AEMN September 1945

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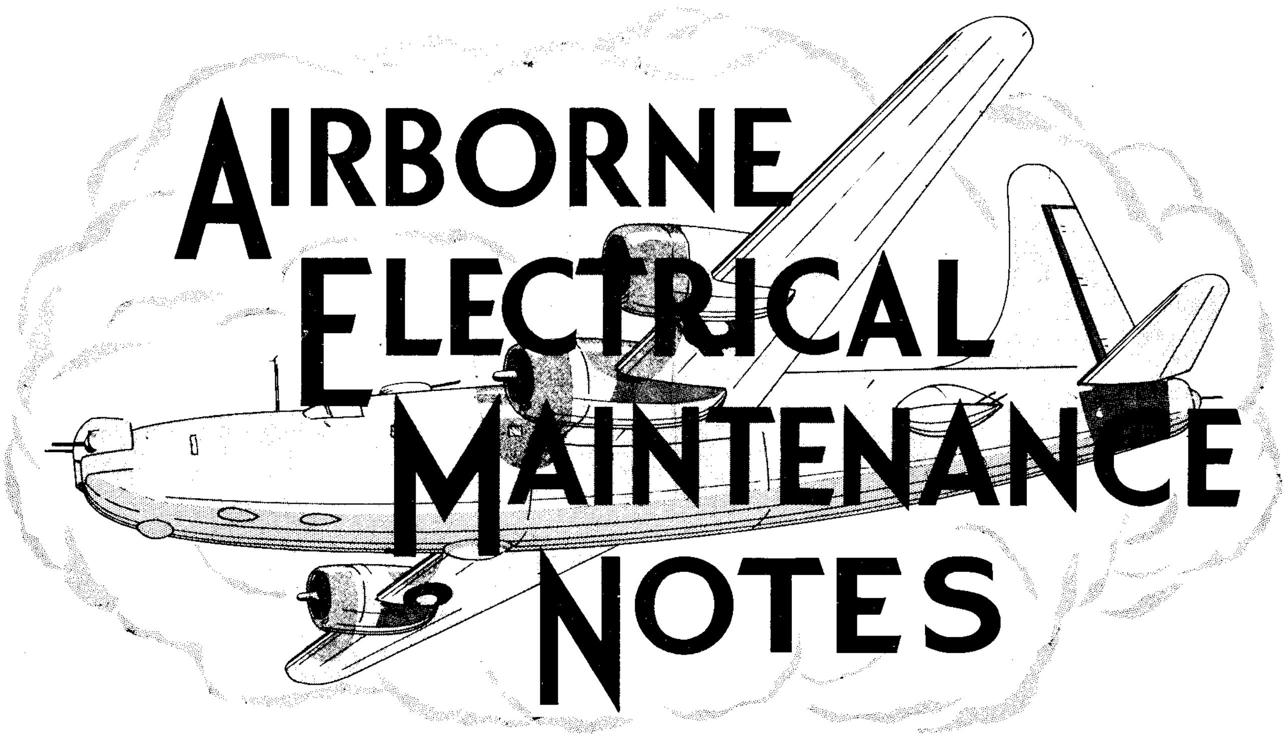

AIRBORNE ELECTRICAL MAINTENANCE NOTES

for

Aviation Electricians' Mates

AIRBORNE COORDINATING GROUP

BUREAU OF AERONAUTICS

U. S. NAVY

SEPTEMBER 1945

AIRBORNE ELECTRICAL MAINTENANCE NOTES

FOREWORD

This September 1945 issue of the AIRBORNE ELECTRICAL MAINTENANCE NOTES is a complete basic issue containing new material and reference material from all the previous fourteen monthly issues. AEMN Nos. 1 through 14 should be destroyed (or filed away).

Monthly issues of AEMN will be supplied to supplement and revise this basic September 1945 issue.

The page numbering system uses a number indicating the section, followed by a dash and another number indicating the page of the section.

The technical accuracy of the information contained in AEMN has been approved by the Bureau of Aeronautics. The AEMN is edited and published by the Airborne Coordinating Group of the Bureau of Aeronautics for distribution to the personnel of the Navy concerned with the maintenance, installation and testing of airborne electrical equipment and systems. Comments, suggestions and criticisms are invited and should be addressed to the Commanding Officer, Airborne Coordinating Group, Naval Research Laboratory, Washington 20, D. C.

AIRBORNE ELECTRICAL MAINTENANCE NOTES

SEPTEMBER 1945

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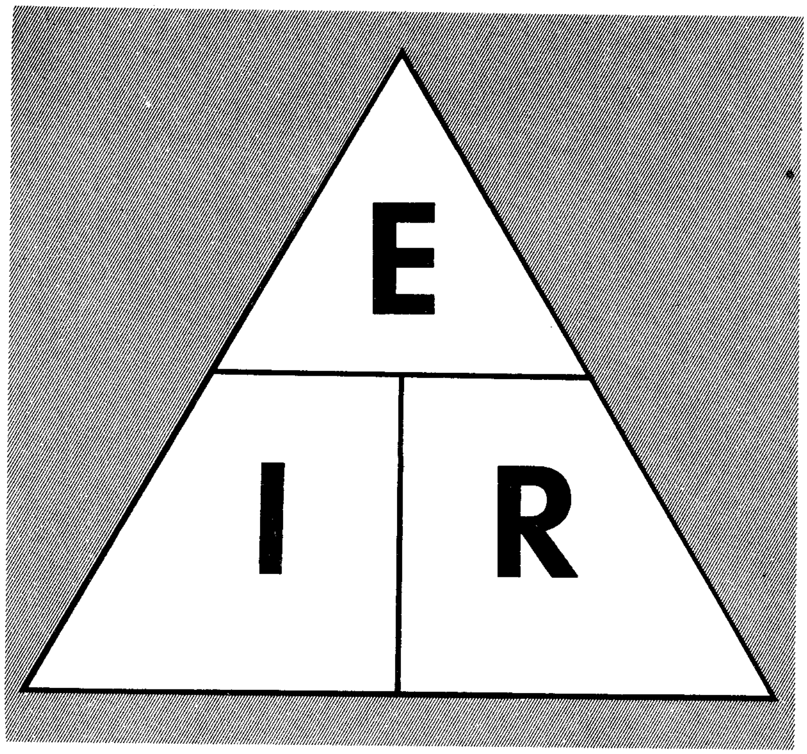
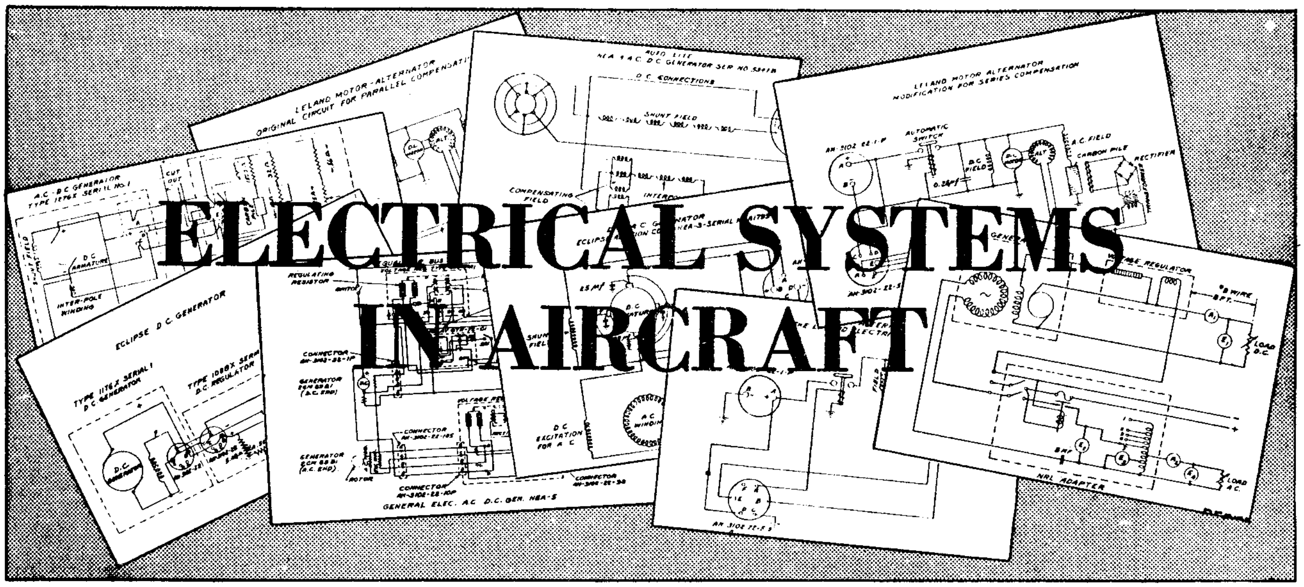


— SECTION 1



ELECTRICAL SYSTEMS IN AIRCRAFT

The primary source of aircraft electrical energy is the engine-driven generator. The battery is intended to be a power standby and normally supplies power for only limited intervals. Engine-driven generators may supply d.c. only or both d.c. and a.c. If the engine-driven generator used in an airplane supplies d.c. only, a motor-alternator can be used to provide a.c. Large multi-engine airplanes carry an auxiliary gas-engine-driven generator unit capable of supplying d.c. or both a.c. and d.c.

High d-c voltage is desirable in aircraft in order to reduce cable weight. But high voltage is undesirable because of the increased battery weight. Twelve-volt systems were standard in the past, but in 1942 it was decided that 24-volt systems would be standard.

Batteries

Storage batteries serve as the source of electrical energy at starting, during low engine speeds, and in case of generator failure. Since batteries in Naval aircraft are of small capacity in order to save weight, the batteries are capable of carrying ordinary aircraft electrical loads for only a very short time. This small battery capacity results in excessive discharging and charging unless demands on the battery are kept to a minimum. For this reason, the airplane's battery should not be used for starting the engine if a portable battery cart, portable power supply unit or auxiliary power unit in the airplane is available. The airplane's generators are required to furnish all normal electric power requirements during flight, and also to maintain the battery in a charged state. Radio, radar and other electrical equipment should not be operated from the battery in a plane on the ground.

Generators

Under normal operating conditions, the generator stores electrical energy in the storage battery, making a reserve of direct current available for a limited time in the event of generator failure. This fact influences the choice of d.c. rather than a.c. for use in airplanes. Because certain loads in aircraft (principally radar) require a.c., many Navy airplanes are equipped with either engine-driven generators which supply both 28-volt d.c. and 120-volt, 800-cycle a.c. or engine-driven d.c. generators and motor-alternators which convert 28-volt d.c. to 800-cycle a.c. The Army uses 120-volt, 400-cycle a.c. for radar. Large multi-engine airplanes usually carry an auxiliary power unit supplying d.c. or both d.c. and a.c.

In order to keep weight and size to a minimum, modern generators are designed to operate at high r.p.m. (about three times engine speed) with high field currents and with blast cooling. Generators so designed will produce, for example, an output of 200 amperes while weighing less and being smaller than the old-fashioned generators producing an output of only 50 amperes.

There is a strong trend toward the use of generators which develop full output at relatively low engine r.p.m. The normal generator does not produce appreciable output at much below cruising speed. This fact must be borne in mind when radio and radar equipment is tested on the ground or when the airplane is running at low engine speeds such as are used on extensive patrol flights.

Regulators

The voltage of an unregulated generator depends in part on its speed of rotation. When engine speed is high, generator voltage is high; and when engine speed is low, generator voltage is low. Since nearly constant voltage is required for satisfactory operation of most electrical loads in aircraft, some type of voltage regulator must be provided. Constant voltage output from a generator is obtained by automatically varying the resistance in the generator field circuit, thereby varying the field current. Regulators are able to hold the voltage to within 2½ per cent throughout the entire speed and load range.

There are three types of regulators: carbon pile, finger, and vibrator. The preferred regulators are the carbon pile and finger types. Present difficulties with regulators arise in many cases from the lack of understanding of their adjustment and maintenance by field personnel.

Carbon pile regulators contain a stack of carbon discs in series with the generator field. The pressure on these discs and hence the generator field current is controlled by a solenoid which is connected with suitable resistance across the generator output. When the generator voltage increases, the solenoid acts to decrease the pressure on the carbon pile, thereby increasing its resistance and reducing the field current, causing the generator output voltage to decrease to the regulated value. The advantage of the carbon pile is that it has no contacts to cause radio interference and that it regulates through an infinite series of steps rather than through a limited number of steps as do vibrator and finger-type regulators. The carbon pile regulator is used to regulate a.c. or d.c., whereas the finger-type regulator is used to regulate d.c. only.

Some difficulty with carbon pile regulators has been due to improper matching of regulators and generators. This trouble was corrected by the use of a "scrambled" carbon pile in the regulator. Shock mounting of regulators has often been necessary to obtain stable operation.

The finger-type regulator has a number of contact fingers which connect varying amounts of resistance into the generator field circuit, depending on the pull of a soleinoid. Finger-type regulators are not used to regulate a.c. because the variation of field resistance in steps causes interference in a.c.-operated radar and radio equipment. Some mechanical difficulty has been experienced with the dashpot and the contacts of the finger-type regulator.

The vibrating-type regulator (obsolete) cuts a resistor rapidly in and out of the generator field in such a way that the average resistance in the field circuit over a period of time is varied to maintain constant output voltage. The output current, however, is sawtooth and the contacts present a maintenance problem.

Voltage regulators in temperate climates should be adjusted to regulate the generator voltage to between 27½ and 28 volts. This optimum range was arrived at after extensive studies of battery charging performance. In hot climates, a slightly lower voltage may be advisable in order to prevent overcharging of the battery.

Reverse-Current Cutout

The purpose of the reverse-current relay or cutout is to: 1. Connect the generator to the airplane electrical system when the generator voltage is above 26.5 volts. 2. Disconnect the generator from the airplane electrical system when a reverse current flows from the system to the generator due to the generator voltage being lower than the system voltage. The cutout prevents flow of current from the battery into the generator which would tend to operate the generator as a motor. The current drawn from the battery would be very large and would probably damage the generator, or, in any event, discharge the battery.

Since the reverse-current cutout is accurately adjusted to close when the generator voltage reaches a certain value which ordinarily is not reached until the engine has been speeded up, radio and radar equipment should not be operated in an airplane when the engine is idling.

When an airplane's engine is speeded up and yet the cutout does not close, mechanics sometimes manually momentarily close the cutout applying battery voltage to the generator. This is called "flashing the field," and is damaging to the equipment. When a cutout does not close, the trouble is either due to the generator voltage not building up or to the cutout or regulator being out of adjustment. When the generator voltage does not build up, the cause is almost always due to a high-resistance film on the commutator and very rarely to loss of residual magnetism in the generator.

Rotary Conversion Machines

Dynamotors convert 12-volt or 24-volt battery d.c. to a higher voltage d.c. for use as a plate voltage for vacuum tube apparatus. A dynamotor has all windings on one armature. Usually each unit of radio or radar equipment is supplied with its own dynamotor.

Motor-alternators or inverters change 12-volt or 24-volt battery d.c. to a higher voltage a.c. Motor-alternators may be used in planes which do not have the combination generators supplying both 24-volt d.c. and 120-volt, 800-cycle a.c.

Auxiliary Power Units

A gasoline-engine-driven auxiliary power unit is usually installed in large airplanes for use as an auxiliary power source. The generator of the auxiliary power unit supplies d.c. or both d.c. and a.c. Auxiliary power units, commonly called "putt-putts," can supply power when the airplane engines are not running or when the load is greater than what the engine-driven generators alone can supply.

SERVICE RECORD OF ACCESSORIES
From T.O. 56-44

Technical Order No. 112-43 requiring the maintenance of accessory service records is cancelled and superseded by T.O. 56-44. The accessory record card was adopted chiefly to provide an operating record of accessories to permit determination, without unnecessary disassembly, of the extent of reconditioning required. It was further intended to indicate storage time so that proper cleaning and relubricating intervals could be followed. However, continued difficulties in the use of the card by overhaul activities because of lack of required entries has indicated that it is impracticable for operating units to maintain it properly. Accordingly, the card NAVAER 32326 and envelope NAVAER 32327 (present form) are discontinued. The system to be used in the future is as follows:

To permit determination of the extent of work which must be performed on carburetors, magnetos, generators, starters, and turbo-superchargers removed from engines and turned in to overhaul activities, an Accessory Removal Tag, NAVAER 1717, shall be filled out by operating units and securely attached to each accessory at the time of its removal from the engine. The tag should show the activity turning in the accessory, reason for removal, appropriate disposition including a statement as to whether repair or overhaul is required, date of removal, and signature of person accomplishing the removal. It shall be destroyed at the time of overhaul or repair of the accessory.

Heretofore, six months was the interval between re-lubrication of accessories in stock. As a result of further service experience, it has been found possible to increase this interval to a maximum of twelve months. To permit the determination of the date on which re-lubrication will be necessary, an Accessory Issue Tag, NAVAER 1718, shall be filled out and attached to each accessory at the time of overhaul or repair. This tag shall also be attached to each accessory now in stock. The back of the Accessory Issue Tag can be used to show any modifications incorporated during the last overhaul.

Accessory Removal Tags (NAVAER 1717) and Accessory Issue Tags, with changes on the back (NAVAER 1718), are available on request to the Bureau of Aeronautics, Publications Section. Until they are available, quantities immediately required may be reproduced locally using Figures 1 and 2 of T.O. 56-44 as a guide.

See T.O. 56-44 for complete information.

REPORTS OF UNSATISFACTORY OR DEFECTIVE MATERIAL
From C.L. 38-44

Aviation Circular Letter No. 38-44 emphasizes the importance of submitting RUDM's (Form NavAer 4112). RUDM's should be submitted every time a failure occurs rather than just the first time the failure occurs. It is important that RUDM's indicate whether equipment concerned has been modified by some Bureau bulletin. Copies of RUDM's should be forwarded to the cognizant BuAer Representative or BuAer Resident Representative. See C.L. No. 38-44 for full information.

THE REPORT OF UNSATISFACTORY OR DEFECTIVE MATERIAL

Why should anyone bother writing RUDM's? They are a nuisance and appear to anyone in the Fleet as a lot of extra work, and nobody ever got a Legion of Merit for writing them. Still, receiving RUDM's is the only way the Bureau of Aeronautics and the manufacturers can tell that you are not getting 2000 hours of service out of every part. To the contractor and to the design and maintenance personnel in the Bureau, no news is good news; so we go merrily on our way shipping out an Unsatisfactory or Defective part. It's for you men in the Fleet that the equipment is made, it's you who must maintain it, so it *must* be you who will tell us when it is wrong. We will go to any extent to correct failures if we can find out what they are.

Possibly you have a single piece of equipment that fails, maybe because of a small resistor that got a little too warm. You, happy to find the trouble so easily and having a spare lying around, repair the set and go on about your job of shooting down the "Slant Eyes," never bothering to report the trouble. The same failure may be repeated in a 100 different squadrons, and may cause some plane with its pilot and crew to be reported "Missing in Action." This situation will go on until someone with more than normal love for his fellowmen will beat through the red tape and report the situation to the proper authorities.

Who

Who are "the proper authorities"? These formidable, high-sounding, often-heard words are officers and men like yourselves, whose job it is to see that the Fleet gets the best possible equipment that American brains and production facilities can provide. RUDM's do require a lot of copies, but without these copies all the personnel concerned would not get the word. In the Bureau alone there are production, design, maintenance, and project engineers for all of the electric equipment manufactured for the Navy. All these men want to know what fails and why, if possible, so they can eliminate the trouble in present equipment and prevent it from recurring in future projects. They also have at their disposal the greatest research laboratories in the country headed by the outstanding brains in the world today. These men are working day and night to design better equipment for the Fleet tomorrow and to solve the problems of the Fleet today. In spite of their background, they don't know "what's wrong" unless you write RUDM's.

The Inspector of Naval Material at the manufacturer's plant is also interested in any failures. Through him the manufacturer's engineers hear what part has caused trouble and possibly can correct it right on their production line, or the inspector can correct the trouble by having a more careful inspection. Unless you write RUDM's, each will lean back in his chair with his feet on the desk thinking everything is hunky dory.

How

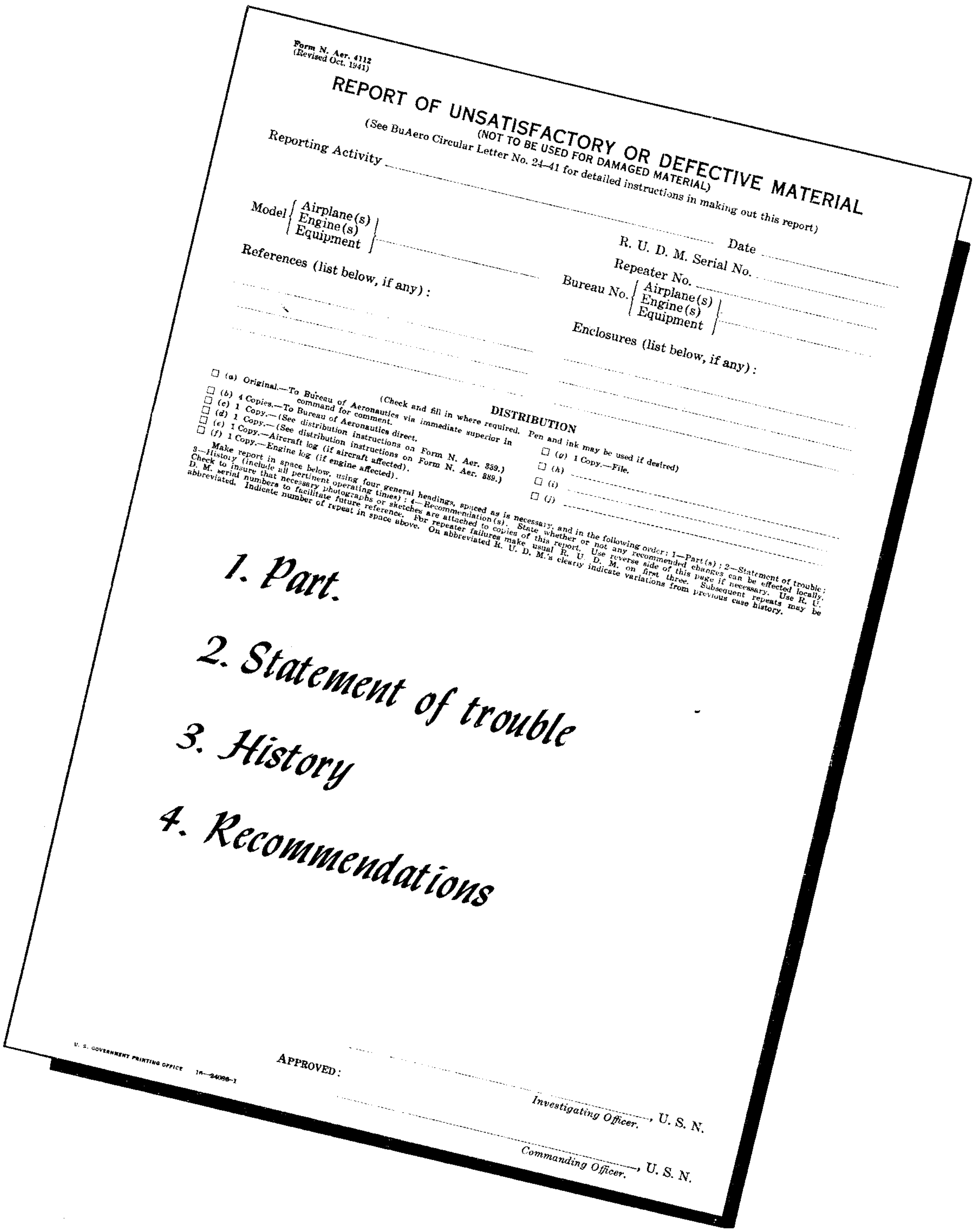
How should RUDM's be written? The procedure is simple. BuAer Circular Letter 26-43 gives detailed instructions on preparation, but there are really only four main points to remember, as the illustration shows.

First, *Identify the part.* Always give complete nameplate data, which should include the name of the equipment, the manufacturer, the Navy type number, serial number and commercial designation. Also include the size or capacity and the circuit symbols if they are involved. Remember, the Navy has thousands of different kinds of electric equipment and we may not be aware that Joe Bloke of East Podunk always works on 2CM70B5B generators. If we don't know what it is, we can't fix it.

Second, *"Statement of Trouble."* This should be a simple, concise statement of what happened. Did something blow up and kill ten people or did a little resistor just burn out before its time?

Third, *History.* Include the approximate number of hours of operation and any previous experience with this same part or equipment. You may be able to include several identical failures in the same RUDM, or several different failures in identical equipments. (This will also help to relieve the paper shortage.)

Fourth, *Recommendations.* How did you fix it, was it a permanent or temporary repair, and what do you suggest for permanently solving the trouble? After all, you are in the Fleet and



Form N. Aer. 4112
(Revised Oct. 1941)

REPORT OF UNSATISFACTORY OR DEFECTIVE MATERIAL
(NOT TO BE USED FOR DAMAGED MATERIAL)
(See BuAero Circular Letter No. 24–41 for detailed instructions in making out this report)

Reporting Activity .... Date ....

R. U. D. M. Serial No. ....

Repeater No. ....

Model { Airplane(s) / Engine(s) / Equipment } ....

Bureau No. { Airplane(s) / Engine(s) / Equipment } ....

References (list below, if any):

Enclosures (list below, if any):

DISTRIBUTION
(Check and fill in where required. Pen and ink may be used if desired)

☐ (a) Original.—To Bureau of Aeronautics via immediate superior in command for comment.
☐ (b) 4 Copies.—To Bureau of Aeronautics direct.
☐ (c) 1 Copy.—(See distribution instructions on Form N. Aer. 339.)
☐ (d) 1 Copy.—(See distribution instructions on Form N. Aer. 339.)
☐ (e) 1 Copy.—Aircraft log (if aircraft affected).
☐ (f) 1 Copy.—Engine log (if engine affected).
☐ (g) 1 Copy.—File.
☐ (h) ....
☐ (i) ....
☐ (j) ....

Make report in space below, using four general headings, spaced as is necessary, and in the following order: 1—Part(s); 2—Statement of trouble; 3—History (include all pertinent operating times); 4—Recommendation(s). State whether or not any recommended changes can be effected locally. Check to insure that necessary photographs or sketches are attached to copies of this report. Use reverse side of this page if necessary. Use R. U. D. M. serial numbers to facilitate future reference. For repeater failures make usual R. U. D. M. on first three. Subsequent repeats may be abbreviated. Indicate number of repeat in space above. On abbreviated R. U. D. M.'s clearly indicate variations from previous case history.

1. Part.

2. Statement of trouble

3. History

4. Recommendations

APPROVED:

.... *Investigating Officer*, U. S. N.

.... *Commanding Officer*, U. S. N.

U. S. GOVERNMENT PRINTING OFFICE 16—24066-1 should be able to suggest repairs or changes that the Fleet can make.

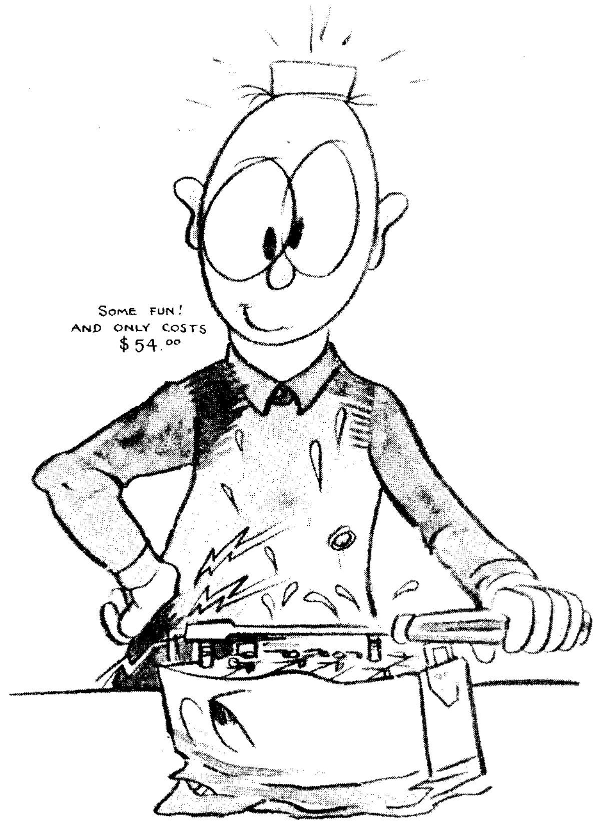
One more point—enclose a couple of photographs of the defective part if possible. Take close-up shots and label them clearly. They'll speak more loudly than words.

What Action Is Taken?

What happens when an RUDM arrives at the Bureau? It isn't, as you may think, just used for scrap paper, nor does it go into the circular file that catches the used Dixie cups. Every RUDM gets action immediately—action which ranges from tabulation of information to a major change in design. Even if the only immediate action is tabulation of information, that tabulation will show where numerous identical failures are occurring. And when the Bureau sees trouble striking often in the same place, it acts to eliminate it by either selecting a different part, changing the circuit design or closer inspection. Also, it procures emergency stocks of the failing item so that a larger-than-normal quantity of spares will be available. Since the number of times a failure is reported helps determine whether changes will be made, you should turn in an RUDM even though you think someone else has already screamed over the same trouble.

When a part fails either because of faulty or poor manufacturing or because of poor design, the part is replaced by the manufacturer at no cost to the Navy and shipped to the ASO at Philadelphia. The activity concerned should order any necessary replacements through the usual channels, taking emergency measures if required. Previously, replacements were shipped directly to the reporting activity instead of to the ASO, but it's a hard job to chase CASU humpty-two all over the South Pacific.

Although frequently the investigating officer who sends in an RUDM never hears any more about his report, he can rest assured that something is done. Like the old adage that "A stitch in time saves nine," one RUDM may save the Fleet a hundred failures. So, next time gremlins get in your equipment, sit down and fill out the form—don't let a little fine print scare you. Be sure to jot down your own ideas for remedying the cause of failures. And send copies to the authorities specified on the blank. You could, of course, spend 10 minutes cussing out the Bureau for letting trouble happen, but you'll get results faster if you spend that time filling out an RUDM.



Count on Spoiler to try making a direct short across the terminals.

GROUND OPERATION OF ELECTRICAL EQUIPMENT

From T.N. 43-42

To insure that airplane batteries will be in a charged condition at take-off so that they will be adequate for emergency conditions, they should be relieved of all duties while the plane is on the ground.

Engines should be started using electrical energy from an external power supply. This can be done by plugging a battery cart or portable power unit into the external power receptacle on the plane by using a "putt-putt" in the plane. Another method is to start the engines with an energizer supplied from an external power supply.

