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Lindsay, A. E.

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60-CYCLE POWER SUPPLY FOR AN/APR-9 RECEIVERS

A. E. LINDSAY

Declassified to:

ORIGINAL SIGNED BY

ORIGINAL SIGNED PAS

Authority:

S. A. MAYMAN

Date:

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ABSTRACT

A 60-cycle power supply for the AN/APR-9 equipment is described. Design considerations are discussed and circuit diagrams are included.

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FIGURES

60-Cycle Power Supply for AN/APR-9 Receiver:

1. Unit 1
2. Unit 2
3. Unit 3

60-CYCLE POWER SUPPLY FOR AN/APR-9 RECEIVERS

- A.E. Lindsay -

INTRODUCTION

The AN/APR-9 is a superheterodyne receiver covering the frequency range from 1.0 kmc/s to 10.75 kmc/s. The received signals are presented aurally, and visually by a panoramic oscilloscope which displays a 20-mc/s band of frequencies.

As this receiver was designed primarily for airborne use it requires a power source of 28 volts d-c and 115 volts at 400 cycles. Since 400-cycle power may not be readily available in most laboratories, a 60-cycle supply was constructed. Such a supply had been designed in the United Kingdom [1]. This design was modified to permit the use of American-type tubes and components.

GENERAL

No electrical changes were made in the receiver which would prevent alternative operation directly from the original 400-cycle supplies. A relay operated from the 28-volt d-c source was inserted in the 115-volt 60-cycle power supply to ensure that 60-cycle power could not be applied to the receiver in the absence of the 28-volt d-c power required for the latch on the rotor of the synchro motor. This was done to reduce the possibility of damage due to excessive current through the synchros in the event of the klystrons being tuned mechanically. Standard transformers and chokes were used wherever possible since the power supply was primarily for laboratory use. All transformers used in the modification were manufactured by Hammond Transformer Co., Guelph, Ontario. Transformer characteristics are given in Table I.

MODIFICATION OF R.F. TUNERS

The filament transformer in each tuner unit was changed to a type suitable for 115-volt 60- and 400-cycle input (see T15, Table I). It should be noted that one side of the secondary of the transformer that supplies voltage to the rotors of the synchros (T11a) is connected to the common side of the 115-volt a-c line (a-c ground). This was done to avoid the use of an additional wire and of an additional plug and socket connector. The voltage applied across the rotors in series was reduced from 115 volts at 400 cycles to 20 volts at 60 cycles in order that the current rating of the synchros will not be exceeded.

POWER SUPPLY OUTPUT REQUIREMENTS

Voltages and currents are tabulated below.

-1610 volts at 30 ma

- 1100 " " 10 ma

-650 " " 35 ma

+300 " " 200 ma

-250 " " 35 ma

+150 " " 70 ma

+105 " " 165 ma

115 volts 800 cycles, at 130 ma

20 volts a-c for the synchro generator and motor

6.3 volts a-c at 4.2 amp, one side grounded, for filaments
in the mixer-amplifier CV-43/APR-9 and indicator unit
1D226/APR-9

6.3 volts a-c at 2 amp, grounded center tap, for the above
units

6.3 volts at 0.60 amp, insulated for 2000 volts to ground, for
the type-3JP1 tube in the indicator.

CHASSIS REQUIREMENTS

The power supplies are mounted on three chassis.

Unit No. 1 is 18" x 18" x 10" overall, and weighs 90 lb. It contains the -1610, -1100, -650, +28 volt and filament supplies for the mixer-amplifier CV-43/APR-9 and indicator unit 1D226/APR-9.

Unit No. 2 is 18" x 12" x 8" high overall, and weighs 57 lb. It contains the +150 and +105 volt supplies. The 20-volt a-c source for the synchros, the 800-cycle oscillator-amplifier for the sweep motor in the mixer-amplifier, and also the sector sweep control circuit which was previously incorporated on the 400-cycle power supply P.P. 336/APR-9, are also on Unit No. 2.

Unit No. 3 is 18" x 12" x 8" high and weighs 45 lb. It contains the +300 volt supply, and a -250 volt supply which is not needed for the APR-9 receiver, but provides a reference voltage for the -1610, -650, +150, and +105 volt supplies.

The voltage-set potentiometers, voltage test jacks, and primary fuses were located on the skirt of each of the three power supply chassis.

INTERCONNECTING CABLES

As a large number of interconnecting cables were required, special care was taken in the arrangement of plugs and sockets to avoid shock hazard. Sizes and types of connectors were selected so that a cable could not be incorrectly connected, except for connectors No. 11 and No. 12, which must be polarized. See Tables II and III for details of connectors.

POWER SUPPLIES

Unit No. 1 (see Fig. 1)

The -1610 volt supply employs V1 and V2 in a full-wave rectifier circuit with an R-C filter. A 5000-ohm resistor is connected in each plate lead of the rectifier tubes to limit current surge. V3 is employed as the regulator and is controlled by V4 and V5 which are cathode-coupled.

The -1100 volt output is obtained from the -1610 supply by use of a cathode follower regulator (V6).

