

THE SW-3: PAN AMERICAN AIRWAYS (PAA) FIRST “AIRPORT RECEIVER”

A quest for the elusive SW-3.

“**T**he SW-3 was designed in the late 1920s, with product development that would appeal both to the radio amateur and be adaptable for use by the airlines as a reliable, light-weight receiver for commercial aircraft. Pan American Airways (PAA) was looking for such a unit for their early flights to South America.¹

Before the SW-3, National² produced and sold three earlier regenerative shortwave receiver model each marketed as a “Thrill-Box.” In order, they were: 1) the SW-2 (a two-tube unit, introduced late 1927 or early 1928); 2) the SW-4 (a four-tube unit, introduced in 1929, with single-ended audio output); and 3) the SW-5 (a five-tube unit, introduced in 1930 but designed by James Millen and Robert Kruse. This version utilized push-pull audio output.³

The SW-3 was introduced in a seven page, September, 1931 *QST* article authored by James Millen, W1HRX (*W1AXL at that time —Ed.*), entitled “A Combination A.C. and D.C. Receiver.” The first SW-3 ad appeared in *QST* the following month.

The SW-3 was a three-tube set having an RF (radio frequency) stage, regenerative detector, and single audio amplifier all in a compact, carefully designed, shielded cabinet. A new feature was “single-dial control” thanks to ganged RF and detector stages (each stage with its own plug-in coil).

The SW-3’s thirteen coil pairs covered from 9 to 3000 meters. Five band spread coils for the amateur bands were also available. A particularly important new feature, at the time—and barely mentioned in the first ad—was the use of “R-39.4

Setting a New Standard in HF Receiver Design

NATIONAL SW-3

This new Ham receiver follows essentially the same circuit as the new NATIONAL SW-5 THRILL-BOX, but being for headset use only, omits the Push-Pull Audio.



FULL A. C. MODEL

Uses Type Nos. 235 and 227 tubes, and operates on full A.C., with National type 5880 Power-Pack, specially designed for featureless operation with RF filter, two-section Ham filter, and electrolytic shield between accessories and line winding (eliminating “rattle” hum).

HIGH SIGNAL-TO-NOISE RATIO

The combined results of careful circuit design give exceedingly high signal-to-noise ratio.

RAND.-SPREAD COILS STANDARD EQUIPMENT

Standard equipment are Hand-Spread Coils for 20, 40, and 80-Meter Amateur Bands.

REAL GAIN IN RF STAGE

The design makes possible a real RF gain because of lower plate impedance of 235.

SMOOTH SENSITIVITY CONTROL

Employing a hitherto unknown and superior characteristic of the 235 Variablemu tube, the point of maximum sensitivity is approached on an inverse exponential curve. Result—extremely stable operation at maximum sensitivity, without critical control-setting.

UNIVERSAL MODEL

Uses new 6 volt, fireproof heater type Nos. 235 and 227 tubes for battery operation or Type Nos. 235 and 227 tubes can be used with 2.5 volts A.C. on the heater and battery for 8-wattage.

COMPACT — ADAPTABLE TO PORTABLE, AIRCRAFT AND BOAT USE

Receiver is extremely compact: 9" x 9 1/2" x 7". Simple, attractive metal cabinet is standard equipment, and forms integral part of the shielding. It can be equipped with hooks for spring mounting on airplanes and will fit in a very small space.

THE PRICE IS RIGHT

The price of the SW-3 puts it within the reach of every amateur. Write us for full particulars and price saving coupons below.



NATIONAL SW-3 AMATEUR HF RECEIVER



See You Now In QST — It Introduces You and Helps QST

COUPON

Send me information on:
 1 National SW-3
 2 Thrill-Box
 3 5880 Power-Pack
 4 5880 Power-Pack
 Please send me full particulars and prices on these new SW-3 Thrill-Boxes.

Name.....
 Address.....
 City..... State..... Zip.....

Fig. 1: First ad for the SW-3 in *QST*, Oct., 1931, Pg. 2.

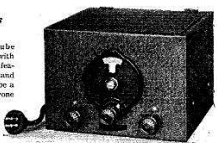
Hugo Leuteritz was an RCA engineer who initially consulted with PAA from 1927 and joined PAA a year later to head up their fledgling Communications group. Early on, Leuteritz tested National’s SW-4 and determined it was ill-suited for transoceanic work not only because of its size and weight but because the receiver’s performance varied tremendously with the weather. This fault was later traced to the coil forms that absorbed moisture (the early coils of the SW-5 suffered from the same issue).

