

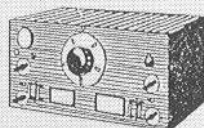
THE COMMUNICATION RECEIVER

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THOSE NATIONAL POWER SUPPLIES

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INTRODUCTION

The National Company, Inc. (the proper name of the company, formally adopted in 1932) of Malden, Mass. was in the radio business from the early years, having started in 1924 by making components for the Browning-Drake broadcast tuner. The business prospered and over the next 15 years National became a world leader in the design and production of communications receivers, components, and associated products.

James Millen, who had started with National in 1926 as radio consultant, quickly became the chief engineer and general manager. In fact, he was the guiding light and "spark plug" of the company. While he had helped put himself through college by writing for various publications about "radio" subjects, his formal training was as a mechanical engineer, and the National product line reflected this background.

The people at National were also experienced in making products involving mechanical engineering. They merged their machine-shop expertise into the rapidly developing field of radio, and, under Millen's guidance, produced a constant stream of innovative products of high quality. These items, unique in the field in ap-

pearance and construction, emphasized the emerging science of shortwave communication. This emphasis continued after Millen left National in 1939 to start his own company.

THE EARLY YEARS

Millen's early experimental work had convinced him that receivers for shortwave use should have isolated power supplies. For decades, National receivers were designed around this principle (see the ad in *QST* for October, 1934 for background). This article began as an effort to sort out the vari-

POWER SUPPLIES FROM NATIONAL

This list covers the principal units. Lesser known supplies, and most of the variations such as 220-V or 25-Hz inputs, are not listed. Rack-mounted supplies are noted; the others are the "doghouse" table design. Year shown is approximate.

DESIGNATION	YEAR	NOTES
7180	1927	Heavy-duty "B" eliminator. The first "doghouse."
7180-AB	1927	"B" voltages + 2.5 & 5 V filament windings.
3580 Velvet B	1929	3 adjust. + 1 fixed "B." For the SW-4 Thrill Box.
SW-5 Power Unit	1930	Low-hum. Product of Millen/Kruse research.
5880-AB	1931	4-prong power socket; for HF receivers like SW-3.
5880-AB-S	1932	5-prong socket with 2 "B" voltages. For the SW-58, ACSW-45.
GR-SPU	1932	Rack-mounted. For AGS; later the HRO.
GR-DPU	1932	Rack-mounted. Double supply; for 2 receivers like AGS/SW-58C.
5887-AB	1933	For the FB-7; 180 VDC, 2.5 VAC.
5897-AB	1933	For FB-7, HRO, HRO Jr.; 240 VDC, 2.5 VAC.
5886-AB	1933	For 6-V receivers (SRR, 1-10, etc.); 180 VDC.
SPC	1936	Rack unit: combo speaker, power, coils for HRO.
686	1939	Vibrator pack, 6-V; 165 VDC @ 50 mA. 6X5 or 0Z4 tube. #1286 for 12 V.
SPU-686	1939	Rack version of the 686.
697	1939	Same as #5897, except 6.3 VAC.
SPU-697	1939	Rack version of the #697.
5856	1939	For the NHU receiver; 200 VDC, 6.3 VAC.
CNA-20090	1939	For the Navy RAS version of the HRO; rack-mounted. 5Z3 tube.
CNA-20089	1939	25-Hz version of CNA-20090.
5886 Version II	1941	General utility pack; 240 VDC, 6.3 VAC.

ous National supplies, which are so similar in appearance as to be confusing. Sources consulted included National catalogs, instruction manuals for the various receivers, and advertising covering the years 1927-49 in *QST* and the ARRL Handbooks.

While some inconsistencies were noted, the following material fairly represents the National stable of power supplies through 1950, and should serve as a guide in their proper use. National receivers should be matched to the correct power supply to avoid equipment damage.

The power supplies were either table-mounted (nicknamed the "doghouse") or rack-mounted. All were of high quality, heavily constructed, replete with mechanical and electrical innovations. The sequence of development followed the general progression of receiver power supplies, starting with "B" eliminators (so-called "Socket Power"), then to combined packs which supplied 2.5 VAC for the new AC tube heaters as well as the B+, to the supplies which powered receivers with 6-V tubes. Other variations and combinations were available: 220-VAC or 25-Hz sources, combined packs supplying both 2.5- and 6-V heaters, etc.

