The New National Ultra Short

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The 5-meter band is within your receiving range, if a short-wave converter of the type here illustrated and described is connected ahead of your ordinary broadcast band receiver. Mr. Millen and his associates have accomplished a fine piece of radio engineering work in the development and perfection of this ultra-short-wave converter, which actually changes your broadcast receiver into a short-wave superheterodyne for the reception of signals in the 5-meter band.

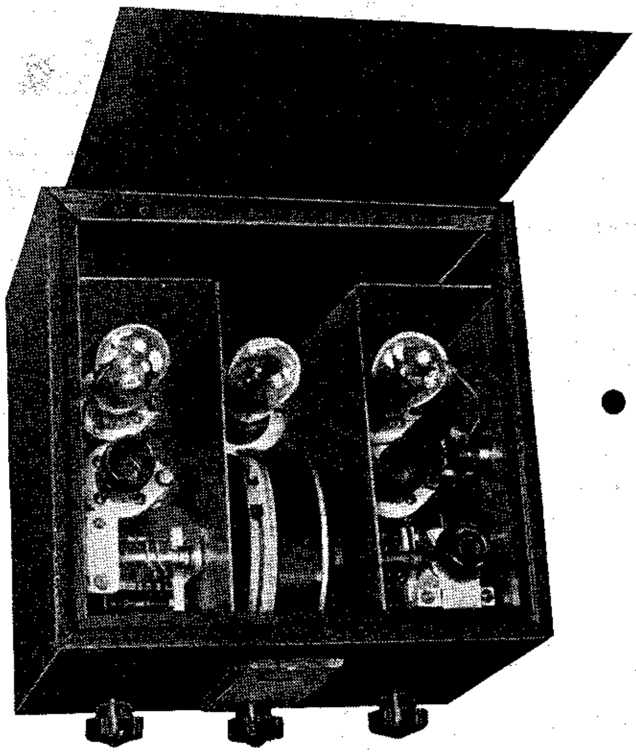


Fig. 4.

Note the business-like appearance of the new National ultra-short-wave converter. It uses three tubes.

● THE almost complete lack of selectivity which is to be found in a super-regenerative receiver was quite an advantage in the early days of ultra-high frequency development when but few transmitters were on the air. With the present popularity of the amateur *five-meter band* this condition no longer exists and the need of a relatively selective *ultra-high frequency* receiver is great.

Another present-day disadvantage of the super-regenerative receiver is extremely high noise level and consequently lack of weak signal activity. All of these difficulties are overcome in the new electron-coupled type of ultra-high frequency superhet, such as the new National type HFR described in the last issue of SHORT WAVE CRAFT.

As the cost of a complete ultra-high frequency receiver of this type is in many instances prohibitive to the average amateur or experimenter, a special converter has been developed, which, when used with a good broadcast receiver, will form a combination having most of the advantages of the new type HFR complete receiver. This converter is illustrated in the accompanying photographs and diagrams. The special coils, sockets and tuning condensers are shown in detail in Fig. 2. The data for winding the coils are given in Fig. 3. The condenser capacity (12 mmf. each) is so selected as to spread the 50-60 megacycle amateur band over approximately 100 dial divisions, so as to give full band spread. In addition to comprising an electron coupled oscillator and ultra-high frequency detector, there is also built into the converter a combination I.F. and coupling stage, so that the converter may be used with most any type of broadcast receiver, regardless of the contents of the complete circuit and regardless of the R.F. amplification or gain, as the I.F. stage in the converter supplies all the necessary amplification. In constructing an ultra-high-frequency converter of this type it is absolutely essential that the insulation used in the condensers, sockets and coil forms be made of special low-loss material suited for ultra-high frequency work, such as National R-39 or National Isolantite. This is particularly true of the coil forms which are molded of the extremely low loss R-39.