Operation of radio and radar transmitters, gun turrets and other heavy loads should not be attempted from the plane's battery. Auxiliary power plants can be used, on planes having them. Otherwise, testing should be done using an auxiliary power supply.

FIELD REPAIR KITS

Field repair kits have been procured for generators, motor-alternators, voltage regulators and starters. These kits contain suitable quantities of wearing parts such as brushes, bearings, carbon piles and buttons, etc., for 700 hours average operating of 10 units. Kits also contain sufficient quantities of nuts, bolts, and other hardware to replace parts lost in installing the wearing parts or in installing the equipment into the plane. Quantities of such parts are sufficient to permit the building of good units from parts salvaged from several failed units. The kits also contain plugs to mate with any receptacles in them, rubber terminal hoods and similar items used in installing the equipment into the plane.

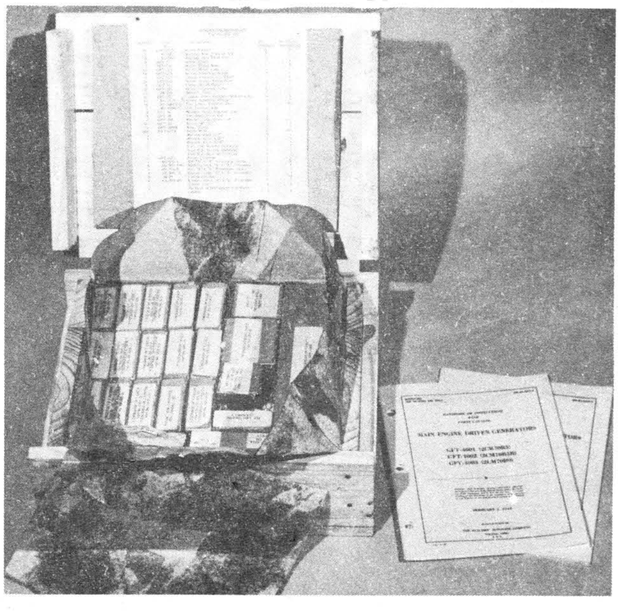
The kits contain two copies of overhaul and installation and service instructions for all units to which they apply. It contains such of the following items as are used in the application of the parts contained in it, or in the field maintenance of the unit: lubricant, tie wire, Allen-head wrenches, special screw drivers and other small tools, special solders and cements, and any other tools which are not in common use. Sleeves shall be included where necessary to permit the installation or removal of pressed fit bearings.

Each kit is contained in a wooden or fiber board container sufficiently rugged to stand up under all conditions of transportation and usage. It will float. It is designed to serve as a stock bin for its contents and is of such a nature as to permit fastening it tightly so that it can be carried around after it has been opened. The box is lined with a completely waterproof sealed inner lining. It is not necessary to reseal this lining after it has been opened. Hardware and small metal parts are coated with preservative oil and are contained in envelopes or cartons which are greaseproof and water-resistant.

Parts which cannot be slushed in oil, and bearings, are contained in boxes which are suitably wrapped and then dipped in a waxeous preservative or placed in hermetically-sealed cans. All identical parts which have been treated with preservative oil may be enclosed in the same container. Brushes, gaskets, and other parts in wax-dipped or hermetically-sealed containers are wrapped individually or in quantities no larger than adequate to repair one generator.

All parts packages are clearly labeled as to part number and, if possible, these labels are visible without removing the parts from the box. A Consist List is fastened inside the cover of the box and waterproofed with shellac or lacquer. This list shows complete nomenclature, manufacturer's part number, Navy Stock number, and quantity per kit. It also shows the number of the kit and the units to which the kit applies. The kit is labeled conspicuously on the top and at least two sides with the kit number and the units to which the kit applies. On each label appears this sentence: "Do not disassemble for stocking purposes. This kit is to be issued as a unit under direction of fleet command."

The part numbers of repair kits can be determined from the last columns of the interchangeability charts at the end of the General section of Airborne Electrical Maintenance Notes.



Let's all help the Supply Officer...

"Why the H--- don't they say what plane it's for and where it's used?"

By giving the right Description, Nomenclature, Part Number, Voltage, Type, Size, plane for which required and equipment to be used with or used on.

FOR EXAMPLE:

VERY POOR

What is it? This helps the enemy.

ITEM	STOCK NO.	DESCRIPTION	QUANT.	
1	17	Motor		10 ea.

POOR

More than one motor used on plane noted.

ITEM	STOCK NO.	DESCRIPTION	QUANT.	
1	17	Motor P.B.M.-3-S	10	ea.

BETTER

ITEM	STOCK NO.	DESCRIPTION	QUANT.	
1	17-M	Motor P.B.M. Cowl Flap 3-S	10	ea.

BEST

Mfg. Name & Part No.
Where Used
Plane for which required

ITEM	STOCK NO.	DESCRIPTION	QUANT.	
1	17-M	Motor-Gen'l. Elec. Part No. 5BA25DJ4A Used on cowl flap on P.B.M-3S	10	ea.

SOME NEW ANTI-FRICTION BEARINGS REQUIRE LUBRICATION BEFORE INSTALLATION (T.O. 32-45)

Many ball bearings in aircraft revolve for hundreds of hours in isolated positions without attention and with only a small initial supply of grease to provide lubrication. It is, therefore, essential to successful performance that the proper grease be in the bearing when it is installed.

As received from the manufacturer, bearings contain one of two general types of materials to protect the highly finished surfaces from corrosion. One type is a grease, the other a soft-film corrosion preventive material, referred to in this Technical Order as "slush." Greases of various characteristics are used depending on the operating conditions expected. The greases provide lubrication in service; a slush does not.

In the past, bearings procured and stocked for maintenance of naval aircraft have contained the proper grease for the application. At present bearings, except those closed on both sides, are being procured and stocked without consideration for the lubricating ability of the protective agent. It is, therefore, necessary for the installing activity to insure that the proper grease is in the bearing when it is installed.

All new ball bearings that are to depend on grease for lubrication while in use, except those closed on both sides by seals or plate shields, shall, before installation, have the protective agent removed by flushing and the grease required for proper lubrication applied. New bearings that are to be lubricated by oil while in use shall have grease removed, but slush need not be removed. Bearings closed on both sides shall be installed as received, as such units are assumed to contain the correct lubricant.

The installing activity shall perform the required flushing and greasing of bearings as follows:

1. Bearings are to be freed of grease, or slush, by flushing with hot light oil, or a petroleum solvent, while being rotated slowly to carry the liquid to all surfaces. If hot oil is used, the material preferred is that complying with Bureau of Ordnance Specification OS-1361. The oil should be heated to 170°–190° F. If petroleum solvent is used, Federal Specification PS-661 is preferred. A system that circulates a fluid for further use should include a filter. Only a clean unused fluid shall be used to charge such a system. The fluid of the system should be changed at least weekly or more often, if experience indicates that it is desirable. If solvent baths are used, the fluids should be changed at least daily and the tanks thoroughly cleaned before the new fluid is added.

Great care must be exercised to avoid the introduction or entrance of foreign matter into the bearings. Bench tops, tote pans, the air of the room, operator's hands, flushing fluid, grease or anything contacting the bearing may transmit chips, abrasive dust or other foreign material that will shorten the life of the bearing, or make operation rough and noisy. Unwrapped bearings shall be rested only on surfaces covered by clean paper and shall be covered with clean paper. Grease should be kept in containers that are covered when not in use. Grease once removed from the container should not be returned.

Anti-friction bearings should never be allowed to reach a condition conducive to rusting or corroding. The fluid used in flushing should be allowed to remain on the bearings as a protective agent before greasing. The light oil, Specification OS-1361, will provide protection for several days.

Grease may be added to the bearings by a non-ferrous spatula or by a finger. Care should be taken so as not to use too great a quantity of grease. The quantity should be between 1/4 to 1/2 of the amount of grease that would fill all the bearing voids. The following procedure may be used to avoid the inclusion of too much grease. The open side, or sides, of the bearing may be filled with grease, the bearing oscillated several times, the grease pushed back in, the bearing again oscillated several times, and all grease then protruding beyond the bearing faces wiped off with spatula or finger. If a pressure device is used for packing, the bearing should be revolved at over 1000 rpm for several minutes to remove the excess grease. Melted grease should never be used.

Grease is required in all anti-friction bearings that do not receive oil during operation. The correct grease should be determined from Bureau of Aeronautics publications pertaining to the apparatus on the aircraft in which the bearing is to be used or from publications pertaining to the use of lubricants. The selection of grease depends on knowledge of the expected temperature of operation, the torque requirements at low temperatures, and the speed and continuity of operation. Specification AN-G-3 grease is suitable for operation at low temperatures and is required for lowest torques at low temperatures. It is not suitable for bearings in high speed electrical equipment which will be required to operate continuously, or at high temperatures. It meets the operating requirements of control bearings in airframes. Specification M-675 grease is suitable for anti-friction bearings that may be required to start at low temperatures, but which also are operated at high speeds and high temperatures. The torque required for starting at low temperatures will be greater than that for the Specification AN-G-3a grease, but less than that for the Specification AN-G-5a grease. The maximum temperature allowable for suitable operation is greater than that for the Specification AN-G-3a grease, but less than that of the Specification AN-G-5a grease. Specification AN-G-5a grease is suitable primarily for high speed, high temperature, continuous operation.

Bearings should be wrapped in paper individually, or in sets for one unit of the completed assembly, using Specification AN-P-12 grade A material with a second wrapping of heavier paper. The contents of the package or the end use of the bearings should be indicated on the outside wrapper to avoid opening of the package before time for installation of the bearings. The package should not be opened until all preparations for mounting the bearings are completed.

RECONDITIONING AND REUSE OF AIRCRAFT ANTI-FRICTION BEARINGS

Technical Order No. 87-44, dated 23 June 1944, consolidates, insofar as is possible, all pertinent information on procedures and equipment for the installation, maintenance, and inspection of anti-friction bearings used in Naval Aircraft. The following subjects are covered:

- Description of Bearing Types
- Grouping by use
- Re-Use, Limitations on
- Removal and Installation
  - General Conditions to be Observed
  - Removal from Shaft
  - Removal from Housing
  - Installation on Shaft
  - Installation in Housing
- Sealed Bearings, Treatment of
- Cleaning of Bearings
  - General Procedure
  - Equipment
  - Detail Procedures
- Protection of Cleaned Bearings
- Inspection
  - Visual Test
  - Hand Test
  - Noise Test
- Lubrication or Preservation
- Preparation for Storage
- Bearing "Don'ts"

All matter contained in T.O. No. 87-44 shall be carefully studied and strictly adhered to by all personnel concerned with the use, maintenance, and/or installation of anti-friction bearings. It is further directed that all overhaul activities obtain the necessary facilities and personnel to permit compliance with the T.O. Separate action is being taken by the Bureau of Aeronautics to provide necessary training for personnel engaged in this work and to supply part of the necessary equipment. The equipment to be supplied is described in the body of T.O. An officer of each major overhaul activity shall be assigned to supervise the carrying out of the provisions of this order and all matters pertaining to conservation of anti-friction bearings.

Technical Order No. 87-44 supersedes and cancels Technical Note 38-41 dated 17 November 1941; also, this Order supersedes information and instructions contained in paragraph headed *"Bearings, Ball and Roller"* on page 5 of General Engine Bulletin No. 8 dated 9 November 1943. For Naval Air use, the Army Technical Orders listed below are replaced by this publication:

A.A.F. Technical Order 03-25A-1 dated 15 July 1943.

A.A.F. Technical Order 29-1-2 dated 1 Sept. 1942.

A.A.F. Technical Order 29-1-3 dated 26 Oct. 1943.

All local process specifications shall be cancelled or revised to agree with this order.

See T.O. 87-44 for detailed information.

HOME-MADE TOOLS

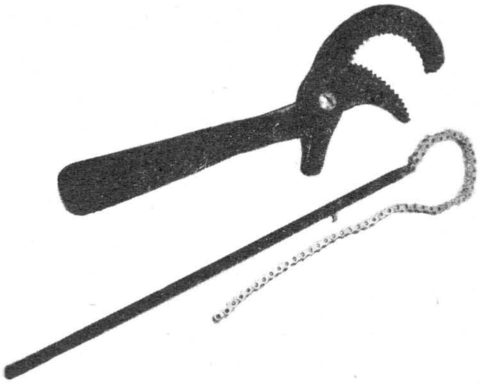


Figure 1—The two above adjustable wrenches were designed and built by CASU-F 13 mainly for use on AN connectors. The alligator wrench (top) is made of chrome alloy and has hardened teeth. The chain wrench (bottom) was made with a rod from a tool set and a chain from a cockpit greenhouse closing gear. Note the hook that permits adjustment of the chain wrench.

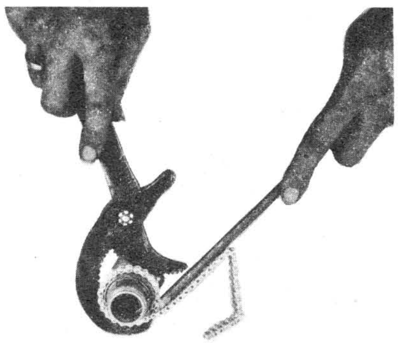


Figure 2—Both wrenches have the advantage that they can be operated with one hand. The chain wrench grips all the way around without exerting a two-point crushing pressure.

Figure 3—The chain wrench is adjustable in size over a large range.

Don't drop tools and parts—they can't be replaced!

ELIMINATION OF NOISE IN AIRCRAFT RADIO

A new book entitled, Handbook for Elimination of Noise in Aircraft Radio, was published 1 March 1944 by the Army. The book treats the subject thoroughly in 150 pages of text and illustrations. Most noise in aircraft radio is caused by the electrical and ignition equipment in the airplane.

Naval activities may request Handbook for Elimination of Noise in Aircraft Radio through official channels from the Bureau of Aeronautics, Publications Section, stating in the request that the publication is available from the Officer-in-Charge, Aircraft Radio Laboratory, Radio Noise Branch, Wright Field, Dayton, Ohio.

MARKING OF ELECTRICAL ACCESSORIES

In order to eliminate installation of 12-volt accessories in 24-volt circuits resulting in damage to the 12-volt accessories and airplane wiring, and to eliminate the installations of intermittent-duty equipment in continuous duty circuits, the A&R Electrical Shop at Pensacola marks all accessories with decalcomanias indicating the voltage and type of duty (continuous or intermittent). These markings are mounted as near the terminals as possible at the time the electrical equipments are overhauled, repaired or tested in the A&R.

Marking of voltage and duty is a good idea in any case, and it is a necessity if nameplates are defaced or destroyed.

APU GENERATOR SHAFT FAILURES

Shaft failures have been reported on generators on auxiliary power units, especially shafts on the 2CM70B5 generators on Lawrence units in the PBM airplane. The failures are caused by sudden loads, such as main engine starting, being applied and overloading the gas engine, causing the engine to slow down to 1600-1800 rpm. Excessive torsional vibration occurs at this speed and sets up a resonant vibration in the generator quill shaft, causing ultimate failure.

Auxiliary Power Plant Bulletin No. 16 dated 25 May 1945 directs installation of an external adjustable resistance in series with the generator shunt field of all Type 2CM70B series generators on Lawrence Auxiliary Power Plants Models 30D and 30D-1. The bulletin explains how to adjust the resistance so as to limit the load imposed on the engine by the generator, thus avoiding dangerously slow speeds and shaft failures. A 6.5-ohm, 160-watt resistor, ASO Stock No. R16-R-21001-125, is recommended, but any similar resistor may be used.

APP Bulletin No. 16 also directs modification of the APP generator circuit so as to utilize the reverse-current cutout as a magnetic contactor for electrical starting of the APP motor.

RADIO INTERFERENCE CAUSED BY AUXILIARY POWER PLANTS

Experience has shown that various installations of the Lawrence Model 30 (30D and 30D-1) auxiliary power plants have caused excessive radio interference. Tests conducted at the Aeronautical Radio-Radar Laboratory, Navy Yard, Philadelphia, have indicated that the major portion of the radiated interference appears to originate from the magneto (SF2RN) cover plate.

This difficulty may be alleviated by replacing the present nonconductive magneto cover plate gasket with a conducting gasket, Scintilla Part No. 10-8665. This gasket is available in existing stocks and additional quantities, if needed, may be requisitioned through regular channels, referring to the Scintilla part number.

Additional study of the problem is under way and it is expected that information for a complete radio interference clean-up of each of the various makes of auxiliary power plants now in use can be supplied to all activities in the near future in the form of Auxiliary Power Plant Bulletins.

OVERHAUL FACILITIES FOR AUXILIARY POWER UNITS

From Aviation Circular Letter No. 127-44

Aviation Circular Letter No. 127-44 includes a chart showing activities within the continental United States designated to recondition and overhaul various types of auxiliary power units and aircraft heaters. Auxiliary power units requiring either major or minor overhaul, or rework, to the extent of partial disassembly in overhaul shops shall be processed only by a designated overhaul activity. Any activity within the continental United States which has an APU, and for which that activity is not the designated overhaul point, shall ship such APU to the nearest or most conveniently located designated overhaul point for the model unit concerned without further reference to BuAer.

The scheduling of APUs for reconditioning and overhaul in maintenance activities outside the continental limits of the United States is a function of the cognizant fleet commands. It is requested that all APUs, which are in excess of the capacity of overhaul activities under cognizance of fleet commands be returned to the United States for overhaul.

All APUs shall be shipped complete except that standard type aircraft generators used on APUs shall not be shipped.

ELECTRICAL SHOP RECORDS

Complete electrical shop records are kept by Naval Air Transport Service, Air Transport Squadron Six, Naval Air Facility, Dinner Key, Miami, Florida. The completeness of their records contributes greatly to the efficient handling of a large quantity of electrical maintenance work on PBMs.

Three forms are used:

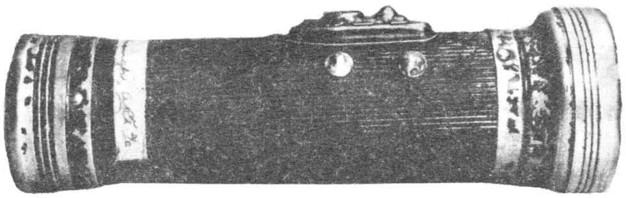
1. Electrical Check Sheet for indicating equipments to be checked or exchanged on 30, 60, 90, 120 and 240 hour checks, and recording work done.

2. Electrical Change Sheet for recording serial numbers of equipment removed from a plane and serial numbers of replacing equipment.

3. Equipment Card File of each piece of electrical gear on hand, what plane it is in, and how long it has been in service.

FUZE TESTER

Merely attaching two leads to the outer casing of a standard flashlight makes a handy device for testing fuzes. Two studs are connected in parallel with the flashlight switch through the side of the case. The connecting wires are so placed inside the case that they do not inter-



fere with the installation of the cells. To test a fuze, the ends of the fuze are placed against the studs with the flashlight switch turned off. If the fuze is good, the light flashes on. The fuze tester was thought of and made by an ART at NAS, Quonset Point.

CHART 1

ITEM NUMBERS OF ELECTRICAL EQUIPMENT IN VARIOUS PLANES

Airplane	Generator (See Chart 2)			D-C Control (See Chart 3)			A-C Control (See Chart 3)			Cutout (See Chart 4)			Battery (See Chart 5)			Aux. Pwr. Unit (See Chart 6)			Motor-Alternator (See Chart 7)		
	Item Number	Replace With	Quant.	Item Number	Replace With	Quant.	Item Number	Replace With	Quant.	Item Number	Replace With	Quant.	Item Number	Replace With	Quant.	Item Number	Replace With	Quant.	Item Number	Replace With	Quant.
VF																					
F3A-1 (1st 225)	97		1	282		1				420		1	590	609 or 606	1[1]						
F3A-1 (226 and Up)	95		1	296		1				419		1	589	609 or 606	1[1]						
F4F-3; 3A; 4; 7	38		1	262		1				410		1	561		1						
F6F-3	129		1	303		1				430		1	590	609 or 606	1[1]						
F6F-3N	129		1	303		1				430		1	590	609 or 606	1[1]				681		1
F6F-5	129		1	303		1				430		1	597		2 Par.						
F6F-5N	129		1	303		1				430		1	597		2 Par.				681		1
F6F-6	118		1	303		1				430		1	597		1						
F7F-1	223		2	296		2	388		1	430		2	597		2 Par.						
F7F-2	223		2	295		2				430		2	597		2 Par.						
F8F-1	111		1	372a		1				430		1	597		1						
FG-1 (1st 300)	97		1	282		1				420		1	590	609 or 606	1[1]						
FG-1 (301 thru 1192)	95		1	296		1				420		1	590	609 or 606	2 Par.						
FG-1 (1193 and Up)	95		1	296		1				419		1	597		2 Par.						
F2G-1	117		1	303		1				430		1	590		2 Par.						
FM-1	38		1	262		1				410		1	561		1						
FM-2 (1st 130)	96	95	1	296		1				420		1	590		1						
FM-2 (131 and Up)	95		1	296		1				419		1	589		1						
F4U-1 (1st 833)	97		1	282		1				420		1	590	609 or 606	2 Par.						
F4U-1 (834 thru 1232)	97	95	1	282	296	1				420		1	590	609 or 606	2 Par.						
F4U-1 (1233 thru 2497)	95		1	296		1				420		1	589	609 or 606	2 Par.						
F4U-1 (2498 and Up)	95		1	296		1				419		1	597		2 Par.						
F4U-2	203		1	281		1	389		1	420		1	589	597	1						
F4U-4	111		1	281		1				420		1	597		2 Par.						
VP and VPB																					
PB2B-1	203		1	281		2	389		2	420		2	569		2 Ser.						
													561		2 Ser.	660		1	687		2
PB2B-2	130		2	303		2				430		2	569		2 Ser.	660		1	682		2
																			687		2
PBJ-1C; 1D; 1G; 1H; 1J	160	144	2	313	306	2				435	430	2	607		2 Par.				682 & 687		2 & 2
PBM-1		130	1		303	1					434	1	570		2 Ser.		660	1	682		1
PBM-3C	168[7]		2	303		2				434		2	569		2 Ser.				682		2
	183		1	303		1				434		1				671		1			
PBM-3S (Converted from	168[7]		2	303		2				430		2	569		2 Ser.						
PBM-3C)				306		1				430		1				650		1			
PBM-3D	168[7]		2	303		2				430		2	569		2 Ser.				681		3
	129		1	303		1				430		1				661		1			
PBM-3R	133		2	303		2				430		2	569		2				657		2
PBM-5	167		2	303		2				430		2	569		2 Ser.	655		1	681 & 687		2 & 2
PBN-1 (thru 69)	129		2	303		2				430		1	561,569		2 Ser.				681 & 687		2
	175		1	320		1				430		2				662		1			
PBN-1 (70 thru 156)	129		2	303		2				430		2	561,569		2 Ser.						
	129		1	303		1				430		1				661		1	681		2
PBY-5 (1 thru 117)	204		2	374	281[1]	2		389	1	422	420	2	570		2 Ser.				680		1
													561		2 Ser.						
PBY-5 (118 thru 165)	204		1	314									570		2 Ser.						
	137	203	1	118	281	1		389	1	422	420	2	561		2 Ser.				681	680	1
	204	203	1	374	281	1		389	1	422	420	1	562 &		2 Ser.						
PBY-5 (166 thru 255)	135	133	1	304		1				436		1	570		2 Ser.						
	175		1	320		1				436		1				662					
PBY-5 (266 and Up)	203		2	281		2	389		2	420		2	561 &		2 Ser.				681		2
	203		1	281		1	389		1	420		1	570		2 Ser.	660		1			
PBY-5A (1 thru 232)	204	203	2	374	281	2		389	2	422	420	2	562 &		2 Ser.	640		1			
	245		1	283		1				420		1	570		2 Ser.						
PBY-5A (233 thru 722)	203		2	281		2		389	2	420		2	562 &		2 Ser.						
	245		1	283		1				420		1	569		2 Ser.	640		1			
PBY-5A (723 and Up)	129		2	303		2				430		2	569		2 Ser.				687		2
	129		1	303		1				430		1				661		1			
PBY-6A (PBY-5A after 723)	129		2	303		2				430		2	570		2 Ser.	660		1	680		2
PB2Y-3 (PB2Y-3R	132		4																682		1
Converted)	183	131	1	303		4				430		4	569		2 Ser.	671		1	687		2
PB2Y-3R (Converted	132	131	4	303		4				430		4	569		2 Ser.				682		1
from PB2Y-3)	183		1	303		1				430		1				671		1			
PB2Y-3R	129		3	303		3				430		3	569		2 Ser.				682 &		1
	129		1	303		1				430		1				658		1	687		2
PB4Y-1	160	129	4	313	306	4				435	430	4	607		2 Par.				681 &		2
				306		1				430		1				650		1	687		2
PB4Y-2	167		4	303		4				430		4	606		2 Par.				682 & 687		2, 2
PV-1	130		2	303		2				430		2	610		1				681		2
PV-2	129		2	303		2				430		2	606		2 Par.				681		2
PV-2C	129		2	303		2				430		1	606		2 Par.				680		2
VSB																					
SB2C-1	134		1	303		1				434		1	561	569	2 Ser.				682		1
SB2C-1A	160		1	313		1				435		1	606		1						
SB2C-2; 3; 4	118		1	303		1				430		1	569		2 Ser.				681		1
SB2C-5				295		1	387		1	430		1	569		2 Ser.						
SBD-1; 2; 3; 3A	196		1	365		1				412		1	561		1						
SBD-4; 4A	204		1	373		1				420		1	590		1						
SBD-5; 5A; 6	203		1	281		1	389		1	420		1	590		1						
SBF-1; 2; 4	118		1	303		1				430		1	569		2 Ser.				681		1
SBF-3	118		1	303		1				430		1	597		1				680		1
SBF-4	118		1	303		1				430		1	569		2 Ser.				681		1
SBW-1; 2	118		1	303		1				430		1	569		2 Ser.				681		1
SBW-3	118		1	303		1				430		1	597		1				680		1
SBW-4	118		1	295		1				430		1	597		1				680		1
VTB and VBT																					
BTD-1	229or230		1	296		1	387		1	430		1	569		2 Ser.						
TBF-1 (1st 326)	134	120[2]	1	304		1				434		1	569		2 Ser.				682		1
TBF-1 (327 and Up)	120[7]	130[3]	1	303		1				430		1	569		2 Ser.				682		2
TBF-1C	232[7]		1	297		1	388		1	430		1	569		2 Ser.				681		1
TBF-1D	232		1	297		1	388		1	430		1	569		2 Ser.				681		1
TBM-1 (1st 50)	134		1	304		1				434		1	569		2 Ser.				682		1
TBM-1 (51 and Up)	120[7]		1	303		1				430		1	569		2 Ser.				682		2
TBM-1C; 3	231[7, 8]		1	297[8]		1	388[8]		1	430		1	569		2 Ser.				681		1
TBM-1D	231		1	297		1	388		1	430		1	569		2 Ser.				681		1
TBY-2	229or230		1	296		1	397		1	430		1	569		2 Ser.						
VOS and SO																					
OS2N-1	22[4]		1	274	260	1				412		1	561		1						
OS2U-1; 2; 3	22[4]		1	274	260	1				412		1	561		1						
OY-1	7		1	264		1				In Control Box			569		1						
SO3C-1; 2	196	197	1	365		1				430		1	561		1						
SO3C-2C; 3	203	38	1	281	260	1	387		1	430		1	590	569	1						
SC-1	223		1	296		1	388		1	430		1	589		1						
SOC-2, 3, 3A	189		1	365		1				412		1	561		1						
SON-1	25		1	274		1				412		1	561		1						
VR																					
RB-1	130		2	303		2				430		2	569		2 Ser.				687		2
R5C-1	160		2	313	306	2				435		2	607		2 Par.				687		2
R4D-1; 2; 3; 4	39 or 40		2	265		2				In Control Box			582		2 Par.						
R4D-5	98 or 99		2	287	286	2				In Control Box			582		2 Ser.				687		2
R4D-5 (last 14)																					
R4D-6	140		2	306		2				435		2	582		2 Ser.				687		2
R5D-1	121		4	313	306	4				430		4	582		2 Ser.				687		2
R5D-2	121		4	306		4				430		1	582		2 Ser.				687		2
R50-4, 5	38	130	1	262	356	1				410	412	1	582		2 Ser.					687	1
	196	130	1	365	356	1				412		1			2 Ser.						
R50-6	101or102		2	292	286	2				In Control Box			582		2 Ser.						
RY-1	121		4	306		4				435		4	607		3 Par.						
RY-2; 3	160		4	313	306	4				430		4	607		3 Par.						
R2Y-1	118		2	303		2				430		2	606		2 Par.						
VJ and VJR																					
B-314	52		2	Spec.						Spec.			583		1						
J2F-2, -2A, -3	189		1	365		1				412		1	570		1						
J2F-5	196		1	365		1				412		1	570		1						
J2F-6	203		1	281		1	389		1	420		1	561		2 Ser.						
J4F-2	27		1	273		1				In Control Box			569		1						
JM-1	160	144	2	313	306	2				435		2	607		1				681 &		1
				306		1				430		1				650		1	687		2
JRB-1	18		2	262		2				410		2	570		2 Par.						
JRB-2	72		2	288	286	2				Contained in Control Box			598		2 Par.						
JRB-4	86		2	306		2				435		2	597		2 Par.						
VJM																					
JRB-3	86		2	313	306	2				435		2	598		2 Par.						
JRC-1	78		2	286		2				In Control Box			598		1						
JRF-1; 1A; 4; 5	189		1	365		1				412		1	570		1						
JM-2	160		2	306		2				435		2	607		2 Par.						
VG																					
GB-1	28		1	271		1				Contained in Control Box			572		1						
GB-2 (Early)	22		1	260		1				412		1	569		1						
GB-2 (Late)	26		1	271		1				In Control Box			569		1						
GH-1	25		1	273		1				Contained in Control Box			572		1						
GH-2	70		1	282		1				420		1	561		2 Ser.						
GH-3	13		1	260		1				410		1	569		1						
GK-1	8		1	With Generator						With Generator			561		1						
VSN																					
SNB-1	72		2	286or287		2				In Control Box			598		2 Par.						
SNB-2 (Early)	72		2	286or287		2				In Control Box			598		2 Par.						
SNB-2C	86		2	313	306	2				435		2	597		2 Par.				687		2
SNB-2C	86		2	306		2				435		2	597		2 Par.				687		2
SNC-1	22		1	274		1				412		1	570		1						
SNJ-2	18		2	262		1				410		1	570		1						
SNJ-3	16		1	266		1				In Control Box			579		1						
SNJ-4	13 or 14		1	264		1				In Control Box			579		1						
SNJ-5	86		1	313	306	1				435		1	607		1						
SNV-1	13 or 14		1	266		1				In Control Box			579		1						
SNV-2	86		1	313	306	1				435		1	606		1						
VN																					
NE-1													618		1						
NH-1 (1st 20)	22	13	1	274	260	1				412	410	1	572		1						
NH-1 (21 and Up)	13		1	260		1				410		1	572	569	1						
N2S-1; 2; 3; 4[5]		58	1		282	1					422	1	589		1						
N2S-5[5]		64	1		282	1					422	1	589		1						
N2T-1													590		1						
VS																					
AE-1	6		1	260		1				412		1	569		1						
HOS																					
HOS-1	86		1	286		1				Contained in Control Box			598		1						
HO2S-1	86		1	286		1				Contained in Control Box			607		1						
HNS-1	6		1	264		1				Contained in Control Box			569		1						
Special																					
TD2C-1	37		1	264		1				Contained in Control Box			607		1						
TDN-1	197		1							412		1									
	38		1	274		1	362		1	410		1	607		1						
TDR-1	197		1							412		1									
	38		1	274		1	362		1	410		1	607		1						
TD3R-1	70		2	282		2				420		2	607		2 Ser.				681		1
LBE	97		1	282		1							606		2						
LBP	97		1	282		1							606		2						
LBT	97		1	282		1							606		2						
AIRSHIPS																					
ZNPK	211	210	2	373	281	2		389	2	422	420	2	569		2 Ser.				681	682	1

1 Additional battery in parallel added in service when substitution of direct cranking starter for cartridge starter is made.

