arranging a raw sugar factory on the Clarence River, and there was a scarcity of fresh water. The new triple effet apparatus installed contained 14,000 sq. feet of heating surface, and the surface condenser was designed to condense 10 lbs. of steam per sq. foot of cooling surface; this apparatus worked satisfactorily and maintained a vacuum of 27 to $27\frac{1}{2}''$. The air pump $19\frac{5}{8}''$ diam. × $24''$ st. × 50 revs. per minute, was one that had formerly been attached to a triple effet containing 3000 sq. feet heating surface and worked with a jet condenser, from which all of the condensing water was voided by the pump, and it could barely maintain a vacuum of $25''$. It was, however, able to maintain a vacuum of $27\frac{1}{2}''$ when working in connection with the surface condenser on an apparatus with four and half times greater heating surface.

The central surface condenser referred to in the paper was designed with a view of keeping the circulating cooling water and the water of condensation separate, on account of drainage difficulties. However, experience in working the factory showed that no serious trouble arose, thus allowing them to mix, and pass over the cooling tower. The surface condenser was, as the author described, therefore dismantled and independent condensers fitted to each of the evaporating vessels, with a decided improvement in the working of the vacuum pans and multiple effet.

The central condensing system had not made much progress in sugar factories mainly on account of the troubles mentioned in the paper.

The author had given particulars of various types of condensers, several of which were probably familiar to members, and it was obvious that they were all designed to break up the water as much as possible, and so present a large surface for the steam to come in contact with.

In sugar factories the torricellean pipe was always used with the condenser when practicable, as by this means the air pump had only to void the air, and it could be of smaller size than it had to void both air and water.

The counter current jet condenser was one of the most efficient so far as the quantity of water was concerned, but it had the disadvantage of retarding the passage of the air, liberated from the water, to the air pump, unless the air was drawn off at various points. This resistance to the passage of the air in some cases amounted to a difference in vacuum between the bottom of the condenser and the air pump of $\frac{1}{2}''$ to 1″ of mercury. He was inclined to the view that the "safe" or "waggon" type mentioned in the paper was the most efficient, as the passage of the steam under the dispersion plate was across the direction of the condensing water jets, and the air passing into the condenser along with the steam, and also that liberated from the water had a free passage to the air pump.

From long experience in the working of condensers, he had found, as the author strongly pointed out, that the main feature to be observed in efficient condensation was to atomise or spray the water as finely as possible, and to thereby present a large water surface for condensing the steam. The condensation of steam in contact with water was practically instantaneous, and if the condensing water was finely sprayed, the area of the condenser need not be large; in fact very little larger than the vapour pipe. From observations made on an ordinary type of jet condenser in which the water was sprayed from a perforated vertical pipe, the velocity of the steam entering the condenser was about 12,000 feet per minute, the time taken to condense the steam he estimated was about the 1/300th part of a second.

The quantity of water that would pass through a given sized hole was fairly accurately determined by the formula given in the paper, provided that the shape of the hole and the velocity head was accurately measured. However, in the case of water flowing through the dispersion plate of a condenser, the flow was somewhat interfered with by the liberation and expansion of the air in the water, as the jets pass through the holes. It should be remembered that water in volume under the influence of vacuum would not part readily with the air in suspension, but if it be broken up into a fine spray the air was very readily liberated.

The importance of an efficient type of condenser to secure condensing water economy was admitted, but it was also equally important to have an efficient air pump and thorough air tightness in all the joints and connections. In Figure 5 of the paper, which gave the results of tests made to determine the air tightness of vacuum pans, it would be interesting if the author gave the volume of air leaking into the pans during the test; this could be done by finding the volume of the space under vacuum and calculating the volume of air required to reduce the vacuum by say 1″.

A useful check upon the working of a condensing plant and ready method of determining the relative amount of air leaking into it was to ascertain the vacuum efficiency of the system, or the ratio between the vacuum actually obtained, and the theoretical vacuum corresponding with the condenser temperature as measured by that of the water flowing from the condenser.

$$\text{Vacuum efficiency (per cent.)} = \frac{\text{Actual Vacuum} \times 100.}{\text{Vacuum corresponding with temperature of air pump discharge.}}$$

Tested by this standard, surface condensing plants, where special attention was given to airtightness, have shown an an efficiency of 99 to 99.5 %.

Referring to the Table Figure 5, No. 2 pan tests $= \frac{28{\cdot}5}{29{\cdot}83} \times 100 = 92.20$ %, and pan No. 8 $\frac{27{\cdot}75}{29{\cdot}91} = 92.78$ % apparent efficiency; the actual efficiency could not be determined without knowing the temperature of the air pump discharge water.