Tubes

The design of this unit is such that it may be operated with either the 6-volt D.C. heater type tubes or 2½-volt A.C. tubes. In the first case, two '36's are employed for detector and oscillator and a '37 for the output coupling tube. For A.C. operation, the corresponding tubes are two '24's and one '27; '35 tubes may be substituted for the '24's if desired. A certain amount of care must be exercised in the selection of tubes or trouble will be experienced from *microphonics* or noise resulting from leakage between heater and cathode. This latter trouble appears as a loud grating or scratchy hum. As a general rule, tubes of recognized quality having standard characteristics will prove entirely satisfactory. No special matching is required, since ample provision for balancing tube capacities, etc., is incorporated in the various circuits.

Antenna

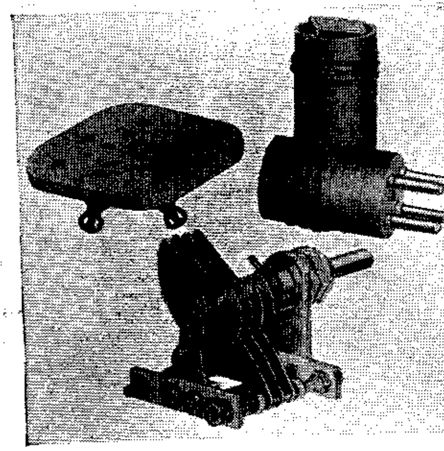
The antenna requirements are not in any way critical, although as a general rule a single wire as high as possible will give best results. The directional effects of various types of antenna are often very pronounced at high frequencies, so that the use of a vertical antenna located well away from any surrounding objects usually gives best results. The length may be between 5 and 50 feet over-all. A longer wire is not recommended, as it tends to increase the noise-to-signal ratio.

Power Supply

The filament or "A" supply may be either a 6-volt storage battery or 2½-volt transformer, depending upon the type of operation desired. In most installations, no connection between the storage battery and B-minus is required, although under certain conditions it may be advisable to ground one side. When a 2½-volt filament transformer is employed, the center of the winding should be grounded by means of a tap on the secondary or a center-tapped resistor having a total resistance of 10 or 20 ohms. The "B" supply may consist of either "B" batteries or a "B" eliminator, the batteries being preferable where fluctuating line voltages are encountered. The voltages are not critical and may be between 67 and 75 for the screen circuits and 135 to 180 for the plate circuits. Reference to the circuit diagram will show that the "B" batteries are subjected to a certain amount of current drain when the converter is not in use. The B-minus should, therefore, be disconnected during idle periods.

Intermediate Frequency Amplifier

The circuit of the type HFC converter is such that almost any broadcast receiver will be quite satisfactory for use as the I.F. and audio amplifier. For best results, the receiver should have a fair degree of sensitivity and should be stable. If the receiver has a tendency to oscillate, it will be somewhat emphasized



Brand new design of sockets, tuning condensers and coil forms, with the lowest possible dielectric loss, have been developed for the high frequency converter here described. (Fig. 2.)

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Wave Converter

when the converter is connected, which may make it impossible to fully advance the volume control without causing overall oscillation. Extreme sensitivity and selectivity are not required, since the converter employs a high gain I.F. stage and is in itself quite selective. As a matter of fact, the use of an extremely selective broadcast receiver is something of a disadvantage, especially when hunting for signals or when receiving signals having a large degree of frequency modulation. The broadcast receiver should be capable of tuning to a frequency of 1550 kc. (about 200 meters), the frequency at which the converter is designed to operate. If it so happens that a powerful station is operating on this frequency, the receiver should be detuned sufficiently to avoid the possibility of interference. Detuning as much as 30 or 40 kc. has no appreciable effect upon the ganging.

Installation

To install the converter, it is only necessary to connect suitable power supply equipment, *connect the* OUTPUT POST *to the* ANTENNA POST *of the* BROADCAST RECEIVER *and connect the* GROUND POST *of the converter to the* GROUND POST *of the receiver*. These two wires should be twisted loosely together or may be run closely parallel to each other. Ordinarily, shielding these leads is not required. The converter should not be placed more than six feet from the receiver and it is usually much more convenient from the operating standpoint to place the two units side by side.