2 Last 226 planes converted in field using Wright sandwich gear #4171915 and four studs #22439-11.

3 Authorized substitution in operational training; remove sandwich gears.

4 Generators blast cooling directed by service change.

5 These planes had no generator or control equipment initially.

6 Generator is wind driven.

7 Generator is attached to step-up sandwich gear bolted to engine pad. Use locking plates (two per generator) to insure tightness of generator mounting nuts.

8 Alternative installation by ComAirPac replaces these items with 2CM70B5B generator, 38BD1A18A regulator, and addition of another 800-1-C motor-alternator.

CHART 2—GENERATORS

CORRESPONDING TO ITEM NUMBERS IN CHART 1

Explanation of Column Headings:

Mfr.—Ecl. —Eclipse.
Champ.—Champion.
LN —Leece-Neville.
GE —General Electric.
DR —Delco-Remy.
West. —Westinghouse.
EA —Electric Autolite.
J&H —Jack and Heintz.

Status—S —Standard item the use of which may be extended.
R —Replacement item to be used in existing installations only.
O —Obsolescent item for which parts only to be procured.
W—"Wipe Out." Maintain by cannibalism only.
I —Shown for information only; no procurement at present.

Connectors—A—AN plug connector; numbers indicate different specific models.
B—External terminal board; numbers indicate different accessories.
C—Internal terminals.

RPM.—Low—Nominally 2500–4500, actually 2200–4500, in some cases 1900–4500.
High—Nominally 5000–10,000, actually 4700–9000, new specs. 4000–8000.

Flange—S —Square, Standard.
Spec.—Special, Non-standard.
R —Round, Standard.

Control—Generator can be used with any control shown on chart 3 having same "Function" letter in "Interchangeability Code" column.

Field Current—Low —Up to about 3 amperes.
Med.—about 3 to 5 amperes.
High—about 5 to 8 amperes.

Interchangeability Code—(Shows preferred replacements when prescribed unit is not available).
1st choice: Item with same Function, Type, and Detail.
2nd choice: Item with same Function, and Type but with different Detail (preferably a lower Detail number).
3rd choice: Item with same Function, Type I, and Detail 1.
4th choice: Item with same Function, Type I, and with different Detail.

Item No. (From Chart 1)	Mfr.	Model	Army or Navy Type	NAF Drawing No. or Army Specification	Status	D-C Output Volts	D-C Output Amps.	A-C Output Volts	A-C Output Watts	A-C Output Cycles	Wgt.	Connectors D-C	Connectors A-C	Rotation	R.P.M.	Flange	Drive Teeth	Cooling	Control D-C	Control A-C	Field Current	Paralleling System	Interchangeability Code Function	Interchangeability Code Type	Interchangeability Code Detail	Repair Kit Part No.
6	Ecl.	308-1-A	....	....	R	14	15	....	....	....	18	C	....	CC	Low	S	6	None	A	...	Low	....	A	I	1	....
7	Ecl.	307-8-A[1]	....	....	W	14	15	....	....	....	19	C	....	C	Low	S	6	None	A	...	Low	....	A	I	2	....
8	Champ.	128[2]	....	....	R	14	15	....	....	....	9	....	....	....	....	....	....	....	...	...	....	....	A	II	1	....
13	Ecl.	790-1-B	E-5A	95-32367A	S	14	50	....	....	....	23	C	....	CC	Low	S	6	Fan	A	...	Low	....	B	I	1	....
14	Ecl.	790-1-A[3]	E-5A	95-32367A	O	14	50	....	....	....	23	C	....	CC	Low	S	6	Fan	A	...	Low	....	B	I	1	....
15	LN	24502	E-5A	95-32018A	S	14	50	....	....	....	21	C	....	CC	Low	S	6	Fan	A	...	Low	....	B	I	1	....
16	Ecl.	310-25-A[4]	NE-1	NAF 1002-2	O	14	50	....	....	....	32	C	....	CC	Low	S	6	Fan	A	...	Low	....	B	I	1	....
17	Ecl.	310-53-A	NE-1	NAF 1002-2	O	14	50	....	....	....	32	C	....	CC	Low	S	6	Fan	A	...	Low	....	B	II	1 & 2	....
18	Ecl.	310-1-A	NE-1	NAF 1002-1	O	14	50	....	....	....	32	C	....	CC	Low	S	6	Fan	A	...	Low	....	B	II	2	....
22	Ecl.	703-3-A[6]	ND-2	NAF 1001-3	O	14	25	....	....	....	23	C	....	CC	Low	S	6	None	A	...	Low	....	B	IV	1	....
24	Ecl.	703-4-A	....	....	O	14	25	....	....	....	23	C	....	C	Low	S	6	None	A	...	Low	....	B	IV	2	....
25	Ecl.	309-1-A	D-1A	NAF 1001-2	W	14	25	....	....	....	26	C	....	CC	Low	S	6	None	A	...	Low	....	B	IV	3	....
26	Ecl.	309-8-A[1]	....	....	W	14	25	....	....	....	26	C	....	C	Low	S	6	None	A	...	Low	....	B	IV	4	....
27	Ecl.	309-9-A	....	....	W	14	25	....	....	....	26	C	....	CC	Low	S	6	None	A	...	Low	....	B	IV	5	....
28	Ecl.	2367-B	NAF1001-1	D-1	W	14	25	....	....	....	24	C	....	CC	Low	S	6	None	A	...	Low	....	B	IV	6	....
35	Ecl.	790-3-B	E-7A	95-32088A	S	14	50	....	....	....	23	C	....	CC	Low	R	16	Fan	A	...	Low	....	C	I	1	....
37	LN	24500	E-7A	95-32088A	S	14	50	....	....	....	23	C	....	CC	Low	R	16	Fan	A	...	Low	....	C	I	1	....
38	Ecl.	310-27-A[4]	NE-1B	NAF 1002-3	O	14	50	....	....	....	32	C	....	CC	Low	R	16	Fan	A	...	Low	....	C	II	1	....
39	Ecl.	310-5-A[4]	E-7	95-32088	O	14	50	....	....	....	32	C	....	CC	Low	R	16	Fan	A	...	Low	....	C	II	2	....
40	Ecl.	310-9-A[4]	E-7	95-32088	O	14	50	....	....	....	32	C	....	CC	Low	R	16	Fan	A	...	Low	....	C	II	2	....
44	LN	24300	ND-2B	NAF 1001-4	W	14	25	....	....	....	23	C	....	CC	Low	R	16	Fan	A	...	Low	....	C	III	1	....
50	Ecl.	728-1-A	E-8	95-32192	I	14	100	....	....	....	35	C	....	CC	Low	R	16	Fan	A	...	Low	....	D	I	1	....
52	Ecl.	311-9-A	....	....	I	14	25	....	....	....	40	C	....	CC	Low	R	16	Fan	A	...	Low	....	D	II	1	....
58	Ecl.	1235-1-A	T-1	32415	R	28	15	....	....	....	16	C	....	CC	Low	S	6	Blast	B	...	Low	....	E	I	1	....
64	Ecl.	1235-3-A	....	....	R	28	15	....	....	....	16	C	....	CC	Low	R	16	Blast	B	...	Low	....	F	I	1	....
70	Ecl.	314-39-A	NM-1C	NAF 1002-5	S	28	50	....	....	....	34	A-8	....	CC	Low	S	6	Fan	B	...	Low	....	G	I	1	D-130742
72	LN	24525	L-2	95-32281-A	R	28	25	....	....	....	25	C	....	CC	Low	S	6	None	B	...	Low	....	G	II	1	....
78	LN	24504	L-3	95-32367-A	R	28	25	....	....	....	24	C	....	C	Low	S	6	Fan	B	...	Low	....	H	I	1	....
86	LN	24506	M-3	95-32361	S	28	50	....	....	....	21	A-11	....	CC	Low	S	6	Fan	C	...	Med.	....	I	I	1	....
88	LN	24501	O-3	95-32359	I	28	100	....	....	....	30	A-16	....	CC	Low	S	6	Fan	C	...	Med.	....	BB	I	1	....
95	Ecl.	1273-1-A[49]	N75-2SB	....	S	28	75	....	....	....	31	C	....	CC	Low	R	16	Blast	C	...	Med.	....	J	I	1	D-130741
96	Ecl.	1308-1-A[4]	N75-2SA	....	W	28	75	....	....	....	36	C	....	CC	Low	R	16	Blast	B	...	Low	....	J	II	1	....
97	Ecl.	314-33-A[4]	NM-1B	NAF 1002-4	O	28	50	....	....	....	34	A-8	....	CC	Low	R	16	Fan	B	...	Low	....	J	III	1	D-130742
98	Ecl.	314-5-A[4]	M-1	32162A	O	28	50	....	....	....	34	C	....	CC	Low	R	16	Fan	B	...	Low	....	J	III	2	....
99	Ecl.	314-7-A[4]	M-1	32162A	O	28	50	....	....	....	34	C	....	CC	Low	R	16	Fan	B	...	Low	....	J	III	2	....
101	Ecl.	314-15-A[4]	....	....	O	28	50	....	....	....	34	C	....	CC	Low	R	16	Fan	B	...	Low	....	J	III	3	....
102	Ecl.	314-17-A[4]	....	....	O	28	50	....	....	....	34	C	....	CC	Low	R	16	Fan	B	...	Low	....	J	III	3	....
103	LN	24225	M-2	95-32285	I	28	50	....	....	....	19	A-11	....	CC	Low	R	16	Fan	C	...	Med.	....	J	IV	1	....
105	Ecl.	718-9-A	M-2	95-32285	I	28	50	....	....	....	23	A-11	....	CC	Low	R	16	Fan	C	...	Med.	....	J	IV	1	....
111	Ecl.	1298-1-A	N75-2RA	....	S	28	75	....	....	....	22	C	....	CC	High	R	16	Blast	B	...	Low	....	K	I	1	D-130750
116	GE	2CM63B4[48]	....	....	S	28	200	....	....	....	32	B-1	....	CC	High	R	16	Blast	B	...	High	Navy	L	I	1	....
117	GE	2CM63B1	....	....	I	28	200	....	....	....	29	B-1	....	CC	High	R	16	Blast	D	...	High	Navy	L	I	2	....
118	Ecl.	914-15-A[39]	....	....	S	28	200	....	....	....	38	B-1	....	CC	High	R	16	Blast	D	...	High	Navy	L	I	3	D-130740
120	Ecl.	914-3-A[8, 39]	P-2	95-32297	O	28	200	....	....	....	38	A-17	....	CC	High	R	16	Blast	D	...	High	Army	L	I	4	D-130740
121	Ecl.	901-5-A[8]	O-4	32415	R	28	100	....	....	....	24	A-16	....	CC	High	R	16	Blast	D	...	High	Army	L	II	1	....
129	EA	GFT4003B[10]	2CM70B9	....	S	28	180	....	....	....	42	B-1	....	CC	Low	R	16	Blast	D	...	High	Navy	M	I	1	124
130	EA	GFT4002B[11]	2CM70B5B	....	O	28	180	....	....	....	41	B-1	....	CC	Low	R	16	Blast	D	...	High	Navy	M	I	2	124
131	EA	GFT4002[12]	2CM70B5A	....	O	28	180	....	....	....	41	B-1	....	CC	Low	R	16	Blast	D	...	High	Navy	M	I	3	124
132	EA	GFT4001[13]	2CM70B5	....	O	28	180	....	....	....	43	A-17	....	CC	Low	R	16	Blast	D	...	High	Navy	M	I	4	124
133	GE	2CM70B2A[12]	....	....	W	28	180	....	....	....	42	B-2	....	CC	Low	R	16	Blast	D	...	High	Navy	M	I	5	....
134	GE	2CM70B2[14]	....	....	W	28	180	....	....	....	42	A-17	....	CC	Low	R	16	Blast	D	...	High	Navy	M	I	6	....
135	GE	2CM70B4[15]	....	....	W	28	100	....	....	....	40	A-17	....	CC	Low	R	16	Fan	D	...	High	Navy	M	I	7	....
137	GE	2CM56A1	....	....	W	28	100	....	....	....	40	A-17	....	CC	Low	R	16	Fan	F	...	Med.	Navy	M	II	2	....
139	DR	5362404	O-1	95-32274A	O	28	100	....	....	....	28	A-16	....	CC	Low	R	16	Blast	C	...	Med.	Army	M	III	1	....
140	LN	22602	O-1	95-32274A	O	28	100	....	....	....	32	A-16	....	CC	Low	R	16	Blast	C	...	Med.	Army	M	III	1	....
141	LN	22600	O-1	95-32274A	O	28	100	....	....	....	32	A-16	....	CC	Low	R	16	Blast	C	...	Med.	Army	M	III	1	....
143	GE	2CM80B7[10]	....	....	O	28	200	....	....	....	48	B-1	....	CC	Low	R	16	Blast	D	...	High	Navy	M	IV	1	8465441
144	GE	2CM80B4	....	....	O	28	200	....	....	....	47	B-1	....	CC	Low	R	16	Blast	D	...	High	Navy	M	IV	1	8465441
145	GE	2CM80B3A[21]	....	....	O	28	200	....	....	....	47	A-17	....	CC	Low	R	16	Blast	D	...	High	Navy	M	IV	2	....
146	GE	2CM80B6A[18]	P-1[27]	95-32275	O	28	200	....	....	....	47	B-1	....	CC	Low	R	16	Blast	D	...	High	Army	M	IV	3	....
147	GE	2CM80B6[18]	P-1[27]	95-32275	O	28	200	....	....	....	47	B-1	....	CC	Low	R	16	Blast	D	...	High	Army	M	IV	3	....
148	GE	2CM80B5	P-1[27]	95-32275	O	28	200	....	....	....	48	B-1	....	CC	Low	R	16	Blast	D	...	High	Army	M	IV	4	....
150	GE	2CM80B3[20]	P-1[27]	95-32275	O	28	200	....	....	....	47	A-17	....	CC	Low	R	16	Blast	D	...	High	Army	M	IV	5	....
151	GE	2CM80B3S[20]	P-1[27]	95-32275	O	28	180	....	....	....	47	A-17	....	CC	Low	R	16	Blast	D	...	High	Army	M	IV	5	....
152	GE	2CM80B3F[21]	P-1[27]	95-32275	O	28	200	....	....	....	47	A-17	....	CC	Low	R	16	Blast	D	...	High	Army	M	IV	5	....
153	GE	2CM70B1[21]	P-1[27]	95-32275	W	28	200	....	....	....	42	A-17	....	CC	Low	R	16	Blast	D	...	High	Army	M	IV	5	....
156	West.	91987GR4	P-1[27]	95-32275	W	28	200	....	....	....	42	A-17	....	CC	Low	R	16	Blast	D	...	High	Army	M	IV	5	....
157	West.	91987GR5	P-1[27]	95-32275	W	28	200	....	....	....	42	A-17	....	CC	Low	R	16	Blast	D	...	High	Army	M	IV	5	....
160	....	....	P-1[23, 27]	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	D	...	....	....	M	IV	5	....
161	GE	2CM70B11	....	....	R	28	200	....	....	....	44	B-1	....	CC	3000 6000	R	16	Blast	D	...	Med.	Navy	M	V	1	....
167	GE	2CM73B5[10]	....	....	O	28	300	....	....	....	48	B-2	....	CC	High	R	16	Blast	D	...	High	Navy	N	I	1	8465440
168	GE	2CM73B1	....	....	O	28	300	....	....	....	47	B-2	....	CC	High	R	16	Blast	D	...	High	Navy	N	I	2	8465440
169	J & H	JH-2000[50]	R-1	32362	I	28	300	....	....	....	47	B-1	....	CC	High	R	16	Blast	D	...	High	Army	N	I	3	JH110Est
170	GE	2CM73B3	R-1	32362	I	28	300	....	....	....	47	B-1	....	CC	High	R	16	Blast	D	...	High	Army	N	I	3	8465440
175	GE	2CM41A4[25]	....	....	O	28	167	....	....	....	60	A-18	....	C	4000	Spec.	Spec.	None	E	...	Spec.	Navy	P	I	1	....
183	GE	2CM91B1[40]	....	....	W	28	267	....	....	....	62	B-3	....	C	4000	Spec.	Spec.	None	D	...	High	Navy	Q	I	1	....
189	Ecl.	346-7-A[29]	NEA-2	NAF 1003-3	R	14	25	120	840	800	43	A-7	A-2	CC	Low	S	6	Fan	I	...	Low	....	R	I	1	....
196	Ecl.	346-5-A[29]	NEA-2B	NAF 1003-4	R	14	25	120	840	800	43	A-7	A-2	CC	Low	R	16	Fan	I	...	Low	....	S	I	1	....
197	Ecl.	346-9-A[30]	NEA-2F	....	O	14	25	120	840	800	43	A-7	A-2	CC	Low	R	16	Fan	I	...	Low	....	S	I	2	....
203	Ecl.	716-3-A[31]	NEA-3	....	S	28	60	120	1200	800 to 1400	45	A-6	A-11	CC	Low	R	16	Blast	B	K	Low	....	T	I	1	D-130219
204	Ecl.	584-3-A[32, 16]	NEA-2D	NAF 1003-5	O	28	25	120	840	800	43	A-7	A-2	CC	Low	R	16	Blast	J	...	Low	....	T	II	1	....
210	Ecl.	716-13-A[33]	....	....	R	28	60	120	1200	800 to 1400	45	A-6	A-11	CC	Low	S	6	Blast	B	K	Low	....	U	I	1	D-130219
211	Ecl.	584-1-A[16]	NEA-2E	NAF 1003-6	W	28	25	120	840	800	43	A-7	A-2	CC	Low	S	6	Fan	J	...	Low	....	U	II	1	....
223	Ecl.	1310-1-C[42]	NEA-4	....	S	28	100	120	1200	800 to 1600	35	B-4	A-11	CC	High	R	16	Blast	C	K	High	Navy	W	I	1	D-130220B
223a	Ecl.	1310-1-B	NEA-4	....	S	28	100	120	1200	800 to 1600	35	B-4	A-11	CC	High	R	16	Blast	C	K	High	Navy	W	I	2	D-130220B
223b	Ecl.	1310-1-A	NEA-4	....	S	28	100	120	1200	800 to 1600	35	B-4	A-11	CC	High	R	16	Blast	C	K	High	Navy	W	I	3	D-130220B
228	Ecl.	1097-3-C[43]	NEA-5	....	S	28	200	120	1200	800 to 1600	48	B-1	A-11	CC	High	R	16	Blast	C	K	High	Navy	X	I	1	822144A
228a	Ecl.	1097-3-B	NEA-5	....	S	28	200	120	1200	800 to 1600	48	B-1	A-11	CC	High	R	16	Blast	C	K	High	Navy	X	I	1	D-130739
229	Ecl.	1097-3-A[10, 44]	NEA-5	....	O	28	200	120	1200	800 to 1600	48	B-1	A-11	CC	High	R	16	Blast	C	K	High	Navy	X	I	1	D-130739
229a	GE	2CM81B4[46]	NEA-5	....	S	28	200	120	1200	800 to 1600	48	B-1	A-11	CC	High	R	16	Blast	C	K	High	Navy	X	I	1	....
229b	GE	2CM81B3[45]	NEA-5	....	S	28	200	120	1200	800 to 1600	48	B-1	A-11	CC	High	R	16	Blast	C	K	High	Navy	X	I	1	8465439
230	GE	2CM81B2[10]	NEA-5	....	S	28	200	120	1200	800 to 1600	46	B-1	A-11	CC	High	R	16	Blast	C	K	High	Navy	X	I	1	8465439
231	Ecl.	1097-1-A[34, 44]	NEA-5	....	O	28	200	120	1200	800 to 1600	48	B-1	A-11	CC	High	R	16	Blast	C	K	High	Navy	X	I	2	D-130739
232	GE	2CM81B1[24]	NEA-5	....	O	28	200	120	1200	800 to 1600	48	B-1	A-11	CC	High	R	16	Blast	C	K	High	Navy	X	I	2	D-130739
245	Ecl.	638-1-A[37]	NEB-1D	NAF 1004-5	O	28	60	120	600	800	43	C	C	CC	4000	S	6	Fan	J	...	Low	....	Z	I	1	....
246	Ecl.	1406-1-A	NEA-7	....	S	28	125	120	2500	800 to 1600	45	B-2	A-13	CC	High	R	16	Blast	C	K	High	Navy	Y	I	1	....

[1] When replacing with generator of opposite rotation, reverse direction of rotation (see T.O. 73-42).
[2] Outboard unit complete with propeller and control equipment.
[3] Convert to 790-1-B (see T.O. 73-42).
[4] Rebuild in accordance with T.O. 9-44 and T.O. 73-42.
[6] Blast cool in OS2U and OS2N (see T.O. 73-42).
[8] Replace aluminum mounting flanges with steel and plug connectors with terminal boards on early generators (see T.O. 3-44).
[10] Twenty-four mounting flange bolts.
[11] Rated at 140 amperes with 3 inches of air and 200 amperes with 10 inches of air.
[12] Improvised terminal board and modify per T.O. 26-44.
[13] Convert to 2CM70B5B (see T.O. 26-44, T.O. 53-43, T.O. 134-34, and T.O. 70-43).
[14] Install terminal board, Autolite KIT-118 (see T.O. 26-44, T.O. 73-42, and T.O. 134-43).
[15] Convert to 2CM70B2 (see T.O. 73-42).
[16] Split field voltage regulation (see T.O. 73-42).
[18] Convert to 2CM80B4. Has jack screws on mounting flange.
[19] Convert to 2CM80B7. Twenty-four-bolt mounting flange.
[20] Convert to 2CM80B4 (see T.O. 70-43).
[23] Specified model unknown; use one of generators item 145 to 159.
[24] Replace Allen-head screws in early units (see T.O. 70-43).
[25] Used on Lawrence 30C-2 auxiliary power unit.
[27] BuAer Technical Note authorizes substitution of items 129 and 130 for items 146 to 160.
[28] Same as item 150 except that internal cooling does not permit 200-ampere rating.
[29] Install AN plug (see T.O. 73-42).
[30] Convert from 346-5-A (see T.O. 73-42).
[31] Also used with fan cooling for limited output (see T.O. 66-43).
[32] Lock clutch and parallel field (see T.O. 73-42).
[33] Rework ZNPK to use in place of 584-1-A.
[00] Will be returned to mfgr. for rebuilding.
[37] Used on Eclipse NEP-2 auxiliary power unit.
[38] Eclipse 1097-3A strengthened to prevent torsional failure.
[39] See T.N. 41-44 for comparison of various Eclipse 914 generators.
[40] Used on Lawrence 75B A.P.U.
[41] Vibration damper added to 1310-1-A.
[42] Has larger through studs on the a-c stator.
[43] Slight modification of terminal board and intermediate head.
[44] Return for rework in accordance with ASO Central Disposal Unit letter 34-45.
[45] Friction-type vibration damper and large front bearing.
[46] Blast cap changed from drawn aluminum to cast aluminum.
[47] Three inch blast tube.
[48] Addition of new type terminal mounting base with four mounting screws instead of three as previously used. This model will be known as the 2CM63B6. A die cast aluminum blast cap and a wrap around inspection cover is used. Weight is now 37 lbs.
[49] The 1273-3-A will incorporate a square flange and a six-tooth spline but is electrically identical to the 1273-1-A. The former is a special purpose generator for use on ZPNK airships.
[50] The Jack & Heintz type R-2 J7H (2000-4) generator is rated 200 amperes between 2500 and 3150 rpm. and 300 amperes between 3150 and 4500 rpm. The weight is 53 lbs. The mechanical construction is similar to the type R-1 generator.

CHART 3—CONTROL EQUIPMENT

CORRESPONDING TO ITEM NUMBERS IN CHART 1

Explanation of Column Headings:

Mfr.—Ecl. —Eclipse.
LN —Leece-Neville.
GE —General Electric.
West.—Westinghouse.
DR —Delco-Remy.

Status—S —Standard item the use of which may be extended.
R —Replacement item to be used in existing installations only.
O —Obsolescent item for which parts only to be procured.
W—"Wipe out." Maintain by cannibalism only.
I —Shown for information only; no procurement at present.

Shock Mounting—a— Voltage regulator—shock-mounted within control box.
b— Regulator and cutout mounted on shock-mounted sub panel within control box.
c— Must be externally shock-mounted as per T.N. 58-44.
d— None.
e— Regulator mounted on shock-mounted panel
f— Shock mounting provided externally.

Connectors—A—AN plug connector; numbers indicate different specific models.
B—External terminal board; numbers indicate different accessories.
C—Internal terminals.

Type Regulators—CP —Carbon pile.
Vib —Vibrator.
Fin —Finger.

Interchangeability Code—(Shows preferred replacements when prescribed unit is not available.
1st choice: Item with same Function, Type, and Detail.
2nd choice: Item with same Function, and Type but with different Detail (preferably a lower Detail number).
3rd choice: Item with same Function, Type I, and Detail 1.
4th choice: Item with same Function, Type I, and with different Detail.

