ARMY MEDICAL RESEARCH LABORATORY

FORT KNOX, KENTUCKY

REPORT NO. 11

Reprinted from
Medical Department Field Research Laboratory Project No. 57-5
30 September 1947

PLASTIC EAR MOLD FOR COMMUNICATIONS EQUIPMENT*

*Sub-project under Studies of Physiological and Psychological Problems of Military Personnel in Relation to Equipment, Environment and Military Tasks. (MDFRL-57). Approved by CG, ASF, 31 May 1946.

MEDICAL RESEARCH AND DEVELOPMENT BOARD
OFFICE OF THE SURGEON GENERAL
DEPARTMENT OF THE ARMY

REPORT NO. 11

PLASTIC EAR MOLD FOR COMMUNICATIONS EQUIPMENT*

by

Joseph H. St. John, Capt., M.C.

from

Medical Department Field Research Laboratory
Fort Knox, Kentucky, 30 September 1947

*Sub-project under Studies of Physiological and Psychological Problems of Military Personnel in Relation to Equipment, Environment and Military Tasks. (MDFRL-57). Approved by CG, ASF, 31 May 1946.

Project No. 57-5 30 September 1947
MEDEA

ABSTRACT

PLASTIC EAR MOLD FOR COMMUNICATIONS EQUIPMENT

OBJECT

To investigate the local physiological implications of the utilization of plastic ear molds for communications equipment. The problem included (1) possible injury to the ear from physical trauma, blast concussion dynamics, discordant radio reception and manual manipulation of molds; (2) consideration of the comfort of such molds in extreme cold and hot climates; (3) consideration of the production of a universal type plastic ear mold for all subjects.

RESULTS AND CONCLUSIONS

Moderate physical blows to an inserted mold produced pain and erythema within the external auditory canal. Because of the rigid structure of the subject device, a more severe or heavier blow might possibly fracture the bony structure of the external auditory canal.

The plastic ear mold HS-30 receiver headset combination, in which the mold canal is occluded, afforded a partial protection against temporary hearing loss from concussion of gunfire but this protection disappeared when the ear mold was used without the attached HS-30 receiver headset, in which the mold canal was patent.

Temporary hearing loss from field radio communication was less with the plastic ear mold HS-30 receiver headset combination than with the tank headset H16/U. A greater signal to noise ratio of field radio communication was noted with the plastic ear mold HS-30 receiver headset combination than with the tank headset H16/U because a lower volume control setting for adequate reception was required.

Moderate manual manipulation of the plastic ear mold or its use in extremes of environmental temperature produced no injury to the ear.

A satisfactory universal plastic ear mold was not obtained because of the variations in anatomical characteristics of the individual ear.

RECOMMENDATIONS

The plastic ear mold is not recommended for general use, but may be suitable for individual use in specialized situations.

Submitted by:
Joseph H. St. John, Capt., M.C.

Approved /s/ Ray G. Daggs
RAY G. DAGGS
Director of Research

Approved /s/ Frederick J. Knoblauch
FREDERICK J. KNOBLAUCH
Lt. Colonel, M.C.
Commanding

(REPRINTED)

PLASTIC EAR MOLD FOR COMMUNICATIONS EQUIPMENT

I. INTRODUCTION

This project was initiated to investigate the local physicological implications of the utilization of plastic ear molds for communications equipment. The problem included (1) investigation of possible injury to the ear from physical trauma, blast concussion dynamics, discordant radio reception and mannual manipulation of molds; (2) consideration of the comfort of such molds in extreme cold and in hot climates; (3) consideration of the production of a universal type plastic ear mold for all subjects.

This report completes the investigation directed by the Office of The Surgeon General, letter dated 12 September 1946, MEDDH, "Plastic ear molds for communications equipment."

II. EXPERIMENTAL

A. Apparatus and Methods

The basic apparatus used in the above test consisted of plastic ear molds (Fig. 1) fabricated at this laboratory according to the method outlined by Lt. Col. G. A. McCracken (1) and a standard receiver headset, HS-30, adapted for rapid fastening to the plastic ear mold.