Around 1930, the Boonton Rubber Company began making custom Bakelite® molding. The Bakelite® molding powder

AUTHOR’S E-MAIL: BRIANKN4R@GMAIL.COM

For Amateurs Only

This new three-tube Ham receiver includes with original and ingenious features. Its efficiency and ease of handling will be a revelation to everyone who employs it.



Read R-Rating Direct

The attenuation control is arranged so that scale of reaction is directly proportional to the R-Rating of signal intensity. Control wheel is so mounted that it may be operated by the hand that does the tuning. This is a new and exclusive feature.

NEW! the NATIONAL SW-3 HAM RECEIVER

A three-tube head set receiver with one stage of AF, for full A.C. or storage battery operation with 50 heater tubes. A.C. model uses two 235 tubes. **EXTREMELY HIGH SIGNAL TO NOISE RATIO**—a feature of the N.C.A. **EXTREME STABILITY AT POINT OF MAXIMUM SENSITIVITY**. Employing inherent unknown feature of 235 tubes, the point of maximum sensitivity is approached along inverse exponential curve, giving stable operation without critical setting of control.

TRUE SINGLE CONTROL. Easy to tune and log. **ALL COILS WOUND ON R-39**, especially designed for the NATIONAL CO. by the Radio Frequency Laboratories, practically eliminating detuning losses in coil fields. **AMATEUR BAND-SPREAD COILS STANDARD EQUIPMENT.** Free from fringe-loss! Compact 9 1/2" x 9 1/2" x 7", especially suitable also for portable aircraft and boat use. **THE PRICE IS RIGHT.** Write for Bulletin SW-3T

R. F. TRANSFORMERS

Available to cover waves from 10 mac. to 150 k.c. Forms are standard R-39, the new low loss coil material developed by Radio Frequency Laboratories. Blank forms also available for winding experimental coils.



SE AND ST VARIABLE CONDENSERS

Model SE, a special high-frequency design, not a cut-down broadcast job. Insulated shaft bearing and constant impedance signals. 230 degrees, variable frequency scale. Model ST has 180 degree capacitor plates. Smaller model available in capacities up to 150 muf.



PRECISION VELVET-VERNIER DIALS

Type N

Made in fingertip and slipstick sizes. Solid German covers, frequency scales and other operations recording, standard accuracy. Equipped with real vernier, mechanical dial reads to 1/10 degree. Smaller model can be estimated to 1/20 degree.



LEVER-TYPE INDICATORS

Types S, M and J

For transmitter panel use. Reliable handling, bronze contacts, available for 15" and 20" chassis. Details on request. Strong metal rods now included with S and J indicators.



NEW DOUBLE SECTION TRANS-MITTING CONDENSER, Model TM

For high-power transmitters or for use in parallel or common both before or after the double section tuning. Made in capacities up to 2000 p.f. and in larger sizes in TMU frames.



THE POWER UNIT

A separate unit with cable and soft rubber covered connecting plug, especially designed for handling operation of high-frequency resistors. See Vol. 15, 15th Element supply. Licensed under R.C.A. Patents.



NATIONAL

Amateur Parts and Receivers

NATIONAL COMPANY, INC., Sherman, Abbott & Jackson Sts., Malden, Mass.

See You Saw It in QST—It Identifies You and Helps QST

Fig 2: SW-3 Ad in QST Nov. 1931, Pg. 95 proclaimed "ALL COILS R-39."

originally used was based on a wood flour filler which was extremely hydroscopic, and with the molding process done by steam...the Q of the coil forms molded by this process varied tremendously: but to the naked eye the coil forms looked identical. To address this problem Boonton Rubber switched over to a ground mica filler and electrically heated presses. The result was precision uniform high-Q molded coil forms which National trademarked as "R-39" and was first used in SW-3 coil forms. R-39 was also used elsewhere in variables and controls as insulating material.

The ad above, in the Nov., 1931 QST proudly mentions "ALL COILS WOUND ON R-39." (Figure 2)

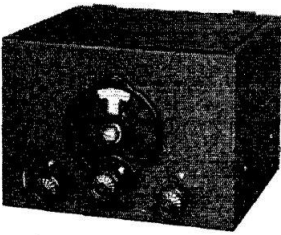
Circuit-wise, the SW-3 was a cost-reduced model of the SW-5 as another ad in QST, Nov., 1931 states (Figure 3).

