

Section 1

General

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1. SCOPE - This technical manual contains information pertaining to the description, assembly, operation and maintenance of High Powered Voice Amplifier, Type DE-1492-A, manufactured by Applied Electro Mechanics, Inc., Alexandria, Virginia.

2. PURPOSE AND CHARACTERISTICS - High Powered Voice Amplifier AEM Type DE-1492-A provides for a portable, lightweight, compact, high gain tactical sound system, illustrated in Figure 1. It is designed for point-to-point dissemination of sound over land, water or from the air. The equipment described herein is capable of satisfactory operation over the temperature range of minus 30 degrees Fahrenheit (-35C) to plus 130 degrees Fahrenheit (55C), relative humidity up to 97 per cent, and altitudes from 0 to 12,000 feet above mean sea level. The maximum useable range is greater than one mile when operated from a favorable vantage point. The maximum rated audio power output is 250 watts feeding a suitable horn array. Amplifiers may be operated in combinations of two, four or more. Information concerning operation in combinations or for other special requirements will be furnished upon request.

3. OPERATING COMPONENTS - Components and cables normally supplied with the amplifier are identified in Figure 2, which includes unit dimensions and weight. Figure 3 is a functional block diagram showing the interconnection of operating components.

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DOC	1	REV DATE	030780	BY	010951
ORIG COMP	056	OPI	56	TYPE	30
ORIG CLASS	17	PAGES	32	REV CLASS	C
JUST	22	NEXT REV	2010	AUTH:	NR 10-2

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4. DESCRIPTION OF AMPLIFIER- Amplifier DE-1492-A is pictured in Figure 5. It contains the amplifying circuits necessary to furnish 250 watts of audio power into a suitable speaker load with an input from a low level dynamic microphone. It also contains the proper operating controls and suitable monitoring devices to check for proper operation. Its reliability is enhanced by conservative design and a unique built-in protective circuit which shuts off the amplifier whenever excessive input or loading conditions threaten to impair vital circuit elements.

a. SPECIFICATION

(1) Supply Voltage- The amplifier will normally be powered from a 24 volt storage battery with a terminal voltage, when charged, of 28 V DC. Lower voltage supplies may be used with lower resultant audio power being generated. Supplies having higher than 32 volt steady or peak values will cause the amplifier protective circuit to trip. No supply used should have an internal impedance greater than 0.15 ohms.

(2) Input Signal - The amplifier will give full power out with an input voltage of 0.01 volts rms.

(3) Frequency Response - The amplifier response is flat within 3 db over the frequency range of 500 to 5000 cps.

(4) Harmonic Distortion - Because amplifier DE-1492-A operates largely in a saturated state, its wave form at full power approaches a square wave. Operating at 0.4 rated power, its amplitude distortion is 12% or less, measured at a frequency of 2000 cps with sine wave input.

(5) Load Impedance - The specified resistive load for the DE-1492-A amplifier is 1.75 ohms. This is the nearest equivalent to a nominal 2 ohm speaker load. Usual load is furnished by two 4 ohm speakers connected in parallel. However, higher directivity may be gained by paralleling four 8 ohm speakers to load one amplifier.

(6) Output Power - Specified output power is 250 watts into a 1.75 ohm resistor with 0.01 volt rms., 2000 cps. sine wave input. Tests for equivalent power delivered to a speaker load are determined by watt meter measurement.

(7) Temperature Range - Amplifier DE-1492-A is capable of operation over the temperature range of  $-30^{\circ}\text{F}$  to  $+130^{\circ}\text{F}$  ( $-35$  to  $+55^{\circ}\text{C}$ ). Operation at the high extreme, however, will necessitate a lower than normal duty cycle to prevent the temperature sensitive protective circuits of the amplifier from interrupting the operation.

(8) Altitude - The amplifier is capable of operating at any altitude up to 12,000 feet.

(9) Input Impedance - The low level MIC input impedance is 60 ohms. The high level Recorder input is approximately 1200 ohms.

b. EXTERNAL FEATURES

(1) Construction - Amplifier DE-1492-A is built into an extruded and welded aluminum chassis which provides both a rugged case and an excellent heat sink. All heavy duty power dissipating components are mounted to the chassis to minimize their internal temperature rise. An overall anodize processing gives both a durable finish and excellent heat radiating capability.

Along the sides and the rear, removable panels protect the power components mounted between the cooling fins from accidental contact with metallic objects. These panels may be easily removed to gain access to the many test points provided.

(2) Jacks and Connectors - A five pin receptacle, type MS 3102A-18-11P provides the power connection for input DC supply voltage and for AC power to the speaker cable. A three pin connector, type MS 3102A-10SL-3P connects the amplifier to microphone and recorder or telephone signal sources. The MIC jack on the front panel allows a microphone to be plugged in directly for local operation or testing purposes. A MONITOR jack allows the use of headphones to monitor the audio signal from the amplifier.

(3) Controls - A power switch, located near the power receptacle, connects or disconnects the input DC line to the amplifier protective circuits. These in turn connect the DC to the amplifying circuits when suitable conditions are met, i. e., correct polarity, voltage, temperature, etc. Individual gain controls attenuate the signals coming from the recorder and the microphone inputs to desired operating levels.

(4) Lights - The application of DC power is indicated by a red "Push-to-Test" pilot lamp. Normally, this lamp indicates the application of power to the amplifying circuits (following the protective circuit). When pressed, the lamp indicates that power is available at the input power receptacle.

Three lamps are used to monitor the output audio power level. The lamp labeled "MIC" should flash with very low output levels; "HALF" and

"FULL" require correspondingly higher levels of power. Because these lamps are voltage sensitive, they will indicate erroneously if the speaker load is disconnected.

5. DESCRIPTION OF AUXILIARY COMPONENTS - Amplifier DE-1492-A is designed to operate with specified commercial components in order to form an effective sound system.

a. MICROPHONE- The microphone normally used in the sound system is a noise cancelling, dynamic type AEM-MIC-1. This microphone has an output impedance of 50 ohms. It comes equipped with cord and a type MS 3106 A-10SL-3S cable connector.

b. SPEAKERS - Amplifier DE-1492-A commonly powers two Atlas type CG-44 speakers equipped with SA-67 drivers and 4 ohm voice coils. They are electrically connected in parallel to furnish a nominal 2 ohm load. Other combinations and types are permissible provided the correct or somewhat higher load impedance is obtained and the combined power handling capacity of the speakers is sufficient.

c. POWER SUPPLY - Storage batteries of the lead acid or nickel cadmium type with a terminal voltage of 24-28 V DC are suitable power sources for the sound system. Rectifier type power supplies which operate from a 50-60 cycle power line can be supplied for shop or permanent installations.

6. ACCESSORIES- Certain accessories are available for testing and complementing the sound system.

a. DUMMY LOAD - AEM-TE-1422A is a two (2) ohm load with three foot cable and type MS 3106A-16-11P connector for ready substitution of the speaker circuit or connecting to the Power Meter Test Unit described below. The use of resistive dummy loads in place of the normal speaker load facilitates testing and power measurement.

b. POWER METER TEST UNIT - The AEM-TE-1421 Power Meter Test Unit is a convenient test unit with connectors and cables for inserting into the power circuits of an amplifier and measuring both the DC current drawn and AC voltage generated across the load. The load may be either speakers or the 2 ohm dummy load described above.

c. PROTECTIVE CIRCUIT TEST UNIT- A special unit is available to test the protective circuit so that its proper adjustment is assured. This unit is used with the 2 ohm dummy load described above.

d. RECTIFIER POWER SUPPLY- The rectifier type power supply permits the amplifier to be powered from a 50-60 cycle power line.

e. PARALLELING TRANSFORMERS - Paralleling transformers are available for driving 2, 4, or 6 amplifiers from the same audio signal source.

f. REMOTE CONTROLS - Units may be obtained to control, or to control and monitor, any number from one to several amplifiers in parallel. All remote units provide audio gain controls and on-off power switching. A solenoid actuated contactor and cabling are also obtainable for remote operation with above.

g. SPEAKER RACKS AND STANDS - Lightweight racks and stands for mounting various combinations of speakers on vehicles or at stationary sites can be obtained.

Section II

System Assembly

1. GROUND SITE SELECTION - Sound waves, which are transmitted by as well as through the air, are strongly affected by wind, weather, time of day, and intervening objects. Satisfactory sound projection over great distances is possible only from a well situated operating site which takes maximum advantage of these natural elements.

Optimum location of the speaker stand is the prime controlling factor in site selection. This is especially important when maximum voice projection is required.

An operating location with a line-of-sight observation of the target objective is desirable. For example, a hillside location with the horns directed down or across the valley would be ideal. Sound carries well across water, consequently, advantage can be taken of a river or a lake, to improve sound transmission considerably. When prevailing winds are objectionable in the operating area, it is preferable to locate upwind of the target in order that the carrying power of the wind can be used to advantage. If the above conditions cannot be entirely met for various tactical reasons, a site devoid of foliage or other obstructions in front of the speaker stand, for at least several hundred yards, will be adequate.

