CANADIAN Y.100

('ST. LAURENT' CLASS A/S ESCORTS)

BY

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The Author is indebted to the Royal Canadian Navy for permission to write this article which is, however, an expression of his own views.

INTRODUCTION

In September, 1948, a visiting team of E.-in-C.'s representatives arrived in Ottawa just as the R.C.N. were deliberating on machinery designs for a new class of anti-submarine escort vessel. As might be imagined the choice lay between U.S.N. and R.N. machinery. The Y.100 design was offered by the team as an example of the latest R.N. development and, after a visit by the Engineer-in-Chief of the Royal Canadian Navy to the United Kingdom early in 1949, this design was accepted. For the full technical details of the Y.100 design, readers should refer to the excellent article by Commander R. G. Raper, R.N., in the January, 1955, issue of the *Journal of Naval Engineering* (Vol. 8, No. 1). These details form an essential background against which the Canadian developments must be placed.

Although the R.C.N. adopted the Y.100 design, they quite naturally insisted upon a 100 per cent production capability either within the boundaries of Canada or, as a last resort, within the North American continent. From that moment the stage was set for a singularly important integration of British design with Canadian production potential. The effect of this far-reaching decision has still to become generally apparent and is not at present widely known or discussed, but there is no doubt that this one single act has had very wide ramifications both for ourselves and the R.C.N. It is hoped that the following article will highlight some of these.

AIM

In order to start their programme, the R.C.N. ordered the first set of machinery from Messrs. Yarrow & Co. in England, and this set has been used as the prototype as far as the Canadians are concerned. All succeeding ships of the Class will be, however, supplied with Canadian built machinery and there is in a sense, therefore, a second prototype ship following the first.

It is thus the primary aim of this article to show how the Canadians have tackled the problem of producing the R.N. Y.100 machinery design in their own country, and to list in detail some of the major problems which they have had to overcome. There is also a secondary aim, and that is to illustrate how Canada's advantageous position, on the 'fence' between the R.N. and U.S.N., enables her to take advantage of both worlds. For this purpose those points in the original design, where the R.C.N. have diverged from the original R.N. proposals, will be discussed.

PRODUCTION

Canadian 'Lead Yard' Policy

In order to conserve the skilled engineering drawing office talent available in Canada, the Royal Canadian Navy have adopted the principle of Lead

Yards for the new construction programmes. For the destroyer escorts this principle has been carried a stage further by setting up a Naval Central Drawing Office (N.C.D.O.) which is actually sited at, and operated by, the Lead Yard —Canadian Vickers. The original concept was that each shipyard engaged in the programme would provide a certain number of personnel to man this central organization, but this has since lapsed and the N.C.D.O. is now manned and operated by the Lead Yard. The N.C.D.O. covers engineering, hull and electrical drawings. The siting of the various types of draughtsmen in adjacent offices achieves a measure of co-ordination between conflicting requirements.

This arrangement, whereby layout, piping and system drawings originate from one source, has gone a long way to achieving standardization between yards. Since the drawings promulgated are not only general arrangement, but consist of pipe fitting sheets detailed to a degree of thoroughness not usually considered necessary in United Kingdom, it is not difficult to understand how this is being achieved. When, to this procedure, is added bulk ordering of items of equipment by the Lead Yard, even down to such things as nuts, bolts, pipe clips, cocks, valves, rivets, etc., the immense advantage of this policy is readily apparent. The procedure is not only economic but logistically sound. One potentially grave disadvantage is that if an error is made, be it on the drawing board or in ordering, then it is multiplied by the number of ships being built. When this is carried over a squadron or more, errors can prove to be very costly and, therefore, great care must be exercised in checking drawings and in the selection of equipment. On the other hand, as already mentioned, bulk ordering gives much cheaper items.

Experience has shown that, to derive the maximum success from this policy, the prototype ship of the class should be from one to two years ahead of the following ships. This would give sufficient time for prototype ship experience to be fed back into the programme.

Canadian Shipyards

It will be realized that the seven Canadian shipbuilding firms engaged in the programme are spread out across the country and they fall naturally into three divisions :—

East Coast :	Halifax Shipyards Limited, Halifax, N.S.
St. Lawrence Area :	Canadian Vickers Limited, Montreal, P.Q.
	Marine Industries Limited, Sorel, P.Q.
	Davie Shipbuilding and Repair Company, Lauzon, P.Q.
West Coast :	Yarrow Limited, Esquimalt, B.C.
	Burrard Drydock Company Ltd., North Vancouver, B.C.
	Victoria Machinery Depot Limited, Victoria, B.C.

The distance between the east and west coast is approximately 3,000 miles, $1\frac{1}{2}$ days air travel or 6 days by rail, so that the problem of co-ordinating the requirements of these widely separated yards can easily be envisaged. Without the Lead Yard policy already described, considerable divergence in production could obviously occur. The advent of the St. Lawrence seaway project opens up a wider field of shipbuilding possibilities for those hitherto smaller yards situated around the Great Lakes, so that the future holds the possibility of increasing Canadian production, if the extra skilled labour force can be found.

