MODIFICATION OF THE INTERNAL TARGET SYSTEM OF THE CS-30 COMPACT MEDICAL CYCLOTRON

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A manual-driven internal target system consisting of an improved stationary target head and target transfer assembly was constructed. Modifications of the factory supplied pneumatically-driven components enhanced routine radioisotope production capability, and reduced radiation exposure of personnel at this compact medical cyclotron facility.

Introduction

Modifications and improvements of the model 4010 internal target system[1] of the CS-30 Cyclotron manufactured by the Cyclotron Corporation (TCC) were necessary[2]. The factory supplied target holder was engaged by the water piston of the target drive assembly and was held in place by the compression of the O-rings which proved to be unsatisfactory for retaining the target on the piston. The piston was driven pneumatically into and out of the cyclotron beam path.

Quite frequently, the target holder disengaged on its outward journey, bringing the cyclotron tank up to atmospheric pressure. The target fell either inside the cyclotron tank, or in the vacuum lock of the internal target system. This caused severe disruption in production schedules and resulted in a high radiation exposure to personnel during removal of the target from the tank or the chamber.

An alternative was sought for quite sometime[3]. Our objective was to develop an internal target that could be engaged firmly and held solidly on the target drive assembly, and be driven mechanically rather than pneumatically into and out of the cyclotron tank. A satisfactory system was constructed and has been in routine use since April. 1986. We feel our experience will be of interest to radiochemists and cyclotron engineers at other compact medical cyclotron facilities[4].

Description

The modified internal target system utilizes the vacuum lock, roughing system and water flow control of the TCC's internal target system. The drive mechanism is supported on an aluminum stand (see Figure 1). The stainless steel shaft is supported in an aluminum block and is driven in and out of the cyclotron chamber by a Servo motor (M1) driving a ball screw. The aluminum block is supported by and travels on two 1" diameter stainless steel rods. A second Servo motor (M2) is mounted on the support block and rotates the shaft clockwise and counterclockwise.

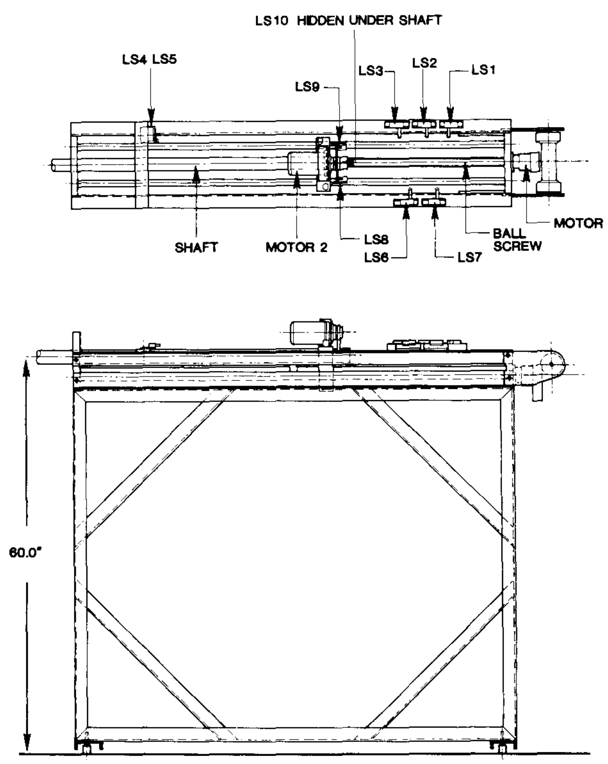

Figure 1: A schematic view of the aluminum stand, angle aluminum, stainless steel shaft, drive mechanism and various microswitch to control different stages of target from loading to the stage of irradiation and back after irradiation. M = Servo motor, LS = limit switches.

The shaft engages the target holder and is pushed out of the target carrier by M1 and rotated to the horizontal position. The shaft is driven in to the desired radius for irradiation. The shaft is electrically isolated from the support block to enabling beam current measurements. Limit switches located on the support block and frame control the motions of M1 and M2 and provide the required interlocks.The pneumatically driven internal target assembly was sealed and secured with three O-ring seals in the body of the target holder. The manual-driven shaft was fabricated with a pin that engages the target holder containing the two O-rings for vaccum seal.