To determine possible injury to the ear from physical blows, pressure was applied with the fingers at various angles to the body of the molds inserted into the ears of 8 subjects. Upon complaint of discomfort or pain, otoscopic examinations were performed. An otoscopic examination was performed on one subject 24 hours after he received an accidental blow over both ears while wearing plastic ear molds under a thin cotton helmet.

Hearing loss from concussion of gunfire while wearing plastic ear molds was determined in the field at Fort Knox, Kentucky. Normal base line audiograms of 5 subjects were compared with audiograms on the same subjects taken immediately following exposure to the blast concussion of 3 successive rounds of a 90 mm. gun with the subject 20 feet behind and facing the muzzle. A Standard Maico audiometer with 10 pure tone frequencies from

128 to 11,584 cycles per second was used for measurement of hearing loss. The experiment was done in triplicate under each of the following conditions: (1) with the plastic ear mold and HS-30 combination in right ear and the left ear open; (2) with the plastic ear mold and HS-30 combination in left ear with the right ear open; (3) with plastic ear molds in both ears without the attached receivers (mold canal patent).

Hearing loss and rate of recovery to the normal base line audiogram under field radio communication were determined in the field at Task Force Furnace, Yuma, Arizona. The radio receiver and transmitter were of the BC-620 type. Immediately following a 2 hour period of radio communication, audiograms of 3 subjects were taken and again at 30 minute, 2, 4, and 24 hour intervals. Duplicate tests were done on each subject to compare plastic ear mold HS-30 combination with the standard tank head-set H16/U. Signal readability was maintained constant by the subject when using the two types of headsets by adjustment of the receiver volume control.

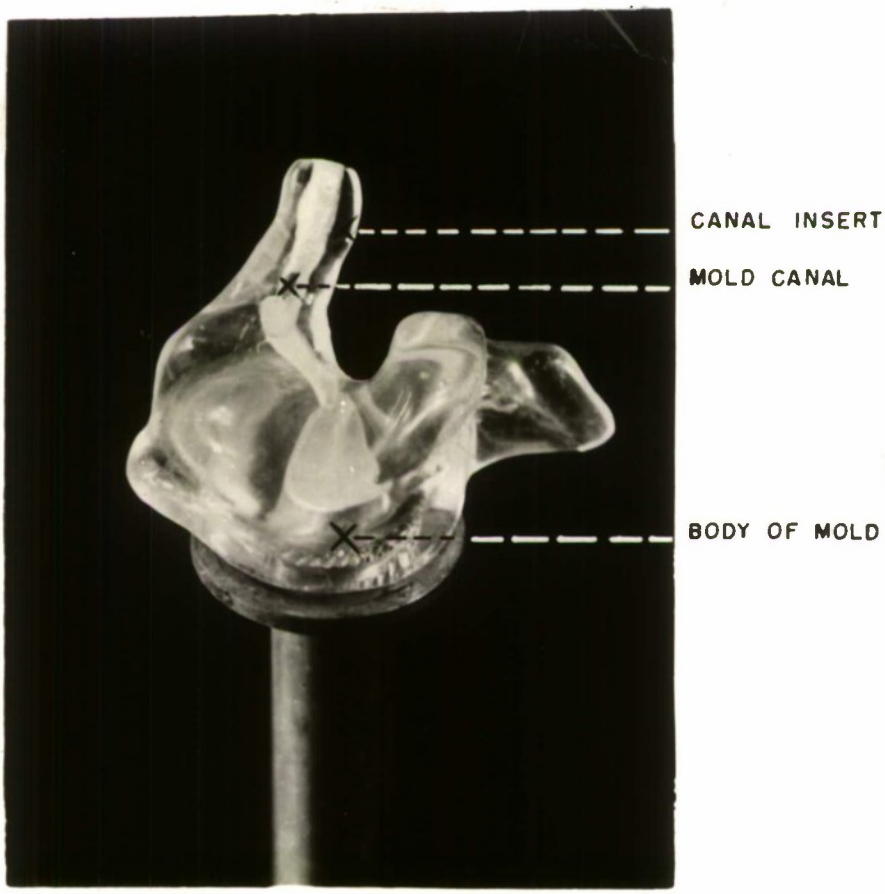

FIG. 1. PLASTIC EAR MOLD

Possible damage to the ear from manual manipulation of the plastic ear mold was determined in 8 subjects. Separate auditory histories and otoscopic examinations were done before and after each of the following test conditions: (1) 48 hours of continuous wearing of the molds, the subject inserting and removing the molds without prior instruction; (2) a daily 8 hour period for 5 consecutive days, with the molds correctly inserted and removed every half hour; (3) a daily 8 hour period of continuous wearing of molds on 5 consecutive days, with the molds correctly inserted and removed.

