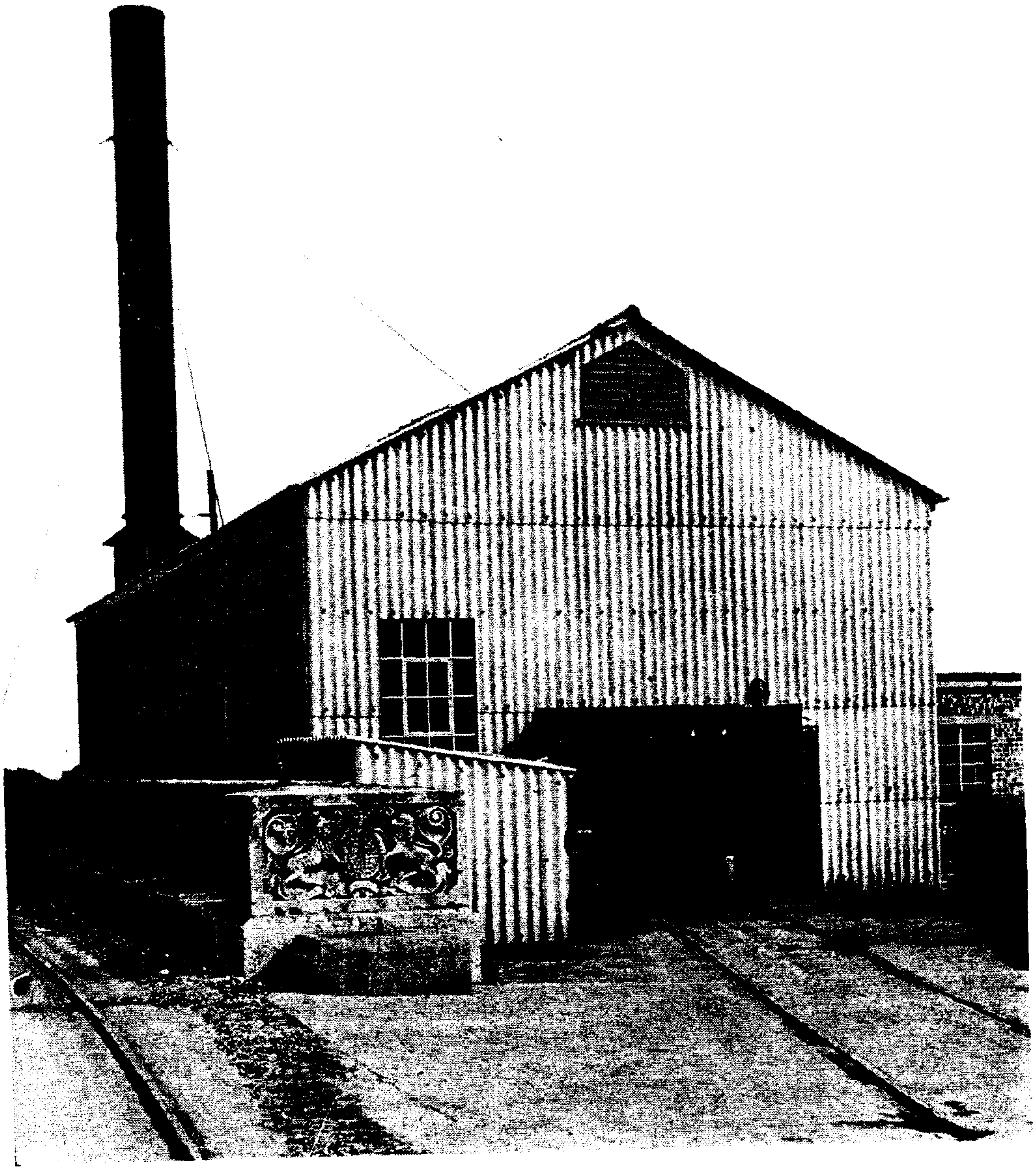

FIG. 1—THE ADMIRALTY DISTILLING EXPERIMENTAL STATION, PORTLAND

THE ADMIRALTY DISTILLING EXPERIMENTAL STATION, PORTLAND

BY

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INTRODUCTION

It is five years since the Admiralty Distilling Experimental Station came into operation. Three years ago a short description of it appeared in the *Journal* (Vol. 5, No. 3) and it is now possible to tell of some of the work carried out in its first five years.