Item No. (from Chart 1)	Control Box					Control Box or Mounting Base		Choke Box or Mounting Base					Voltage Regulator						Cutout Group Number (see Chart 4)		Ratings					Filtering Coil Type	Interchangeability Code			Repair Kit Part No.
	Mfr.	Model	Army or Navy Type	NAF Drawing No. or Army Specifications	Status	Connector	Shock Mounting	Mfr.	Choke Box	Mounting Base	NAF Drawing or Army Specification	Status	Mfr.	Cover Assembly Including Regulator	Voltage Regulator	NAF Drawing or Army Specif.	Type of Regulator	Status	Included in Control Box	Separate Unit	D-C Volts	D-C Amps.	Field Current	A-C Volts	A-C Watts		Function	Type	Detail	
260						C	d	Ecl.	111924			S	Ecl.	111143	956-4-A		CP	O		I	14	100	Low			Air	A	I	1	
261	Ecl.	344-1-A[1]	NF-2C	NAF 1005-5	O	C	a	Ecl.							355-8-A[2]		Vib.	W		I	14	100	Low			Air	A	I	2	
262	Ecl.	326-1-A[1]	NF-2B	NAF 1005-4	O	C	a						Ecl.		355-9-A[2]		Vib.	W		I	14	50	Low			Air	A	II	1	
264	LN	24559	A-1A	94-32016A	R	C	a						LN		S22452		Vib.	R	V		14	50	Low				A	II	2	
265	Ecl.	323-4-A	A-1A	94-32916	R	C	b						Ecl.		355-16-A		Vib.	R	VI		14	50	Low				A	II	2	
266	LN	11606	A-1	94-32016	O	C	b						LN		S7416		Vib.	O	V		14	50	Low				A	II	2	
267	Ecl.	323-1-B	A-1	94-32916	O	C	b						Ecl.		355-3-A		Vib.	O	VI		14	50	Low				A	II	3	
271	Ecl.	320-2-A			W	C	b						Ecl.		355-2-A		Vib.	W	VI		14	50	Low				A	II	3	
274	Ecl.	322-1-A[1]	NF-2	NAF 1005-2	O	C	a						Ecl.		355-6-A[2]		Vib.	W		I	14	25	Low			Air	A	III	1	
273	Ecl.	1035-2-A			W	C	a						Ecl.		355-2-A		Vib.	W	VI		14	25	Low				A	III	1	
281	Ecl.	1002-1-A			O	A-9 or A-10	c						Ecl.		939-3-A		CP	O		II	28	75	Low				B	I	1	D-130744
282						C	d	Ecl.	111924			S	Ecl.	111144	939-4-A		CP	O		II	28	75	Low			Air	B	I	1	
283	Ecl.	673-1-A[1]	NF-2D	NAF 1005-6	O	C	a						Ecl.		357-1-A[3]		Vib.	W		II	28	75	Low			Air	B	II	2	
285	Ecl.	1202-2-A[29]	B-1B	94-32163B	O	C	b						Ecl.		1201-2-A[30]		Vib.	O	VII		28	50	Low				B	III	1	
286	Ecl.	1202-1-A	B-1B	94-32163B	I	C	b						Ecl.		1201-1-A		CP	S	VII		28	50	Low				B	III	2	
287	LN	24567	B-1B	94-32013B	W	C	b						LN		S22559		Vib.	W	VIII		28	50	Low				B	III	2	
288	LN	11985	B-1A	94-32163A	W	C	b						LN		S13327		Vib.	W	IX		28	50	Low				B	III	3	
292	Ecl.	667-2-A			W	C	b						Ecl.		358-4-A		Vib.	W	VI		28	50	Low				B	IV	1	
294	Ecl.	1305-3-B[28]			S	C	f						Ecl.		1042-9-A		CP	S		III	28	300	Med.				C	I	1	D-130744-C
295	Ecl.	1305-3-A[27]			S	C	f						Ecl.		1042-5-A[36]		CP	O		III	28	300	Med.				C	I	2	D-130744
296	Ecl.	1305-1-A[24]			O	C	c						Ecl.		1042-5-A		CP	O		III	28	300	Med.				C[5]	I	3	D-130744
297	Ecl.	1260-1-A[24]			O	A-14	f						Ecl.		115335		CP	O		III	28	300	Med.				C[5]	I	4	D-130744
297A		1260-3-A[25]			O	A-14	f						Ecl.		115335		CP	O												
303	GE	3GBD1A18A[37]			S	A-15	a						GE		6994451G10		Fin.	S		III	28	300	High				D	I	1	K9035579
304	GE	3CBD1A18[6]			O	A-15	a						GE		6994451G10		Fin.	O		III	28	300	High				D	I	1	K9035579
305	GE	3GBD1D7			W		a								[7]			W		[7]	28	200	Spec.				D	I	2	D-130743
306					O	C	e			LN24554[8, 23]	40D8445-2	S	Ecl.		1042-2-A[24]	AC32276A	CP	O		III	28	300	High				D	II	1	D-130743
307					S	C	e			LN24554[8, 23]	40D8445-2	S	LN		24950	AC32276A	CP	O		III	28	300	High				D	II	1	D-130744-C
308					S	C	e			LN24554[8, 23]	40D8445-2	S	LN		24700	AC32276A	CP	O		III	28	300	High				D	II	1	
309					S	C	e			LN24554[8, 23]	40D8445-2	S	DR		1118401	AC32276A	CP	O		III	28	300	High				D	II	1	
310					S	C	e			LN24554[8, 23]	40D8445-2	S	West		11710009A	AC32276A	CP	O		III	28	300	High				D	II	1	
311					S	C	e			LN24554[8, 23]	40D8445-2	S	GE		3GBD2B11	AC32276	Fin.	R		III	28	200	High				D	II	1	
312					S	C	e			LN24554[8, 23]	40D8445-2	S	West		1248275		Fin.	W		III	28	200	High				D	II	1	
313		Army 32276A Specifications, Regulators (Item 308 to 320) in General, Specified Model not known.																					High				D	II	1	
314	GE	3GBD1A5			W	A	a										Vib.	W		III	28	300	Low				D	III	1	
															1042-6-A[31]		CP	S												
320	GE	3GBD1B18			R	A-15	a						GE		6994451G2		Fin.	R		III	28	300	Spec.				E	I	1	
340					S	C	e			LN24554	40D8445-2	S	GE		3GBD2B4[9]		Fin.	W		III	28	200	High				F	I	1	
356						A-10 or A-9	e	GE		GEB-1D		R	Ecl.		1337-1-A[13]		CP	S		I	14	200					H	I	1	
362						C	d	Ecl.	111925			S	Ecl.	111143	956-4-A		CP	O		I	14	100	Low			Iron	I	I	1	
363						C	d	Ecl.	111925			O	Ecl.	106432	956-4-A		CP	O		I	14	100	Low			Iron	I	I	1	
365	Ecl.	343-1-A[14]	NF-1	NAF 1005-1	O	C	a						Ecl.		956-4-A		CP	O		I	14	100	Low				I	I	1	
371						C	d	Ecl.	111925			S	Ecl.	111142	939-4-A		CP	O		II	28	100	Low			Iron	J	I	1	D-130746
372						C	d	Ecl.	111925			S	Ecl.	101074	939-4-A		CP	O		II	28	100	Low			Iron	J	I	1	D-130746
372a	Ecl.	1002-5-A[26]	NF-1D	NAF 1005-7	S	C	f						Ecl.		939-3A		CP	S		II	28	75	Low				J	I	1	D-130746
373	Ecl.	1002-2-A[14]	NF-1D	NAF 1005-7	O	C	c						Ecl.		939-4-A		CP	O		II	28	100	Low				J	I	1	D-130746
374	Ecl.	588-1-A[14]	NF-1D	NAF 1005-7	O	C	a						Ecl.		956-4-A		CP	O		II	28	100	Low				J	I	1	D-130746
386	Ecl.	1322-3-B[32]			S	C	f						Ecl.		1317-2-A		CP	S						120	1200		K	I	1	D-130744-C
387	Ecl.	1322-3-A[17]			S	C	f						Ecl.		1317-1-A		CP	S						120	2000		K	I	2	D-130744-C
387a	Ecl.	1001-8-A[33]			R	A-9 or C-10	f						Ecl.		986-4-A		CP	R						120	1200		K	II	1	D-128029
388	Ecl.	1001-4-A[17, 34]			O	A-9 or A-10	c						Ecl.		986-4-A		CP	R		IV				120	1200		K	II	2	D-130746
388a	Ecl.	1001-7-A[35]			R	A-9 or C-10	f						Ecl.		986-4-A		CP	R						120	1200		K	II	3	D-128029
389	Ecl.	1001-2-A[17]			O	A-9 or A-10	c						Ecl.		986-4-A		CP	R		IV				120	1200		K	II	4	D-130746-B
391-A	Contained in 800-1-D Motor-Alternator					C							Ecl.		986-6-A[17]		CP	S		IV				120	1200		K	III	1	D-128029
392	Contained in 800-1-B; C Motor-Alternator					C							Ecl.		986-5-A[20, 17]		CP	O		IV				120	1200		K	III	2	D-128029

[1] Convert to 111924.
[2] Replace with 111143 (see T.O. 73-42).
[3] Replace with 111144 (see T.O. 92-43 and T.O. 73-42).
[5] "D" regulators can be substituted for "C" regulators but "coming-in" rpm. will be raised.
[6] Send to G.E. for conversion to 3GBD1A18A (see T.O. 69-43).
[7] No sub-assembly number.
[8] T.O. 62-44 requires addition of equalizing resistor, Eclipse 1-B131198, to permit use of Navy paralleling system.
[9] Regulates two fields independently.
[13] Used with 1348-1-A generator and 2CM70B5 for 14 volts.
[14] Convert to 111925 choke box (see T.O. 73-42).
[17] See T.O. 51-44 for use on Kellogg type "A" condenser box.
[20] Installed in 800-1-B, -C, -D motor-alternators.
[23] Replace vibration absorbers, U. S. Rubber A-321, with B-323.
[24] T.O. 63-44 describes interchangeabilities of items 296, 297, and 306; and directs replacement of carbon piles.
[25] Same as 1260-1-A except shockmounted.
[26] Same as 1002-1-A except shockmounted.
[27] Same as 1305-1-A except shockmounted.
[28] Same as 1305-3-A except with mechanical stabilizer.
[29] Same as 1202-1-A except with 1202-2-A regulator.
[30] Same as 1201-A except screw driver adjustments on core and pile.
[31] Similar to 1042-2-A except has self-locking pile screw.
[32] Same as 1322-3-A except with mechanical stabilizer.
[33] Same as 1001-4-A except shockmounted.
[34] Same as 1001-2-A except 5" by 5" mounting holes.
[35] Same as 1001-2-A except shockmounted.
[36] 1042-8-A supersedes and is the same as 1042-5-A except for self-locking pile screw.
[37] G.E. Model GED2B1 carbon pile regulator will replace the Model 3GBD1A18A finger type regulator.

CHART 4—CUTOUTS

CORRESPONDING TO ITEM NUMBERS IN CHART 1 AND GROUP NUMBERS IN CHART 3

Explanation of Column Headings:

Manufacturer—Ecl. —Eclipse.
SD —Struthers-Dunn.
GE —General Electric.
LN —Leece-Neville.
West.—Westinghouse.

Status—S —Standard item the use of which may be extended.
R —Replacement item to be used in existing installations only.
O —Obsolescent item for which parts only to be procured.
W—"Wipe out." Maintain by cannibalism only.
I —Shown for information only; no procurement.

Interchangeability Code—(Shows preferred replacements when prescribed unit is not available.)
1st choice: Item with same Function, Type, and Detail.
2nd choice: Item with same Function, and Type but with different Detail (preferably a lower Detail number).
3rd choice: Item with same Function, Type I, and Detail 1.
4th choice: Item with same Function, Type I, and with different Detail.

Item No. (from Chart 1)	Group No. (from Chart 3)	Volts	Amps.	Mfr.	Model	Army or Navy Type	NAF Drawing No. or Army Specification	Status	Interchangeability Code		
									Function	Type	Detail
410	I	14	100	Ecl.	352-3-A	A-1B	NAF 1116-3	S	A	I	1
411	I	14	100	SD	QT-1	A-1B	NAF 1116-3	W	A	I	1
412	I	14	35	Ecl.	350-3-A	A-1	NAF 1116-1	O	A	II	1
413	I	14	25	SD	CXA1535	A-1	NAF 1116-1	W	A	II	1
420	II	28	100	Ecl.	665-2-A	A-1D	NAF 1116-4	S	B	I	1
421	II	28	100	SD	1535-B	A-1D	NAF 1116-4	W	B	I	1
422	II	28	25	Ecl.	688-2-A	A-25D	NAF 1116-2	W	B	II	1
430	III	28	300	GE	3GTR72C1A	......	AC32278A	S	C	II	1
431	III	28	300	GE	3GTR72C1	......	AC32278A	O	C	II	1
432	III	28	300	GE	3GTR72A5	......	AC32278A	W	C	II	2
433	III	28	300	LN	24565	......	AC32278A	W	C	II	1
434	III	28	200	GE	3GTR72A1A	......	AC32278	W	C	II	3
435	III	Army Specification AC32278 Cutout. Specific model not known. Like items 434 to 438									
436	III	28	200	GE	3GTR72A1	......	AC32278	W	C	II	3
437	III	28	200	West.	1240224-A	......	AC32278	W	C	II	3
438	III	28	200	LN	24552	......	AC32278	W	C	II	3
FOLLOWING CUTOUTS CONTAINED IN CONTROL BOX											
....	V	14	50	LN	S11624	......	....	R	A	III	1
....	VI	14	50	Ecl.	367-1-A	......	....	R	A	III	2
....	VII	28	50	Ecl.	367-6-A	......	....	S	B	III	1
....	VIII	28	50	LN	S22570	......	....	W	B	III	2
....	IX	28	50	LN	S13353	......	....	W	B	III	3

CHART 5—BATTERIES

CORRESPONDING TO ITEM NUMBERS IN CHART 1

Explanation of Column Headings:

Status—S —Standard item the use of which may be extended.
R —Replacement item to be used in existing installations only.
W—"Wipe out." Maintain by cannibalism only.

Interchangeability Code—(Shows preferred replacements when prescribed unit is not available.)
1st choice: Item with same Function, Type, and Detail.
2nd choice: Item with same Function, and Type but with different Detail (preferably a lower Detail number).
3rd choice: Item with same Function, Type I, and Detail 1.
4th choice: Item with same Function, Type I, and with different Detail.

Item No. (from Chart 1)	Volts	Ampere-hour	Shielded	Weight	Footnote	ASO Stock Number	NAF Drawing Number or Army Specification	Army or Navy Number	Manufacturer's Numbers				Status	Interchangeability Code			Dimensions		
									Exide and Willard	National (Gould)	Autolite (Prestolite)	Delco-Remy		Function	Type	Detail	Height (Inches)	Length (Inches)	Width (Inches)
561	12	17	Yes	27	......	R17-B-6587	NAF 1062-17A	......	6-TS-7H	12-S-17	....	....	W	A	I	1	9	$9\frac{1}{5}$	$8\frac{1}{2}$
562	12	17	Yes	27	......	R17-B-6644	AN 3153	......	6-TS-7H	....	....	....	R	A	I	1	9	$9\frac{1}{5}$	$8\frac{1}{2}$
569	12	34	Yes	40	1	R17-B-6660-50	AN 3152	......	6-TS-9L	12-AN-34	R-129-DN	3412-AN-D	S	B	I	1	$10\frac{1}{8}$	$11\frac{3}{4}$	$8\frac{1}{2}$
570	12	34	Yes	40	......	R17-B-6660-50	NAF 1062-34	S-34	....	....	R-129-DN	3412-AN-D	W	B	I	1	$10\frac{5}{8}$	$11\frac{3}{4}$	$8\frac{1}{2}$
571	12	34	Yes	39	......	R17-B-6660	AC 70-42	C-5	6-TS-9	....	....	....	W	B	I	2	$10\frac{3}{8}$	$11\frac{3}{4}$	$8\frac{1}{2}$
572	12	34	No	36	......	R17-B-6657	....	C-2	6-TS-13	....	....	....	W	B	I	3	$11\frac{1}{4}$	$10\frac{1}{4}$	$5\frac{1}{4}$
573	12	34	No	38	......	R17-B-6680	NAF 213080	B	6-TAS-9	....	....	....	W	B	I	4	$11\frac{3}{8}$	$10\frac{3}{4}$	$5\frac{1}{2}$
579	12	68	Yes	71	......	R17-B-6665	AC33G3377	D-6A	....	12-S-68	....	....	R	C	I	1	$10\frac{1}{4}$	$16\frac{3}{4}$	$9\frac{1}{2}$
582	12	88	No	78	......	R17-B-6670-20	....	......	6FHM-13-1	....	....	....	W	C	II	1	$10\frac{3}{4}$	$13\frac{1}{4}$	$7\frac{1}{4}$
583	12	105	No	90	......	R17-B-6672	....	......	....	R1213-GB	....	....	W	....	....	....	$10\frac{3}{4}$	$13\frac{1}{4}$	$7\frac{1}{4}$
589	24	11	Yes	34	1	R17-B-6631-50	AN3154	......	12AC-7A	....	....	1124-AN-D	R	D	I	1	$7\frac{3}{4}$	$9\frac{3}{4}$	$10\frac{3}{8}$
590	24	11	Yes	34	......	R17-B-6632	NAF 1062-11A	......	....	24-AN-11	....	1124-AN-D	W	D	I	1	$7\frac{3}{4}$	$9\frac{3}{4}$	$10\frac{3}{8}$
597	24	17	Yes	52	1	R17-B-6650	AN3151	......	12-TS-7H	24-AN-17	....	1724-AN-D	S	E	I	1	$8\frac{3}{8}$	$7\frac{3}{4}$	$13\frac{1}{4}$
598	24	17	Yes	52	......	R17-B-6652	....	F-1	12-TS-7F	24-A-17	....	....	W	E	I	2	$8\frac{3}{4}$	$9\frac{3}{4}$	$13\frac{1}{4}$
599	24	17				Two Function A Type I Batteries (Item 561) in Series							R	E	I	3	9	$9\frac{1}{5}$	$8\frac{1}{2}$
600	24	22				Two Function D Type I Batteries (Item 589 and 590) in Parallel							R	E	I	4	$7\frac{3}{4}$	$14\frac{1}{16}$	$7\frac{1}{4}$
606	24	34	Yes	76	1	R17-B-6660-75	AN 3150	......	12-TAS-9A	....	R-249-D	....	S	F	I	1	$10\frac{1}{4}$	$11\frac{3}{4}$	$13\frac{1}{4}$
607	24	34	Yes	17	......	R17-B-6660-100	....	G-1	....	24-AN-34	....	....	W	F	I	2	$10\frac{1}{8}$	$11\frac{3}{4}$	$13\frac{1}{4}$
608	24	34				Two Function B Type I Batteries in Series							R	F	I	3	$10\frac{5}{32}$	$11\frac{3}{4}$	$8\frac{7}{16}$
609	24	34				Two Function E Type I Batteries in Parallel							R	F	I	4	$8\frac{13}{16}$	$7\frac{3}{4}$	$15\frac{5}{16}$
610	24	51	No	104	......	R17-B-6661	....	......	12-TAS-13	....	....	....	W	F	II	1	$10\frac{3}{8}$	$15\frac{1}{4}$	$9\frac{1}{2}$
617	24	68				Two Function F Type I Batteries in Parallel							S	G	I	1	$10\frac{3}{16}$	$9\frac{3}{4}$	$13\frac{5}{16}$
618	6	10	No	8.4	......	....	....	......	3AC-7	....	....	....	W	....	....	....	$7\frac{1}{8}$	$4\frac{1}{8}$	$3\frac{7}{8}$

[1] There are two types of these batteries:
(A) Batteries with microporous rubber separators. These batteries are supplied to maintenance activities.
(B) Batteries with moist wood separators and a $\frac{1}{2}$-inch red stripe around the carton. These batteries have been supplied to aircraft manufacturers for installation in new planes. These batteries are not to be supplied to maintenance activities because they require long initial charging and do not keep so well in storage.

CHART 6—AUXILIARY POWER UNIT

CORRESPONDING TO ITEM NUMBERS IN CHART 1

Explanation of Column Headings:

Manufacturer—Ecl. —Eclipse.
Hom.—Homelite.
And.—Andover.
Law. —Lawrance.

Status—S —Standard item the use of which may be extended.
R —Replacement item to be used in existing installations only.
O —Obsolescent item for which parts only to be procured.
W—"Wipe out." Maintain by cannibalism only.

Interchangeability Code—(Shows preferred replacements when prescribed unit is not available.)
1st choice: Item with same Function, Type, and Detail.
2nd choice: Item with same Function, and Type but with different Detail (preferably a lower Detail number).
3rd choice: Item with same Function, Type I, and Detail 1.
4th choice: Item with same Function, Type I, and with different Detail.

Item No. (from Chart 1)	Mfr.	Model	Army and Navy Type	Status	Interchangeability Code			Generator on A. P. U.						Starter Contactor[2]
					Function	Type	Detail[1]	K.W.	RPM	Flange	Spline	Model	Item No. (from Chart 2)	
640	Ecl.	699-1-A	NEP-2	R	A	I	1	2.5	4000	S	6	NEB-1D	245	....
650	Hom.	HRU-28	....	S	B	I	1	2.1		Integral Generator				....
655	And.	V32	D-2	S	C	I	1	5.0	6000	R	16	P-2	118	....
657	Law.	30D-1	1B	R	C	II	1a	5.0	4000	R	16	NEA-5	232	....
658	Law.	30D-1	1B	R	C	II	1b	5.0	4000	R	16	2CM70B5B	130	....
660	Law.	30D	1A	R	C	II	2a	5.0	3600	R	16	NEA-3	203	....
661	Law.	30D	1A	R	C	II	2b	5.0	3600	R	16	2CM70B5B	130	....
662	Law.	30C-2	1	W	C	II	1	5.0	4000	Spec.	Spec.	2CM41A4	175	3GTR72B1[5]
671	Law.	75B	2A	W	D	I	1	8.0	4000	Spec.	Spec.	2CM91B1	183	3GTR72B5[5]

[1] Letters a and b, in preference code detail column distinguish between different auxiliary power units that are identical except for generator installed.

[2] B-8 starter contactor can be substituted by required remounting.

[5] Starter contactor must be ordered separately.

CHART 7—MOTOR-ALTERNATORS

CORRESPONDING TO ITEM NUMBERS IN CHART 1

Explanation of Column Headings:

Manufacturer—Ecl. —Eclipse.
H.C.—Holtzer-Cabot.

Status—S —Standard item the use of which may be extended.
O —Obsolescent item for which parts only to be procured.
W—"Wipe out." Maintain by cannibalism only.

Connector—A—AN plug connector; numbers indicate different specific models. Compare with connectors on chart 2.

Interchangeability Code—(Shows preferred replacements when prescribed unit is not available).
1st choice: Item with same Function, Type, and Detail.
2nd choice: Item with same Function, and Type but with different Detail (preferably a lower Detail number).
3rd choice: Item with same Function, Type I, and Detail 1.
4th choice: Item with same Function, Type I, and with different Detail.

Item No. (from Chart 1)	Mfr.	Model	Status	A-C Output			Connector		Interchangeability Code			Voltage Regulator Model	Voltage Regulator Type	Repair Kit Part No.
				Volts	Watts	Cycles	Input	Output	Function	Type	Detail			
680	Ecl.	800-1-D[4]	S	120	1200	800	A-3	A-5	A	I	1	Included	CP	D-128029-A
681	Ecl.	800-1-C[4]	O	120	1200	800	A-3	A-5	A	I	1	Included	CP	D-128029-A
682	Ecl.	800-1-B[4]	O	120	1200	800	A-3	A-5	A	I	1	Included	CP	D-128029-A
684	Ecl.	802-3-A[4]	W	120	1000	800	A-3	A-5	A	II	1	Ecl. 1001-3-A	CP	....
687	HC	MG-149F	S	{ 115 26	500 250	400 400 }	A-1		B	I	1	Included	R.P.M.	106197

[4] Used with Kellogg Type A condenser.

SAMPLE ELECTRICAL CHECK-OFF LIST

PREVENTIVE MAINTENANCE CHECK-OFF LIST FOR ELECTRICAL SYSTEMS IN NAVAL AIRCRAFT

Plane		Date of Check
Bureau No.		Squadron
Engine No.	Hr. Check	Place

PLANE CAPTAIN MAKES ALL DAILY CHECKS

1. DAILY checks, A below, shall be performed prior to engine warm-up.
2. DAILY checks, B & D below, shall be performed at engine warm-up and at various engine speeds.
3. DAILY checks, C below, shall be made prior to flight.
4. DAILY checks, E, F, G & H below, shall be performed at engine warm-up or with external source of power.

5. Checks other than DAILY, of E below, shall be as follows: Check operation of motors, control switches and relays only on 30 and 90 hr. check. The following applies to 60, 120, 240, and engine change checks. a. Check brushes for length and for condition of pig tails. b. Inspect brush rigging for security and remove copper and carbon dust. c. Check all leads, cables, plugs, receptacles and insulators for signs of fatigue, wear, cracks and faulty insulation. d. Clean inside of end covers of copper and carbon dust, and check security of motor mounting. e. Check all associated switches and relays for operation, security, and condition of contacts.
6. Checks other than DAILY, of F & G below, shall be as follows: a. Inspect switches for security and operation, signs of fatigue and wire insulation at contacts. b. Check light mounting. c. Check and fill "SPARE" lamp containers of lights listed.
7. Miscellaneous checks, H below, All meters shall be checked on the 120 and 240 hr. checks for security, mechanical and electrical defects. On "engine change" check meter against a precision type meter for accuracy. Check gun heaters for operation, security, and condition of plugs and cables. Check gun camera cct. for operation and condition of plugs and cables. Flying suit outlets shall be checked with a 24-volt lamp for operation. Check Pitot heaters for operation and condition of wiring. Check Pylon gas tank for connections and couplings.

VPB	VBT	VF (1 eng.)	VF (2 eng.)	VOS	VR	VN			For Plane Captain Daily	30 hr.	60 hr.	90 hr.	120 hr.	240 hr.	Eng. Ch.	NOTE	Elect. Mate Plane Capt. or Radioman	Inspector
							A	BATTERY										
x	x	x	x	x	x	x	1	Check electrolyte level and S. G. S. G. limits 1.300 to 1.220.		x	x	x	x	x	x	AEMN, NavAir 08-1-507		
x	x	x	x	x	x	x	2	Check security, connections, and terminals for corrosion and acid on top of cells.		x	x	x	x	x	x			
x	x	x	x	x	x	x	3	Check battery relay connections, operation and contacts.		x	x	x	x	x	x			
x	x	x	x	x	x		4	Check booster coils or induction vibrators.			x		x	x	x			
							B	GENERATORS										
x	x	x	x	x	x	x	1	Check operation at warm-up for output.	x	x	x	x	x	x		AEMN, NavAir 08-1-507		
x	x	x	x	x	x	x	2	Check for loose connections and mtg. security.			x		x	x				
x	x	x	x	x	x	x	3	Check brush length, connections & rigging.			x		x	x				
x	x	x	x	x	x	x	1	Check operation at warm-up for output.	x	x	x	x	x	x		AEMN, NavAir 08-1-507		
x	x	x	x	x	x	x	2	Check for loose connections and mtg. security.			x		x	x				
x	x	x	x	x	x	x	3	Check brush length, connections & rigging.			x		x	x				
x	x	x	x	x	x	x	4	Check condition of commutator.			x		x	x		Planes E&M Manual		
x	x	x	x	x	x	x	5	Check condition of cables, plugs & receptacles.		x	x	x	x	x				
x			x		x		6	Check generators paralleled.	x	x	x	x	x	x				
x	x	x	x	x	x	x	7	Check lubrication.						x				
x	x	x	x	x	x	x	8	Clean out cover of copper and carbon dust.			x		x	x				
x	x	x	x	x	x	x	9	Remove and send to overhaul.							x			
							C	AUXILIARY POWER UNITS & MOTOR-ALTERNATORS										
x	x		x		x		1	Check operation under load.	x	x	x	x	x	x				
x	x		x		x		2	Check brushes, rigging & commutator.			x		x	x				
x	x		x		x		3	Check condition & security of plugs & cable.		x	x	x	x	x				
x	x		x		x		4	Check output voltage with precision meter.			x		x	x				
x	x		x		x		5	Check lubrication.					x	x				
x	x		x		x		6	Remove and send to overhaul.							x			
							D	VOLTAGE REGULATORS & CUTOUTS										
x	x	x	x	x	x	x	1	Check regulators with precision voltmeter 13.75 volts for 12 volt system & 27.5 volts for 24 volt systems.			x		x	x		AEMN, NavAir 08-1-507		
x	x	x	x	x	x	x	2	Remove and check carbon pile on test bench.			x		x	x	x			
x	x	x	x	x	x	x	3	Check cut-out operation. Aprox. 26.5 volts.	x		x		x	x		Planes E&M Manual		
x	x	x	x	x	x	x	4	Remove cut-out and overhaul on bench.							x			
							E	MOTORS										
x	x	x	x	x	x	x	1	Starters.	x		x		x	x	x			
x	x	x	x	x	x	x	2	Fuel booster.	x	x	x	x	x	x	x			
x	x	x	x	x	x		3	Hydro booster.	x	x	x	x	x	x	x			
x	x	x	x	x	x		4	Anti-icer.	x	x	x	x	x	x	x			
x	x	x	x	x	x		5	De-icer.	x	x	x	x	x	x	x			
x	x	x	x	x	x	x	6	Cowl-flap.	x	x	x	x	x	x	x			
x	x	x	x	x	x	x	7	Landing flap.	x	x	x	x	x	x	x			
x							8	Inter-cooling.	x	x	x	x	x	x	x			
x	x	x	x	x	x	x	9	Propeller pitch.	x	x	x	x	x	x	x			
x							10	Wing floats.	x	x	x	x	x	x	x			
	x	x	x	x			11	Arresting hook.	x	x	x	x	x	x	x			
x	x	x	x	x	x	x	12	Landing gear (in flight).	x	x	x	x	x	x	x			
x	x	x	x	x	x	x	13	Gyro pump.	x	x	x	x	x	x	x			
x	x	x	x	x	x		14	Flux-gate compass.	x	x	x	x	x	x	x			
x	x	x	x	x	x		15	Check starter relay.					x	x				
x	x	x	x	x	x		16	Change starter relay.							x			
							F	LIGHTS—EXTERIOR										
x	x			x	x	x	1	Landing.	x	x	x	x	x	x	x			
					x	x	2	Passing.	x	x	x	x	x	x	x			
x	x	x	x	x	x	x	3	Recognition.	x	x	x	x	x	x	x			
x	x	x	x	x	x	x	4	Wing.	x	x	x	x	x	x	x			
	x	x	x	x			5	Approach.	x	x	x	x	x	x	x			
x	x	x	x	x		x	6	Formation.	x	x	x	x	x	x	x			
x	x	x	x	x	x	x	7	Tail.	x	x	x	x	x	x	x			
x	x	x	x	x		x	8	Section.	x	x	x	x	x	x	x			
							G	LIGHTS—INTERIOR										
x	x	x	x	x	x	x	1	Panel.	x	x	x	x	x	x	x			
x	x	x	x	x	x	x	2	Indicators.	x	x	x	x	x	x	x			
x	x	x	x	x	x	x	3	Instrument (fluorescent or red).	x	x	x	x	x	x	x			
x	x	x	x	x	x	x	4	Instrument (spot).	x	x	x	x	x	x	x			
x	x	x					5	Altimeter.	x	x	x	x	x	x	x			
x	x				x		6	Marker.	x	x	x	x	x	x	x			
x	x				x		7	Signal light.	x	x	x	x	x	x	x			
x					x		8	Work table.	x	x	x	x	x	x	x			
x							9	Berth.	x	x	x	x	x	x	x			
x	x				x		10	Dome.	x	x	x	x	x	x	x			
x	x						11	Bomb bay.	x	x	x	x	x	x	x			
x	x	x	x	x			12	Gun sight.	x	x	x	x	x	x	x			
x	x				x	x	13	Baggage compartment.	x	x	x	x	x	x	x			
x	x	x	x	x	x	x	14	"Spare" lamp container.	x	x	x	x	x	x	x			
							H	MISCELLANEOUS										
x	x	x	x		x		1	Flying suit outlets.		x	x	x	x	x	x			
x	x	x	x	x	x	x	2	Checkvoltmeters,ammeters&voltammeters.					x	x	x			
x	x	x	x	x			3	Gun heaters.	x	x	x	x	x	x	x			
x	x	x	x	x	x	x	4	Pitot heaters.	x	x	x	x	x	x	x			
x	x	x	x	x			5	Gun camera circuits.	x	x	x	x	x	x	x			
x	x	x	x	x			6	Pylon gas tank.	x	x	x	x	x	x	x			

Checkers Notes	Inspectors Notes

During flight I have noted the following defects in this plane which should be remedied before next flight.

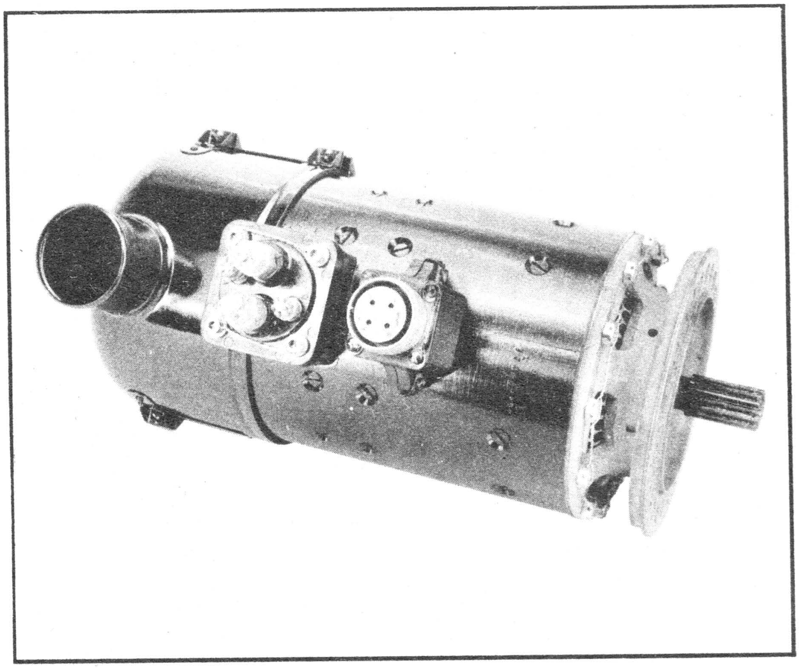
Pilot______________________________

Engineering Officer______________________________

Operations Officer______________________________

Generators . . .

