Antique Wireless Association of Southern Africa

 # 211 **February 2024**

RCA AR88 RECEIVER

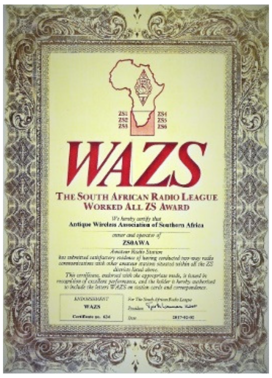
The AR88 is a general purpose communications receiver manufactured by RCA in the U.S.A between 1941 and 1945. They were made in large numbers for service use. Most were sent to the U.K. and Russia for the war effort. They came in 2 versions, the AR88D and the AR88LF (low frequency version). The R.A.F. designation was R1556A and R1556B for the LF version. They evolved into the CR88 in 1946 with crystal phasing, and the CR88A with an S meter. Later models CR91 and CR91A have the same coverage as the AR88LF. Model SC-88 is like the CR88 but shows only the band in use. CR88B is the last version in 1951 and has a crystal calibrator. D89 is a triple diversity version.

This is the LF receiver, and it is very nice to use, with the exception of the small dial scale and band indication. The tuning is smooth and it is very sensitive. It is also very stable. The front panel layout is handsome, with dial light behind the 3 windows. The circuit uses 2 RF stages (6SG7), a first detector (6SA7) and oscillator (6J5), 3 IF stages (6SG7), second detector and AVC (6H6), noise limiter (6H6), BFO (6J5), AF amplifier (6SJ7) and power output amplifier (6V6GT), a power supply (5Y3GT), and regulator (VR150). They are all metal valves; except for the audio output, rectifier, and regulator. The aerial can be a 200 ohm balanced line or an unbalanced single lead in, connected to screw terminals on the back.

The main differences between the AR88D and the AR88LF are the frequency coverage. They also have different IF frequencies (AR88D is 455kcs, AR88LF is 735kcs) and different audio output valves (AR88D is 6K6, AR88LF is 6V6). The frequency coverage is:

	AR88LF	AR88D
Band 1	73 - 205 kc	535 - 1600 kc
Band 2	195 - 550 kc	1.57 - 4.55 mc
Band 3	1.48 - 4.4 mcs	4.45 - 12.15 mcs
Band 4	4.25 - 12.15 mcs	11.9 - 16.6 mcs
Band 5	11.9 - 19.5 mcs	16.1 - 22.7 mcs
Band 6	19.0 - 30.5 mcs	22.0 - 32.0 mcs

It is a 19" rack mount type chassis, and usually comes in a cabinet, the total weighing 100 pounds. It will run on 115v or 240v AC mains, 25-60 cycles and draws 100 watts. It can also run on 6v DC (12 amps) with the external power supply type MI-22215 (a vibrator supply). It can also have an external metal speaker box. The sensitivity is quoted as 15 micro volts for 20db signal to noise for MCW and 5 micro volts for CW. It will deliver 2.5 watts to the loudspeaker. The designers have put a lot of effort into screening the RF and oscillator circuits to reduce radiation, and making the receiver stable by rugged metal work, temperature compensated oscillator circuits, and a regulated HT supply for the oscillator.



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Reflections:

I very often reflect back on my early days as a ham. What makes it even more interesting is when I meet up with people with who I forged such close relationships with in those days, because of amateur radio.

Since moving to the Northern Cape I have again had such an experience. Meeting up with the person who introduced me to amateur radio has been such a thrill. I am now trying to coerce him back into getting active on the air again and one of these days it will happen.

My friend Lemmie, I first met in the Kommando in Hay Kommando here in the Northern Cape. He was in charge of sigs for the commando. Because I was a CB'er, I got into sigs and was a platoon signals op. Pretty soon he heard of me and I was then drafted into the HQ, where I tried to convince him that CB was not so bad. On his farm, about 13km from Griekwastad, he had a 7 element beam up at 20m. I convinced him to let me couple my CB to his antenna and we had fun. I proved to him that, in those days with such good band conditions, we could contact the world on 12w.

Now after 40 years, we have met up again. My elmer still has his TS830s which he had then. He also has a Yaesu FT107, which is the first time I have seen one of them and we are working at getting him back on air. He is a sprightly 82 years young and still gives extra lessons to school kids in mathematics and physics. Nothing wrong with that brain.

