D.T.D. 922A

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Abbey Wood
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BS34 8JH

OBSOLESCENCE NOTICE

All DTD specifications were declared obsolescent from 1st April 1999. All DTD 900 series approvals also lapsed at that time. The standards will no longer be updated but will be retained as obsolescent documents to provide for the servicing of existing equipment.

Further Guidance

The aim in declaring the specifications obsolescent is to recognise that the documents are not being updated and thus should be used with care by both purchaser and supplier. For example, a specification could contain valid technical information but may also contain type approval clauses that contradict procurement policy and/or use materials that do not comply with environmental legislation. The obsolescent specification can still be used as a basis for a purchase provided that the supplier and purchaser agree suitable changes to the specification within the purchase order/contract.
For the DTD 900 system, each specification has provided an MoD approved material and process. For these items, the declaration of obsolescence will constitute the termination of both the extant MoD approval and the continuing MoD assessment that had underpinned those approvals. Again, the technical content of the document remains valid and can be used by both purchaser and supplier as a basis for a contract but an acceptable (to the parties) approval/assessment procedure would be required.

MINISTRY OF AVIATION SUPPLY/
DEPARTMENT OF TRADE AND INDUSTRY

D.T.D. 922 A

Amendment No. 1
September, 1970

Aircraft Process Specification

MANUFACTURE OF CARBON MONOXIDE INDICATOR TUBES MARK III

APPENDIX I

Method for Testing Indicator Tubes

(a) Sealing Test.-

Delete Four of the five selected indicator tubes in their sealed envelopes shall be exposed for 2 hours in a closed vessel containing coal-gas at about 40° C and then allowed to cool to room temperature overnight without opening the vessel. They shall then be examined visually and compared with the unexposed tube.

Insert Four of the five selected indicator tubes in their sealed envelopes shall be exposed for 2 hours in a closed vessel containing coal-gas, or 25 per cent carbon monoxide in air, at about 40°C and then allowed to cool to room temperature overnight without opening the vessel. They shall then be examined visually and compared with the unexposed tube.

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Aircraft Process Specification

MANUFACTURE OF CARBON MONOXIDE INDICATOR TUBES MARK III

NOTE.- The method of manufacture and the indicator material described herein are the subject of U.K. patent application No. 112381/43. No authority is necessary to use the method in connection with work carried out for or on behalf of H.M. Government. Applications for Licences to use the method for non-Governent purposes should be made to the Patents Division, Ministry of Supply, First Avenue House, High Holborn, London, W.C.1.

SECTION 1

General Requirements

1. **Scope.** -This specification covers the manufacture and testing of Indicator Tubes, Mark III, for use in Carbon Monoxide Indicators, Mark I and Mark III.

2. **Description.** -The indicator tubes shall be made of good quality, colourless, soft glass in the form of a cylinder, slightly flared at one end and joined by a taper to a shorter and narrower cylinder flame-smoothed at the open end. They shall be filled with the materials described in Clause 5.

Each filled tube shall be enclosed in an outer envelope of good quality, colourless, soft glass in the form of a cylinder with one hemispherical closed end, the other end being drawn out and sealed by fusion.

3. **Dimensions.** - Before being filled, the indicator tubes and outer envelopes shall have the following dimensions-

(a) Indicator tube :-

(i) Overall length: 4 inches ± $\frac{1}{16}$ inch.
(ii) Wall thickness: $\frac{3}{64}$ ± $\frac{1}{64}$ inch.
(iii) Length of flare : approximately $\frac{1}{16}$ inch.
(iv) External diameter of flare : approximately ½ inch.
(v) Length of long cylinder : approximately 3½ inches.
(vi) Internal diameter of long cylinder : $\frac{23}{64}$ ± $\frac{1}{64}$ inch.
(vii) Length of taper : approximately $\frac{3}{8}$ inch.
(viii) Length of short cylinder : approximately $\frac{1}{8}$ inch.
(ix) External diameter of short cylinder : $\frac{5}{32}$ ± $\frac{1}{64}$ inch.

(b) Outer envelope :

(i) Overall length : approximately 8 inches.
(ii) Wall thickness : approximately $\frac{1}{32}$ inch.
(iii) Internal diameter : $\frac{8}{64}$ ± $\frac{1}{64}$ inch greater than the external diameter of the flare of the indicator tube to be enclosed.

Before cleansing as described in Clause 4 the Indicator Tubes shall be sorted into two groups having internal diameters *(a)* from $\frac{22}{64}$ in. to $\frac{23}{64}$ in. and *(b)* from $\frac{23}{64}$ in. to $\frac{24}{64}$ in. and shall be treated separately during the whole of the following operations.

4. **Cleansing of Tubes and Envelopes for filling.** -Indicator tubes and outer envelopes shall be cleansed by successively rinsing with tap water, scrubbing the interior with a cylindrical brush approximately 1 inch in diameter, boiling in distilled water, and drying in a steam or electric oven at about 100°C.

The cleansed tubes and envelope shall be stored in dust-proof, glass or metal boxes in readiness for filling.

5. **Filling.** -After each indicator tube has been cleansed as described in Clause 4, the following materials shall be introduced into it in the order and as described below :-

(a) A conical brass, bronze, or Monel metal gauze, having square meshes $\frac{1}{100}$ to $\frac{1}{50}$ inch in length of side of aperture. The conical gauze shall be shaped from a disc approximately $\frac{5}{8}$ inch in diameter having a radial slit, and shall be heated for a moment in a bunsen flame to destroy organic matter before insertion

in the tube, any handling of the gauze during heating and insertion being effected by forceps. After insertion at the flared end of the tube the gauze shall be pressed down into the tapered end of the tube by means of a clean, conical-ended, steel rod approximately $\frac{5}{16}$ inch in diameter.

(b) White granules of protective material, prepared as described in Clause 11. The granules shall form a column approximately $1\frac{5}{8} \pm \frac{1}{8}$ inches in length measured from the open end of the conical gauze. The granules shall be compacted together and their upper surface made accurately level by tapping the vertical tube into which has been inserted a clean, flat-ended steel rod approximately $\frac{5}{16}$ inch in diameter and 6 inches in length.

