the leak and into the air in the room. This should be continued until the air is clear.

FIRST AID TREATMENT

Gassing

Summon a doctor at once.

Remove patient into fresh air.

If necessary, remove clothing, particularly from moist parts of body.

Keep warm with blankets and hot water bottles. Keep at rest.

If conscious, and if mouth is not burnt, give hot sweetened tea or coffee.

Administer oxygen.

If breathing fails, apply artificial respiration, and continue until patient breathes again, or until a doctor instructs otherwise.

Eyes—Splashes or Concentrated Vapour

Irrigate immediately, and continue for at least 30 minutes.

Summon a doctor as soon as possible.

For the purpose of irrigation, an irrigation bottle, containing 2½ per cent each of borax and boric acid in water, should be kept at hand wherever any posibility of splashes may arise.

Irrigation may be followed by dropping into the eye, medicinal liquid paraffin or castor oil.

Refer to a doctor or hospital for further treatment.

Skin—Splashes or Concentrated Vapour

In severe cases, summon a doctor at once.

Wash immediately with large quantities of water for at least 15 minutes.

If clothing is affected, remove immediately, and wash injured part as above.

During or after washing, remove all clothing and wrap patient in blankets until fresh clothing is available.

After washing, apply wet compresses (2½ per cent each of borax and boric acid in water) to affected parts for several hours, or until medical advice is available. Remove patient to hospital as soon as compresses are applied, if medical aid cannot be obtained.

Figure 1 Elevation of Cracker (Code M.I.)