Due to circumstances, drought and stock theft, he was eventually forced to sell the farm and move on. Teaching was always his passion and although he kept up his license all those years, there was no time for amateur radio.

When I think of the friends I have made along this road of amateur radio, I consider myself to be quite privileged. These are friendships that are made to last for years on end and are always so easy to maintain. Usually just a PTT away.

In this case, it was not to be, but circumstances have caused our paths to cross again, like so many missed opportunities that seem to pass us by.

I often wonder what has happened to so many other friends I have made along this road. The guys who were all involved in the CWIG in the early 80's. Many have gone SK, but I know too there are still quite a few around.

My friend Cliff, who I met while on a training course in Maccauvlei, also in the 80's. I had a Kenwood 700G with a portable Slim Jim antenna and called in on the Vereeniging repeater. Next thing I knew, I was invited to supper.

Friendships forged in time cannot be forgotten.

Best 73

DE Andy ZS3ADY

Coronal Mass Ejection (CME) **Wikipedia**

Interactions in the heliosphere

As ICMEs propagate through the interplanetary medium, they may collide with other ICMEs in what is referred to as *CME–CME interaction* or *CME cannibalism*.

During such CME-CME interactions, the first CME may clear the way for the second one and/or when two CMEs collide it can lead to more severe impacts on Earth. Historical records show that the most extreme space weather events involved multiple successive CMEs. For example, the famous Carrington event in 1859 had several eruptions and caused auroras to be visible at low latitudes for four nights.[31] Similarly, the solar storm of September 1770 lasted for nearly nine days and also caused repeated low-latitude auroras. The interaction between two moderate CMEs between the Sun and Earth can create extreme conditions on Earth. Recent studies have shown that the magnetic structure in particular its chirality/handedness, of a CME can greatly affect how it interacts with Earth's magnetic field. This interaction can result in the conservation or loss of magnetic flux, particularly its southward magnetic field component, through magnetic reconnection with the interplanetary magnetic field.

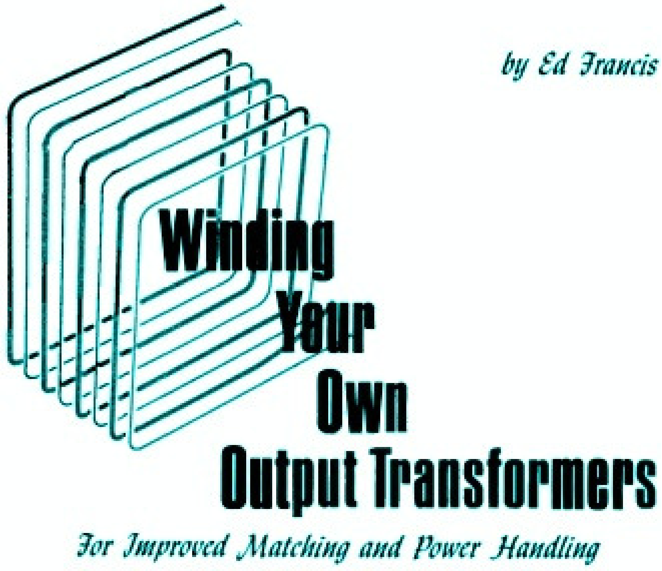
Winding Your Own Output Transformers

September 1970 Popular Electronics

Even if you no longer - or never did - have the need to wind your own audio frequency output impedance matching transformers, this article from a 1970 issue of Popular Electronics magazine provides good insight into the factors necessary for consideration when doing so. One particularly nice feature here is that power handling is taken into account, including wire size to use for the primary and secondary (or multiple outputs). At audio frequencies, where the transformer is driving speakers with typical impedances of 4, 8, or 16 ohms, you do not need to worry too much about parasitic capacitance and inductance. The basic equations do a pretty good job of predicting performance. Author Ed Francis explains how to modify a junk-box laminated core transformer to work, as well as providing a table of enameled wire size ampacities and turns per linear inch. An example of how to perform all the steps is given.

For Improved Matching and Power Handling

By Ed Francis



Circuits involving solid-state components frequently require "non-standard" audio output transformers. This article describes simplified methods of calculating the primary/secondary ratios, wire sizes, and numbers of turns for low-impedance matching transformers wound on "salvaged" cores.