Echoes constitute wasted power; therefore, the speakers should be aimed so that the "sound beam" clears any intervening mass, such as buildings or hills. However, it is sometimes possible to utilize the echo effect to

reach an obscured objective by reflecting the sound beam from a distant cliff or steep rise. When it becomes necessary to transmit cross wind, the horns should be directed slightly upwind of the target, the amount depending on the distance and the wind velocity. The approximate amount of correction is 25 yards per mile of transmission for each 10 mph. of cross wind.

2. AIRBORNE INSTALLATION - Experience shows that projection of sound from fixed wing or helicopter aircraft is feasible up to two (2) miles. If a circling course is planned, the horns should point horizontally abeam from the aircraft frame. This permits the bank of the aircraft or the downward thrust of the rotor blades to direct the sound beam toward the ground target. The speakers may be mounted in an open doorway to reduce air resistance or fitted into a streamlined pod which is mounted under wing or fuselage. In the case of helicopter use, a bracket on the side or front of cabin will suffice.

3. ASSEMBLY - The sound system assembly is straightforward and considerably simplified by the use of factory prepared cables. Information given by the block diagram of Figure 3 and the instructions given here should suffice to assemble a properly operating system for any purpose.

Power cable AEM-CBL-1 connects to the 5 pin power receptacle (P-3) on the amplifier, connector type MS 3102A-18-11P. At the other end of CBL-1, connector type MS 3101A-16-11S attaches to either extension speaker cable (CBL-10 to 100) or directly to "Y" connection, AEM-CBL-2.

One half of the CBL-1 cable terminates in dressed red and brown leads. These wires must be clamped to a 28 volt DC power junction board or battery with the RED lead to the POSITIVE terminal. CAUTION - Failure of the POWER



that the input polarity of the DC power is reversed.

The microphone, AEM-MIC-1, fitted with connector type MS 3106 A-10SL-3S may be used alone by coupling to the MIC receptacle (P-1) on the amplifier chassis.

If an input audio line from microphone, radio, recorder, etc. is used, precautions are necessary. The high gain of the amplifier requires care in prevention of feedback either electric or acoustic. To prevent electric feedback, shielded lines should be used. ALSO, the shield of the shielded line (s) should not be connected or allowed to touch any electrical ground or potential circuit. This may mean that an isolation transformer will be necessary if not otherwise provided by the signal source. Both shields should be securely tied to pin C at the type MS 3106A-10SL-3S connector.

Acoustic feedback is prevented by shielding the microphone from direct sound waves from the speakers. This may be effected by an enclosure or operating at a considerable distance behind the speaker pattern.

A further precaution relates to the relative phasing of the speakers. It is important that identical connections be maintained to both speaker driving coils, otherwise sound cancellation will greatly reduce the projected power. The proper phasing is provided by the cables supplied. Wiring may be checked against the diagram of Figure 3 for correctness if repairs or recabling is required.

## System Operation

1. OPERATING PROCEDURES - Operating the voice Amplifier system is relatively simple. However, several techniques, some of which will be learned by experience, are important for the most favorable results.

a. Techniques of Voice Transmission- The system possesses the capability of high quality voice transmission over long-distances and for long periods of time. However, effective utilization of these features depends, to a great extent, upon proper operating procedures.

To successfully project the voice over long-distances, it is necessary to develop a microphone technique different from the normal conversational manner. Talk clearly and distinctly, separating each word with noticeable pauses, keeping the voice volume up, and the lips touching the mouth piece. It is important not to obstruct the vent located at the top rear of the microphone when depressing the "MIC" switch. A normal (medium pitched) voice is more intelligible and carries farther than a bass voice.

For proper voice operation the "Gain" control is adjusted until the Audio Power "Full" Indicator illuminates intermittently while a "Test-count" is being made.

To minimize feedback (which if allowed to persist will overdrive and possibly damage the components) it may be necessary to adjust the input "Gain" control or improve the sound shielding of the microphone position.

b. Operation With Recorder - When a recorder, or other sound source, is to be operated with the amplifier, connection is made through Pins B & C of the audio input connector and the "Radio Recorder Gain" control is rotated to the proper gain position. Because of the very high gain of the amplifier, care must be exercised when coupling to the input circuit to prevent undesirable feedback. Battery operated recorders can be coupled directly without adverse effects, however, it is necessary to keep the recorder case above ground. An alternate solution is to employ an isolation transformer between the radio /recorder output and the amplifier input pins.

If the recorded sound is voice the correct input level is adjusted in the same manner as for microphone operation. If the recorded sound is music, it is advisable to operate at a reduced "Gain" control setting. Failure to do so will cause excessive average audio power to be dissipated in the speaker units resulting in probable failure of the voice coils.

2. RESETTING PROTECTIVE CIRCUIT - Amplifier DE-1492-A is designed with self protecting circuitry to interrupt the operation whenever unusual conditions exist which might endanger the amplifier components. Such a condition might be an excessive voltage, voltage spike, current surge or temperature rise. Once the protective circuit is activated, the flow of power is stopped and no further operation is possible without corrective action. If the trouble was due to a temporary or transitory cause, operation may be resumed by simply turning the power switch to OFF and back to ON. If the protective circuit again shuts the amplifier off, the power switch should be immediately turned to OFF and the cause of trouble determined and corrected.

3. CARE AND PRECAUTIONS- The transistors of this system are subject to damage when exposed to excessive heat, voltage, and current for even short periods of time. The design incorporates a protective circuit which disables the amplifier when safe operating currents, voltages or temperatures are exceeded. Operation of the protective circuit is indicated by the extinguishing of the amplifier panel light. These protective circuits are adequate in most instances; however, they themselves are subject to damage when extreme or sustained stresses are allowed to exist. Careful monitoring is therefore necessary when operating under unusual environmental extremes. When operating under temperature and solar conditions more extreme than those described in Section I paragraph 4a, precautions should be taken to maintain temperature within recommended limits. Other stress conditions causing activation of the protective circuits are excessive battery charging voltages; short circuits within the system; transmission of compressed, high level music and reversed polarity from the battery supply.

