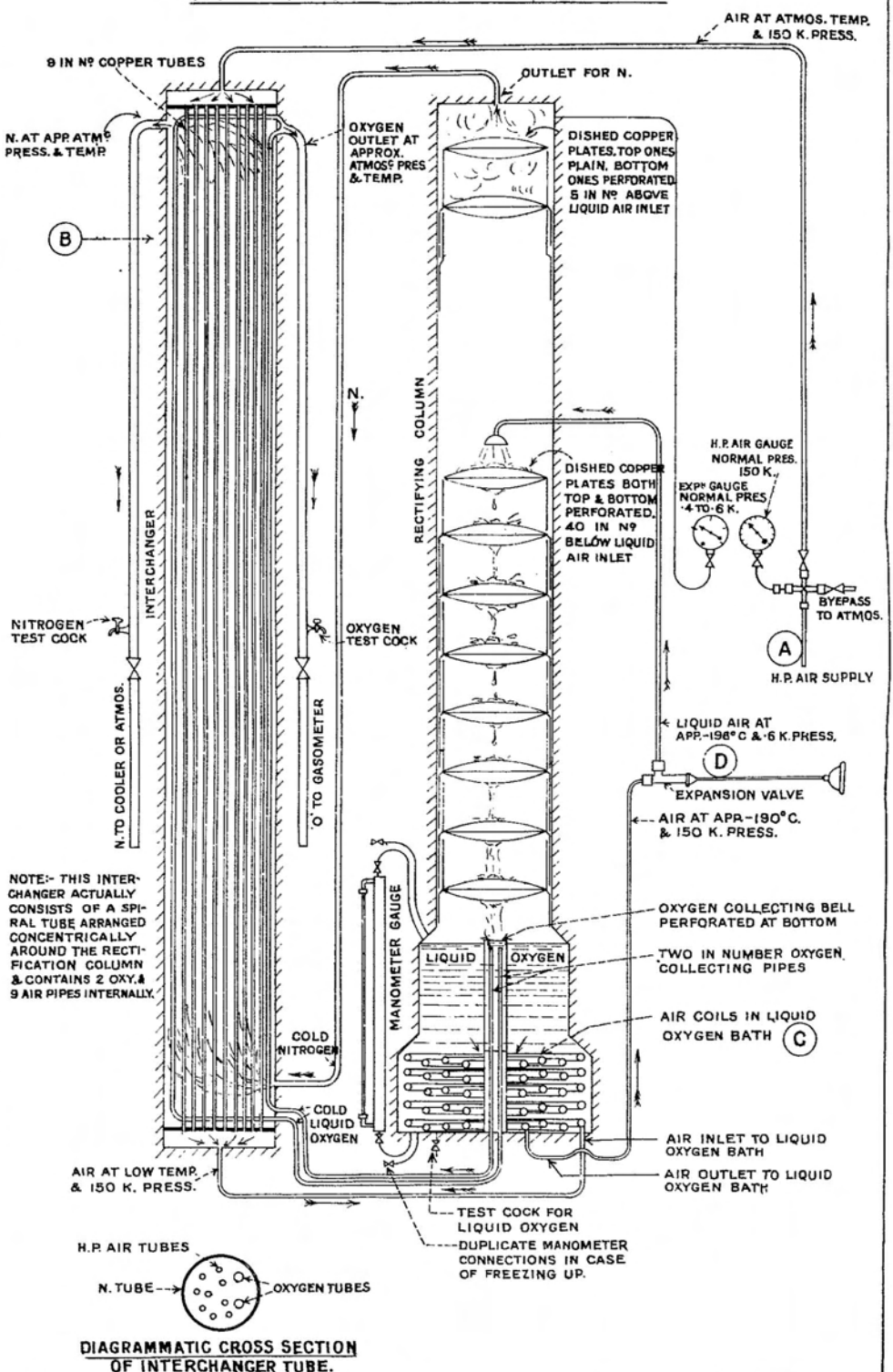
LIQUID AIR COLUMN.

AS SUPPLIED BY OXYLITHIC Coy FOR H.M. DOCKYARDS.

NOTE:- ARRANGEMENT IS DIAGRAMMATIC ONLY.



DIAGRAMMATIC CROSS SECTION OF INTERCHANGER TUBE.

W 224. C. WT 29661/8/D 58. 1,500. 2/22. J.W. LTD

THE MANUFACTURE OF OXYGEN FOR H.M. DOCKYARDS.