(c) Yellow granules of indicator material, prepared as described in Clause 12. The granules shall form a column $1\frac{1}{8} \pm \frac{1}{8}$ inches in length above the white granules *(b)*, and shall be compacted by gently tapping the tube without inserting the rod. The filling of the yellow granules into the tube and the tapping shall be effected so that the accuracy of level of the junction between the white and yellow granules is not disturbed.

(d) Two circular discs of gauze similar to gauze *(a)* except that the discs shall be flat and approximately $\frac{3}{8}$ inch in diameter. Each disc, after heating for a moment in a bunsen flame, shall be forced into the flare end of the tube by means of the flat-ended steel rod, and gently pressed down on the flat surface of the granules *(c)*, any handling of the gauzes during heating or insertion being effected by forceps.

(e) A steel spring (see Fig. ID) which shall be compressed and inserted into the flare of the tube by forceps or pliers so that the flats of the spring are parallel to the length of the tube. The spring shall be pressed down on the gauze discs by means of the flat-ended steel rod, the tube being tapped while firm hand pressure is exerted on the rod to compact the contents of the tube. The pressure shall not be such as to break or crush the granules.

Each spring shall be formed from a strip of softened spring steel 1¼ inches in length, $\frac{1}{4}$ inch in width, and $\frac{9}{1000}$ inch (34 s.w.g.) in thickness, stamped into the form of an M with rounded angles, the width between the free ends being approximately $\frac{1}{2}$ inch after hardening.

Before use, the springs shall be de-scaled by sand or grit blasting, washed in acetone (A.R. quality), dried in a steam or electric oven at about 100°C. and stored in dust-proof glass or metal boxes.

A suitable apparatus, for filling the granules *(b)* and *(c)* into the tubes without contamination by the air, is described in Clause 14.

Owing to the absorptive capacity of silica gel materials for easily condensible gases and vapours, care should be exercised at all times to avoid exposure of the white or yellow granules to organic gasses or vapours.

6. **Enveloping and Sealing.**-When inserted in the outer envelope the flared end of the indicator tube shall rest on an asbestos plug at the closed end of the envelope the indicator tube being held firmly in position by another plug of asbestos and a spring attached to the narrow end of the tube.

The asbestos plug shall consist of 4 inches of six-thread asbestos yarn approximately $\frac{3}{16}$ inch in diameter, and shall be cleansed by heating for two hours at 500°C. in an open muffle furnace or electric oven. The cleansed lengths of yarn when cool, shall be stored in dust-proof, glass or metal boxes in readiness for use.

A length of cleansed asbestos yarn, roughly formed into a ball, shall be inserted in the open end of the envelope.

The flared end of the tube shall be inserted in the envelope, thus pushing the plug down the envelope to the closed end. A length of cleansed asbestos yarn roughly formed into a ball shall be inserted to follow the narrow end of the tube and the whole compressed by means of the clean flat-ended steel rod described in clause 5 *(b)*. A steel spring as described in Clause 5 *(c)* having its free ends opened to $\frac{5}{8}$ inch apart and with its flats parallel to the length of the tube shall then be pushed down the envelope so as to hold the tube firmly between the two asbestos plugs.

The envelope, at about 2 inches from the open end, shall then be sealed by fusion in a blow-pipe flame after being drawn out to a short capillary.

The contents of the envelope shall be protected from contamination during the sealing operation by affixing a guard-tube containing yellow granules of indicator material to the open end of the envelope by means of an asbestos or rubber bung, care being taken to avoid undue heating of the bung during the sealing operation.

(Note.-The foregoing precautions, relating to the cleansing, filling, enveloping and sealing of the indicator tubes are necessary to avoid the presence of organic matter which, during sealing or later in storage, may discolour the indicator material and render it useless.)

7. **Marking.** - A label shall be affixed to each sealed outer envelope over its empty part showing :-

(a) The two calibration lengths of colour change in mm., corresponding to the ground and flight acceptance limits for carbon monoxide contamination of aircraft.

(b) Such other particulars as may be specified in the contract.

8. **Testing.** - From the indicator tubes produced for inspection in their sealed envelopes not less than 5 in every 1,000 tubes shall be selected, examined and tested by the Inspector. The method described in Appendix I shall be used in testing the sealing and calibration of the tubes.

(a) In the sealing test none of the tubes shall show any perceptible colour change in the column of indicator material when compared with the fifth unexposed tube.

(b) (i) In the calibration test using 0.005 per cent, carbon monoxide the length of colour change in each tube shall not differ by more than 0.4 mm. from the "flight" calibration length declared on the label of the outer envelope.

(ii) In the case of the test with 0.020 per cent. carbon monoxide the length of colour change in each tube shall not differ by more than 0.8 mm. from the "ground" calibration length declared on the label of the outer envelope.

Should any of the tubes tested not meet any of the above requirements the inspector may at his discretion either reject the whole batch or call for a repetition of the tests. If the tubes fail to meet the requirements during the second test the whole batch must be rejected.

9. **Packing.** - The indicator tubes in their sealed envelopes shall be packed in fabric pads as described in Clause 18.

SECTION 2

Preparation of silica Gel

10. **Preparation of Dry Purified Silica Gel.** - Granules of good quality commercial silica gel, light in colour and substantially free from all metallic salts and opaque particles, shall be used. The gel shall be substantially dust-free and capable of being uniformly impregnated by the method described in Clause 12. The granules shall pass through a sieve having square meshes $\frac{1}{40}$ to $\frac{1}{42}$ inch in length of side of aperture, and shall be retained on a similar sieve $\frac{1}{72}$ to $\frac{1}{80}$ inch in length of side of aperture.

The gel, preferably in 3-litre, round-bottom glass flasks each containing 250 grams of material, shall be covered with pure concentrated nitric acid and heated on a boiling water bath until no more brown fumes are evolved. The free acid shall be poured off and the gel washed six times with hot distilled water. One litre of water shall be used for each washing per 100 grams of gel taken. During each washing the flasks shall be replaced on the boiling water bath for half an hour and frequently shaken during the heating.