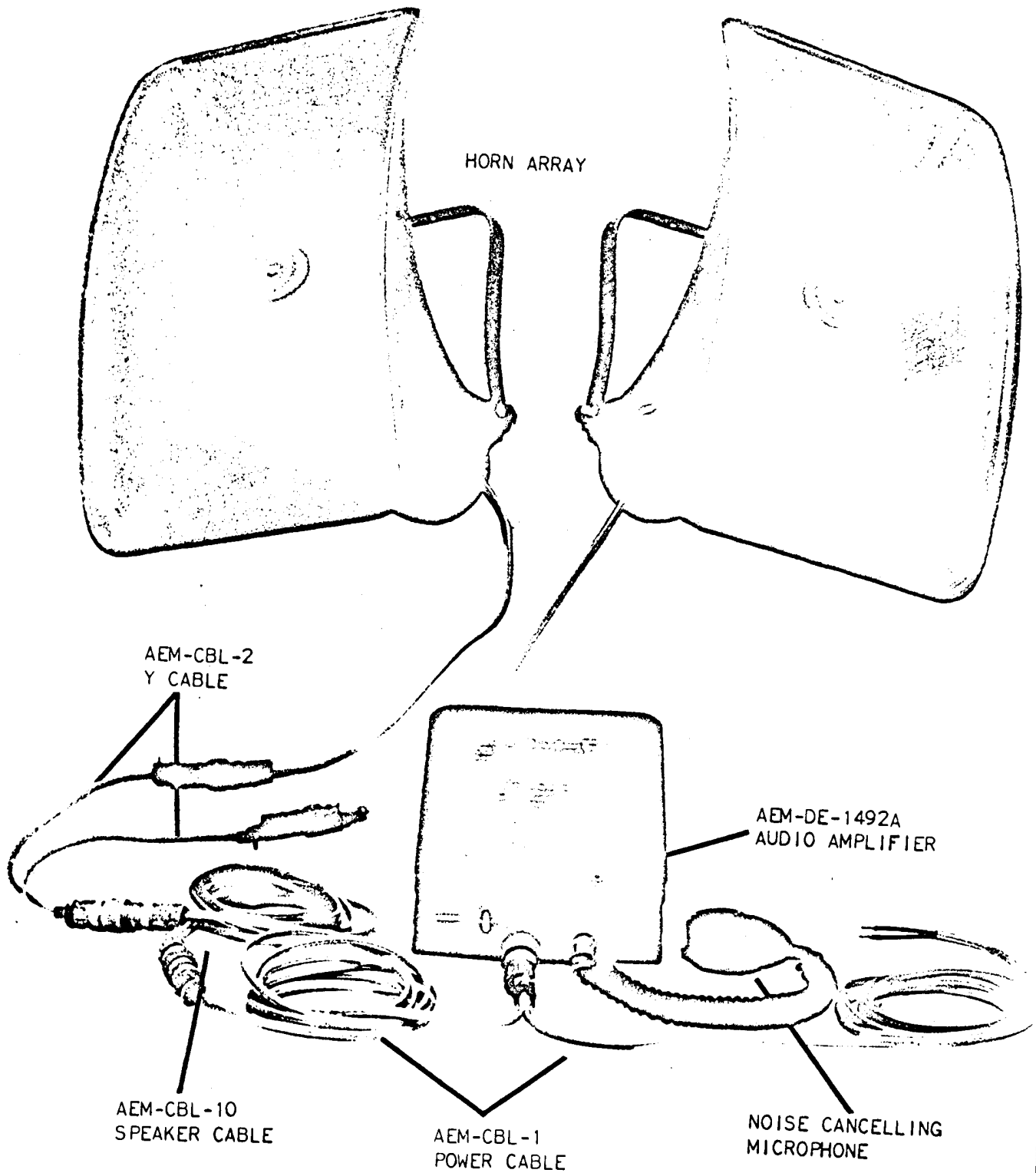


FIGURE 1 HIGH POWERED VOICE AMPLIFIER SYSTEM TYPE DE-1492-A

QUANTITY PER SYSTEM	NAME OF UNIT	DESIGNATION	DIMENSIONS	WT/UNIT
<u>System Components</u>				
1	Audio Amplifer	AEM-DE-1492-A	8 5/8 x 9 3/4 x 3 3/8 in.	10.0 lbs.
1	Microphone and Cable	AEM-MIC-1	Hand Size	1.0
2	Speaker with 3 foot Cable and Connector	Atlas Horn CG-44 Atlas Driver SA-67	22 x 12 x 20 in.	13.5
<u>Cables</u>				
1	Power Cable	AEM-CBL-1	10 feet	2.5
1	Extension Cable	AEM-CBL-10 to 100	10 feet to 100 feet	3.5/ 7.5
1	"Y" Cable	AEM-CBL-2	18 in.	.5
<u>Accessories or Optional Equipment</u>				
	Dummy Load (2 ohms)	AEM-TE-1422A	6 x 3 1/2 in. with 3 feet Cable and connector	1.5
	Power Meter Test Unit	AEM-TE-1421	8 1/2 x 3 1/2 x 3 in.	6.0
	Protective Circuit Test Unit	AEM-TE-1424	3 x 4 x 6 in.	1.5
	Rectifier Type Power Supply	AEM-DE-1522	13 x 7 x 19 in.	95.0
	Paralleling Transformer	AEM-JBT-2A (for use with 2 amplifiers)	4 1/4 x 2 3/4 x 1 3/4 in. with 3 feet Cables and Connectors	1.0

A-3

Figure 2 Table of Components and Accessories

(Cont'd)	DESIGNATION	DIMENSIONS	WT/UNIT
<b>Accessories or Optional Equipment</b>			
Paralleling Transformer	AEM-JBT-4A (For use with 4 amplifiers )	4 1/4 x 2 3/4 x 1 3/4 in. with 3 feet Cables and Connectors	1.0 lbs.
Remote Control	AEM-CON-1 (For use with 1 or more amplifiers with no monitoring)	5 x 2 3/4 x 2 1/4 in.	1.0
Remote Control	AEM-CON-2 (For use with 2 amplifiers )	8 1/2 x 3 1/2 x 3 in.	1.5
Remote Control	AEM-CON-4 (For use with 4 amplifiers )	8 1/2 x 3 1/2 x 3 in.	1.6
Remote Control	AEM-CON-6 (For use with 6 amplifiers )	3 1/2 x 4 x 9 1/2 in.	1.8
Speaker Rack	AEM-RAC-5	9 x 52 x 10 1/2 in.	8.2
Speaker Stand (For 4 amplifier systems)	AEM-RAC-6	96 x 96 in.	43.7
Speaker Stand (For 2 amplifier systems)	AEM-RAC-8	72 x 72 in.	39.0
Tripod (For 1 amplifier )	TP-1	4 to 7 feet high	8.75

