

THE COMMUNICATION RECEIVER

EDITED BY

WILLIAM FIZETTE, K3ZJW
RD #1 Box 55, Henryville, PA 18332

All correspondence requires SASE for reply



THOSE NATIONAL 6-PRONG PLUG-IN COILS

William B. Fizette, K3ZJW

INTRODUCTION

Except for the power supplies, no group of National Company products is as confusing to the beginning collector as the 6-prong plug-in coils for the receivers of the 1930s. I refer, of course, to the sets personified by the SW-3 and SW-5, although there were several others.

Our Editor, on acquiring one of these, a SW-45, set out to master the conundrum of the 6-prong coils. This review includes material researched by both him and the writer, with the aid of Paul Bohlander, W3VVS, and summarizes the information needed by a collector who wishes to make one of these receivers operational.

Fortunately for us, the subject has attracted many writers over the years, and there is no shortage of information about these coils. Besides the various National Company catalogs, there are the early writings of Robert Kruse, James Millen and Dana Bacon, followed by more recent articles by National experts John Nagle and Bill Orr. Recently, Reno Ruggere and Jim Troe attacked the problem with a story in the *ARCA Gazette*. The references at the end of this article list ample source material for the serious collector-restorer.

THE R-39 STORY

The SW-2 of 1928 was National's first attempt at a short-wave receiver. Designed for both SW and experimental TV reception, it used a set of

four coils covering 2.5-115 meters (2.6-120 MHz). These coils, wound on 2" bakelite tubing, varied in "Q" and inductance depending on the weather, and the receiver performance suffered accordingly. The National SW-4 and early 3-tube regenerative receivers also used coils wound on the usual forms of the day, bakelite filled with wood flour with a coloring agent added and molded in steam presses.

Enter the team of Millen and Kruse and the SW-5 receiver [3]. Along with other research involving hum and the use of AC power packs, they attempted to make the receiver more stable. The problem of frequency swings with environmental changes was given to the Radio Frequency Laboratories of Boonton, NJ, who ascertained that it lay with the use of the hygroscopic wood-flour filler [7]. The Boonton Rubber Co., of the same town, developed an improved formula using finely ground mica as the filler for the bakelite resin [15], replacing the wood flour and coloring dye. Using electrically heated molds, they obtained a precision, high-Q coil form that permitted manufacture of stable and uniform inductors. The first production run was during the summer of 1931 [15].

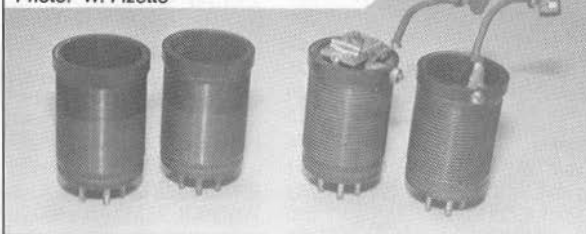
THE SPECIAL PIN CONFIGURATION

The 6-prong coil form was developed prior to the introduction of the 6-pin "UZ" tube base about 1932, and is mentioned by Kruse in his article [2]. The decision was to provide independence for each of the three windings. National continued to make and sell the special form after 1932, realizing that it was both illogical to change something that was established, and was also a good source of revenue.

They also continued to make receivers using them. No old tube bases here . . . the blanks or finished coils had to be purchased from National, who essentially controlled the market for this item.

Left: a pair of #15 (blue) coils for 115-200 m.; right, #13A detector and RF coils for 40-m bandspread.

Photo: W. Fizette



The pins were in two groups of three, with the second group having a wider spacing. Thus the distinctive asymmetric format, made by no one else (that I am aware of) at the time.