Comfort of the plastic ear mold, in both arctic and desert temperatures was evaluated.* Three subjects wore the plastic ear molds under arctic conditions at Fort Churchill, Canada during the winter 1946-1947; 4 subjects wore them an average of 4 hours daily for a period of 2 weeks at Task Force Furnace, Yuma, Arizona, during June-July 1947.

In considering the possibility of developing a universal plastic ear mold each of 10 subjects received trial fittings of 10 different pairs of plastic ear molds made to fit other subjects but not specifically designed for these subjects. Their degree of fit, comfort and acoustic seal was ascertained.

B. RESULTS

Physical blows produced various effects on the ears into which plastic ear molds were inserted. Moderate pressure, on the body of the inserted mold, in the direction of the auditory canal produced no pain or evidence of injury (otoscopic examination); at all other angles, it produced discomfort. Heavy pressure produced pain and a resultant transient erythema of the auditory canal (otoscopic examination). Moderate erythema of the external auditory canals was noted in the subject who had received an accidental blow to both ears 24 hours prior to otoscopic examination.

Audiometric curves, following exposure to blast concussion, showed a partial protection against temporary deafness with the subject wearing the plastic ear mold HS-30 receiver headset combination but this protection disappeared when the plastic ear molds

*Fort Churchill, Canada, day temperature range -20° to -40° F.
Yuma, Arizona, day temperature range 100° to 120° F. June-July.

were worn without the attached HS-30 receiver headset, that is, with the mold canal patent (cf. Figs. 2 and 3).

Tests under field radio communication showed that a lesser temporary hearing loss was produced when using the plastic ear mold HS-30 receiver headset combination than when using the tank headset H16/U. However, audiograms with either type of headset approximated the control levels within 4 hours after the 2 hour period of radio communication (Fig. 4). For the same readability of reception, the volume control of the receiver averaged one fourth open when using the plastic ear mold HS-30 combination as compared to one third open when using the tank headset H16/U.

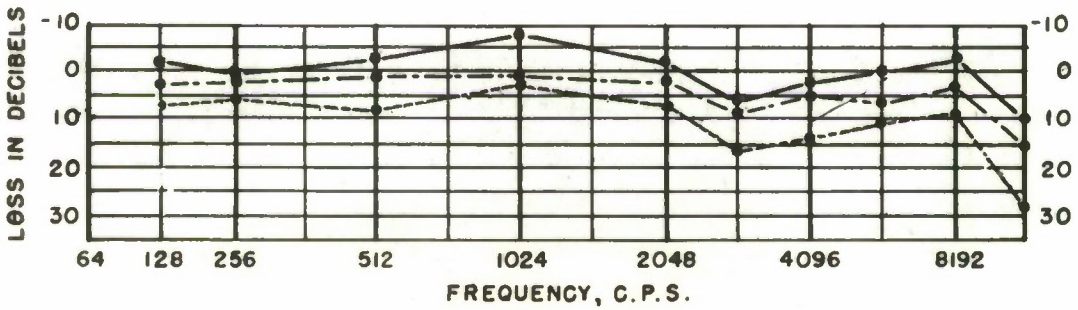

FIG. 2. AVERAGE AUDIOGRAMS OF 5 SUBJECTS BEFORE AND IMMEDIATELY AFTER 3 SEPARATE EXPOSURE PERIODS TO 3 SUCCESSIVE ROUNDS OF 90 MM GUN BLAST

LEGEND

AVERAGE NORMAL AUDIOGRAMS

PLASTIC EAR MOLD & HS-30 RECEIVER HEADSET

WITHOUT PLASTIC EAR MOLDS (EARS OPEN)