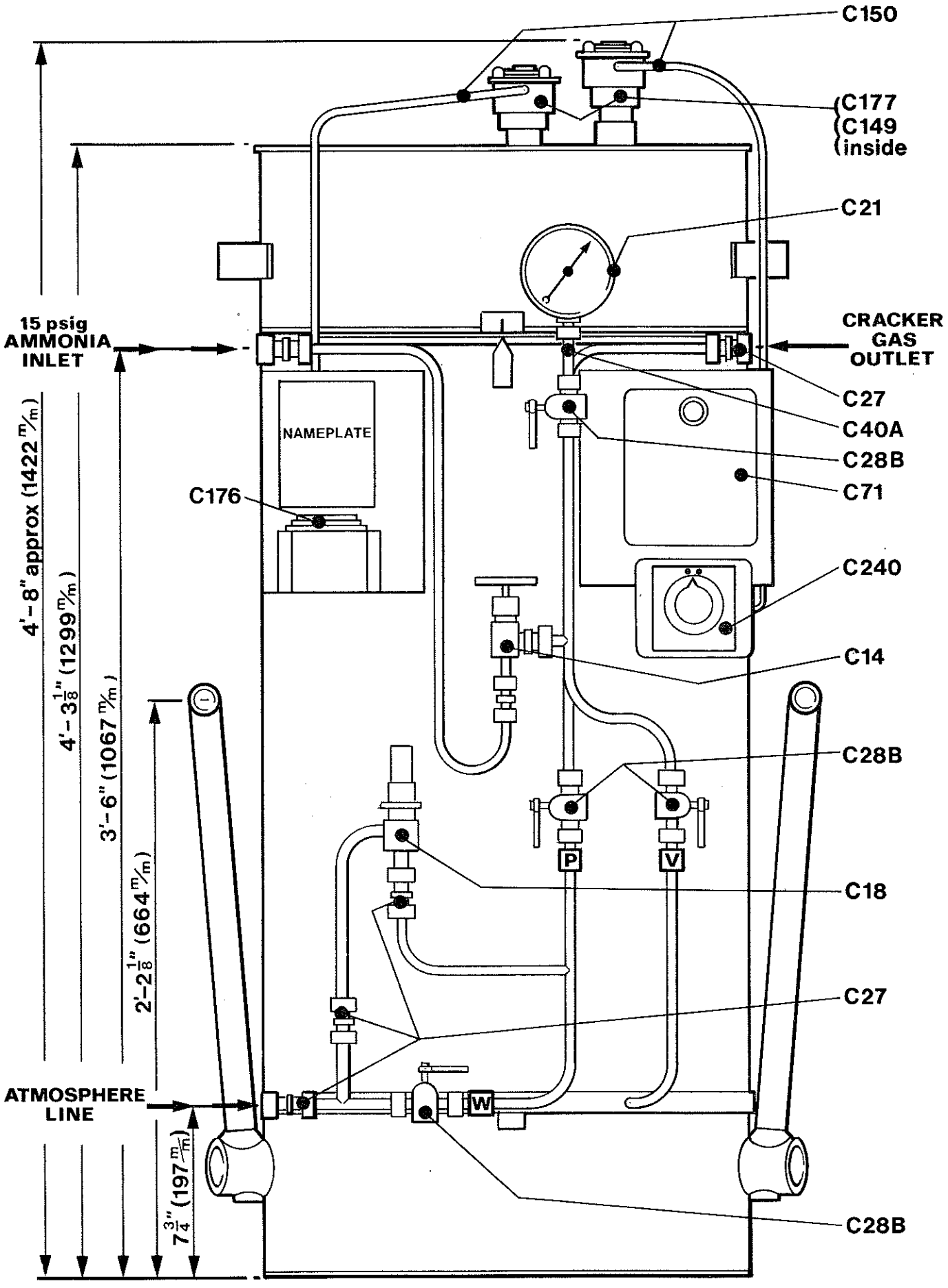


Figure 2 Section through Cracker (Code M.I.)