The free water shall be poured off the gel, the wet mass transferred to large porcelain evaporating basins and heated in an electric oven at about 100°C. until the granules are free-flowing. The temperature of the oven shall then be raised and maintained for 6 hours at 270°-280° C. At the end of this period the hot gel shall be transferred immediately to clean, air-tight tins with close-fitting lids, and, when cool enough to handle, the lids shall be sealed with adhesive tape until required for use.

To protect the gel from dust or loose corrosion products during heating in the oven it is advisable daily before using the oven to clean out the ventilator and thermometer holes, and to swab the oven roof, walls, floor, door and shelving with a damp cloth.

In the bulk the dry, purified gel should be pure white in colour and free from visible impurities and opaque particles, the individual granules of gel being colourless and transparent.

The granules are used only for preparing white silica gel containing 15 per cent. of added water, as described in Clause 11.

11. **Preparation of White Silica Gel Containing 15 Per cent. of Added Water.** -A weighed amount of dry, purified silica gel, prepared as described in Clause 10, shall be placed in a stoppered glass flask and 15 grams, of distilled water added for every 100 grams of dry gel taken. The damped gel shall be thoroughly mixed by gentle shaking, allowed to stand for not less than 48 hours with occasional shaking and then transferred to clean, glass jars or bottles having ground stoppers, each being sealed with adhesive tape till required for use.

This free-flowing white silica ge1 containing 15 per cent of added water is used as a protective filling for indicator tubes as described in Clause 5, and in the preparation of indicator material as described in Clause 12.

SECTION 3

Preparation of Indicator Material

12. **Preparation of Yellow Indicator Material. -** White silica gel containing 15 per cent. of added water, prepared as described in Clause 11, shall be impregnated with a cold aqueous solution of potassium pallado-sulphite, prepared as described in Clause 13, and the impregnated material shall be dried to the original water content, at reduced pressure, and at a temperature not exceeding 50°C.

The impregnating solution for each 500 grams of gel shall be made by dissolving, by boiling if necessary, l.62 grams of potassium pallado-sulphite in 200 ml. of distilled water. The solution shall be cooled before use.

Great care shall be taken to exclude organic matter throughout the preparation, the recommended method for which is as follows :-

The impregnation and drying of the material is performed in 3-litre bolt-head flasks, fitted with good rubber bungs carrying swan-neck tubes with glass stopcocks (see Figs. 2A and 2B), leading to a train of drying towers of flasks containing activated commercial silica gel to protect the vacuum pump, and so arranged that the drying train, when saturated, can be replaced without interfering with the preparation. The flasks should be warmed in an electrically heated water bath large enough to take several flasks.

The flasks before use must be cleaned with chromic : sulphuric acid mixture, followed by thorough washing with distilled water and drying.

Care must be taken that none of the material comes into contact with the rubber bungs during the preparation. Each flask with bung and stopcock is weighed to the nearest half gram, and 500 grams of white silica gel containing 15 per cent. of added water (see Clause 11) is added to each flask and re-weighed. For each 500 grams of gel taken the foregoing cold solution containing 1.62 grams potassium pallado-sulphite is added, and the mass gently shaken until wetted throughout and uniformly yellow in colour.

The flasks are placed in the water bath and connected to the drying trains, the pressure being reduced to about 5 mm. of mercury and the temperature slowly raised to about 50°C. During the early stages of the drying each flask is frequently shaken to prevent any solution draining to the bottom and to ensure uniform impregnation of the gel. After the gel is dry enough to be free-flowing only an occasional rotation of each flask to expose a fresh surface is necessary. The drying is continued until the weight is reduced to the first weight of flask and unimpregnated gel, the net weight of indicator material thus being equal to the weight of unimpregnated gel taken (500 grams).

In order to avoid grease from the tap being drawn into the flask if the pressure were released during weighing, it is advisable to keep the flask under reduced pressure during weighing and to add 3.5 grams to the gross weight to allow for the weight of 3 litres of air. For the same reason it is preferable, on completion of the preparation to release the pressure by lifting the rubber bung rather than by opening the tap.

The bright yellow indicator material thus prepared is stored in clean, wide-mouthed glass jars or bottles, with ground-glass stoppers, each being sealed with adhesive tape till required for use.

13. **Preparation of Potassium Pallado-sulphite.** - To 10 grams of palladium chloride, $PdCl_2$ in a glass evaporating basin, 25 grams of potassium pyrosulphite $K_2S_2O_5$, dissolved in 100 ml. of distilled water shall be added. After stirring at room temperature till the solids have dissolved, the yellow solution shall be filtered through a clean sintered glass funnel to remove suspended impurities if any. The clear solution shall be evaporated on a boiling water bath and occasionally stirred until reduced to about one-third of the original volume, a yellow solid separating during evaporation. After cooling, the liquid shall be filtered through a clean sintered glass funnel and the solid residue thoroughly washed with 25 ml. of cold distilled water in lots of 5 ml. The washed solid shall be dried in a desiccator at reduced pressure.

About 17 grams of pure potassium pallado-sulphite, $K_2Pd(SO_3)_2$, should be obtained as a yellow crystalline powder ; for use in the preparation of indicator material as described in Clause 12.

SECTION 4

Filling of Indicator Tubes

14. A suitable apparatus for filling the indicator tubes with the white granules of protective material (Clause 11) and with the yellow granules of indicator material (Clause 12) is shown in Fig. 3, it consists of :-

(a) A pear-shaped glass reservoir with filler neck and short tubular outlet at the base.

(b) A glass funnel attached to the tubulus of *(a)* by a rubber bung.

(c) A stainless steel cone (for closing the tubulous outlet) supported by a stainless steel rod passing up through a stainless steel bush in a rubber bung closing the reservoir filler neck.

(d) A stainless steel adjustable collar on the upper end of the rod and separated from the bush by a coiled spring threaded on the rod.

(e) A guard tube containing yellow granules of indicator material inserted through the rubber bung in the filler neck. This guard tube is to purify contaminated air entering the reservoir.

The reservoir may be filled by releasing the collar and spring from the rod, removing the bung with its bush and guard tube, and the funnel at the base, and resting the reservoir on the cone while the white or yellow granules are poured in through the filler neck, a separate apparatus being used for each type of granules.