GENERAL DESCRIPTION OF THE COILS

As with most National products of the 1930s, these were *quality*. The development work was done well enough that the design did not change,

TABLE 1. GUIDE TO CORRECT COIL SERIES FOR RECEIVERS

RECEIVER	TUBES	SERIES
SW-5	35 + 35 + 27 + P-P 27s	10-20
SW-45	35 + 35 + 27 + P-P 45s	10-20
DCSW-34	34 + 34 + 30 + P-P 31s	10-20
ACSW-58	58 + 58 + 56 or 27 + P-P 45s	60-70
Orig. SW-3 AC	35 + 35 + 27	10-20
6DCSW-3 (6 V)	36 + 36 + 37	10-20
2DCSW-3 (2 V)	32 + 32 + 30	10-20
ACSW-3	58 + 58 + 27 or 6C6 + 6D6 + 76	60-70
Universal SW-3	6J7 + 6J7 + 6C5 or 1N5 + 1N5 + 1A5	30-40

and once marketed, they continued on for years. Introduced in 1930 with the SW-5 as the "10-20" series, the last "30-40" series was still listed in the price list in catalog No. 700, 1947. The blank forms (XR-4, XR-5, and XR-6) were sold into the 1950s. The special 6-prong socket used was the XC-6C.

The forms were ruggedly molded of hard, dark-brown bakelite, 1- $\frac{1}{2}$ " in diameter with a 2" winding field, with a $\frac{1}{2}$ " reinforcing shoulder at the top. A 1/16" groove was machined into the form near the bottom for the "slot" winding, and a small groove in the top shoulder was usually (but not always) filled with colored paint for identification. These forms were very stable physically.

A feature unique at the time was the machining of wire grooves tailored to the individual windings, assuring that they would stay firmly in place. Inspection of coils that are over 60 years old confirms that the idea was a good one; the turns are right where they were put in 1930.

WHERE WERE THESE COILS USED?

Table 1 lists the various receivers by name and tube types, and gives the coils to be used. The SW-3s can be confusing, since there were a number of different models, but they can usually be identified by the tube designations on the sockets (assuming, of course, no untoward rebuilding by some previous owner.)

The coils also often appeared in home-construction projects, especially those in *QST* and the ARRL *Handbooks* of the day, probably due to the close working relationship between National and ARRL. A noteworthy example of this is George Grammer's simplified high-performance superhet described in *QST* for April, 1936.

By far the most use was in the SW-5 series and the SW-3, which enjoyed a production run of some 14 years. While some cross-use of coils is permitted among the various sets, not all the coils can be used in all the receivers, usually due to differing numbers of turns

in the tickler (slot) windings [16].

The "slot" winding, incidentally, is used as the primary in the RF coil to minimize antenna-capacity effects. In the detector coil it becomes the tickler.

HOW MANY DIFFERENT TYPES WERE MADE?

Table 2 gives a master list of the 6-prong coils [19]. The first coils to be made, the "10-20" series, were color-coded with a paint dot on the bottom of the form and a matching color in the groove on the top. In 1932 the "60-70" series was introduced for use with the AC SW-58 and the AC SW-3 [10]. These had the coil number hot-stamped into the bottom. The last types, the "30-40" series, came on the market with the Universal SW-3 in 1940; these were also numbered on the bottom.

The initial "10-20" coils for the SW-5 covered 2.5-21 MHz, with 1.5-2.7 and 19-35 MHz optional. The 500-1500 kHz coils were added for the SW-45. Nos. 10, 10A, and 69-72 appeared after 1934, 22 and 72 after 1938 [19].

National catalog No. 144 [4] listed eight available sets, covering 9-550 meters (0.55-33.3 MHz) and selling for \$42, a large sum in those days.

The bandspeed (BS) coils may or may not be numbered; I have some of each. This probably reflects when the coils were made. Another anomaly has been noted with the BS coils: I have two sets in original boxes, 14A and 64A, apparently unused, with the numbers on the bottom and with color codes. However, in each case the RF coils are coded black and the detector coils red. Perhaps some knowledgeable reader will explain this.