Figure 2 Table of Components and Accessories

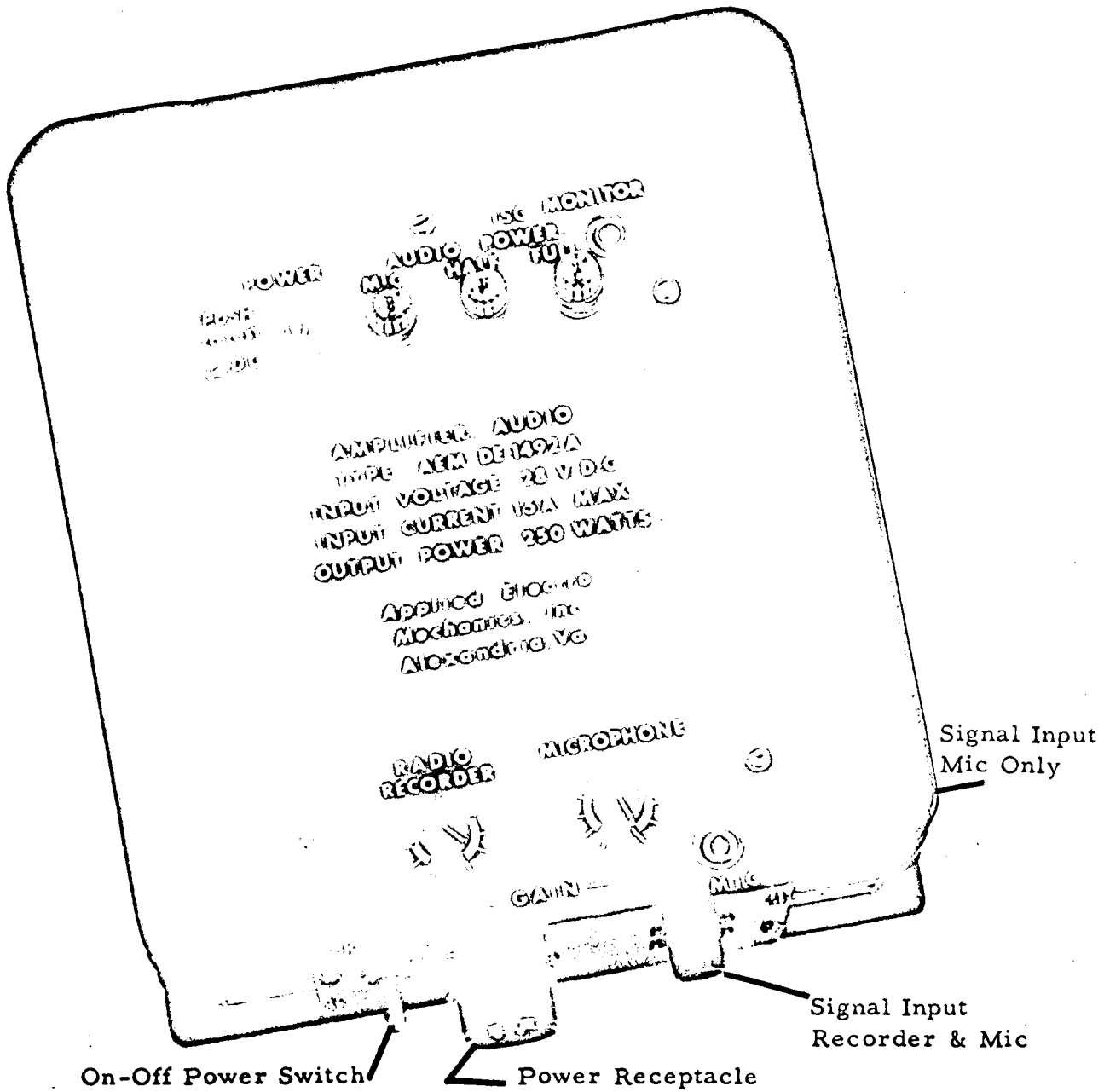


Figure 5 Audio Amplifier Type AEM-DE-1492-A



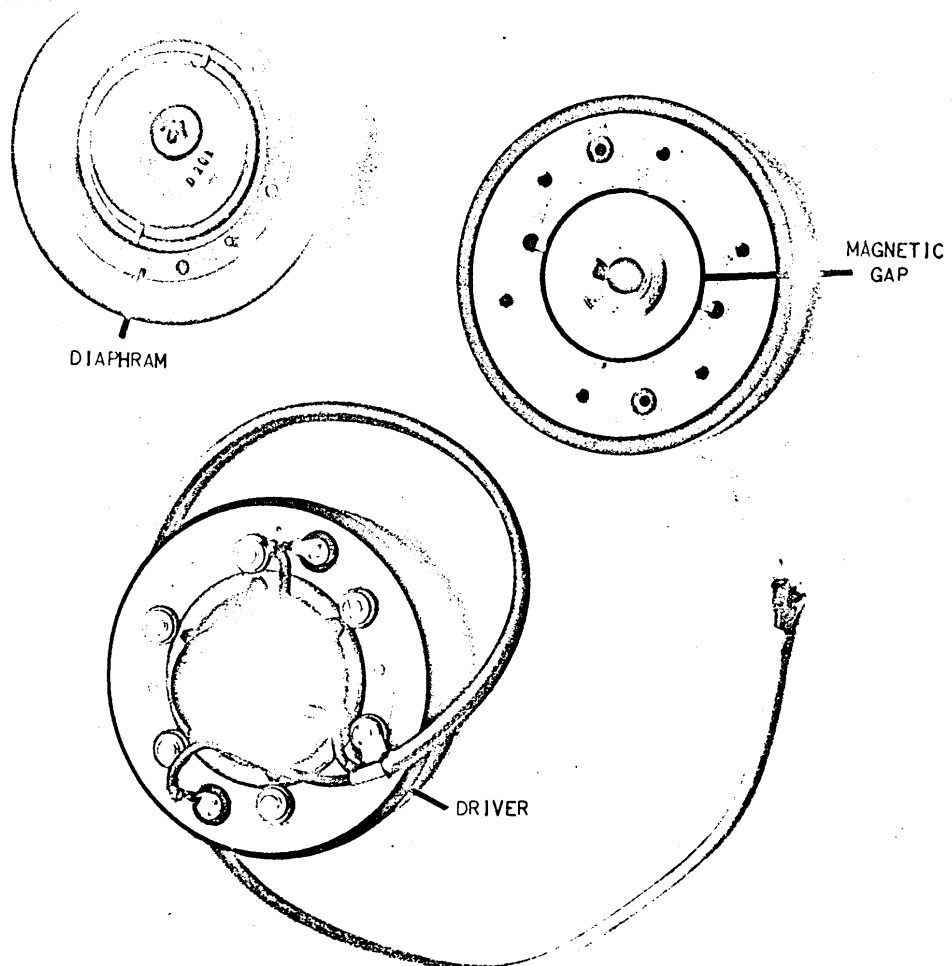
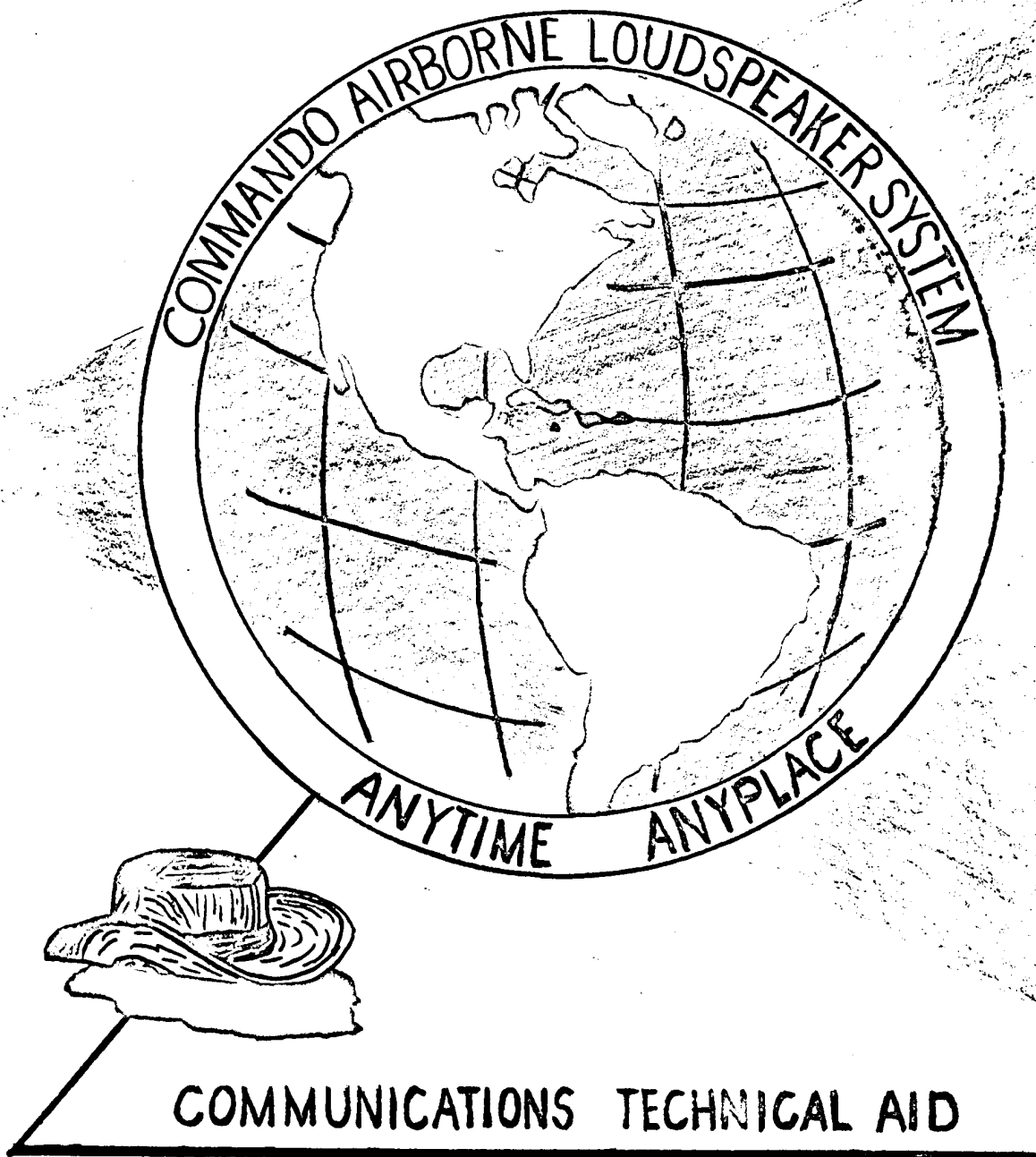


Figure 6 Speaker Driver Unit Showing Internal View of Diaphragm, Voice Coil and Magnet with Air Gap

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## "THE VOICE FROM THE SKY"

### COMMANDO AIRBORNE LOUDSPEAKER SYSTEM

#### I. GENERAL

- a. Purpose
- b. Theory of operation
- c. Equipment used
- d. Characteristics
  1. Physical
  2. Drawbacks

#### II. Theory of OPERATION

- a. Principle of sound
- b. Mike techniques
- c. Aim of speaker
- d. Bank of aircraft
- e. Amplifier checks (Maint)

#### III. AIRCRAFT SPEAKER CAPABILITY (Alt & Radius)

- a. Cessna 185/U-10/Light Aircraft
- b. C-46/C-47.Similar Cargo Aircraft
- c. Cessna Chopper

#### IV. EQUIPMENT USED AND COST

- a
  - a. Cessna 185/U-10 Small Aircraft
  - b. C-46/C-47/SA-16
  - c. Speaker Mounts
  - d. Speaker hookup

#### V. FURTHER INFORMATION

- a. AEM
- b. 605th Commandos

#### GENERAL

1. The purpose of this paper is to present theoretical and operational information on the Commando Airborne Loudspeaker System (The Voice from the Sky) so that this information can be used by interested personnel. This information is the most up to date on the system and has been prepared by the 605th Air Commando Squadron's (Composite) Communications Section, Howard AFB, Canal Zone.
2. The primary aim of the Airborne Loudspeaker is to provide aural air to ground communication where none other exist. The system can be used in almost any type of aircraft and under varying conditions.
3. The adaption of a public address system to an aircraft is a relatively new form of communication which offers unlimited possibilities both in civilian and military operations. The systems is ideal for psychological warfare, disaster

control, ground control from the air, rescue operations, riot control, highway patrol, for emergency traffic instructions and other applications requiring a "Voice from the Sky" with an overseeing eye.

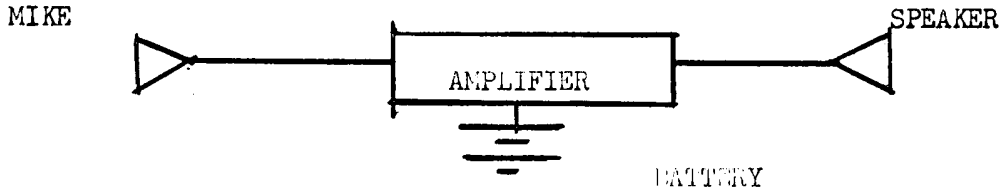
4. The 605th ACS initiated and supervised the construction of an air field in the Panama Jungle from the air by the use of the Airborne Loudspeaker System in a U-10 aircraft. It also has been used successfully to notify the local populace, in remote and difficult areas to reach, of the arrival time of supplies, personnel and help.

5. The whole concept of an aerial loudspeaker system has been well received by all and proved worth its cost.

6. The Coast Guard has adopted the system and use it quite successfully in rescue operations. Companies are being formed using this system as an advertising media. Cities can disseminate information to their populace in a matter of minutes by employing this aerial public address system.

7. The operation of the system is relatively simple and can be set up in a matter of minutes with the availability of proper equipment. The system is basically the same as public address systems found in churches, schools, offices, etc. except that it is airborne.

