The development of a new turbine-blade material for 1200 F had been accelerated during the past years resulting in an alloy called Nivco.[2] High-temperature strength plus damping capacity were designed into this material. The turbine design was finalized too early to incorporate this development. At the present time several rows of blades made from Nivco are installed and operating satisfactorily in machines of much more moderate steam conditions. Various types of aging treatment have been found to have marked beneficial effects. Studies of such effects are continuing. Because of the critical nature of blading when applied to such extreme conditions, an enormous amount of data must be accumulated and checked before a designer may use it.

The future of high-temperature blading will benefit considerably from the research involving this new material.

Other High-Temperature Parts

Stop and control valves are exposed to steam temperatures exceeding those ever experienced in electric utility service. For long and satisfactory service, these parts must exhibit excellent creep resistance and strength at elevated temperature. Therefore the valve bodies and bonnets were made of a modified Type-316 stainless steel as are the permanent strainers mounted in the valves. The same modified Type-316 austenitic steel resulted in excellent inner cylinder castings. A modified Discaloy was used for the valve stem; the valve-stem bushings and the valve itself are Discaloy.

Conclusions

Some of the materials and many detail design features of the Eddystone superpressure machine described here have not previously been used commercially under the severe operating conditions to be encountered. However, extrapolations from other successful service have been confirmed by extensive laboratory and shop tests on components, and long-time successful operation of Philadelphia Electric Company's Eddystone No. 1 superpressure turbine is looked to optimistically.

DISCUSSION

N. L. Mochel[3]

This is the second time that I have departed from a self-imposed rule of never discussing a Westinghouse-authored paper.

For good and perhaps obvious reasons, my associates have seen fit to compress a tremendous amount of development effort into a short paper of but seven pages, with twelve illustrations. Without prejudice and with no criticism implied in either direction, had they written even in the same degree of restricted detail presentation as some of the other papers in these two Eddystone sessions, it would have been, probably, the most voluminous of the day.

In the matter of the back-up rotor forgings, I feel that some clarification is in order, since the rather condensed form of the paper may leave some impressions not entirely correct, and in one case, a little unfair.

Comparison of the properties of the several rotor forgings has been made only at room temperature and at 1200 F. I can hear, already, some of my metallurgical friends asking the obvious question—were you so foolish as to think that the 422 alloy steel or the Cr-Mo-V steel would have ample properties at 1200 F? And of course the answer is no.

No provisions have been made at Eddystone No. 1 to operate independent of the superpressure turbine. All the steam must pass through that portion of the unit. Were we to have been so unfortunate as to be unable to procure the desired Discaloy rotor, or were we to have lost it for any reason, the delay in realizing the output of this large unit would have been a most serious matter and, naturally, we wanted to guard against such a situation. The provision of back-up rotors was a logical step.

Metal temperatures in the rotor proper are not 1200 F, but somewhat lower. Further, the unit is to be first operated with inlet steam of 1100 F, later moving upward to 1150 F, and later on to 1200 F. Thus, operation could be maintained at 1100 F or at 1150 F with rotors of materials of better procurability background, and adequate for these lower temperatures, during any period necessary to procure a rotor for the maximum temperature, should such need arise for any reason.

There were conditions of procuring and manufacture of the Discaloy rotor that made back-ups desirable. There were uneasy moments during the manufacture and testing.

We ordered the G-18-B alloy rotor forging from abroad. There was good background of forging manufacture. It was hoped that this rotor would be satisfactory for maximum temperature operation. The paper records that the G-18-B rotor is comparable to the Discaloy rotor as regards the 1200 F properties, but its lower yield strength at room temperature would necessitate limiting the load which could be carried by this element. We must, in all fairness, record that when the forging was ordered the output of the superpressure turbine was planned to be at a lower kw level, and no requirement as to a higher yield strength was passed on to the supplier. The G-18-B alloy is by nature one in which the desired higher yield strength cannot be realized by heat-treatment only.

The 422 alloy steel rotor was subjected to the same stability test referred to in the paper, as applied to the Discaloy rotor, excepting the temperature was reduced from 1200 F to 1150 F and the total time was 145 hours, and it was concluded it was a stable rotor and would give unlimited service at 1150 F inlet steam.

The rotor forging ordered of the usual Cr-Mo-V steel analysis, for possible operation at 1100 F, or short interim operation at higher temperature, was actually a composite forging which could be applied to either Eddystone No. 1 or to an order for an 1100 F unit. Before it was completed, it was transferred to the other order.

Reference has been made in this paper, and in this discussion, to the Jessop-developed alloy, G-18-B. In another paper[4] in the Eddystone story, reference was made to the important control valves in the plant piping having been made of this same material. We have been much interested in this alloy as a high-temperature piping material, and the experiences at Eddystone on this material will be followed with much interest. Incidentally, it is not a completely new alloy in our experiences in this country. We have used it for all nuts operating on austenitic steel bolting at temperatures of 1050 F and 1100 F; also for valve stem guide bushings, in a nitrided state, for these same temperatures. The experience is excellent, in some eight turbines, and going back over 10 years.

[3] Manager, Metallurgical Engineering, Westinghouse Electric Corporation, Steam Division, Lester, Pa. Mem. ASME.

[4] E. C. Chapman and R. E. Lorentz, Jr., "The Selection of Materials and Fabricating Techniques for the Eddystone Boiler and Sulzer Control Valves," published in this issue, pp. 275–284.