The station is situated at the land end of the inner breakwater of Portland harbour, with the back of the building within twenty yards of the open sea. This makes it possible to obtain uncontaminated sea water at the right density, supplied by a 1,000-ton pump, situated in a separate building on the beach, the suction pipe running some 160 feet into the sea. The main building is large enough to house a water-tube boiler, a turbo generator and three or four distilling plants. Two offices and a mess room for the staff are adjacent to the plant house, and the feed and fuel tanks for the boiler are outside, overlooking the sea. The station, the entrance of which is shown in the illustration, covers an area of just under 4,000 sq ft and measures approximately 75 by 50 feet. For those historically interested, the stone shown in the picture bearing the royal coat of arms, commemorates the laying of the first stone of the breakwater by the Prince Consort on the 25th July, 1849, and is nothing to do with distilling.

The complement, all civilian, allows one working charge-hand, three fitters, twelve stokers working in three shifts, and a labourer. Trials, once started, are continued day and night, hence the three shifts of stokers, who are recruited when possible from ex-naval engineering ratings.

By virtue of being situated in the naval base, full use is allowed and made of base facilities. Payment of the staff is by the Cashier, fuel and stores are drawn from the N.S.O. and the larger repairs of machinery are undertaken by the dockyard, and many other amenities are offered. These allow the complement and the cost to be kept to a minimum.

The station is one of a group of research establishments administered by the Engineer-in-Chief's Department, and trials programmes are carried out in accordance with Admiralty directions. Liaison is maintained with the Admiralty Materials Laboratory at Holton Heath, which is nearby, and any laboratory work required in connection with a trial is carried out by that establishment. This normally means the analysis of scale and brine, and the checking of salinities and *p*H readings. The A.D.E.S. is well equipped for providing accurate records of pressures, temperatures and densities, etc., required for assessing the results of trials on distilling plants, and extensive records are kept during each trial. These are forwarded to E.-in-C. at regular intervals during a long trial or on completion of a short trial. A short trial is reckoned to be in the order of 500 hours or less, a long trial can go on for any period up to about 1,500 hours. It naturally depends on what one is trying to establish from