The two coils accompanying the converter, while similar in appearance, have definitely different electrical characteristics. The coil having the red mark on the base should be placed in the detector coil socket (left-hand compartment), while the coil marked with black is for use in the oscillator circuit (right-hand compartment). The coils must be placed firmly down in their sockets or trouble will be experienced in obtaining correct ganging and maintaining calibration. It will be noticed that the connecting leads between the ends of the coils and the pins in the coil form are bent. These leads must not be straightened or altered in any way, since the coils are individually calibrated by carefully adjusting the leads in the laboratory. When the converter is properly aligned, the range from 56-60 megacycles will cover from approximately 125-55 on the dial. The calibration of individual sets may vary appreciably, however.

Operation, Alignment, Etc.

After the converter has been properly connected, the broadcast receiver should be tuned to approximately 1550 kc. (about 200 meters) and the volume control fully advanced. From left to right the converter controls are detector *trimmer condenser, tuning control* and detector *regeneration control.* The oscillator padding condenser will be found at the top of the oscillator (right-hand) compartment.

It is first necessary to set this padding condenser to properly align the oscillator and detector circuits. The detector trimmer condenser should be set at approximately half capacity and the tuning dial at about 100. No signal is necessary during this procedure, other than the usual background hiss from static, tubes, etc. Starting with the regeneration control (right-hand knob) fully advanced, rotate the padding condenser back and forth over the entire range, meanwhile slowly reducing the regeneration. At a certain setting of the regeneration, it will be found that as the padding condenser is rotated, the background noise will sharply increase at two points. At these points the oscillator is aligned with the detector, the lower capacity setting of the padding condenser being the correct adjustment, since the oscillator is designed to work on the high frequency side of the detector. In other words, while there are two points where the oscillator and detector may be aligned (when the oscillator is tuned either above or below the detector by the amount of the intermediate frequency), the correct

(*Continued on page* 381)

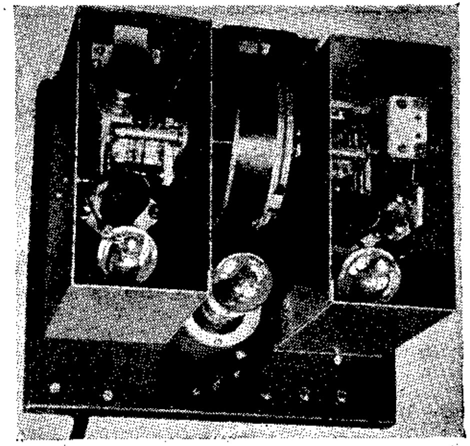


Fig. 5, above—Rear top view of U.S.W. converter with shield covers removed.

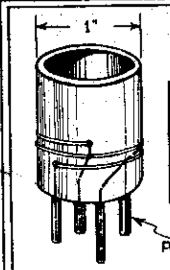


FIG. 3

56-60 MEGACYCLE DATA

COIL	WIRE	TURNS	TAPPED
MOD.	No.18	$2\frac{1}{6}$ T	$\frac{3}{8}$ T
OSC.	No.18	$2\frac{1}{12}$ T	$\frac{3}{8}$ T

Winding data for the coils used in the 5-meter band converter.

