The roof of the condenser is conical in form, and the air is drawn off from the centre. There is no doubt that this arrangement is the most efficient, as it quite definitely prohibits air locking; the air brought in with the water is most effectively collected from the surface, and this is a most important point, for it is obviously undesirable to allow the air to become heated, and so increased in volume, whilst the air is also evenly drawn from the whole area of the body of the condenser. In the figure under review, it will be observed that the air is finally drawn off to the pump through an auxiliary condenser or cooler, this device consisting of an inverted fine jet spray, which is regulated to act primarily as a final air cooler, and secondly to supply lubricating water to the valves of the pumps. In some cases tubular coolers, similar in construction to small surface condensers, are installed, through which the whole, or part of the injection water, is passed on its way to the condenser. Such coolers are of undoubted benefit if carefully operated, but if not, there is always the risk that excessive water may be used and consequently instead of being useful, they unnecessarily add to the quantity of air to be withdrawn by the pump. With very careful adjustment, there is no reason why the final injection water temperature should not be the same as that of the vacuum, as herein lies the economy of counter current condensing, but in sugar factories the rate of condensing varies to some extent, so that it is desirable to fix upon a temperature a few degrees lower.

It is almost unnecessary to mention the usefulness of man and handholes at certain points in a condenser, whilst the provision of light and sight glasses for observing the behaviour of the condensing water within will often lead to the detection of obstructions or other faults that otherwise might go unnoticed.

It is outside the scope of these notes to enter into a full discussion of the theoretical considerations required in the design of counter current condensers, but obviously the most important points are the diameter and the height. The latter has been dealt with, although rather superficially, and only in a similar manner will the diameter be referred to.

From calculations based on the pressure of the rising steam acting on the falling water, which is a governing factor in this type of condenser, it will be found that condensers without steps should be approximately 50% larger in diameter than the steam inlet, providing, of course, that the latter is reasonably designed for ordinary exhaust steam velocities. For condensers with steps or obstructions due allowance for these should be made. For condensers with woven wire water breaks there seems no good reason why more than the actual area of obstruction should be allowed for. These remarks apply to the diameter of the condenser where the steam enters, and if it is practicable, there is no reason why the body of a condenser should not be tapered towards the air outlet, but the parallel circular form is so convenient for manufacture and provides such ample area for the perforations in the spray plate, that it is the most usual.

In an earlier Figure, 13, was seen a condenser that was partly parallel and partly counter current in its action. The writer knows of no theoretical reason why such a combination should be better than the simple counter current, although by doing so in the condenser in question the condition of reduced air volume already referred to is made use of. In the next Figure, 19, however, there is a reason for the com-

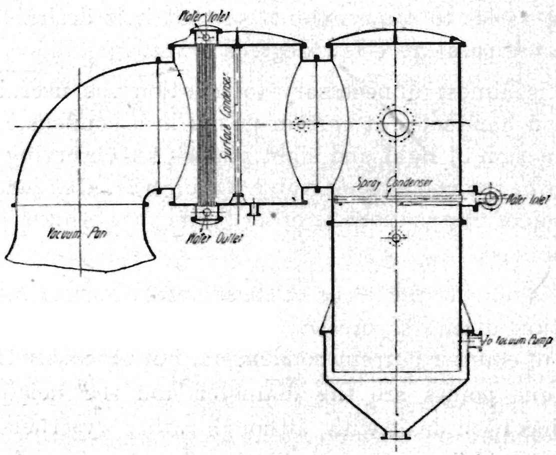


Fig 19.

bination of surface and jet condensers, although from a condensing point of view the arrangement cannot be very economical. The surface condensing tubes in this instance are principally to act as intercepters or baffles to prevent entrained particles of sugar from being carried over to the jet condenser and so lost. Many similar means are adopted for this important purpose, but generally solid plates or bars are used—the surface condenser in question is an expensive means, but is an interesting development, although not new.

In referring to the ejector condenser, it is to be understood that the true ejector type is meant, i.e., the one in which the whole of the air is drawn off by induction and no air pump is required.