Canadian Main and Auxiliary Machinery Contractors engaged in the A/S Escort Programme

Firm	*Location*	*Equipment Manufactured*	*U.K. Associates*	*U.S. Associates*
John Inglis Ltd.	Toronto	Marine Turbines Main Condensers Automatic Clutches Refrigeration Units Air Conditioning Mov.	English Electric Pametrada	Worthington
Dominion Engineering	Montreal	Main Reduction Gears Flexible Couplings	David Brown	(MAAG)*
Babcock-Wilcox & Goldie McCulloch Ltd.	Galt	Main and Auxiliary Boilers Boiler Mountings	Babcock-Wilcox Dewrance	B. & W.
Canadian Westinghouse	Hamilton	Turbo Generators Turbo Blowers Turbo Circulators	W. H. Allens & Sons	Westinghouse
Peacock Bros.	Montreal	Main and Auxiliary Feed Pumps Extraction Pumps Deaerators Forced Lubrication Pumps Air Ejectors Oil Fuel Pumps Hull and Fire Pumps Feed Controllers Gland Condensers	G. & J. Weir Ltd. Hick Hargreaves Ltd.	
Russell-Hipwell	Owen Sound	Forced Lubrication Coolers Oil Fuel Heaters	Serck Ltd.	
William Kennedy & Sons Ltd.	Owen Sound	Propellers Castings—Ferrous and Non-Ferrous	Millspaugh	
Canadian Vickers Ltd.	Montreal	Steering Gear Oil Fuel Pumps (IMO)	Hastie Bros.	de Laval
Bailey Meter Co. Ltd.	Montreal	Feed Water Regulators Boiler Controls Boiler Room Control Consoles Engine Room Control Consoles	Bailey Meter Co.	Bailey Meter Co.
Project Sales (Montreal Locomotive Works Manufacturers)	Montreal	Maxim Evaporators	Frederick Braby & Company Ltd., 352 Euston Rd., London	Maxims
Chadburn Canada Ltd. (Crosbie & Son, Manufacturers)	Toronto	Telegraphs Revolution Indicators	Chadburn Ltd., Liverpool	

* *Switzerland*

Canadian Production Policy

An important point which must be appreciated at the outset is that Canadian shipbuilders differ fundamentally from those in the U.K. They are not equipped, nor have they the staff, to build warship main engines and boilers of advanced design. It has therefore been necessary to manufacture the main engines and boilers at two single firms respectively and supply each shipbuilder in turn with his own propulsion unit. The effect of this is profound since line production of warship machinery becomes a practical and working proposition.

The Canadian Government laid down a Crown owned, but privately operated, Naval Turbine Factory outside Toronto and a similarly owned and operated Main Reduction Gear Plant in Montreal. These plants together are capable of considerable capacity in time of emergency. In the case of the main boilers, it was not necessary to construct a Crown owned plant and production has been undertaken by Babcock-Wilcox (Canada) on their own premises. The Canadian auxiliary machinery manufacturers, the majority of whom are associated with United Kingdom or American firms, supply their equipment to the various shipyards in the usual manner.

Magnitude of the Task

The task undertaken by the R.C.N. was, therefore, not simply one of introducing a new design into an already existing, well-established, marine industry, but one of creating plants and production techniques where, in some cases, none existed before.

The effect of being associated with a programme of such scope has been refreshing indeed and the satisfaction experienced by the author on visiting, three years later, a series of large, well-planned and fully operational factories, where once there had been fields, will not lightly be forgotten. Added to this, as will be seen in a later paragraph, a full scale research programme had also to be conducted simultaneously with the production programme, in order to solve the problem of producing sound rotor forgings from North American steels, capable of meeting the Y.100 stress requirements.

