TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 272

SPECIAL PROPELLER PROTRACTOR

By A. L. Heim
Forest Products Laboratory

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Introduction

Lack of equipment suitable for measuring airplane propellers at flying fields and storage depots prevents the accumulation of reliable information on the effect of storage and service on the warping and change of blade angles in propellers. Such information would be of much value in perfecting specifications for manufacture and storage, and it is thought that a single instrument for this purpose would be appreciated.

With practically all protractors of any degree of accuracy it is necessary to clamp the propeller being measured to a plane surface and measure all angles with reference to this surface. This requires a heavy plane table and equipment which is expensive and is not available at most flying fields. Furthermore, propellers cannot be measured by this type of protractor without removing them from the shaft of the engine. To overcome these difficulties a special protractor was designed and built at the Forest Products Laboratory, Madison, Wisconsin, with a view toward supplying a simple, inexpensive, practical, portable instrument for making these measurements under practically all conditions and without the use of auxiliary equipment. The work was

made possible through the cooperation of the U. S. Navy Department, by whom funds for its design and manufacture were furnished.

Description

Figures 1 and 2 show photographic views of the instrument, and Figures 3 and 4 show dimension drawings with details for use in manufacturing it.

The protractor consists of a base plate A, and two movable circles B and C. A rack is cut into the circumference of each of the movable circles, and they may be rotated by means of pinions at D and F. The letter E indicates a screw clamp which locks the circle B to the base plate A when desired, and G is a spring pin which locks circle B to circle C in a position where the zero points on the two movable circles are directly opposite. H is a 60-second level bulb rigidly fixed to circle C, with its axis perpendicular to a line connecting the center and zero graduation of this circle. K is a level bulb hinged to plate A and provided with a stop which places the axis of the bulb perpendicular to plate A when it is open. This bulb is also arranged to rotate on its axis for convenience in use. R is a metal handle which may be used to rotate circle C or C and B together if desired, instead of using the rack and pinion adjustments. A folding handle is attached to the back of the instrument as shown in Figure 2.

All measurements are made with reference to the edge M, which may be termed the "reading edge."

The first instrument constructed is entirely of brass (nickel plated) and the arrangement of parts are exactly as shown in Figures 1 and 2. Rearrangement of parts and slight changes in the details of construction were found desirable in test and these have been provided for in Figures 3 and 4, which are dimensioned drawings for use in building additional protractors. Light steel plates will replace brass, and wherever possible the fixtures will be of aluminum. The pinions will be of brass so that injury to the racks will be avoided in case it is attempted to turn the circles without releasing the clamps.

How to Measure a Propeller

The first step in measuring a propeller is to lay off, on the flat side, the center line and all measuring stations as determined from original manufacturers' drawing. These markings should be with paint if future measurements are to be made. Otherwise, a soft pencil will be satisfactory. The method of laying off these lines is indicated in Figure 5.

The next step is to place the propeller with marked side up on any suitable foundation, adjust so that the center line is level, and weight down to avoid its moving during examination. If the propeller is attached to the engine shaft simply turn it around until the center line is horizontal. The protractor may

be used as a simple level for placing the propeller in the proper position.

Having adjusted the propeller as described, the protractor is adjusted as follows:

1 - Raise bubble K, and release clamps E and G.

2 - By means of pinion D adjust scale C so that the zeros on C and B circles coincide. Then set clamp G.

3 - Place reading edge M on hub face, perpendicular to the center line, and with bulb K indicating level. Operate pinion F until bulb H indicates level. Set clamp E and loosen clamp G.

The protractor is now adjusted for all measurements for this propeller, and each of the stations is measured as follows:

Place reading edge M, along station line marked on propeller and with bulb K indicating level, operate pinion D until bulb H indicates level. The blade angle for this station is then read on circle C and vernier on circle B. (In reading the vernier always read in a direction away from the zero on circle C.)

Each of the various stations is measured in this manner, and suitable record forms should be provided so that a permanent record may be made.

For each propeller measured it is necessary to make an initial adjustment of the instrument as described in points 1, 2, and 3. This will also be necessary if the propeller moves at all during measurements.

Appendix

How to Use the Protractor to Set Detachable Blade-Type Propellers on an Airplane

By Lieut. Comdr. Clinton H. Havill, U.S.N.

For measuring and setting the blade angles of an adjustable pitch metal propeller on an airplane, the following method has been found convenient, the measurements in this case being made at one radius only:

1 - Raise bubble K, and release clamps E and G.

2 - By means of pinion D adjust scale C so that the zeros on C and B circles coincide. Then set clamp G.

3 - Place side X against the hub face, perpendicular to the crank shaft center line and with bulb K indicating level. Operate pinion F until bubble H indicates level. Set clamp E and loosen G.

The protractor is now adjusted for all measurements for this propeller and the desired blade angle is measured as follows:

Place side Y along station previously marked on the propeller and with bubble K indicating level, operate pinion D until bubble H indicates level. The blade angle is then read on circle C and vernier circle B. (In reading the vernier always read in a direction away from O on the circle C.)