TABLE 2. SIX-PIN COILS FOR SW-3, SW-5, AND DERIVATIVES

RANGE MHz	RANGE METERS	SERIES 10-20	SERIES 60-70	SERIES 30-40
		1930	~1933	~1940
0.09-0.16	2000-3000	22	72	42
0.15-0.22	1500-2000	21	71	41
0.19-0.28	1200-1500	20	70	40
0.25-0.39	850-1200	19	69	39
0.32-0.65	500-850	18 (Purple)	68	38
0.50-0.90	350-550	17 (Yellow)	67	37
0.69-1.50	200-360	16 (Orange)	66	36
1.5-2.7	115-200	15 (Blue)	65	35
2.5-4.5	160 BS	15A (Blue)	65A	35A
	65-115	14 (Green)	64	34
	80 BS	14A (Green)	64A	34A
4.2-8.0	40-70	13 (White)	63	33
	40 BS	13A (White)	63A	33A
7.0-12.0	23-41	12 (Red)	62	32
12.0-21.0	13.5-25	11 (Black)	61	31
	20 BS	11A (Black)	61A	31A
19.0-35.0	9-15	10 (Brown)	60	30
	10 BS	10A (Brown)	60A	30A

Tables 1 and 2: L. A. Sibley

THE BANDSPREAD COILS

A key article for students of the SW-3 is that by James Millen in *QST* for September, 1931 [7], in which he introduces the SW-3 to the short-wave fraternity. In the same article he describes the new band-spread coils using the tapped inductance. Another key reference is in *Radio News*, May 1931 [6].

Briefly, previous attempts to bandspread a tuning range involved removing plates from the tuning capacitor. National opted instead to tap down on the inductance, with the entire frequency-selection process now resting with the plug-in coil. This system made for a good circuit L/C ratio, giving sensitivity and stability. The general-coverage qualities of the receiver were unimpaired, and all coils, both GC and BS, tuned with a 90-pF variable capacitor.

Besides the tap on the secondary, each detector coil was fitted with a grid leak and grid capacitor inside the form, a shunt trimmer capacitor on the top of the form, and a lead with a clip to attach to the grid cap of the detector tube.

National quickly began to promote the coils as suitable for use with the existing SW-5, with no change necessary to the set. In separate publications, Dana Bacon and James Millen of National discussed the subject at length [6, 9].

The following notes concerning these coils are taken from the instruction sheet packed with each BS coil set [11]:

1. The 11-A, 13-A, 14-A, and 15-A coils are for use in the AC SW-5, DC SW-5, AC SW-45, AC SW-3 (using 235 tubes), the universal SW-3 (DC) and the SW-34. The 61-A, 63-A, 64-A, and 65-A coils are for use in the SW-58 and the later model AC SW-3 using type 58 tubes.

2. The detector coil is located at the left side of the receiver in the AC or DC SW-5 and the AC SW-45

models, and at the right side in the SW-58, SW-34, and all models of the SW-3.

3. When the detector coil trimmer is correctly adjusted, the high-frequency edges of the bands will be between 65 and 70 on the dials of the SW-5, SW-45, and SW-3 models, or between 30 and 35 on the dials of the SW-58 and SW-34. The spread may be increased or decreased by tightening or loosening the trimmer.

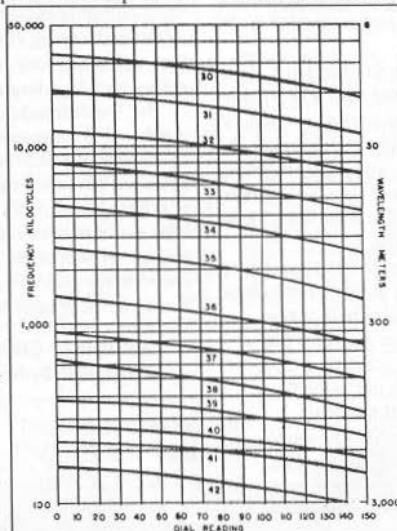
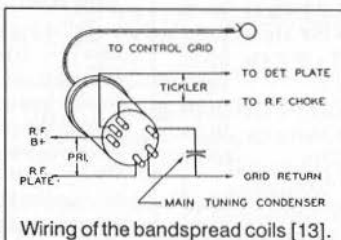
The serious collector may wish to consider that the bandspread coils were introduced to the market in late 1931 or early 1932 (by Feb. 1932 BS coils for the 20-, 40-, and 80-meter bands were included as standard equipment with every SW-3) and match his receiver and coils accordingly. The SW-3 had insulated posts on the sides of the shield cans to hold the unused internal grid

leads when the BS coils were used. In contrast, the earlier SW-5s did not have these keepers, and while the BS coils were promoted, they were not shipped as standard equipment.