The -650 volt supply employs V7 and V8 in a full-wave circuit with an R-C filter. The regulator comprises V9 and V10 connected in parallel. The control tubes (V11 and V12) are cathode-coupled. Operation of this supply is the same as that of the -1610 volt supply. A 2-mfd capacitor is connected across the output to prevent high-frequency oscillation.

An interlock relay (Potter Brumfield No. 555D) is used in the primary circuit of the -1610 and -650 volt supplies to ensure that the +300 and -250 reference voltages are available before power may be applied.

A delay relay (Edison B2104) which is operated from the contacts of the interlock relay, is provided to allow a 30-second warm-up period for the klystron in the tuner. An additional 3-pole relay was added so that the +300, -250, and -115 a-c voltages would be applied to the -1610 and -650 volt supplies simultaneously. This prevents the control tubes in these supplies from drawing excessive current during the 30-second warm-up period.

The 28-volt d-c 1-ampere supply consists of a full-wave selenium bridge and an L-C, R-C filter. The secondary winding of transformer T6B was used as a choke, since a suitable choke was not available. This supply operates all the relays, panel lights, and the tuning motor. The filament supply, T3, T4A, T5A, T5B, for the tubes in the mixer-amplifier CV-43/APR-9 and indicator 1D226/APR-9 are located on this chassis. The filament voltage for the type-3JP1 cathode-ray tube in the indicator unit is also supplied from this chassis by the high voltage isolating transformer, T7, whose primary is connected to the 6.3-volt filament transformer T5B.

Unit No. 2 (see Fig. 2)

The +150 volt supply employs V16 in a full-wave circuit and an L-C filter with choke input. V18 is the regulator and is controlled by V17. A 2-mfd capacitor is connected across the output to prevent high-frequency oscillation.

The +105 volt supply employs V13 as the rectifier in a full-wave circuit, followed by an L-C filter with choke input, as well as a dropping resistor to keep the regulator tube within its rating. The operation of the voltage-regulating circuit is the same as that of the +150 supply.

Unit No. 3 (see Fig. 3)

The +300 volt supply employs V29 and V30 in a full-wave circuit, and an L-C filter with capacitor input. V31, V32 in parallel act as regulators, and are controlled by V33. The reference voltage is maintained by V34. A 2-mfd capacitor is connected across the output to prevent high-frequency oscillation.

The -250 volt reference voltage supply comprises V25 connected in a full-wave circuit, an L-C filter with choke input, a regulator tube (V26) and a control tube (V27). The reference voltage is maintained by V28. A 2-mfd capacitor is again used to prevent high-frequency oscillation.

SWEEP REVERSAL

The sweep reversal circuit comprises V23 and V24 in conjunction with relays SK5070 and SG8039 (see Fig. 2). A separate filament source, T4B, was provided for V23 and V24 to prevent any tendency for noise from these tubes to be coupled into the receiver. This section was formerly in the 400-cycle power supply unit PP336/APR-9.

800-CYCLE SOURCE

The 115-volt 800-cycle source for the sweep motor in the mixer-amplifier is shown in Fig. 2. V19, a dual-triode, is connected in a Wien bridge circuit whose output is coupled to V20, used as a phase splitter, which drives V21 and V22 in push-pull. Potentiometer, P6, in the grid circuit of V20 sets the output to 115 volts.

PRELIMINARY TESTING

Before connection to the AN/APR-9 receiver the power supply should be interconnected and resistive loads should be placed on each output and all voltages adjusted to the proper level. Then the supply may be connected to the AN/APR-9 receiver and the voltage checked again at the jacks and reset, if required.

COMMENTS

Power supply voltages, from no load to AN/APR-9 receiver load, remained substantially constant, indicating satisfactory load regulation. Line voltage variation of $\pm 10\%$ produced a maximum change of 0.3% in output voltages.

Overall performance of the AN/APR-9 receiver is improved by substitution of the 60-cycle power supplies, as there appears to be less noise in the audio and video systems. Previously, when operated with the 400-cycle power units, considerable ripple voltage was noticeable on the d-c leads in the audio and video systems and this made it difficult to detect small signals.

ACKNOWLEDGMENT

The author is indebted to Mr. W.L. Haney and Mr. A. Staniforth for many helpful suggestions in carrying out this project.

Reference

1. GCHQ Technical Report No. 104, 1957 (Confidential)

TABLE I

TRANSFORMER CHARACTERISTICS

T1	Hammond No. 13422 (Special) Primary 0, 110, 115 V 60~ Secondary 2500-2000-0-2000-2500 V .075 amp
T2	Hammond No. 724 Primary 115 V 60~ Secondary 750-0-750 V .200 amp
T3	Hammond No. 1125 Primary 0, 100, 115 V 60~ Secondary 5 V 13 amp CT; 5 v 13 amp CT Insulation 3000 V
T4a, T4b	Hammond No. 167D Primary 115 V 60~ Secondary 6.3 V 2 amp CT
T5a, T5b	Hammond No. 1128 (40147) Primary 0, 100, 115 V 60~ Secondary 6.3 V 5 amp Insulation 2000 V
T6a, T6b	Hammond No. 26434 Primary 0, 105, 115, 125 V 60~ Secondary 35 V; Output 35 VA
T7	Hammond No. 43418 Primary (Special) 6.3 V 60~ Secondary 6.3 V 1 amp Insulation 3000 V
T8	Hammond No. 278 Primary 115 V 60~ Secondary 400-0-400 V .200 amp; 5 V 3 amp CT; 6.3 V 6 amp CT