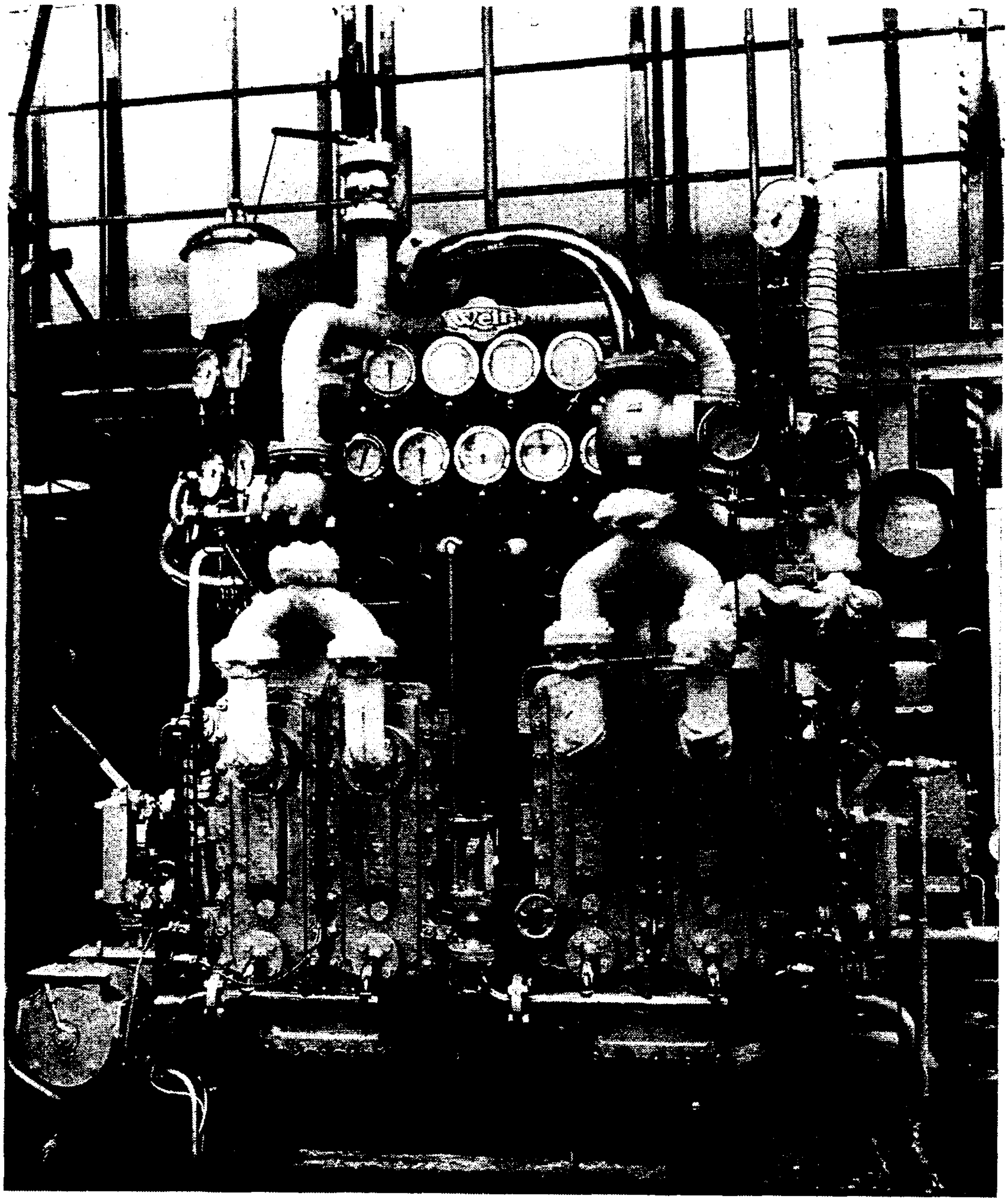

FIG. 2—WEIR'S DOUBLE EFFECT DISTILLING PLANT AS INSTALLED AT THE STATION

the plant in question. The testing of a new design prototype can go on for thousands of hours providing the plant does not fall over in the meantime.

The main function of the station has been the testing of prototype plants, usually, at the beginning, in co-operation with the makers. Trials involving the use of various types of chemicals as scale inhibitors have also been extensively carried out. Because of its position near the sea, use has been made of the station by outside bodies to test equipment not associated with distilling, but which has needed a good and plentiful supply of sea water for cooling or other purposes. The major portion of the water made here is pumped to a storage tank and is issued to ships as required. This, unfortunately, without charge, so there is no rebate to help defray the cost of the station.

Reference has been made to the use of chemicals in an endeavour to reduce, if not completely eliminate scale ; let it be said at once that no chemical safe enough to handle in ships, which has been tried out here, has proved of any real value. An exception possibly, was a mixture of silica and sequestrol tried in the vapour compression plant, which ran for a thousand hours without a drop in output and only a fine powdery deposit, which was easily wiped off, was left on the coils. This compound was too expensive to be used extensively in ships. Admiralty evaporator compound helps, so one is given to believe from certain chemists and some engineers, and according to reports from the Fleet. But one notices even from a favourable report given in a recent edition of the *Journal* (Vol. 9, No. 2), resort had to be made to the old custom of ' off doors and hose down hot coils ' in an endeavour to crack off as much scale as possible. The use of ferric chloride injection in certain merchant ships has, it is understood, been very successful. In the past it has been frowned upon for warship use, but it is being tried