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An Evaluation of Nylon Flight Progress Strip Holders

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AN EVALUATION OF NYLON FLIGHT PROGRESS STRIP HOLDERS

SUMMARY

This report describes the testing of nylon flight progress strip holders in the Airways Operations Evaluation Center and the Air Route Traffic Control Center at Indianapolis, Indiana. These strip holders were molded in one piece of Dupont's Zytel 101 in its natural ivory color The nylon holders are superior to the standard aluminum holders in respect to reducing noise and light reflections They are lighter in weight, which is advantageous in resequencing or inserting new strip holders on the boards. However, due to the lighter weight, the nylon strip holders tilt more easily when writing pressure is applied to the end section which extends outside the supporting rods on the flight progress boards. Practically all of the nylon strip holders have some bow or twist and are not as mechanically rigid as the metal strip holders.

In general, the nylon strip holders are considered satisfactory. It is recommended that a slight modification be made in the design of any additional plastic holders, which may be procured in the future, to reduce the problem of tilt.

INTRODUCTION

Previous studies have indicated that one of the principal factors contributing to noise in Air Route Traffic Control (ARTC) Centers is the noise produced by the metal strip holders on the flight progress boards. Another disadvantage of the standard aluminum strip holders is the glare produced by light reflections from edges of the holders after they have become polished from wear. In efforts to obtain improved strip holders, the Civil Aeronautics Administration (CAA) has contracted for strip holders to be made of several different materials. This report covers the evaluation of strip holders made of nylon, Zytel 101, manufactured by E. I du Pont de Nemours and Co., Inc. Four thousand of these nylon strip holders were procured from Millman-Marshall Associates under CAA Contract Cca-32793. These strip holders were shipped to the Technical Development Center (TDC) on October 15, 1957

For the test, all of the metal strip holders used in the Indianapolis ARTC Center were replaced with the nylon strip holders for 90 consecutive days. In addition, the nylon holders were used in the air traffic control simulator and the Airways Operations Evaluation Center (AOEC) at TDC This report covers the results of these usage tests and includes measurements of noise, light reflection, weight, mechanical strength, shape, and size.

NOISE

Operational use of the nylon strip holders in the ARTC Center indicates that a considerable reduction in noise in the Center is achieved when using the nylon strip holders as compared to the standard aluminum strip holders. A

previous noise study[1] of ARTC Centers by Bell Telephone Laboratories, under an AMDA-sponsored contract, indicated that the noise caused by the impact of aluminum flight strip holders has a high-frequency component and the amplitude of the ringing noise does not diminish rapidly with distance. The impact noise of nylon strip holders results in a click rather than a metallic ring.

To compare the noise produced by metal and nylon holders, a Type 759-B General Radio sound level meter was used to make a number of sound measurements The ambient room noise as measured in the AOEC was 52.1 db.

Test I.

Single holders were allowed to slide down 26 3/4-inch flight progress board rods supported at a 45° angle and strike an uncushioned wooden bumper. The noise produced by the nylon holders measured 75 0 db and by the aluminum holders, 79.8 db.

Test II.

This test was the same as Test I except that one strip holder of the same material was placed at the lower end of the board to act as a bumper This reduced the slide distance to 25 3/4 inches The noise produced by the nylon holders measured 75.0 db and by the aluminum holders, 77.5 db.

Test III.

This test was made to compare impact noise of holders dropped on the floor. Both nylon and aluminum strip holders were dropped singly a distance of 30 inches to the floor, which is steel Q-duct covered by adhesive and 1/8-inch vinyl tile. The noise meter was placed 10 inches from the point of impact. The noise produced by the nylon holders was 71.8 db and by the aluminum holders, 78.5 db.

Test IV.

The holders in this test were dropped from a height of 10 inches onto a wooden shelf. The noise meter was placed 15 inches from point of impact. The noise produced by the nylon holders measured 73.5 db and by the aluminum holders, 78.2 db.

During busy periods in the Center, more than 1,000 strip holders may be in use on the boards at one time, therefore, any reduction in noise from this source is desirable.