There are many condensers in use which partly make use of the ejector action, but from which the bulk of the air is drawn off by an air pump. Such a condenser is illustrated in the next Figure, 20, which shows the "Alberger" con-

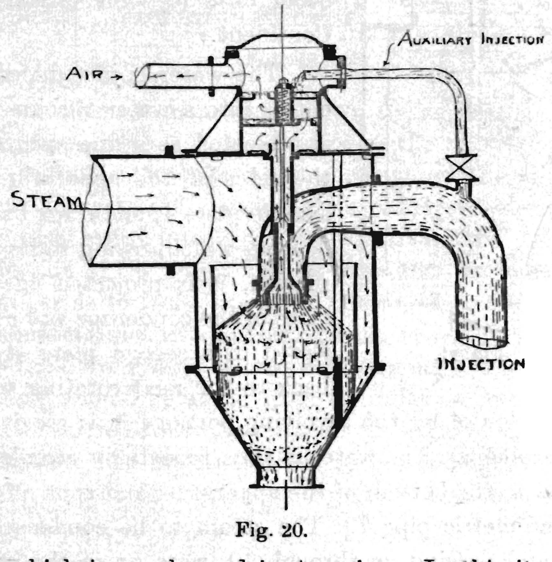


Fig. 20.

denser, which is much used in America. In this it will be noticed that inside the body of the condenser there is fitted an open ended cylinder, between which and the body of the condenser there is formed an annular space, the area of which is nearly equal to the area of the steam inlet pipe. Part of the steam passes down through this annular space, where it meets a sheet of water falling from the inner cylinder, is condensed, and the air carried off by the water. The bulk of the air is drawn up through the centre of the condenser in the manner shown by the arrows.

Although the cost of a good condenser is usually warranted, there does seem a tendency latterly towards the complication of the "jet" type. As an instance of such, Figure 21 is interesting. Doubtless, the results would be satisfactory, but it is quite certain that equally good could be obtained by a simple, well-designed condenser.

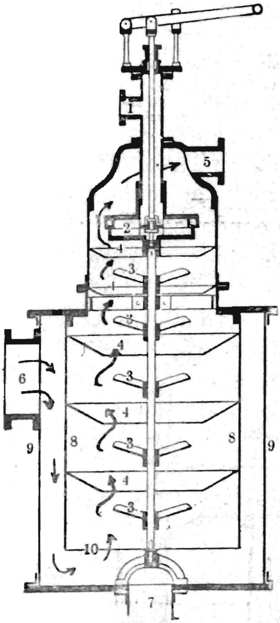


Fig. 21.

The condenser illustrated is being used to some extent on the Continent.

The water is introduced at (1), enters into a water turbine (2), and is projected as a fine spray against the sides of the apparatus; it collects in plate 4, and flows back upon 3, from which, owing to its rotating motion, it is projected against the sides of the condenser and again collected in a second plate, 4, to run back to the next rotating tray, etc. The motion of all the revolving portions 3, is received from the turbine 2. The water is thus repeatedly atomized from the top to the bottom of the apparatus, and runs off through the barometric pipe 7. The steam to be condensed enters at 6, and passing up through 10, rises up in the condenser through the successive showers of water, the air being drawn off through 5 by the air pump.

The aggravation caused by air leakage into vacuum apparatus needs no further description here, and although it is unavoidable to a certain extent, it is within reasonable bounds preventable. Joints carefully designed and made are the main factors, whilst the amount that is sent to a condenser in the injection water can be considerably reduced by careful handling of the water before it reaches the condensers.

In the injection supply tank shown in Figure 22,

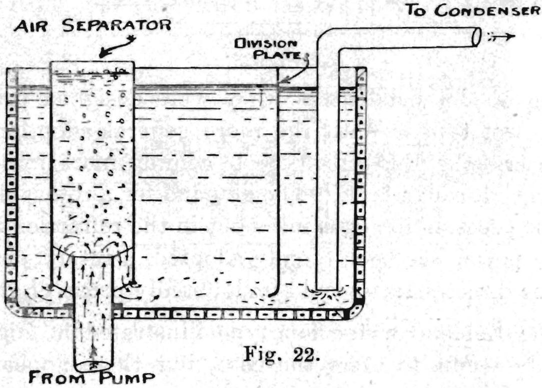


Fig. 22.