The operations can be controlled manually, or at the local control panel to allow "connections" to be taken "OFF". "VENT" the target chamber. This step provides power for index to go "IN", when the chamber is at atmospheric pressure. The target connections may now be taken "OFF". With the water "OFF", activating "CONN OFF" causes M2 to rotate towards LS10 (locking pin vertical), and then energizes M1 to disengage the shaft from the target. When the shaft reaches LS1, this energizes relays removing power from the connection off relay "(CONN OFF)", and also allows the chamber valve to open as the blower is energized. A relay then de-energizes to hold the "Index In" until the sequence is restarted.

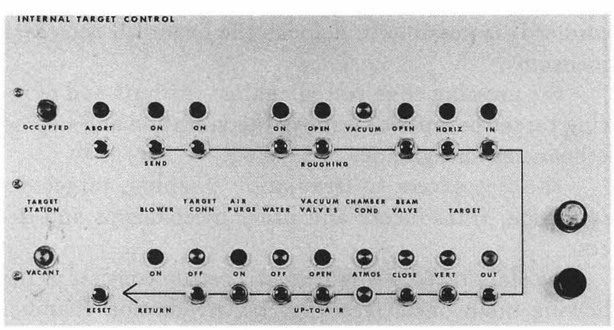

Figure 2: The Remote Control Panel, located in the main control room, showing push buttons for manual operations and the sequence of operations as indicated by the direction of arrow.

A booster pump was installed to achieve a water flow rate in excess of 5 gpm through the target head assembly with maximum pressure of 120 psi. The water flow rate of the TCC supplied internal target hand assembly was 1.5 gpm. The water passages on the target holder were enlarged from 0.25 inch to 0.453 inch. The target cooling was increased by a factor of 2.

A cross sectional schematic of the modified target head assembly is illustrated in Figure 3. With the modified internal target head and cooling water at 8 °C, it is possible to operate the identical target (e.g. ^{68}Zn, ^{112}Cd, ^{203}Tl) at 30-60% higher beam current on target than was previously possible with the TCC target assembly. The beam current routinely used for ^{67}Ga, ^{111}In and ^{201}Pb production with the target held in stationary position throughout the 1 to 6.5 hr irradiations are 50 μA; 40 μA and 65 μA, respectively. In the case of ^{124}Te targets for iodine-124 production, the target will sustain 85 μA of 15 MeV deuterons for 6-hour irradiations. The original TCC system for iodine-123 production was limited to 30 μA of 26 MeV protons.

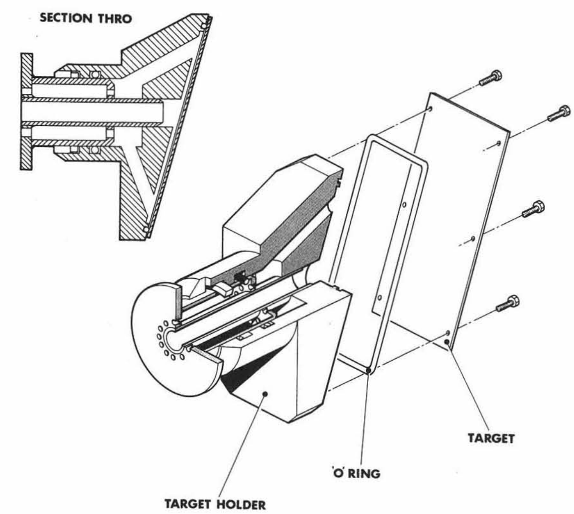

Figure 3: A three dimensional view of the modified target assembly. The scale is noted. The water cooling enters into the center of the target plate and exists at either end of the target head assemble through 0.25 inch ports.

Due to exceptional cooling in the new target assembly and subsequently the use of much higher beam currents a new and simple method of making multiple targets was developed[5].

In our experiences, we conclude that the mechanically driven internal target system with increased target cooling capability is preferred over the factory-supplied pneumatically driven internal target system. The modified internal target system was constructed in-house at an estimated cost of US$ 2,000.

References

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