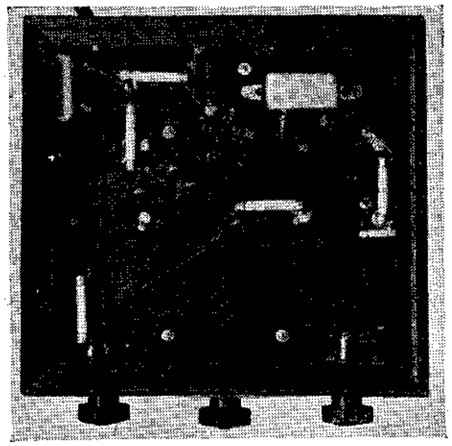
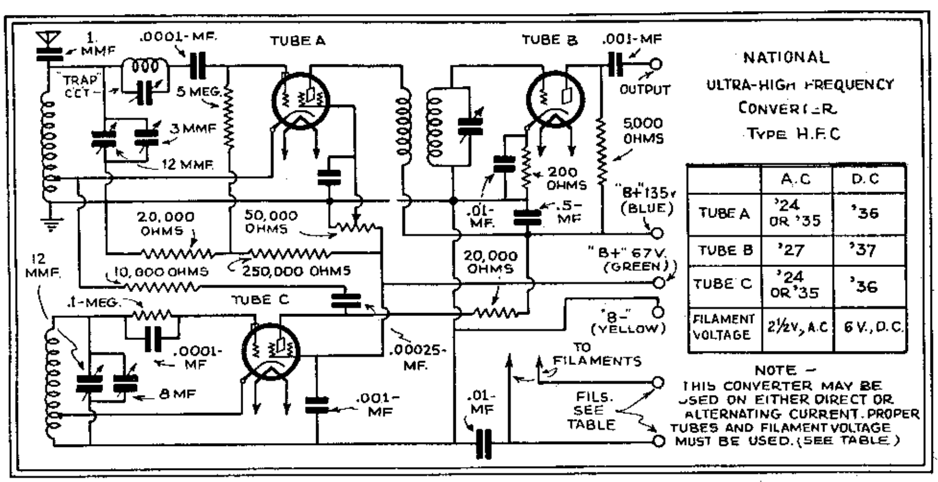
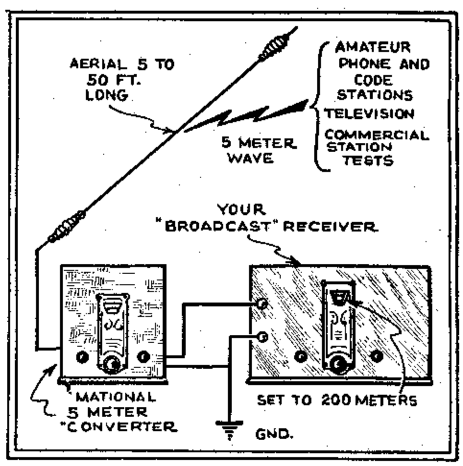


Fig. 6, above—Bottom view and relatively simple wiring of 5-meter converter.



	A.C	D.C
TUBE A	'24 OR '35	'36
TUBE B	'27	'37
TUBE C	'24 OR '35	'36
FILAMENT VOLTAGE	2½V., A.C	6 V., D.C

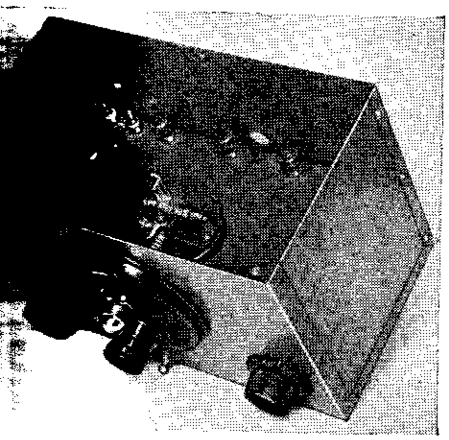
Diagram showing arrangement and connection of parts in the new National ultra-short-wave converter. (Fig. 1.)

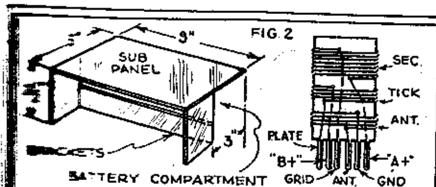


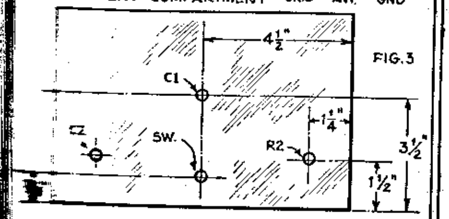
By simply adding this U.S.W. converter ahead of your broadcast receiver, you can hear 5-meter signals.

