FREEZING LINERS INTO "A" BRACKETS

Within recent years the practice of shrinking machinery parts by freezing instead of heating has been adopted in certain circumstances. Freezing offers several advantages, one of the most important being the absence of fire risk in confined spaces, the gear required is also more easily handled and the risk of distortion of the parts affected by the operation is lessened.

In the following article an account of freezing in phosphor bronze liners to "A" brackets of *H.M.S. Effingham*, while refitting at Devonport Dockyard is given in some detail.

The starboard inner and port outer "A" bracket bushes were found to be slack in the "A" brackets. It was decided to re-bore these "A" brackets, shrink in phosphor bronze liners and machine the existing bushes to suit the bore of the liners. In order to avoid possible distortion of the "A" bracket by heating, it was decided to effect the shrink fit by freezing the liner.

In the existing bush, four landings were arranged, which required a draw-in of about 14 in. In order to reduce the draw-in to 3½ in. for ease in fitting, the liner was provided with 8 in No. external landings. The liner was 6 feet long, approximately 2 feet in diameter with a minimum thickness of ⅞ in. In *Effingham* the shaft had to be withdrawn from the "A" bracket in a forward direction, but as the internal diameter of the liner was less than the original bore of the "A" bracket, a mock-up was made when withdrawing the shaft so as to ensure that this operation could be carried out after the liner was in place as ⅞ in. was considered to be the minimum thickness for the liner. A flange was fitted at the forward end for use when drawing in. The weight of the liner was 13½ cwt.

The external diameter of the liner was made .003 in. greater than the bore of the "A" bracket, giving a shrinkage hoop stress when fitted of about one ton per square inch and necessitating a minimum calculated reduction of temperature of 20° F. To ensure a margin to cover heat losses and possible difficulties in centring the liner, a reduction of 50° F. was proposed.

The freezing effect was obtained by the evaporation of liquid CO_2.

Blanks were provided at each end of the liner and an internal baffle consisting of a drum 4 ft. long and about 2 in. smaller in diameter than the bore of the liner fitted inside (see Fig. 1). A spiral 1 in. high and about 4 in. pitch was welded on the outside of the drum. (Subsequent experience has shown there is no necessity to fit the spiral baffle.

The CO_2 flasks were arranged in groups of three, supported in the vertical position with the outlet valves at the bottom. Pressure gauges and the necessary isolating valves were fitted to allow of fresh groups being connected when the flasks were emptied. The bottles were connected by a long and flexible pipe to an expansion valve on the forward blank. To act as an evaporation bath a small trough was welded to the inside of the blank. After evaporation in the bath the CO_2 passed around the spiral of the baffle, exhausting through a pipe at the after end. The liner was lagged by means of insulating paper and fearnought while millboard lagging was arranged externally on the blanks.

Thermometers were fitted in each blank and also tucked under the top layer of lagging at each end and in the middle of the liner. As these latter thermometers were not in contact with the liner, their readings were probably slightly above the actual temperatures of the metal.

The liner was slung immediately forward of the "A" frame.

The three CO_2 flasks forming a group were opened up simultaneously and expansion controlled at the valve on the forward blank. The rate of expansion was such that the pressure in the group fell from 650 lbs. per sq. in.