After re-assembly of the apparatus it is fixed in a suitable stand at such a height that an indicator tube for filling can readily be placed under it with the funnel outlet inserted about ½ inch into the tube.

By depressing the collar at the top of the rod the cone is depressed from contact with the lower end of the tubulus, thus releasing granules from the reservoir at any suitable rate of flow into the funnel and thence into the tube to be filled.

As far as is possible tubes from only one of the size groups described in Clause 3 shall be used for filling one batch of Indicator material. Should it prove necessary to use tubes of both sizes, the tubes of each size shall be filled separately and treated as an individual batch having its own batch number and declared calibration lengths.

SECTION 5

Calibration of Filled and Sealed Indicator Tubes

15. **Calibration of Indicator Tubes.-** Not earlier than seven days after filling and sealing six indicator tubes from each batch of indicator material shall be selected, unsealed and tested, three being used to determine the "flight" calibration length and three for the "ground" calibration length.

Pure carbon monoxide, prepared as described below, shall be diluted with clean air to the following concentrations of carbon monoxide by volume :-

(a) 0.005 per cent. .. .. .. 5 parts per 100,000 (flight calibration)
(b) 0.020 per cent. .. .. .. 20 parts per 100,000 (ground calibration).

The carbon monoxide diluted to one of the above concentrations shall be passed through each selected tube, maintained at 0° C., entering at the narrow end at the rate of 60 ml. per minute for 2 minutes, a different tube being used for each test. A suitable prodedure is described in Clause 17.

Each tube, when the flow of 2 minutes is completed, shall be removed from the iced water and the length of colour change from yellow to brown measured to 0.1 mm. at four positions 90° apart. The average of the 12 measurements from the three tubes of each batch shall be taken as the calibration length for each of the two specified carbon monoxide concentrations, and shall be declared to the nearest 0.1 mm. on the labels affixed to the outer envelopes (see Clause 7).

Batches of Indicator which give a ground calibration length greater than 6.0 mm. when determined by the above procedure shall be rejected.

16. **Preparation of 10 per cent. Carbon Monoxide.** - Pure carbon monoxide for use as indicated in Clause 15 may be prepared in an apparatus of the type illustrated in Fig. 4A.

In this apparatus about 50 ml. of pure concentrated sulphuric acid are placed in the 100 ml. bolt-head flask. Formic acid (98-100 per cent.) is allowed to run into the acid as required, the flask being gently warmed if the evolution of gas is sluggish. The levelling reservoir is arranged so that the burette is just filled with water when stop cocks A and B are open. When carbon monoxide is being evolved smoothly the burette is filled by closing B. B is then opened to allow the burette to fill with water. This is repeated five times, thus displacing all air from the apparatus. The sixth 100 ml. is collected for use. The levelling reservoir is lowered to the 100 ml. mark, B is opened to bring the pressure to atmospheric, and A is closed.

The burette is then connected to the 1 litre measuring cylinder shown in Fig. 4B, which contains 900 ml. of air at atmospheric pressure, and the 100 ml. of carbon monoxide are transferred to it. Stopcock C is then closed and the gas mixed thoroughly.

17. **Description and Manipulation of Apparatus.** - The apparatus shown in Fig. 4C gives a means of supplying diluted carbon monoxide at a steady rate of flow (60 ml. per minute). A stock of 10 per cent. carbon monoxide is kept in the bottle A. Measured amounts of this are transferred via burette C to bottle E where the gas is diluted to 1 litre. Thus 0.5 C.C. of 10 per cent. carbon monoxide on dilution to 1 litre gives 5 parts of carbon monoxide per 100,000 parts of air.

The burette C is made from glass tubing of 5 to 6 mm. internal diameter, having a short length of capillary sealed to the lower end to act as a choke making control of the water level easier.

A soft rubber bung is used for vessel E to give flexibility and is wired in to prevent change in volume. E is marked with a calibration line so that the volume contained between the line and the bung is 1 litre.

The vessel Q together with side tube O provides a means of displacing gas from E at a constant rate of flow. Q has a capacity of about 1 litre. The tube carrying stopcock P is adjusted so that the water flowing through the capillary displaces gas from E at a rate of 60 C.C. per minute.

The flowmeter L is calibrated for a flow of 60 ml. per minute.

The apparatus is used as follows. Reservoir D is raised and by manipulating two-way stopcock G, completely fill the gas burette C and capillary tubes connecting C to vessels A and E with distilled water. These tubes should always be left filled with water, when the apparatus is not in use tap G should be closed.

Reservoir B is raised and A and the capillary tube carrying stopcock H completely filled. H is connected to the measuring cylinder containing the 10 per cent. carbon monoxide and the gas transferred to A by lowering B. When sufficient gas has been taken H is closed and B arranged so that the gas is kept under a slight head of water pressure. This gas supply should remain substantially unchanged for a week.

From A 0.5 ml. of gas are drawn off into burette C if 5 parts per 100,000 or 2 ml. if 20 parts per 100,000 are required. The measurements should be made at atmospheric pressure.

Flowmeter L is disconnected at K and stopcock N opened. E and F are put into communication by means of three-way stopcock J and E filled with water to the bung. Water should not be forced into the delivery tube leading to the flowmeter. F is lowered and 1 litre of air drawn in. This is levelled off and tap N closed.

The gas from the burette is driven over into E until the capillary tube is once again completely filled with water. The water in E is gently rotated to ensure thorough mixing of the gas.

J is turned so as to connect E to the side tube O but not to F. The flowmeter is connected to the delivery tube at K.

The inlet of a two-way stopcock is connected at M to the flowmeter L. The two outlets from the stopcock are connected to the narrow parallel ends of two of a number of indicator tubes maintained at 0° C. by submerging in ice and water. The connections from the stopcock to each indicator tube shall have a total length not exceeding 8 inches and a bore not exceeding $\frac{1}{8}$ inch and shall be made from suitably bent glass tubing and rubber connections. Other indicator, tubes for calibration with their connecting tubes attached and inlets and outlets temporarily but securely plugged to obviate contamination, may be placed in the iced water. The inlet ends of the connections and the outlet ends of the indicator tubes shall project about ½ inch above the iced water. The calibration of any tube shall not commence earlier than 30 minutes after immersion at 0° C.

