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Chapter 21
FREQUENCY REGULATORS, TYPE LKK-Z1

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LEADING PARTICULARS

Frequency regulator Type LKK-Z1	*Ref. No. 5UC/6160*
Regulated frequency at 115 volt a.c. output	*400 cycles per second*
Carbon-pile regulator	*"Newton" Type E/41259*
Weight of frequency regulator	*3lb. 3oz.*

Introduction

1. The frequency regulator Type LKK-Z1, is designed for use with the inverter Type D2 A2 and it is recommended that this chapter be read in conjunction with the appropriate inverter chapter to be found in A.P.4343B, Vol. 1, Book 3, Sect. 16. The function of this frequency regulator is to hold the frequency of the inverter at 400 cycles per second within the limits of ±5 per cent. The frequency regulator appears in a variety of forms, the differences between each are detailed in Appendix 1. General information on the principle of operation of carbon piles can be found in A.P.4343, Vol. 1, Sect. 6.

DESCRIPTION

General

2. The frequency regulator consists of a Newton carbon pile regulator mounted on an aluminium alloy base, designed for flexible mounting to minimize vibration. On the underside of the base are assembled the smoothing capacitor C2, for the operating coil of the carbon pile regulator, the potentiometer R10, together with four small germanium, junction-type rectifiers. These rectifiers are bridge connected, and supply a direct current for the operation of the carbon pile operating coil.

3. A parallel tuned circuit in the inverter control unit, comprised of the inductance L1, and the capacitor C1, is connected across phases A and B of the inverter. This tuned circuit is designed to resonate at a frequency of approximately 450 cycles per second. The inductance L1, is tapped in two places, and potentiometer R8 in the inverter control unit is connected across the last few turns so that, if necessary, the effective inductance may be varied slightly to assist in taking up the capacitor tolerance, or alternatively to