LIGHT REFLECTIONS

When aluminum strip holders are used, glare from light reflections is observed frequently because the edges of the holders become polished or nicked through normal use. These bright spots of reflection cause eye fatigue. Control personnel stated the nylon strip holders were superior to the aluminum holders in this respect.

[1]Bell Telephone Laboratories Task 4, Part 1, "A Noise Study of CAA Air Route Traffic Control Centers," August 31, 1954

To compare the light reflections from the metal and nylon holders, a series of measurements was made in the Indianapolis ARTC Center. Lighting in the Indianapolis ARTC Center is completely indirect from multiple fluorescent fixtures mounted near the ceiling, which is white enameled metal acoustical tile. The ambient illumination on the board measured 22.5 foot-candles using a General Electric precision light meter. A Photo Research Corp. spectra brightness spot meter was mounted on a tripod at the normal viewing angle of a controller looking at the Type A3 flight progress boards Since the field area being measured by the light meter was greater than the narrow edges of the strip holders, it was necessary to measure the light reflections from a piece of sheet aluminum placed at the same angle as the holders against the flight progress board. Comparative measurements indicated a brightness of 11 foot-lamberts, reflected from the paper strips, 65 foot-lamberts reflected from the sheet aluminum, and 11 foot-lamberts reflected from the nylon strip holders. This is excessive contrast when one considers the intelligence on the display board is carried on the paper strips, and these bright reflections from the aluminum holders are annoyance factors in viewing the desired information.

WEIGHT AND TILT FACTORS

All controllers contacted agreed that it was less tiring to handle the lighter nylon holders than the standard aluminum holders. For example, a controller lifting 15 to 20 strip holders on the board, to resequence the strips or insert a new flight strip, would exert about 1 pound lifting effort for the nylon strip holders compared to 3 to 4 pounds for lifting the aluminum holders This operation must be performed hundreds of times each day in a busy sector. The nylon holders weigh 1.18 ounces compared to 3.0 ounces for the aluminum holders

The reduction in weight, however, caused some problems in that the nylon holders tend to tilt when writing on the end section outside the support rods This tilting was the cause of the greatest number of complaints registered against the nylon strip holders Measurements were made with a teletypewriter tension gauge of the relative pressures required to cause the strip holders to tilt The results are shown in Fig. 1. With the holder at the top of a stack of strips, as would be typical for an assistant copying a new flight plan, an average of 3.75 ounces pressure caused the nylon holders to tilt, compared to an average of 8.6 ounces pressure to cause aluminum holders to tilt. With 3 strip holders above the holder tested, an average of 8.24 ounces was required to tilt the nylon holder compared to an average of 20.9 ounces to tilt the aluminum holders. It is believed that a redesign of the nylon holder may help to correct this deficiency.

PHYSICAL CHARACTERISTICS

Most of the nylon strip holders were warped or twisted to some extent when received. In this respect, the metal holders are greatly superior. Figures 2 and 3 illustrate the type of curvature found to be most prevalent. Many of the control personnel felt that the nylon strip holders tended to warp or bow further after some use on the boards due to writing on the center of the strips, however,

tests did not bear this out. One hundred nylon strip holders were unpacked from the shipping cartons and measured for curvature. The strip holders then were placed in the ARTC Center, where they underwent normal use for one week. At the end of the week, the holders again were measured to ascertain if any change had taken place. The results of this test are tabulated below Before use, it was determined that none of the nylon holders were straight.

Fifty-five per cent were bowed 1/16-inch or more, of these, 5 per cent were bowed up in the center instead of down.

Thirty-five per cent were bowed 1/32-inch or more but less than 1/16-inch.

Five per cent were bowed 1/64-inch or more but less than 1/32-inch

Five per cent were warped or twisted so that the amount of bow could not be measured.

After one week of use in the ARTC Center.

Thirty per cent showed no change.

Fifty-six per cent showed less bow, of these,7 per cent were straight.

Nine per cent showed more bow.