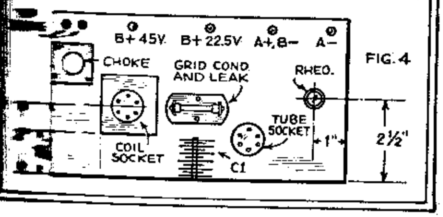
er — June Contest

N. D., $7.50 Prize









[illegible] to the schematic diagram. This is [illegible] that no special instructions should [illegible]. When the wiring has been com- [illegible] and thoroughly checked, the batteries [illegible] connected to the proper binding posts. [illegible] the tube and the 95 to 200 meter [illegible]. Connect the antenna and ground to the [illegible] on the switch and advance the fila- [illegible] rheostat until the tube just begins to [illegible]. With condenser C2 set at maximum no [illegible] be experienced in receiving [illegible] in the vicinity of 200 meters [illegible] regeneration control is advanced. If [illegible] not oscillate, increase the number [illegible] the tickler. If the set goes into [illegible] with a thud, reduce the size of the [illegible] Also try different values of grid leak. [illegible] all of the parts used in this [illegible] on hand when the receiver was [illegible]. Persons who desire or must use [illegible] are advised to substitute parts of [illegible] design. The list of parts used [illegible] together with the recommended [illegible] are given below:

COIL TABLE

15-30 METER COIL

L1	L2	L3
[illegible]	4 T. No. 20 dsc	5 T. No. 26 dsc
30-60 METER COIL		
[illegible]	10 T. No. 20 dsc	5 T. No. 26 dsc
50-110 METER COIL		
[illegible]	20 T. No. 26 dsc	8 T. No. 26 dsc
95-200 METER COIL		
[illegible]	40 T No. 26 dsc	9 T. No. 26 dsc

[illegible] on National forms; ¼-inch spac- [illegible] windings.

C1—Pilot 13 plate midget condenser
C2—Pilot 23 plate midget condenser
C3—Sangamo .0001-mf. fixed condenser
C4—Polymet .001-mf. fixed condenser
C5—Pilot .006-mf. fixed condenser
C6—Muter .25-mf. fixed condenser
R1—Tobe 9 megohm grid leak
R2—Electrad 0-500,000 ohm Royalty 25 ohm resistor
R3—Bradleystat rheostat
L4—Wirco radio frequency choke coil
SW—ICA filament switch
4—National "6 prong" coil forms
1—National coil socket
1—5x6x9 metal cabinet (1—5x6x9 Alcoa aluminum can recommended)
1—Pilot Kilograd dial (National or Kurz-Kasch 3" dial recommended)
1—Silver-Marshall 5 prong tube socket (Eby wafer socket recommended)
2—Yaxley tip facks
6—Binding posts
2—Burgess type 4156 "B" batteries
4—Burgess No. 1 Unicells.

National U. S. W. Converter

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setting of the oscillator is equal to the detector frequency plus the intermediate frequency. Under certain conditions, where the capacity of the tubes employed vary somewhat from normal, the padding condenser may be almost at its minimum capacity. It will now be found that by rotating the detector trimmer control the background noise will peak at approximately half capacity. Further reducing the regeneration will broaden the peak and reduce its amplitude, until finally it will no longer be apparent. Advancing the regeneration, the peak will increase until the point is reached where the detector actually goes into oscillation, at which time the converter will be practically inoperative, due to detector overload from its own oscillation and due to I.F. overload by the strong beat between detector and oscillator.

S-W Beginner

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correspond in minutes and seconds with the Greenwich time, although the hours vary one hour forward or back for each meridian east or west of Greenwich. In the United States the standard times are: Eastern, 75 degrees west (five hours slower than Greenwich); Central, 90 degrees west (six hours slower); Mountain, 105 degrees west (seven hours slower), and Pacific, 120 degrees west (eight hours slower).