8. Below is a block diagram of the system operations:



9. A single 12V or 24V battery provides all the necessary power for the whole system. The mike changes the sound pressure of intelligence to electrical impulses. The transistorized amplifier, which is high powered, lightweight, and rugged, amplifies these electrical impulses and feeds it to speakers protruding from an opening in the aircraft. The speakers convert the electrical impulses to intelligence and beams this sound earthwards. This is basically the same process a basic public address system uses. The equipment used is as follows:

- a. AEM-DE-1492            Amplifier
- b. SA-67                 Speaker driver
- c. CJ-44                 Speaker horn
- d. AEM-MIC-1            Microphone
- e. Associated AEM electrical cables.

The system is sold by: Applied Electro Mechanics, Inc., 2350 Duke St, Alexandria, Virginia

10. The amplifier used is the most compact, reliable, rugged and has the greatest power output. Technical data on the amplifier (the heart of the system) is as follows:

- a. Power Requirements - 15 amps (peak) at 28 volts D.C. Standby less than 1.5 amp. Operates on battery voltage between 12 VDC - 30 VDC.
- b. Power Output - 250 watts of audio power at .2 duty cycle.
- c. Gain - 90DB
- d. Weight - 9 3/4 pounds.
- e. Size - 8 1/2 x 9 3/4" x 3 1/4"
- f. Controls - Microphone and recorder input levels, on-off switch.
- g. Monitors - Power on, microphone alive half and full power indicating lights.
- h. Construction - Extremely rugged design to withstand mobile use in all types of applications. Aluminum chassis design provides heavy frame for component support as well as heat sink for the high power transistors.
- i. Modular construction.
- j. Protective Circuits - Reversed voltage, high voltage, high current, shorted output, temperature.
- k. Operation - With microphone, tape recorder or radio receiver, input temperature - 30° F (35° C) = + 130° F (55° C) Altitude 0 to 12,000 feet.

#### THEORY OF OPERATIONS

1. Sound by definition is an alteration in pressure propagated through the air or other elastic material. Sound is also the sensation produced through the ear by the above alterations. Sound travels in air at approximately 1100 feet/second. The sensation produced through the ear by sound does not vary directly as the sound (stimulus) but approximately as the logarithm of the unit measuring the sound.
2. Sensation = constant x log (sound). The amplitude of sound is measured in terms of pressure, intensity or power. Intensity is the energy transmitted by the sound wave per unit areas, in watts/CM<sup>2</sup>. Pressure is the force per unit areas perpendicular to the path of the wave, exerted by the sound wave on the medium. Power denotes the energy transmitted per second. It is equal to the intensity times the perpendicular areas through which the sound is radiated.
3. The range of sound intensities and pressures, is very great. A decibel or DB is a unit used to express the ratio between two pressures, intensities, etc.
4. The sensation law expressed above applies to the perception of sound amplitude and so the DB unit of amplitude ratio is more accurate in relation to human perception. When we say that the intensity of a sound has increased 3DB, it means that the intensity has approximately doubled; then we can conclude from this, that

the intensity of sound on a person =  $DB = 10 \log P_1/P_2$  where  $P_1$  is the output power and  $P_2$  is the input. Thus increasing our DB we increase sound intensity by more amplifications in an amplifier system. Intensity values for various sounds range from 0 DB to the threshold of hearing and to 120 DB threshold of pain.

5. A sound wave travels in a straight line along the direction in which it was radiated unless it is absorbed, reflected, refracted or diffracted.

Absorption is the dissipation of sound.

Reflection is the simple bouncing of sound off of objects, etc.

Refraction of sound is the slowing down or speeding up of it when it encounters new mediums. The behavior is the same as that exhibited by light waves.

Diffracted is the change of direction of a sound wave which is caused by travel around an obstacle.

Interference is the reception of sound from more than one source; either adding or subtracting to the intensity of sound.

6. The change of pitch in sound is called the Doppler Effect. This happens when the source of sound and point of reception are moving with respect to one another, the frequency detected by the listener will not be that of the vibrating source. Suppose that the listener is approaching the source and since he is moving towards each wave impulses at the same time that it is moving towards him, he meets it a little sooner than if he had merely waited for it, and the perceived period between impulses is shortened, which is to say the perceived frequency is higher. When source and listener are moving apart, the effect is the opposite that of lowering pitch. Motion which does not change the distance between source and listener has no effect on pitch.

7. Distortion of sound results when the instantaneous response is not directly proportional the instantaneous stimulus (sound) at all times.

8. The discussion above on the theory of sound effects the Airborne Loudspeaker system. As we go on the different properties and shortcomings of sound will be discussed as applied to the Airborne Loudspeaker system.

9. Proper mike techniques, speaker aim and bank of the aircraft will determine the success or failure of this system. If the proper techniques are used, the shortcomings of sound discussed previously can be eliminated.

10. The system possesses the capability of high quality voice transmission over long distances for several hours. However, effective utilization of these features depends, to a great extent, upon proper operating procedures.

11. To successfully project the voice over long distances, it is necessary to develop a microphone technique different from the normal conversational manner. Talk clearly and distinctly, separating each word with noticeable pauses, keeping the voice volume up and the lips touching the mouthpiece. A medium pitch voice is more intelligible and carries farther than a bass voice.

12. For proper operation, turn the power switch to ON and make a test count into the mike. Adjust gain control to OFF and advance clockwise to the point where Audio Power meter just swings between the two red marks, to minimize feedback (a singing sound whenever microphone switch is depressed) the gain control may

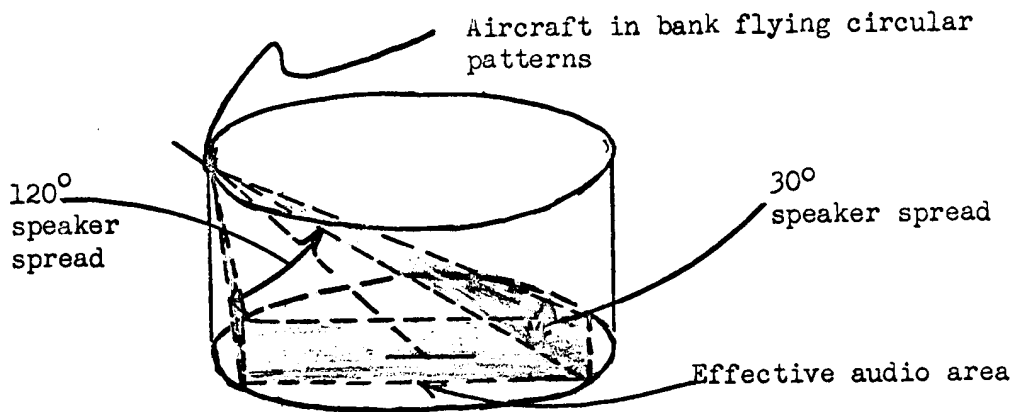
to be backed off, or preferably, better sound shielding provided between speakers and microphone. This latter can be accomplished by increasing the separation or enclosing the microphone position.

Operation with Recorder - When a recorder or other sound source is to be connected with the amplifier system, connection is made through the "Recorder" receptacle and the "Gain" control is rotated to the counter-clockwise "REC" position. A choice of high (2000 ohms) or low (500 ohms) impedance is available. Because of the very high gain of the amplifier, care must be exercised when connecting to the input circuits to prevent undesirable (electrical) feedback. Battery operated recorders will give little trouble if the recorder case is insulated from electrical ground. An alternate solution, in any case, is to use an isolation transformer between the signal source and amplifier.

If the recorded sound is music, the correct input level will be the same as for the microphone operation. If the recorded sound is music, it is advisable to operate at a reduced average power level. Transmission of compressed high level music at full power may cause overheating in the amplifier or speaker units.

13. The speakers must be aimed like a gun to give best voice projections. The aim of the speakers is extremely important and this can be easily demonstrated in test flights. The spread of the speaker is 120 degrees in the vertical plane and 30 degrees in the horizontal plane. At an altitude of 1000 ft with direct projection on the ground, approximately 1.35 million square feet of area is covered.

14. Circular patterns are best for air to ground communications. The plane should bank when using the loudspeakers so that the plan of the speakers are pointed towards an object or area which you want to project your sound to. The sketch below shows the pattern described and speaker effects:



17. Amplifier checks - With the output level indicator, the amplifier chassis is largely self-indicating as far as its normal operation is concerned. When the operation is not normal, the following possibilities should be checked.

a. Polarity of input D.C. voltage. If reversed, the panel light will not indicate until pressed.

b. A short in speaker or cable. Pilot light will not indicate until pressed and protective circuit is energized.

c. Excessive D.C. voltage. Battery may not be properly connected. Panel light does not indicated until pressed.

d. Power switch OFF. Panel does not indicate until pressed.

e. No D.C. to chassis. Panel light does not indicate normally or when pressed.

f. Speaker coil or cable open. Output level indicator will illuminate with little or no signal.

g. An external ground in the audio input circuit through auxiliary device (recorder, etc.) Indicator lamps illuminate with not input signal. Feedback caused by "loop" currents.

h. Amplifier may be faulty. This will require shop maintenance.