The "doghouse" design first appeared in 1927 in the National-B Type 7180 heavy-duty "B" battery eliminator. While other manufacturers were offering battery eliminators, the National product was marketed as "an entirely new and unique heavy duty better-B . . . a strictly heavy-duty power unit" (National Bulletin Q-123.) Four B+ voltages were available, three adjustable and one fixed at 180 V (at 70 mA) with terminal posts on a sloping panel. The distinctive heavy steel cover could be removed easily. This unit was in due course designated the Super Velvet-B Type 7180 (Bulletin 144), with four adjustable B+ taps off a common

14,000-ohm 25-watt resistor, with each tap individually filtered.

Another version, the "AB" 7180, designed for AC-tube receivers, had two 2.5-V and one 5-V winding in addition to the B+ taps.

The National Velvet-B, also in "doghouse" style but somewhat smaller, was announced in January, 1929 (Bulletin 132.) It provided three adjustable voltages and one fixed (180 V) suitable for one- to six-tube sets. In due course it was termed the Velvet-B Type 3580 (Bulletin 144.)

The first table supply in 1927 established the physical design which prevailed for many years. The rectifier, a UX-280 (later 80; not changed to a 5Y3 until after WW II), hung upside down inside the case and was accessible through the bottom. In the beginning the transformer, choke and filter-capacitor modules were tar-encased, following prevailing practice, and the switch was part of the cloth-covered line cord.

At the same time, National was rapidly building its reputation as a supplier of distinctive and high-quality parts. The older catalogs and advertising present a line of power-supply components, uniquely National in appearance.

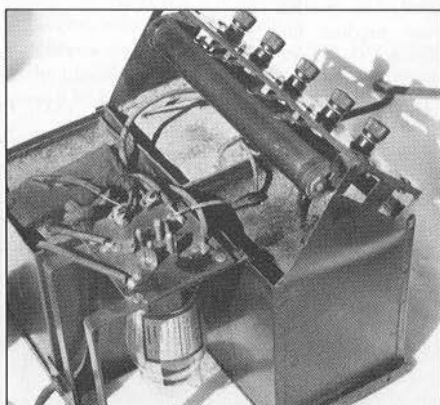
The Type 3580B power unit was listed in the 1930 ARRL Handbook, 6th Edition, for use with the National SW-4 screen-grid shortwave receiver.

THE SW-5 AND FUNDAMENTAL RESEARCH

In 1930 the National ACSW-5 "Thrill Box" shortwave receiver was announced, firmly establishing Jim Millen and National as experts in the art of short-wave reception. Copyrighted by National in 1930, "The Manual of Short Wave Radio," compiled and edited by Zeh Bouck with 11 contributors, included a key article by Millen and Robert S. Kruse titled "An Analysis of AC Operat-



National 7180 B-eliminator. The four voltages are set by rockers above the terminals.



Inside the 7180. Parts are potted in tar, the tube socket is marked RECTRON, and the voltages are tapped off a common resistor by rotating sliders. Note the line-cord switch.



The 5880 Velvet AB supply, as used with the early Thrill Box receiver. Nameplate proclaims "ESPECIALLY DESIGNED FOR SHORT WAVE RECEPTION."

ed Short-Wave Receiver Design." This had first appeared in the June 1930 issue of *Radio News*, and included discussion of the AC power supply as an important element of the system.

Briefly, one of the design parameters of the ACSW-5 was hum-free operation on the short waves, much more difficult to achieve than in BC-band receivers. After a year of laboratory work, Millen and Kruse announced that they had achieved this goal, and the end result was, indeed, totally hum-free operation. The features of the power supply included (1) separate from receiver, and at least three feet away; (2) completely shielded, with a steel cabinet to exclude stray low-frequency magnetic fields; (3) Low inherent hum in the output . . . at least a double-section filter with good quality chokes and plenty of condenser capacity; (4) The transformer to have an electrostatic shield between the windings, isolating the set from line disturbances; (5) An RF filter (RF choke and 0.01- μ F mica bypass) in the output of the rectifier tube; (6) Voltage dividers in the receiver, not the power supply, to eliminate RF or common coupling from the power supply.