The stopcocks N and P are opened and the flow through the first of the two selected indicator tubes allowed to reach a steady rate of 60 ml. per minute. By means of the two-way stopcocks, the flow is quickly switched from the pilot tube to the second tube and the flow maintained for 2 minutes. While the flow is passing through the second tube, the first tube is removed and a third tube substituted, the flow being switched to this tube immediately the 2 minutes of flow through the second tube is completed. Any number of indicator tubes can be successively calibrated. The pilot tube first used or any of the tubes may be retained for future use as pilot tubes in arranging steady rates of flow in calibration.

SECTION 6

Packing of Completed Indicator Tubes

18. The indicator tubes in their sealed outer envelopes, marked as prescribed in Clause 7, shall be inserted singly in pockets of fabric pads, each containing 10 pockets.

The following materials and method of making the pads are suitable:-

Cotton flannelette, raised on one side and weighing about 8 oz. per square yard, is cut into strips 18 inches in length by 13 inches in width. Each strip is folded double across the width at 7½ inches from one end with the raised surface inwards, thus leaving a single thickness flap 3 inches in width and 13 inches in length. The double material

is then stiched, commencing ¼ inch from one side, along 11 parallel lines 1¼ inches apart, to form 10 pockets, each 1¼ inches in width and 7½ inches in length, all closed at one end by the fold.

The pads shall be marked "10 Carbon Monoxide Indicator Tubes Mark III".

After filling, the flap is folded over the open ends of the pockets and the pad rolled up.

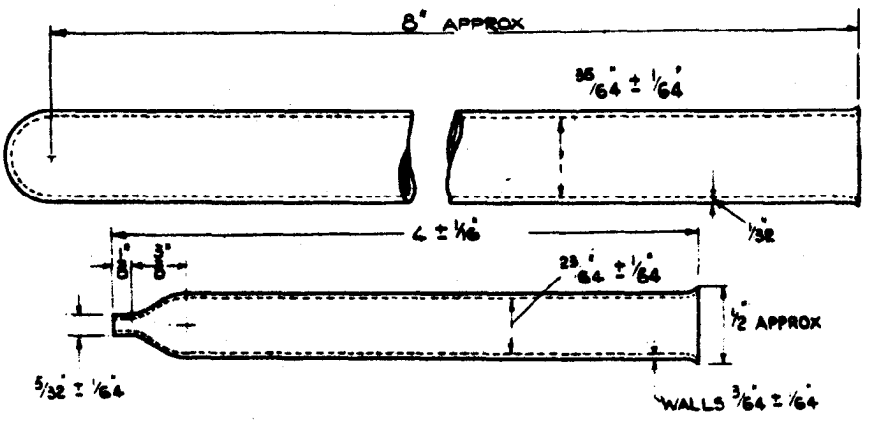
APPENDIX I

Method for Testing Indicator Tubes

(a) Sealing Test.-Four of the five selected indicator tubes in their sealed envelopes shall be exposed for 2 hours in a closed vessel containing coal-gas at about 40° C. and then allowed to cool to room temperature overnight without opening the vessel. They shall then be examined visually and compared with the unexposed tube.

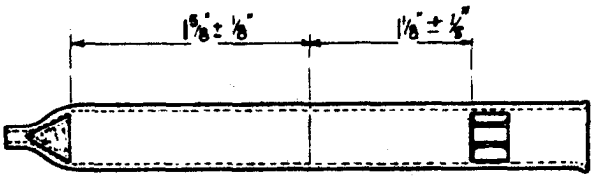
(b) Calibration Test.-Two of the four tubes passing the foregoing sealing test shall be unsealed and tested at ordinary temperature by passing air, containing 0.005 per cent. of carbon monoxide through each tube separately for 2 minutes, the air entering the narrow end of the tube and passing at the rate of 60 ml. per minute.

The remaining two of the four tubes passing the foregoing sealing test shall be similarly calibrated using air containing 0.020 per cent. of carbon monoxide. In all four tubes tested the length of colour change shall be measured to the nearest 0.1 mm., each measurement being the average of four taken at positions 90° apart.