Project Builders and experimenters occasionally need a small impedance matching audio transformer with an uncommon impedance ratio. When such a transformer is specially wound, its cost is usually prohibitively high compared to the total cost of the project in which it is to be used. However, with a few calculations and a little work on your part, you can duplicate many unusual transformers or and special audio coupling or matching transformer to suit your needs. The techniques prescribed in this article are limited to transformers of average size and low-to-medium impedance. It is impractical to duplicate subminiature transformers that normally cost only $1 or less and high-impedance transformers that require many turns of very fine wire.

Throughout tins article, you will find the term "volt amperes" (VA) used in the same manner that "watts" is used for power. This usage involves an assumption which is not quite true. However, for this type of work, if you accept the assumption that the two are equal, the results will be acceptable.

Calculations involved in designing an audio transformer are covered by the nine steps outlined in the box on page 81. To see how these steps work, let's design a typical transformer. Assume that a transistor output transformer with a 130-ohm primary and a 4/8/16-ohm secondary is needed to match the output of an RCA CA3020 IC to a loudspeaker. By referring to the mail-order catalogs, we find that the full output of the IC is 0.5 watt. The nearest thing you can find in the catalog is a 125-ohm center-tapped transformer rated at 300mW. This transformer could be used, but, you can make one that will be. just as good and design it for a full watt if space and weight requirements permit.

First calculate the core area required. Note, however, that tile core area applies only to the cross-sectional area of the core's center leg as shown in Fig. 1. Referring to Fig. 2, we find that the graph shows an approximate core area of 0.18 sq. in. will snit our requirements. (We can use an approximation since the actual core area is not too critical.)

Determine the turns ratio from the impedance ratio. Since we know the primary and lowest secondary impedances to be used, plug 130 and 4 into the equation: Ratio = the square root of (130/4):1 = 5.7:1. Hence, the actual turns ratio required shows 5.7 turns in the primary winding for every turn in the secondary winding.

Next, determine the d.c. voltage to be applied to the transformer's primary. In this ease, we desire 9-volt operation. The CA3020 employs a push-pull. output. So, bear in mind that an 18-volt figure must be used in all primary calculations.

Calculate the wire size needed for the primary winding.

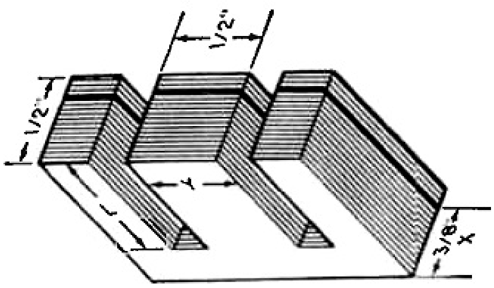


Fig. 1 - Calculate X dimension needed to provide core area when multiplied with Y dimension; then, as indicated by heavy lines, remove required number of metal laminations.

Since we have decided to design the transformer to handle 1 watt of power, let us first determine how much current will be handled by the primary: I = (VA/ Vcc) = 1/9 = 0.111 A. Now, because of the push-pull division of the current, we divide the primary current by two for determining the wire size; this gives us 55 mA in each half of the primary winding. If 700 circular mils/ ampere is desired, refer to the Wire Table (column four) on page 80, and locate the current at or greater than 55 mA. Column one shows that #34 wire will safely handle 57 mA, the nearest figure to 55 mA. This size is quite small and difficult to work with, so choose #28 wire for ease of winding.

We will have to make some assumptions now in determining the number of primary turns to be used. For this calculation, we will use 2Vcc, or 18 volts, and an area of 0.18 sq. in. for our 1-watt transformer. The frequency we will arbitrarily settle on as being 100 Hz. For flux density BM in gauss/sq. in., any figure between 40,000 and 90,000 can be used; we'll settle on 70,000 to be conservative:

$$\text{Primary Turns} = 2Vcc \times 10^8 / (4.44 \times A \times f \times BM)$$

$$= 18 \times 10^8 / [4.44 \times (0.18) \times (100) \times (70{,}000)] = 321$$

so, 320 turns will be close enough.

Having calculated the number of primary turns, we use the turns ratio formula to calculate the number of secondary turns needed. This is a step-down-type transformer, so we divide the number of primary turns by t to turns ratio: Secondary Turns = Primary Turns / Turns Ratio = 320 / 5.7 = 56 turns.