Enter the PAA SW-3s (in Airport Service)

Pan Am used SW-3s as their original

Bargains!

NATIONAL SW-3



This is the receiver fully described in the September issue of QST. Essentially, this new Ham receiver follows the same circuit as the S-W 5, but being for headset use only, omits the Push-Pull Audio. Your Cost (less tubes), complete with band-spreading coils for 20, 40 and 80 Meter Amateur Bands. (A.C. or D.C. Models).....**\$32.34**

National 5880 Power Supply for A.C. Model.....**\$20.30**

Fig. 3: SW-3 is an SW-5 Ad in QST, Nov. 1931, Pg. 57.

"Airport Receivers" world-wide. Pictures of these units in service can be found in the References section, page 58.⁵ Receivers were used in Macau, Guam, Manila and Port Lam-poon, Philippines

PAA added the following modifications to their SW-3s at their PAMSCO (Pan Am Manufacturing and Supply Company) facility in Coral Gables, FL.

- On-off switch at front left bottom corner.
- Headphone jack at front right bottom corner.
- Logging scale at front top left corner.
- PAA data tag with serial number in the middle of the lid.

An Inventory: Two and Counting

Receiver One: Only two PAA SW-3 Airport Receivers are known to exist at present. PAA Serial #50 (See References⁶) was a 2022 donation to the San Francisco International Airport (SFO) Museum. The SFO Museum is the first and only accredited museum located in an airport. Some of the items on display there can also be viewed online.

The SFO Museum example was reportedly used at the original PAA “Clipper” flying boat base at Alameda, CA which was superseded by PAA’s new Treasure Island, CA flying boat base starting in 1939. Treasure Island was the setting of the Golden Gate International Exposition (GGIE) World’s Fair in 1939-1940.

This receiver has the earlier PAA data tag mounted in the front top right corner, and an additional later PAA tag mentioning the C.A.A.T.C. in the middle of its lid. This dates the radio (or at least with the additional lid tag being added) to post-June, 1938, when the Civil Aeronautics Authority Test Center was created (C.A.A.T.C.).

Receiver Two: PAA SW-3 Airport Receiver Serial #32 showed up in an estate sale held by the Northwest Vintage Radio Society (NWVRS) in 2024. This was an exceptionally large radio collection with local silent auction events open to club members over multiple weekends. My friend, Hue Miller, forwarded a few pictures to me of one of the later upcoming sales including the picture below. I begged Hue to make the



Figure 4: SW-3 Serial #32 spotted at a Pacific Northwest estate sale.



Fig. 5: Possible modified SW-3 in PAA aircraft.

trek, bid and purchase, then box and ship the receiver to me. He did and I owe Hue!!!

Closeup pictures of this PAA SW-3 #32 can be found in the References section, page 59.⁷ The detector coil (marked with white paint) has the same serial number as well as calibrated dial settings for the lowest and highest frequencies covered for this receiver.

Most of the photographs I’ve seen show PAA SW-3s in use on the ground. However, here is one aircraft picture “possibly” showing a modified SW-3 in use in the air as above, Figure 5.

SW-3 Models, Versions and Coils

There were a number of different National SW-3 models. Here are the tube lineups for a few of them:

Model I:

- 1st version: 35 RF amp, 35 detector, 27 audio [8]
- 2nd version: 36 RF amp, 36 detector, 37 audio – “6V mobile use” (this is the tube lineup of PAA SW-3 #32)
- 3rd version: 30 RF amp, 30 detector, 32 audio – 1.4V tubes for dry battery operation

Model II:

- 2.5v or 6V tubes – 58 (or 6D6) RF amp, 58 (or 6D6) detector and 27 (or 76) audio.

National did produce an SW-3 model with front panel on-off toggle switch and a head-

phone jack, the exceedingly rare post-WWII Model III “Universal.” This model features a chassis switch that allows it to use either standard 6.3 volt metal tubes (6J7, 6J7, or 6C5) or 1.4 volt octal tubes (1N5,1A5) for battery operation. It is the only SW-3 model known that came with labeled front panel controls⁹ as shown below. The “40” stamped on the chassis in Figure 7 refers to the “30-40” coils optimal for this receiver.

