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SUMMARY

ADVANCED ABSORBER ASSEMBLY DESIGN FOR BREEDER REACTORS

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The purpose of this work is to develop an improved breeder reactor absorber assembly design that provides economic and performance benefits relative to the reference FTR absorber assembly design.

While the reference absorber assembly design for the FTR has been shown to satisfy all required operating and safety criteria, development work has indicated that alternate designs can provide improved performance and economic benefits. The reference design consists of a bundle of 61 sealed small-diameter pins arranged in a hexagonal array. The absorber material is boron carbide in pellet form, and the cladding and duct material is 20% CW Type 316 stainless steel. The advanced absorber assembly and pin design are shown in Figures 1 and 2, respectively. This concept employs 19 large-diameter pins arranged in a circular pattern inside round duct tubes. The absorber pins are vented via a diving bell-type device used in conjunction with a porous metal frit located near the bottom of the pin. Cladding and duct material will be selected from one of the leading advanced alloys candidates.

The FTR reference absorber design is limited to an operating lifetime of nominally 600 full-power days, primarily by duct bowing and reactivity depletion considerations. Duct bowing is caused by differential irradiation-induced swelling resulting from thermal and flux gradients that exist in the reactor. With first-core stainless steel duct material, this bowing behavior will eventually lead to interference in the vertical travel of the control rods and thus limit the lifetime. Irradiation results for alloys under consideration for this advanced assembly design, however, show extremely slow in-reactor swelling rates. This performance, combined with the shorter pin lengths achievable with vented designs (no gas plena required), effectively eliminates duct bowing as a lifetime-limiting

factor for the advanced design. The transition to a bundle of fewer, larger-diameter pins with thin-walled cladding permits an increase in the total absorber material loading for the assembly. As a result, the increased reactivity worth of the advanced design allows a reactivity-limited lifetime of at least 900 full power days to be achieved. Scram response times are also improved relative to the FTR reference design. Thus, utilization of the advanced design is expected to provide at least a 50% extension in service lifetime and improved scram performance relative to the FTR reference absorber assembly design.

Experimental testing supports development of this advanced design.[1,2] A 900-day service period in the FTR will result in boron carbide burnup levels near 115×10^{20} captures/cm^3, and structural material exposures in excess of 2×10^{23} n/cm^2 (E > 0.1 MeV). The base irradiation test program is directed at characterizing the irradiation performance of boron carbide pellets to burnups well beyond this level. The feasibility of vented pin concepts has been proven in irradiation tests to moderate exposure levels[3] and testing is continuing to extend the data base to higher exposures ($\sim 100 \times 10^{20}$ captures/cm^3). Swelling behavior and mechanical properties data are being accummulated on the advanced alloy candidates at increasingly higher fluence levels. Results at a fluence of 1.5×10^{23} n/cm^2 (E > 0.1 MeV) are anticipated by 1980.

Two absorber assemblies of this advanced design are targeted for insertion in the FTR control rod system at the beginning of Cycle 4 of operation ($\sim$ April 1981). Results from these tests will provide a performance capability demonstration for advanced absorber assembly designs with extended lifetimes and the data base necessary to support further absorber assembly design optimization.

An advanced absorber assembly design has been developed for breeder reactor application that provides improved performance and lifetime behavior related to the FTR reference absorber assembly design. The advanced design will be tested in actual FTR control rod positions beginning with Cycle 4 of operation.

FIGURE 1.