Secondary wire size is determined by the current ratio method. Secondary current is equal to the primary current multiplied by the turns ratio: 0.111 x 5.7 = 0.64 A. The secondary wire size is determined by the same method as used for the primary. At 700 circular arils/ ampere, the Wire Table indicates a 577 mA current capacity for #24 and 728 mA for #23 wire. Since 640 mA is about midway between the two sizes, we will settle on #23 wire.

Finally, the 8-and 16-ohm taps must be calculated. Again, refer to the turns ratio formula, and determine the turns ratio for 8 and 16 ohms separately. Then use these ratios with the primary turns to determine the exact number of turns required for each impedance: 16 -ohm ratio = the square root of (130/16):1 = 2.86:1; 8 -ohm ratio = the square root of (130/8):1 = 4.04:1. Secondary turns = 320/2.86 = 112 turns for the 16-ohm ratio; Secondary turns = 320/4.04 = 79 turns for the 8-ohm ratio. Hence, the composite secondary will consist of 112 turns of wire with taps at the 56th and 79th turns.

Now that we have all of the design parameters, we can proceed to assembling our special-purpose transformer.

Assembling the transformer from the design parameters derived from the above procedure is easy. We know that the core area must be about 0.18 sq. in. The simplest and least expensive way of obtaining a suitable core is to salvage an old audio output transformer. Many such transformers have a core area of 0.25 sq. in. If about a quarter of the laminations are removed, approximately the correct dimensions will be obtained (about 0.185 sq. in.).

Disassemble the salvaged transformer, and remove and discard the windings, but reserve the plastic winding bobbins if it has one. It no bobbin is available, you can make one from an index card or heavy waxed (butcher's) paper. This bobbin should easily slide over the core leg and be a little shorter than the center leg of the laminations.

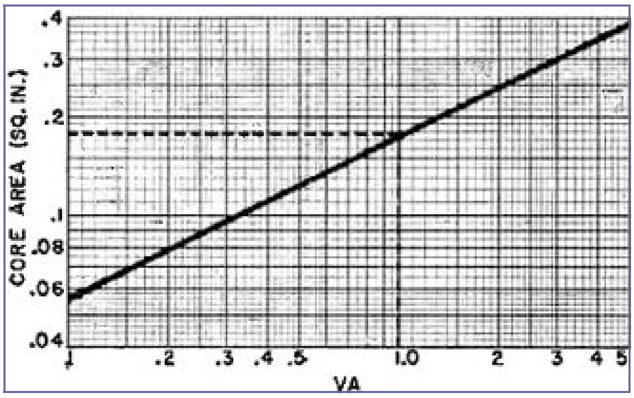


Fig. 2 - Lengthy mathematical computations for determining the transformer core area can be avoided with the aid of the graph shown here.

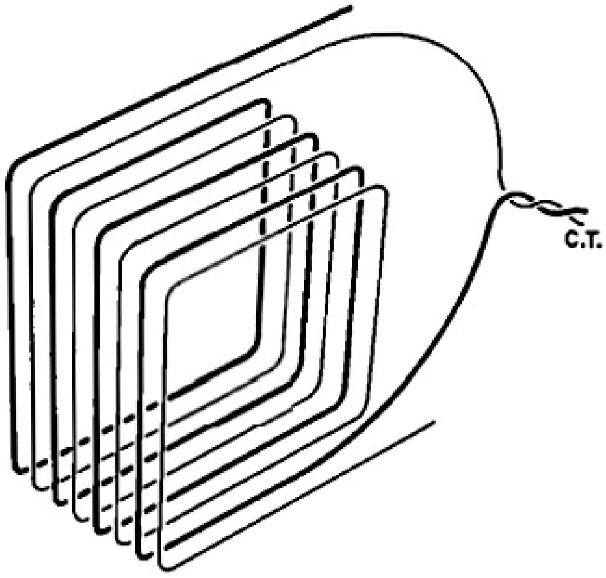


Fig. 3 - Bifilar winding technique precisely locates center-tap. Center-tap is derived by twisting together opposite ends of winding.