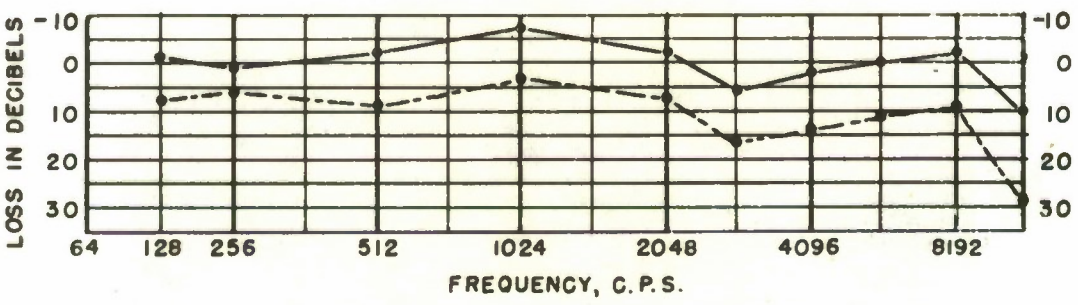

FIG. 3. AVERAGE AUDIOGRAMS OF 5 SUBJECTS BEFORE AND IMMEDIATELY AFTER 3 SEPARATE EXPOSURE PERIODS TO 3 SUCCESSIVE ROUNDS OF 90 MM GUN BLAST