For setting a propeller blade, the above procedure is varied only in that the desired angle is set on the instrument by operating pinion D and the blade turned until bulb K indicates level.

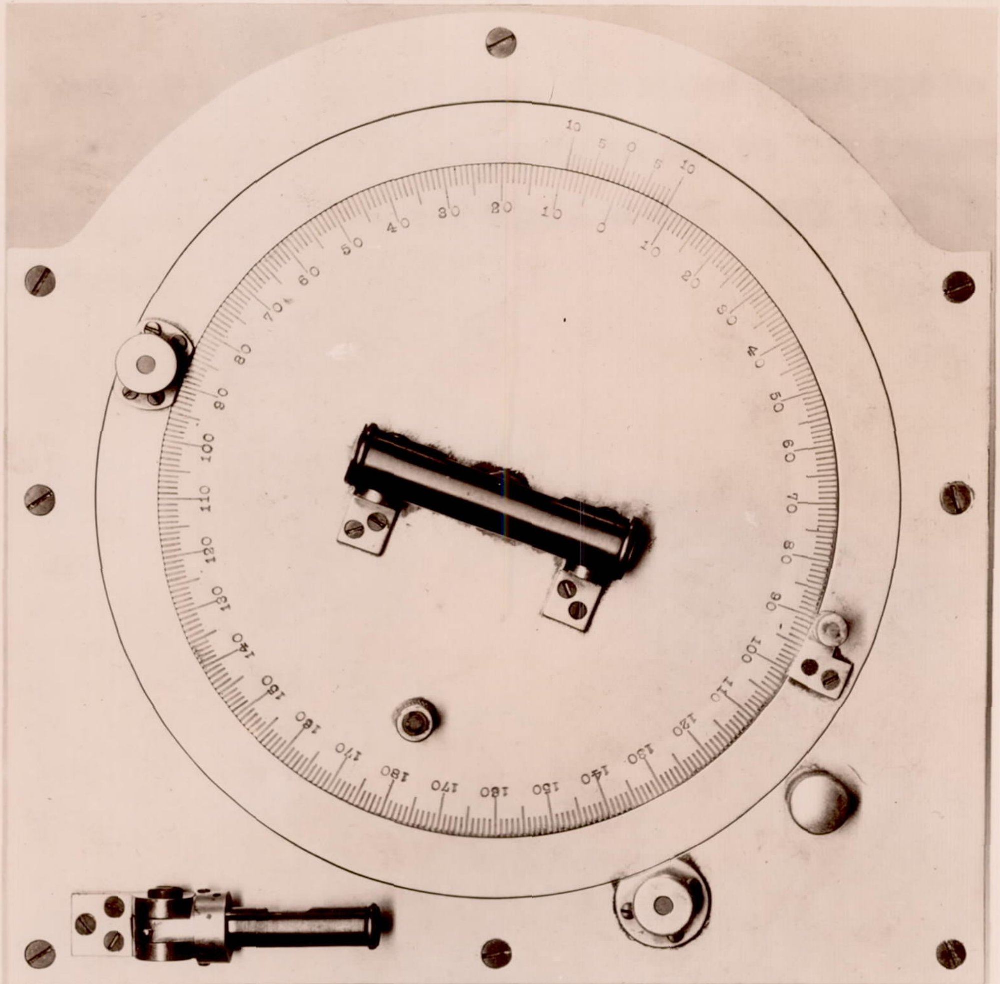

Fig.1

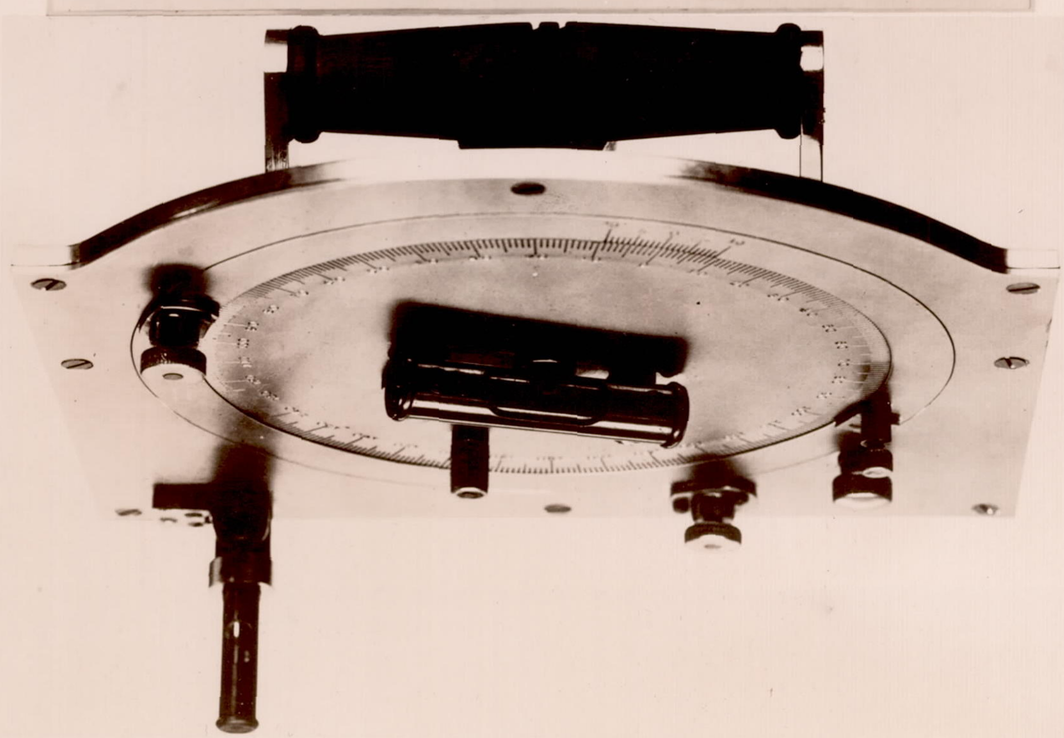

