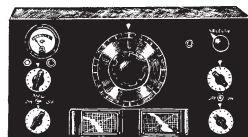


THE COMMUNICATIONS RECEIVER



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The National SW-4 Thrill Box

The 4-tube SW-4 “Thrill Box” was the second production receiver built by The National Company. It is the most rare of the early National sets. Radio writer, editor and historian Bill Orr called it “a collector’s dream.” It was produced for just a little over a year, spanning 1929, with a few built in 1928 and 1930. The SW-5, which followed, was a much better receiver. Once it was announced, the SW-4 was definitely obsolete.

It is possible that the design of the SW-4 may have been influenced by that of the RCA 1145. Some accounts indicate that the 1145 design was given to James Millen by friends at RCA. RCA may have also given the design to several others in order to increase the sales of their tubes.

The chassis of the SW-4 has a tag that reads “This Receiver Designed for Best Operation When Used With RCA Radiotrons.” The battery hook up and tuning instructions on the inside of the lid states “This apparatus has been designed for best operation with RCA Radiotrons.”

The RCA 1145 was an export shortwave receiver with an untuned RF stage using a screen grid tube. The disadvantage of this

design was the reduced selectivity and tendency to overload. The advantages were the elimination of tuning “holes” caused by antenna circuit resonance, the reduction of the effect of antenna movement effect on tuning, and the reduction of the signal generated by an oscillating detector reaching the antenna.

If the SW-4 was designed after the RCA 1145, it includes several improvements. Both receivers were four-tube designs with an untuned RF stage using the new screen grid type 22A. Both had regenerative detectors and two audio stages. The RCA design used an 01A detector with an 01A first audio. The final audio in the RCA receiver was a 12A, usually called a semi-power tube in period literature. This lineup allowed good performance from batteries. The RCA audio stages were coupled by transformers.

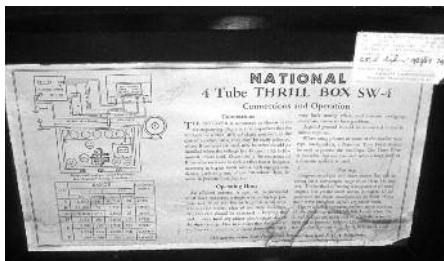
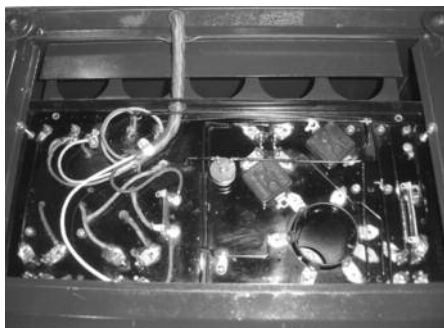
The SW-4 took advantage of a couple of newer tubes. It used the 22A, which was the only screen grid tube available, in the RF stage, an 00A as detector, the 40 high mu triode in the first audio and the 71 power audio.

The 00A is a gaseous detector tube. By operating the plate close to the breakdown



Two views of the SW-4.





Underchassis wiring and hookup instructions on lid.

point, the conversion gain was good, but the noise from the tube caused it to mask weak signals. Many users swapped their 00A detectors for 01A tubes. This needed a change in plate voltage and a larger amount of regeneration, but the results allowed the user to hear weaker signals.

National used impedance coupling in the audio system. At that time, transformers had narrower frequency response compared to resistance or impedance coupling. In the first National *Annual* the only receivers shown were Browning-Drake receivers. These were built in National's lab with all three types of coupling. The resistance coupling provided the best audio frequency response, but was also the least efficient method. Impedance coupling was more efficient and had very good frequency response.

The SW-4 was the first receiver to incorporate National "Impedafomer" coupling units. The set used a dual section coupler National called the "Duo Coupler." This type of coupler was also used in the SW-3, though that receiver used a single section unit (S-101). Each section contained a plate resistor, a coupling ca-

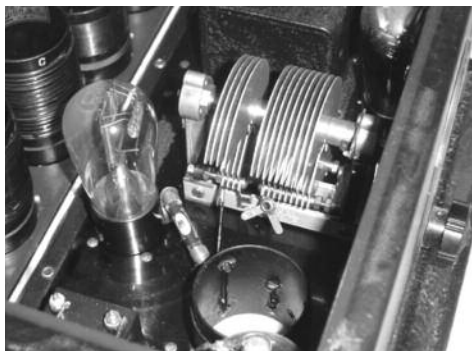
pacitor and a tapped inductance wired as an autotransformer.

Probably the most interesting circuit innovation was the type EC tuning capacitor. This capacitor was split into two sections. The rotor and its plates are common to the two sections. The rear 4 stator plates are permanently connected in the circuit. A very simple manual switch couples the front stator plates in parallel with the rear section. This allows the switch to be opened and the rear section used for tuning on the short wave bands.

