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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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MINES BRANCH INVESTIGATION REPORT IR 58-175

A RETRACTABLE ANTENNA MAST

by

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SUMMARY

A description of the experimental manufacture of a spring steel tubular component of a retractable antenna mast for A.D.E. Project 58-062.

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(0 tables, 2 illus.)

INTRODUCTION

In accordance with the letter request of Col. L.R. Franklin of the Army Development Establishment, June 30, 1958, and earlier informal talks with design staff of their Electronics Section, work was undertaken on the production of a retractable strip type antenna mast for mobile use. This equipment resembles a carpenter's steel roll tape in which the slight arc of the extended tape is formed into an overlapping circle. Figure 1 shows a tape partly rolled into its storage position.

Movement of the tape in or out of a storage drum was to be accomplished with a reversible motor drive. This part of the project was to be handled by the client.

A similar device for a one shot expendable application had been made by Mr. George Klein of the National Research Council and we are indebted to him for many helpful suggestions.

PROCEDURE

The tape, 6-in. wide by 0.008-in. thick, was made of SAE 1095 steel in the annealed and severely cold-worked condition. This material is commonly known as "blued spring steel" and is available from warehouse stocks.

The tape was drawn into its tubular form through a steel cone formed of 20 gauge steel sheet. Abutting the cone's small end was a smooth bore restraining tube into which the tape was led after forming.

The cone itself was threaded by hand but the more difficult task of loading the restraining tube was done by silver brazing the tubular end of the tape to a brass plug which was in turn screwed to a draught rod. The draught rod was threaded through the tube and pulled with a chain tackle. It was necessary to refasten the tape to the brass plug after each length of tube had been loaded. The conical cone, of course, needed loading only once for each coil of tape.

Figure 2 illustrates the arrangement of tape, cone, restraining tube and pulling gear.

The tape was lubricated during drawing-in with SAE 90 lubricating oil applied with an oil wiper at the entrance of the cone.

Clamping for brazing was made very easy with a pair of worm type hose clamps.

A tape holding device made of a combination of a steel sleeve, smaller in outside diameter than the bore of the restraining tube and an expanding rubber mandrel was not entirely satisfactory due to the difficulty of keeping the lubricant off the gripped end of the tape.

The loaded restraining tubes were heat-treated for four hours at 650° and 675°F to stress relieve the contents. Due to the non-uniform temperature distribution in the furnace, the assemblies were reversed end-for-end at half time. A more resilient tube was produced at 650°F but the best joint overlap resulted from the 675°F treatment. A 700°F treatment was not satisfactory.

No attempt was made to assess the effect of time of heat-treatment as other experience would indicate that four hours was ample.

The restraining tube of 1-3/8-in. bore produced mast sections of 1-5/8-in. diameter. (The difference of 1/4-in. was the result of spring-back when the tape was removed from the restraining tube.) The diameter of 1-5/8-in. was equivalent to an overlap of approximately

0.9-in. or 65 degrees.

Two finished samples have been delivered to the client. Additional material has been ordered.

MINES BRANCH CAPACITY

The Mines Branch furnace is capable of heat-treating single lengths of 18 ft at a time and twenty lengths of 16 ft at a time. Mr. C. Cottee of the client's staff has suggested a design of an inexpensive furnace which could be built to take three or four longer units at one time.

It is doubtful if the Mines Branch could provide space for drawing-in over 20 ft long.

OUTSIDE HELP

We are indebted to Mr. C. F. Anderson, Vice-President, Page-Hersey Tubes Limited, 100 Church Street, Toronto for having manufactured the specially smooth I.D. restraining tube in several sample sizes at very short notice and at no charge.

This tubing is known as "20 gauge, electric resistance weld, special hydraulic cylinder inside finish" and is a specialty of this firm. Should future orders be placed, only the superior inside surface need be emphasized as the very close dimensional tolerance achieved in the sample lot is of no significance for this application.

OTHER EXPERIENCE

During the work, three other proposals have suggested themselves. Two of these have been tried:

(a) To form a tube of AISI Type 302 spring temper stainless steel. This involved wrapping up a strip by drawing through a forming die sufficiently small that upon spring-back it would assume the required tubular form of the correct dimension. This was not possible without a collapse of the tube into longitudinal wrinkles and these were unacceptable.

(b) The failure to work the Type 302 stainless in the spring temper suggested forming in the annealed condition and then achieving the high yield stress required by heat-treating. As Type 302 is not capable of being heat-treated and as it is not practical to heat-treat the AISI 400 series in light gauges, one of the new precipitation hardening type of stainless steel, AM 350 was tried. At yield stresses of the order of 150,000 psi obtainable by elevated temperature treatments, the permanent set of the mast tubes when re-rolled into storage position was too high and the mast section was useless after four cycles.