out at the A.D.E.S. in the vapour compression plant and will be used in certain new frigates fitted with these plants. However, it does entail handling difficulties and more care is required than when using normal evaporator compound. No, the real answer for distilling plants in the future is to produce a heating element to replace the coils, that will be flexible enough to shed scale as fast as it forms, while still retaining the physical properties of the metal of which it is made. It would appear that we are near to the day when that element will be standard equipment in evaporators.

SOME PLANTS AND TRIALS

The flexible heating element was first introduced in the Maxim evaporator, which, as far as one knows, has been fairly successful and has been fitted in ships across the Atlantic. This plant had some disadvantages, the main one being that the element had to be removed through the bottom of the shell. A great deal more space is required in consequence and this always presents a problem in British ships but a plant, modified to suit requirements, is being built in this country and it will be extensively tested at the A.D.E.S. to assess its performance. In the meantime firms in this country have been encouraged to design new plants incorporating flexible heating elements. So far two firms have done so and the first plant has been produced and is now at the station under trial. This is the Weir's double effect distilling plant recently described in detail in the *Journal* (Vol. 9, No. 1). The plant has run, so far, for some three thousand hours, the longest continuous run being fifteen hundred hours, when the elements were removed for examination. Because it is still under trial, it is not intended at this stage to give details of its capabilities, it is enough to say that it is producing plenty of water with very little effort and that faults in design are being sorted out. The production plants should be all the better for the modifications that have resulted from the extensive tests carried out here. The plant is shown in FIG. 2.