ADVANCED ABSORBER ASSEMBLY

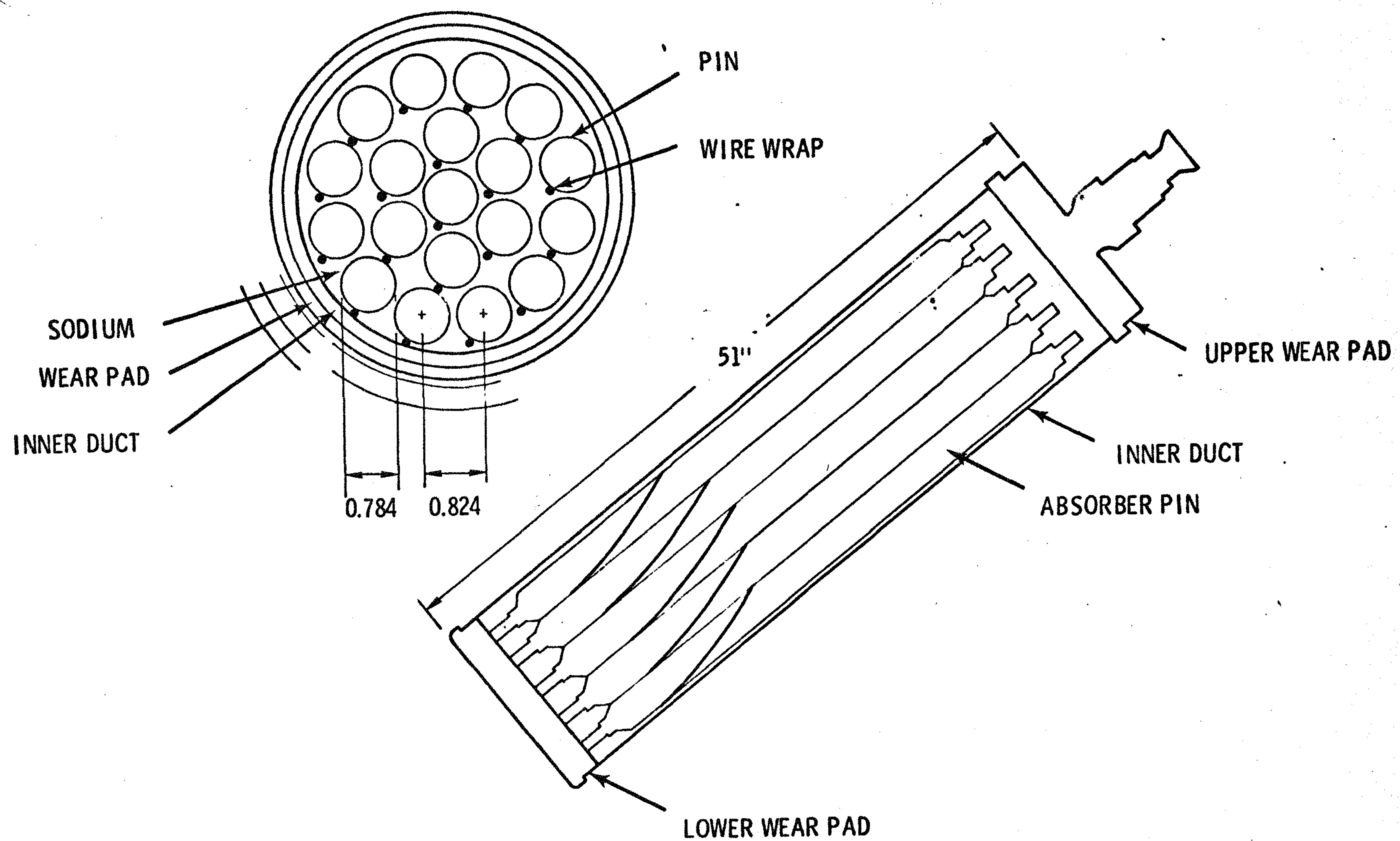
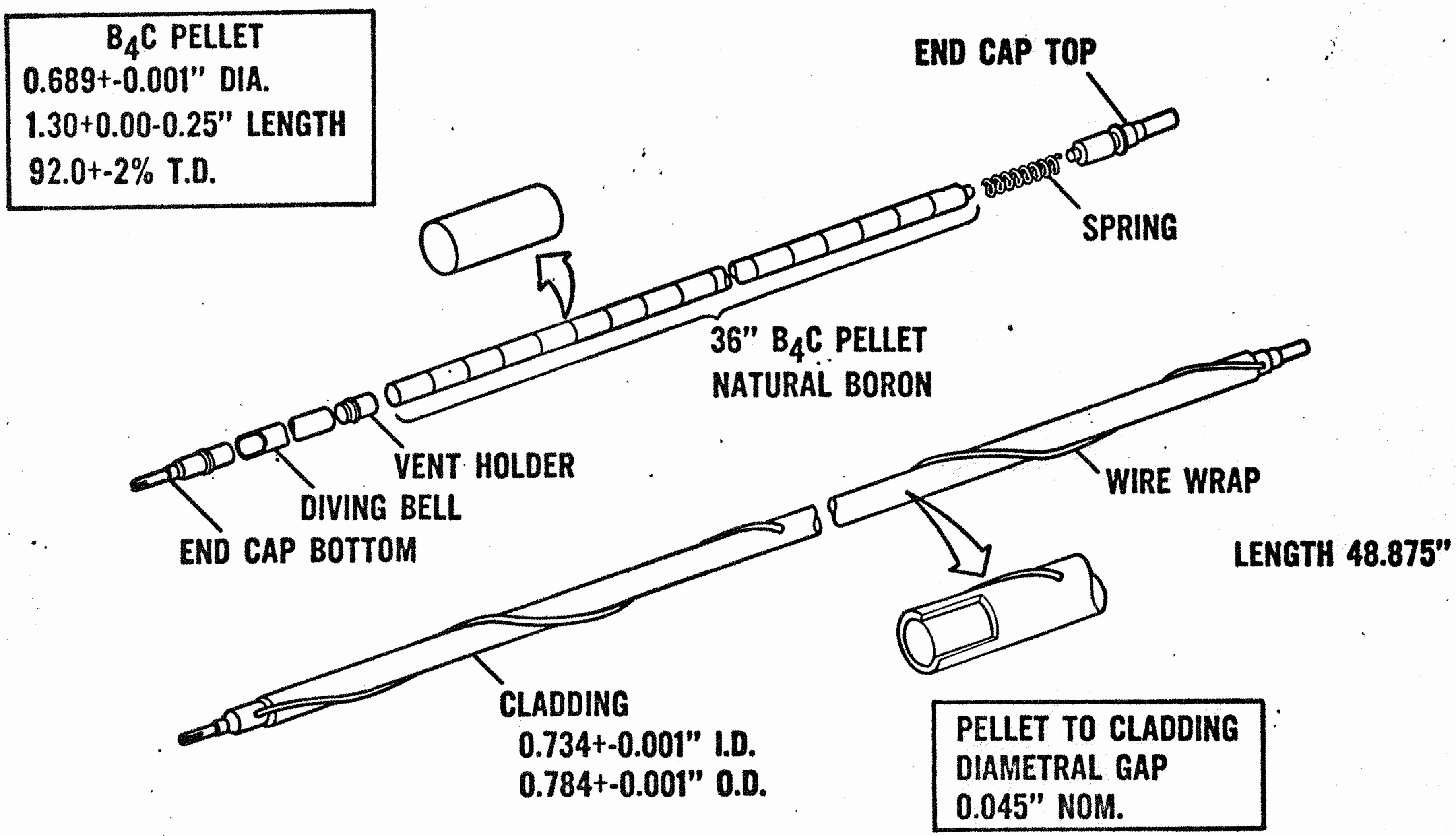


FIGURE 2.

ADVANCED ABSORBER PIN



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