Fig.2

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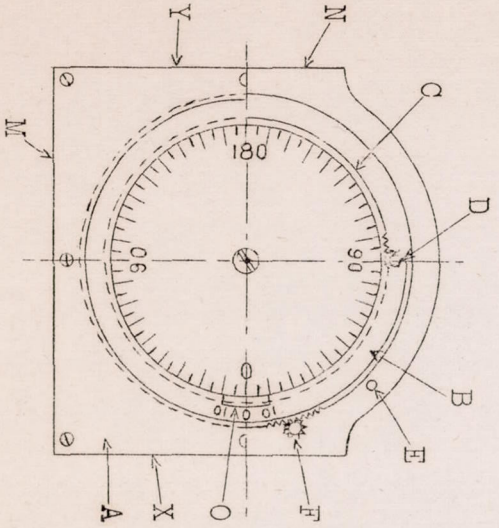

Fig.4

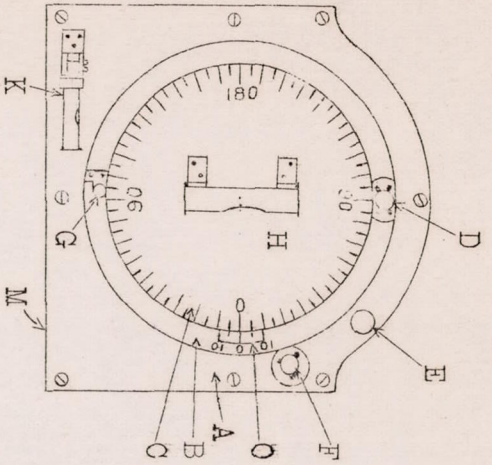

Fig.3

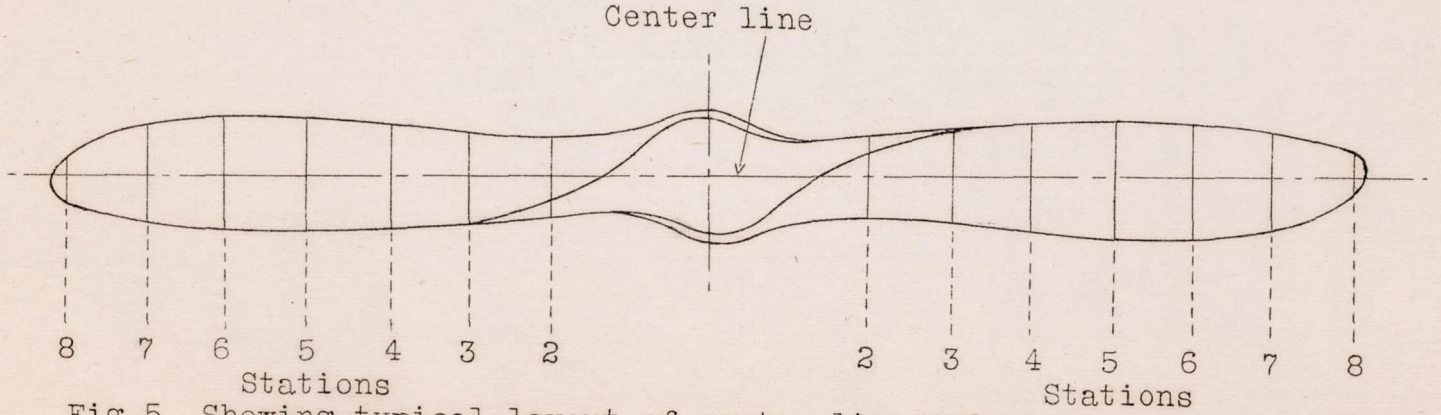

Fig.5 Showing typical layout of center line and stations on propeller blades.