IDENTIFYING THE COILS

The color-coding in the "10-20" series is often missing or hard to distinguish, with the possible exception of the red-, white-, yellow- and orange-marked coils. The paint dot on the bottom is usually gone. The best way, in case of doubt, is to compare the windings with a turns chart (see Table 3) or with a known coil.

The "60-70" and "30-40" series are usually number-marked on each coil, making for positive identification. The BS coils may or may not be numbered; the early ones were not. Remember that the units with the mica padder on top and the grid leak inside the form are the BS detector coils. Also, some coils, specifically Nos. 36, 37, 38, and 42, are marked with a D or an R after the number; these are for the detector and RF stages, and are not interchangeable.



Calibration curves for the "30-40" series coils [13]: above, general-coverage; below, bandspread.

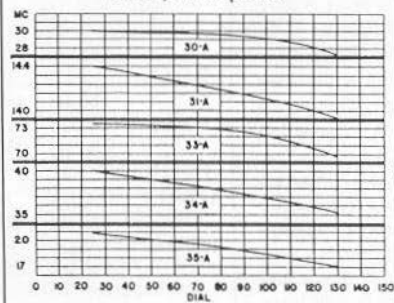


TABLE 3. WINDING SPECIFICATIONS FOR EARLY NATIONAL 6-PIN COILS

COIL	CODE	RANGE, METERS	SECONDARY TURNS	PRIMARY TURNS	TICKLER TURNS*	BS TAP**
11	Black	13.5-25	5-3/4 #16E, 5 TPI	4-1/6 #26 E, 5 TPI	3-1/8 #28 DSC	-
11A	-	20 BS	9-7/8 #22 E, 8 TPI	7-7/8 #34 DSC, 8 TPI	3-1/8 #28 DSC	2-1/3
12	Red	23-41	11-5/6 #18 E, 8 TPI	7-5/6 #34 DSC, 8 TPI	3-1/8 #32 DSC	-
13	White	40-70	19-5/6 #18 E, 14 TPI	12-5/6 #34 DSC, 14 TPI	4-1/8 #32 DSC	-
13A	13A	40 BS	21 #22 E, 14 TPI	16-1/6 #32 DSC, 14 TPI	4-1/8 #32 DSC	5-5/6
14	Green	65-115	34-5/6 #22 E, 24 TPI	21-5/6 #28 DCC, 24 TPI	4-1/8 #32 DSC	-
14A	14A	80 BS	34-5/6 #22 E, 24 TPI	21-5/6 #28 DCC, 24 TPI	4-1/8 #32 DSC	16-7/8
15	Blue	115-200	62-5/6 #24 E, 40 TPI	39-1/6 #32 DSC, 40 TPI	5-1/8 #32 DSC	-
61	61	13.5-25	6-1/3 #16 E, 5 TPI	5-7/8 #24 E, 5 TPI	2-1/8 #30 DSC	-
61A	61A	20 BS	9-7/8 #22 E, 8 TPI	7-7/8 #30 DSC, 8 TPI	3-1/8 #30 DSC	2-1/3
62	62	23-41	11-7/8 #18 E, 8 TPI	9-7/8 #22 E, 8 TPI	2-1/8 #30 DSC	-
63	63	40-70	19-7/8 #18 E, 14 TPI	12-7/8 #30 DSC, 14 TPI	2-1/8 #30 DSC	-
63A	63A	40 BS	21 #22, 14 TPI	15-7/8 #32 DSC, 14 TPI	4-1/8 #30 DSC	5-5/6
64	64	65-115	34-5/6 #22 E, 24 TPI	21-5/6 #28 DCC, 24 TPI	4-1/8 #30 DSC	-
64A	64A	80 BS	34-5/6 #22 E, 24 TPI	21-5/6 #28 DCC, 24 TPI	4-1/8 #30 DSC	16-7/8
65A	65A	160 BS	62-5/6 #24 E, 40 TPI	26-5/6 #30 DSC, 40 TPI	4-1/8 #30 DSC	26-1/8