WIRE TABLE

AWG B&S	Area (circular mils)	Current capacity at 600 c.m. per ampere	Current capacity at 700 c.m. per ampere	Current capacity at 800 c.m. per ampere	Turns/ linear inch, enamel insulation
14	4107	6.85	5.87	5.14	15.0
15	3257	5.43	4.65	4.07	16.8
16	2583	4.31	3.69	3.24	18.9
17	2048	3.42	2.93	2.56	21.2
18	1624	2.71	2.32	2.03	23.6
19	1288	2.14	1.84	1.61	26.4
20	1022	1.71	1.46	1.28	29.4
21	810	1.35	1.16	1.02	33.1
22	642	1.07	.918	.804	37.0
23	509	.848	.728	.636	41.3
24	404	.674	.577	.505	46.3
25	320	.534	.458	.400	51
26	254	.424	.363	.318	58
27	201	.336	.288	.252	64
28	160	.265	.228	.199	72
29	126	.210	.181	.158	81
30	100	.167	.144	.125	90
31	79	.133	.114	.096	101
32	63	.105	.090	.079	113
33	50	.083	.072	.063	127
34	39	.065	.057	.049	143
35	31	.053	.045	.039	158
36	25	.042	.036	.031	175
37	20	.033	.028	.025	198
38	15	.025	.022	.019	224
39	12	.020	.018	.015	248
40	10	.017	.014	.012	282

Wire Table

Slide the bobbin onto a length of wood to serve as a winding handle. Then begin winding the primary turns onto the bobbin, starting and ending along the 1/2" side of the bobbin to avoid having the ends exit from the core "windows" when the bobbin is in place. Ordinary "scatter" winding is acceptable in most cases; but if space is limited, you might have to close-wind the turns. Our hypothetical transformer has a further complication: The primary winding is center-tapped. It must be wound so that both sides of the winding are balanced. To do this we will use the "bifilar" winding method shown in Fig. 3.

For our 320-turn primary winding, we wind two wires onto the bobbin simultaneously, side by side, until there are 160 double turns on the bobbin. Then to complete the bifilar winding, we connect one end of one wire to the opposite end of the other wire and solder on a 5" length of stranded hookup wire to make the center tap. Two more stranded wires soldered to the free ends of the primary windings complete the primary assembly. Color code the wires so that the center tap is easily identifiable. Make sure that each soldered connection is well insulated from the others; then wrap a layer or two of plastic tape over the windings.

Now wind the secondary turns onto the bobbin. Count tile turns as you go, and make a pig-tail tap leads at the 56th and 79th turns for the 4- and 8-ohm taps (see Fig. 4). Use color coded stranded hookup wires for the winding ends and taps so that each can be easily identifiable. Again, make s ire that the solder connections are well insulated from each other, and wrap a layer or two of electrical tape over the assembly to prevent the windings from unraveling.

Slip the bobbin assembly off the winding handle. Orient the primary leads to one side and the secondary leads to the other side of the bobbin. Then slip the bobbin onto the center leg of the transformer core laminations. Assemble the transformer.

Testing the completed transformer is not really necessary if you exercised care during assembly and followed each step exactly as described. However, if you want to be on the safe side, von can test the transformer with the aid of an audio signal generator, two ac VTVM's or FET VOM's, an 8-ohm load resistor, and a 1000-ohm potentiometer as shown in Fig. 5. Set the generator's amplitude control for an output of several volts at 1000 Hz. Adjust the potentiometer for mini-mum resistance so that both meters have an identical reading.

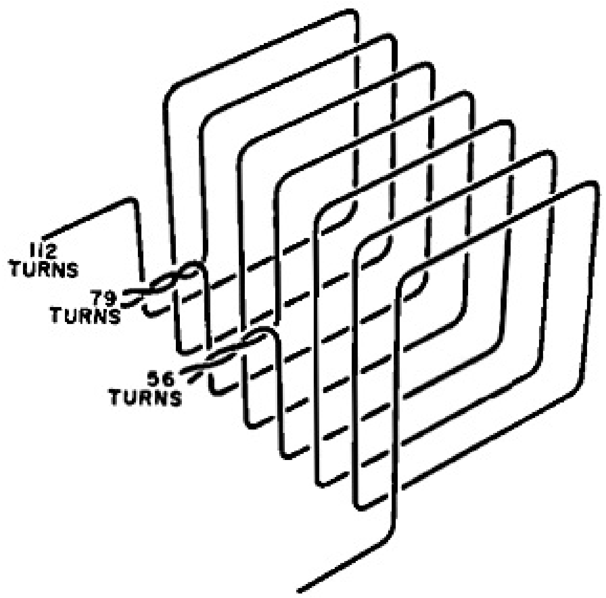


Fig. 4 - Individual taps are obtained by twisting short pigtails from continuous length of wire. Attach stranded wire leads to pigtails.