simple, yet effective means are shown for separating out as much air as possible. In the first place the tank is as large as it is profitable to make it, so as to afford the air every chance to separate out naturally; secondly, the injection water is discharged into a casing, which has for its object the projection of the water and its entrained air upwards in such manner as to assist the air bubbles to follow their physical inclination and rise to the surface, the water escaping into the tank from the bottom of the casing. The division plate shown should be as far from the inlet as possible, and it should be carried down to within a few inches of the bottom of the tanks. The injection pipes to the condensers would draw from the bottom of the compartment formed by the division plate.

A few remarks only will be made in reference to air pumps for sugar factory plant. The most extensively adopted hitherto has been the wet, displacement, or torpedo plunger type, illustrated in an earlier view, but of which Figure 23 shows a section, and although many of them are

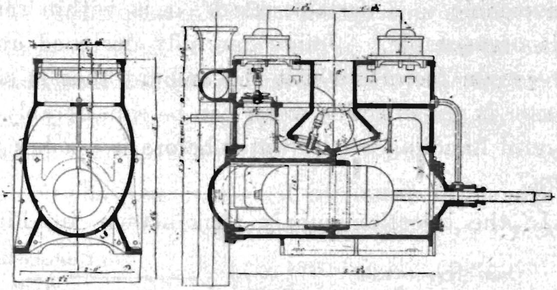


Fig 23.

working on dry condensers, they were designed principally for the wet type. With the more general adoption of dry condensers, the Edwards type is coming more into use, as also the slide valve type. The demand for a rotary air pump is not so pressing in sugar mills, but in the refineries in which electric power has been largely adopted, a rotary pump that could be direct driven would undoubtedly prove of great use.

The Leblanc water fan type illustrated in Figure 24, certainly seems to meet the case, but there appears to be

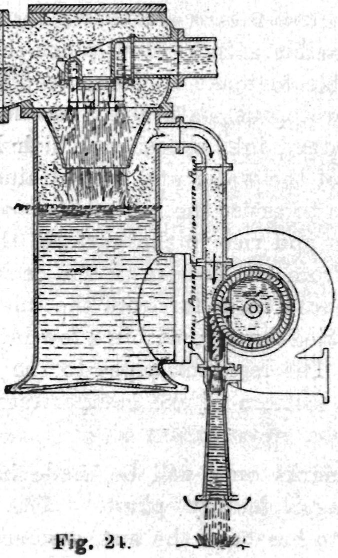


Fig. 24.

some doubt as to its overall efficiency compared with the older types of machines. A decidedly interesting rotary air pump is the "Rotrex," made by the Wheeler Co. of America. It is illustrated in section in Figure 25, from which it will be seen that it resembles the many designs of eccentrically revolving drums for air compression. It differs principally from them in so far as that the drum never comes in actual contact with the sides of the pump body; a definite clearance is maintained which is water sealed. These pumps are in use in connection with vacuum pans, but the writer has no personal knowledge of

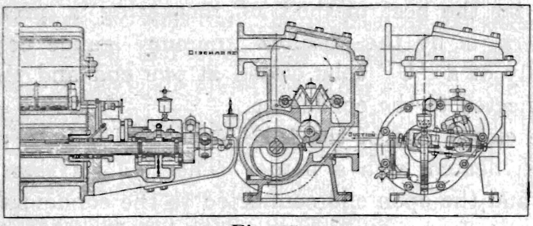


Fig. 25.

the results obtained. A general arrangement of a complete condensing plant, for which a steam driven circulating and Rotrex air pump are combined, is shown in the next Figure 26.