Five per cent were too twisted to measure

Although this twist or bow does not present too much of a problem with handwritten preparation of strips, it is doubtful that the bowed or twisted holders can be used in the mechanical strip cutter and loader which is being built for automatic loading of strips prepared by an electronic computer system

The design of the nylon strip holders varied from the aluminum holders in several respects. On the nylon holders, the bearing slots on the bottom of the holders,which support the holder on the rods of the flight progress boards, were rectangular in shape with filleted inside corners instead of semicircular, as in the case of metal holders. In addition, the actual bearing surface also was reduced, since only about 1/8-inch of the upper and lower edges of the nylon holders was used for support on the rods, whereas with the metal blocks, the entire width of the aluminum strip holders is used for support. This rectangular design allowed the holders to move from side to side on the rods when the strips were being written upon, and this extra movement was considered undesirable and annoying by the control personnel. In view of this, it appears that the nylon strip holders should have a semicircular rod bearing slot similar to that used on the present aluminum holders.

The nylon strip holders tested are a light cream or ivory color. This neutral color appears very satisfactory and met with the approval of control personnel.

Information gained during the test period indicated that the nylon material, Zytel 101, used in the holders had hygroscopic characteristics To test the effects of absorption of moisture, the major dimensions of one strip holder were measured accurately by micrometer prior to and after a 24-hour period of immersion in water. The results of this test are given below.

TABLE I

DIMENSIONAL CHANGE DUE TO MOISTURE
(All Dimensions in Inches)

	Length	Width	Bed Thickness	Bow
Before	7 916	1.123	0.128	0 045
After	7.927	1.130	0.131	0.045

Since the humidity in operating facilities normally does not vary by great amounts, and since the tolerances of flight progress boards are rather large, dimensional variations due to moisture should be of no consequence

No complaints were registered by control personnel relative to abrasion on the fingers. Apparently, nylon strip holders were superior to metal holders in this respect, as no sharp edges or burrs were noted after the period of use.

Center personnel could determine no appreciable difference between nylon or aluminum strip holders when loading or unloading. As with metal holders, it frequently is necessary to insert more than one paper strip to provide sufficient friction so that the strips will not slide in the holders.

CONCLUSIONS

The nylon strip holders are superior to aluminum holders in the following respects

1. Less glare is reflected into the controller's eyes.
2. Impact noise is reduced.
3. The lighter weight lessens controller fatigue.
4. The absence of nicks and burrs reduces abrasion on the fingers

The nylon strip holders tested are inferior to aluminum holders in the following respects·

1. The shape and size of the bearing slot permits more side movement on the rods.

2. The light weight allows the holders to tilt when writing pressure is applied to the ends protruding beyond the supporting rods.

3. Most of the nylon holders were bowed or twisted. (Automatic strip loaders may not be able to load bent or crooked holders.)

Personnel participating in the tests preferred the nylon holders to any holders used previously

RECOMMENDATIONS

To overcome the mechanical deficiencies noted in the nylon strip holders, it is recommended that any additional procurement should be of a design similar to that shown in Fig. 4. The end section should be deepened to reduce travel when the strip holder tilts under writing pressure on the ends of the strip. The bearing slot for supporting the holders on the rods on the flight progress boards should be semicircular and shaped to fit the rods with a minimum of side movement. It also is recommended that specifications call for strip holders that are straight with bow not to exceed plus or minus 1/32-inch. The possibility of using metal reinforcements molded into the holders should be considered.