Canadian Industrial Firms

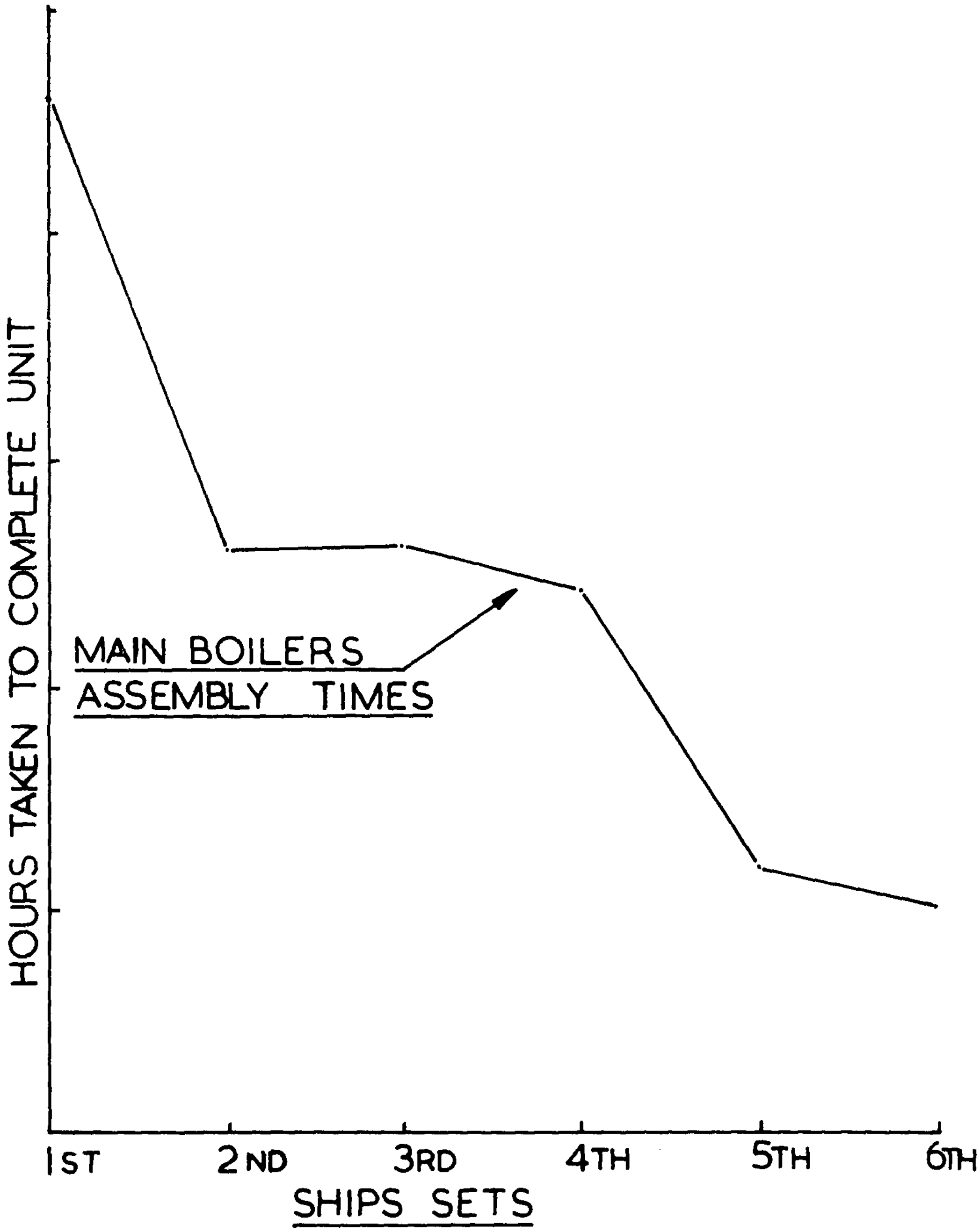
In view of the increasing interest shown by the R.N. and U.K. industry in the emergence of Canada's marine industrial potential, it is considered that a table of those Canadian firms actively engaged in the production of the anti-submarine destroyer escort machinery would prove of interest, and this is shown in the Table.

Test Establishments

Since the majority of the major manufacturers were making and assembling new plants at the beginning of the programme, no facilities or plant equipment existed for testing the units produced. The R.C.N. was therefore faced with the problem of providing test plants in order that such items as the main propulsion turbines, main reduction gears, turbo-blowers, turbo alternators, turbo and reciprocating pumps could be given running and performance tests. As the plants were being installed for the first time, it was thought prudent to design them for greater capacity and higher pressures and temperatures than were being used in the Destroyer Escort Programme, so that such plants would be available for any future development.

In all, three test plants were established :—

(*a*) John Inglis Limited—Toronto (Main Engine Plant).



BOILER PRODUCTION CURVE

(*b*) Canadian Westinghouse—Hamilton.

(*c*) Peacock Brothers Limited—Montreal.

The John Inglis Limited plant is integral with the Naval Turbine Factory at Scarborough, Toronto, and has a 25,000 lb/hr test boiler operating at 600 lb/sq in, 850°F. Since this plant is at present only required to conduct no-load spin tests on the main and cruising turbines coupled to the gears, higher conditions were not required. A standard test boiler of 24,000 lb/hr capacity, capable of operating (after minor modifications) at 1,000 lb/sq in, 950°F. has been fitted to both plants (*b*) and (*c*). The plant built to test Peacock Brothers' auxiliaries is Crown owned and is located in a separate building some two miles away from the main factory. This plant has now become the Naval

Engineering Test Establishment (N.E.T.E.) and is also capable of testing Canadian Westinghouse auxiliaries should an emergency arise, while prototype tests on the lubricating oil cooler and oil fuel heater manufactured by Russell-Hipwell will also be conducted.

With the fitting of a light and medium weight high impact shock testing machines, N.E.T.E.'s role in the naval programme has been widened and it seems certain that the establishment will play a larger and larger role in the production and design of naval auxiliaries for the R.C.N.

Running and performance tests are thus being conducted on all units destined for service in the R.C.N. destroyer escorts, and shock tests have been undertaken on other selected units. Advisedly, no unit which has undergone shock tests is fitted in a ship. In the case of the Dominion Engineering Gear Factory, arrangements were made to undertake ' front to front ' tests of each complete ship set of gears. For this trial a special torque converter was designed by Dominion with the unique feature of the torque being applied at the high speed shafts, instead of at the low speed shaft.

