of the cooling water and t the temperature of the hot well, and Q the quantity of cooling water per pound of water in the steam.

Then $Q = \frac{T - t}{t - T}$. This is the number of lbs. of cooling water for each lb. of water in the steam. Example: Find the amount of injection water required. Exhaust 19½ lbs. injection water, 60; hot well, 110:

$$\frac{1182.1 - 110}{110 - 60} = 21.44, \text{ or } \frac{1114 + .3 \times 227 - 110}{110 - 60} = 21.44.$$

Pressure began to rise above 35 lbs.; the jet condenser was abandoned, and the surface condenser began to take its place. One of the principal causes was on account of the feed water carrying so much salt, which, as the water in the boiler was evaporated, became so saturated as to be eventually deposited on the plates, and thus destroy the boiler. The only way to avoid this was to blow off some of the brine and feed in some with less salt. The hot water blown away caused a large loss of heat, varying according to the different degrees of saturation. The maximum density is three times that of sea water. The loss was generally from 12 to 15 per cent. of the fuel supply. In order to stop this loss it became necessary to feed the boilers with fresh water. This could only be done by keeping the steam and condensing water separated, and this led to the surface condenser. Another reason was that in order to effect any considerable economy in the engine, it became necessary to raise the steam pressure. Now if the pressure be raised above 35 lbs., the temperature of which is 280, the sulphate of lime in the sea water is deposited in hard insoluble layers on the heating surface, and destroys its efficiency. To obviate this, it became necessary to use fresh water, which was another reason for the surface condenser.

The amount of water required with a surface condenser is from 30 to 40 per cent. greater than with a jet condenser. *In experiment, it was found that sheet copper* backed by water condensed from 21 to 50 lbs., and under special conditions 100 lbs. per square foot per hour. It is usual, however, to allow only 12 to 13 lbs. per square foot per hour, for ordinary compound engines. In a surface condenser, the circulating water must be kept in constant circulation to realize the greatest efficiency by keeping up as great a difference of temperature between the two sides of the plates. The air pump, with the surface condenser, is much smaller than with the jet; but the condenser is much larger, heavier and more costly than the jet.

The amount of cooling surface allowed per h.-p. varies from 1¾ to 3 square feet, but is usually 2 or 2½. The surface used is now always brass tubing. In former times copper tubing was used, as it was such a good conductor of heat, and had the qualities to resist the varying strains and temperatures, and it could be drawn out very thin; but it was found that the acids from the fatty matter used in cylinders dissolved some of the copper, and formed soluble copper salts which was fed into the boilers with the feed water, and did great damage to the boiler. This gave the surface condenser a set back, as the saving was offset by the extra wear and tear on the boilers. To prevent this, the tubes were coated with tin inside and out, and this partly prevented the trouble, but not altogether. Brass tubes were tried, and after getting the proper mixture proved a perfect success. Much has been said about the corrosive action of distilled water; but most of the trouble from pitting and corrosion in boilers and their fittings using distilled water has been found to be the action of the water on something else, and the matter formed is what does the damage to the boiler.

Before closing with condensers, I will say a few words about the necessary complement of the condenser, the air pump, of which there are different types. The most efficient, the writer believes, is the single acting vertical pump, having valves in the bucket, as well as foot and delivery valves. This is a very familiar form of pump. Another is the double acting, made both vertical and horizontal, having a piston with foot and delivery valves at each end. In most of the stationary plants the air pump is of this type and driven by an independent steam cylinder. This is a good arrangement, as a vacuum can be produced before starting the main engine. The disadvantage is, it is the most wasteful way of operating the pump. In marine engines the pump is usually driven from the cross-head and is generally single acting. The advantage of this arrangement is the pump is driven at least expense for power. The efficiency of the single acting pump is due to its certainty of taking the water through the bucket valves, and to the certainty of the valves closing, due to their position; also the valves are always flooded with water and the clearage may be reduced to a minimum.

The size of the air pump can be calculated theoretically, and it has been found that the single-acting pump, working under favorable conditions, has an efficiency of .6 and varies to .4. The efficiency of the double-acting pump may be taken as from .5 to .3. The size may be taken as three times what theory demands. With a surface condenser there is also a circulating pump to circulate the water through the tubes. In stationary work, the pumps are arranged with the steam cylinder in the middle, with the air-pump at one end and circulating pump at the other, all on one rod. In marine work some use an independent pump, either an ordinary double-acting plunger or a centrifugal pump. Others use a single or double-acting pump driven from the main engine. The capacity of the circulating pump may be calculated the same way as the air-pump. The centrifugal pump has many advantages as a circulating pump, if the lift is not great. It has no valves to interfere with the flow of water or get out of order. Being worked by a separate engine, it can be started before the main engine, and keeps the condenser cool while warming up. Having an independent engine, the quantity of water may be varied to suit conditions, the power to run it varying in proportion. The supply of water is continuous, thereby avoiding all shock to the condenser and piping, and its efficiency is greater for low lifts than any reciprocating pump.

Another type of condenser I will just mention is the ejector condenser, which is perfectly satisfactory under certain conditions. The principle on which it works is the same as the ejector, but the water should have a small head to make it work satisfactorily when as good a vacuum can be maintained as with any other type. The water should not be over 60°, although it has been used at a higher temperature. The rise in temperature is usually about 20 or 25°, but in experiments it has been raised 60 to 64 with a final temperature of 120°, but under these conditions the vacuum fell considerably. In this type the power to run the air pump is saved; these condensers have also been made to lift their own water, but under these conditions they are unreliable.

The Carlisle Packing Company, Victoria, B.C., is now exporting canned salmon in tin cans which have a porcelain lining. If these cans can be produced at a reasonable price, their use should enormously extend the Canadian trade in canned fish, fruits, etc., as in this way the goods could be indefinitely preserved without danger of becoming poisoned by the corrosion of the can.