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and research work on the subject of gun erosion, torpedo motive power, the gyroscope, submarine guns, protection against submarine, torpedo and mine attack, improvement in submarine attachments, improvement and development in submarine engines, storage batteries and propulsion, airplanes and aircraft, improvement in radio installations and such other necessary work for the benefit of the Government service, including the construction, equipment and operation of a laboratory [and] the employment of scientific civilian assistants as may become necessary." Although some of the above-enumerated functions are now prosecuted in specialized laboratories under the cognizance of various Naval bureaus, much purely scientific work is done at the Naval Research Laboratory.

Prior to this time, research in the Navy, principally restricted to radio development, was performed at the Bureau of Standards under a group financed by the Navy Department, and at various other laboratories under the cognizance of the Navy Department.

During all this period from 1918 to 1941, the Navy maintained and still maintains the closest contacts with the commercial research laboratories. The fact that the Navy found itself technologically in such splendid condition at the outbreak of war in 1941 reflects great credit on industry, on the commercial research laboratories, and those of the Navy who were so eager to embody in Naval warfare the best products of industry and the products of industry's best brains.

High Pressure and High Temperature Steam

This short title covers a large and widespread development with an interesting historical background. Prior to 1933 the design of the machinery for Naval vessels was pretty much in the hands of the so-called ship and engine builders with licenses from Parsons Ltd.

You will remember that when James Watt put a condenser on the steam engine, steam engines were quite universally used for pumping mines. It was Watt's invention or development which sent the steam engine to sea and from the time of Fulton on for a great many years the scientific development in steam engineering was to be found on Naval or commercial vessels. In other words, marine engineering led the steam engineering field.

FINAL EXAMINATION

The forty winners assembled in the inspiring surroundings of the rotunda of the National Museum to take their final written examination. Here they are hard at work.

With the invention of the Parsons and the Curtis turbines, and with the beginning under Thomas A. Edison of the great central power plants for generating light and power, the situation gradually changed until the central power plant design dominated the field of steam engineering. Thus, it became apparent to those of us who were in charge of engineering design for the Navy that in our time at least, and perhaps for a long time to come, marine engineering must derive its inspiration from the central power plant. Central power plant performance was much more efficient than Naval steam plants and to effect improvements, pressures and temperature were raised to 600 pounds and 850° F.

This was one of the wisest decisions ever made because the large American turbine manufacturers with their competent research and test facilities behind them were in a position to afford splendid support to the Navy in its effort to bring its engineering more in line with the phenomenal work which had been done in the central power plants of the United States in raising pressures and temperatures due to utilizing the great progress which had been made in metallurgy in this country.

This decision naturally encountered much opposition from those who could not realize that we had passed a big turn in the road; that intense specialization was the order of the day; that we must greatly increase the fuel efficiency of our ships, which of course, adds greatly to the cruising radius. With high pressure high temperature came high-speed turbines with much fewer blades, double-reduction gears, much improved feed-water systems, with the corresponding reduction in the oxygen content of feed water, super-heat control boilers, and many other engineering details too numerous to mention on this occasion.

Flameproof Cable

The development of flameproof cable is typical of the procedure which has happened literally thousands of times where the Navy Department goes to a group of manufacturers and asks them to create something which not only does not exist but is way beyond anything required in commerce and industry.

Multi-Engine Submarines

One of the great accomplishments of this period was the multi-engine Diesel electric drive for submarines. It has enabled us to build submarines vastly superior in performance and reliability to anything which had been produced be-