Results of the Line Production Programme

The implications of the line production programme are considered sufficiently important to show them on a graph. The curve shows the savings in man-hours achieved by building boilers on a line assembly basis. This experiment and the results achieved by the Canadians make anything we have to offer on the same basis somewhat antiquated, and it seems likely that future marine engineering trends in the United Kingdom will follow this lead. The reasons for the improved efficiency, when operating a line production assembly, are not hard to find when it is realized that the initial cost of expensive, difficult to make, production jigs and special expensive automatic labour-saving equipment, such as tracer lathes, are spread over the whole programme.

ROYAL CANADIAN NAVY STANDARDS

Before 1949, the Standards used by the R.C.N. in World War II ships and the Canadian-built Tribal Class destroyers, were generally those of the Admiralty. After taking the decision to adopt the Y.100 design the Canadian Navy decided to undertake their own manufacture, and, of necessity, discarded Admiralty Standards for materials, screw threads, pipes, valves, cocks, etc., to ease the task of their main and auxiliary machinery manufacturers and shipbuilders. The basic reason for this decision lay in the fact that the vast majority of Canadian firms were already firmly wedded to North American industrial practice and standards, and the imposition of an entirely new set of standards on top of their normal practice would have been uneconomical.

The original concept was that commercial standards—A.S.A., C.S.A., A.S.T.M.,* etc., would be used wherever possible, but experience has since shown the need to devise separate R.C.N. standards and this was especially so in the case of low pressure valves. Obviously many of these new standards have been derived either from Admiralty, U.S.N. or straight North American commercial standards, but they have had to be brought into existence, and that in itself has posed a considerable problem. As can be visualized, the decision to impose on the Y.100 design different standards from those for which the design had been created, gave rise to many problems, the more serious of which are described.

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* A.S.A.—American Standards Association
C.S.A.—Canadian Standards Association
A.S.T.M.—American Society for Testing Materials

Unified Screw Threads

The R.C.N. decided to use unified screw threads wherever possible and at the start of the programme this requirement was made mandatory. Unfortunately, experience showed that many Canadian and American firms had not obtained the necessary taps and dies and relaxations became necessary. American threads were accepted. It should be noted that, in this instance, American national fine and coarse threads are practically interchangeable with unified, even though they possess slightly different thread forms. However, it is still the R.C.N.'s policy to fit unified screw threads wherever possible and this policy of standardization should give considerable gains when the destroyer escorts become operational between Canadian, United Kingdom and American bases.

Ball Bearing Standards

North American ball bearing manufacturers produce bearings in the metric series only, and since these items need special notice when considering logistic support for the ship as a whole, there could be no question of the R.C.N. accepting British Standards. On the surface, this change would appear minor, but it must be remembered that not only dimensional interchangeability has been affected, but also, in certain cases, the type of bearing itself. Moreover, both spindle and housing diameters had to be considered and sometimes modified.

C.S.A. Flanges

The special chamfered Admiralty flanges, which were produced for the Y.100 design for high pressure steam lines, were replaced in the R.C.N. design by Canadian Standards Association flanges. These flanges, though heavier than the chamfered design, are lighter than the standard 600 lb Admiralty series. They also differ from the American Standards Association (A.S.A.) in that the bolt hole clearance is $\frac{1}{16}$ in as opposed to $\frac{1}{8}$ in. In this respect the R.C.N. have followed U.S.N. practice rather than R.N., which calls for 1/32 in.

Pipe Sizes

The A.S.A. code for pressure piping has been used to determine the thickness of the R.C.N. piping, and schedule 40 was selected for the high pressure steam lines. Although the A.S.A. code differs from the R.N. Standards in every pipe size, the differences are non-uniform, being greater in some sizes and smaller in others. Thus there is actually very little to choose between the two codes, although, generally speaking, the R.C.N. main and auxiliary steam piping installation will be lighter than the R.N. Obviously the advantage to the R.C.N. of using a readily available standard range of piping has been considerable.

The main difficulty arising from this decision has been the curious absence of odd number sized pipes above 6 in. in the normal A.S.A. standards. This means that 7 in, 9 in, 11 in, etc., nominal pipe sizes cannot be fitted in the R.C.N. destroyer escorts, and the Y.100 design has to be altered to suit this condition. Fortunately, only one system was seriously affected by this, namely the closed exhaust range. However, as this system had in any case been the most difficult to fit into the machinery space with its original pipe diameters of 7 in, the consternation when it became apparent that a re-design would be necessary, is not hard to imagine. As the design steam velocities in this range were close to sonic speed any reduction in pipe sizes to 6 in could not be tolerated, and the R.C.N. design was therefore forced to 8 in nominal bore pipes. The larger pipe sizes meant more generous bends and even further congestion in an already difficult pipe layout. Messrs. Yarrows & Company Limited, the ship layout design agents, supervised by the Admiralty, eventually produced a re-designed closed exhaust system to suit the R.C.N. pipe sizes. Naturally this system is heavier than its R.N. counterpart.

Welding of Pipe Lines

Generally speaking, North American welding technique is superior to European and one immediate reaction of the R.C.N. to the Y.100 steam pipe systems was to suggest that flanges be eliminated and an all welded pipe line be fitted in the ship. Although considerable steps have been made in training qualified welding operators across the country in the special techniques, it has not been found practicable to implement this policy, mainly, of course, because of difficulties of welding pipe lines in place in the ship.