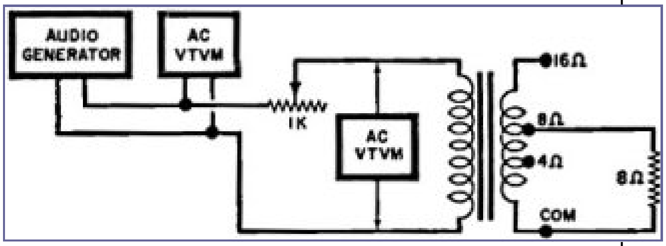
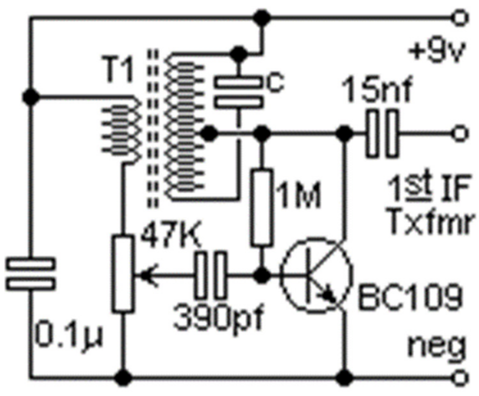


Fig. 5 - Although not really necessary if you followed all steps carefully, the finished transformer can be tested as shown in drawing.

Now, increase the resistance of the potentiometer until meter #2 indicates exactly, one half its original indication while making sure that meter #1 remains at the original voltage setting. Since changing the resistance of the potentiometer decreases the load on the audio generator, meter #1 will indicate an increase in voltage. Simply reduce the generator's output level to return meter #1 to the original voltage setting.

After jockeying back and forth between the generator's amplitude control and the potentiometer a few times, you should be able to arrive at settings where meter #1 indicates the original voltage and meter #2 indicates exactly half of its original voltage. When this occurs, remove the potentiometer front the circuit without upsetting its final setting and measure its resistance. This resistance should be equal (or as near as possible) lo the transformer's input impedance, or 130 ohms. However, if the transformer is loaded with an incorrect impedance (say, the 8-ohm load resistor connected acres the 4-or 16-ohn output leads), it will reflect an incorrect impedance into the primary. As a matter of tact, if you use a 3.2-ohm speaker on the 4-ohm transformer output, a primary, impedance somewhat lower than that for which the transformer was designed will be reflected. But if you plan to rise such a speaker with the transformer, yon could easily have plugged into the equations the 3.2-ohm figure for the 4-olun figure.



9-Step Audio Transformer Design Example

In approaching something like the design of your own special-purpose audio matching or output transformer, you should use a practical, realistic procedure. The nine steps outlined here are set up so that you will not overlook time and work -saving steps and will lead you from start to finish without a lot of messy mathematical calculations.

Step (1). Refer to the catalogs for all available data (such as primary and secondary impedances and power and voltage ratings) concerning

NEW J.B. 'UNITUNE' CONDENSER – *a triumph of precision*

NEW J.B. PRODUCTS include entirely **new Gang Condensers** in semi- or fully-screened types. **New Gang Condensers for Super Hets. New Illuminated Disc Drive** for use with above gangs.