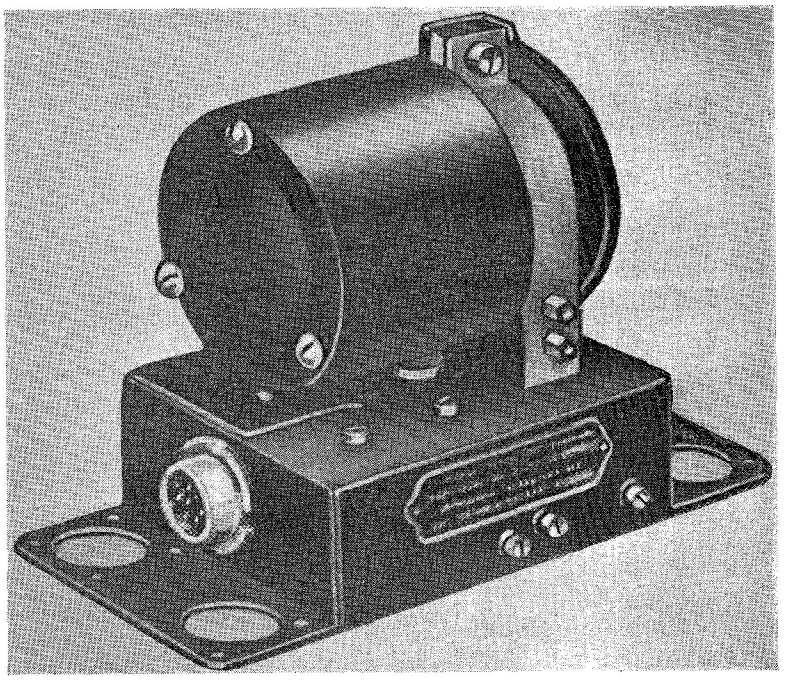

Fig. 1. General view of frequency regulator Type LKK-Z1

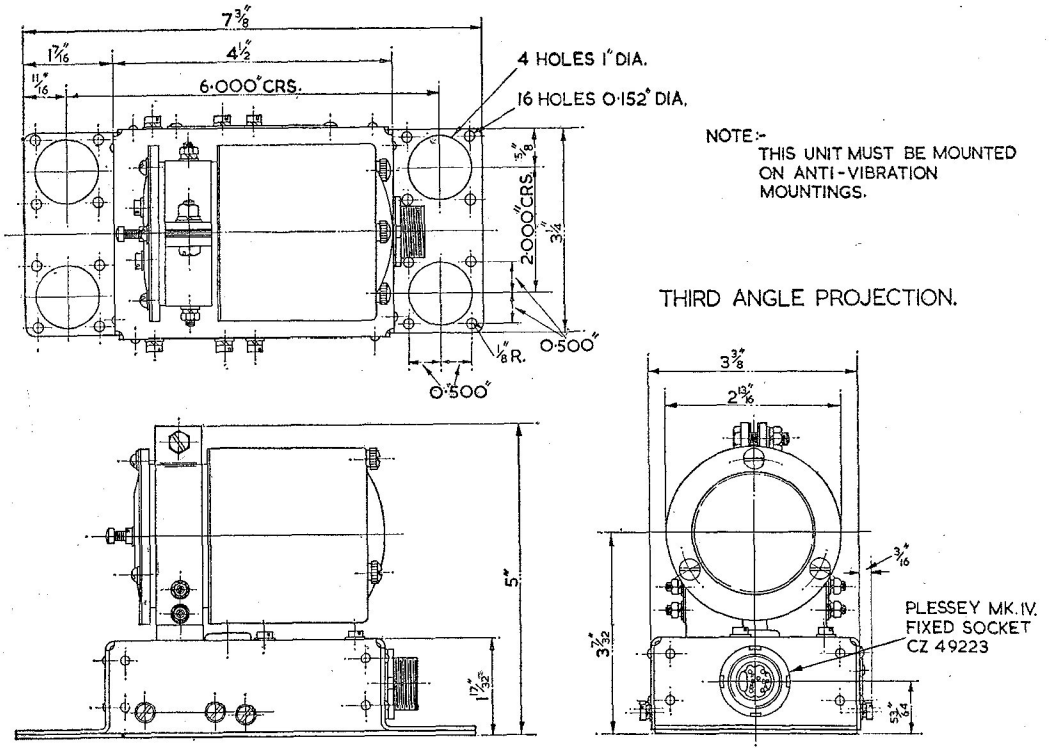

Fig. 2. Sectional views of frequency regulator

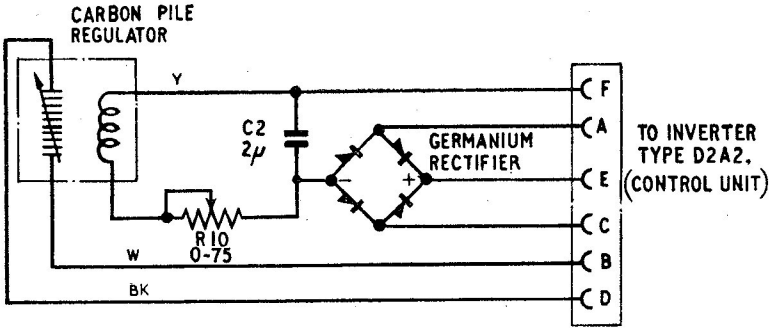

Fig. 3. Circuit diagram of frequency regulator Type LKK-Z1

give a fine speed control. An adjustable resistor R7, also located in the inverter control unit, is connected in series with this tuned circuit and is used to set the speed of the machine. The bridge connected circuit of the four germanium rectifiers completes the a.c. circuit. This rectified a.c. is applied to the carbon pile operating coil of the frequency regulator, the carbon pile is connected in the 28-volt d.c. supply circuit to the motor field of the inverter.

4. The potentiometer R10, enables the impedance of the control circuit to be pre-set, consequently any variations due to coil tolerances can be eliminated, and interchangeability of the frequency regulator is possible without extensive adjustment of trimmer resistances.

Screened cable

5. The frequency regulator is connected to the inverter control box via a 6 core screened cable. Pren 6 cable is recommended for this purpose. The resistance of B and D leads of this cable must be as low as possible and must not exceed 0·25 ohms. When, using Pren 6 cable the cable lengths must not exceed 15 feet.

OPERATION

6. Consider the case where the speed of the inverter falls, i.e. the frequency falls below 400 cycles per second. Since the parallel circuit has been tuned to a frequency higher than 400 cycles per second, the impedance of the tuned circuit will decrease as the frequency falls. This means that the current in the frequency regulator operating coil will increase, attracting its armature and causing the pressure to be relieved on the carbon pile. This increases the resistance in the motor field circuit of the inverter, thus decreasing the field current and tending to increase the speed of the machine.

7. Conversely an increase in frequency, which will not normally be permitted to exceed the resonant frequency of the control system, increases the impedance of the tuned circuit, and will consequently have the opposite effect on the motor field circuit, thereby decreasing the armature speed.

8. A stabilizing winding X–XX is wound on the main poles of the motor side of the inverter, and is in series with the operating coil of the frequency regulator carbon pile operating coil (*fig.* 4) and associated rectifiers. Any instability in the field current induces a voltage in the stabilizing winding; this voltage in phase opposition to the initial disturbances, energizes the coil of the frequency regulator, operating the carbon pile to dampen the disturbance. The possibility of the machine hunting is consequently eliminated. The action of this device is similar to that of the stabilizing transformer in the inverter control unit.