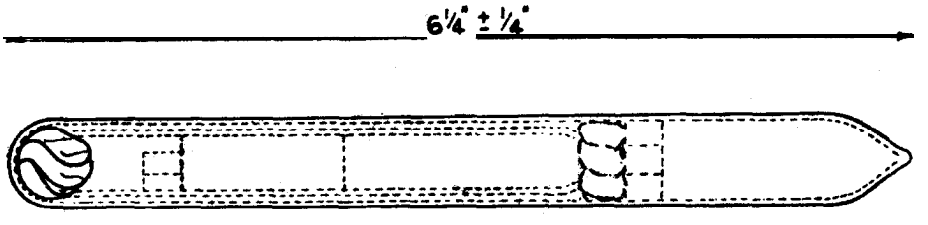
ENVELOPE AND TUBE BEFORE FILLING

FIG 1 A



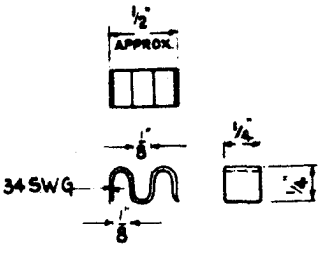
FILLED TUBE

FIG 1 B



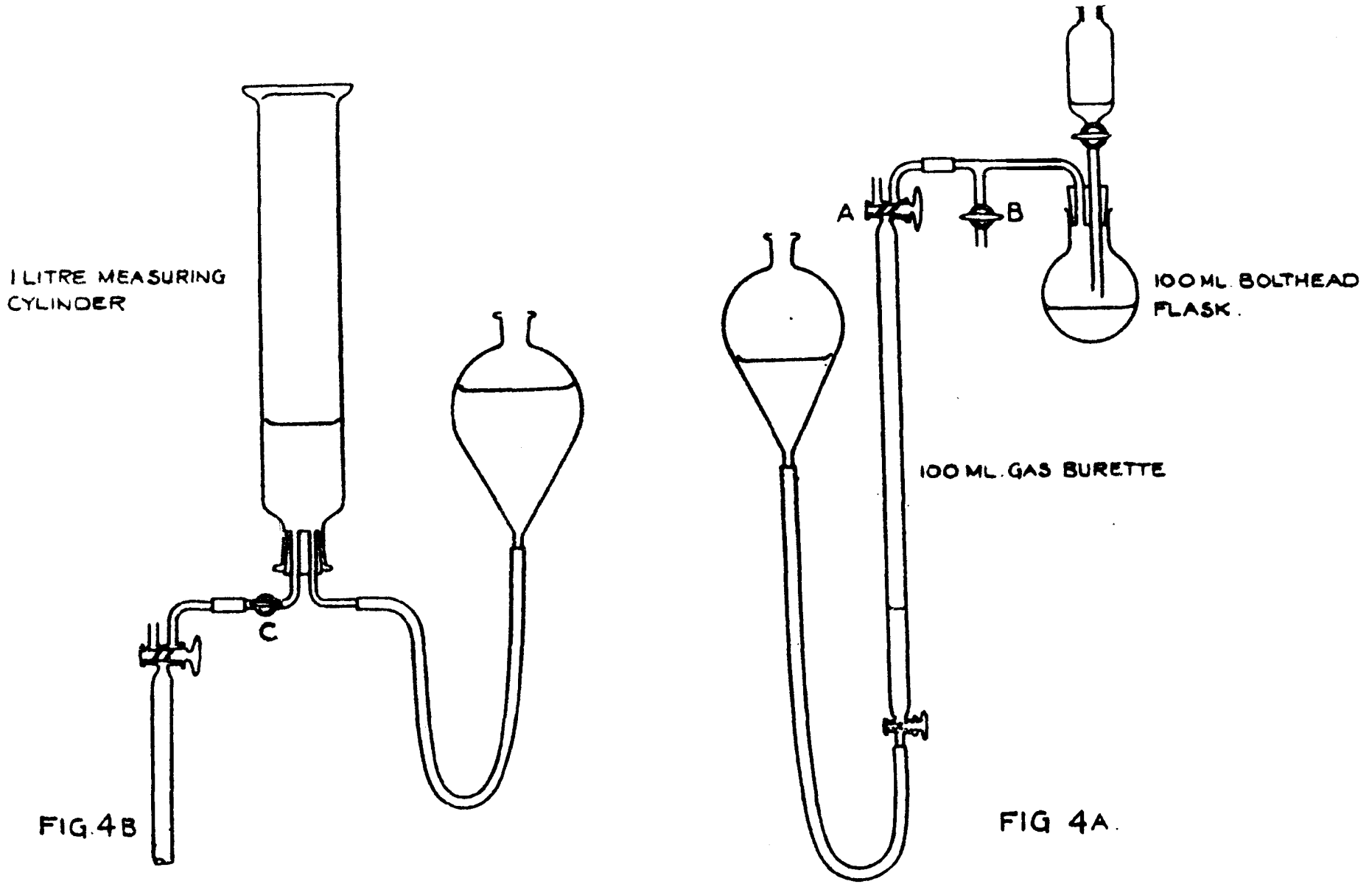
PROTECTED TUBE SEALED IN OUTER ENVELOPE

FIG 1C



SPRING

FIG 1D.



PREPARATION OF 10% CARBON MONOXIDE

(D.T.D. 922 A)