The extended application of oxy-acetylene welding for constructional and repair work has caused the question of the supply of oxygen to be of the greatest importance, and oxygen producing plants have been installed at Portsmouth, Devonport and Rosyth.

The two principal methods of producing oxygen commercially, are by the electrolytic process and by the liquefaction of air; the former has advantages in that the oxygen produced has a very high purity, but unless there is a demand for the hydrogen produced, it is very costly in comparison with the liquid air method. Consequently the latter method, which yields oxygen of about 98 per cent. or even higher purity as measured by the Standard commercial testing apparatus, the impurities consisting almost entirely of nitrogen, is almost invariably used.

The plants installed by the Admiralty are of the Jaubert type, the principle of which is as follows :—

Oxygen Column.

Air is compressed by an air compressor to an initial pressure of 150 kilos. per sq. cm. (equal to about 2,100 lbs. per sq. in.), cooled, dried and delivered to the oxygen column at " A," at about atmospheric temperature; thence it passes through tubes contained in an interchanger coil " B," thence to a coil contained in the lower portion of the rectifying column " C," which forms a bath, and then to an expansion valve " D," through which it is expanded down to a pressure of about ·6 kilos per sq. cm. (or about 8·5 lbs. per sq. in.), and passes downwards through a rose into the rectifying column.

Air not being a perfect gas does not follow the law $pv = ct.$, though it only differs from it very slightly, this very slight difference however is the principle on which the whole action of the column is based and causes the air to cool on expansion.

The air entering the rectifying column is therefore colder than the air before expansion. This cold air passes out of the top of the rectifying column through a pipe and passes to the bottom of the interchanger coil and there surrounds the tubes containing the high pressure air. It then flows out to the atmosphere through the coil in the opposite direction to the incoming air, thus reducing the temperature of the incoming air, which in turn expands through the expansion valve, and a continuous lowering of temperature thus proceeds until the temperature of liquefaction of air is reached. Liquid air is then discharged through the rose and falls through a series of perforated diaphragm plates in the rectifying column, the nitrogen, which has a point of liquefaction about 13° below that of oxygen, re-evaporating during the fall, and liquid which is practically pure oxygen forms in the bath at the base of the column. This liquid oxygen takes heat from the coil of high pressure air in the bath thereby further cooling the incoming air and a constant stream of practically

pure gaseous oxygen passes up the rectifying column meeting the falling liquid air and re-condensing, thus supplying the necessary heat for the re-evaporation of the nitrogen.

This action maintains the purity of the oxygen in the bath and a mixture of about 90 per cent. of nitrogen and 10 per cent. of oxygen passes out through the top of the rectifying column and interchanger by way of a pipe led out of the column and called the nitrogen pipe, through which the air passed out during the earlier stage of the operation when the cooling was taking place. When sufficient liquid has formed in the bath, liquid oxygen is drawn away by means of a pipe leading from the top of an inverted bell placed in the oxygen bath, to two pipes passing through the interchanger where it is evaporated, taking its heat of evaporation from the incoming air and is led away from the column through the oxygen pipe. The process then continues, the liquid being maintained at the right level by means of adjusting the ratio of expansion by the expansion valve, and the adjustment of the oxygen cock as necessary, until the column " freezes up " or is shut down purposely.

As soon as a steady condition is realised, a pressure of about 100 kilos. per sq. cm. (or 1,420 lbs. per sq. in.). is found to be sufficient on the high pressure side in order to maintain the balance of the column. The whole column is of course very thoroughly lagged with hair felt to prevent passage of heat from the surroundings into the column as far as possible.

Purification of the Air.

The purification of the air before entering the column is of the greatest importance as any moisture or CO_2, which is allowed to pass into the column, will at once freeze and it takes very little to choke the passages in the column and thus stop the action. The air is drawn by a Roots blower from the atmosphere at a point some distance above ground level, where the air should be as free as possible from CO_2, and is discharged through two scrubbers in series; each scrubber contains coke through which a stream of caustic soda solution of a specific gravity of about 20° Beaume is kept falling by means of a circulating pump, which draws the solution from the bottom of each scrubber and discharges it at the top. The air passing up through the coke meets the caustic soda solution which extracts the CO_2 from it. From the scrubbers the air passes through three ordinary mechanical separators where all traces of the caustic soda solution are removed as far as possible and thence to the suction side of the air compressor, which is a three-stage compressor of the ordinary type. On leaving the air compressor, the air passes through a separator and then through 8 steel cylinders in series, each containing calcium chloride which absorbs the moisture in the air, which is then ready to enter the oxygen column.