Some physical changes appeared in the table power packs about this time. While the doghouse design remained, the individual taps of the "B" eliminator were replaced with a four- or five-pin socket, depending on the receiver model. Some time later the AC cord in-line switch was replaced with a panel-mounted toggle unit.

The SW-5 power unit supplied 180 VDC and 2.5 VAC for the heaters. The term "tunable hum" was used for the first time, referring to a type of hum having its origin in the power line. Readers who wish to read more about the SW-5 and its powering are referred to the Kruse article in the January



The 5897 Velvet AB supply, designed for the FB-7. Nameplate announces "ESPECIALLY DESIGNED FOR THE FB-7 RECEIVER." This particular unit was shipped with an early HRO.

1931 issue of *QST*, and to John Nagle's classic article in *CQ* for November 1978.

THE EARLY THIRTIES

In April 1931, a National *QST* ad listed the low-hum 5880 power unit, designed for high-frequency work. In writing this article I ran into some confusion regarding this model. One version (see photo) has a four-prong socket (original equipment, riveted in place), while the instruction book for the ACSW-58 amateur receiver, copyrighted 1932, clearly shows a five-prong socket on a Type 5880. The distinction seems to be in the power demands of the SW-58; the 5880-AB (four-prong socket) was the norm, and could be used with the new SW-3 and other regenerative receivers, while the SW-58 used push-pull 45s in the output, and required both 180- and 300-VDC sources. This supply was designated the 5880-AB-S, and had a five-prong socket. This unit could also be used with the ACSW-45.

Both supplies, incidentally, were available in either 110- or 220-V versions; also, 25-Hz models were listed. The catalog designations were 5880-AB, 5880-AB-25, 5880-AB-220, 5880-AB-S, and 5880-AB-S25. While the type may be listed on the label, check carefully if you wish to use one of these supplies. You may find a 750-ohm bias resistor for the P-P 45s in the filament center tap if you have the -S model.

The specifications for the 5880-AB were plate supply 180 V at 30 mA, and heaters 2.5 VAC at 8.75 A. The circuit included a double-section hum filter, an RF filter, an electrostatic shield around the primary, and balancing resistors across the filament windings. In the 5880-AB-S supply it would appear that the higher voltage was tapped off the junction of the two filter chokes.

All supplies, incidentally, were manufactured under license from RCA, and all advertising and even the product labels carried this notation. National was fortunate in having the RCA license, and it became of considerable value as their product line expanded. Nagle's *CQ* article discusses this point.

Following a detailed description by Millen in the September, 1931 issue of *QST*, the famous SW-3 receiver was announced the next month. The AC version used the Type 5880 power pack, and the advertising emphasized hum-free operation. The pack listed for \$34.50 and was sold by the Leeds mail-order supply house for \$19.00, still a considerable sum in those days. As a consequence, many SW-3 purchasers tried to economize by building their own supplies from old receiver components, not always with satisfactory results. As with the later FB-7 and the HRO, it was necessary to have 2.5 V at the tube sockets, and the voltage drop in the power cable could lead to low filament voltage and erratic receiver operation. This was discussed by Millen in the second of his famous "letters" in *QST* in the April, 1934 issue.

THE AGS AND FB-7 RECEIVERS

The AGS airport receiver was announced in October, 1932, and with it the first (that this writer has encountered) of the rack-mounted supplies, the GR-SPU and GR-DPU units. The initials stand for Ground Radio - Single (Double) Power Unit. To explain the dual unit, the AGS was often paired with the SW-58C, a regenerative stand-by receiver. A single power panel, similar to that pictured below, housed two separate power supplies. These could assume several forms, depending on receiver heater requirements; either 2.5 or 6 V or a combination. Catalog ordering designations were GR-DPU2/6, GR-DPU6/6, and so forth. The same approach was used with the -SPU model.