A-C Engine



— SECTION 6

MECHANICAL FAILURES OF NEA-5 GENERATORS

From T.O. 41-45 and TBF-TBM Airplane Bulletin No. 115

A number of improvements in both Eclipse and General Electric NEA-5 generators have been made from time to time in order to overcome mechanical failures of various parts.

The Eclipse NEA-5

The new improved Eclipse NEA-5 generator now in production is the Type 1097-3-C which incorporates the following features:

(a) Twenty-four ¼-24 mounting head cap screws instead of twelve 10-32 screws.

(b) Seven ¼-24 front end studs instead of five 10-32 studs.

(c) Improved support for the flexible leads from the AC winding to the AC receptacle.

(d) Steel spacer in place of magnesium spacer.

(e) Aluminum alloy casting over the commutator instead of magnesium.

(f) Use of longer and heat-treated bolts for securing the DC terminal board to the housing.

The Type 1097-3-B generator is similar to the Type 1097-3-C, and the two are interchangeable. Technical Order No. 41-45 directs that earlier model Eclipse NEA-5 generators (Type 1097-1-A and Type 1097-3-A) be removed from service and converted to Type 1097-3-B as soon as replacement generators are available. Satisfactory replacements include Eclipse Type 1097-3-C and 1097-3-B, and General Electric Models 2CM81B4, 2CM81B3, 2CM81B2, and 2CM81B1.

All type 1097-1-A and type 1097-3-A generators in issuable stock and in class 265 are to be reported to the ASO Central Disposal Unit for disposition in accordance with the procedure outlined in ASO Bulletin 1-45. All type 1097-1-A and type 1097-3-A generators will be marked 1097-3-B after conversion.

The General Electric NEA-5

The General Electric Model 2CM81B4 generator is a new model put into production after T.O. 41-45 was issued. It superseded Model 2CM81B3 and is the same except for a terminal block spacer of improved design. Model 2CM81B3 superseded Model 2CM81B2 and included the following improvements:

(a) Larger bearing on the commutator end.

(b) Friction-type vibration damper.

(c) Brazed commutator.

(d) New design air blast cover.

(e) Die cast aluminum end shield in lieu of magnesium.

Model 2CM81B2 superseded and is the same as the Model 2CM81B1 except that the Model 2CM81B2 (and all later models) includes a stronger mounting flange and 24 flange-to-frame bolts.

No conversion of G.E. generators is necessary as troubles have been of minor degree, and all G.E. NEA-5 generators are satisfactory for use.

OIL DRAIN HOLES IN NEA-3 GENERATOR

From T.O. 66-43

In the 1820-60 engines installed in SBD-5 aircraft, difficulties with the generator oil seal have permitted leakage of oil from the engine into the NEA-3 generator. Although new oil seals are being provided as fast as possible, in the meanwhile it is desirable that holes be drilled in the NEA-3 generator mounting flange to permit any excess of oil to drain out.

The manufacturer is drilling four holes in new NEA-3 generators with serial numbers greater than A-4851. Many of the generators with lower serial numbers have been and are being drilled by the Douglas Aircraft Corporation. It is directed that all generators now in service which have not been so drilled be reworked on or before the next overhaul as follows: Drill four holes ⅛″ in diameter and spaced equally around its circumference, through the mounting flange ¾″ in from the outside front face of the flange. During the drilling operation the vent holes should be masked off to prevent the entry of chips.

REPLACEMENT OF THE A-C ELECTRICAL CONNECTOR ON NEA-3, -4 AND -5

T.N. 26-45

Technical Note No. 26-45 cancels and supersedes Technical Note No. 101-44, which contained an incorrect A.S.O. stock number for replacement insert assemblies.

This connector replacement will require approximately one hour's time and should be performed the next time the NEA-3, -4 or -5 generator is removed from the airplane for inspection or repair purposes. It is recommended that this replacement be made on all generators in stock.

Several reports have been received from the service on the failure of the AN-3102-22-10S receptacle installed on the General Electric NEA-5 generator and the Eclipse NEA-3, -4 and -5 generators. These failures are presumably due to severe vibration of the generator which results in badly burned contacts and insert material.

To overcome this difficulty, current-production generators will be furnished with connector receptacles having (a) more rugged socket contacts (machined from *bar stock instead of punched-pressed*) and (b) inserts of much higher arc resistance (made of *khaki-colored cellulose or mineral-filled melamine instead of black phenolic material*).

These new insert assemblies (socket contacts and melamine insert), manufactured by the American Phenolic Corporation, can be identified by the khaki appearance of the insert. Generators already having receptacles with the khaki-colored inserts should not be reworked.

Replacement insert assemblies, which may be ordered through regular supply channels by their A.S.O. Stock No. R-17-AMP-I-22-870SM, have been procured for the service and distributed as follows:

ASA, Oakland	500
NASD, Norfolk	500
NAS, Jacksonville	200
NASD, Philadelphia	500

To make this replacement, remove the AN-3102-22-10S receptacle from the generator, unsolder the four leads, replace the black phenolic insert assembly in the receptacle shell with the new melamine insert assembly (A.S.O. Stock No. R-17-AMP-I-22-870SM), resolder the four leads and install the receptacle in the generator. Original inserts should be disposed of in accordance with existing salvage instructions.

BEARING AND BRUSH MODIFICATION IN ECLIPSE TYPE NEA-2, -2B, -2D, -2E, -2F GENERATORS

From T.N. 45-44

Service reports have indicated that, in some instances, the intermediate-head bearing of NEA-2 generators has rotated causing excessive wear on the bearing liner. This has resulted in improper alignment of the armature shaft and ultimate failure of the generator. T.N. 45-44 recommends modifications to prevent this. Naval activities that do not have suitable facilities for performing the recommended modification should return these generators to the nearest major overhaul base to have the work done.

The manufacturer is now supplying harder brushes for use with these generators. It is recommended that these harder brushes be installed at the next generator overhaul, since they provide longer life at high generator speeds.

In order to have complete information concerning previous modifications to these generators, it is recommended that the following references be reviewed:

1. T.O. 92-43 dated 16 October 1943—Locking of NEA-2D Constant Speed Clutch.
2. T.N. 3-43 dated 3 January 1942—NEA Generator Bearings and Clutches.
3. T.N. 31-44 dated 6 April 1944—Modification of Armature Shaft on Eclipse Type 309, 310, 314, NEA-2, NEA-2B, NEA-2D and NEA-2E Generators.
4. BuAer Circular Letter dated 23 August 1943, Reference Aer-MA-1242-KT, Subject: "Failure of Eclipse Clutch Springs in Eclipse NEA-2D Generators."

MODIFICATION OF NEA-2 ARMATURE SHAFTS

Service reports have indicated excessive wear sometimes occurs on the commutator end of the armature shaft of subject generators. This wear is due to a loose armature shaft nut which permits the inner race of the bearing to spin on the armature shaft.

In cases where this wear has not progressed to a point where the shaft diameter is less than the diameter over the top of the threads, these armatures may be modified by operating units. See T.N. 31-44 for the recommended modification.

NEW TYPE BRUSHES FOR NEA-2D, ECLIPSE TYPE 584-3-A, GENERATOR

It has been found that by using brushes having thin contact surfaces, as shown in Figure 1 on the Navy Type NEA-2D, Eclipse Type 584-3-A, generator, the generator operating temperature will be lowered 20° C. and the generator minimum speed will be lowered about 400 rpm. The Eclipse NEA-2D generator previously used two brushes Part No. B-76888. The generator will now use positive brush Part No. B-825569 and negative brush Part No. B-825568.

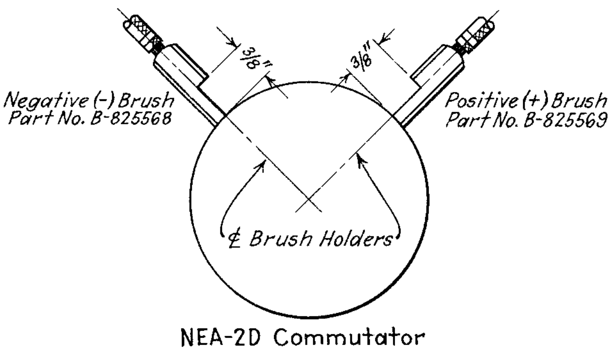
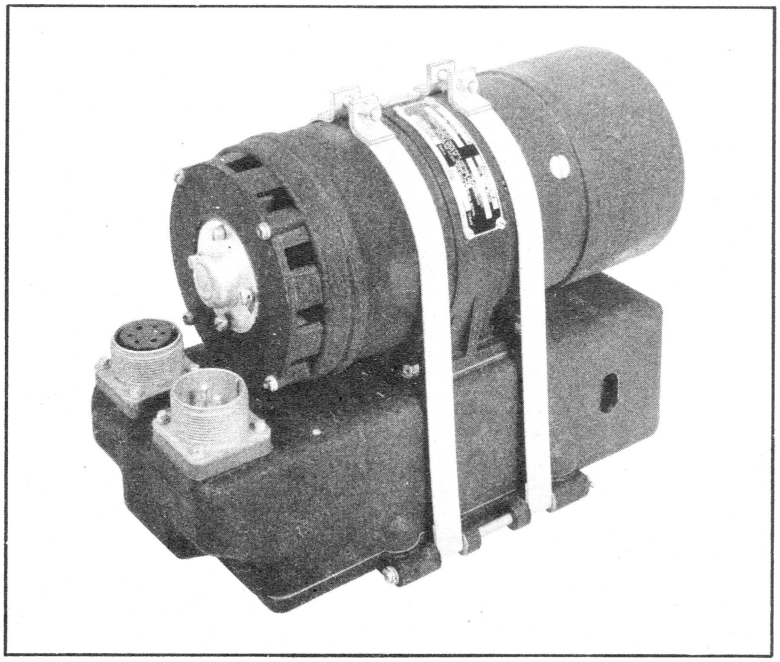


Figure 1

Motor-Alternators



— SECTION 7

PREVENTING FAILURE OF TYPE 800-1 ECLIPSE MOTOR-ALTERNATORS

The Type 800-1 Eclipse motor-alternator is often considered an unglamorous piece of machinery that doesn't need any attention—that is, until it stops supplying steady constant-voltage power. By regular frequent preventive maintenance, difficulties and failures can be avoided.

Failure by overheating (see Figures 1 and 2) has been reported on a considerable number of Type 800-1 Eclipse motor-alternators. Two possible causes of failure by overheating are: (1) Tight brushes, and (2) Inferior ball bearings.

Unsatisfactory operation of APS-2 (or ASG) radar and APX-2 IFF supplied from 800-1 motor-alternators has been reported as due to: (1) Lack of Type A compensating capacitor in the circuit, and (2) Vibration of the carbon-pile voltage regulator in the base of the motor-alternator.

Tight Brushes

A number of motor-alternators have been sent to the field with brushes which cannot move freely in the brush boxes. This tightness prevents good contact of the brush with the commutator, resulting in excessive arcing and heating at the commutator. Excessive heating at the commutator causes the grease to run out of the ball bearings which then get still hotter and fail. Finally, the armature stops rotating and electrical failure results.

To forestall failures, all new 800-1 motor-alternators, before being installed in an airplane, should be inspected for tight brushes by removing the end cap, lifting the brush spring, and pulling the brushes by their pigtails to see whether they move freely in the boxes. Any tight brush may be thinned down with No. 0000 sandpaper or equivalent, until the brush just moves freely in the brush box.

Inferior Ball Bearings

Many motor-alternator failures which appear to be due to overload are in reality due to commutator-end ball bearings not having high-temperature high-speed grease or ball bearings not having seals for retaining the grease.

Starting with Type 800-1 Model D serial numbers 450 and E-14144 (subcontractor's production), motor-alternators have ball bearings, Eclipse Part No. B-824748 (A.S.O. Stock No. R-42-B-34536) or B-127212 (A.S.O. Stock No.

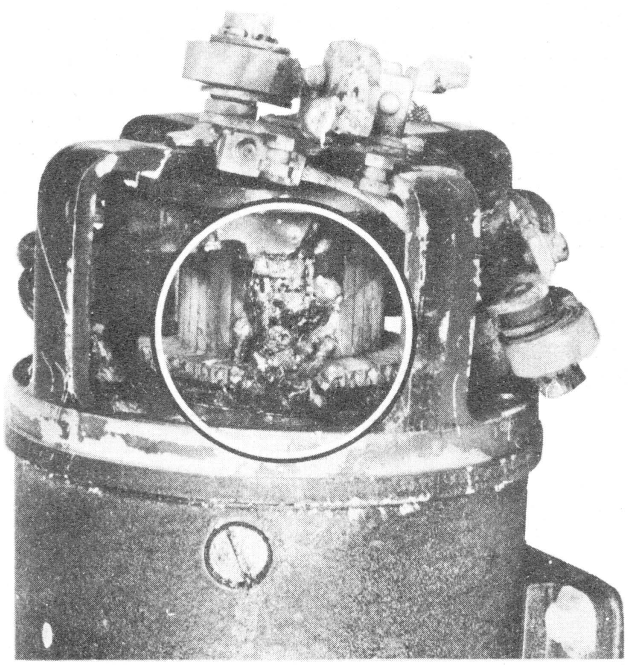


Figure 1—800-1-C motor-alternator commutator end (circled portion shows failure)

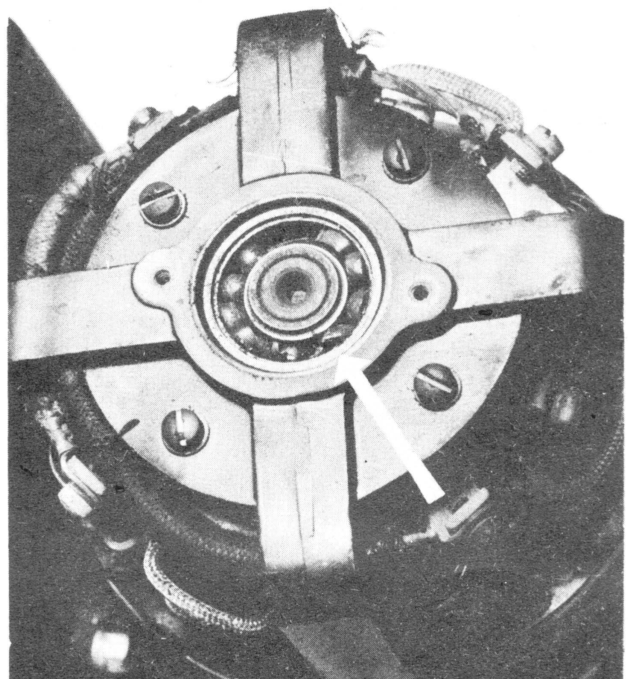


Figure 2—800-1-C motor-alternator ball bearing at commutator end

R-42-B-5725-153). These are double-seal ball bearings packed with Andok C, a satisfactory high-temperature high-speed grease. Previously-manufactured motor-alternators may fail because they have unsealed, single-sealed, or double-sealed ball bearings packed with Royco No. 6a, a low-temperature, low-speed grease.

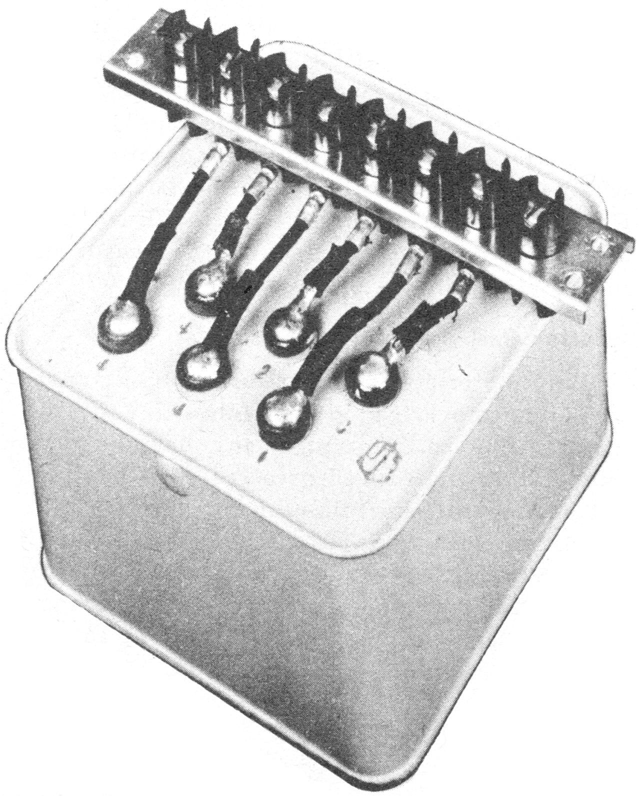


Figure 3—Kellogg Type A Compensating Capacitor (ASO Stock No. R16-C-11688)

Replacement double-seal ball bearings packed with high-temperature, high-speed grease have been procured and will be made available to the field through regular supply channels. They should be ordered as Eclipse Part No. B-824748, SKF 6201-2RS-J/HT2 with Andok C grease, A.S.O. Stock No. R-42-B-34536. Until these replacement bearings are available, the following measures should be taken if there is a tendency for motor-alternators to burn up and it is known that the brushes are not tight. Pack bearings with Royco No. 5 grease (or as a second alternative, with Andok C grease) *before* they burn out. Remember that too much grease in a ball bearing operated at high speeds is just as bad as too little. Double-seal bearings cannot practicably be cleaned internally or relubricated unless changed to a single-seal bearing by carefully removing one metal shield and seal with a screw driver. Throw the seal and shield away and replace the greased bearing in the motor-alternator so that the unsealed side is outward.

Lack of Compensating Capacitor

If the connected load amounts to more than 500 watts, an external Type A compensating capacitor (Figure 3) should be connected in series with the motor-alternator output. When the load is more than 500 watts, at least one and one-half microfarads of capacitance should be connected for each ampere of load. If a smaller amount of capacitance per ampere is connected, the capacitor will overheat and may fail. If a larger amount of capacitance per ampere up to the 15 microfarads available is used, there is no undesirable effect.

The primary purpose of the capacitor is to compensate for the inductive reactance of the alternator windings — *not* of the load. Radar equipments are nearly resistive as loads. If capacitance is not connected when the load is over 500 watts, the voltage regulator is unable to maintain the voltage. It may be possible to adjust the regulator to supply up to 800 watts without a compensating capacitor, but then at lighter loads the voltage will be excessive.

Cases have been reported of unsatisfactory operation of motor-alternators where a single motor-alternator was used without compensating capacitor on patrol planes to supply both APS-2 (or ASG) radar and APX-2 IFF equipment. In these cases it has been found that the compensating capacitors were in the airplane but had been disconnected from the electrical circuit. When the compensating capacitors were properly connected into the circuit, the voltage regulation difficulties ceased.

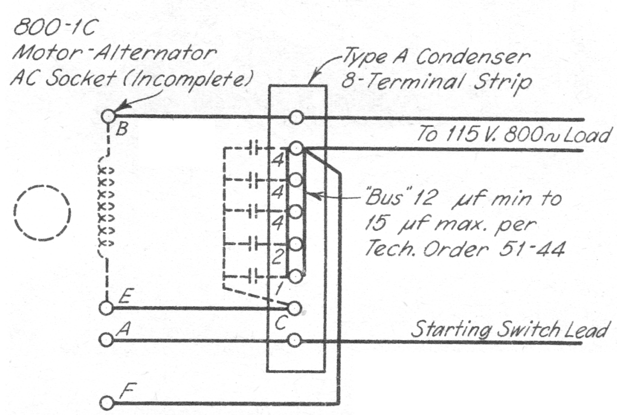


Figure 4—Connections to compensating capacitor

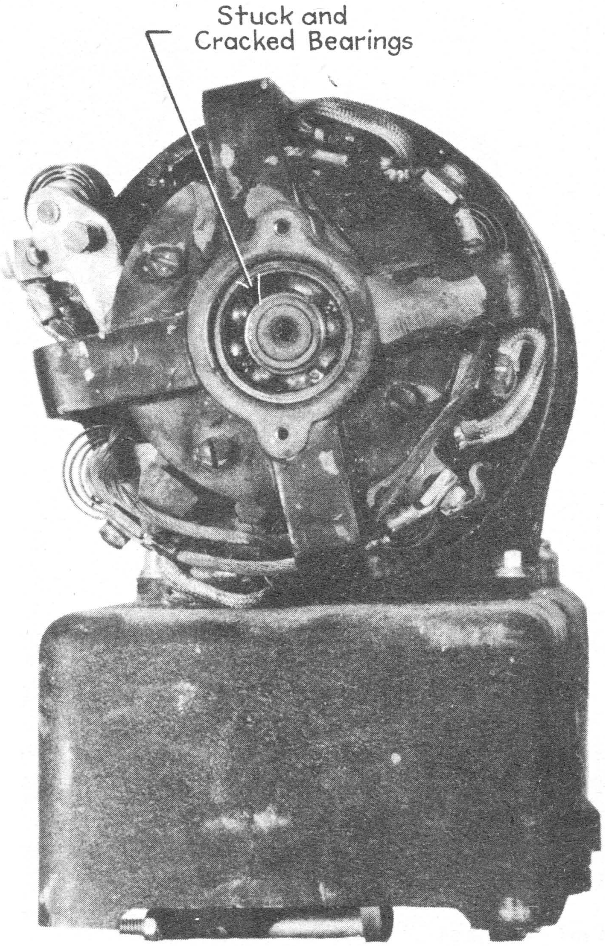
Some confusion has resulted from the "dummy" terminals on each end of the eight-terminal condenser strip. Figure 4 shows the correct capacitor connections. Careful attention must be given to actual markings of terminals to assure proper connections.

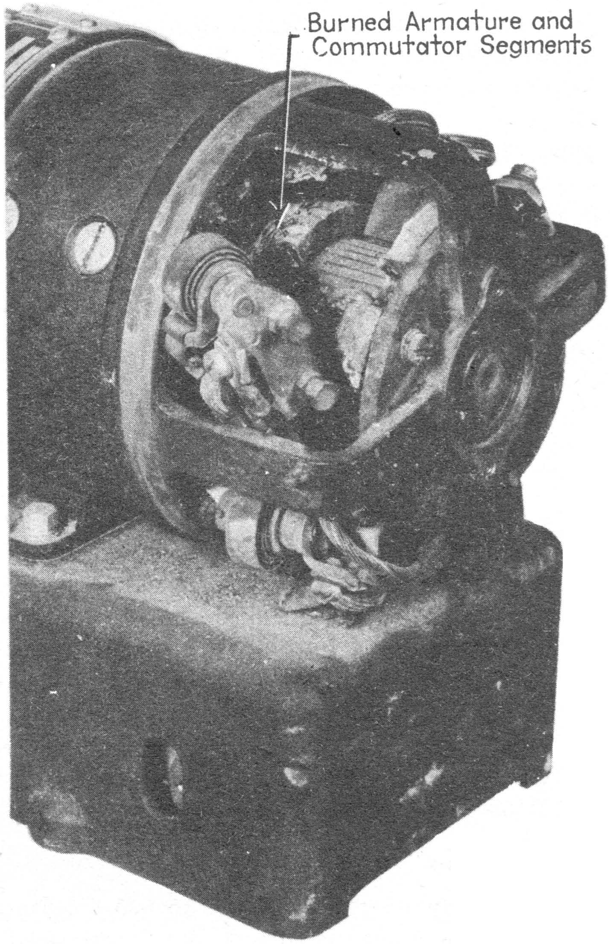
Carbon Pile Vibration

When radar instability or jitter is caused by the motor-alternator, the cause is usually due to instability or "chatter" of the carbon-pile voltage regulator. Instability of the carbon pile is due to maladjustment of the carbon pile or to excessive external vibration transmitted to the carbon pile.

To correct instability, the carbon pile should be carefully readjusted on the test bench and checked for chatter by means of a pair of headphones in series with a one-microfarad capacitor connected across the carbon pile.

If the carbon-pile instability is caused by excessive external vibrations, measures which reduce the carbon-pile vibration in line with the pile will alleviate the trouble. Specific instructions may be published after completion of tests and experimentations.





These pictures from a CASU 36 RUDM show what happens to a Type 800-1 Eclipse motor-alternator when low-temperature, low-speed grease runs out of the ball bearing. These failures can be prevented by packing the bearing 40 per cent full of Royco No. 5 grease (or as a second alternative, with Andok C). A double-sealed bearing can be greased by first carefully removing the outward seal with a screwdriver. Inspection of the bearing should be made very frequently

TYPE 800-1 ECLIPSE AIRBORNE MOTOR-ALTERNATOR
T.N. 18-45

Technical Note 18-45 dated 2 March 1945 cancels and supersedes Technical Note 92-44, dated 20 October 1944, and gives up-to-date information on output, brush grade, tight brushes, style changes, ball bearings and circuit protection of airborne motor-alternators of the 800-1 series. As a change to high-temperature grease has been made in the double-seal ball bearings in production, the ball bearing part numbers in the superseded Technical Note are no longer correct for replacement. Also, circuit breaker information has been added.

Output

As long as the electrical load placed on 800-1 motor-alternators was less than the nameplate rating no uncertainty as to overload arose. However, load has been added until the nameplate rating of 840 watts has been exceeded. At the direction of the Bureau, load tests have been conducted which show that the following maximum output may be taken from the 800-1-B, 800-1-C or 800-1-D:

Altitude (feet)	*Watts*	*Power Factor*	*Duty Cycle*
20,000 or less	1350	.9	One hour
20,000 or less	1200	.9	Continuous
40,000 to 20,000	900	.9	Continuous

Brush Grade Change

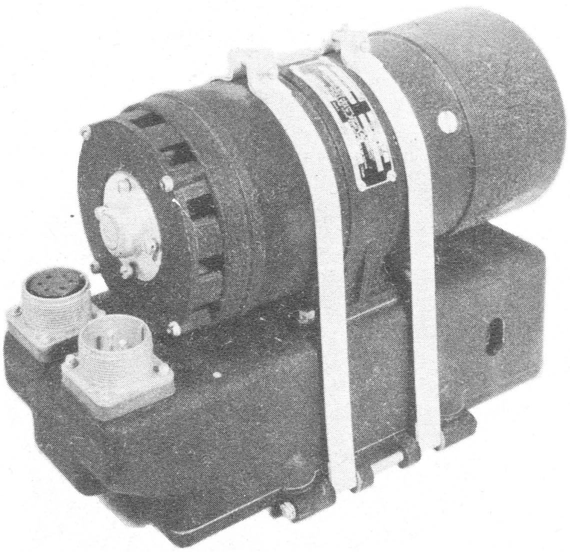
Motor-alternators are now being delivered to the Navy with Morganite Grade EG12/2 brushes (in place of Grade BO) as tests have shown that Grade EG12/2 has about 3 times the life of the Grade BO brush. Bulk spares for normal service replacement include Grade EG12/2 brushes. (Note: Both grades of brush are Eclipse Part No. B100784.)

Tight Brushes

Failures by overheating of the 800-1 motor-alternator have been reported. An "overheated" unit with no service time which was recently examined indicated that "tightness" of the brush in the brush box prevented good contact of the brush with the commutator. This tightness produced excessive heating at the commutator and resulted in failure by unsoldering of the armature conductors.

Effects of a "tight" brush are sometimes mistakenly interpreted as a weak spring, since the tight fit prevents the spring from pressing the brush firmly against the commutator. A tight fit may also cause rapid wear of brushes and may erroneously be interpreted as brushes having unsatisfactory wear properties.

To forestall failures all new 800-1 motor-alternators, before being installed in an airplane, should be inspected for tight brushes by removing the end cap and lifting brushes by the pigtails. Any tight brush may be "thinned" down with No. 0000 sandpaper, or equivalent, to provide a free fit.



800-1-C Motor-Alternator

Style Change

Recently the vendor has changed from style 800-1-C to 800-1-D, the difference being only in the voltage regulator which has an improved pile screw retaining device. The new voltage regulator sub-assembly is identified as 986-5-B (instead of 986-5-A) and is interchangeable with the regulator of the 800-1-B and 800-1-C.

Ball Bearings

Motor-alternators are now delivered to the Navy with double-seal ball bearings, prepacked with high-temperature grease, on each end. Double-seal ball bearings are considered superior, especially in humid climates, to the single-seal ball bearings (Eclipse Part No. 78565) previously used. Therefore, when replacement is necessary on any 800-1-B, 800-1-C, or 800-1-D, double-seal ball bearings should be used. Replacement double-seal, high-temperature grease prepacked ball bearings, ASO Stock No. R42-B-34536, equivalent to Eclipse Part No. B-824748 are available in limited quantities.

Note—Eclipse Part No. B-127212, ASO Stock No. R42-B-5725-153, may be substituted for Eclipse Part No. B-824748 in subject motor-alternators. However, Eclipse Part Nos. 92583-2 and 120574, listed in some publications, are obsolete and should not be used for replacements.

Circuit Protection

It is recommended that a 125-ampere switch-type circuit breaker (ASO Stock No. R17-C-9247 or equivalent) be installed in the A-plus lead of the d-c power input to the motor-alternator in each airplane that does not now have circuit protection. If the present circuit protection consists of an automatic-reset circuit breaker (Spencer, Type PLA), it should be replaced with the switch-type circuit breaker. As this circuit breaker is not to replace, or to be used instead of, any "start—stop" switch now controlling the motor-alternator, no special control panel or console installation is required. However, the circuit breaker should be accessible for resetting during flight. Identification marking may be added near the circuit breaker as follows: "800-1 Circuit Breaker. Leave 'on' at all times."

TYPE MG-149F INVERTER

Type MG-149F inverters are being used on several types of Naval aircraft and will be added to several others. It supplies power to both radio and instruments. Since it is being used in increasing numbers, it will probably require more attention from field service men. Detailed information is contained in a Handbook of Instructions with Parts Catalog which can be obtained through official channels from the Chief of the Bureau of Aeronautics (Publications Section) by requesting T.O. No. 03-5H-5. A general description of the inverter follows:

The inverter operates on a d.c. input voltage of 24 volts and delivers a.c. power at 400 cycles. The 24-volt d.c. rating is the nominal value stamped on the nameplate; the actual operating voltage is 27.5. The a.c. power thus generated is used to operate remote indicating instruments, fluorescent lights, aircraft radio equipment, and small induction motors.