C.S.A. Valve Standards

Although leaving the high pressure steam lines virtually unaffected, the decision to fit C.S.A. valves has produced a most unpleasant increase in the weight on the low pressure system. Indeed, so seriously has this increase been viewed, that steps have already been taken to create an R.C.N. Valve Standard, which is aimed predominantly at achieving :—

(1) Low weight.
(2) Maximum degree of interchangeability between component parts (i.e. valve spindles bodies, etc.).

These standards are being produced by the Naval Central Drawing Office and will be used in all future new construction programmes.

MATERIALS

The change from Admiralty Standards and U.K. proprietary materials to those available on the North American continent, posed a problem of considerable magnitude at the start of the programme. Each case had to be decided on its own merits, with particular reference to strength and any special properties which might be required, i.e. corrosion resistance, weldability, high temperature creep resistance, etc. Many material problems emerged as the programme progressed, and the R.C.N. have now succeeded in producing an equivalent book to the Admiralty's *Specification of Materials for Marine Engineering*. This is, of course, not yet complete, but it will be a working foundation on which to build another new construction programme.

Rotor Forgings

The development of a Canadian source for rotor forgings proved to be the most difficult problem of all and was only finally solved after some four years of costly and bitter experience. In view of the Admiralty's similar experience with their own U.K. forgemasters this was hardly surprising.

Following their standard policy, the R.C.N. demanded that North American steel practice produce a forging capable of meeting the physical requirements of the Y.100 turbine design. The outcome of this was the birth of an R.C.N. Specification (E.-in-C. 101. F.1), which essentially combined the chemical requirements of U.S. Specification MIL(S) 860 Class A with the physical requirements of the Admiralty Specification E.-in-C. 3.F.1 plus the experience gained from the Canadian Government's research forging programme.

To understand the metallurgical difficulties involved in such an effort, it must be appreciated that the majority of English forgemasters used a 3 per cent chrome molybdenum oil quenched steel to obtain the necessary physical characteristic, while the standard North American practice is to use an air hardened nickel alloy steel for rotor forgings. When to this is added the fact that the steel furnaces are at Montreal, Quebec, and the forging press was in Trenton, Nova Scotia, being separated by over 800 miles, it is not exaggerating to state that the production of successful rotor forgings was one of the hardest problems that the R.C.N. had to solve.

The shipment of the alloy steel ingots, after hot stripping, was carried out in a specially designed box on a railway flat car, packed with insulating vermiculite, the whole being sent by rail. Experience showed that the Montreal ingots arrived with a temperature in the range of 1,500 to 1,600 degrees Fahrenheit. On arrival, the ingots were charged in an oil fired car type heating furnace and forged on the Government owned 7,000-ton oil hydraulic press using a 75-ton manipulator. An extensive sectioning programme was conducted on the first forgings and, after several disappointments, success was achieved. Of all the associated problems the cleanliness of the bore was by far the most difficult. Throughout the whole programme the assistance of the Government Department of Mines and Technical Surveys was invaluable.

Condenser Tubes

Another interesting point is the difference between Royal Naval and North American (U.S.N.) cupro nickel condenser tubes. The U.S.N. practice is to fit the tubes to their tube plates by expanding them in place and to allow for expansion by ' bowing ', the tubes are thus supplied in the fully annealed state and are soft. R.N. and R.C.N. practice is to fit Crane packing and allow the tubes to slide in the tubeplate, hence in this case hard tubes are necessary and only stress relieving, not annealing, is called for. Since serious necking can occur if soft tubes are fitted with Crane packing and indiscriminate tightening of the ferrules is carried out, an R.C.N. cupro nickel condenser tube specification had to be produced stating the hardness requirement for the benefit of North American suppliers.

Propeller Material

A new R.C.N. propeller specification was also produced to suit North American foundry techniques and yet maintaining the necessary physical and corrosion-resistance properties.