FIGS. 4A & 4B

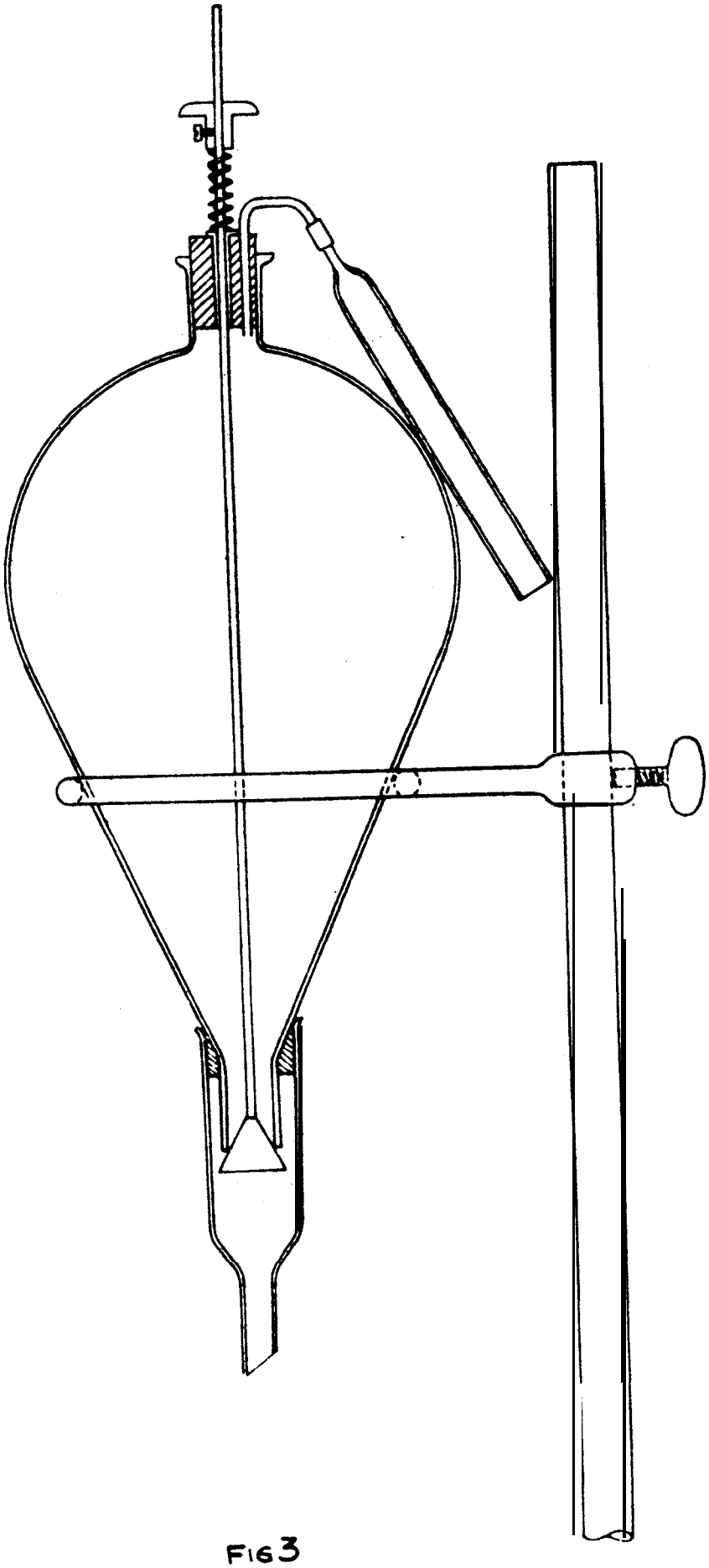


FIG 3

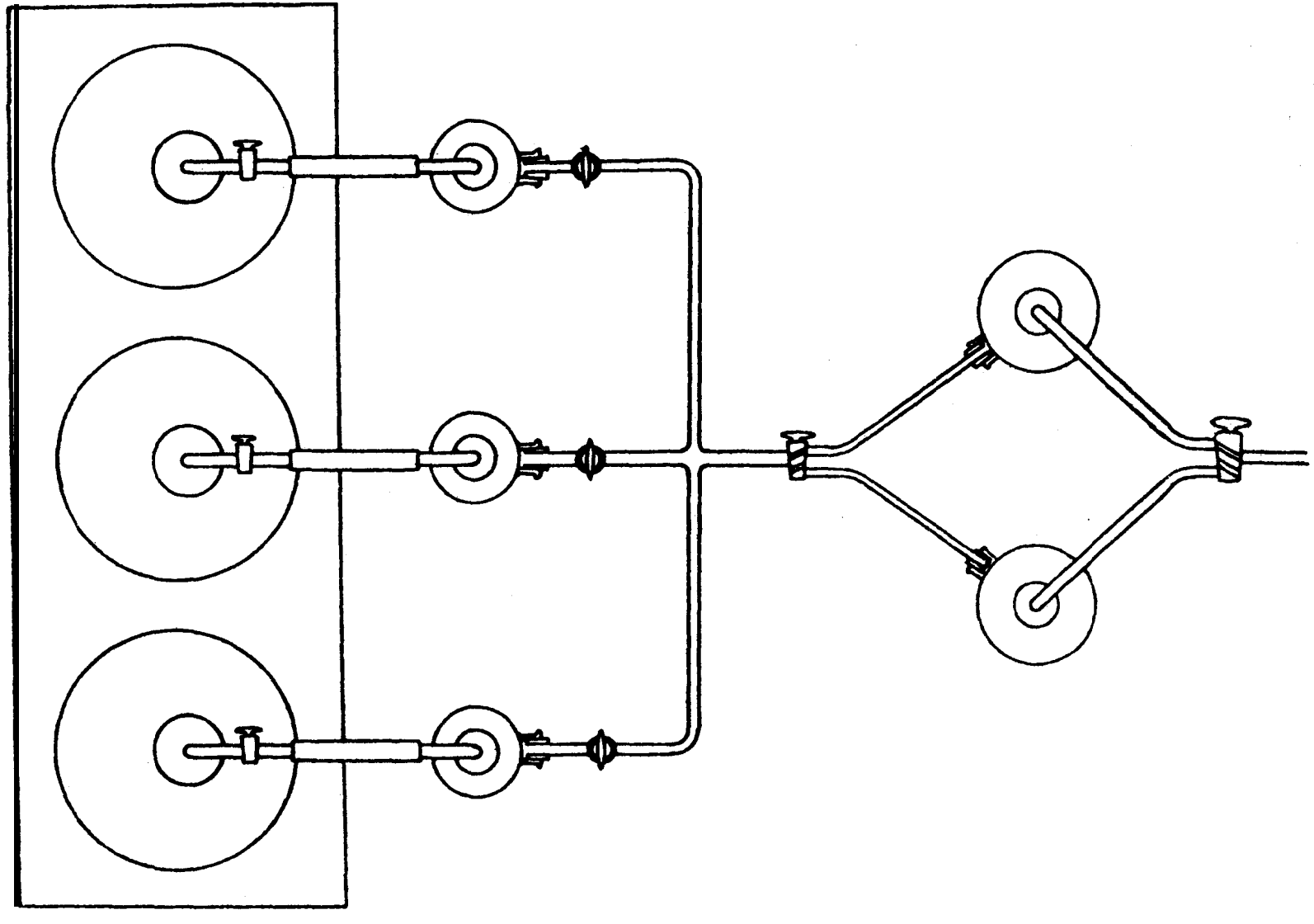


FIG 2A

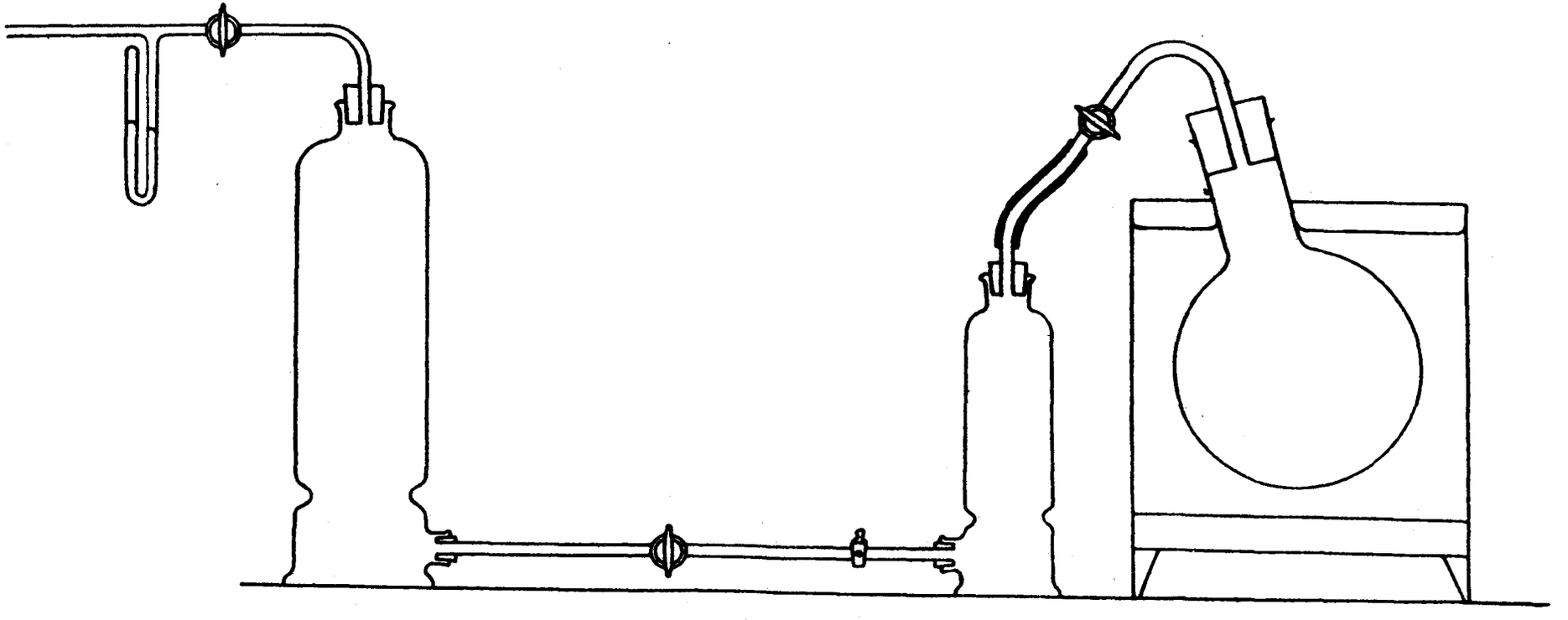