INSTALLATION

9. For duplication of supplies and maximum overall efficiency, a typical aircraft installation will generally require two of these frequency regulator units with their associated inverters. Overall dimensions of the frequency regulator are shown in installation drawing (*fig.* 2).

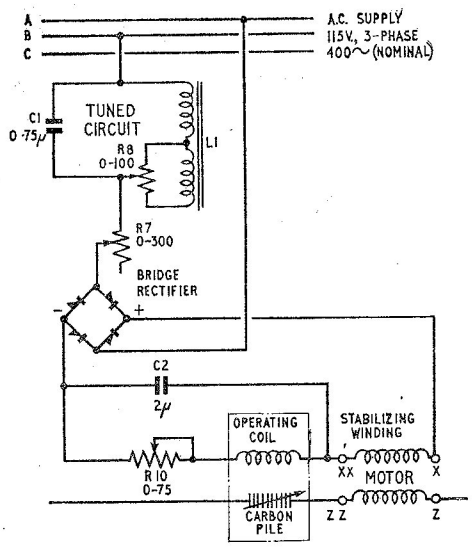

Fig. 4. Circuit diagram of frequency regulator and parallel tuned circuit and stabilizing winding in inverter

Note . . .

This frequency regulator must be mounted on anti-vibration mountings.

SERVICING

General

10. Examine the regulator for security and signs of damage, checking that the carbon pile is rigidly fixed to the base, tightening the 2 B.A. screw and nut which secures the clamping strap as necessary. Renew the miniature Mk. 4 socket if it is not in good condition. Blow dust and other foreign matter from the base of the unit with the aid of clean, dry compressed air. Examine all connections to ensure that the soldered joints are sound and the terminal nuts secure. All insulation covering on the connection leads must be undamaged. Examine the germanium rectifiers; if the white plastic cover which carries the type number and manufacturer's name shows signs of flaring outwards, it is an indication that over-heating has occurred and that the rectifier is faulty.

Testing of components

11. The condition of the rectifiers should be checked by measuring the forward and inverse resistance with a testmeter Type F. The forward resistance must be less than 20-ohms when using the 10,000-ohms range, and the inverse resistance must be greater than 30,000-ohms when using the 1-megohm range. Any rectifier suspected of being faulty must be renewed. Check the insulation resistance of the capacitor C2 with a 250-volt insulation resistance tester; the insulation resistance must not be less than 50 megohms. The value of capacitor C2 must be 2 microfarad $\pm$ 10 per cent.

12. ◀Adjust the potentiometer to set the resistance appearing across the terminals of C2 to 440 $^{+5}_{-0}$ ohms. Lock the potentiometer spindle with red, white or black celloluse paint. The insulation test, when measured between pins A, C, E and F joined together, and the unit case; between A, C, E and F joined together, and pin B; between pin B, and unit case, should not be less than 5 megohms.▶

Appendix A

STANDARD SERVICEABILITY TESTS for FREQUENCY REGULATORS, TYPE LKK-Z1

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LIST OF ILLUSTRATIONS

Introduction

1. The tests detailed in the Appendix may be applied to the unit before it is put into service, or at any time to determine its serviceability.

TEST EQUIPMENT

2.

For R.A.F. use	*Ref. No.*
Inverter test panel	5G/564
Motor Generator Type D2-A2	5UB/6339
Milliammeter 0-150mA ...	5Q/851H
For R.N. use	
Multimeter (complete with shunts)	0557/AP.48A
Rheostat	5G/4019
Variable reactive air cored load	5G/3723
Test set, frequency and voltage	5G/3626
Motor Generator Type D2-A2	5UB/6339
Testmeter Type "D"	5QP/10610
Relay Type "T" No. 1	5CW/4620
Switch AM Type "B" (S1)	5CW/543
Switch (S2)	

TEST PROCEDURE

Functional test

3. (1) Connect frequency regulator to an Inverter Type D2-A2 and check that the machine frequency is within the limits of 400 c/s ± 5 per cent under following conditions:—

25 and 28 volts input, no load
25 and 28 volts input, full load

(2) Check that machine will start satisfactorily, on no load, when switched on to supplies trimmed to apply 25V and 28V d.c. at machine terminals under final light load running conditions.

(3) Check that the machine will start satisfactorily onto the supply trimmed to apply 28 volts input to the machine terminals under final full load running conditions.

4. If the unit does not function within the limits indicated above, the following procedure should be adopted.

(1) Connect circuit as shown in fig. 1 for R.A.F. use, as shown in fig. 2 for R.N. use. Adjust the supply voltage to 28 volts d.c. and run at full load for 15 mins.

(2) Shut down. Open line B-B to carbon pile. Restart and control machine speed by adjusting supply voltage. Run on full load, adjusting frequency to 400 ± 1 c/s, output voltage to 115 volts r.m.s. Regulator coil current in line F-F should be $105 \pm \frac{1mA}{0}$. Adjust potentiometer R8 in inverter control box, if necessary.