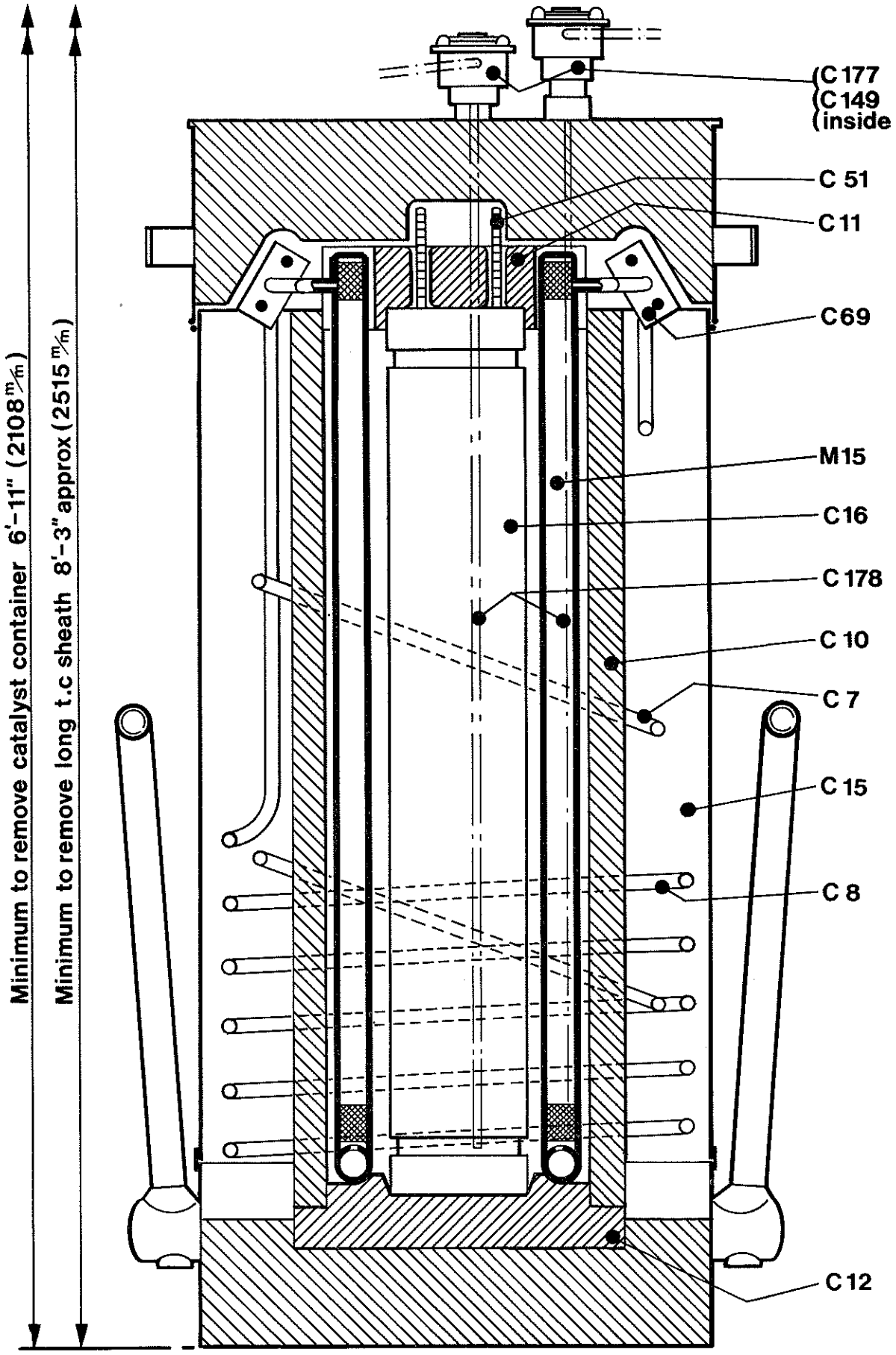


Figure 3 View with cover removed

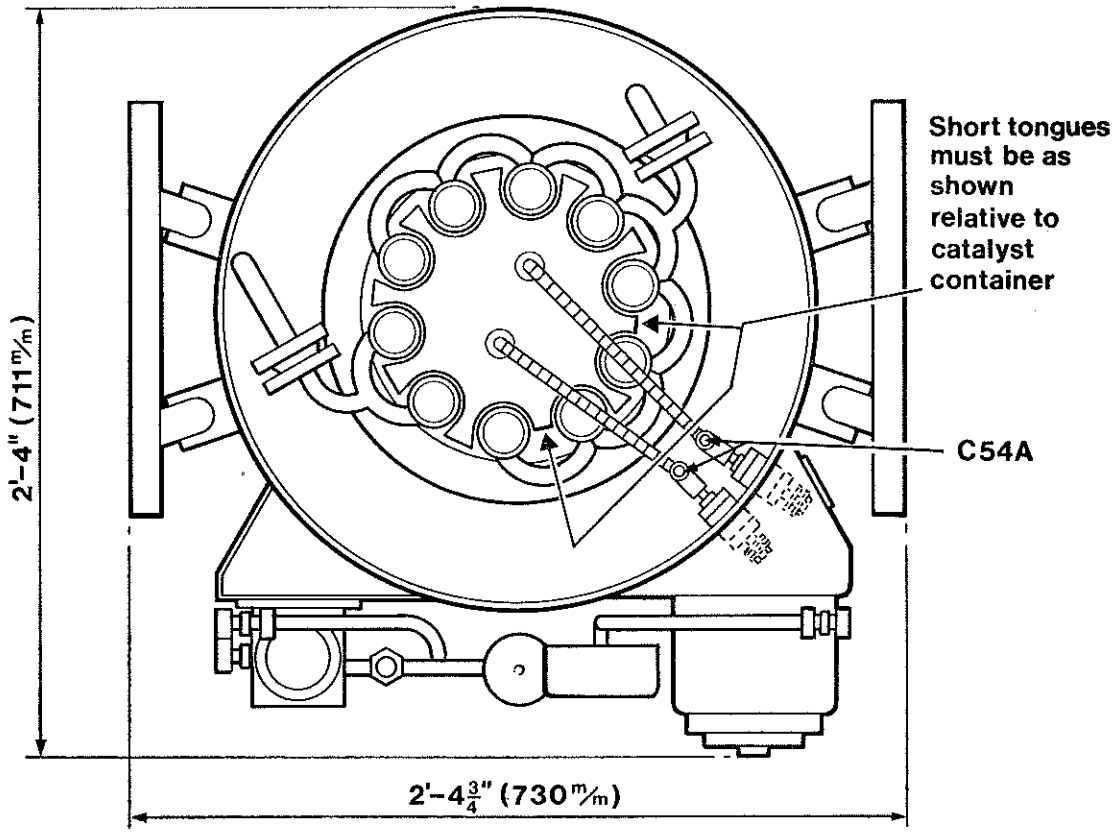


Figure 4 Wiring diagram