DESIGN CHANGES

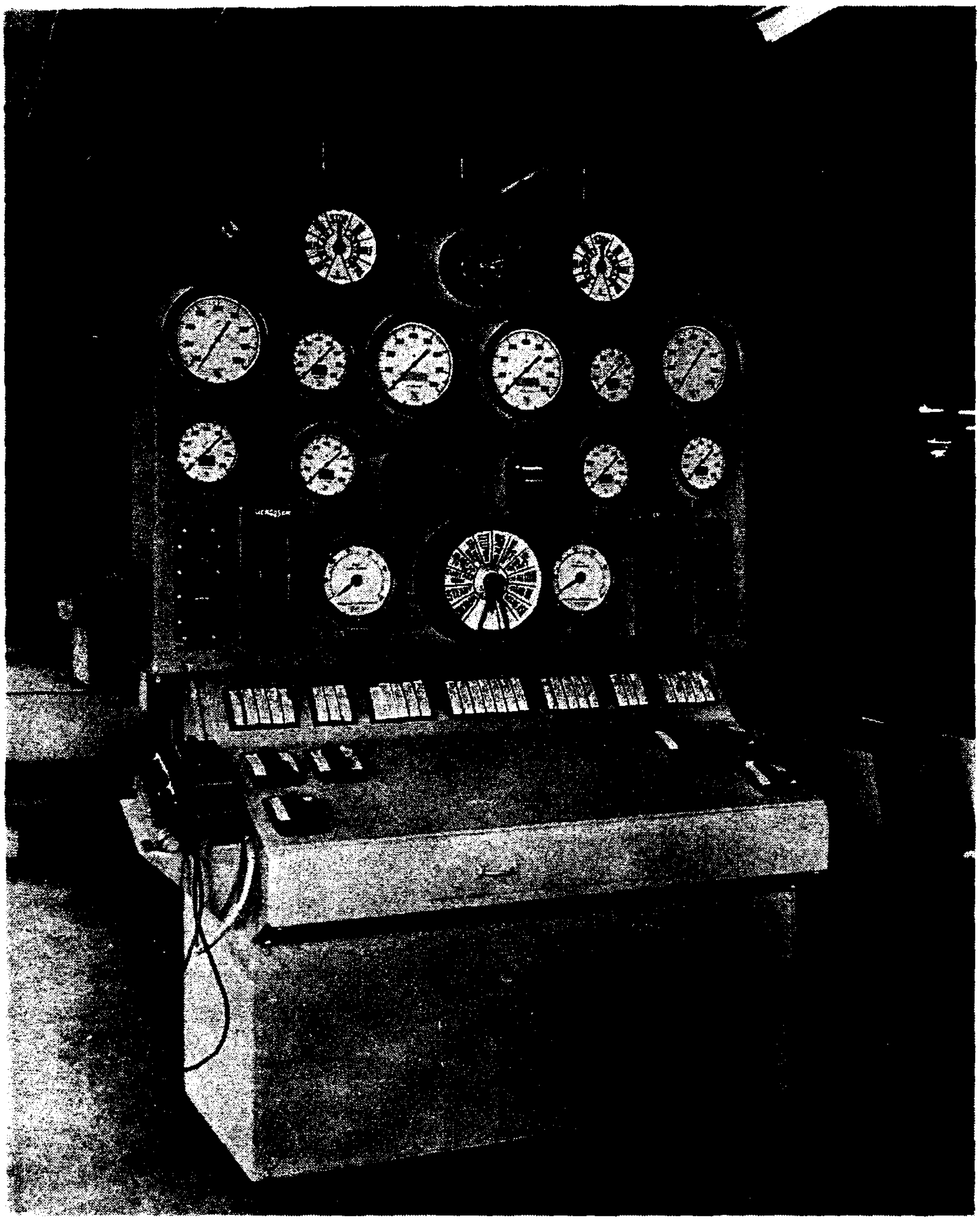
The preceding paragraphs have shown the effect of altering the general standards on the Y.100 design ; now we must study the points where deliberate changes have been introduced. These are briefly :—

Layout

The R.C.N. considered the R.N.'s provision of two 200-kW. Diesel generators insufficient for their ships and, in order to instal an additional similar machine, the boiler room was increased from 36 ft in the original design to 45 ft, the extra two frames being used to accommodate both the Diesel generator and the auxiliary boiler.