The other firm, Messrs. Caird and Rayner Ltd., have so far produced an element but no plant to go around it. This element has been constructed to fit into a standard plant installed in the A.D.E.S. and used extensively for trials. This is a 50-ton Buckley and Taylor plant which, with the coils removed and a new type of door fitted, makes an excellent test-bed for the element. The element, of which we have high hopes, is very simple in design, and is shown in FIGS. 3 and 4. It is made of monel and is of all-welded construction, fairly light and easy to handle, the steam and drain connections being the heaviest parts. In its present form it really does work, that is, no scale builds up on the heating element surfaces but only on the rigid tube plates, and it is hoped to reduce, if not eliminate, this scale.

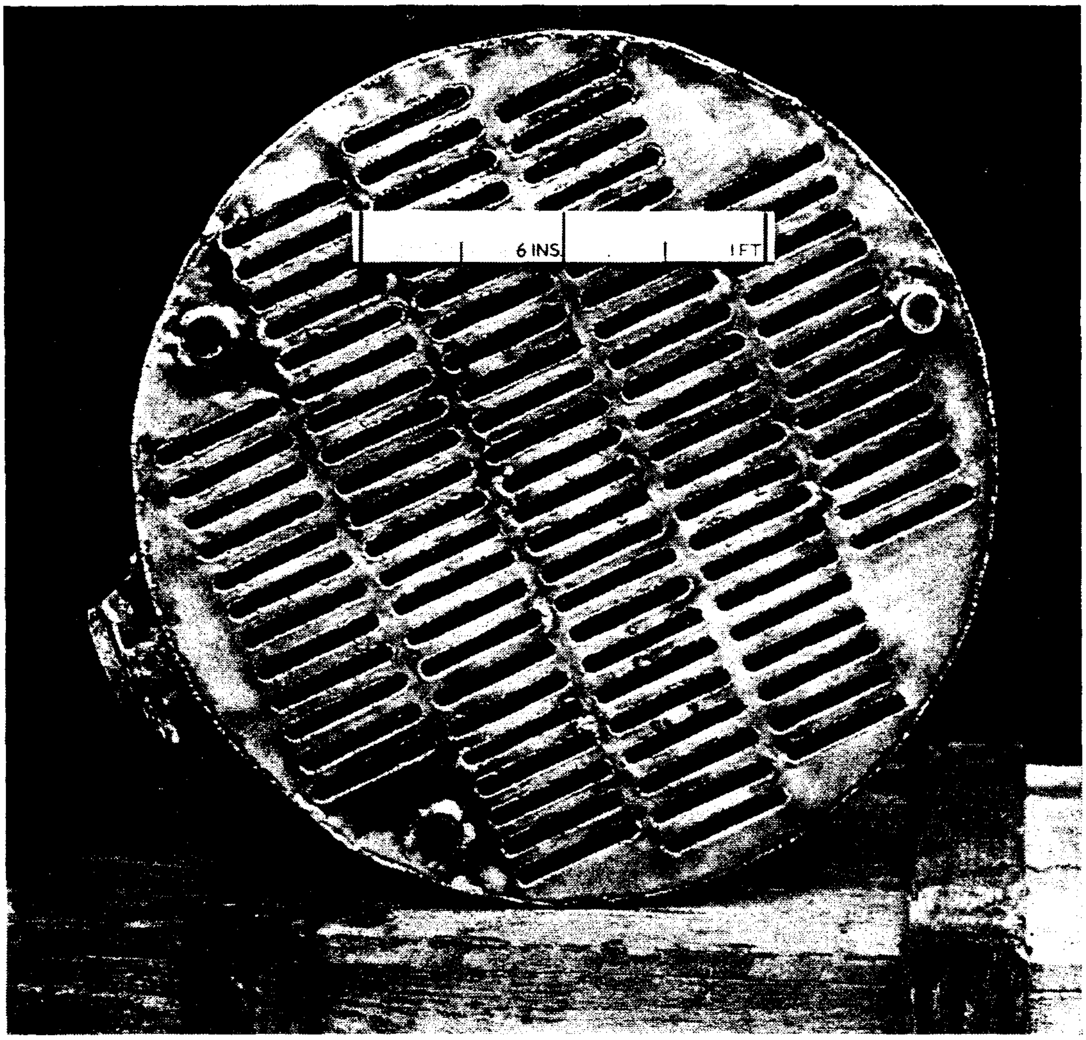

FIG. 3—FLEXING ELEMENT DESIGNED BY MESSRS. CAIRD AND RAYNER LTD.