Three different coil versions were produced by National during the SW-3 production years. The coils were designed to complement whichever tubes were employed in the receiver models over the years.¹⁰

The earliest coils were called the 10-20 series and were designed to work with Model I receivers employing type 235 screen-grid tubes. 10-20 series coils have paint dot color codes to identify tuning ranges and are stamped on the base. Detec-

tor band spread coils have an internal capacitor and the base number stamp includes an “A” (i.e.,15A). (See Table 1, page 57.)

Next in the chronology were the 60-70 series coils which were designed to be optimal for the newer type 58 and 6D6 pentodes Model II. 60-70 coils only have an identifying number stamped in the base between the pins to denote tuning range. Detector band spread coils have a capacitor inside and were stamped with an “A” (i.e. 64A). (See Table 2, page 57.)

The newest coils were identified as the 30-40 series and were designed for the metal octal equipped post-WWII “Universal” SW-3. 30-40 series coils also have an identifying number stamped in the base between the pins to denote tuning range, and detector band spread coils have a capacitor and, for example, are also stamped as 35A. (See Table 2.)

Within a coil series, detector and RF coils are interchangeable, except for the band spread and the exceedingly rare longwave coils.

SW-3 coils across the three-coil series are interchangeable. The only difference between the coils is a small amount of antenna coupling and the degree of control rotation required to cause the detector to spill over into regeneration. National would remove a winding turn from the tickler each time RCA introduced a new tube with more gain. The intent was to maintain general spill over at the center of control rotation. James Millen understood marketing and National



Fig. 6: National Universal post-WWII front panel with power switch. .

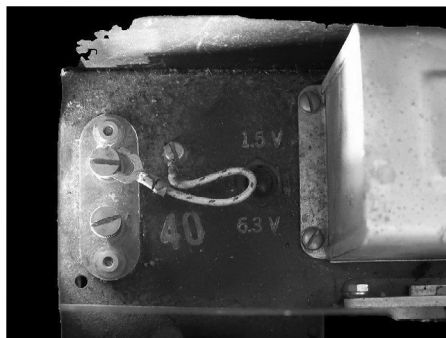


Fig. 7: National Universal post-WWII filament switch.



Fig. 8: Modified SW-3: almost a PAA but not quite.

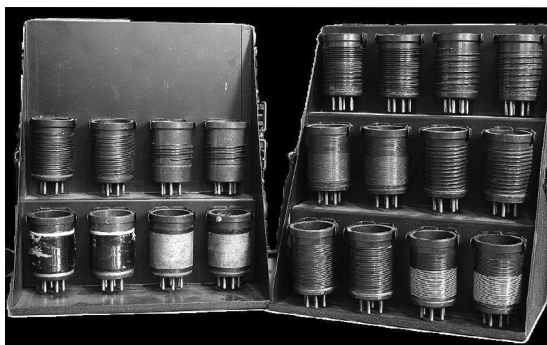
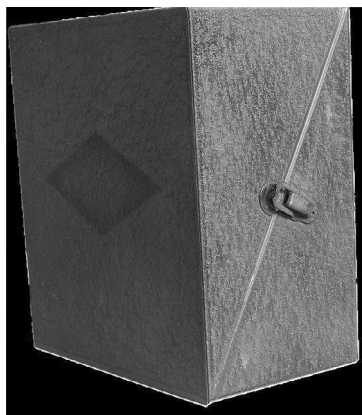


Fig. 9: Left: National SW-3 coil box front view.
Fig. 10: Above: National coil box with coils installed.

sold copious coils.

Note that all modified SW-3s are not necessarily PAA SW-3s. For example, a recent eBay posting displayed an apparent “imposter” SW-3. It has a logging scale frame on the front panel and toggle switch, but both are incorrectly placed to be a *legitimate* PAA SW-3s (Figure 8).

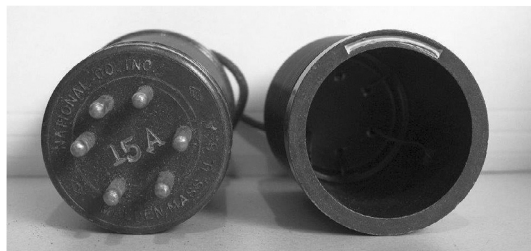


Fig. 11: 10-20 series coil markings.