With an efficient air pump, the vacuum efficiency of a jet condensing system and Torricellian pipe to carry off the water should reach 97.5 to 98 %, if the system be thoroughly airtight.

There were quite a number of types of airpumps in use in sugar factories, and provided they were well designed and the piston or plunger speed be not too high, they gave very good results. An important point to be observed was to keep the plunger or piston and all glands water sealed, and to make the passages for the water and air of ample size to allow of free flow.

He did not quite follow Mr. Stobo in his remarks about explosions on sinking steamers, but he would say that it was the celebrated Zera Colburn, who was the first to point out the improbability of trouble occurring in connection with boilers by sudden contact with cold water. The idea was at first poohpoohed, but they had probably all read about the tests made by the Corporation of Manchester in this connection, to show that there was no danger. As a consequence, he felt quite sure that no explosion of the boilers took place when vessels sank. Mr. Stobo also referred to the reduction in the size of air pipes. There was no doubt the practice in sugar factories had been to make the vapour pipes rather large, but that was done with a view to reduce the loss of vacuum.

In Figure 12, the author drew attention to a device for facilitating the separation of the air and water, with a view to prevent the air from getting into the condenser; this was an important point where high vacua were required.

He considered that the thanks of the Association were due to the author for his interesting and highly instructive paper.

Mr. Henry Shaw remarked that the introductory passages of the paper showed them what an extremely happy condition of working existed, when a manufacturing firm was able, after using steam for power purposes, to further utilize it for evaporating, boiling, and the like. When the main operation was evaporation, power became, not exactly a by-product, but at least exceedingly cheap. Such a fact, he thought, gave encouragement for dissimilar trade amalgamations, where upon the one side power, and upon the other, evaporation was sought after, or required.

The author had in a very interesting and instructive manner set before them quite a variety of types of condensers, all of which no doubt possessed some advantages under certain circumstances, and there was an application of the condenser principle which was familiar to all who live in touch with sugar machinery, and which it may be of interest to again refer to. He referred to the multiple effet in which were utilized a number of surface condensers arranged in series for the purpose of evaporating light sugar and other liquors. A series of 3 or more vessels may be used, the vapour driven off from the first of the series being condensed in the second and from the second in the third, and so on. Mr. Kidd referred to the effet apparatus, but it had not been brought out clearly that such was practically a series of condensers. By such an arrangement, too, it was claimed, 1 lb. of steam by weight would evaporate approximately 1 lb. of water in as many vessels as constitute the series.

The author had mentioned the barometric column in connection with a jet condenser; this was no doubt a very convenient way of getting rid of the condensing water automatically, and thus dispense with the expense of pumping it by means of a voiding pump. It was, he believed, coming more generally into use. There was, however, the expense of elevating the condensing water to the condenser, which of course should be situated at least 34 ft. above the level of the barometric column discharge. This expense may be a considerable item where the plant is a large one, as at Pyrmont Refinery, where a 260 H.P. centrifugal pumping set was employed exclusively on this duty. The principal desiderata in designing a jet condenser are a fine division of the condensing water, a uniform distribution of the shower throughout the vapour space of the condenser, and sufficient time in which the heat transfer between the condensing water and steam may be effected. The illustration furnished by the author of the sub-division obtained by subjecting the shower to what may be termed a woven wire diaphragm was interesting. In some respects it was reminiscent of an anti-splash device used occasionally in connection with an ordinary bibcock in which a fine wire mesh was introduced for the purpose of consolidating the stream by capilliary action. In that device, however, the object attained was the antithesis of that aimed at by the introduction of a woven wire mesh into a condenser, and it seemed to him that considerable importance must attach to the size of the mesh if the best results were to be obtained. If on the one hand the mesh was too small, capilliary attraction might defeat the object aimed at—if too large, it might be practically useless for disintegrating purposes. Possibly the author might be able to inform them what size of mesh had been found most suitable, and how it withstood the corrosive action of salt water. Then with regard to the disintegration of the shower whereby a uniform distribution and intermingling of the vapour and water was aimed at, it appeared to him that the vapour being in an extremely attenuated and sensitive condition, within limits the larger the individual drops composing the shower, the greater the stability of flow of the vapour, and as a consequence the less likelihood of short circuiting. It would be interesting to know what was the efficiency of some of the condensers described, as compared with a mechanical mixture.

In conclusion, he would like to express the enjoyment he had experienced in listening to the author's paper. In his opinion, both it and the slides, had proved most interesting and instructive.