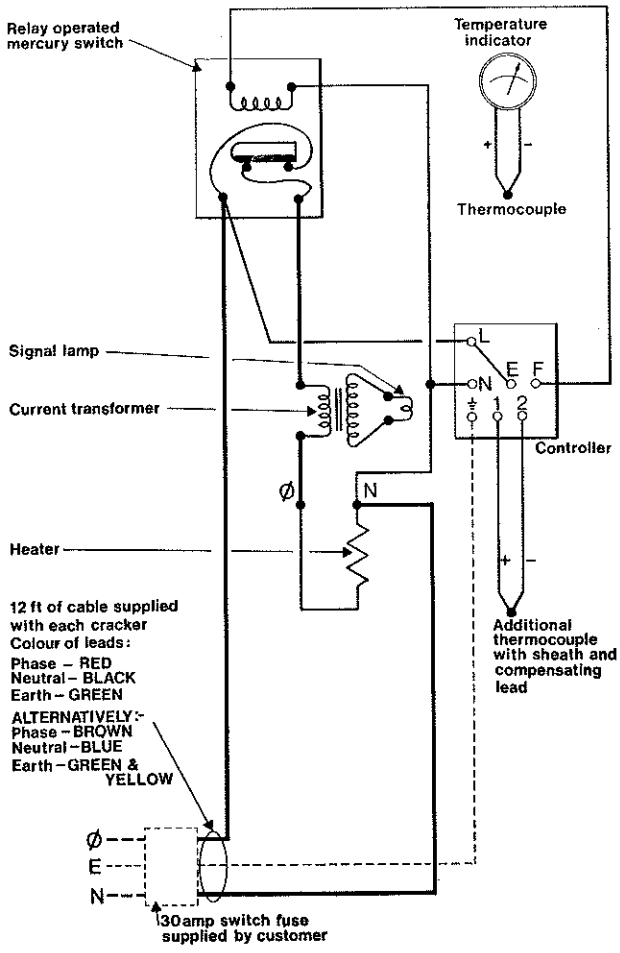


Figure 5 Joint on catalyst container

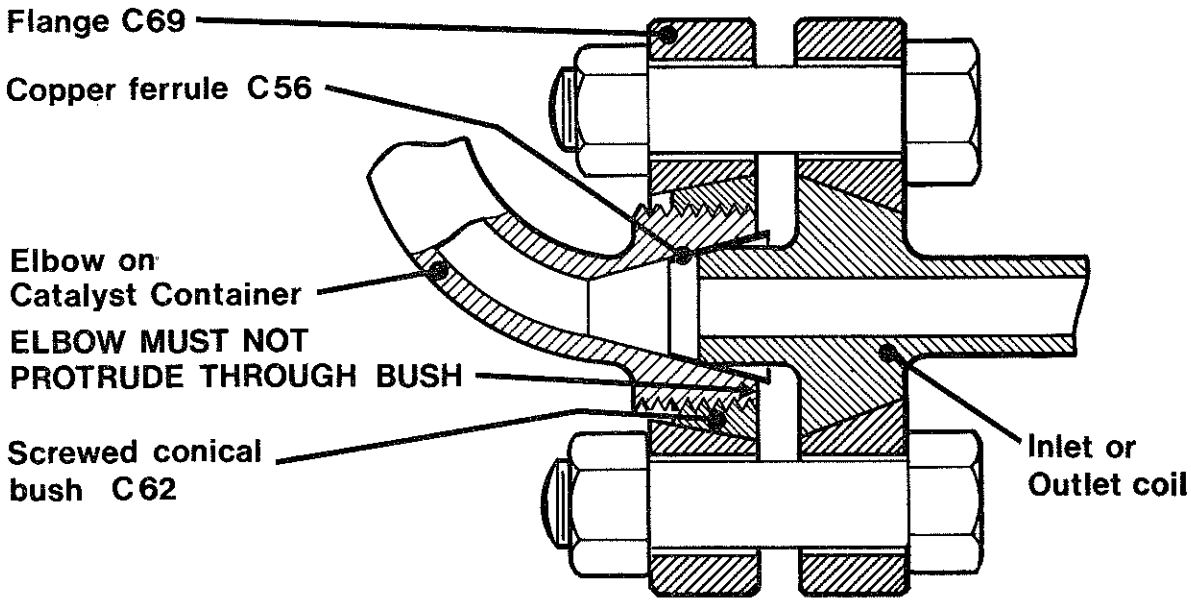


Figure 6 $\frac{1}{4}$ in. sleeve packed cock C.28b.