Table I (cont)

T9	Hammond No. 272 Primary 115 V 60~ Secondary 310-0-310 V .070 amp; 5 V 2 amp; 6.3 V 2.4 amp
T10	Hammond No. 1635 P.P. 6L6, 30 watts, 5000 CT Primary; Output Taps 4, 8, 15, 250, 500 V
T11a	Hammond No. 1136
T11b	Hammond No. 42530 Primary 0-100-115 V 60~ Secondary 5 V 3 amp CT; 6.3 V 5 amp CT; 6.3 V 5 amp CT; Insulation 2500 V
T12	Hammond No. 275 Primary 115 V 60~ Secondary 400-0-400 V .135 amp; 5 V 3 amp CT; 6.3 V 5 amp CT
T13	Hammond No. 710 Primary 115 V 60~ Secondary 375-0-375 V .300 amp
T14	Hammond No. 165 Primary 115 V 60~ Secondary 2.5 V 3 amp; 2.5 V 3 amp; Insulation 1000 V
T15	Hammond No. 45691 Primary (Special) 115 V 60~/400~ Secondary No. 1 6.3 V 1 amp To replace Secondary No. 2 6.3 V 1.5 amp filament transformer Insulation 2000 V in tuners

TABLE II
TYPES OF CONNECTORS MOUNTED ON CHASSIS

Connector Number	Connector Type		Connector Number	Connector Type	
(see Fig. 3)					
1	Cannon	RSK-M10-31SL	9	Cannon	WK-S5-32SL
2	"	RWK-6-31SL	10	"	RWK-4-31SL
3	"	WK-4-32SL	(see Fig. 1)		
4	"	RWK-M2-31SL	11	Winchester	202B-MOD-3102A36
(see Fig. 2)			12	"	202B-3102A36
5	Amphenol	AN3102A-32-7P	13	Cannon	RWK-S5-31SL
6	"	AN3102A-28-12S	14	"	SK-19-32SL
7	Cannon	RSK-19-31SL	15	"	RSK-C6-31SL
8	"	SK-M10-32SL	16	"	WK-3-32SL
			17	"	WK-6-32SL

TABLE III
TYPES OF CONNECTORS MOUNTED ON CABLES

Connector Number	Connector Type		Connector Number	Connector Type	
(see Fig. 3)					
1	Cannon	RSK-M10-23C- $\frac{5}{8}$	9	Cannon	WK-S5-21C- $\frac{3}{8}$
2	"	RWK-6-21C- $\frac{3}{8}$	10	"	RWK-4-21C- $\frac{3}{8}$
3	"	WK-4-21C- $\frac{3}{8}$	(see Fig. 1)		
4	"	RWK-M2-21C- $\frac{3}{8}$	11	Winchester	201B-MOD/3106B-36 * Cable Clamp AN3057-24 *
(see Fig. 2)			To Tuner P101	Winchester	212B-MOD/3106B-36 * Cable Clamp AN3057-24 *
5	Amphenol	AN3106B-32-7S * Cable Clamp AN30-57-20 *	12	Winchester	201B/3106B-36 * Cable Clamp AN3057-24 *
To Remote Control P1301	Amphenol	AN3108B-32-7P * Cable Clamp AN3057-20 *	To Indicator P601	Winchester	202B/3106B-36 * Cable Clamp AN3057-24 *
6	Amphenol	AN3106B-28-12P * Cable Clamp AN3057-16 *	13	Cannon	RWK-S5-21C- $\frac{3}{8}$
To Mixer P514	Amphenol	AN3106B-28-12S * Cable Clamp AN3057-16 *	14	"	SK-19-23C- $\frac{5}{8}$
7	Cannon	RSK-19-21C- $\frac{5}{8}$	15	"	RSK-C6-21C- $\frac{5}{8}$
8	"	SK-M10-23C- $\frac{5}{8}$	To Remote Control P1302	Amphenol	AN3106B-22-12S * Cable Clamp AN3057-12 *
			16	Cannon	WK-3-21C- $\frac{3}{8}$
			17	"	WK-6-21C- $\frac{3}{8}$

* Supplied with AN/APR-9 equipment

NOTE

If Thompson Products power switch and radio relay (C4B4GB) is used in installation, the following additional power connectors and clamps will be required.

Winchester Connectors: 202B-MOD/3106B-36 (four); 201B-MOD/3106B-36 (four)

Cable Clamps: AN3057-6 (one); AN3057-8 (one); AN3057-24 (eight)

Amphenol Connectors: AN3106B-14S-5P (one); AN3106B-16S-1S (one)