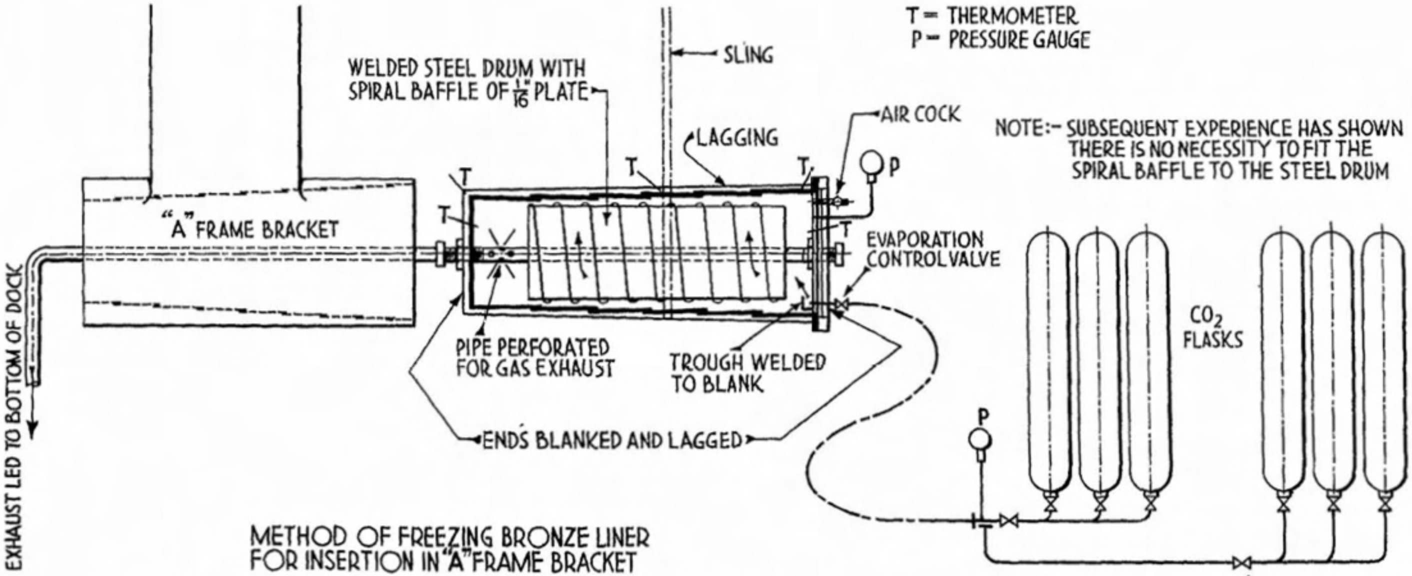

FIG. 1.—SET UP FOR FREEZING PHOSPHOR BRONZE LINER INTO "A" BRACKET AS CARRIED OUT AT DEVONPORT DOCKYARD

to 150 lbs. per sq. in. in 15-25 minutes, after which a fresh group was connected. Approximately three groups were required to reduce the temperature of the liner the necessary amount, a fourth group being utilised while the liner was being stripped of lagging and during the process of forcing home. The force required for final draw-in was provided by 2 in. No. 1½ in. diameter studs and nuts, using short spanners.

The reduction of temperature obtained was as follows :—

	Internal Temp.		External Temp.	
	For'd end	After end	For'd end	Centre	After end
Starb'd Inner { Initial 55° F.		55° F.	55° F.	55° F.	55° F.
Starb'd Inner { Final (off the scale) ..		17° F.	–33° F.	12° F.	43° F.
Port Inner { Initial 42° F.		42° F.	42° F.	42° F.	42° F.
Port Inner { Final (off the scale) ..		3° F.	–42° F.	–6° F.	27° F.

The only difficulties experienced were in the case of the starboard inner, the first liner to be frozen, and were :—

(a) Freezing up of the isolation and expansion valves, believed to be due to one flask containing a percentage of water. This necessitated the opening up of valves, etc., and caused a loss of time of one hour in the middle of the freezing process.

(b) Some non-freezing oil was applied to the liner under the paper insulation. This solidified at the cold end, so that, when unlagging, the paper had to be scraped off in small pieces instead of stripping readily.

Atmospheric conditions were very damp when the starboard inner liner was frozen in, but ice formation on the liner after removal of the lagging was very slight and was readily cleaned off when pushing the liners into place.

On removing the end blanks after the freezing-in was complete, a considerable quantity of CO_2 snow was found in the forward end, the temperature of which was probably of the order of —100° F. If the casting to be shrunk in was of a more complex nature with a liability of locked-in casting stresses, it might be undesirable to reach such local low temperatures as obtained at the forward end and which resulted in a considerable temperature gradient across the length of the casting.

Under these conditions, it would be proposed either to evaporate the CO_2 at a considerably slower rate, maintaining an interior temperature at the forward end not below —40° F., and taking probably three times as long to obtain the necessary reduction of temperature. Alternatively, if evaporation could be arranged to take place at both ends of the job, CO_2 being exhausted at the centre, the large temperature gradient would be avoided and the reduction of temperature would be obtained in about half the time.

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