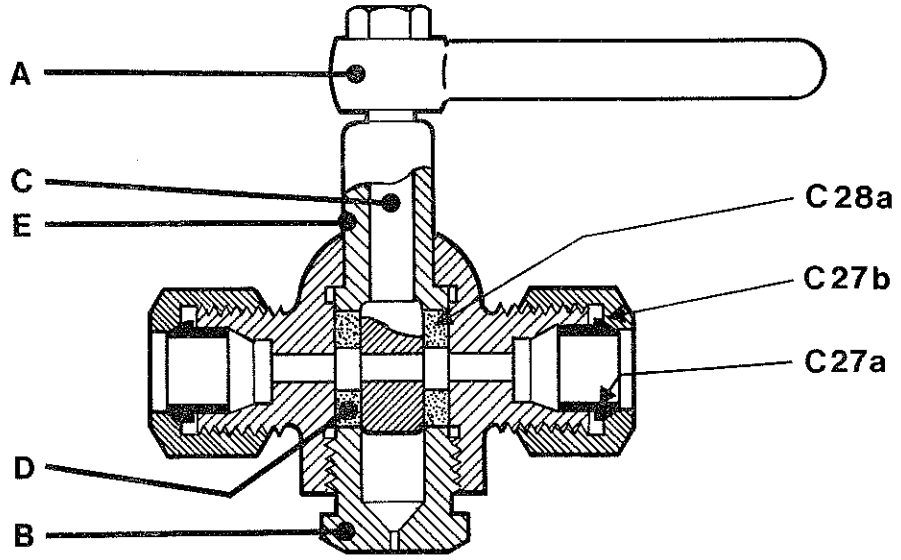


Figure 7 $\frac{5}{16}$ in. control valve C.14.

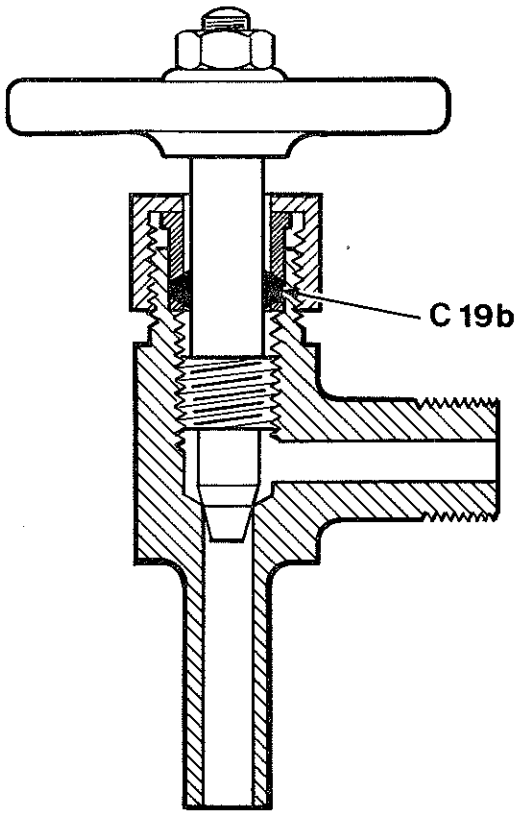


Figure 8 Relief valve C.18.