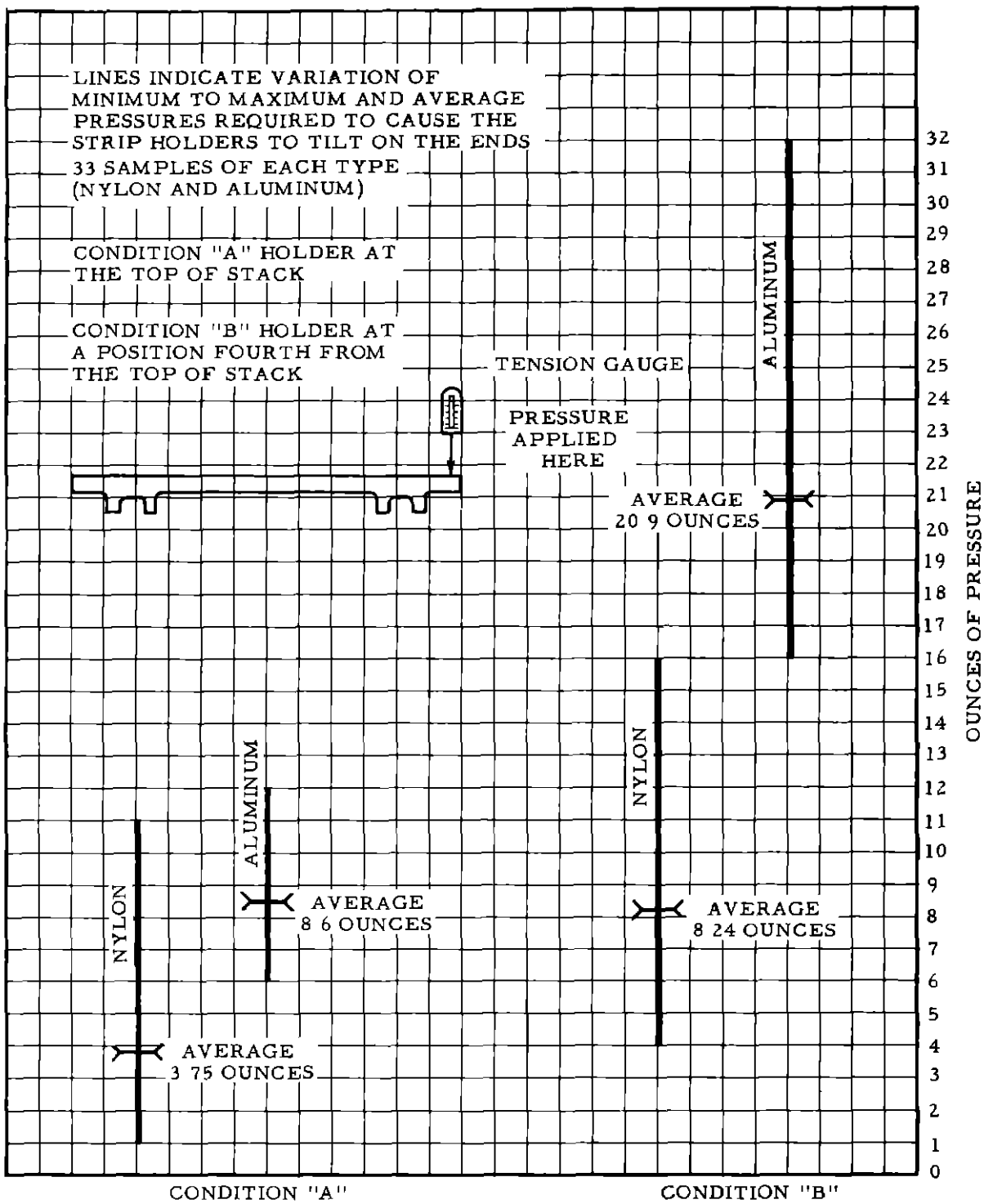

FIG 1 A COMPARISON OF PRESSURES WHICH CAUSED THE STRIP HOLDERS TO TILT