18. Power supply checks - Battery voltages can vary between 12 VDC to 30 VDC.

19. Speaker and cable checks - Testings of speakers and cables may, to some extent, be done visually. All connections may be examined for freedom from dirt, moisture and open or short conditions. All receptacle threads should be thoroughly engaged. Use of an ohmmeter may be made to establish the state and correctness of wiring.

#### AIRCRAFT SPEAKER CAPABILITY

1. The Airborne loudspeaker system can be used from 0 to 3000 feet altitude and out to 1 mile radius. These values are the results of the testing by the author of this paper. It should always be kept in mind that when operating these speakers, you have the initiative. When someone hears a voice from the sky you unconsciously have his undivided attention consequently increasing the systems audibility factor. Transmissions in clear areas or better than hilly or congested areas. Echoing of signals, increases and decreases sound intensity, consequently causing the intelligence to be garbled and distorted. When flying in areas where hills exist, use clear areas where a line of sight exists to the target on the ground. Follow the instructions contained above and the system will work amazingly well.

b.

2. The following is recommended altitudes and amplifier's power setting when used in an area of less than 5 knots ground wind relatively clear area, and noise level normal or relatively low and using an airspeed between 80 - 120 knots:

a. Light Aircraft Operation - Cessna 185/U-10 Helio

Altitude 500 feet



Radius of turn in miles	Amplifier setting
$\frac{1}{4}$	1
$\frac{1}{2}$	2
$\frac{3}{4}$	3
1	4

Altitude 1000 - 1200 feet

Radius of turn in miles	Amplifier setting
$\frac{1}{4}$	2
$\frac{1}{2}$	2
$\frac{3}{4}$	3
1	4

Altitude - 1500 feet

Radius of turn in miles	Amplifier setting
$\frac{1}{4}$	3
$\frac{1}{2}$	3
$\frac{3}{4}$	4
1	4

Altitude - 2000 feet

Radius of turn in miles	Amplifier setting
$\frac{1}{4}$	3
$\frac{1}{2}$	4
$\frac{3}{4}$	4
1	4

b. Dual Engine Aircraft - C-46/C-47

Altitude - 500 feet

Radius of circle in miles	Amplifier setting
$\frac{1}{4}$	2
$\frac{1}{2}$	2
$\frac{3}{4}$	3
1	4

Altitude - 1000 - 1200 feet

Radius of circle in miles	Amplifier setting
$\frac{1}{4}$	2
$\frac{1}{2}$	3
$\frac{3}{4}$	4
1	4

Altitude - 1500 feet

Radius of circle in miles

1/4  
1/2  
3/4  
1

Amplifier setting

3  
3  
4  
4

Altitude - 2000 - 3000 feet

Radius of circle in miles

1/4  
1/2  
3/4  
1

Amplifier setting

4  
4  
4  
4

50 ft  
100 ft  
150 ft  
300 ft  
500 ft  
700 ft  
850 ft  
850 ft  
700 ft  
600 ft  
500 ft  
400 ft  
300 ft

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SPEAKER SYSTEM ON CESSNA CH-1C HELICOPTER

1. The following equipment is required to install the airborne speaker system on the CESSNA CH-1C SKYHOOK Helicopter.

- 1. AEM DE1942 AMPLK-1GA
- 1. MICROPHONE, M-34 with SHIGLD
- 1. POWER CABLE
- 2. SJ-47 SPEAKERS & DRIVERS
- 12. FT OF DEXION STEEL
- 4. 10/32 2" INCH BOLTS, STEEL.
- 1. ALUM BRACE 12 INCHS LONG

2. The 2 SJ-47 speakers are mounted on the left side of the chopper. Dexion is run from the front landing strut to the rear landing strut and secured with the 4 steel bolts mentioned above. The 2 SJ-47 speakers are mounted to this dexion. A short length of dexion is then used to bolt the 2 speakers together and the 12 inch brace is then added from the rims of the speakers to the landing runner. To make the 2 speakers rigid it is required to bolt the rims of the 2 speakers together.

3. This speaker system was tested at alt of 50 to 850 ft. There is no feed back at all with this system and max volume could be used all the time with no bad side effects. The distance from the objective point was varied from directly overhead to 1 mile away and clarity was good at all times.

4. The CESSNA CHOPPER is a 4 place a/c and has ample room to place the ampl anywhere in the cabin so all passengers are able to use the system without changing positions in the a/c. The CESSNA CHOPPER has a 24 VDC battery that is easy to string the ampl power cable to and has a small vent window that the speaker cable can be run through to the speakers.

5. The last test-run of the speakers gave the following results:

6. Find  
The

a.  
amplifie

Find  
6831-ND-  
6831-ND-

6831-ND-  
6905-254  
6831-ND-  
6831-ND-

F. 1  
1000m.

Find  
6831-ND-  
6831-ND-  
6831-ND-  
6831-ND-  
6831-ND-  
6831-ND-  
6905-254-  
6905-285-

1. speak  
2. mar  
3. dc  
4. the s

ALT	DISTANCE TO OBJECT	CLARITY
50 ft	Overhead	Very Good
100 ft	1/4 Mile	" "
150 ft	Mile	" "
300 ft	Mile	" "
500 ft	Mile	" "
700 ft	Mile	" "
850 ft	Mile	" "
850 ft	1 Mile	" "
700 ft	1 Mile	" "
600 ft	1 Mile	" "
500 ft	1 Mile	" "
400 ft	1 Mile	" "
300 ft	1 Mile	" "

On the landing run the CHOPPER was approximately 2½ miles from the object point at and altitude 1000 ft and could still be heard but not with ideal clarity. This can be used on other types of helicopters just as well.

6. Equipment used and cost.

The following is a list of equipment used in each aircraft and its cost:

a. Light Aircraft - Cessna 185/U-10 Helio employing two speakers and one amplifier.

AIR FORCE FSN NUMBERS

FSN	ITEM	QTY	COST
5831-ND-000230L	Amplifier AEM-DE-1492	1 ea	\$975.00
5831-ND-000231L	Speaker Driver - 75 watts with 9 ft. cable and connector	2 ea	56.50
5831-ND-000232L	Speaker Horn CJ-44 Standard Wt	2 ea	42.50
<del>5965-254-9228</del>	<del>Microphone M-34/LAC</del>	1 ea	5.00
<del>5965-285-0641</del>	<del>Microphone Shield MX-1334 A/C</del>	1 ea	15.00
5831-ND-000233L	Cable amplifier, power 10 ft, AEMCBL-1	1 ea	17.50
5831-ND-000235L	"Y" paralleling cable AEM-CBL-2	1 ea	15.00
<b>TOTAL COST.....</b>			<b>\$1229.50</b>

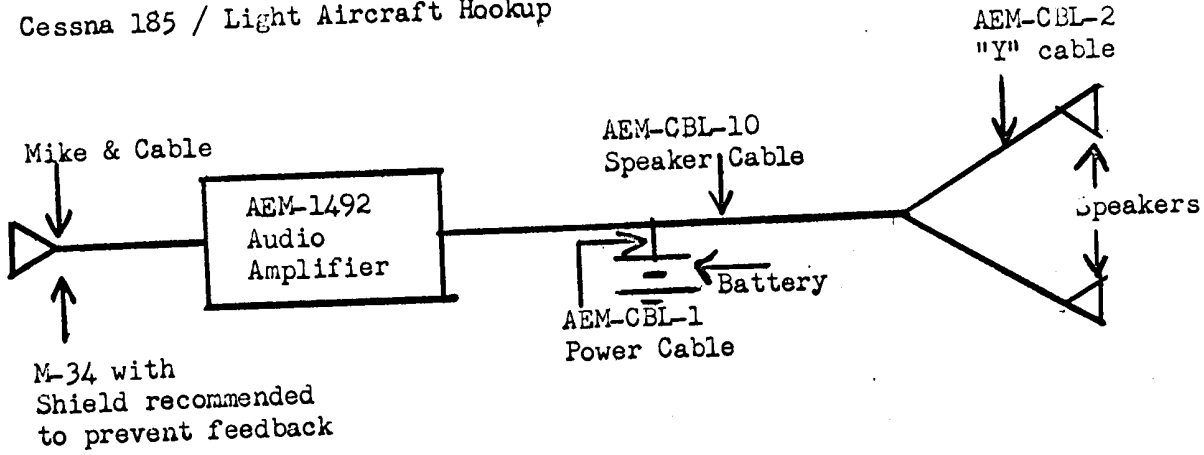
b. Dual engine aircraft - C-46/C-47/SA-16 - Four speakers, two amplifiers, system.