The element is at present positioned on the door of the shell, by means of the steam and drain connections, so that the heating tubes or elements run vertically, with a diffuser plate fitted at the top to prevent priming. It would appear that it is not so much the flexibility of the element that makes it so efficient, but the velocity of the brine flowing upwards through the elements which is so great that the scale hardly has time to form on the heating surfaces. That which does form and which is cracked off the elements readily, averages 0·005 in. in thickness, which means that it has formed and been removed in a very short time. Arrangements were made so that the element could be 'shocked' periodically to assist the shedding of scale. This was done by heating and suddenly quenching the element with a cold water spray. It was soon found that this was not necessary as the scale was self-shedding. All that was necessary was a daily rake-out of the scale from the bottom access door. On removal and examination, the scale can only be described as looking rather like soap flakes in size and shape. Being so small, quite a lot would be ejected with the brine discharge, but not sufficient to prevent the build-up of scale held in suspension in the shell. This tends to affect the brine circulation and in time reduces the output. Hence the daily rake-out of scale which, if done regularly, prevents a drop in output. The success of the element, assisted by the scale clearing routine, was quite remarkable and the trial continued for over sixteen hundred hours before a halt was called. The amount of water produced was

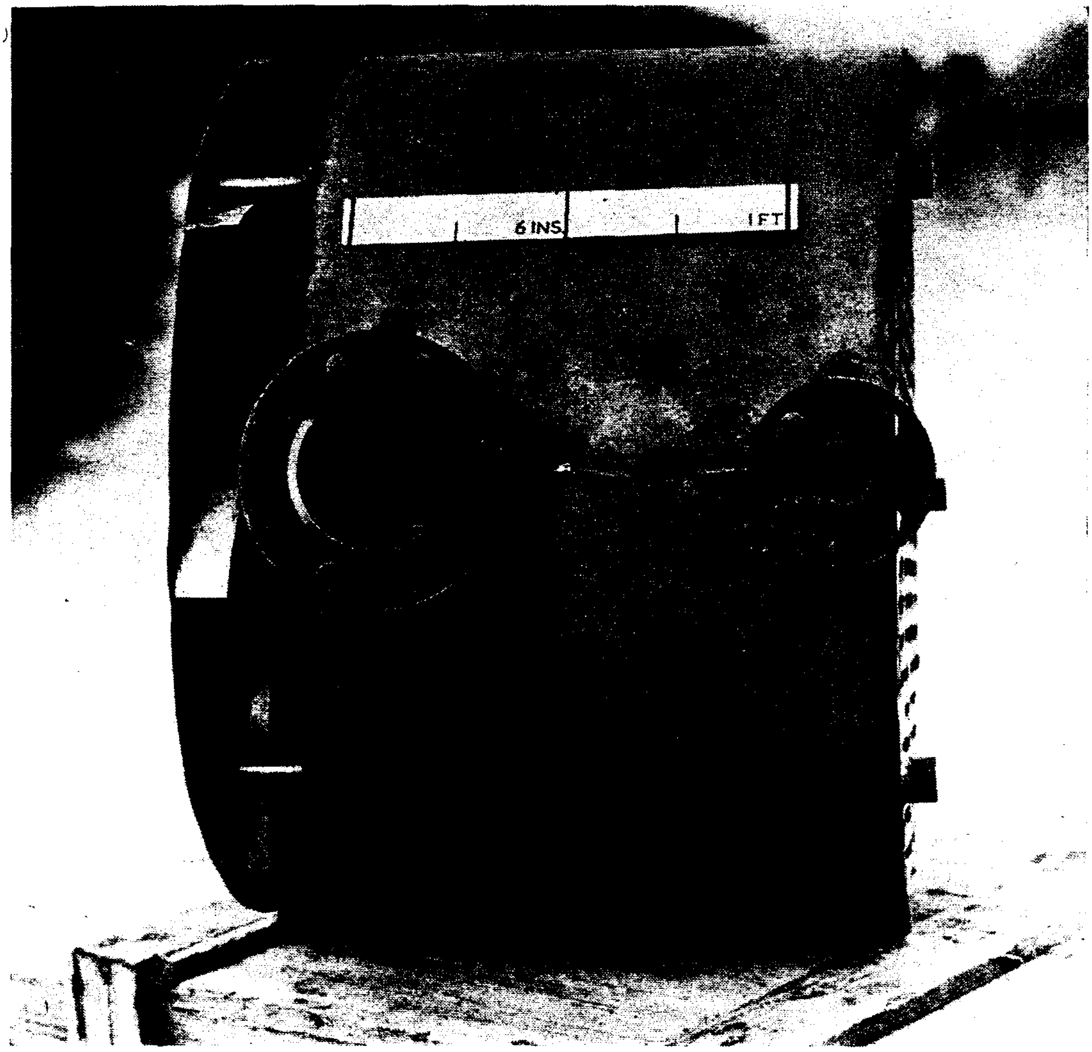

FIG. 4—FLEXING ELEMENT DESIGNED BY MESSRS. CAIRD AND RAYNER LTD.

almost the same as the plant produced under the same conditions when fitted with coils, yet the area of the heating surfaces of the element was only slightly more than half that of the coils. It is only fair to state that a small split developed in the outside wrapper plate of the element, due to buckling of the plate when being shocked. Although not affecting the performance, a slightly heavier gauge metal in future elements will no doubt be required, for the wrapper plate at least. As this was the only real fault discovered during the trial, one can say that this element has great possibilities, and it will be interesting to see what its capabilities are when fitted in a shell designed for it. One will, of course, still be faced with the scaling of the brine pipes, and the only solution here is that designers will position them so that they can easily be removed for cleaning.

The vapour compression plant which is shown running during a ferric chloride injection trial in FIGS. 5 and 6, is the prototype of the plants now being fitted in new I.C.E. driven frigates and was manufactured by Messrs. Caird and Rayner Ltd. It consists of a heating chamber containing sixteen coils, a flash chamber, an electric immersion heater capable of taking a load of 500 amps. at 220 volts to provide the heat for the initial boiling and as a boost once the plant is running, brine and fresh water pumps and coolers, and a Reavell two-stage centrifugal steam compressor. The latter is driven by a 95 h.p. electric motor running at 1,750 revs. and the compressor is geared to run at 21,000 r.p.m. This means there is no time to waste if things go wrong.