The inverter consists of two units: a motor, and a generator in a single frame. The motor is designed to operate at 6000 rpm and is provided with a speed governor to maintain this speed within the limits of 5700 and 6300 rpm from no load to a full load of 750 volt-amperes and over a primary d.c. voltage range of 26.5 to 28.5 volts. The 750 volt-ampere output is delivered at two voltages: 26 and 115 volts, the 26-volt output being 250 volt-amperes at 40 per cent power factor, and the 115-volt output being 500 volt-amperes at 90 per cent power factor. The inverter is capable of delivering this output continuously.

A filter is provided with the inverter for the purpose of reducing radio frequency interference. This filter is mounted on the frame of the inverter.

A two-position switch is provided to permit the operation of the inverter with one-half rated load on the 115-volt circuit. With the switch in the LO position, approximately 115 volts is obtained at one-half rated load.

ADJUSTING VOLTAGE OF TYPE MG-149F MOTOR-ALTERNATOR

Recent reports of voltage output variations of the 115-volt winding of the 400-cycle type MG-149F motor-alternator indicate that misunderstanding exists regarding the construction and operation of this motor-alternator.

Continuous automatic voltage regulation of the MG-149F is not provided for, but in lieu of a voltage regulator a tap is provided in the 115-volt field winding so that a portion of the winding may be cut out when less than 75 per cent rated load is connected (rated 115-volt load is 500 volt-amperes at .9 power factor). A toggle switch marked "Hi" and "Lo" is mounted on the frame just below the radio-noise filter to permit cutting out part of the field winding. The motor-alternator manufacturer sets the toggle switch in the "Lo" position when the units are shipped. On later units a locking bracket is also supplied over the toggle switch. To change to the "Hi" position, the locking bracket may be reversed.

For airplanes having connected loads of 375 volt-amperes or less on the 115-volt winding, the toggle switch should be left in the "Lo" position. In this position and with 27.5 volts d.c. supplied, the voltage and frequency are about as follows:

Load	*Volts*	*Frequency*
No-load	127 approx. max.	410 approx. max.
250 volt-amps	110 to 120	400
375 volt-amps	100 approx. min.	390 approx. min.

For installations having simultaneously operated loads which total more than 375 volt-amperes on the 115-volt winding, the toggle switch may be changed to "Hi." In this position and with 27.5 volts d.c. supplied, the voltage and frequency are about as follows:

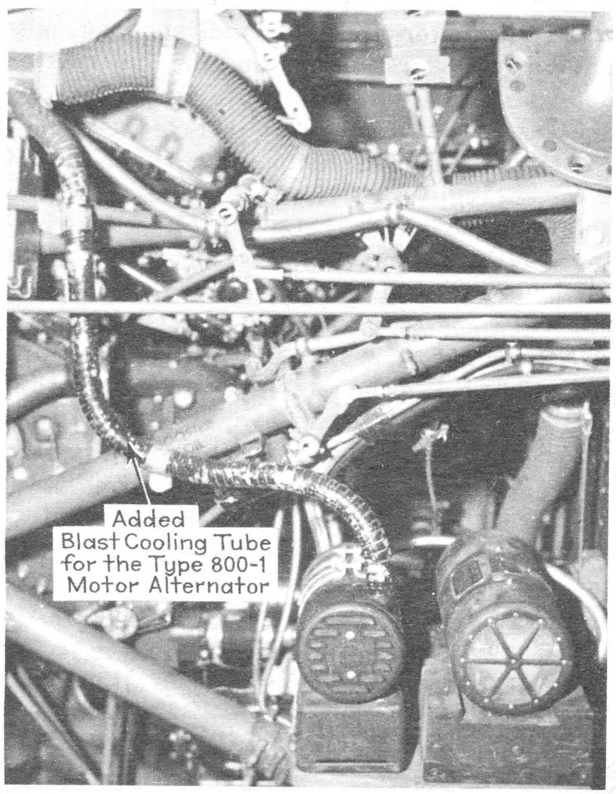
Load	*Volts*	*Frequency*
No-load	140 approx. max.	410 approx. max.
500 volt-amps	110 to 120	375 to 385

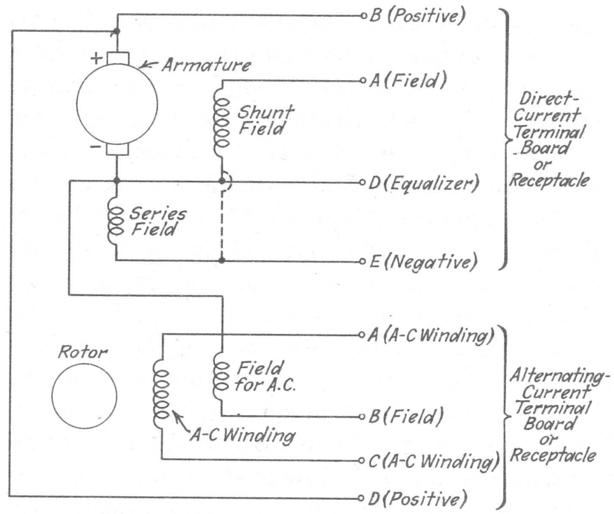
Because the voltage in either switch position may be excessive for some single equipments having a low power requirement, it is recommended that the MG-149F be ballasted (by turning on part of its load) at all times.

BLAST COOLING OF TYPE 800-1 MOTOR-ALTERNATOR IN SB2C AIRCRAFT

In a test report dated 1 March 1945, NAS, Patuxent River, Maryland, recommended that blast cooling be provided for the Type 800-1 Eclipse motor-alternator if it is to be retained in the present location in the accessories compartment. The motor-alternator cannot very well be moved aft from its position because of the effect on the airplane balance.

The illustration shows an improvised method of blast cooling the motor-alternator reported by CASU 4 in RUDM No. 1-45. It has been found desirable to leave the louvers on the end cap open for the escape of some of the cooling air.





Schematic diagram of a-c/d-c generator, NEA type. Note that the d-c shunt field may be connected internally to either D or E

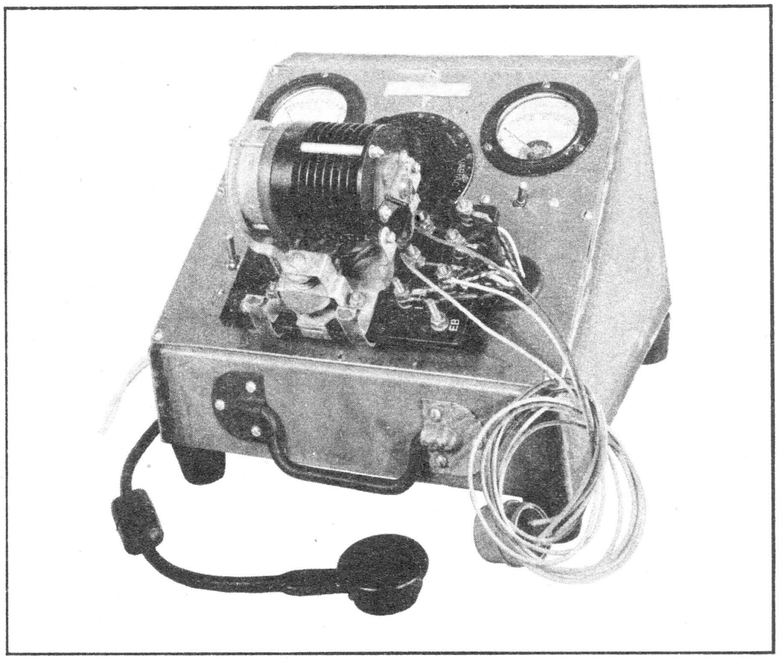
REPLACEMENT CARBON PILES FOR VOLTAGE REGULATORS IN 800-1 MOTOR-ALTERNATORS

When carbon piles and carbon buttons of voltage regulators are broken or burned every effort should be made to obtain new parts through regular supply channels. The makeshift practice of sanding off burned carbon disks and contacts makes operation of the regulator erratic and frequent adjustment necessary.

Motor-Alternator	Type Voltage Regulator	Carbon Pile No.	Carbon Button No.
800-1-B, -C	986-5-A	B-96614	B-96611
800-1-D	986-5-B	B-96614	B-126738

Regulators . . .

General



— SECTION 8

Regulator Adjuster

You Can Make This Portable Voltage Regulator Adjuster

CARBON-PILE voltage regulators can best be adjusted in the shop, using a variable-speed generator test stand (varidrive) where the operation of the regulator can be checked over the speed and load range of the generator. The disadvantages of the variable-speed generator test stand are that it is very large, heavy and requires quite a bit of power. For these reasons some carriers and small units do not have a test stand available.

A small, portable Carbon-Pile Voltage Regulator Adjuster has been conceived, designed, and built by ACG fieldman Karl E. Lugosch. The Regulator Adjuster was made at Pearl Harbor from salvaged parts. Power for the Regulator Adjuster is obtained by merely plugging into a 110-volt, 60-cycle, 400-cycle, or 800-cycle a-c socket. Both d-c and a-c regulators can be set on the Regulator Adjuster. The adjustment procedure used on the Regulator Adjuster is very similar to the standard procedure used on the variable-speed generator test stand.

The Regulator Adjuster as described herein cannot be used to adjust Army-type regulators having the carbon-pile circuit connected to the potential coil circuit. Eclipse plug-in d-c voltage regulator units Type 1042-2 and Type 1042-6 cannot be adjusted on the Regulator Adjuster unless the wiring in these regulators is changed to be like the wiring in the Navy-type regulators.

The following voltage regulators can be adjusted on the Regulator Adjuster:

Eclipse Type 1002-1-A d-c carbon-pile voltage regulator.

Eclipse Type 1260-1-A d-c carbon-pile voltage regulator.

Eclipse Types 1042-5, 1042-8 and 1042-9 d-c carbon-pile voltage regulator plug-in units (used in Type 1305 control box).

G.E. Model 3GBD1A18A finger-type d-c voltage regulator. (Certain modifications must be made to the Regulator Adjuster if it is to be used for adjusting finger-type regulators.)

All 120-volt a-c voltage regulators.

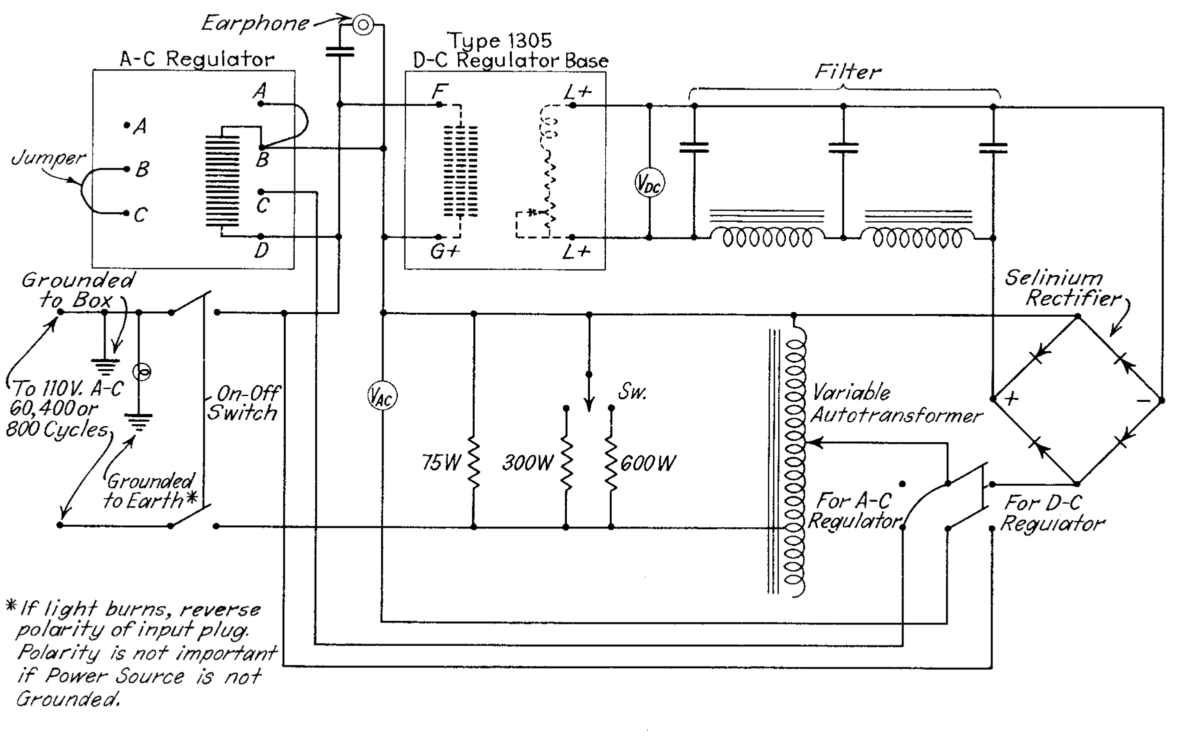


Figure 1—Schematic wiring diagram of Regulator Adjuster for adjusting both d-c and a-c voltage regulators

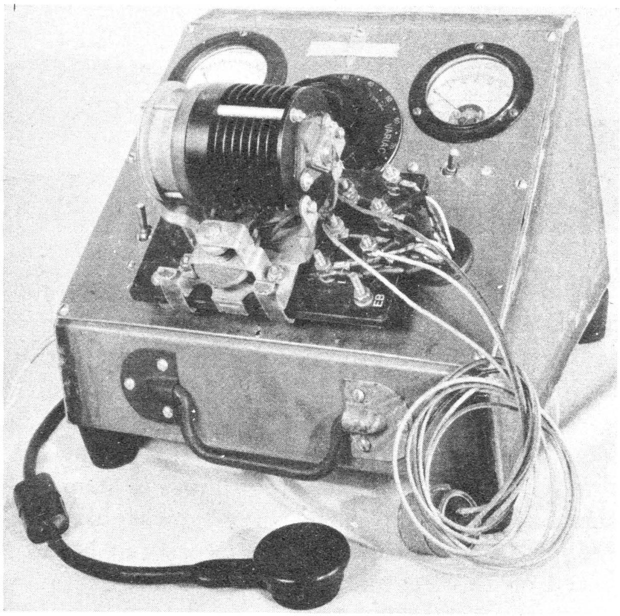


Figure 2—The Regulator Adjuster with a Type 1042 voltage regulator plugged into the Type 1305 regulator base. The unconnected cannon plug is for connection to an a-c voltage regulator. The earphone is connected across the carbon pile to detect chattering of the regulator

The Regulator Adjuster can also be adapted for the adjustment of reverse-current cutouts.

The Regulator Adjuster was made from available salvaged parts and therefore some of the values of components are not the best possible. The Bureau of Aeronautics is making extensive laboratory tests of the Regulator Adjuster to decide on the best possible design. It is intended to then have Regulator Adjusters manufactured and supplied to Naval Air activities. In the meantime, enterprising electricians can make the Regulator Adjuster from salvaged parts. The first few times voltage regulators are adjusted on the Regulator Adjuster they should be checked on a variable-speed generator test stand to make sure that the Regulator Adjuster is being properly used and that the regulators are ready for installation in airplanes.

Principles of Operation

Figure 1 shows a schematic wiring diagram of the Regulator Adjuster. Figure 3 is a simplified schematic showing the arrangement for the adjustment of d-c regulators only.

A carbon-pile voltage regulator consists basically of a carbon-pile stack which varies in resistance depending on how tightly the carbon disks are held together. A magnetic potential coil is arranged in the regulator so that when, for example, a higher voltage is applied to the magnetic potential coil, the magnet works against a spring and decreases the compression on the carbon pile. The carbon pile then has greater resistance and allows less current to flow through it.

When a carbon-pile voltage regulator is used with an aircraft generator, the carbon pile is in series with the generator field circuit and the potential coil is connected across the generator output terminals. When the generator output voltage changes, the resistance of the

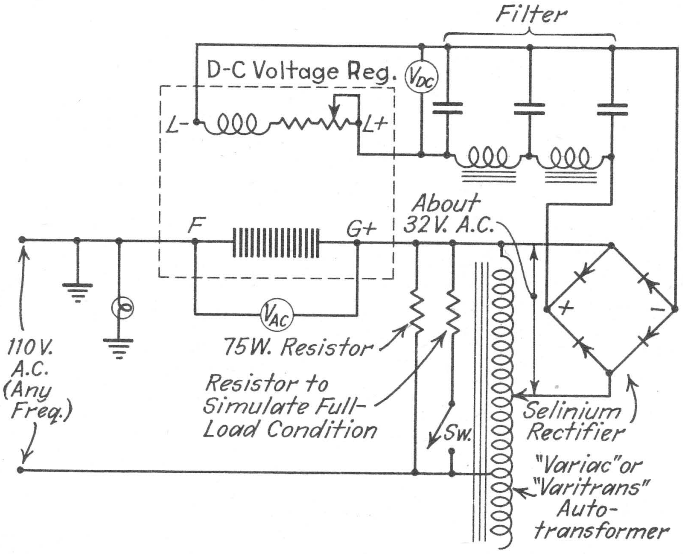


Figure 3—Simplified schematic diagram of the d-c regulator part of the Regulator Adjuster

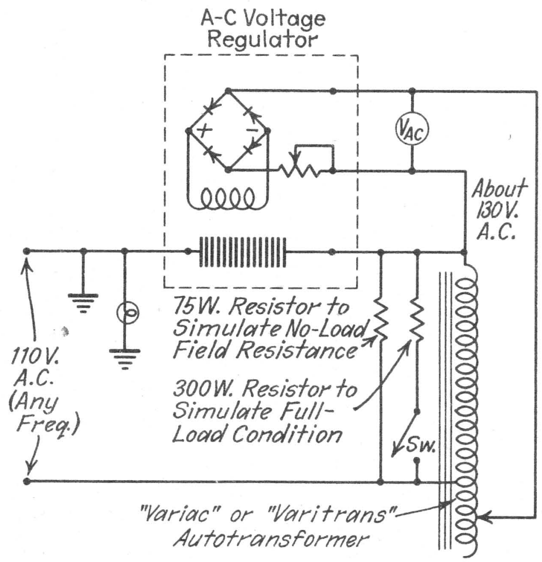


Figure 4—Simplified schematic diagram of the a-c regulator part of the Regulator Adjuster

carbon pile changes, which in turn changes the amount of field current. The changes in carbon-pile resistance and field current are such as to cause the generator output voltage to return to the original set value.

The d-c carbon-pile voltage regulator is connected to the Regulator Adjuster in such a way that the carbon pile is in series with the primary of a variable autotransformer supplied with 110-volt a-c. The variable autotransformer ("Variac" or "Varitrans") output is passed through a selenium rectifier and a choke-condenser filter to convert the a-c into d-c. The variable autotransformer is initially adjusted so that 32 volts d-c is supplied to the potential coil of the voltage regulator. The voltage regulator connected in the Regulator Adjuster "regulates" the d-c voltage supplied to the potential coil from the secondary of the autotransformer by changing the resistance of the carbon

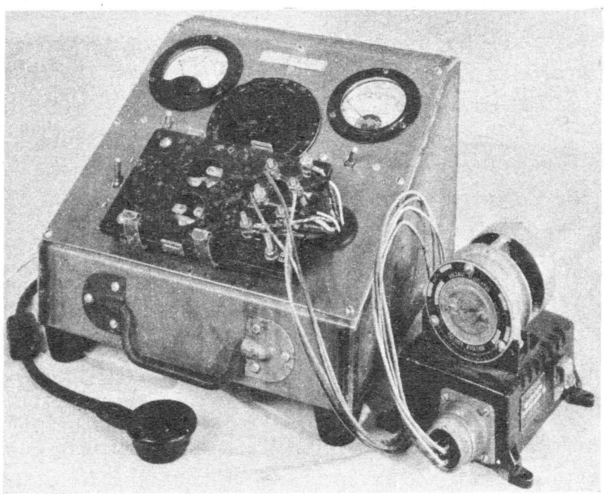


Figure 5—The Regulator Adjuster with a Type 1001 a-c voltage regulator connected. A jumper must be connected across pins B and C of the connector on the other side of the regulator

pile in the primary of the autotransformer. The voltage regulator doesn't know what is connected to it and it "regulates" the same as when it is connected to an aircraft generator.

A resistor in the Regulator Adjuster is connected across the primary of the autotransformer to simulate the application of load to an aircraft generator. When load is applied to an aircraft generator, the potential coil in the voltage regulator allows more current to flow through the carbon pile in the field circuit in order to maintain the generator output voltage. When the "load" resistor in the Regulator Ad-

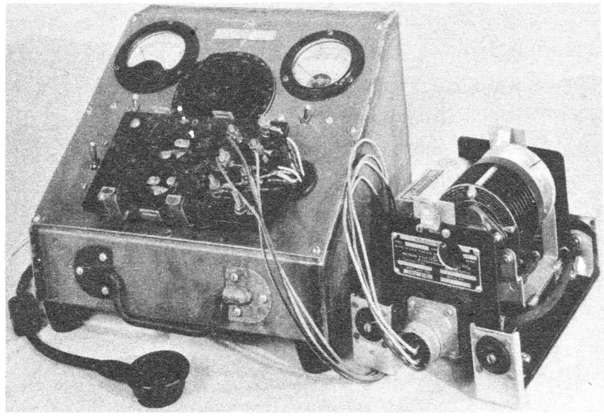


Figure 6—The Regulator Adjuster with a Type 1322 a-c voltage regulator connected

juster is connected across the autotransformer primary, the potential coil in the regulator allows more current to flow through the carbon pile in order to maintain the d-c voltage supplied to the potential coil. So far as the voltage regulator is concerned, the two situations are effectively the same except that a-c is passing through the carbon pile instead of d-c.

Since there is a-c in the carbon pile, there is more danger of damaging the carbon disks during the adjustment procedure. For this reason, the adjustment procedure using the Regulator Adjuster is started with the voltage regulator pile screw tight instead of loose. The pile screw is then turned out until the voltage dip is reached and the unstable region is avoided. An earphone is connected across the carbon pile to detect chatter of the regulator. An Army-type high-Z earphone can be connected directly across the carbon pile, but if a Navy-type low-Z earphone is used, a one-microfarad condenser must be connected in series with the earphone. The 60-cycle hum in the earphone should not be confused with the clicking sound which indicated that the regulator is chattering.

The a-c voltmeter is connected across the carbon pile as a check to make sure that the regulator is regulating.

Figure 4 is a simplified schematic showing the arrangement for adjustment of an a-c voltage regulator. The arrangement is the same as for a d-c voltage regulator except that the variable autotransformer is adjusted for an output of about 135 volts a-c instead of about 32 volts d-c. No rectifier or filter is needed in the Regulator Adjuster because a-c voltage regulators are designed to operate from a-c and have a rectifier in them.

Figure 2 shows the appearance of the Regulator Adjuster made by Lugosch. The Regulator Adjuster can just as well be made on an open "breadboard." It is important to use voltmeters that are of known accuracy. If accurate voltmeters are not available for use solely on the Regulator Adjuster, it is recommended that voltmeter jacks be provided so that a Westinghouse PX-14 portable d-c voltmeter and a Westinghouse NA-35 (or RA-35) a-c voltmeter can be plugged into the Regulator Adjuster when adjustments are being made.

Figure 5 shows the important parts that are necessary for the construction of a Regulator Adjuster. A certain amount of initiative and common sense may be required to find and make use of the parts that are available in your locality.

List of Parts

1. Variable autotransformer (trade name "Variac" or "Autotrans") rated 115 volts, 1 ampere or more. Efforts are being made to make 1-ampere variable autotransformers available through ASO. Variable autotransformers are used on ships and submarines, and it may be possible to obtain autotransformers from activities that supply ships. A limited number of the following over-size variable transformers are available through ASO:

Variac 115v., 7.5a., 9 lbs., ASO Stock No. (GR200-CM) R17-T-7090.

Varitrans 115v., 5a., 11 lbs., ASO Stock No. (V-2) R17-T-7098.

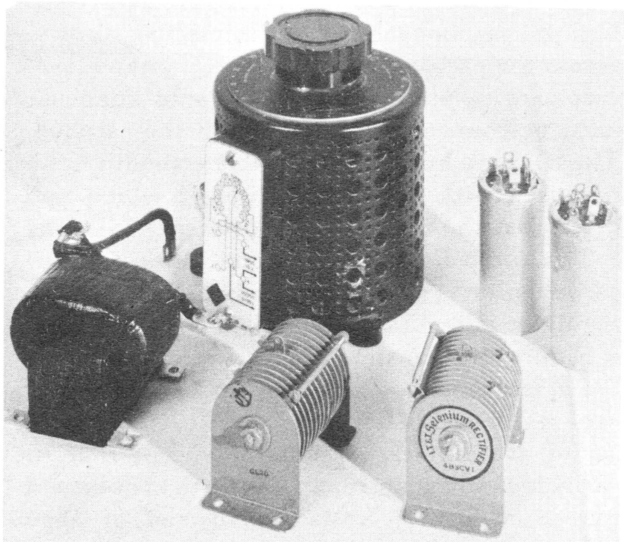


Figure 7—The more important parts required for building a Regulator Adjuster. One choke coil is shown but two are needed

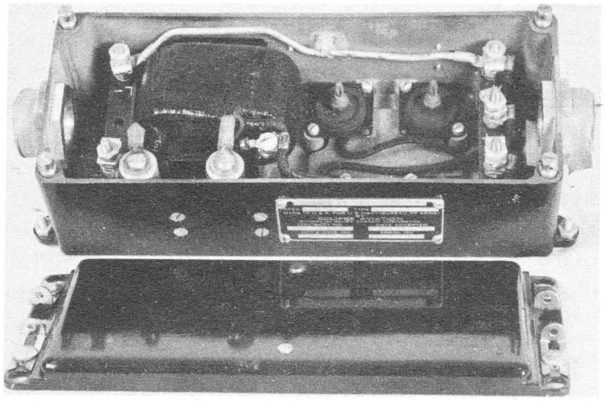


Figure 8—An NF-1 control box from which a choke coil can be obtained

2. Selenium rectifiers, Part No. CR-1001 of ASB-3 radar bulk spares. These rectifiers are used to supply d-c to the radar antenna switching motor and are each rated 30v., 0.37a., a-c input and 36v., 0.6a., d-c output. One rectifier unit may be used but two units connected in parallel are better.

3. Filter chokes can be obtained from two of any of the following obsolete control boxes:

Navy Type	*Drawing No.*	*Eclipse Model*
NF-1	NAF 1005-1	343-1-A or 1028-1-A
NF-1D	NAF 1005-7	588-1-A or 1002-2-A

4. Electrolytic filter condensers rated 35 volts or more, 100 microfarads or more each. Some radio and radar equipments have in a single can several small value condensers that can be connected in parallel to get 100 or more microfarads of capacitance. Condenser C-122 of AN/ARC-1 radio equipment is rated 100 microfarads and 50 volts d-c. Condenser C-177 of the same AN/ARC-1 radio equipment has three sections, each rated 100 microfarads and 35 volts d-c. The more capacitance used in the filter the better it filters. Condenser C-31 in AN/ARC-4, 233A radio equipment has 40, 40, 15 and 15 microfarads in four sections that can be connected in parallel to provide 110 microfarads total.

5. "Load" resistors rated 110 volts, 75 watts, 300 watts and 600 watts. Lamp bulbs, soldering irons, or heating elements can be used. The 75-watt resistor allows an amount of current to flow through the carbon pile that corresponds to the no-load field current of a generator. The 300-watt resistor simulates the full-load condition for an a-c regulator or for the Type 1002-

1-A d-c regulator. The 600-watt resistor simulates the full-load condition for the Type 1305 and Type 1260 d-c regulators.

6. One accurate voltmeter, 0-30 volts d-c, Westinghouse PX-14, ASO Stock No. R17-V-802.

7. One accurate voltmeter, 0-150 volts a-c, Westinghouse NA-35, ASO Stock No. R16-V-1965.

8. Three aircraft toggle switches:

DPST	AN3023-2 or -2B
DPDT	AN3023-1 or -1B
SPDT	AN3022-1 or -1B

9. One Type 1305 voltage regulator plug-in base.

10. One AN connector plug for a-c regulators, AN 3106-24-2S or AN 3108-24-2S.

How to Use the Regulator Adjuster

The following adjustment procedures are recommended by ACG for use with the Regulator Adjuster. The first few times a type of voltage regulator is adjusted on the Regulator Adjuster, the regulators should be checked on a varidrive to make sure that the Regulator Adjuster is being properly used and that the regulators are ready for installation in airplanes.

D-C Voltage Regulators

1. Plug into 110-volt a-c power supply. Either 60-cycle power or the 800-cycle output of a Type 800-1 motor-alternator may be used.
2. Set regulator rheostat at its midpoint.

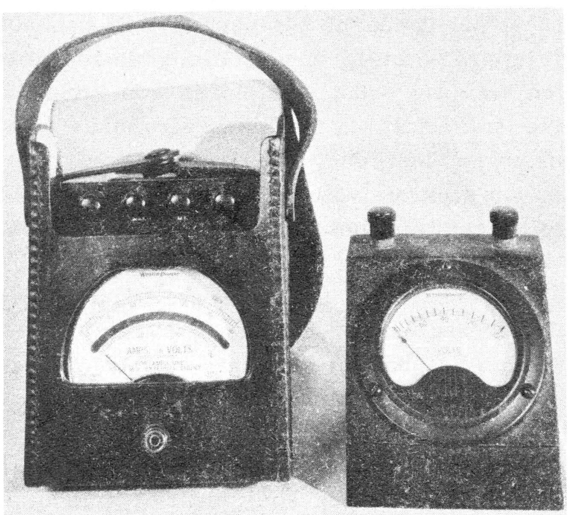


Figure 9—An accurate portable Westinghouse PX-14 d-c voltmeter (left) and a Westinghouse NA-35 a-c voltmeter (right)

3. Make sure that the pile screw is not tight. This is necessary to avoid damage to the regulator during step 4.
4. Turn the core screw until it is flush with the surface of the case. Then turn the screw counterclockwise from the flush position one full turn.
5. Tighten the pile screw until a reasonable resistance to the turning is felt. Do not turn pile screw so tight that the carbon pile is damaged. (In this procedure the adjustment is started with the pile screw tight instead of loose in order to avoid regulator chatter.)
6. Plug Navy Type 1042-5, 1042-8, or 1042-9 voltage regulator into the Type 1305 regulator base.
7. Turn variable autotransformer to zero volts output.
8. Flip the double-pole, double-throw switch to "d-c regulator," and turn on the "on-off" switch.
9. Increase the output voltage of the variable autotransformer until the d-c voltmeter reads 31 or 32 volts.

Caution—Never allow the d-c voltage to go above 32 volts to avoid damage to the voltmeter and to the rectifier in the Regulator Adjuster.