From the limited variety of blued steel we have seen and tested, it appears that the lower limit of useful yield stress is about 200,000 psi, measured at 0.01% offset. It is unfortunate that the type AM 350 steel was the one most readily available when the choice was made. Yield stresses of approximately 215,000 psi have been claimed for Armco types 17-7 PH and PH 17-7 Mo.

(c) A variety of blued strip is available in which the spring temper has been produced by heat-treatment instead of by cold rolling. A sample lot of tape has been ordered for trial.

CONCLUSIONS

It is our opinion that the cheapest and most satisfactory mast section will be made of the blued steel. While it is more difficult to form than the softer materials meant for post-forming hardening treatment, it is likely to make a tube of better cross-section with less expensive forming equipment. The furnace equipment is also likely to cost less.

The relative corrosion resistance of the carbon steel and stainless steel have not been compared. However, it is possible that the stainless may not show a worthwhile advantage when all the factors of use and storage are considered.

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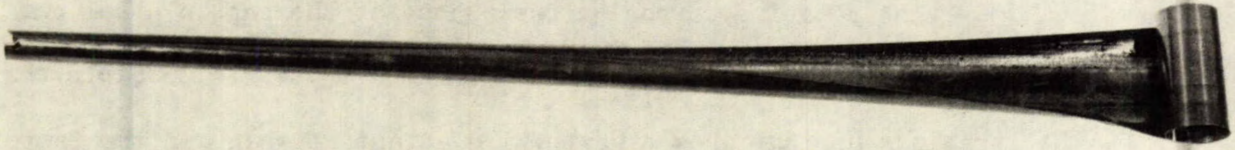

Fig. 1. - Steel Tape Partially Rerolled into Storage Position.

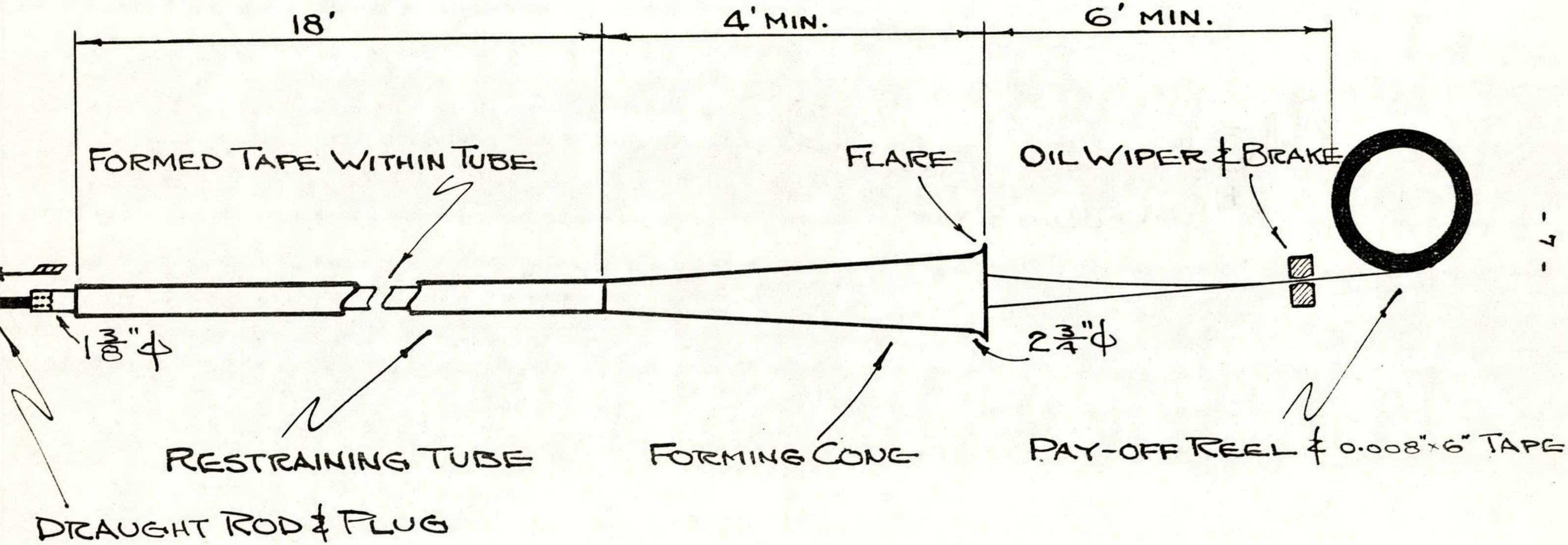

FIG 2. DIAGRAMATIC SKETCH OF FORMING GEAR