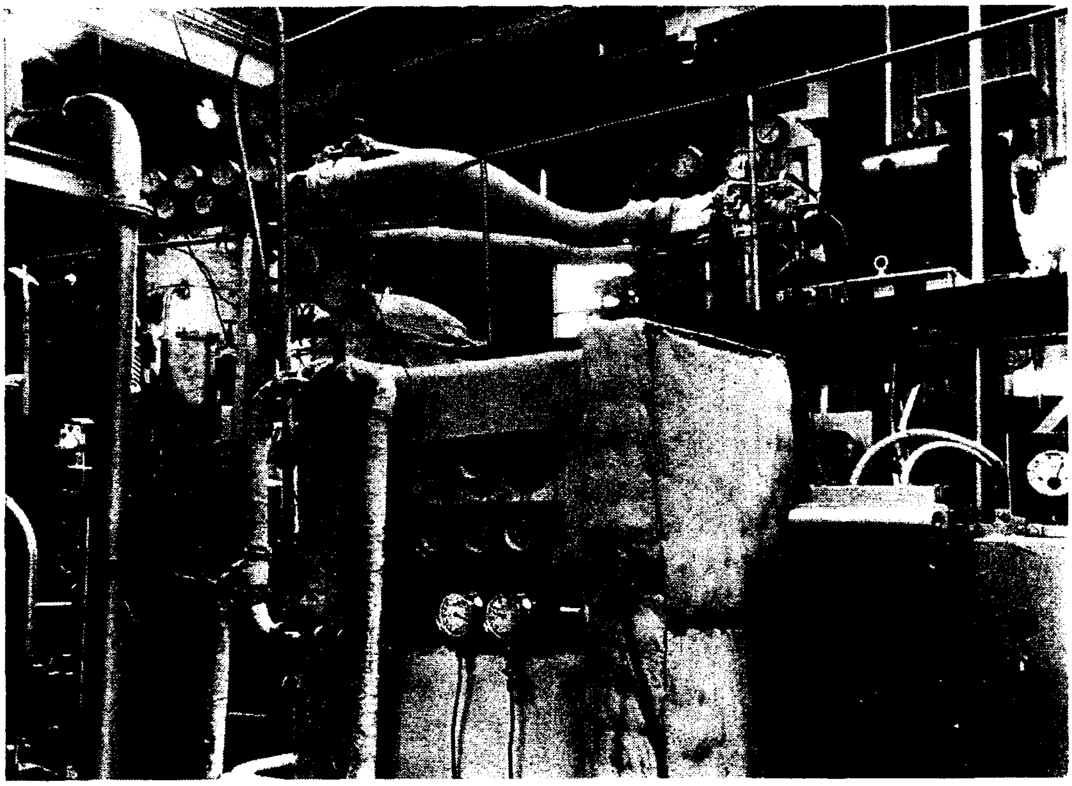

FIG. 5—VAPOUR COMPRESSION PLANT UNDER TRIAL USING FERRIC CHLORIDE INJECTION

The plant has a maximum output of 25 tons daily, and is very easy to run once it has settled down after the initial start. Unfortunately it tends to scale up fairly quickly and the output falls off rapidly. To maintain reasonable output the immersion heater elements requite to be de-scaled every 100 hours approximately, the maximum period of efficient running being about 1,000 hours. It is not possible to blow down the plant and thus no external assistance can be given to cracking off the scale. Several scale inhibitors have been tried in this plant in an endeavour to reduce the build-up and, except for the one already mentioned, a mixture of sequestrol and silica, they have made very little difference. The use of ferric chloride in the plant at the present time appears to be working satisfactorily ; first results indicate there is no build-up on the immersion heater elements and only a fine powdery deposit on the main heater coils. The latter dissolves in fresh water and on re-starting the plant has regained its maximum output. It rather looks as if a temporary expedient has been found for ships having this type of plant. But to would-be users, this chemical is proving to be highly corrosive, and polythene linings and stainless steel must be used in the injection system.

Briefly, other trials carried out on either, or both, the vapour compression plant and the 50-ton Buckley and Taylor plant in an effort to prevent or reduce scale formation have included electrical and chemical treatments of the feed water.

OTHER TRIALS

Aquastat

This consists of a casting, containing an electrode in the form of a grid, fitted in the feed system. Across this was passed a current of 8·4 milliamps from a dry-cell battery, and the feed to the evaporator flowed through the electrode. The makers claimed that it had proved successful when used in connection