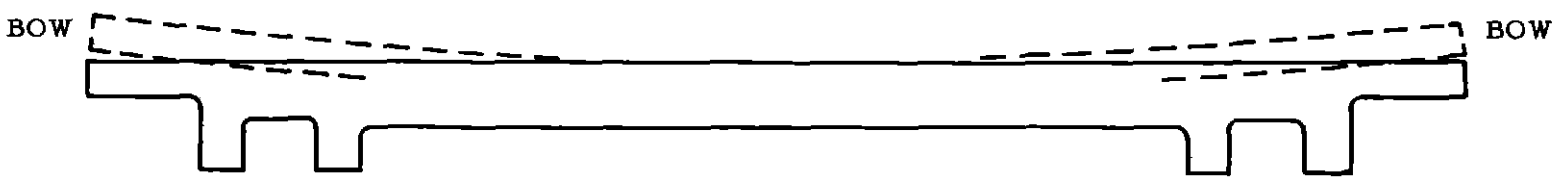

FIG 2 EXAGGERATED ILLUSTRATION OF BOW IN NYLON STRIP HOLDERS

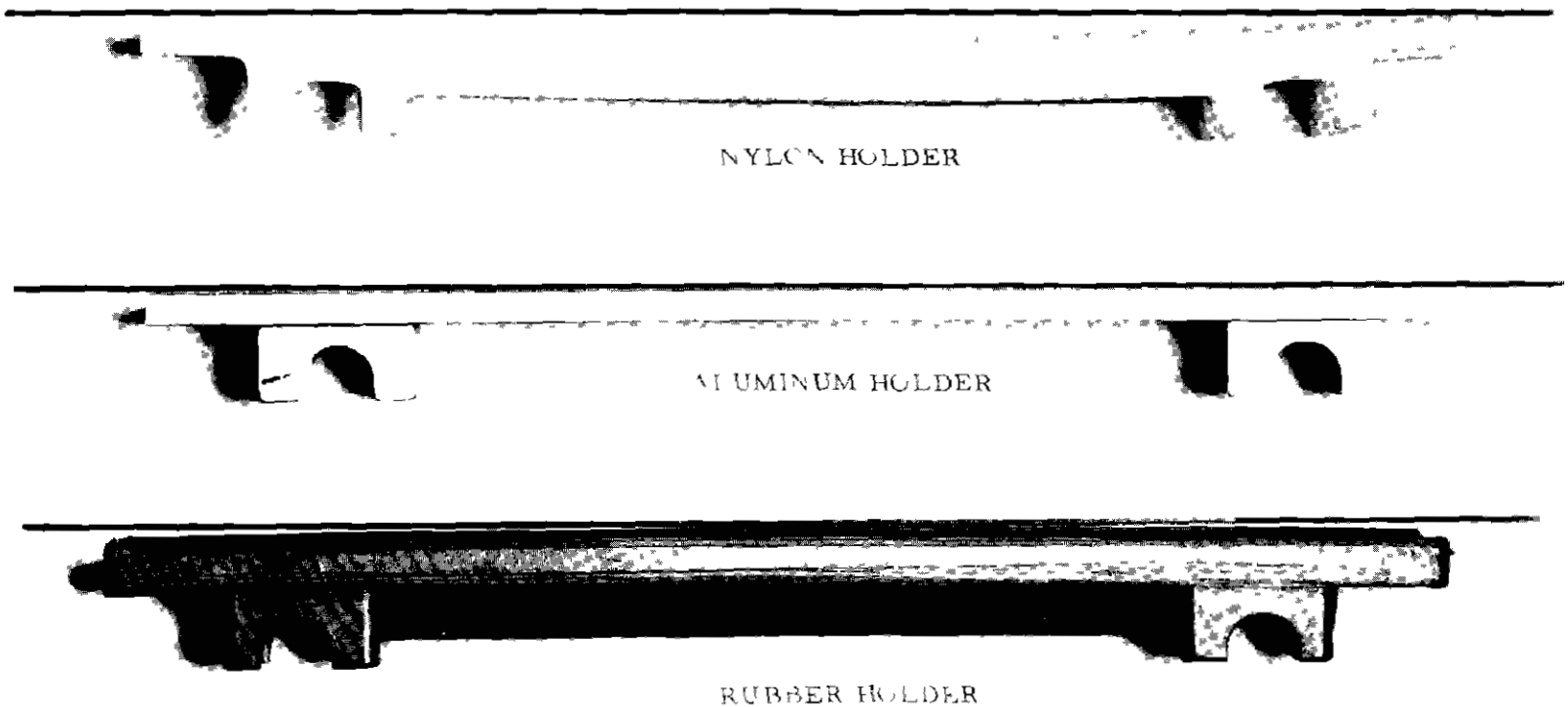