(3) Shut down. Reconnect line **B-B** to carbon pile. Restart and apply full load. Adjust supply voltage to 28 volts d.c., and trim output voltage to 115 volts.

(4) Remove regulator stop screw. Adjust core plug to obtain frequency of 400 $\pm$ 2 c/s. Lock core plug.

(5) Running at full load, reduce voltage until field current in line B-B is 0·9A.

(6) Re-insert regulator stop screw. Screw in until screw is just in contact with pile armature. (This will be indicated by an increase in both field and regulator coil currents, and a fall in frequency.) Lock stop in this position.

(7) Recheck as indicated in Para. 3 sub-paras. (1) to (3).

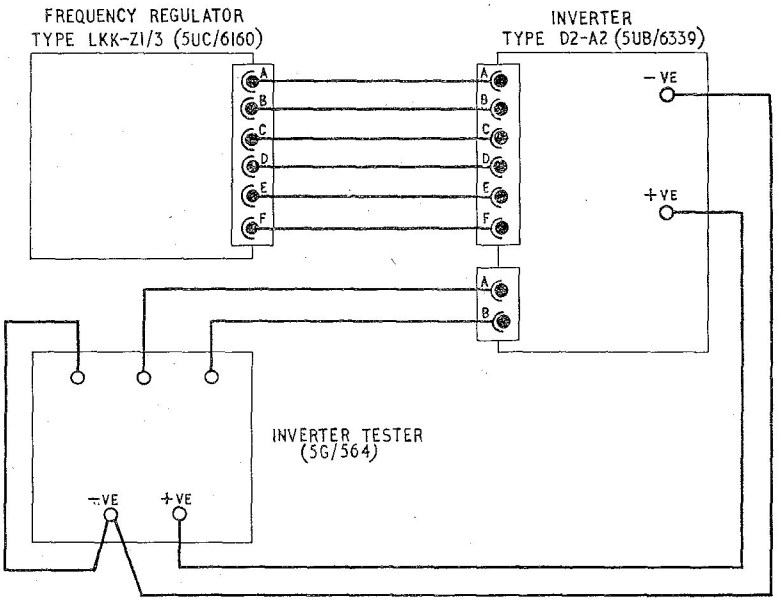

Fig. 1. Test circuit diagram (R.A.F.)

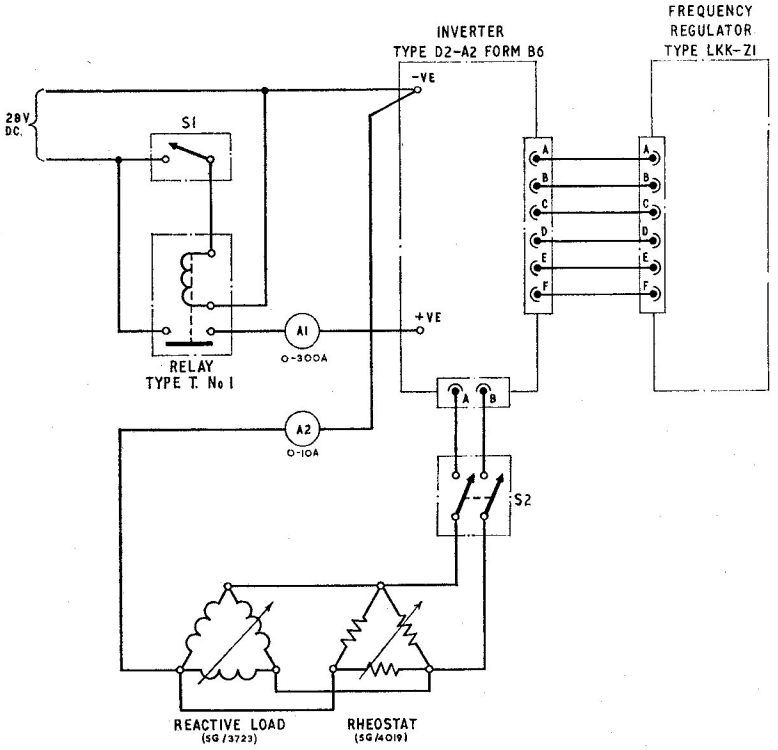

Fig. 2. Test circuit diagram (R.N.)

Appendix 1

FREQUENCY REGULATORS, TYPE LKK-Z1
VARIATIONS IN FORM NUMBERS

Form Z1/1—as described in the main chapter except resistor R10 is not fitted.

Form Z1/2—as described in the main chapter.

Form Z1/3—as Form Z1/2 with an improved type of rectifier fitted. This rectifier has better electrical qualities, and is more resistant to humid conditions.

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