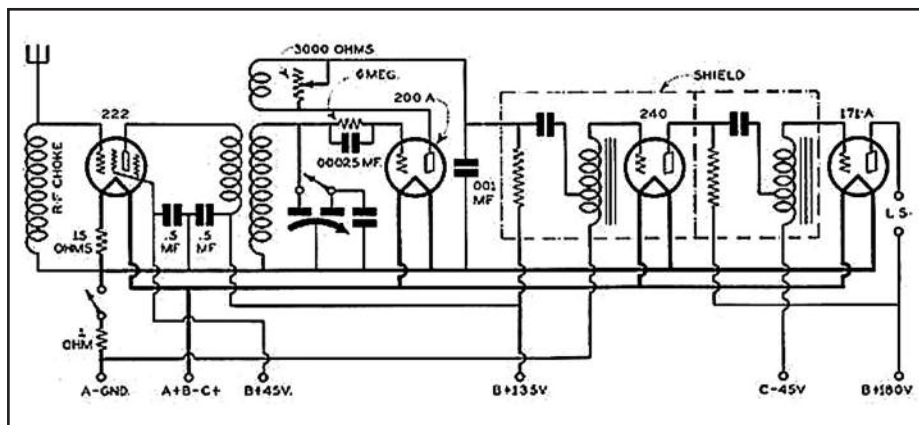
The switch was closed for tuning the medium wave (AM broadcast) bands. The rotation of the tuning capacitor is 270 degrees, with a tuning dial reading 0 to 150 divisions. This system allowed reasonably slow tuning on the short wave bands with full coverage of the broadcast band at a faster tuning rate.

The cabinet for the SW-4 is similar to the one later used on the SW-5. Basically there is a bottom skirt on a rectangular box with hinged lid. The front panel has a type E lighted dial with a variable resistor to the left and a switch to the right. The 3,000 ohm variable resistor is used to vary the feedback and gain. The switch is to control the filament power.

The coils for the SW-4 are very similar to the ones used in the SW-2. A,B,C and D coils were standard, the E and F coils were available as additional items. The coils



The special Type EC tuning condenser. Simple butterfly switch on frame was used to connect the two stator sections for broadcast band reception.



Schematic of the National SW-4.

were wound on a 2" diameter phenolic tube. The form material was made with wood flour and phenolic resin. These were hygroscopic, so performance would vary with humidity and temperature.

The coil coverage is shown in the table below:

Tuning Ranges of the SW-4 Coils					
Dial Reading		0 150			
Coil	kHz	Meters	kHz	Meters	Switch
A	16,600	18	10,700	28	Open
B	12,500	24	7,500	40	Open
C	8,000	37.5	4,600	65	Open
D	3,000	60	2,650	115	Open
E	2,680	110	1,750	175	Open
E	1,760	170	1,000	300	Closed
F	1,034	290	526	570	Closed

The first five coils are wound with number 16 wire with the same spacing (about a wire diameter). The coil forms increase in height up to the E coil. The F coil is much shorter than the E coil and closely wound with much smaller wire. The primaries are wound between the secondary windings and the tickler is wound in a slot at the bottom of the coil.

National sold the receiver either as a kit or completely assembled. The assembled versions were "built" by Abbott Laboratories. There was actually no such company. Abbott Street happened to run across the

end of the National facility. The subterfuge was carried out to bypass RCA agreements which would have required payment of 10% of income from all products, not just licensed receivers.

Each factory-wired receiver will have an Abbott Labs sticker in the lid. The sticker

was also the final test document. My receiver was tested by receiving the British short wave station G5SW. The test was carried out at 7:00 P.M. on 10/23/1929.

The power recommended for the SW-4 included a National 3580 B Battery Eliminator, a "C" battery, and a wet cell "A" battery. The 3580 is adjustable, so the voltages can be set properly. The battery hook up instructions warn that voltages must be

within 10% of the nominal voltage. In case the operator uses batteries for the B+ supplies they must be within the 10% value, this and the high current demand of the 71A makes the use of batteries less appealing.

The instructions discuss the internal resistance of batteries. When this gets too high there will be problems with howl, or motor-boating. This can be corrected by adding a large capacitor of the "Mershon" type.

The voltages required are 45 volts, 135 volts, and 180 volts as well as the C-

voltage of 4.5 volts. The battery cable has six conductors, the Black lead goes to the A- terminal, the Green goes to the C- terminal, the Yellow line goes to A+, B-, and C+, the Blue goes to +45, the Brown to 135 volts and the Red to 180 volts.

The instructions call for an antenna about 75 to 100 feet long as high and clear as possible. The ground is connected to the negative terminal of the "A" battery, not the chassis of the receiver.

The audio output of the 71A is adequate to drive a large speaker. If a smaller speaker or headphones were to be used, National recommended the addition of a "National Tone Filter" for protection.

The parts kits available included the following:

- Foundation Unit
- Set of 4 Coils
- Type E Lighted Dial
- Type EC4 Special Tuning Condenser
- SW-4 Duo Coupler
- No. 10 HF Impedance
- Switch with National Knob
- 15 Ohm Fixed Resistor
- 1 Ohm Fixed Resistor
- .00025 Fixed Condenser
- .0001 Fixed Condenser
- .001 Fixed Condenser
- Two .5 Fixed Condensers
- 3000 Ohm Special Variable Resistor
with National Knob
- 6 Megohm Grid Leak

- Three Binding Posts
- Six Wire Power Cable

Extras included the following:

- Cabinet
- Type "E" Coil
- Type "F" Coil

As was normal, no tubes were included. The list price for a wired receiver, case and all coils was \$65.00. The net price from Chicago Radio Apparatus Co. Inc. for this receiver wired and tested was \$38.22.

It is interesting to compare the RCA 1145 and the SW-4. The idea of an untuned screen grid tube to couple a standard three tube receiver to the antenna is not unique. The differences in tubes used, the interesting capacitor with switch and the type of audio coupling argue against the direct use of the RCA design.

The fact that Millen was a mechanical engineer, and did not do a complete design of a receiver, indicates that he did have some help with the electrical design. Glenn Browning and Frederick Drake both worked with National. Browning's resume indicates that he worked as a consultant to National for several years ending in 1928, though he was given recognition by National in the M-B receivers (Millen and Browning.) Robert Kruse also was a consulting engineer with National at this time. In all I believe that the differences indicate that this was not a direct copy of the RCA receiver.