The metal National Coil Box shown above in Figures 9 and 10 is hard to find, especially with coils!

Also watch for orphan SW-3 coils. The lower-frequency SW-3 coils are the least common and have the most windings, especially the 160 meter band spread coils shown in Figure 12 and the super-rare #42

VLF coils and their amazing coil windings shown in Figure 13. Figure 11 highlights the unique numbering and color marking typically used by National for coil identification.

Good hunting and I would appreciate hearing about unusual SW-3s, especially any used by an airline.



Fig. 12: 160M band spread coils—rare!



Fig. 13: #42 coils VLF 2000-3000 meters—very rare!

TABLES

General Coverage SW-3 Coils				
10-20 Series	60-70 Series	30-40 Series	Wavelength	Frequency
10 (Brown)	60	30	9-15 Meters	19-35 MHz
11 (Black)	61	31	13.5-25 Meters	12-21 MHz
12 (Red)	62	32	23-41 Meters	7-12 MHz
13 (White)	63	33	40-70 Meters	4.2-8 MHz
14 (Green)	64	34	5-115 Meters	2.5-4.5 MHz
15 (Blue)	65	35	115-200 Meters	1.5-2.7 MHz
16 (Orange)	66	36	200-360 Meters	690 KHz-1.5 MHz
17 (Yellow)	67	37	350-550 Meters	500-900 kHz
18 (Purple)	68	38	500-850 Meters	320-650 kHz
19	69	39	850-1200 Meters	250-390 kHz
20	70	40	1200-1500 Meters	190-280 kHz
21	71	41	1500-2000 Meters	150-220 kHz
22	72	42	2000-3000 Meters	90-160 kHz

Table 1: General coverage SW-3 coils.

Band Spread SW-3 Coils				
10-20 Series	30-40 Series	60-70 Series	Wavelength	Frequency
10A	30A	60A	10 Meters	28-30 MHz
11A	31A	61A	20 Meters	14-15 MHz
13A	33A	63A	40 Meters	7-7.5 MHz
14A	34A	64A	80 Meters	3.5-4 MHz
15A	35A	65A	160 Meters	1.5-2 MHz

Table 2: Band spread SW-3 coils.

REFERENCES

1. *CQ Magazine* (July, 1971 Pg. 35)

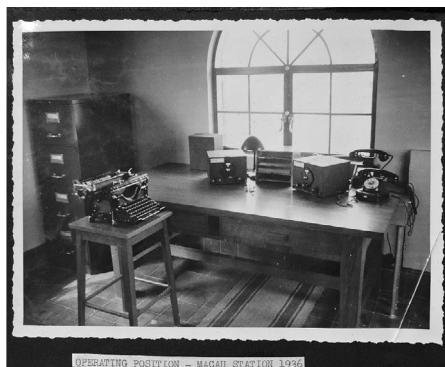
2. National Radio Company has a storied history that spanned seventy-seven years from 1914 to 1991. Started as a toy company (National Toy Company) in 1914, it quickly shifted focus and broadened its product line to include household goods. Then, in 1916, it birthed a new corporate name, National

Company, Inc. In the 1920s, the company enjoyed further diversification to electronic components including capacitors, transformers, coils, knobs and their now famous “Velvet Verniers.” Throughout the later 1920s and ’30s, National introduced new amateur radio equipment receivers, including the highly regarded “HRO” series and the receivers discussed here. —Ed.

3. Curiously, the SW-5 was developed before the SW-3 (1929). The numeric model number indicated the receiver tube count. —Ed.
4. According to National's 1931 ad in *QST* (Figure 2), all coils in the SW-3 were "wound on R-39 to practically eliminate

dielectric losses in coil fields." Little is known of the "R-39" formulation. Radio Frequency Laboratories developed the specialized low-loss coil form material for National. —Ed.