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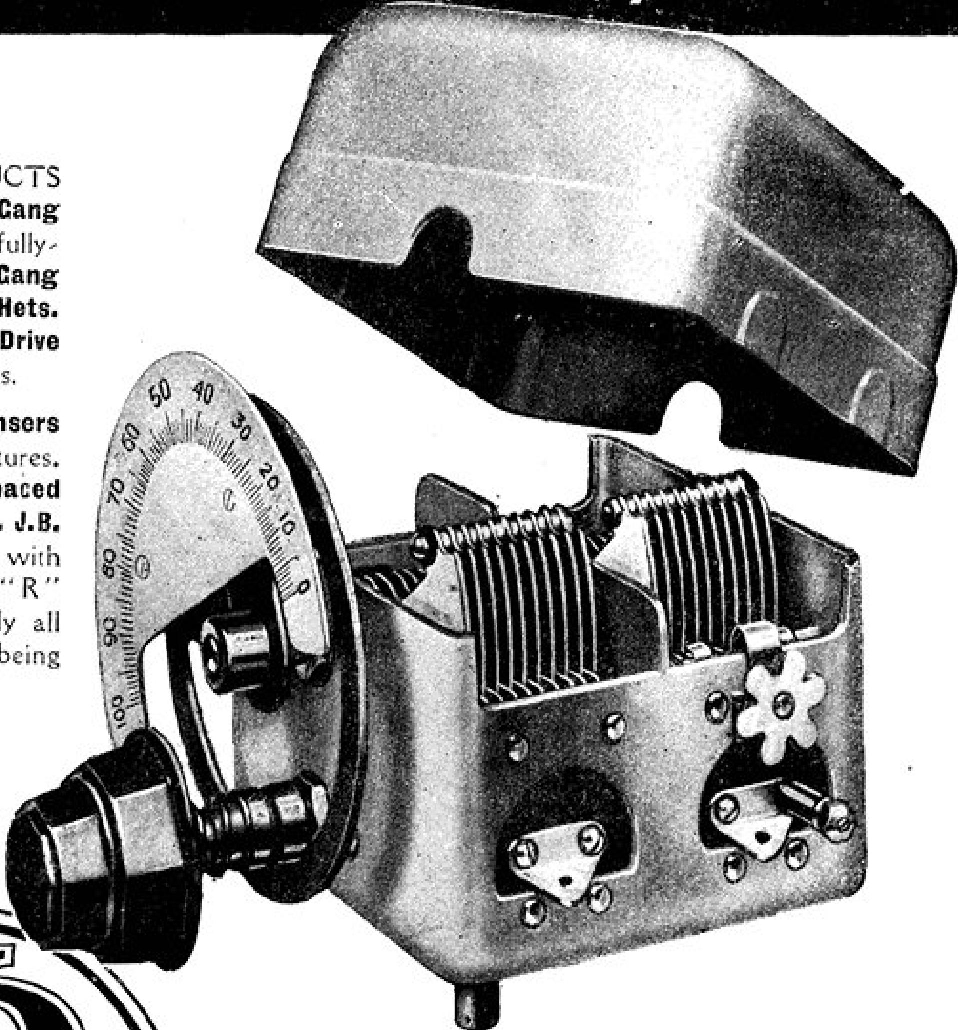
STAND No. 204
NATIONAL RADIO EXHIBITION



REG TRADE MARK

J.B. "UNITUNE" Gang Condenser.

A pre-set trimmer is fitted to one half, while the other half has a trimmer which is operated from the front of the panel. The panel-trimmer control is concentric with the main tuning knob. Capacity ·0005. Complete with disc drive and bakelite escutcheon plate.

2 gang - - **18/6** 3 gang - - **27/-**

PRECISION INSTRUMENTS

Advertisement of Jackson Bros., 72, St. Thomas' Street, London, S.E.1. Telephone: Hop 1837.

the transformer needed.

Step (2). Determine the transformer core area; from the transformer power rating (VA), area is equal to the square root of VA divided by 5.58. A quicker method is to refer to the graph in Fig. 2. Read up from the selected volt-amperes figure to the diagonal line, project to the left and read the core area in square inches.

Step (3). Calculate the turns ratio. From the impedance ratio, the turns ratio is equal to the square root of (Z1/ Z2), where Z1 is the larger and Z2 the smaller impedances.

Step (4). Determine the voltage for which the transformer primary is to be used. For single -ended operation, use supply voltage Vcc; for push-pull operation use 2Vcc.

Step (5). Compute the size of the wire needed for the primary turns. Using the transformer power rating and the d.c. operating voltage (Vcc), primary current equals VA/Vcc. For audio service, a minimum of 600 circular mils/ ampere is recommended; winding space permitting, it would be better to figure on using 700-1000 circular mils/ ampere. A center. tapped primary would have only half of the total current flowing through each half of the winding at any one time, so the metric area can be reduced by half.

Step (6). Calculate the number of primary turns needed:

Primary Turns = