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THE BELT METHOD FOR MEASURING PRESSURE DISTRIBUTION

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THE BELT METHOD FOR MEASURING PRESSURE DISTRIBUTION

By Blake W. Corson, Jr.

SUMMARY

The measurement of pressure distribution may be accomplished rapidly for any number of locations deemed necessary in model or full-scale investigations by use of the "belt" method. Reasonable accuracy may be obtained by careful use of this method.

INTRODUCTION

In wind-tunnel investigation of engine cowlings it is desirable to obtain a clear picture of pressure distribution everywhere in the vicinity of the engine installation. The importance of pressures within the cowling which bear directly on engine cooling is obvious. Of equal interest are the pressures over various regions of the cowling exterior in that these affect the internal pressures available for engine cooling, indicate drag qualities associated with external flow, and determine the critical compressibility speed.

Full-scale engine nacelle installations recently tested were not provided with surface pressure orifices. If such provisions had been made, the time and expense for installing a satisfactory number of pressure orifices would have been excessive and the time required for connecting and disconnecting their leads whenever the cowling had to be removed would have made their use impractical. If external pressure distributions were to be measured, it would have to be by a quickly applicable method.

Since pressure measurements were desired at a large number of points, and inasmuch as surface pressure orifices were missing, these measurements could have been made by the use of a "mouse." However, the time lost during the shutdowns that would have been necessary for the relocation of the mouse made this method prohibitive also.

DESCRIPTION OF "BELT" METHOD

The construction of a mouse suggested the use of a belt of small-diameter copper tubes, sweated together, each of which is provided with a single orifice at a point where the pressure measurement is to be made. All of the tubes are sealed at one end and connected to manometer leads at the other. Such a belt may readily be placed at any location that the measurement of a pressure distribution is desired.

Since the application of a belt to the surface of a body in effect changes the shape of the body, it is realized that the pressure distribution over the body near the belt will be altered by its presence. On the other hand, the use of the belt method permits a means for obtaining a pressure distribution over a large area during a single run. Alteration to the model is inconsequential. The belt may be easily moved from one region to another on the model and may be discarded entirely upon completion of pressure-distribution measurements, leaving no impedimenta on the model to interfere with subsequent tests.

DESCRIPTION OF TEST

In order to ascertain the feasibility and reliability of this method for measuring pressure distribution, a brief test was made to determine the extent of agreement between a pressure distribution measured by the belt method and one measured by the use of surface orifices. These tests were conducted in the NACA propeller-research tunnel using a body of revolution as the model on which the pressure distributions were measured.

A photograph of the belt installed on the model is shown in figure 1. Figure 2 is a sketch showing the construction of the belt. The model used as a subject had 17 surface orifices in a plane on its upper surface. The pressure belt was made with 19 tubes, but the extreme tube at each edge was not used. A single orifice was made in each tube. Orifices were located at distances aft from the leading edge to correspond approximately to the surface orifice locations on the body. Copper tubing of 0.040-inch diameter was used for the belt, which when completed was about 3/4 inch wide. The maximum diameter of the model was

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approximately 21 inches. The leading edge of the belt was screwed to the interior surface of the lip, the belt was then bent to conform snugly with the surface of the model and was secured at the trailing edge with Scotch tape. The belt was located approximately 6 inches to one side of the plane of the surface orifices.

The leads from the pressure belt and the surface orifices were connected to the same multiple manometer and a simultaneous reading made at an airspeed of approximately 100 miles per hour.

DISCUSSION OF RESULTS

The results of the tests are shown in figure 3. Pressures were plotted directly in inches of alcohol, the plot showing variation of pressure with distances from the leading edge of the body. It can be seen that there is good agreement between the pressure distribution measured with the pressure belt and that obtained with the surface orifices. It is believed that for many investigations the slight loss of accuracy incurred by the use of a belt for measuring pressure is more than offset by the simplicity of its structure and application.

Several factors should be considered in the fabrication and use of such a belt. The maximum permissible diameter of the copper tubes used for making the belt depends on the diameter and shape of the body on which the belt is to be used. No tests have yet been made to establish this relation. The curvature of the surface probably affects the reliability of pressure measurements by the belt method. In the subject tests the air flow at the body surface was parallel to the tubes comprising the belt. It is for this type of application that the belt method is intended. Error would very likely be incurred by oblique flow over the belt.

No attempt is made here to describe refinements of fabrication or to point out the possible uses for the belt method. The test described demonstrates that the belt method used with discretion will give a measurement of pressure distribution closely approximating that obtained from the use of surface orifices.