E: Enameled; DCC: Double Cotton-Covered; DSC: Double Silk-Covered; TPI: Turns Per Inch

* In slot at bottom

** Turns from bottom

Table 3: W. Fizette, K3ZJW

RESTORING AND WINDING THE 6-PRONG COILS

Unfortunately, the passage of time and the advances in technology relegated most of the coils to the junk boxes of amateurs who had prized them in the 1930s. Those that can be found after all these years are often worn, chipped or even worse. If the original windings are still intact, I clean them by wiping on a coat of Butcher's woodworker's wax and then buffing lightly, taking care with the fine wires. Often the grid-clip leads from the BS coils are missing, and must be replaced. Do it right and use only the matching National No. 24 grid clip. If some of the strands of the grid-cap wire are broken, do a repair job or replace the wire.

If a coil must be rewound (there are a lot of these, unfortunately), match the machined winding grooves on the form to a known coil, and then duplicate the windings as closely to the original as possible. The silk- and cotton-covered wire used back then can often be salvaged from early junker BC sets (get as close as you can; the exact wire size is not critical), and the larger enameled wire obtained from Radio Shack or an electric-motor repair shop. Once I have a set of coils identified, cleaned and restored, I find that zip-lock sandwich bags make fine storage containers.

MAKING REPLACEMENT COILS

National marketed blank forms, and it is possible to wind your own coils with care. Also, coils can be made using repro forms and the instructions (a 16-page information summary on the SW-3) from James Fred, of Antique Radio Labs, RR 1, Box 41, Cutler, IN 46920 - see the catalog review in the May *OTB*, p. 65. An interesting approach to making a set of coils for the broadcast band is to use

these forms with pre-wound Miller coils. Refer to the sidebar for details. Dana Bacon also tells how to make three sets of long-wave coils covering 850 to 2000 meters (150-350 kHz) [8], but the quantity of wire involved is considerable and could be hard to find.

Table 3 details the winding data for many of the coils, especially the early ones. I have seen home-made coils that were superbly done, differentiated from the factory-wound versions only by absence of the machined grooves.

For specifications for winding the 20-, 40-, and 80 meter BS coils, see reference 7. Originally [8], in the detector coils ("transformers" was the term used then) the grid leak was 5 megohms, the grid capacitor 100 pF, and the trimmer capacitor approximately 8 pF.

MISCELLANEOUS NOTES

It is worth while to try to get any of the coil sets working in any of the subject receivers. However,

MAKING BROADCAST COILS

A good simulation of the No. 16 coil for the upper part of the BC band can be made up easily with a blank form and, inside it, a P-70-RF coil available from Antique Electronic Supply. A tickler winding is added to the coil by winding seven turns of small (24- to 30-ga.) magnet wire on the form, in the same direction as the grid winding. The slug in the coil can be adjusted to give either 800-1510 or 820-1600 kHz as the tuning range. This saves the effort of winding a huge number of turns of fine wire. -LAS

if the detector fails to oscillate, the problem may be in the number of turns on the tickler (slot) winding. Later receivers with higher-gain tubes require fewer turns on the coil to make it work. In fact, the slot turns were progressively fewer from the "10-20" to the "60-70" to the "30-40" series.

Orr [16] suggests changing the slot windings, but from the viewpoint of a historian/collector I recommend this with good coils only as a last resort, as any change is obvious and degrades the antique value of the factory-wound coil. Another, perhaps preferable, approach would be to use the forms from James Fred and wind your own. If the set goes into oscillation with the regeneration control near mid-position, the slot winding is correct [16].

The long-wave coils are rare and may not work in the earliest SW-3s, due to the absence of a choke in the plate circuit of the detector tube [16].

Another rare National Company product is the NCC-10 two-piece metal storage cabinet, with space for 10 pairs of coils.

CONCLUSION

Few collectors, if any, have a complete set of all the six-prong R-39 plug-in coils. The "10-20" series is the most common, the "60-70" series not so available, and the last one, the "30-40" series, very uncommon indeed, probably due to low demand at the late date. Depending on the application of the individual receiver, National usually shipped four sets of the coils in the middle frequency ranges, commonly 1.5-21 MHz, for the short wave listeners, with band-spread amateur band coils for the amateurs. The BC coils for sets like the SW-45 were optional [19].