LEGEND

AVERAGE NORMAL AUDIOGRAMS

WEARING PLASTIC EAR MOLDS WITHOUT ATTACHED HS-30

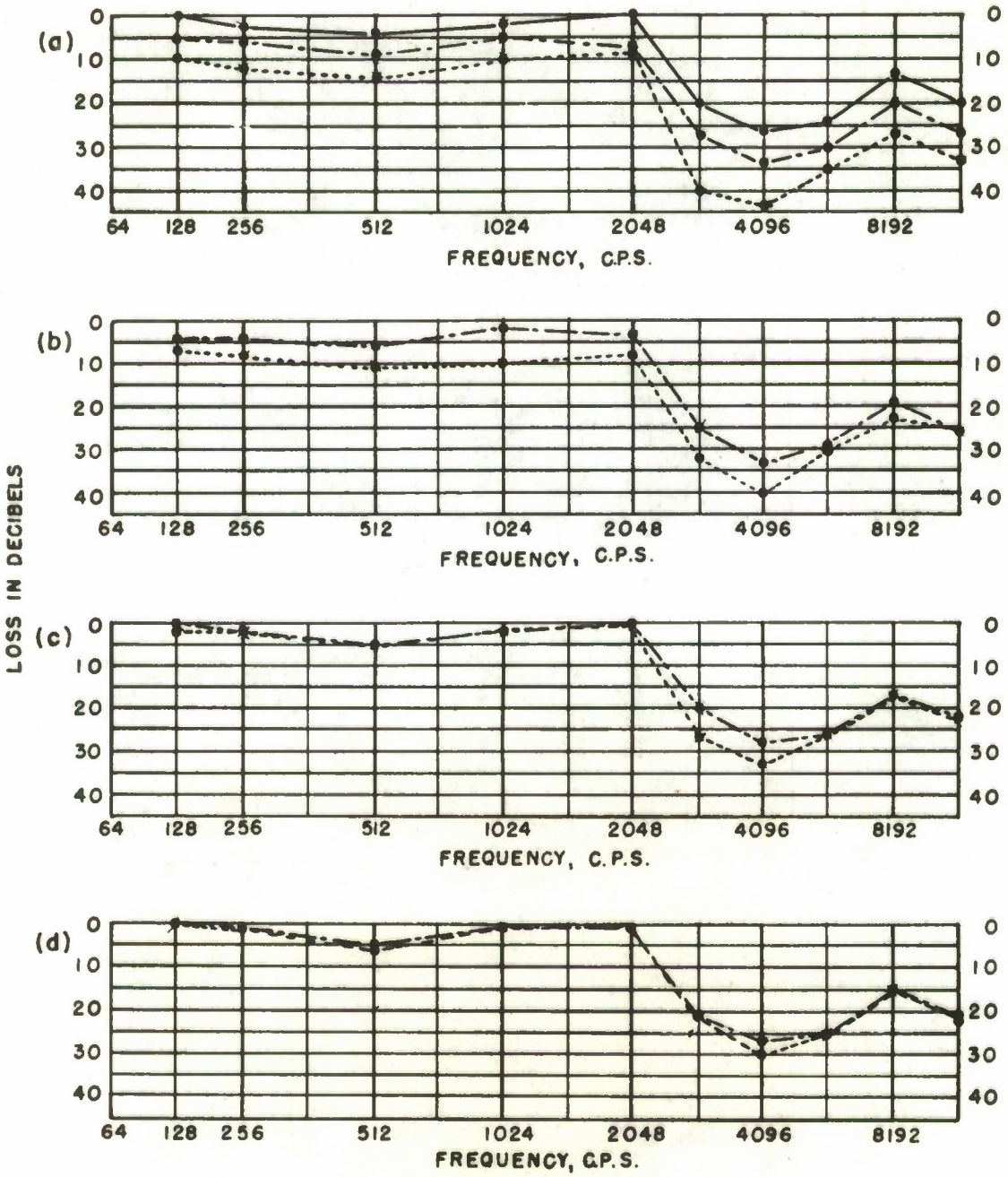

FIG. 4. AVERAGE AUDIOGRAMS OF 3 SUBJECTS BEFORE AND AFTER 2 SEPARATE EXPOSURES TO 2 HOURS OF FIELD RADIO COMMUNICATION

(a) IMMEDIATELY AFTER EXPOSURE
(b) 30 MIN. AFTER EXPOSURE
(c) 2 HRS. AFTER EXPOSURE
(d) 4 HRS. AFTER EXPOSURE

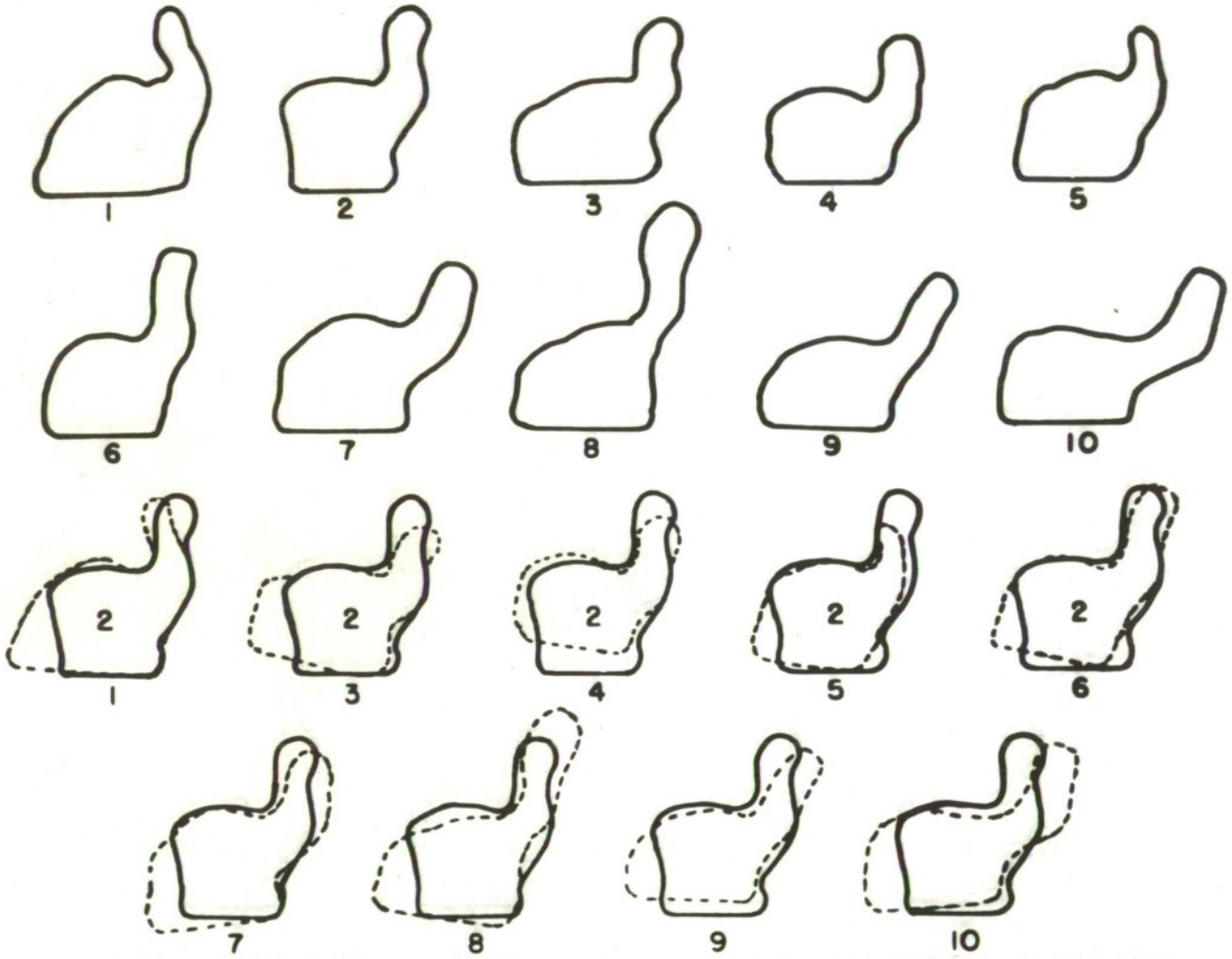

FIG 5 ONE SIDE VIEW TRACING OF SHADOWPHOTOGRAPH PICTURES OF TEN REPRESENTATIVE SIZES AND SHAPES OF PLASTIC EAR MOLDS

Manual manipulation of the molds produced no evidence of damage after long continuous wear or after correct insertion and removal; however, slight soreness of the entire external ear occurred after incorrect insertion and removal.

No discomfort or auditory lesions from wearing plastic ear molds under the two extremes of environment were noted. One subject in the arctic climate preferred the plastic ear mold HS-30 combination over other standard headsets because of greater comfort, less bulk under the Parka Hood and better radio reception.

No satisfactory degree of fit, comfort or acoustic seal was obtained in the 10 subjects who had each received trial fittings of 10 different pairs of plastic ear molds. The reason for this is evident from examination of the shadowgraph tracings (2) in Figure 5 of a representative group of molds. The variations in size and contour of different molds represent anatomical variations of different ears. These anatomical differences are not easily deformable by the insertion of foreign molds without resultant discomfort or damage to the external ear.

III. SUMMARY AND CONCLUSIONS