In spite of the greatest care it is impossible to eliminate all traces of CO_2 and moisture from the air, so that if run long enough

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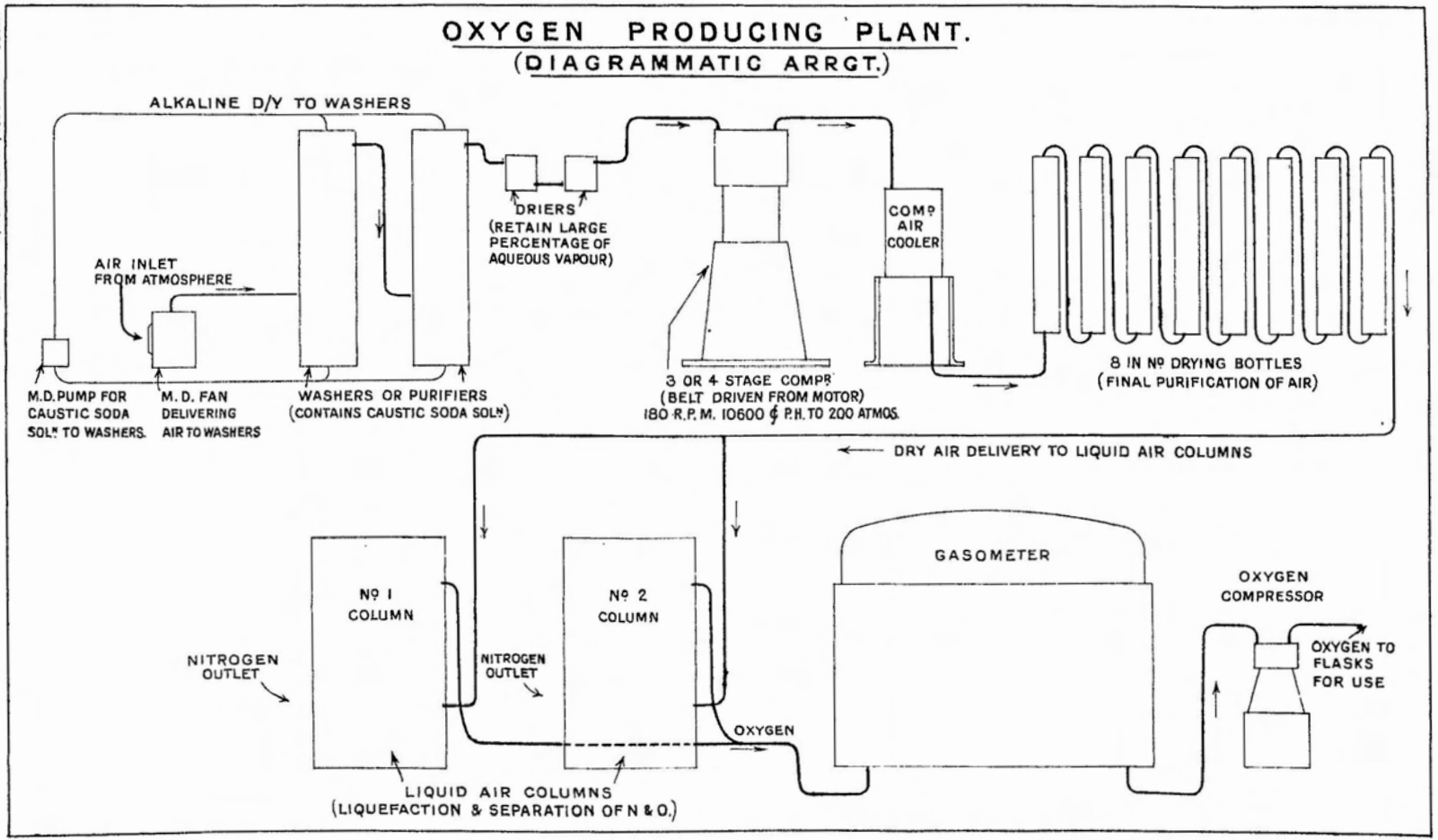
OXYGEN PRODUCING PLANT.

(DIAGRAMMATIC ARRGT.)



the column will eventually freeze up. The length of time a column will run is dependent on the atmospheric conditions; five days' continuous running appears to be quite a normal period, but it is stated that columns have run as much as fourteen days continuously, or even longer, under favourable conditions.

Bottling the Oxygen.

After leaving the column, the oxygen is led through a meter to measure the quantity produced, and then through a pipe to a gasometer, where it accumulates at just above atmospheric pressure. It is drawn from the gasometer by the oxygen compressor which delivers it into the storage cylinders at a pressure of 1,750 lbs. per sq. in.