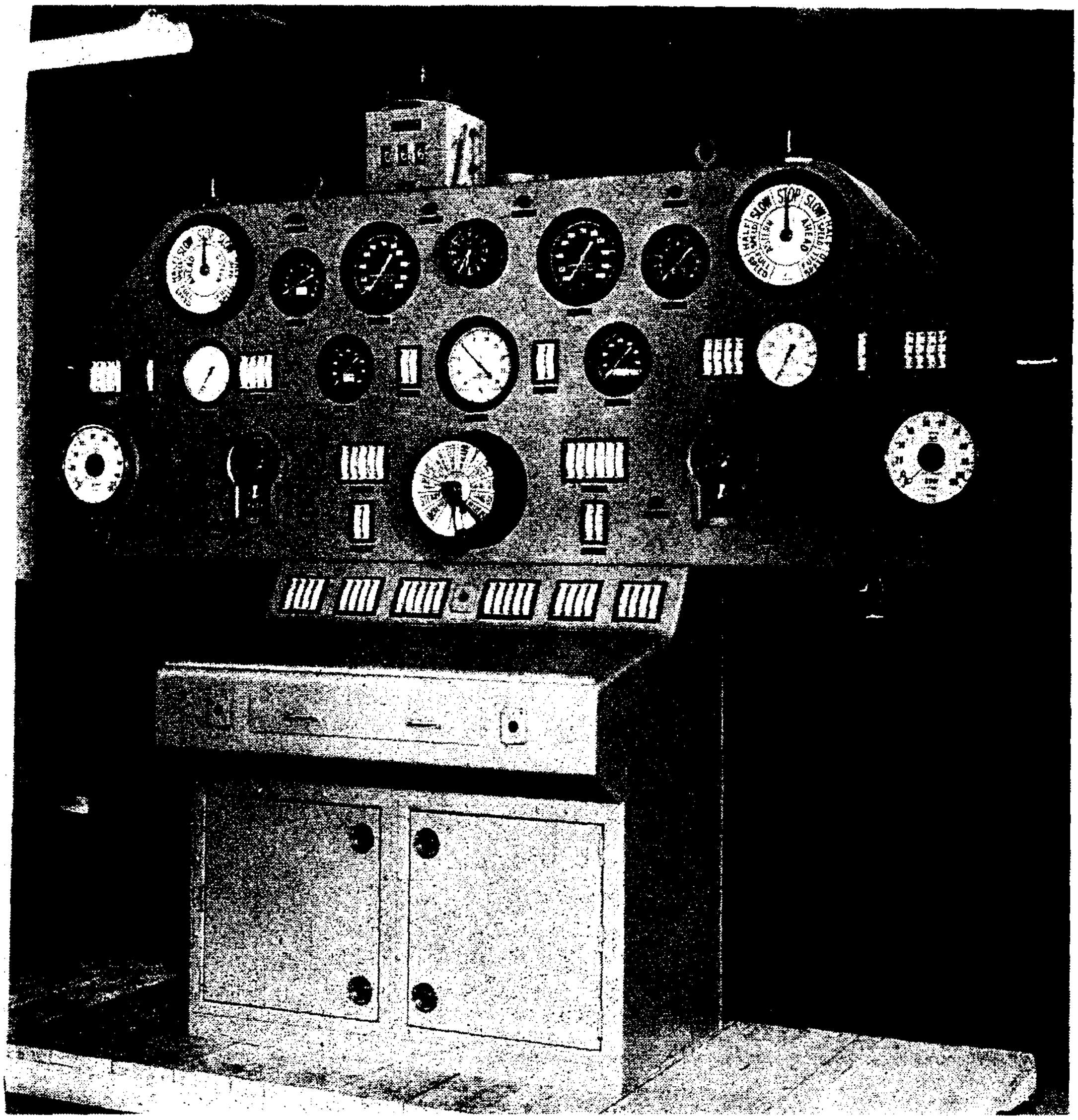
Main Reduction Gears

As Canada possessed no established large gear cutting industry already heavily committed to one particular type of gear cutting equipment, the R.C.N. were free to make a bold decision in favour of hardened and ground gears,



BOILER ROOM CONTROL CONSOLE AND PANEL

and this they did. Instead of David Brown designed, hobbed and shaved gears, a hardened and ground Maag design was chosen. This design consists of single helical double reduction gears with a top ' K ' value of 412 on the secondary pinion, which is higher than the ' K ' values used in the David Brown design. This particular change brought with it many interesting production problems such as the need for the conversion of drawings from metric scale to inches, differences in fits and tolerances and all the attendant headaches of setting up a gear cutting plant from scratch. In addition the R.C.N. added an important alteration on the original Maag design by deciding to aim for complete interchangeability of bearings. The hardening process used is petroleum gas carbonizing and the main gear cutting section of the plant has been so constructed that air conditioning maintains a temperature level of $\pm$ 2°F.



Engine Room Control Console and Panel for a ' St. Laurent ' Class A/S Escort of the Royal Canadian Navy

It was most fortunate that extensive shore testing trials were undertaken by the R.N. at Pametrada, since these trials showed conclusively the need to use a special enhanced load carrying additive oil, if scuffing of the tooth surfaces was to be avoided at powers above 60 per cent F.P. The R.C.N. have therefore had to accept the use of a special type of lubricating oil for their main engines. This is not such a grave disadvantage logistically as might appear, since it may prove possible to add the E.P. agent to standard 3 GP-357T (which is equivalent to OM 100).

A modified tooth design with lower slide/roll ratios has been produced which it is hoped may ultimately operate satisfactorily *ab initio* or, after initial running, on enhanced load carrying oil, or standard mineral oil, without detriment to the gear teeth.

Boiler Automatic Controls

At an early date in the R.C.N. programme, it was decided to fit Bailey Meter three-element feed water control instead of the Copes two-element feed water regulator. The original reason for this change arose from a desire to avoid concentrating too many of the auxiliaries with one firm (Messrs. Peacock), but this design, once taken, proved to be a blessing in disguise as a whole new field of approach to boiler operation was opened up. In order to fit this device the use of L.P. air as a control medium had to be accepted. Once this was done and a reliable system of L.P. air decided upon, the next logical step was to apply automatic air operated damper controls to maintain the superheated steam temperature constant, at any desired level.

The fitting of these controls necessitated a boiler room console in order to accommodate the hand selector switches, and control relays. This soon became expanded to take indicating gauges and, having had to fit devices for metering steam and water flow, additional indicating gauges were added for oil and air flow, with the ultimate objective of experimenting with automatic combustion control. The R.C.N. destroyer escorts are therefore provided with automatic feed water and superheat temperature control and are fitted with a modern power station type console.

Engine Room Control Panel

The appearance and design of the boiler room control console was so successful that the lessons learnt were applied to the design of the engine-room control panel, and the R.C.N. destroyer escorts are therefore fitted with a desk console between the two manœuvring hand wheels. As can be seen by the photographs, the control panel consists basically of two portions—the desk console on which are mounted Bailey Meter miniline edgewise gauges recording data not of immediate operational importance, and the vertical front which comprises a mixture of circular gauges and miniline gauges.