Moderate physical blows to an inserted mold produced pain and erythema within the external auditory canal. Because of the rigid structure of the subject device, a more severe or heavier blow might possible fracture the bony structure of the external auditory canal.

The plastic ear mold HS-30 receiver headset combination in which the mold canal is occluded afforded a partial protection against temporary hearing loss from concussion of gunfire but this protection disappeared when the ear mold was used without the attached HS-30 receiver headset in which the mold canal was patent.

Temporary hearing loss from field radio communication was less with the plastic ear mold HS-30 receiver headset combination than with the tank headset H16/U. A greater signal to noise ratio of field radio communication was noted with the plastic ear mold HS-30 receiver headset combination than with the tank headset H16/U because a lower volume control setting for adequate reception was required.

Moderate manual manipulation or use in extremes of environmental temperature produced no injury to the ear.

A satisfactory universal plastic ear mold was not obtained because of the variations in anatomical characteristics of the individual ear.

IV. RECOMMENDATIONS

The plastic ear mold is not recommended for general use, but may be suitable for individual use in specialized situations.

V. BIBLIOGRAPHY

1. McCracken, G. A., Lt. Col., D.C. Ear Molds for Hearing Aid Appliances. Article submitted to Historical Section, The Surgeon General's Office, 17 July 1946.

2. Carpenter, A.W. Photoplanator. MDFRL Project 54-1, (in press).