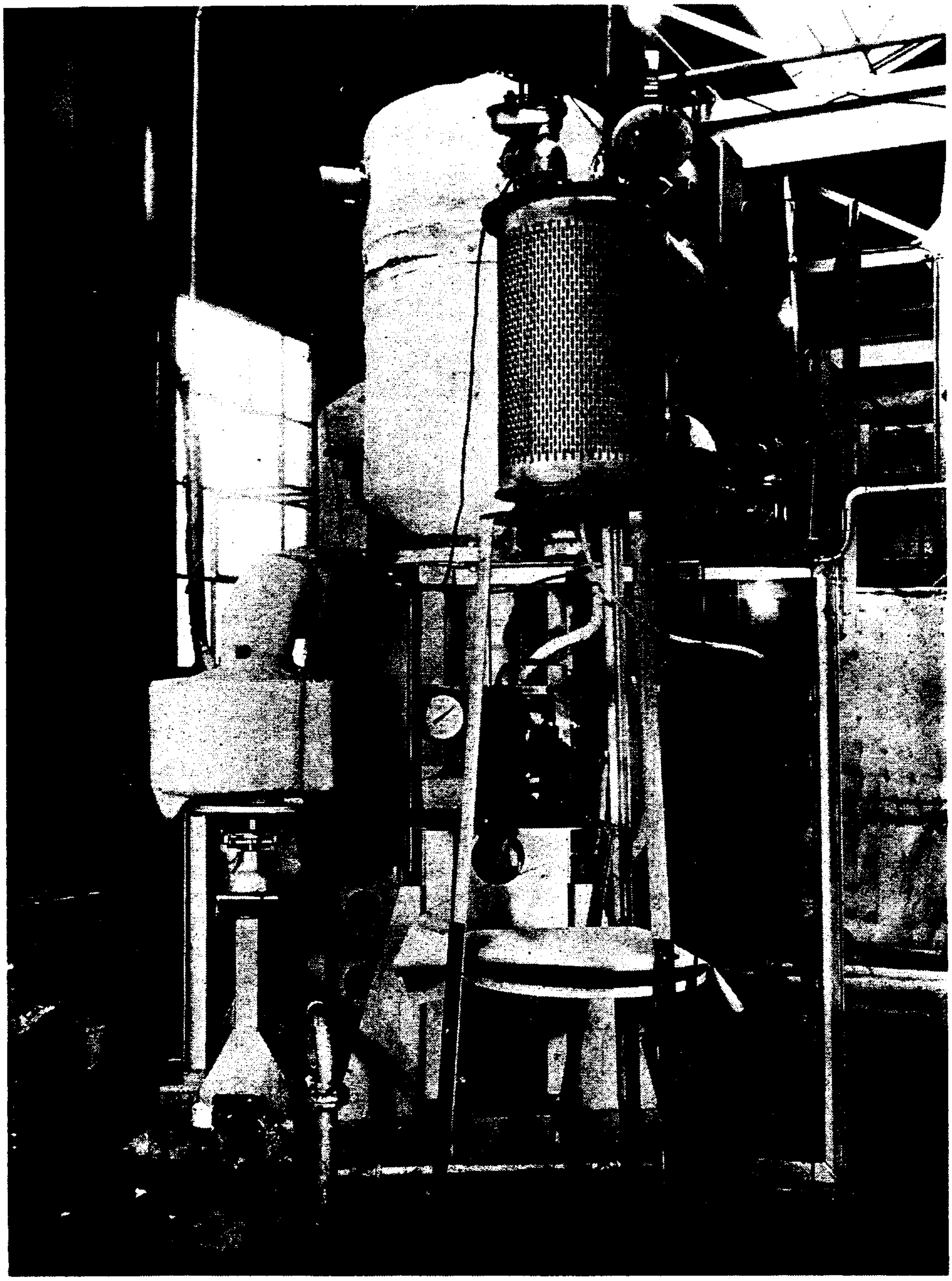

FIG. 6—VAPOUR COMPRESSION PLANT UNDER TRIAL USING FERRIC CHLORIDE INJECTION

with heating and cooling systems in factories, etc., but it was soon possible to show that it has no value when used with sea water.

Aluminium Copper Battery

This consisted of a mild steel plate tank 4 ft × 3 ft × 3 ft into which were fitted insulated aluminium and copper plates. A current, depending on the trial and varying from 50 to 400 amps. at a low voltage was passed across the plates and the feed to the evaporator flowed through the battery. This showed distinct possibilities as the feed became sufficiently acid to prevent scale on the coils. Unfortunately, so much aluminium hydroxide, which could not be filtered, was formed at the plates, that it built up in the coils and reduced output more than ordinary scale formation. The expenditure of aluminium plate was also economically unsound, and it was almost a full-time job for a fitter to make plates to keep up with the trial.

Crustex

Another electric scale-prevention apparatus was tried on the vapour compression plant. It consisted of a number of oscillators attached to the shell of the heating chamber and from these, impulses were transmitted to the brine. Presumably they were intended to separate the constituents of the brine before they were deposited on the coils. Unfortunately scale formed at the normal rate.

Chemicals

Among the chemicals used have been sodium bisulphate, D.M. compound, silica, sequestrol, evaporator compound with and without anti-foam properties, and ferric chloride. Except for the latter and a mixture of silicia and sequestrol, the results have not been particularly successful in eliminating scale.

In the cause of science a trial was carried out using pumice stone as a contact stabilizer in the 50-ton plant. It was broken up into pieces the size of peas and an amount weighing some 30 lb was placed in the bottom of the shell on a grid, the latter having been made and fitted to prevent choking the outlets. The general idea was that the scale would form on the pumice and give the coils a miss ; however, it formed on the pumice as well as normally on the coils.

These trials, although failures, have been mentioned to show that no idea has been turned down in efforts to achieve success, however unlikely they have seemed.

Immediate plans for future trials include the use of a flexible heating element in the vapour compression plant, and trials in the Buckley and Taylor plant using twin elements of the same principles of construction, but of rectangular section. These latter types of elements are being fitted in a new design plant at present under construction by Messrs. Caird and Rayner Ltd.

No doubt these flexing heating elements and their capabilities, will be the subject of a future article on distilling plants in the *Journal*, but, without giving away any secret, it can be said that this type of element has a higher heat transfer rate than any other type so far designed and, providing the materials of construction stand up to the job, it should be successful.