A very useful time conversion chart may be obtained by sending 10 cents in coin to the Superintendent of Documents, Government Printing Office, Washington, D. C., for a copy of Miscellaneous Publication No. 84, entitled "Standard Time Conversion Chart."

Skipping and Fading

A transmitting antenna sends out radiations which move in straight lines, as shown in Fig. 2. The waves which travel along the surface of the earth are called *ground waves* and those which are directed upward are the *sky waves*. Actually the ground and sky waves are identical, except for the direction of travel. The ground waves follow the surface of the earth and pass through mountains, cities, forests, etc., and are slowed down and weakened by these obstructions. This weakening effect is so strong that the ground waves are practically non-existent at 500 miles, depending of course on the wavelength and the power used. It is evident that if the ground waves alone were heard in our receivers, long distance transmission would be out of the question.

The sky waves do not travel in straight lines indefinitely, for if they did they would never return to the earth and would not affect our sets. According to the Heaviside layer theory, there exists around the earth's surface, at varying heights, an enveloping layer of ionized gas. This ionization may be caused by radiations of electrons or ultra-violet light from the sun. In any event, this layer is thought to be present around the earth. When the sky waves reach it, they are reflected from it as shown in Fig. 3 in a similar manner to the way light rays are reflected by a mirror.

This reflecting layer explains skipping. As seen from Fig. 3, the receiver may be located so far from the transmitter that it does not receive the ground waves. If the reflected sky waves return to the earth beyond the location of the receiver, no signal will be received. This reflection may also explain fading, for if the reflecting layer is not constant, the point at which the reflected wave hits the earth may vary, causing the signals to keep fading and returning.

Fringe Howl

A great many short-wave receivers are troubled with a condition known as *fringe howl* which prevents their correct operation. When the regeneration is increased just under the point of oscillation, the receiver starts to howl or hum. This trouble is not very prevalent in sets without amplification, but when the receiver uses two audio frequency stages, it often becomes unmanagable.

Increasing the amount of regeneration will stop it, but it is sometimes desirable to operate the set just under the point of oscillation. One simple method of eliminating the trouble is to connect a resistor of about 100,000 ohms (the grid leak type) across the secondary of the first audio transformer. Those of us who built the Beginner's Short-Wave Set will not be bothered with this difficulty yet, as we have not added the amplifier to the set.

Dead Spots

A great many short-wave sets are troubled with so-called *dead spots* or points on the dial at which the set will not oscillate.

In the first article of this series, we found that if a coil was placed in the proximity of another coil which was connected to a source of current, a current would also be picked up in the second coil. This may be expressed in the following manner: If a coil is coupled to a second coil with a current flowing, the first will absorb energy from the second.

This is what happens at the dead spots. For some reason, a circuit tuned to that particular frequency is absorbing current from the coils of the set. The trouble is most commonly caused by the aerial being tuned to that frequency and the energy is absorbed in the antenna system.

The solution to the problem is evident. The aerial must be tuned to a different wavelength at which there are no stations. This may be done in any one of three ways. The first is to change the dimensions of the aerial, either making it longer or shorter. This is not always practical, both because of structural difficulties and also because it is difficult to know what length will eliminate the trouble. It would be very disappointing to find that the wavelength of the aerial had been shifted to another waveband where stations might be received.

The second method is to connect a small variable condenser in series with the aerial lead, in order to tune it to another point on the scale at which no stations are heard.

The third method is to tune the aerial to an entirely different waveband, by connecting a coil and a condenser in the aerial circuit. A coil such as the one described in the article last month for eliminating broadcast interference will be suitable. It may be used for the dual purpose of changing the fundamental wavelength of the antenna and also stopping broadcast interference, by tuning it to the point where the broadcast station disappears and the oscillation returns. The dimensions of this wave-trap are repeated in Fig. 5 for the benefit of the reader.