Those readings which are vitally necessary for the immediate control of the main engines consist of large circular gauges and are plainly visible and easily seen. Edgewise gauges have been used for those measurements of secondary importance. As might be expected, such items as boiler pressure, forced lubrication pressure, vacuum, etc., are represented by circular gauges. Motor warning lights are located adjacent to, or above, the appropriate gauges. The inside of the control panel consists of a neatly laid out arrangement of piping with all control valves grouped in an orderly fashion. The unit is prefabricated completely at the maker's works and delivered to the shipyard for installation. Detail piping drawings have been drawn up for the connection details. This method avoids the individualistic efforts which have frequently been associated with R.N. built destroyers and provides the Engineer Officer with a control position which is functional and yet neat of appearance.

Evaporators

The R.C.N., with their larger fresh water requirement than the R.N., were forced to seek an improvement on the conventional submerged tube type evaporators which had been proposed in the original Y.100 design. They accordingly selected the Maxim 10,000 U.S. g.p.d. double effect—which gave the required capacity, as well as the low weight and space requirements, general reliability, and ease of operation. The unit has been described in Vol. 6, No. 4, of the *Journal of Naval Engineering* in 'A Modern Approach to Sea Water Distillation'.

There is no doubt, however, that the original approach which this company made to the evaporator problem, by introducing a vertical corrugated monel basket-type heating element and using the principle of a cyclonic type separator for vapour purification, influenced the R.C.N.'s decision to introduce this change in the original design.

Another interesting point that has arisen, is the improvement in endurance, particularly at 5 per cent F.P., due to the economy achieved by fitting these double effect evaporators.

Generator Capacity

As previously stated, the R.C.N. considered the original R.N. generator capacity insufficient for their needs and, when the fitting of large electric galleys, improved ship's lighting and air conditioning are considered, this was not surprising. Accordingly, therefore, two steps were taken :—

(*a*) The Allens designed turbo generator was upgraded from 350 kW. to 400 kW.

(*b*) An additional 200 kW. Diesel generator was placed in the boiler room.

These changes resulted in increasing the available capacity from the R.N. figure of 1,100 kW. to 1,400 kW.

L.P. Air Compressors

With the introduction of automatic boiler controls, the L.P. air system became of paramount importance and two U.S. Navy light-weight radial two-stage, 3-cylinder air cooled motor driven compressors, operating at 50 cu ft per min. 100 lb/sq in discharge pressure, have been fitted. These units were specifically designed for the U.S. Navy for use in conjunction with combustion controls and are thus ideal for the R.C.N.'s requirements.

Oil Fuel Pumps

In the case of the second seven destroyer escorts, it was decided to replace the reciprocating oil fuel pumps by rotary. This decision was taken despite the favourable consumption curve of the steam reciprocating unit, and hence its advantageous effect on endurance, on the grounds of greater ease of maintenance and operation, particularly if automatic control or starting should ever be required. The IMO de Laval oil fuel pump was chosen, and, on study compared very favourably with the original Weir's pump both in weight and space and, surprisingly enough, even in steam consumption. The turbine is a single de Laval wheel using saturated steam.

Auxiliary Boiler

A ' D ' type natural circulation auxiliary boiler of 5,000 lb/hr capacity 100 lb/sq in saturated steam has been fitted with a semi-automatic single burner firing unit. This unit is not modulating, but operates on a low, high forcing rate controlled over a limited pressure range of 10 lb/sq in. Experience with a fully automatic ' once through ' type boiler on the converted frigates has indicated that, very considerable gain in weight and space can be achieved, and future design will almost certainly be fitted with this type of unit.

Air Conditioning Units

The R.C.N. destroyer escorts are fitted with two main air conditioning units using motor driven reciprocating compressors working on a direct expansion freon gas system, with a total capacity of 350,000 B.Th.U/hr. From these main units a chilled water ring main is led round the ship to nine air-distributing cooling stations. It is of interest to note that the modulating controls at the distributing points are air operated. As this system requires some 25 kW. for full operation, the effect on endurance is not negligible.

Minor Design Changes

The list given so far does not, of course, cover all the changes introduced by the R.C.N., but only the larger and more interesting ones. Many minor innovations have been made, such as overlapping staggered boiler water gauges, remote sited boiler water level instruments giving readings in inches of water, automatic air operated Leslie control valves for the closed exhaust pressure, and many others.

CONCLUSIONS

The basic conclusions which must be drawn from the Canadian Y.100 programme is that, although the R.C.N. have taken an R.N. machinery design, they have introduced many ideas which Great Britain would be well advised to study carefully. The chief of these are :—

(*a*) Line Production—of main engines and boilers.

(*b*) Centralized Naval Drawing Office—issuing more detailed drawings and using bulk ordering of standard items.

(*c*) Hardened and ground gears—Canadian experience in this line should be carefully studied.

(*d*) Automatic Controls—air operated automatic control and miniline gauges which lead to remote operation and the introduction of ' miniaturization ' with a view to economizing space.

(*e*) Auxiliary Boilers—the projected use of ' once through ' automatic auxiliary boilers to take the harbour hotel load.

(*f*) Evaporators—generous provision of improved design evaporators.

(*g*) Generators—generous provision of generator capacity both turbo and Diesel to meet inevitable increases in ship's load.

The combination of British naval engineering design with North American production technique has been an experiment, beneficial to both countries, and the effects of this ' marriage ' will become increasingly apparent in the years ahead.