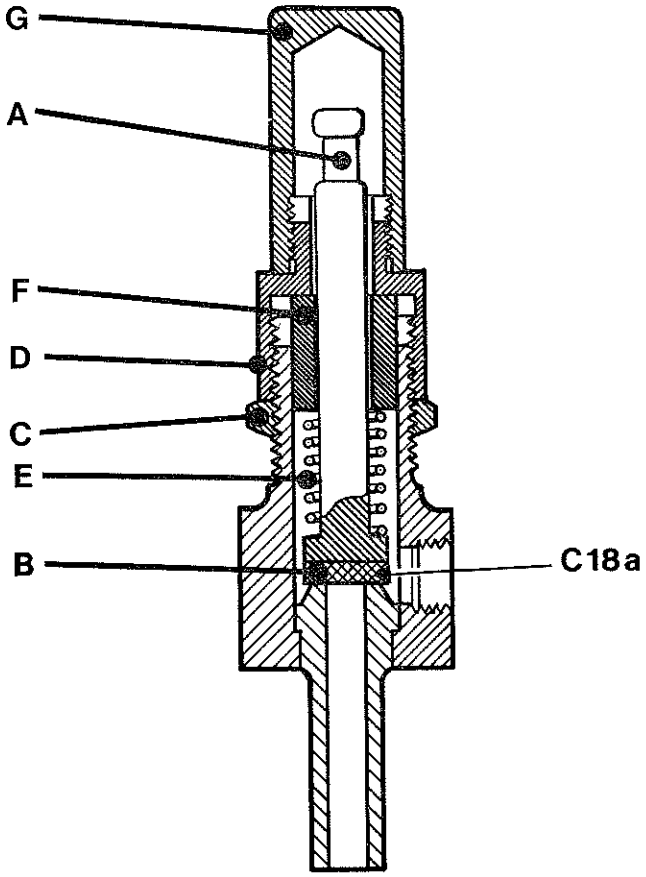
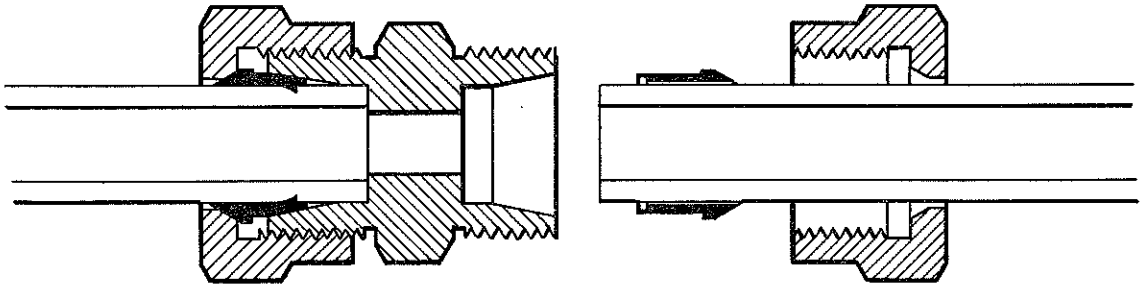


Figure 9 Assembly instructions for $\frac{1}{4}$ in. 'Ermeto' coupling



1. Cut pipe ends square and remove burrs.
2. Sparingly lubricate screw thread and rings.
3. Assemble as shown—nut must bear against collar on ring.
4. Hold coupling body and tighten nuts hard up, with pipes held right home in coupling. For first assembly only, use long or extended spanners to cause hardened lip of each ring to bite into pipe.
5. Unscrew nuts and check that rings have bitten into pipes. If coupling has been correctly assembled, rings cannot be moved along pipes even though they may be rotated.
6. Re-assemble coupling, using normal spanners.