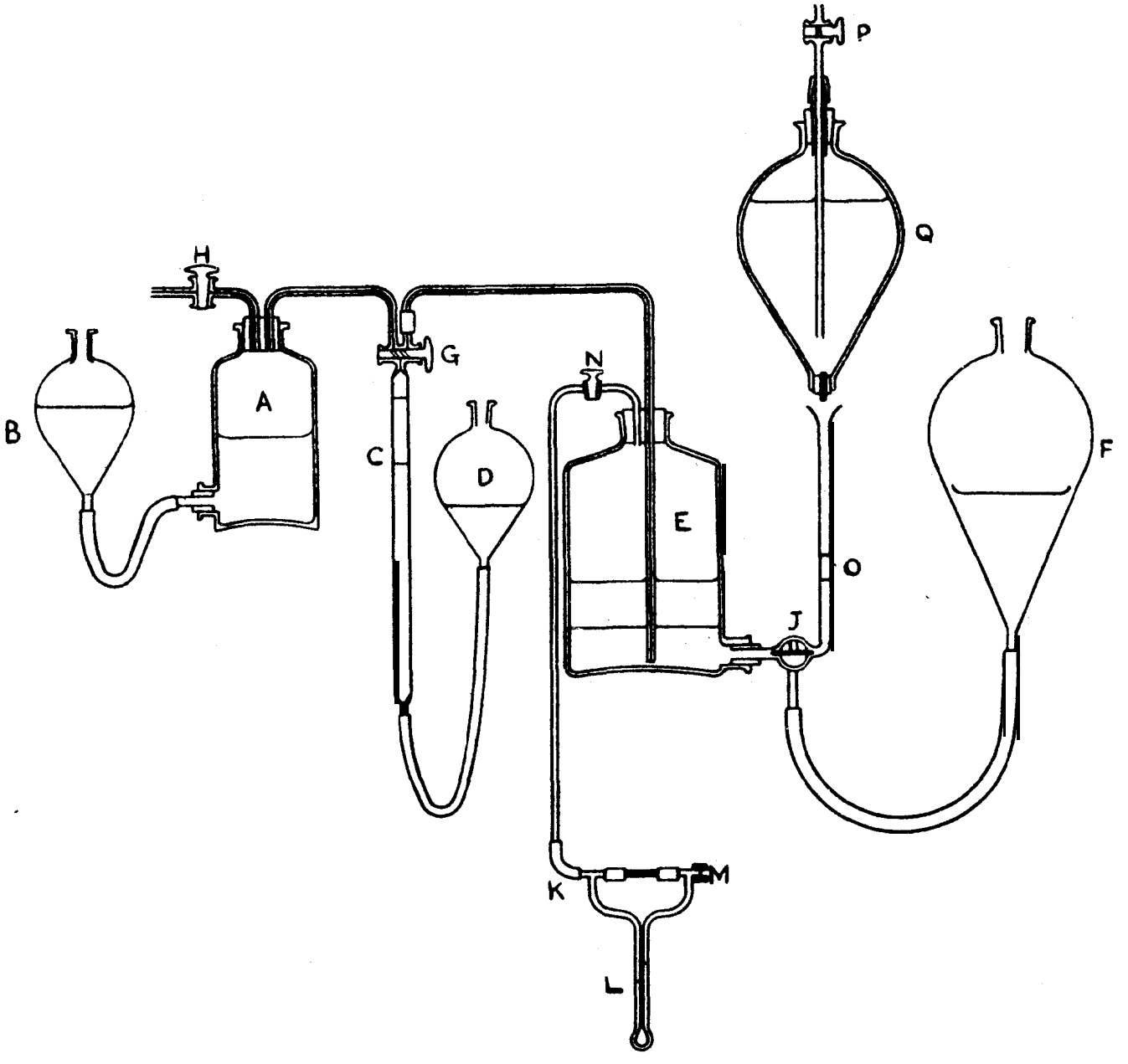


FIG 2B.



APPARATUS FOR CALIBRATING CARBON MONOXIDE INDICATOR TUBES.

FIG. 4C

(D.T.D. 922A)

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