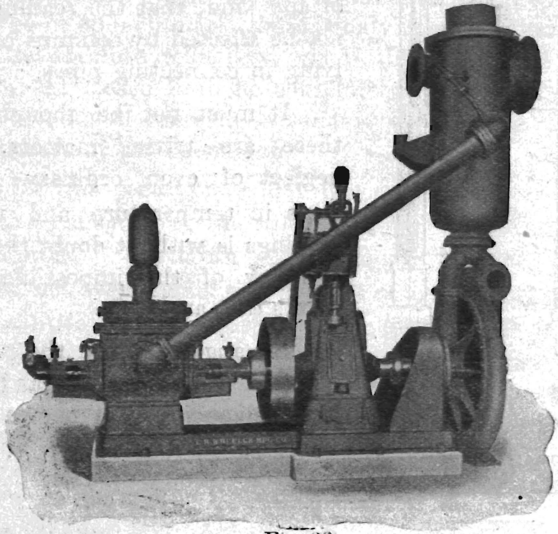


Fig. 26.

Measurement of vacuum by the ordinary dial (Bourdon Tube) gauges is by far the most common method, but it is not only inconvenient because a simultaneous reading of the barometer is required, but is also unreliable because these gauges are rarely found in adjustment, or to remain adjusted.

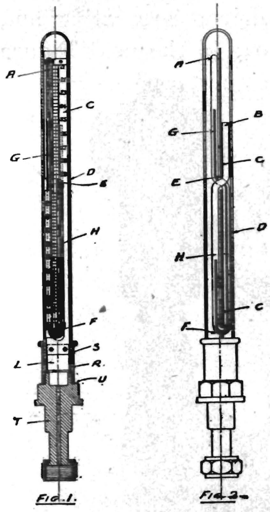
Measurement by full length mercury column, where both it and the barometer are carefully read and precautions taken to have pure, clean mercury, can be made with scientific accuracy, but there is room for error even in this method.

By far the best method of measuring a pressure in condensers, is by the absolute mercury gauge comprised essentially of a "U" tube closed at one end and the other end connected to the condenser.

The closed end of the tube is first filled with mercury and then heated with a flame. The "U" is then turned upright and the open end connected to the condenser. Since there is an absolute vacuum in the closed end of the "U" tube, the difference in level of mercury in the two limbs is the absolute pressure. Care must be taken in connecting vacuum gauges of any kind, that the readings may not be affected by columns of water lying in connecting pipes.

It must not be thought that these are trivial matters. The neglect of even ordinary precautions in temperature and vacuum readings is without doubt the cause of many of the impossible statements that are made.

A gauge in which the principle of the closed "U" tube has been ingeniously adapted is shown in the last Figure, 27, which illustrates the invention of Mr. N. M. Thomas, a chemist in the C.S.R. Co.



'THOMAS' PATENT.
ABSOLUTE VACUUM GAUGE.
No 24661.

Fig. 27.

A is the sealed end of the U tube, and B the open end; C is the scale plate on which the tube is mounted, and has an aperture or notch at E to receive the legs of the tube at the point where these are bent across each other. Another notch at F receives the lower bend of the tube. D is a stout glass casing cylinder cemented into the metal collar R, which is screwed on to the union piece T, with a gasket at U to form an air-tight joint. The hole through the union piece gives communication between the interior of the gauge casing and the condenser or other vessel to which it is coupled. The essentially original feature of this gauge is the crossing of the limbs at E, so that only the registering portions (G and H) of the closed and open legs respectively, are exposed on the face of the scale plate, the other portions lying behind the plate. This construction and mounting of the tube economises the space needed on the scale face for clearness and simplicity of reading, and reduces the gauge to an instrument of very neat and handy proportions.

A special feature of this gauge, is the double reading scale, whereby the self-checking possibilities of the closed U tube are availed of. With air-tight connections, and with correct graduation of the scale in half-inches both ways from the centre or 30 inch mark, there is only one condition essential to its absolute reliability, viz. :—that when not under vacuum, the closed limb be completely filled with an unbroken column of mercury extending beyond the U bend into the base of the open limb.

Under this condition, which can be readily verified at any time by inspection, the true vacuum is the mean of the two readings. The latter are of course designed to be identical, but even should they get out of agreement, as from loss of a little mercury, displacement of the tube from its correct place on the scale, unevenness in the bore of the tube, or from any cause outside the condition above-mentioned, the mean of the two readings will still infallibly represent the degree of vacuum inside the gauge casing, expressed in relation to the usual standard of 30 inches for absolute vacuum.