The inside of the -DPU version is pictured below, and a circuit diagram is available in Rider's Vol. 3. Two 15-Hy chokes were combined with three 8- μ F filter capacitors. The specs on these

units were the same as for the 5880, 5886, or 5897, whichever was ordered at the time. They are substantial and can be used on the FB-7 and the HRO as well as the AGS. Again, watch the heater voltage.

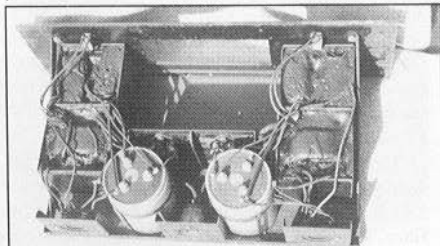
The FB-7 was announced in March, 1933, and with it the new 5887 power pack. This unit was lower priced than the 5880 (which could also be used), as the FB-7 did not require the degree of filtering that the earlier regenerative receivers needed. The 5897 AB supply was also designed for the FB-7, providing a higher plate voltage (around 240 V) to power the 59 output tube for maximum audio.

The National ad in the October, 1933 issue of *QST* (Bulletin 220) is a goldmine of information on the National power supplies to date. The 5886-AB pack was listed for the three-tube SRR high-frequency receiver, which had the relatively low power demands of 6 V AC at 0.9 A for the heaters, and 180 VDC. However, it apparently had enough capacity to operate the HRO (see below.)

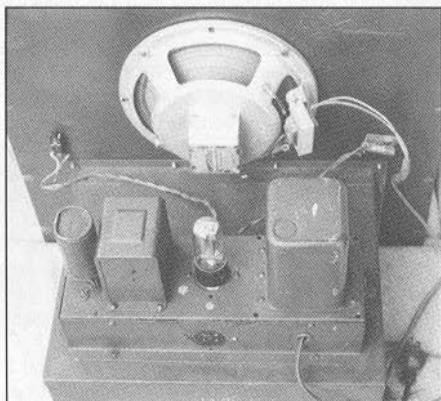
POWERING THE HRO

In October, 1934 the most famous National receiver, the HRO, was announced (Bulletin 240, reproduced in *QST*, October, 1934.) Initial shipments of the HRO were made with the FB-7 supply 5897-AB. The 6-volt version of the HRO would work with either the AGS rack supply or the Type 5886 pack. The 5887 and 5880 packs could be used, but were not recommended. The HRO Jr. (February, 1936) also used the 5897-AB supply.

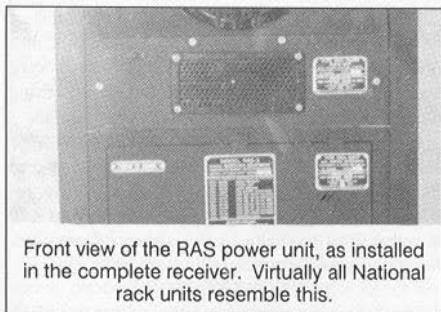
Unfortunately, within a short time of the introduction of the HRO, a modulation hum around 15 MHz was discovered when six-volt tubes were used with the AC pack. Not until better tubes were introduced in 1939 was this defect remedied. In the mean time, batteries were suggested for tube



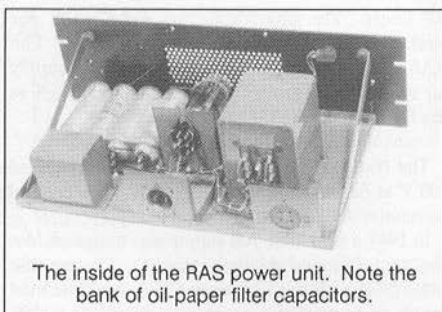
The original GR-DPU for the AGS and SW58-C combination, less tubes and front cover. Note the "Mershon"-style capacitors.



An SPC combination rack unit for use with the HRO. The power transformer and speaker have been replaced.



Front view of the RAS power unit, as installed in the complete receiver. Virtually all National rack units resemble this.



The inside of the RAS power unit. Note the bank of oil-paper filter capacitors.

heaters when using six-volt tubes in the HRO.