FSN	ITEM	QTY	COST
5831-ND-000230L	DE-1492 Amplifiers	2 ea	\$975.00
5831-ND-000231L	SA-67 75 Watt driver	4 ea	58.50
5831-ND-000232L	CJ-44 Horns	4 ea	42.50
5831-ND-000233L	AEM-BL-1 Power cables	2 ea	17.50
5831-ND-000234L	AEM-CBL-20 Extension cables (50 ft)	2 ea	13.00
5831-ND-000235L	AEM-CBL-2 "Y" Paralleling cables	2 ea	15.00
5965-254-9228	Microphone M-34 LAC	1 ea	15.00
5965-285-0641	Microphone shield MX-1334 AC	1 ea	5.00
	Paralleling transformer AEM-JBT-2	1 ea	41.56
<b>TOTAL COST.....</b>			<b>\$2505.56</b>

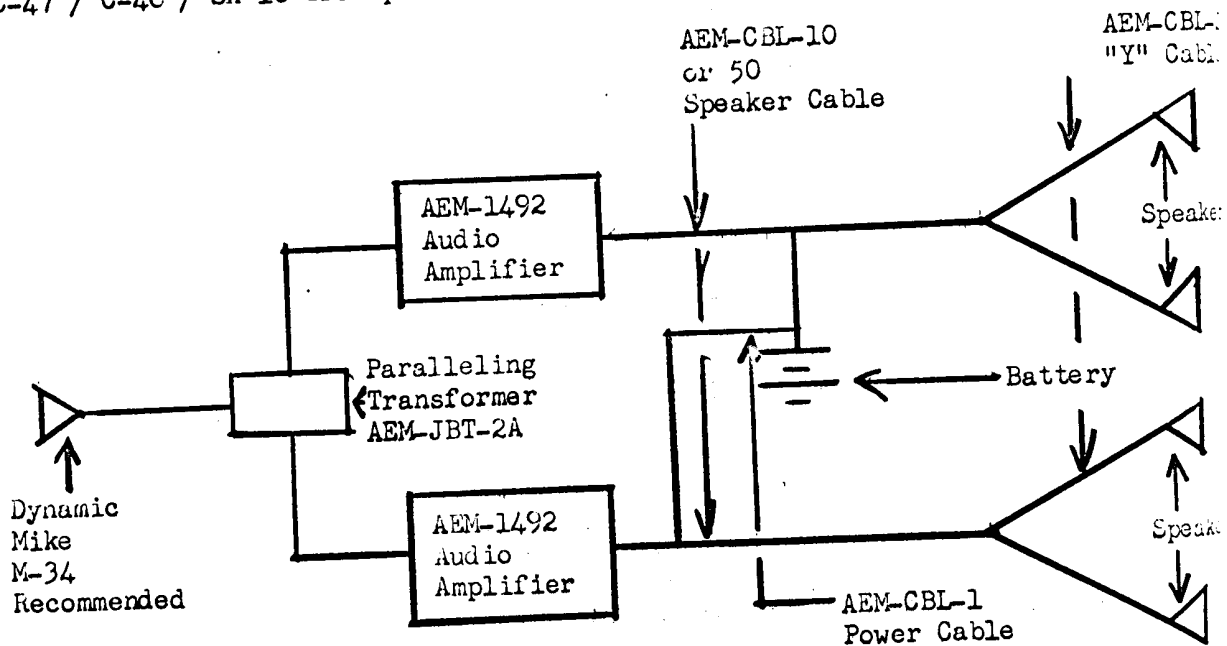
7. Speakers can be mounted in the aircraft numerous ways. The best way, naturally is to manufacture a door around the speaker. A more simple and less expensive is to use dexion steel as shown in the pictures. A more simple way is to physically tie the speakers down in the aircraft doorway.

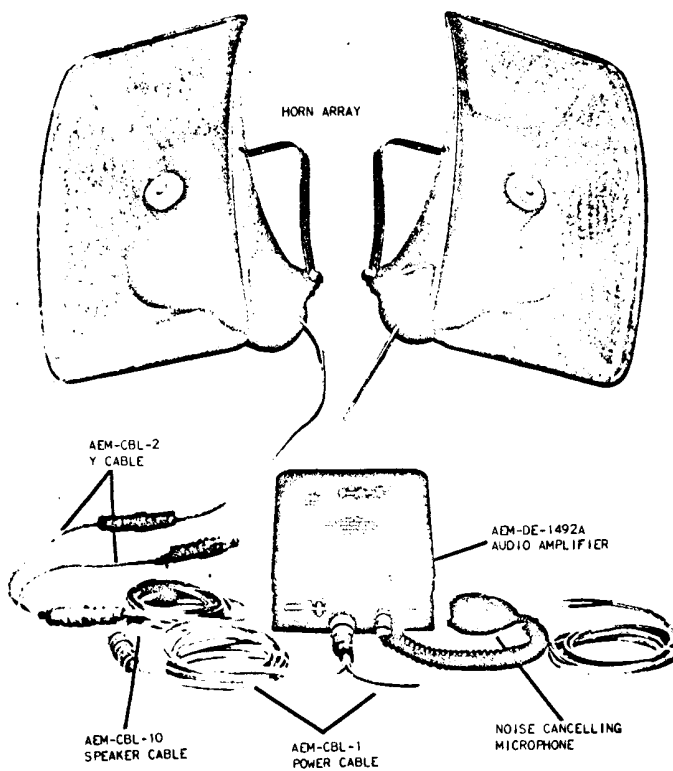
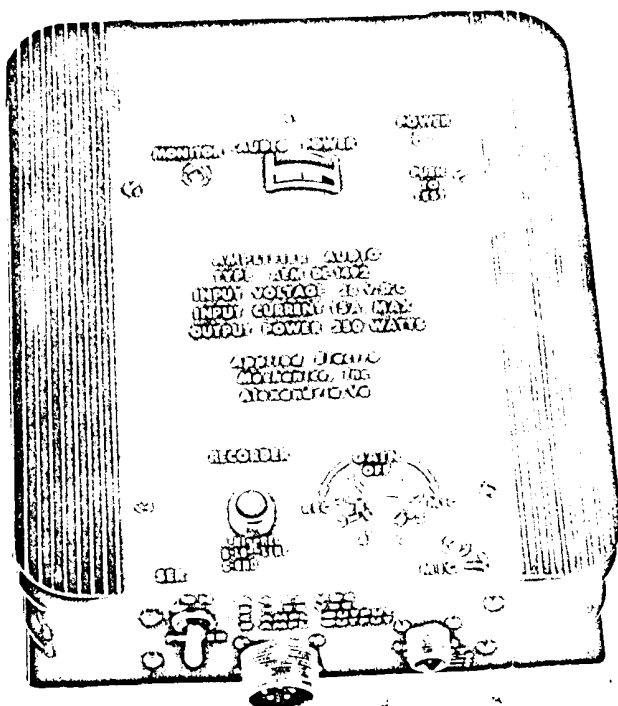
8. Construction of speaker doors will be determined by material available but initiative and strong imagination will greatly expedite matters. All structures should be safely secured to the aircraft to prevent loss of equipment.

Cessna 185 / Light Aircraft Hookup

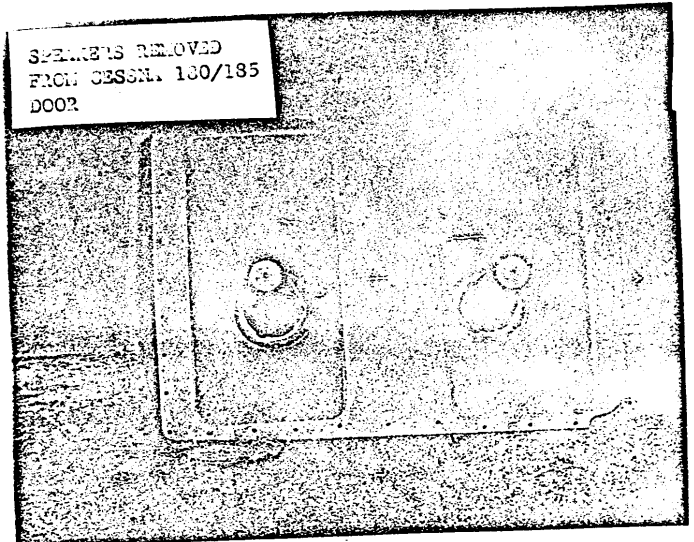
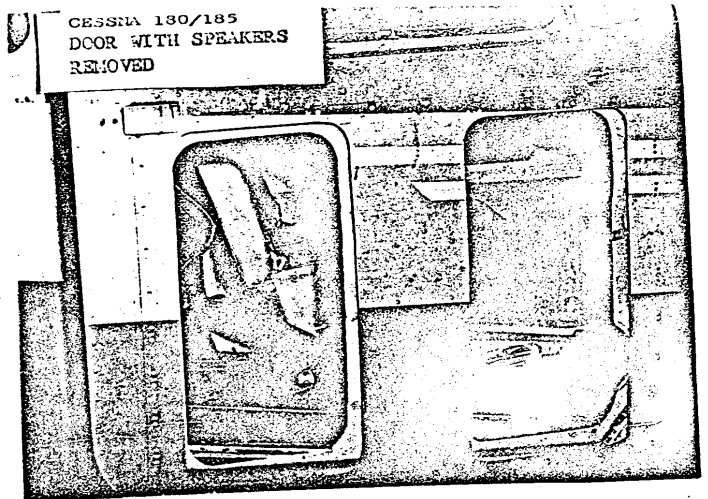
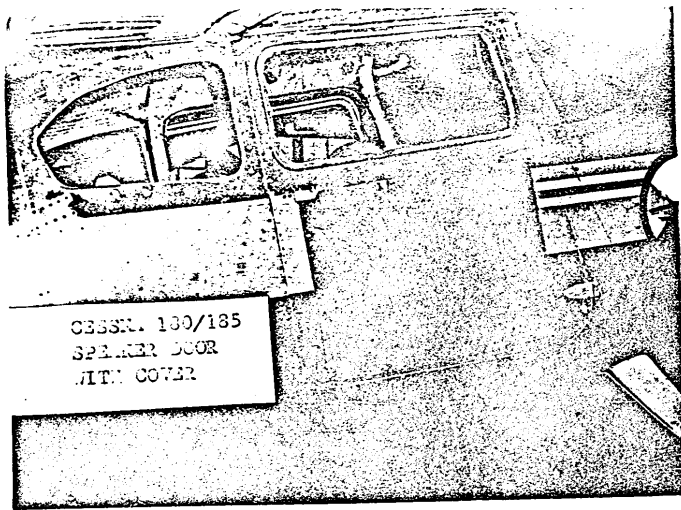