Space limitations preclude giving a complete set of turns data for the coils. However, if there is enough interest, I will publish all available information in a subsequent column. I have no turns data for the "30-40" series, and if any reader has this information, I would be indebted for a copy.

REFERENCES

1. Kruse, Robert S., "A Multi-Range Receiver with Four Tuned Circuits," *QST*, October, 1930.
2. Kruse, Robert S., "The All-Purpose Short Wave Receiver," *The Manual of Short Wave Radio*, Zeh Bouck, Ed., 1930.
3. Millen, James and Kruse, Robert S., "An Analysis of AC Operated Short-Wave Receiver Design," *ibid.*, 1930. (See also *Radio News*, June, 1930.)
4. National Company Catalogs 144 (1930), 210 (1932), 220 (1933), 240 (1934), 260 (1936), and 600 (1946.)
5. Kruse, Robert S., "Revising Amateur Tuner Design," *QST*, January, 1931.
6. Millen, James, "Solving the Band-Spread Problem," *Radio News*, May, 1931.
7. Millen, James, "A Combination AC and DC Amateur-Band Receiver," *QST*, September, 1931.
8. Millen, James, "An Amateur Band Receiver," *The Manual of Short Wave Radio*, Vol. II, Zeh Bouck, Ed., 1932.
9. Bacon, Dana, "Short Wave Reception - DeLuxe - The SW-45," *ibid.*, 1932.
10. Bacon, Dana, "Solving the Band-Spread Problem," *ibid.*, 1932.
11. Millen, James, "World Wide Short Wave Reception with the ACSW-58 and DCSW-34," National Company, 1932.
12. "Instructions for Amateur Band Spread Coils," instruction sheet packed with coils, National Company, 1933-1947.
13. Gernsback, Hugo, *1934 Official Short Wave Radio Manual*, Lindsay Publications, Inc. reprint, pp. 180-182.
14. "Instruction Manual for the National SW-3 Receiver," National Company, 1941.
15. Rider's Manual 14-8, 1944.
16. Orr, William, "The Year Is 1931. National Radio Introduces the SW-3 All-Wave Receiver," *CQ*, July, 1971.
17. Orr, William, "The National SW-3 Receiver: Revisited," *CQ*, February, 1978.
18. Nagle, John, "The SW-5, A Pioneer Amateur Receiver," *CQ*, November, 1978.
19. Ruggere, Reno and Troe, Jim, "The National SW-3 Receiver and Its Baffling Coils," *ARCA Gazette*, Vol. 19, No. 4, 1991.
19. Sibley, L. A., personal communication, 1993.

(Continued from p. 37)

CALL	EQUIPMENT	SCORE	CALL	EQUIPMENT	SCORE
W6ZZ	MOD	42	K8UBL	'38 6F6 xtal @ 2.9 W; '38 HB 6J7-6F6	222
W7BCT	'38 Stancor; '41 SX-28	18	W9ET	MOD	153
W7LOG	'37 6V6-807 @ 30 W; '38 HQ-120	80	WB9K	'33 Collins 150B @ 90 W; '37 HRO	357
K7MO	'41 Meissner-813 @ 90 W; '36 HRO	468	W9POC	'38 6F6 xtal-6L6; '37 NC-100	486
W7SEH	'39 6V6 xtal-807 35 W; '36 HRO Jr.	270	N9TT	'35 BC-375; '37 BC-312	222
K7SKP	MOD; '38 NC-101X	79	KC0CW	'39 6L6 xtal-809 @ 95 W; '35 HRO	1440
K2WW/7	MOD	72	W0FXV	MOD	141
K7YIR	'38 Stancor 125, '40 Stancor 60P; '41 SX-28, '38 HQ-120	360	VE2SEI	'38 6L6-807 @ 35 W; '39 AR-77	297
W8AQ	MOD	12	VE3CLX	'41 6SK7 et al.-807; '41 HRO	909
W8CZR	MOD	38	VE3HIE/3	MOD	51
WD8OFB	'33 Hartley @ 2.5 W; '33 FB-7	12			