Millen deviated from his strong views on external power supplies in designing the NC-100 series of receivers, first announced in 1936. The common explanation is that the high power requirements necessitated an internal supply, but since he was aiming at a broader market than amateurs and SWLs, it is probable that he was considering consumer resistance to the external pack with its dangling cable and other complexities. Whatever the reasoning, the NC-100 and its siblings were a resounding success.

Another sidelight to the power-supply story was the introduction of the combination panel unit for use with the HRO, the SPC (Speaker-Power-Coils). National also sold the special relay rack, the MRR, for \$13.50 list. The postwar HRO-5R rack-version receiver had an SPC option.

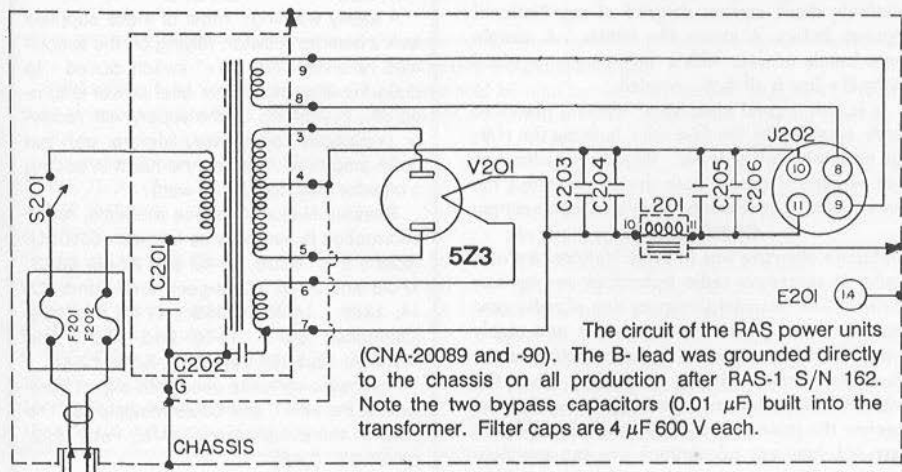
In April, 1939 National finally approved the use of 6.3-V AC tubes in the HRO. The 697 power unit was recommended, the same as the 5897 but with a 6.3-V heater winding (specs: 115-V 60-Hz input, 6.3 VAC at 3.4 A, 240 VDC at 75 mA). It listed for \$29.50, including, at long last, the tube! There was also a rack version of this supply, the SPU-697.

As National receivers spread across the world of shortwave communications, a demand arose for power supplies for emergency work. Catalog 300L mentions a 6-V vibrator pack, the Model 686, which could power National AC receivers, including the HRO, NC-100, SW-3, and NC-200, from a standard car battery. Versions included the 686-S and the SPU-686-S. These produced 165 VDC at 50 mA. Models for 12 volts were available and are covered in Rider's.

THE NAVY RAS RECEIVER

An unusual and still little-known version of the HRO was the model designed for the U. S. Navy in the late 1930s, the RAS. This receiver was essentially an HRO Jr. with a 175-kHz IF for marine use and with a full set of coils, all mounted in a massive desk rack. The 115-V power supply (see photos) was designated CNA-20090 (60-Hz) or -20089 (25-Hz). Specs were 240 VDC at 70 mA and 6.2 VAC [yes, 6.2!] at 3.4 A, with a power consumption of 70 watts.

Construction was heavy, with high quality components as with most National gear, but with military requirements added. Both sides of the primary were fused, the transformer (see diagram) had an electrostatic shield, and C201 and 202 are



The circuit of the RAS power units (CNA-20089 and -90). The B- lead was grounded directly to the chassis on all production after RAS-1 S/N 162. Note the two bypass capacitors (0.01 μ F) built into the transformer. Filter caps are 4 μ F 600 V each.

RF filters. The filter capacitors were paper, not electrolytics, and are still likely to be good. The RAS power unit is a fine general-purpose supply for any of the common National receivers such as the HRO or FB-7.

MISCELLANEOUS

The National VHF receiver, the NHU, required 200 V at 65 mA and 6.3 VAC at 3 A. The manual recommended the Type 5856 table supply.