10. Turn out the pile screw until the voltage dip point is reached. This should require less than two turns of the pile screw. If no voltage dip is found, turn the pile screw back in again and turn the core screw ¼ turn in. Now turn pile screw out again until voltage dip point is reached.
11. Adjust the core screw for 27.5 volts.
12. Check the reading of the a-c voltmeter across the carbon pile. Once the a-c voltmeter indicates any reading, the regulator is "regulating." Experience has shown that when a regulator on the Regulator Adjuster is properly adjusted, there is about 20 volts a-c across the carbon pile. This voltage is constant for both no-load and full-load conditions.
13. Turn on the 600-watt "load" and allow the regulator to heat up for about 15 minutes.
14. Readjust the pile screw for proper voltage regulation as the "load" switch is turned on and off. Voltage should drop about 0.2 volt when "load" is applied.
15. Readjust the core screw for 27.5 volts.
16. Check the voltage of the regulator when installed in an airplane. Use an accurate d-c voltmeter and adjust the regulator rheostat to get 27.5 volts.

A-C Voltage Regulators

The method of adjusting a-c voltage regulators on the Regulator Adjuster is essentially the same as the method for d-c regulators. The steps given below are different:

Steps 1 through 5 same as d-c method.

6. Connect the a-c regulator to the 4-prong a-c cannon connector and connect a jumper across prongs B and C of the 3-prong cannon receptacle on the regulator.
7. Same.
8. Turn the double-pole, double-throw switch to "a-c regulator," and turn on the "on-off" switch.
9. Increase the output voltage of the variable autotransformer until the a-c voltage reads 130 or 135 volts.
10. Same.
11. Adjust the core screw for 117 volts a-c.
12. Same.
13. Turn on the 300-watt "load" and allow the regulator to heat up for about 15 minutes.
14. Readjust the pile screw for proper voltage regulation as the "load" switch is turned on and off.
15. Readjust the core screw for 117 volts a-c.
16. Check the voltage of the regulator when it is installed in the airplane, using an accurate a-c voltmeter. Adjust the regulator rheostat to get 117 volts.

When adjusting a-c voltage regulators it is very important that the a-c voltmeter used be highly accurate over the frequency range of, say, 25 to 1600 cycles. Even the Westinghouse NA-35 a-c voltmeter is not as accurate as would be desirable. Much of a-c voltage regulator trouble is due to inaccuracy of a-c voltmeters used.

VOLTAGE REGULATOR ADJUSTMENT WITHOUT USE OF VARIDRIVE GENERATOR TEST BENCH

It is very important that voltage regulators be properly adjusted. The adjustment can best be made using a Varidrive Generator Test Bench. The adjustment cannot very well be made in the plane using the engine-driven generator because of vibration and inaccessibility when in flight, and the short time engines can be "turned up" when plane is on the ground. But if you lack a Varidrive Generator Test Bench, you still may be able to make emergency voltage regulator adjustments — if you use your ingenuity.

To adjust voltage regulators you should have (1) a generator, like the one in the plane, driven at the airplane engine speed by an electric motor, gas engine, or jeep, (2) a load equal to full rated load of the generator, and (3) ammeter and accurate voltmeter.

1. The generator should be like the one in the plane, but many regulators have been adjusted using entirely different generators. It may be possible to make a satisfactory emergency regulator adjustment using the generator of a motor-generator or gas-engine-driven generator designed for battery charging.

In the case of planes having an auxiliary power unit, the generator driven by the auxiliary power unit usually has a lower rated output than the engine-driven generators. But in many cases regulators used to regulate the engine-driven generators have been adjusted satisfactorily by plugging them into the regulator base connected to the auxiliary power unit.

The generator should be driven at the cruising-speed rpm of the airplane engine, but a generator will generate rated voltage over a wide range of speeds. It may be possible to drive an engine generator at approximately the right speed by means of a belt and pulleys. Making a direct connection between an engine generator and a miscellaneous driving electric or gas engine usually requires the facilities of a machine shop, but coupling may be made by clamping heavy rubber hose to the shafts.

2. The load should be equal to full rated load of the generator, but if a regulator is adjusted for ¼-volt droop at ½ load, it will probably give approximately ½-volt droop at full load. Even welding rods, iron wire, iron strips, or spare landing lights can be used to make a load bank in an emergency.

3. An accurate voltmeter should be used, but a voltmeter like those in the plane may be used when nothing better is available.

The above recommendations are strictly emergency measures. Of course, every unit should make sure it has an adequate supply of spare regulators and cut-outs before leaving the U. S. or supply base. But if you find yourself out in the middle of nowhere without spares and without G.I. maintenance equipment, you may be able to use your ingenuity and rig up test equipment that will keep the planes from burning up the batteries or prevent whatever electrical troubles are being encountered.

MECHANICAL STABILIZER IS NEW FEATURE ON CARBON-PILE VOLTAGE REGULATORS

The following new carbon-pile voltage regulators incorporate a mechanical stabilizer device which acts as a snubber to prevent chatter of the armature and to prevent high voltages that otherwise would result from excessive wear of the carbon-pile disks:

Direct current—Type 1042-9-A plug-in unit which is a part of the Type 1305-3-B shock-mounted box.

Alternating current—Type 1317-2-A plug-in unit which is a part of the Type 1322-3-B shock-mounted box.

The mechanical stabilizer consists of a nut and a spring at the core-screw end of the carbon pile. Adjustment of the mechanical stabilizer is the fourth adjustment on the carbon-pile voltage regulator and it must be left off or loose (on the bench) until the other adjustments are completed.

A regulator with a mechanical stabilizer is properly adjusted when:

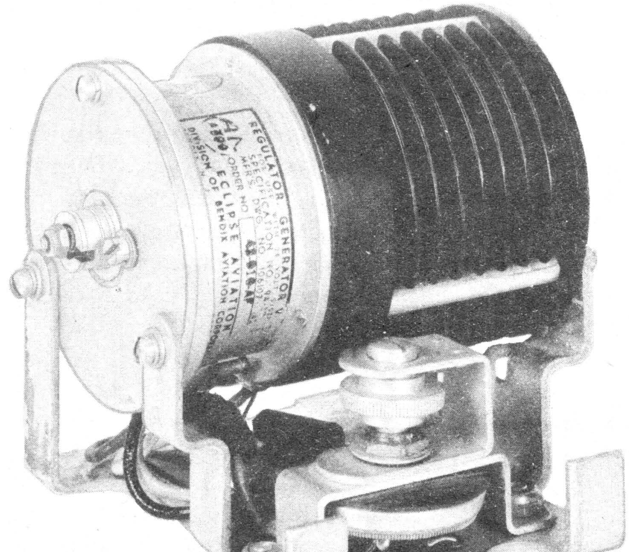


Figure 1—The core-screw end of a carbon-pile voltage regulator incorporating a mechanical stabilizer spring. Note the mechanical stabilizer self-locking nut and spring in the center of the extended core screw. The mechanical stabilizer nut and core screw are ordinarily covered by a small metal cap

1. The no-load voltage is 28 volts or whatever voltage that has been decided best under the climatic conditions encountered.
2. The voltage droops a fraction of a volt when full load is applied.
3. The voltage does not change more than 1.5 volts when the pile screw is loosened ¼ turn from its set position.

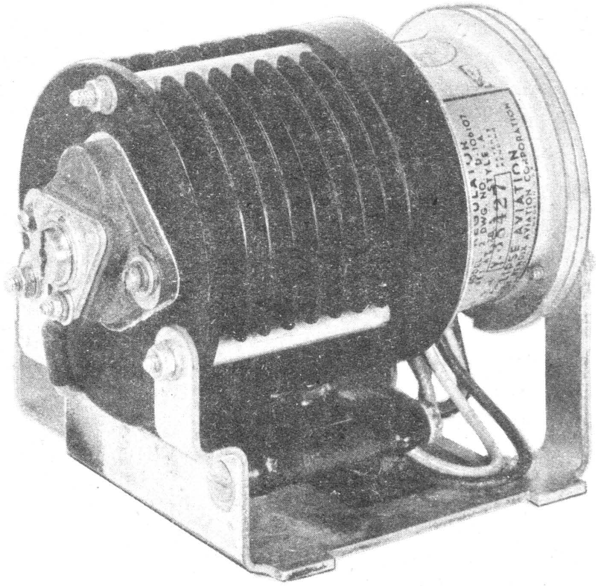


Figure 2—The pile-screw end of the improved carbon-pile voltage regulator. Note the new pile screw bracket and the self-locking pile screw having finer threads

4. There is no evidence of instability or chatter over the speed and load range of the generator when the pile screw is loosened ¼ turn from its set position. (After the checks given in numbers 3 and 4 above, the pile screw must be returned to its previously set and marked position.)

Tentative Adjustment Procedure

(There follows a tentative, simplified adjustment procedure for the mechanical stabilizer.)

The mechanical stabilizer nut is left loose or off until the pile screw and core screw adjustments are completed in the conventional way.

1. Mark the position of the pile screw with a pencil.
2. Tighten the mechanical stabilizer nut by small increments until when the pile screw is

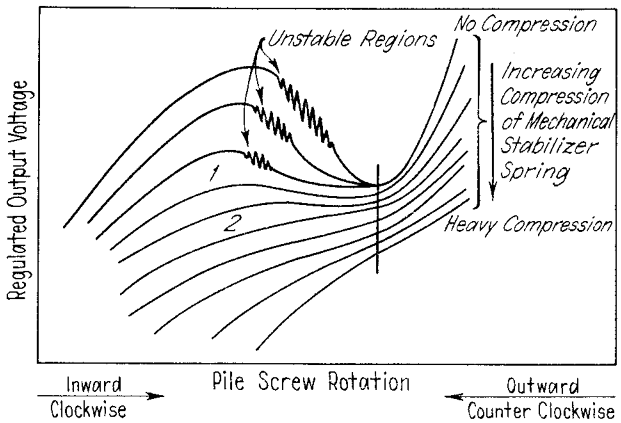


Figure 3—Curves showing how the voltage vs. pile screw characteristic of a carbon-pile voltage regulator changes when the mechanical stabilizer nut is tightened. The stabilizer nut should be tightened enough so that a characteristic between curves 1 and 2 is obtained

turned out (counterclockwise) ¼ turn from the marked position, the voltage does not rise or fall more than 1.5 volts.

3. Make a check of regulator stability over the speed and load range of the generator with the pile screw turned out ¼ turn from its set and marked position. If the regulator is unstable, tighten the mechanical stabilizer nut just enough to prevent the chatter.

4. Return the pile screw to its previously set and marked position. *Caution*—Never go back to readjust the pile screw for voltage dip after the mechanical stabilizer nut has been adjusted. It is necessary to loosen the mechanical stabilizer nut and start all over again.

5. Slightly readjust the core screw to get a no-load voltage of about 28 volts.

6. Check to see that the voltage droop with load is a fraction of one volt.

7. Install the regulator in the airplane and adjust the rheostat to obtain a no-load voltage of about 28 volts. The rheostat *only* (of a regulator with an adjusted mechanical stabilizer) should be used to readjust the voltage in the airplane if necessary after periods of operation.

EFFECT ON BATTERIES OF INSTABILITY OF CARBON-PILE REGULATORS

Experiments have been made at the Naval Research Laboratory to determine the effect of chattering or instability of carbon-pile voltage regulators. Chattering or instability is due to maladjustment of the regulator. Tests were also made to determine the effect of subjecting a correctly adjusted carbon-pile voltage regulator to vibration such as it gets in an airplane. It was found that the effect of vibration on the output effective (rms) voltage and current is negligible.

Tests indicate that the output voltage of a maladjusted unstable regulator fluctuates as a sawtooth wave having a frequency of roughly 20 cps. The effective (rms) output sawtooth voltage of an unstable regulator is only a few per cent higher than the stable output voltage. But the effective (rms) charging current to a storage battery may be from two to sixty times the average value. This increase in effective charging current may be very injurious to the battery, causing high temperature in the battery and shorting of the plates. The damage to the battery is especially serious in actual service because of the regulated-voltage rise that usually accompanies regulator instability.

These results explain the field experience of having carbon-pile voltage regulators become unstable in flight and causing the battery to burn up or explode. Voltage regulator instability can be prevented by careful adjustment of regulators on a variable-speed test stand and by frequent voltage checks in the airplane on the ground.

Battery failure due to regulator instability should become a thing of the past when the new Type 1305-3-B d-c regulators and the Type 1322-3-B a-c regulators (which have mechanical stabilizers) are in common use—provided these regulators are properly adjusted on the bench.

EMERGENCY RENOVATION OF CARBON PILES

Whenever carbon piles in aircraft voltage regulators show signs of wear, the entire carbon pile should be replaced with a new carbon pile of the same type. However, in the course of operations in forward areas, an adequate supply of replacement carbon piles is sometimes not available. When this condition exists, field activities often attempt to renovate the carbon piles by smoothing down the surfaces of the individual carbon disks. This practice must be regarded as an emergency expedient and not resorted to when complete replacement carbon disks can be obtained.

An Army enlisted man in the European theater was decorated for keeping airplanes flying in the absence of replacement carbon piles. The Army man smoothed individual carbon disks with crocus cloth and then polished the disks with parachute silk. Excellent results were reported with the renovated carbon piles. However, this expedient is to be discouraged. An Army T.O. now prohibits such renovation.

Tests have been made to determine the effect of renovating carbon piles. In the normal testing of any carbon pile that is manufactured, resistance is checked with thirty pounds compression and .06 pound compression. Since there are considerable data on the performance of the pile at these values, these two compression values were used for this test. The pile tested was the scrambled pile used in the Navy, and therefore the figures are not directly applicable to all other carbon piles, but at least the resistance changes are illustrative.

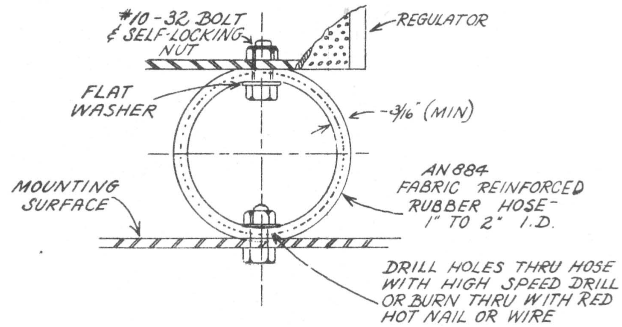
	30 pounds	*.06 pounds*
Standard Carbon Pile as Manufactured		
Pile No. 1	.092 ohms	6.30 ohms
Pile No. 2	.092 ohms	6.50 ohms
After Lapping on Parachute Silk		
Pile No. 1	.140 ohms	21.0 ohms
Pile No. 2	.170 ohms	26.0 ohms

Examination of the above data shows that a lapped pile does not have the low resistance that a standard pile has. Thus, the minimum generator speed at which the generator will develop 27.5 volts will be increased because of the increased "minimum" resistance of the carbon pile. Furthermore, it appears that the surface on the carbon disks produced by lapping with silk does not stay.

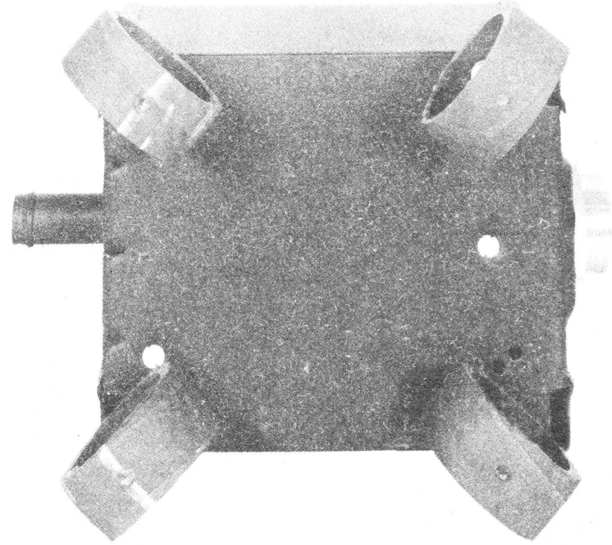
If the supply of carbon piles is so limited that a new carbon pile cannot be used in the regulator at the time of each overhaul, the pile should be removed and each carbon disk should be examined for roughness or pits. If the two disks on either end (and an occasional disk in the center of the pile) show need of replacement, a like number of new disks should be used to replace the damaged ones. The life of a carbon pile renovated in this way should approximately equal the life of a new pile. In this manner one new carbon pile may be used to overhaul twelve to fourteen regulators.

SHOCK MOUNTING OF ECLIPSE CARBON-PILE VOLTAGE REGULATORS, TYPES 1305-1A, 1002-1A, 1001-2A, 1001-4A AND 1260-1A

Naval Speedletter F36-1(1) dated 25 May 1944 states that considerable increase in life and improvement in operation of carbon-pile voltage regulators can be obtained by adding shock mounts. Pending receipt of factory built shock mounts, now in production, use of rubber hose



is recommended on those installations where short life or unstable voltage has been experienced. Illustrations show recommended method of installing one-inch lengths of AN884 synthetic rubber hose. Diameters of 1 to 2 inches have been found satisfactory. Hose axis should be at 45 degrees across each corner of regulator for most effective vibration absorption. Most resilient sample of AN884 hose available should be used. ASO stock numbers are R-33-H-345-105, 115, 125, 135, and 145. Hose is identified by parallel solid white and broken red lines on outside. Hose used should have a minimum thickness of 3/16 inch. Drill holes through hose with high speed drill or burn through with red hot nail or wire.



VIBRATION OF CARBON-PILE VOLTAGE REGULATORS

This article will consider the effect on carbon-pile voltage regulators of vibration in line with the carbon pile, vibration at right angles to the pile, and the damping effect of shock mounting.

Vibration in Line with the Pile

During operation, the armature and carbon disks move back and forth, against the restraining action of the spring. Since the armature has appreciable inertia, it responds to external vibration if the amplitude of this vibration is sufficient to overcome friction of the moving parts. With each cycle of vibration in line with the pile, the armature moves back and forth compressing and decompressing the carbon disks. This action changes the resistance of the pile (since its resistance depends on the degree of the compression of the carbon disks), and the change in resistance jumps the generator voltage up and down. The voltage regulator coil does not realize that this fluctuation in generator voltage is caused by vibration and tries to compensate for it by an opposing change in the generator voltage. We now have two unmatched forces acting upon the armature, the force of the operating coil and the forces due to vibration.

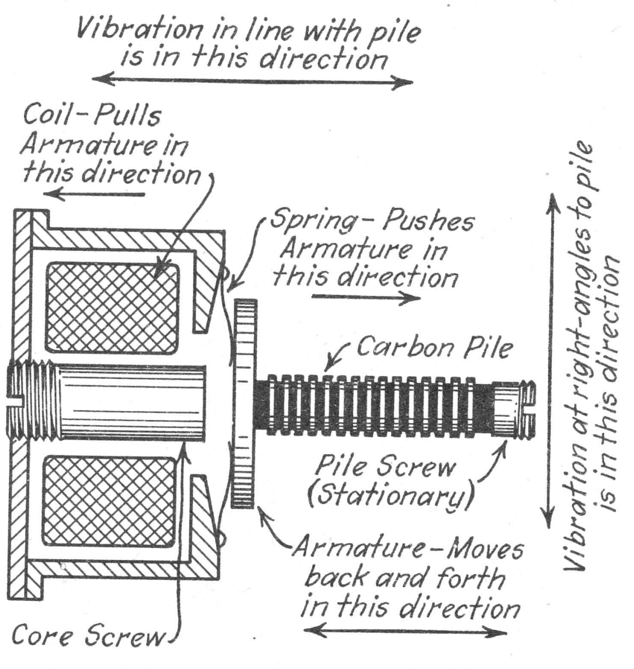
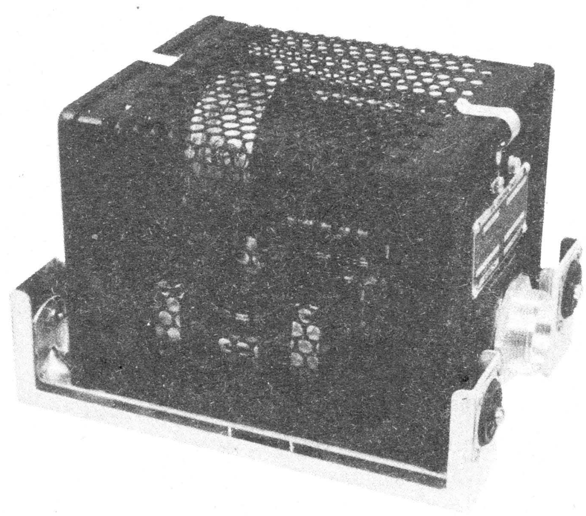


Figure 1—The guts of a carbon-pile voltage regulator



Eclipse 1305-A regulator with shock mounts using Lord 1-pound units

It is unfortunate, but true, that the armature is sensitive to vibration. The armature moves a very small distance to vary the pile resistance over the entire operating range. In a 1305 regulator, for example, the armature moves only .005 inch to vary the pile resistance from 1.5 to 55 ohms.

Vibration may move the armature sufficient distances to separate the carbon disks. With each separation of disks, there is a small arc as the field current (averaging from 4 to 8 amperes) is broken. These arcs burn projecting points on the disks and on the pile screw and armature plugs. If this arcing continues long enough, craters and bumps are formed on the disks and the arcing wears away the surface of the disks. This pile "wear" decreases the effective thickness of the disks and causes the armature to move away from the core where there is less pull on the armature. As the armature moves away from the core, the resultant pressure on the pile goes up, compressing the disks tighter and lowering the pile resistance. Result: high generator voltage, burned out batteries, failures of radio and radar gear and, finally, nasty tempers throughout the squadron.

Vibration at Right Angles to the Pile

As closely as experts can determine, a limited amount of vibration *at right angles to the pile* is not detrimental; in fact, it may even assist in the satisfactory operation of the regulator. The pile disks fit snugly into the ceramic tube and do not move appreciably when vibration is applied at right angles. The design of the armature and spring prevents their movement with this direction of vibration. Some schools

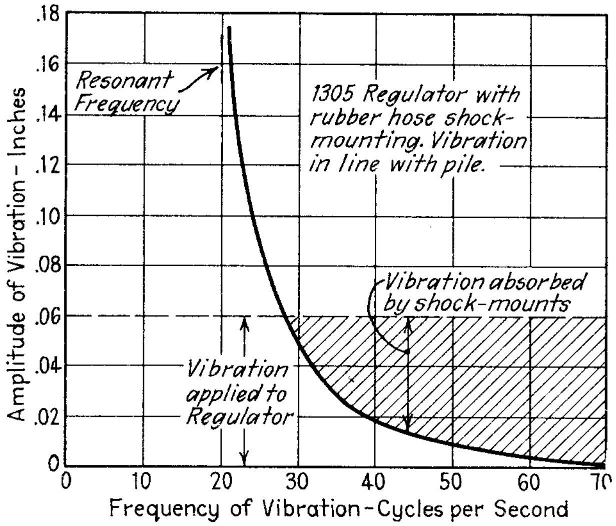


Figure 2—Frequency amplitude curve with rubber-hose shock mounting

of thought believe a small amount of vibration at right angles to the pile is actually necessary to help overcome the static friction of the disks against the ceramic tubes. A few gentle taps on the regulator during adjustment help to straighten out the carbon disks and overcome instability.

Shock-Mounting

After considerable study, thought and testing, a program of shock-mounting all carbon-pile regulators has been inaugurated. BuAer speed-letter of 25 May 1944 recommends rubber hose shock-mounting of voltage regulators with short sections of rubber hose as shock-mounting units.

A typical rubber hose shock-mounting gives a frequency-amplitude curve as shown in Figure 2.

As a permanent remedy, Eclipse has designed and is producing a shock-mounting assembly using Lord 1-pound shock-mounting units. This Eclipse assembly may be attached to a 1305, 1322, 1001 or 1002 regulator. BuAer Technical Note No. 58-44 describes this shock-mounting.

The photo on Page 8-10 shows a 1305 regulator with Eclipse shock-mounts attached.

This Eclipse shock-mount is specifically designed to reduce the detrimental vibration in line with the pile. Vibration at right angles to pile is not absorbed over the entire operation frequency range; in fact, at lower frequencies the vibration is actually amplified. This is an unfortunate but not necessarily detrimental condition. Aircraft and accessory design is a series of compromises. We must sacrifice vibration absorption at right angles to the pile in order to obtain vib ation absorption in line with the pile. Figure 3 illustrates a typical frequency-versus-amplitude characteristic of an Eclipse shock-mounting unit.

Future Development

BuAer has enlisted the help of Robinson Aviation, Incorporated, in developing a better shock-mounting unit. This corporation manufactures shock units for heavier radio and electronic equipment with which you are probably familiar. After considerable work, the firm has

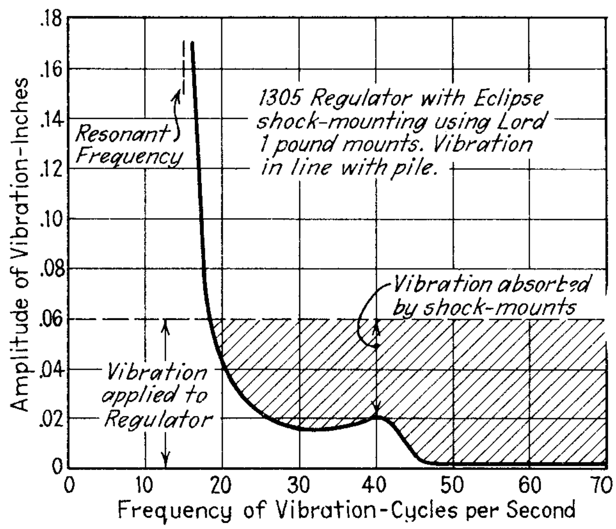


Figure 3—Amplitude curve when using Lord 1-pound mounts

successfully designed a unit for a piece of equipment as light (comparatively speaking) as a voltage regulator. If this unit fulfills present expectations, it is planned to replace the Eclipse unit now being produced with the Robinson unit. A later article will give activities the latest word on Robinson shock-mounting units.

IMPROVED VIBRATION MOUNT FOR AAF VOLTAGE REGULATOR BASE
T.N. 81-44

The AAF Type No. 40D8445-2 voltage regulator base has been supplied on SB2C-1A, PBJ, PB4Y, R5C, JM, SNJ, SNV, and SNB airplanes and other miscellaneous airplanes obtained from the Army. These bases are manufactured by the Leece-Neville Company under their part number 24554. Voltage regulator bases manufactured prior to 1 December 1943 have been supplied with 4 square-section rubber vibration mounts, U. S. Rubber part number A-321, as illustrated in Figure 1. Numerous failures of these vibration mounts have been reported after comparatively few hours of service.

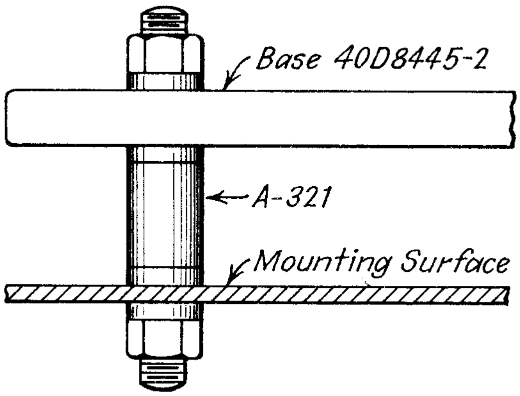


Figure 1

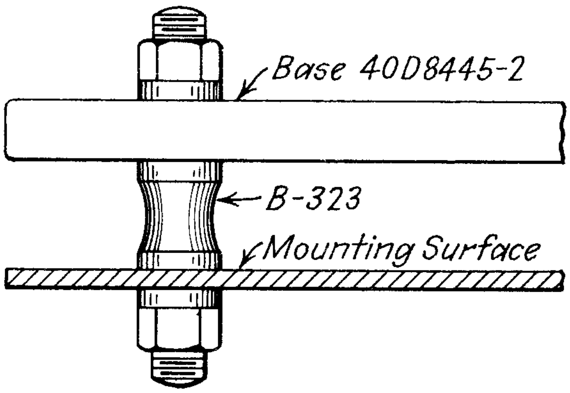
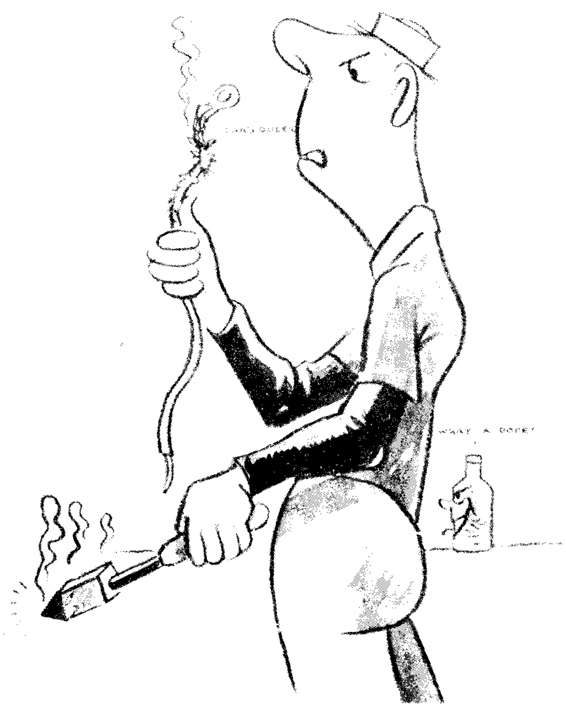


Figure 2

The manufacturer has developed a more satisfactory vibration mount of a different shape which is manufactured from 50 durometer rubber, instead of the 30 durometer previously used. This improved vibration mount, U. S. Rubber part number B-323 as illustrated in Figure 2, has been supplied on bases manufactured since 1 December 1943.

It is recommended that all 40D8445-2 voltage regulator bases be inspected and, if there is any indication of deterioration of the A-321 vibration mounts, that the mounts be replaced at once. It is also recommended that the improved U. S. Rubber B-323 (Leece-Neville part number 26155) vibration mount be installed on all bases at the next overhaul.

Distribution of the B-323 vibration mount is being made to NASD, Philadelphia; NASD, Norfolk; ASA, Oakland, and NAS, Jacksonville. The material necessary to accomplish the above shall be obtained in accordance with prescribed procurement procedures from the places listed above (or the established supply sources).