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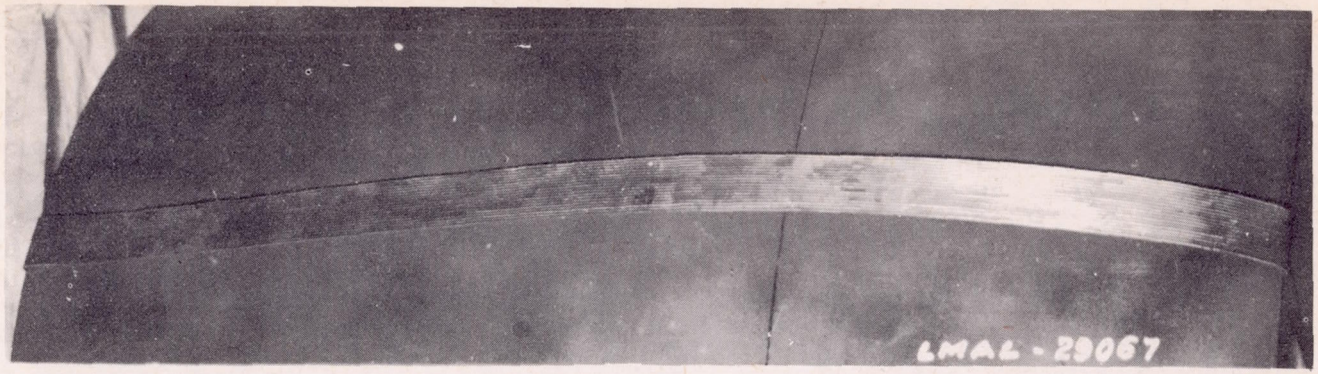

Figure 1.- Installation of belt for measuring pressure distribution.

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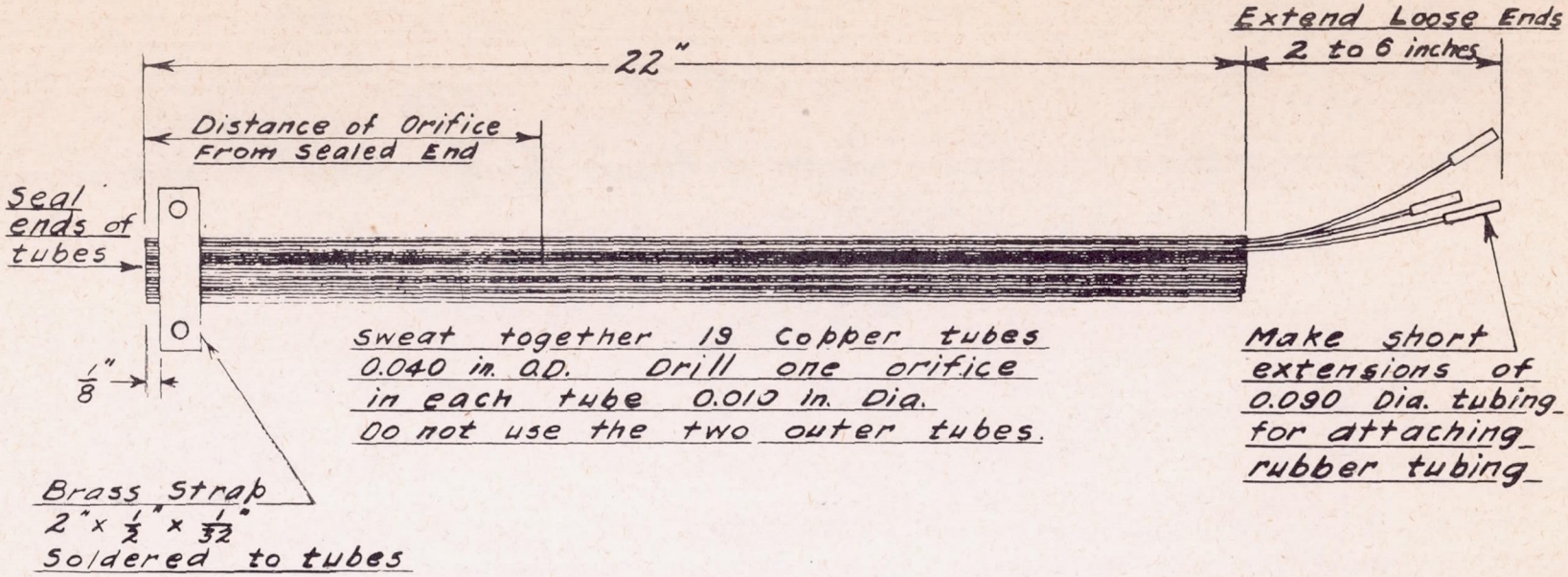