When oxygen under high pressure comes into contact with the more readily combustible substances, spontaneous combustion takes place, hence it is necessary that the greatest care should be taken that the compressed oxygen should come into contact with no such substances.

No oil or grease must be used in the oxygen compressor cylinders, pure distilled water with a little glycerine if necessary only being used for internal lubrication, and all pipes, bottles, valves, pressure gauges, &c., must be absolutely free from grease or oil. Cases have occurred of new pressure gauges when used for compressed oxygen having exploded owing to grease having been left in the pressure gauge tube. Occasionally men have been injured by these explosions. Grease can be effectively removed from pressure gauge tubes by washing them out with ether.

Obviously oxygen cylinders must not be coated internally with oil or grease for preservation and grease must not be used when dealing with the valves of oxygen cylinders.

Regulation of the Column.

The regulation of the column requires considerable care and experience. The satisfactory working is entirely dependent on the temperature balance being maintained.

The cooling effect which is governed by the ratio of expansion is adjusted as necessary to maintain the correct liquid level and temperature of the bath. The temperature of the bath directly effects the purity of the gas.

The liquefaction temperatures of a mixture of oxygen and nitrogen varies according to the proportion of each gas. At atmospheric pressure the temperature varies from $-182{\cdot}5^{\circ}$ C. for pure oxygen to $-195{\cdot}6^{\circ}$ C. for pure nitrogen; it will be seen, therefore, that it is necessary, in order to ensure the purity of the oxygen, that the temperature should be kept as high as possible consistent with maintaining the requisite amount of liquid in the bath. In actual practice with the normal expansion pressure of 600 to 700 grammes per sq. cm., the temperature in the bath is kept at about -174° C., and the purity of the gas

falls if the temperature is allowed to fall appreciably below that. The pressures and ratio of expansion are regulated by means of the expansion valve, but good results are also obtained at times by partially closing the oxygen cock which has the effect of causing less oxygen to be withdrawn from the bath, raising the liquid level and thus causing more oxygen to be evaporated in the rectifying column.

General.

The nitrogen given off from the process contains 8 to 10 per cent. of oxygen and is not sufficiently pure to be of any commercial value. The purity cannot be improved without impairing the purity of the oxygen. In the Admiralty plants, however, the gas issuing from the nitrogen pipe is passed through an economiser where its lowered temperature is made use of to cool the circulating water for cooling the H.P. air in an aftercooler, between the air compressor and the drying flasks.

Before commencing a run, the column is dried out by passing air through it from the compressor, which is heated by means of a blow lamp or gas forge playing on a coil in the air pipe just before its passage into the column.

This is accomplished by removing a small screwed plug, which is situated below the main regulating valve. The latter is kept closed until the discharged air is perfectly dry, the time taken being usually 1½ hours. The purge plug is then re-inserted. Dry hot air is then passed through the column and escapes by the nitrogen, oxygen and liquid level pipes for a period of about 1 hour. The blow lamp or gas forge is then extinguished and the temperature reduction commenced.

Liquid air can be drawn from the column by means of a draw off valve placed immediately after the expansion valve, but this has to be very carefully done as it disturbs the heat balance of the column. In order to show the height of liquid in the bath small pipes are led from the top and bottom of the bath to two air vessels connected together by a gauge glass tube, the lower vessel being partially filled with water with a little colouring matter. The head of liquid oxygen will cause a difference in pressure in the two air vessels, and this difference in pressure causes the liquid to rise to a corresponding height in the gauge glass.

The purity of the oxygen produced is measured by a very simple instrument. A sample of the gas is drawn off in a bladder, and passed into a graduated tube until 100 cc. of gas at atmospheric pressure are contained in the tube. The gas is then passed over to another vessel containing coils of very fine copper wire, immersed in a solution of ammonia and ammonium carbonate. In passing the gas into the vessel, the solution is displaced, leaving only a thin film on the copper coils. The oxygen gas combines with the copper, and the oxide so formed is immediately dissolved off by the solution, thus exposing a fresh surface of the copper to contact with the gas.

After a few minutes all the oxygen is absorbed out of the gas. The remaining gas is then passed back into the graduated tube, and the quantity gives the amount of impurity contained in the sample.

The ammonia solution then refills the flask ready for the next test.

A high purity of oxygen is more necessary for cutting than for welding, but experience has shown that a purity of 97 to 98 per cent. gives very good results.