Spoiler never figured out IN ADVANCE that too hot a copper or an acid flux would RUIN electrical cable

SHOCK MOUNTING OF CARBON-PILE VOLTAGE REGULATORS

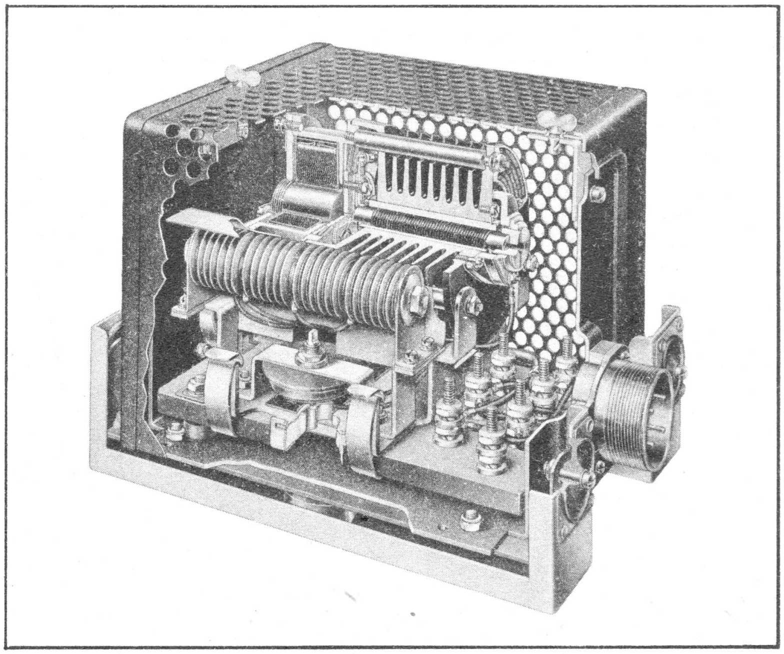
Eclipse Type 1305-1A, 1322-1A, 1001-4A, 1260-1A, 1001-2A and 1002-1A (From T.N. 58-44)

Excessive vibration of the subject voltage regulators has caused wear of the carbon disks and short operating life. Test installations have indicated that a longer operating life is obtained by shock mounting.

The manufacturer has developed a shock mounting which will be supplied on production regulators. Kits containing the required parts for shock mounting regulators now in service have been distributed to ASA, Oakland; NASD, Norfolk; NASD, Philadelphia, and NAS, Jacksonville. Pending receipt of these kits, the required brackets may be fabricated in the field and installed on the regulators in accordance with Figures 1 to 6 of Technical Note No. 58-44.

Eclipse Kit, part No. B-131139, is for regulators 1305-1A and 1322-1A. Eclipse Kit, part No. B-131072, is for regulators 1001-4A, 1001-2A, 1260-1A, and 1002-1A. See T.N. 58-44 for complete information.

Regulators . . .
A-C Voltage



— SECTION 10

INFORMATION ON ADJUSTMENT OF A-C CARBON-PILE VOLTAGE REGULATORS ECLIPSE TYPES 1001 AND 1322 (T.N. 60-45)

Unsatisfactory IFF operation has been reported on carrier-based aircraft equipped with NEA-4 and NEA-5 a-c/d-c generators. This unsatisfactory operation has been caused in part by poor voltage regulation of the a-c power supply which is due to improper adjustment of the voltage regulators and drift of the regulated voltage as the regulator heats.

All a-c regulators properly adjusted will maintain the a-c voltage output of the engine-driven generator between 114 and 120 volts after the first 15 minutes of operation. Some early regulators will permit the initial voltage to rise to 124 volts before the regulator heats up to the stable operating temperature. (Recent production regulators have improved heat compensation.)

Each regulator when received should be re-adjusted in accordance with the instructions contained in this Technical Note. The factory or A&R adjustments which have been made for one particular generator or load combination should not be relied upon to provide satisfactory operation under other loads or with other generators.

Principles of Operation

A brief review of the principles of operation of a-c carbon-pile regulators when used with the alternator section of a-c/d-c generators follows:

The function of the voltage regulator is to maintain the voltage of the alternator at a desired value. This is accomplished by changing the resistance of a carbon pile which is connected in series with the exciting field winding of the alternator. The carbon-pile regulator is connected to the alternator so that the field current passes through the carbon pile and the alternator voltage to be regulated is impressed across the operating coil. The force exerted by a leaf spring on the carbon pile is controlled by the magnetic force of the operating coil. An increase in a-c output voltage from the generator increases the current in the operating coil, resulting in an increase in the regulator magnetic flux which in turn decreases the pressure on the carbon pile, allowing the carbon pile to loosen slightly. As the pile becomes looser, its resistance rises, and the field current of the alternator is decreased, restoring the alternator voltage to the proper value. The pressure on the

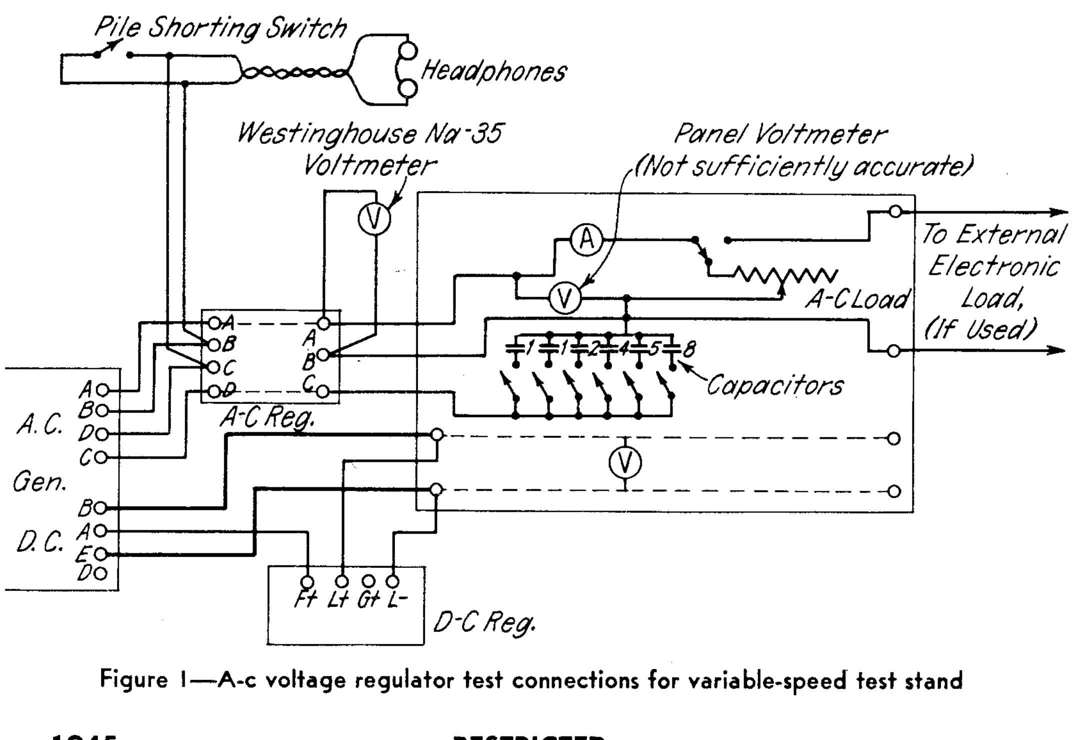


Figure 1—A-c voltage regulator test connections for variable-speed test stand

carbon pile is small in comparison to the spring and magnetic forces and, therefore, it is necessary to adjust the regulator carefully to obtain optimum operation.

The carbon-pile regulator will maintain a different voltage when hot than when cold as the heating changes the balance between the spring force and the magnetic force mentioned above. This change in balance is due both to change in resistance in the regulator coil and to expansion or contraction of the regulator parts. In an attempt to compensate for this change, a-c voltage regulators use a bi-metallic (temperature compensating) washer. This bi-metallic compensator is not perfect, however, and it is necessary to adjust the regulator when hot.

Modification of Test Panel

The a-c portion of the test panel supplied with generator test stands should be modified in accordance with the article in the Test Equipment section of AEMN titled "Suggested Modification to A-C Part of U. S. Testometer Portable Generator Test Panel" to permit satisfactory regulator adjustment. The corrected wiring diagram is shown in Figure 1.

The regulators and generator should be connected to the test panel as shown in Figure 1.

Note—Generator and d-c regulator types under test should be the same as installed in the airplane.

Voltmeters

A-C Voltmeter, Westinghouse Models NA-35 (mounted in a black metal case) or RA-35 (unmounted) should be used for a-c regulator adjustments. Other a-c voltmeters, such as the Westinghouse Type NA-33 mounted on the generator test panel, are inaccurate over the frequency range of the a-c generators. If NA-35 or RA-35 meters are not available, the NA-33 may be calibrated against a satisfactory instrument such as a Weston 341 or Weston 433. The correction factors contained in an article in the Test Equipment section of AEMN titled "Inaccuracy of A-C Voltmeter on Generator Test Benches," are not to be used except as a last resort.

Type of A-C Load and Capacitance

Very important factors in adjusting a-c voltage regulators are the amount of capacitance connected in series with the generator, and the type and amount of load supplied by the generator. In addition, the type of generator is an important factor. Hence, it is very important that the type of generator to be used for adjustment should be the same as that to be used in the airplane.

The regulation of an NEA generator when controlled by an Eclipse 1001 or 1322 regulator will vary with the type of load supplied (lamp bank, resistor, or 0.965 pf inductive) and the amount of load. These a-c regulators are designed to hold the generator voltage within plus or minus 2½% of an adjusted voltage. This can be accomplished only when the regulator is adjusted using full generator load and using the *type of load with which it is to operate* in the airplane (or an equivalent resistive-reactive load which has been determined to simulate the equipment load). If the airplane load does not require 10 amperes, which is full load, additional resistive load must be added so that the generator will be fully loaded for adjustment purposes.

Regulation of the generator-regulator combinations will vary with the amount of compensating capacitance used as well as with the load applied. The A-C Systems section of AEMN contains an article explaining the theory be-

Amount of Compensating Capacitance to Be Used

Generator Type	*Optimum* Capacitance*	*Test Bench (For Adj.)*	*Aircraft Installation***	
			Under 8-amp. Load	*Over 8-amp. Load*
Eclipse NEA-3	10 mfd.	10 mfd.	12 mfd. (1 Type A)	15 mfd. (1 Type A)
Eclipse NEA-4	7.5 - 9.0 mfd.	8 mfd.	12 mfd. (1 Type A)	7.5 mfd. (2 Type A)†
Eclipse NEA-5	7.5 - 9.0 mfd.	8 mfd.	12 mfd. (1 Type A)	7.5 mfd. (2 Type A)†
GE NEA-5	5 - 15 mfd.	15 mfd.	15 mfd. (1 Type A)	15 mfd. (1 Type A)

* This amount of capacitance must be used if voltage is to vary no more than plus or minus 2½% over generator speed and load range with generator and regulator hot.

** The thermal limitation of the Kellogg Type A makes it necessary to connect at least 1.5 mfd. per ampere of current through capacitor.

† Connect 2 Type A's in series, each connected for 15 mfd. to provide 7.5 mfd., so that the thermal limitation of the Kellogg Type A capacitor will not be exceeded.

hind compensating capacitance as applied to alternators. It should be borne in mind that when a variable speed (variable frequency) alternator is considered, there is a maximum as well as a minimum value of compensating capacitance that will allow the generator and regulator to perform properly over the complete speed and load range of the generator. If too much capacitance is connected, either load or voltage must be sacrificed at high generator speeds, and if too little capacitance is connected, the sacrifice occurs at low generator speed.

Since the present Kellogg Type "A" capacitor will overheat when used with the capacitance required for satisfactory regulation at full load, a new condenser, specification NAVAER M-640, has been issued and a new Compensating Capacitor, Type NAF 1222, ASO Stock No. R-16-11687-500, manufactured in accordance with that specification, will be in production in the near future. This capacitor has a higher current-carrying capacity, and the use of two condensers will no longer be necessary in those cases bearing loads greater than 8 amperes.

Thus, to properly adjust the a-c regulators it is necessary to:

1. Use type of generator on which regulator is to operate.
2. Use type of load with which regulator is to operate whenever possible, otherwise use load resistor (carbon pile) in test panel.
3. Use full generator load of 10 amps, adding resistive load as necessary.
4. Use capacitance as indicated above.

Adjustment of A-C Regulators with Variable Speed Test Stand

The steps in the adjustment of a-c carbon-pile voltage regulators are given below. This method of adjustment is based on using a variable speed test stand, since that is the only sure method of adjusting regulators for optimum operation.

Note—In this description it is assumed that the regulator is completely out of adjustment and that a new carbon pile has just been installed. If the regulator is already partially adjusted (as received from supply) and is found to be unstable when installed on the generator, the paragraphs (a) to (n) inclusive can be omitted and the heat run of paragraph (o) started.

The three adjustments on a carbon-pile voltage regulator are (see Figure 2):

(a) *Rheostat:* Controls the operating current in the potential coil circuit. This rheostat is provided for slight voltage adjustments at time of installation of the regulator in the aircraft.

(b) *Core Screw:* Controls the magnetic air gap. The core screw is primarily a voltage adjustment, although regulating characteristics are also affected.

(c) *Pile Screw:* Controls the degree of pile compression and armature position. The pile screw primarily adjusts the regulating characteristic, although the voltage is also somewhat affected.

During the adjustment of any carbon-pile regulator, the pile must be repeatedly settled. This can be readily accomplished by the sudden application and removal of load or by continuous tapping with the handle of a screwdriver or vibration of regulator.

(a) Loosen the two locking screws which hold the CORE SCREW in position and turn the core screw just flush with the outside of the magnet case. Now turn the core screw outward one full turn and tighten the two locking screws.

(b) Set the *rheostat* to its midpoint.

(c) Set the *pile screw* until the contact plug just touches the carbon pile in the old-type bracket or until the bottom thread of the contact plug engages the copper-colored friction device on the new-type bracket.

(d) Place the regulator in the test mounting shown in Figure 1.

(e) Close the pile-shorting switch.

(f) Start the vari-drive and with no load gradually increase the generator speed until the regulator voltage is 125 volts.

(g) Open the pile-shorting switch.

(h) Slowly turn the *pile screw* clockwise (inward). As the screw is turned inward the output voltage will rise to a maximum and decrease to a minimum and then begin to rise rapidly again. (See Figure 3.)

(i) If the characteristic curve (paragraph (h)) of the regulator is not apparent on first trial, then turn PILE SCREW outward to the original position as described in paragraph (c). Next, loosen the locking screws and turn the CORE SCREW *inward* ¼ turn. Repeat the procedure of turning the PILE SCREW inward. If this second attempt still does not produce the characteristic curve, turn the CORE SCREW ¼ turn farther *inward* and repeat the procedure. If the characteristic curve is still not apparent, the regulator should be overhauled as described in the manufacturers' instruction book.

(j) After the output voltage has begun to rise rapidly from the minimum described in paragraph (h), reverse the direction of turning the PILE SCREW and turn it slowly outward just enough to be sure the voltage is back to a minimum.

(k) Increase the generator speed slowly while observing the value of the output voltage. As the voltage starts to climb, turn the PILE SCREW out until the voltage drops to a minimum. If regulator becomes unstable turn PILE SCREW in until regulator is again stable. (Instability can be determined by use of the earphones. When regulator is stable there will be a humming noise in the earphones. However, should a rapid series of staccato noises be heard, it is an indication that the regulator is unstable.) *The regulator should never be operated in the unstable condition, since arcing occurs, causing burning and pitting of the carbon disks.*

(l) Repeat this sequence of increasing the generator speed and backing out the PILE SCREW until the generator reaches its maximum rated speed.

(m) Turn the *core screw* counterclockwise (outward) until the output voltage is approximately 117 volts.

Note—When a steel screwdriver is removed from the core screw the voltage rises about one volt.

(n) Readjust *pile screw* for minimum voltage as described in (j).

(o) It is now necessary to give the regulator a heat run to bring it up to the normal operating temperature. Connect a portable d-c voltmeter across the carbon-pile terminals and lower the generator speed until the voltage drop across the pile is approximately 14 volts d-c. Under this condition the regulator is dissipating its maximum wattage. Allow the regulator to heat up for about *30 minutes.* Since the carbon-pile regulator normally operates hot, it must be adjusted hot. If adjusted cold, it will maintain incorrect voltage when hot.

(p) At the end of the 30-minute heat run increase the generator speed to its maximum rated speed.

(q) Apply and remove full load. The a-c or generator voltages under these two conditions should be the same. This is shown as a flat characteristic. If the load voltage is lower than the no-load voltage, the regulator has a drooping characteristic. If the voltage rises when the load is applied, the regulator has a rising characteristic. With some generator-regulator combinations it is impossible to obtain a flat characteristic. In those cases the regulator should be adjusted for the minimum droop that gives stable operation.

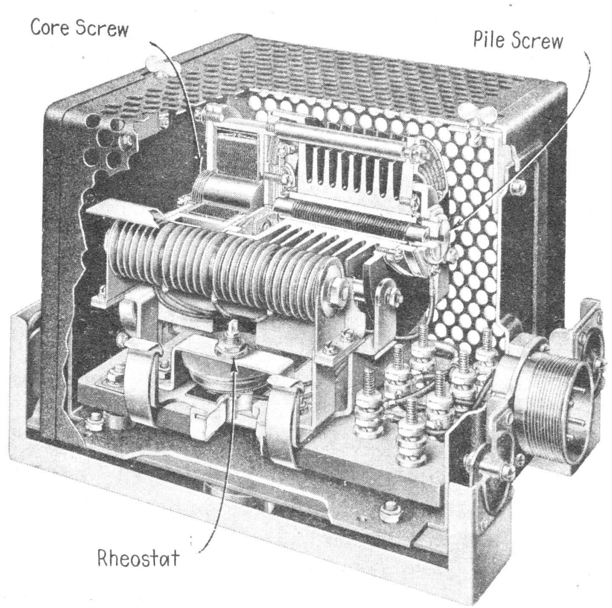


Figure 2—Cutaway view of an Eclipse Type 1322 voltage regulator control box plug-in voltage regulator

(r) If the regulator does not have a flat characteristic, turn the *pile screw* outward to overcome a drooping characteristic or turn it inward to overcome a rising characteristic.

(s) If the voltage is not 117 volts when flat characteristic has been obtained, turn the *core screw* inward to lower the voltage or outward to raise the voltage.

(t) Check for stability with headphones.

(u) Continue adjusting *core screw* and *pile screw* as described in paragraphs (r) and (s) until regulator has a flat characteristic and is stable at 117 volts (or minimum droop consistent with stability with 117 volts full load) and *maximum* rated speed (regulator will usually have a drooping characteristic at lower speeds).

Note—During the adjustment of any carbon-pile regulator, the pile must be repeatedly settled. This can be readily accomplished by the sudden application and removal of load.

In setting the *pile screw* for any position, always approach this position by turning the *pile screw* outward. Due to a hysteresis effect a different voltage would be obtained by turning the *pile screw* inward. (Figure 3.)

(v) Apply *full* load to generator and reduce generator speed to average rated speed. If necessary, turn *core screw* to obtain 117 volts.

(w) Regulator is now adjusted and should meet the requirements of the test below.

(x) Regulated voltage should remain between 114 and 120 volts under the following conditions with the regulator still hot:

(1) Minimum rated speed with zero load, ½ full load, full load.

(2) Average rated speed with zero load, ½ full load, full load.

(3) Maximum rated speed with zero load, ½ load, full load.

(4) With full load at maximum rated speed, decrease speed to minimum rated and check voltage; then remove load and increase speed to maximum rated and again check voltage.

Note—Regulators will pass this test only if capacitance is within the values recommended in paragraph 10 and regulator is hot. If regulator is cold it must be heated for 15 minutes before testing.

Adjustment of A-C Regulators with Constant Speed Test Stand

Although the adjustment of carbon-pile regulators on the constant speed test stand is not the best possible adjustment, the constant speed test stand can be used when a variable speed stand is not available. The same test set-up is used as that described for the variable speed test stand, shown in Figure 1, with the following exceptions:

(a) A 10-ohm, 60-watt variable resistance rheostat is inserted in the field lead between (B) on the a-c regulator and (B) on the a-c end of the generator.

(b) A 10-ampere switch is connected across the rheostat to permit shorting it. (This is in addition to the pile-shorting switch shown in Figure 1.)

The steps in the adjustment of an a-c carbon-pile voltage regulator on a constant speed test stand are outlined below:

(a) The generator with which the regulator is to be adjusted is installed on the low speed or high speed test stand mounting depending upon the speed range of the generator.

(b) Set the *core screw, rheostat,* and *pile screw* as described in method of adjustment for variable speed test stand (paragraph 11).

(c) Place regulator in test circuit.

(d) Open field rheostat-shorting switch, put all resistance in the circuit, and close the pile-shorting switch.

(e) Start the drive and cautiously adjust the field rheostat to give 125 volts.

(f) Open pile-shorting switch.

(g) Turn *pile screw* inward, going through characteristics as outlined in paragraph 11 (h) and setting value of voltage at minimum as in paragraph 11 (j).

(h) Reduce the field rheostat to zero, at the same time maintaining the point of minimum voltage by turning *pile screw* outward.

(i) Close field rheostat-shorting switch.

(j) Adjust *core screw* until voltage is 117 volts.

(k) Readjust *pile screw* for minimum voltage as in 11 (j).

(l) Apply *full* generator load to heat the regulator and allow it to heat for 30 minutes as in paragraph 11 (o). (On constant speed test stands it is not possible to adjust load and speed so that Ir volts is across the pile and full load is the hottest condition available.)

(m) Remove and apply full load and readjust *core screw* and *pile screw* to get a three-volt drooping characteristic of 120 volts at no load to 117 volts at full load.

(n) Check for stability with headphones.

(o) Now check regulation as follows:

(1) Remove load and stop stand.

(2) Regulated output voltage, as test stand is restarted without load, should not rise above 125 volts.

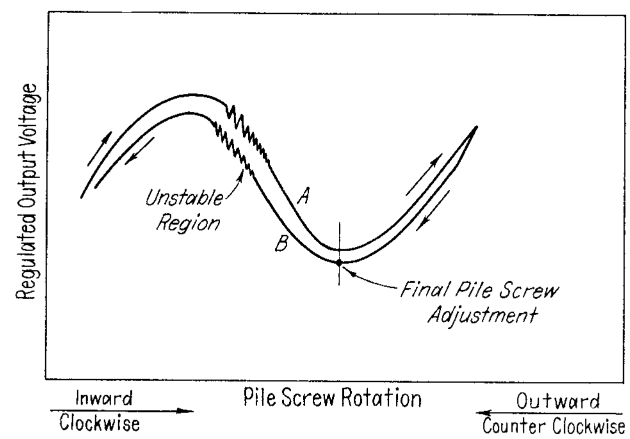


Figure 3—Curve showing the hysteresis effect of pile screw rotation (with or without load)

(3) With stand running, cycle full load, output voltage should return to its original setting of 117 volts at full load.

Note—A-C regulators will pass this test only if capacitance is within values recommended and regulator is hot.

Adjustment of A-C Regulators After Installation on Aircraft

It will probably be necessary to adjust the *rheostat* (see Figure 2) after installation of the regulator to compensate for the wiring of the aircraft and to obtain the desired system voltage. This adjustment is made with the aid of an accurate portable voltmeter connected directly to the regulator terminals as shown by Figure 1. It is essential that this final *rheostat* adjustment be made with the regulator hot.

The following procedure will give the desired results:

(a) Speed the engine at 1000 rpm for approximately 30 minutes to heat the regulator. This can be done while new or overhauled engines are given the one-hour run-in at 1000 rpm, put normal load (installed electronic equipment) on the generator and adjust the rheostat until the desired voltage is supplied. The desired value is usually 117 volts at the regulator so that approximately 115 volts will be obtained at the equipment.

If it is found impracticable to speed the engine as required by the above, it is preferable to install and operate the regulator on the test stand rather than to adjust the rheostat with the regulator cold. If the rheostat is not adjusted at the time of installation, it would be extremely desirable to do so during or immediately after the first flight (while the regulator is still hot).

The rheostat should *never* be readjusted in the aircraft after the initial adjustment. If the voltage is later found to have appreciably departed from the initially adjusted value, the regulator *must* be removed from the aircraft for complete readjustment on a test stand.

A great deal of experimental work has been conducted on carbon-pile regulators during the last several years by the manufacturers' engineers, ACG field technicians, BuAer representatives, and NRL engineers. This article describes the combined recommendations of these technicians and strict compliance with this procedure will result in satisfactory operation of the carbon-pile regulators.

DIFFERENCES BETWEEN VARIOUS ECLIPSE A-C CARBON-PILE VOLTAGE REGULATOR CONTROL BOXES

1001-2-A Lengthwise mounting holes 4.687 inches apart. Sidewise mounting holes 4.531 inches apart. Uses Type 986-4-A voltage regulator mounted on top. T.N. 58-44 recommends shockmounting.

1001-7-A Same as 1001-4-A but shockmounted.

1001-4-A Lengthwise mounting holes 5.000 inches apart. Sidewise mounting holes 5.000 inches apart. Uses Type 986-4-A voltage regulator mounted on top. T.N. 58-44 recommends shockmounting.

1001-8-A Same as 1001-4-A but shockmounted.

1322-1-A T.N. 58-44 recommends shockmounting. Uses Type 1317-1-A (132022) plug-in carbon-pile unit.

1322-3-A Shockmounted. Uses Type 1317-1-A (132022) plug-in carbon-pile unit.

1322-3-B Shockmounted. Uses Type 1317-2-A plug-in carbon-pile unit with mechanical stabilizer.

REPLACEMENT CARBON PILE FOR EACH A-C VOLTAGE REGULATOR

When carbon piles and carbon contact buttons of voltage regulators are broken or burned every effort should be made to obtain new parts through regular supply channels. The makeshift practice of sanding off burned carbon disks and contacts makes operation of the regulator erratic and frequent adjustments necessary.

The following chart shows manufacturer's part number of replacement carbon piles and carbon buttons:

Type Regulator Control Box	Type Voltage Regulator	Manufacturer's Part Nos.	
		Carbon Pile	Carbon Buttons
Eclipse 1322-3-A	1317-1-A	B-128203	B-126738
1322-3-B	1317-2-A	B-128203	B-126738
1001-2-A	986-4-A	B-96614	B-96611
1001-7-A	D-820604	B-96614	B-126738
1001-4-A	986-4-A	B-96614	B-96611
1001-8-A	D-820604	B-96614	B-126738

ADJUSTING A-C REGULATORS BY EXTENSION CORD METHOD

Voltage regulators should be adjusted on a variable-speed generator test stand having the same generator as there is in the airplane. But a variable-speed test stand may not be available.

It is very difficult to adjust voltage regulators in the airplane by running the engine because of the:

1. Inaccessibility of the voltage regulator in the airplane.
2. Vibration of the airplane.

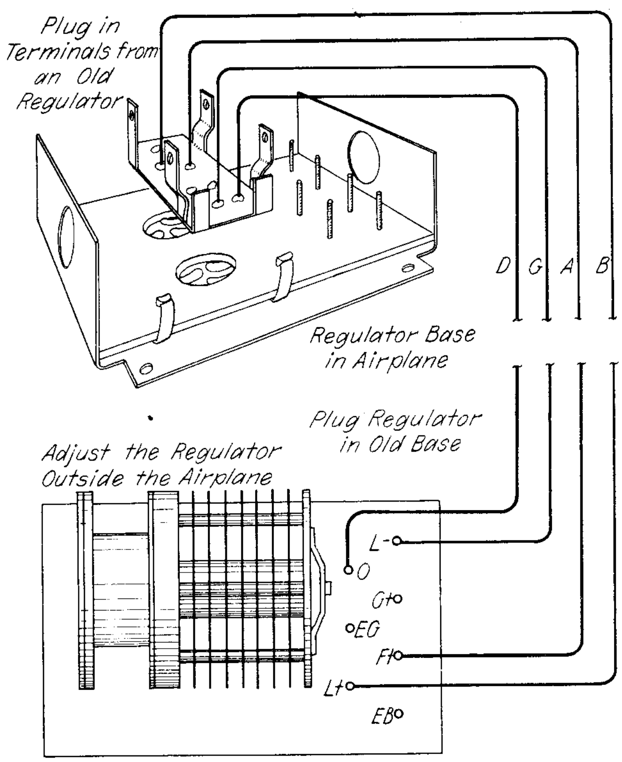


Figure 1—A-C 1322 Box (132022 or 1317-2-A Reg.)

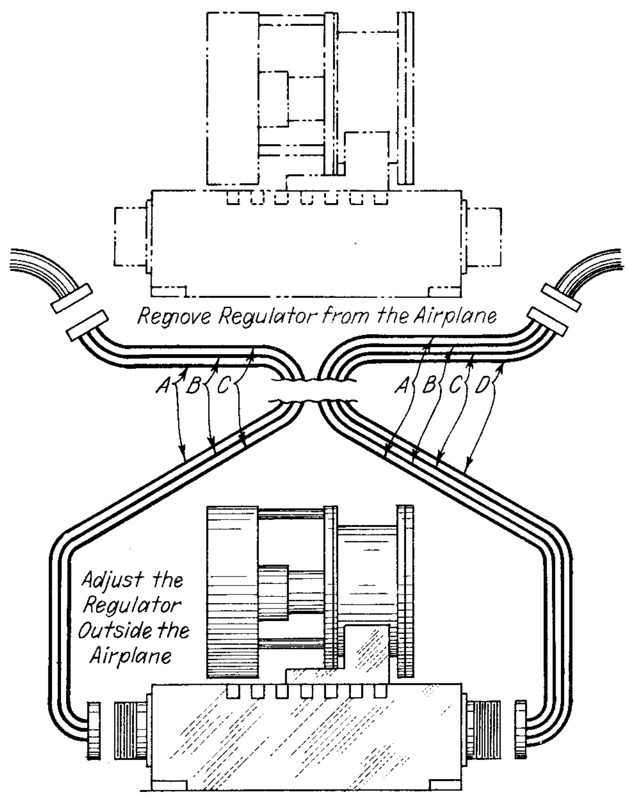


Figure 2—A-C 1001 Control Box

3. Noise in the airplane.
4. Air blast from the propeller.
5. Short time that an airplane engine can be "revved up" when on the ground.

All of these objections, except the last one, can be overcome by removing the voltage regulator from the airplane and adjusting it at the end of a 15-foot extension cord. This extension cord method can be used to good advantage on "jeep" carriers and at other activities where a variable-speed generator test bench is not available.

Large enough wire must be used in the extension cord so that there is no appreciable voltage drop in the cord. Wire size AN-12 is large enough for the field circuit. AN-18 is large enough for the other circuits.

Figures 1 through 4 show extension cord connections for the most common d-c and a-c regulators.

A system of hand signals must be agreed on so that the AMM in the cockpit will know when to "rev nu" the engine and when to apply load to the generator.