FIG 3 FLIGHT PROGRESS STRIP HOLDERS

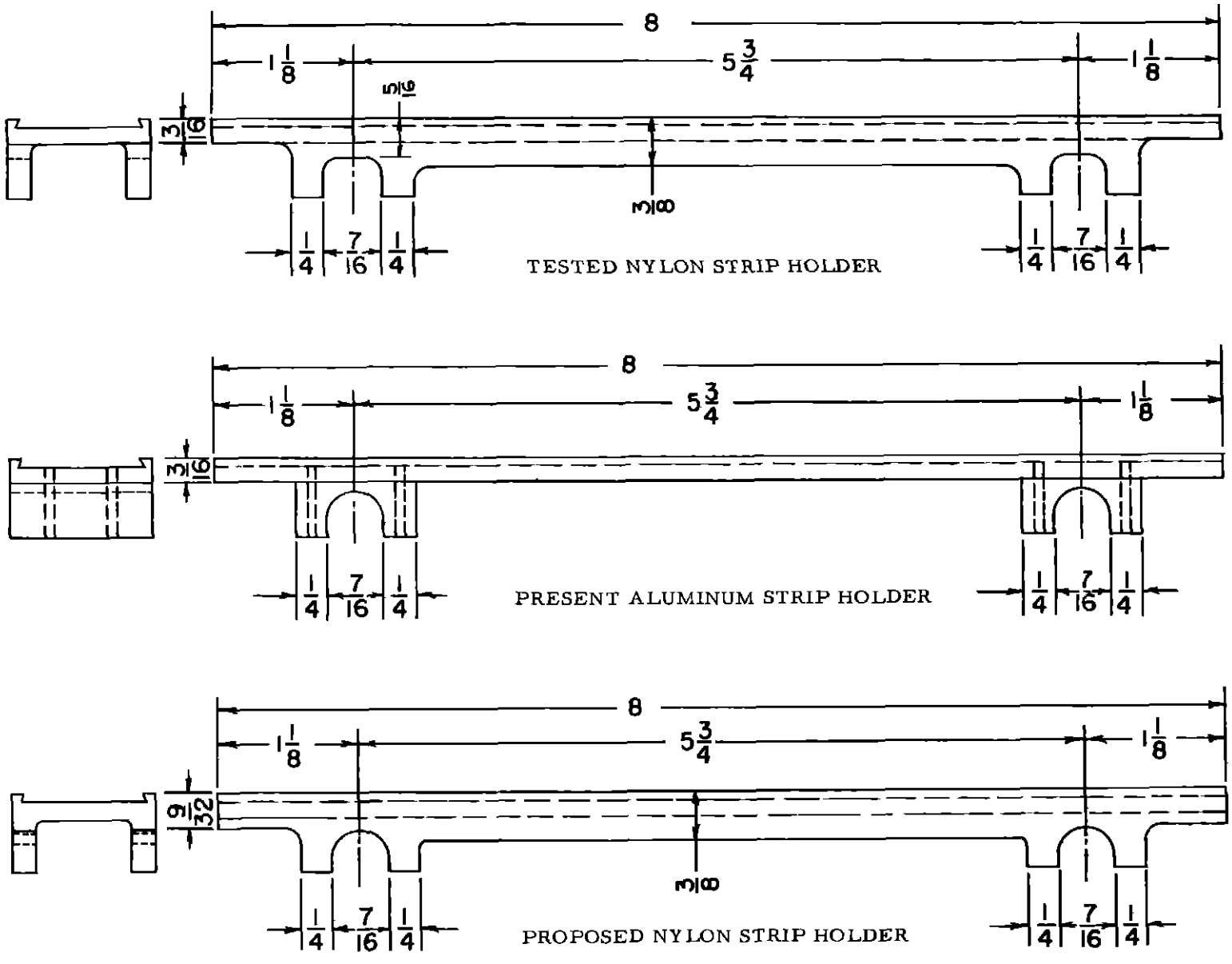

FIG 4 DETAIL OF FLIGHT PROGRESS STRIP HOLDERS