In 1941 a new 5886 AB supply was designed, less the center-tapped heater resistor. To use the older 5886 with the Universal SW-3, it will be necessary to remove this resistor to eliminate the B-connection to the heater circuit.

The 5886 is one of the basic utility supplies and is found in different versions. In addition to those mentioned above, the postwar model was finished in smooth gray enamel, used a 5Y3 rectifier, and often had a 110-220 V switch inside the cabinet. It was also used to power the 1-10 VHF receiver.

Immediately postwar (in January, 1946), the HRO-5 was announced, paired with the 697 power unit. In August, 1947 the HRO-7 was advertised, and a subsequent ad shows the HRO-7C in a table rack with the SPC-1 combination unit. Then, in November 1949 the HRO-50 appeared with a built-in supply. This was the beginning of the end for the external power supply and the "doghouse."

ON RESTORING A NATIONAL POWER SUPPLY FOR ACTIVE USE

It is feasible to restore these units electrically using standard techniques. However, many of the components are "period" and quite distinctive, especially the filter capacitors. I prefer to leave these physically in place and wire small modern cartridge electrolytics into the circuit. Unfortunately, many of the original National transformers have burned out and have been replaced (see the SPC photo). In order to preclude this I routinely check current demand of any National receiver before it leaves the bench. A simple male-female adapter with a 100-mA meter wired in the B+ line is all that is needed.

It is also a good idea, when applying power to these supplies for the first time, to bring the voltage up slowly with a Variac. Monitoring voltage as well as current checks both the receiver and the power pack. Ripple can be measured with a scope.

CONCLUSION

Millen's objective was to make National a world leader in shortwave radio technology and he succeeded. The National Company line of radio gear and associated products were unique and highly successful for many years. Today collectors recognize these items as highly desirable. When the original accessories are included with a National receiver the price paid rises dramatically. While I have not done any calculations, one can speculate that a significant part of National sales (perhaps

half?) came from components and accessories: the power supplies, loudspeakers, extra coils, and other gear. Unfortunately, the sales records were destroyed years ago, and we are left with nothing more than speculation, and perhaps testimonials.

But we are fortunate to have the products to work with and enjoy. National is a big story, and the power supplies very much a part of the receiver technology. If anyone has anything to add or corrections to make to the above information, the writer would appreciate hearing from you.

ACKNOWLEDGMENT

The writer expresses his appreciation to AWA member Paul Bohlander, W3VVS, for allowing review of his notes on National power supplies in preparation of this article.

MORE ON NATIONAL SUPPLIES

The list below may be helpful in matching a National receiver with the right power unit.

1-10, 1-10A	5886
ACSW-3 (2.5 V)	5880-AB
ACSW-45	5880-AB-S
AGS	GR-SPU or GR-DPU
FB-7	5887-AB or 5897-AB
HFS	5886 or 686S
HRO (2.5 V)	GR-SPU or 5897-AB
HRO (6 V)	5886-AB or 697
HRO (12 V)	1286
HRO-5R	SPC (option) or 697
HRO Jr. (2.5 V)	5897-AB
NHU	5856
RAS	CNA-20090 (or -20089)
R-211/U	SPU-697
SRR	5886-AB
SW-3U (6 V)	5886
SW-4	3580
SW-58	5880-AB-S
SW-58C	GR-DPU

A safety warning: most of these supplies lack a bleeder resistor, relying on the associated receiver - with "B+" switch closed - to drain the filter capacitors after power is turned off. In working on the supply with receiver unplugged, an unwary restorer can get quite a surprise. There's no harm in adding a bleeder (say, 220 K 1/2 watt).

Besides National service manuals, repair information is available as follows: **GRDPU**, Rider's 3-1; **650S**, 21-49 and 22-46; **686S**: 17-28 and 22-5 (Changes), and Sams 62-14; **1286**: 14-35; **1286S**: 17-28 and 22-5 (Changes); **697**: 14-35 and 17-21, and Sams 50-12; **5886 Version II**, Sams 62-14.

For the power units used with export versions of the HRO, see Louis Meulstee's "The HRO in the British Army," *OTB*, Feb. 1992, pp. 21-23. (LAS)