Distances of Orifices from the Sealed End, inches			
2.0	2.7	5.0	10.5
2.1	3.0	6.0	12.5
2.3	3.3	7.5	14.7
2.5	4.2	9.0	16.8
			19.0

Figure 2 - Experimental Pressure Belt For Measuring Pressures

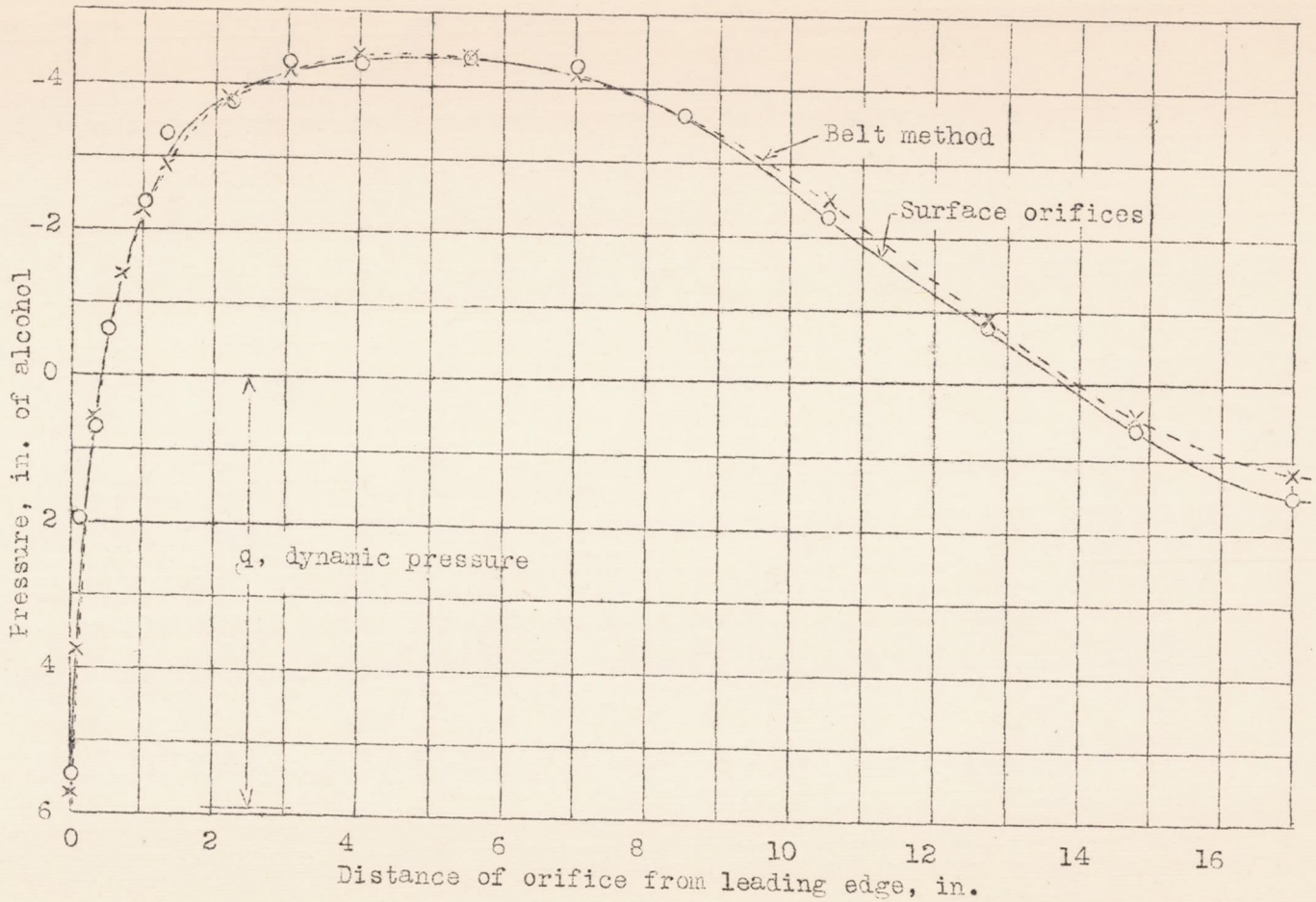

Figure 3.- Comparison of pressure measurements obtained with surface orifices and a pressure belt.

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ABSTRACT:

The belt consists of small copper tubes, sweated together, each of which is provided with a single orifice at a point where the pressure measurement is to be made. Tubes are sealed at one end and connected to manometer leads at the other. Comparison of pressure measurements obtained with surface orifices and a pressure belt is illustrated. Agreement is shown between the two methods so the slight loss of accuracy by use of the belt is more than offset by the simplicity of its structure and application.

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