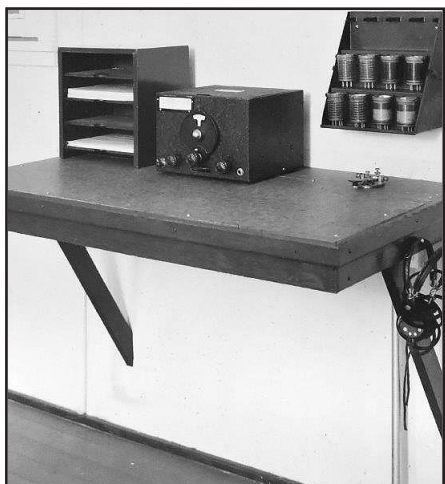
5. Below are pictures of PAA SW-3s in airport service:



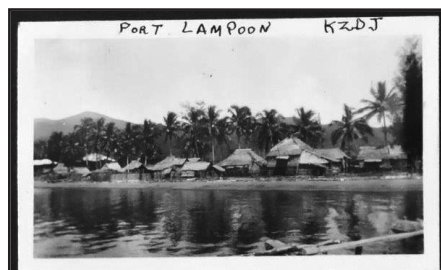
Two PAA SW-3s Macau (Near Hong Kong) 1935-1936.



PAA SW-3 Guam 1936.



PAA SW-3 Manila 1937.



PAA SW-3 Port Lampoon Philippines.

6. The SFO PAA SW-3 Serial #50 has the logging scale and data tag in very readable condition:



SW-3 Serial #50 logging scale and front data tag.

7. Closeup pictures of the PAA SW-3 Serial #32:



SW-3 #32 front view.



SW-3 #32 rear view vent holes.



SW-3 Serial #50 front and top view.



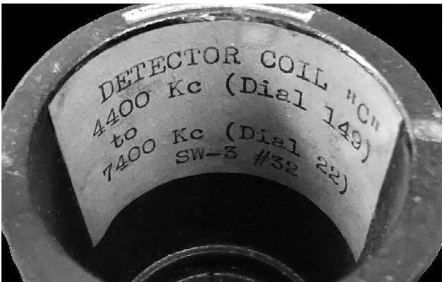
SW-3 Serial #50 lid data tag C.A.A.T.C.



SW-3 #32 logging scale.



SW-3 #32 PAA data tag on lid.



SW-3 #32 detector coil.

— References continue on page 63 —

rightmost CD4017 and the main counter will stop counting.

But Then a New Challenge and Remedy

It almost worked! But the CO terminal carries 1 for half of the LED counts and is reset to 0 at the fifth count and goes to 1 again at the 10th count. So, it was critical to detect the transition from 0 to 1 on the 10th count, and not simply that a 1 is on the CO terminal. Another IC to perform this function had to be inserted in the path between CO and CI. I diagnosed this problem by noting that the timer was counting for less than the full second. The input to an IC can be triggered by a rising transition but it took me about a week to figure out why that occurred.

The solution was inserting a logic circuit that detected the rising transition from 0 to 1. Triggering from one board to the next was achieved by attaching the CO (carry out) terminal directly to the CLK (clock) terminal of the next board. The CLK input was only triggered by a rising 0 to 1 transition, something that I didn't realize right away. I installed the pulse 555 IC that came with each board only on the first board of the series of counter boards, and I rewired it to accept external pulses for the main counter and pulses from the 10 kHz oscillator for the timer boards. (In a few places on

the boards a rotary burr tool was used to grind away a small bit of a trace to eliminate a connection). To add connections, #28 tinned copper wire with Kynar covering was used.

In Summary

Don't be too concerned with exactly how an IC achieves its function. The details of how thousands of transistors operate in an IC don't have to be understood to build or repair useful circuits. But it is important to understand the function of a particular IC and how interconnections are made. The beauty and utility of ICs is that they are building blocks in more modern circuits, much like tubes, with discrete components like resistors, capacitors, and transformers were the building block in older (vintage) devices.

What's Next

In the next issue, I will expand on more of my journey in the use of ICs and my success in overcoming some of the counter challenges that I encountered. I will also discuss how control circuits were used to select time intervals; how a simple digital IC comparator from my junk box was used to boost the oscillator signal; and I will expand on the various families of IC chips details.

THE SW-3, REFERENCES, *continued from page 59*

8. 1st version SW-3s marked as "Jackson Research Laboratories" are rare—these very early SW-3s were sold as un-wired kits before National had an RCA license and were wired by "Jackson Research Laboratories"...a dummy company named after one of the streets on which National Company was located.
9. Photos courtesy of Jon Weiner, K1VVC.
10. Coil information supplied by Greg Gore, WA1KBQ, and Jon Weiner, K1VVC. Both are regarded National collectors.