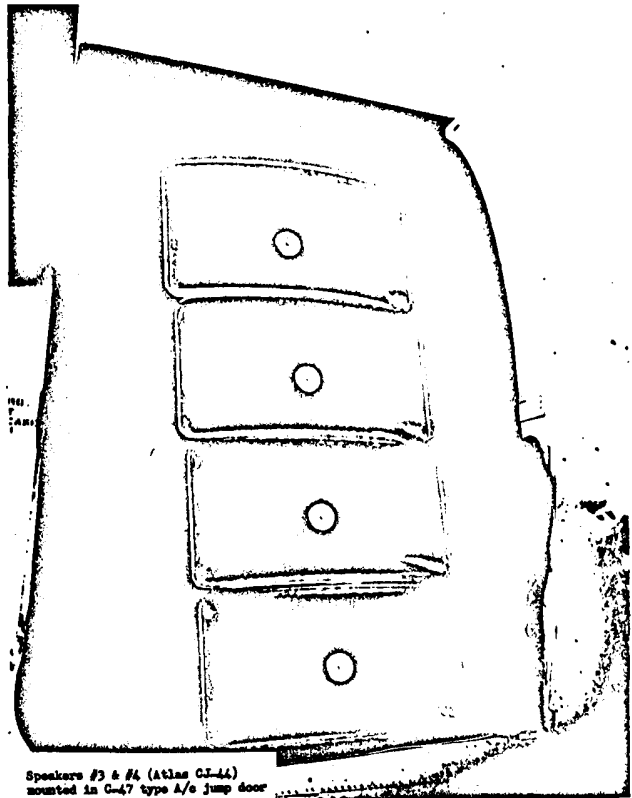
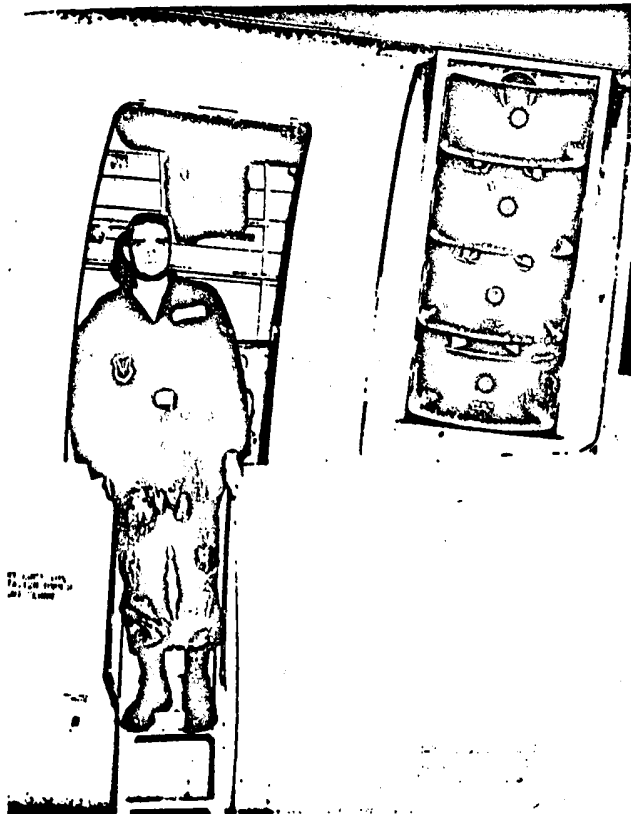
C-47 / C-46 / SA-16 Transport Aircraft





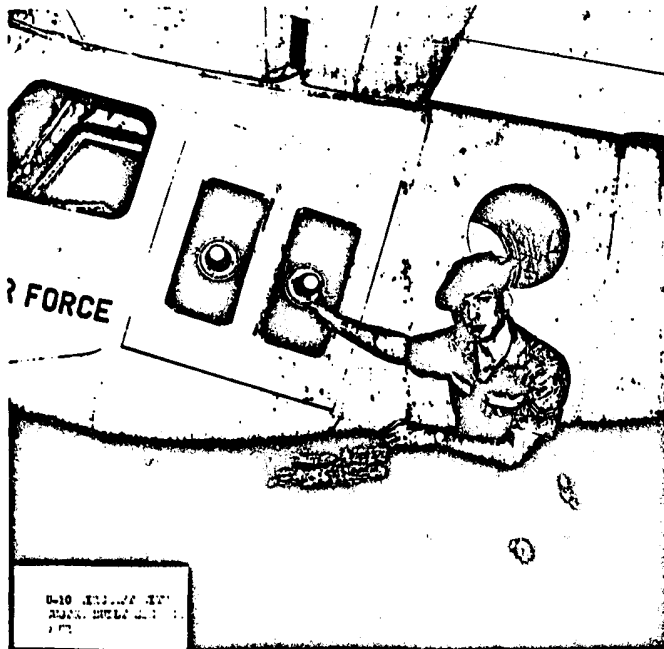
HIGH POWERED VOICE AMPLIFIER SYSTEM TYPE DE-1492-A



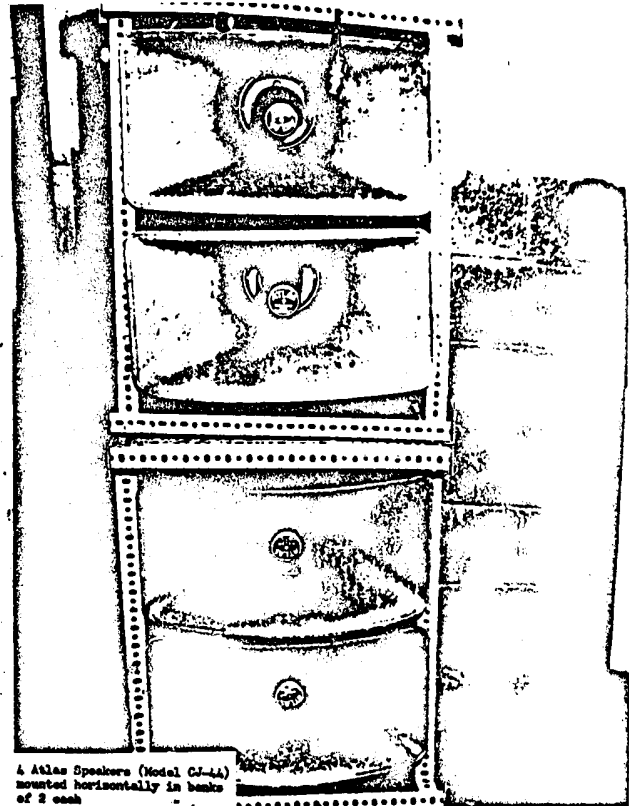


Speakers #3 & #4 (Atlas CJ-44) mounted in C-47 type A/c jump door

CESSNA 180/185  
DOOR WITH SPEAKERS



D-10...  
...  
...



4 Atlas Speakers (Model CJ-44) mounted horizontally in banks of 2 each

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9. Further Information

a. The price list covered above apply to our 2 and 4 speaker system. Any combination of speakers may be made from the list given. The figures quoted are basic cost F.O.B. Alexandria, Virginia, USA. This does not include installation cost or mounts for the speakers. Production lead time is 30 days from applied Electro Mechanics Inc. Their address is:

APPLIED ELECTRO MECHANICS, INC.  
2350 DUKE STREET  
ALEXANDRIA, VIRGINIA, USA

b. For further information for Latin American Countries, 605th ACS (Comm) box 3012, Howard AFB, Canal Zone can be contacted. The author of this paper is also available for technical advice with consent from the 605th Air Commando Squadron (Composite) Commander. For further information write:

COMMUNICATION OFFICER  
605TH AIR COMMANDO SQUADRON (COMPOSITE)  
BOX 3012  
HOWARD AFB CANAL ZONE

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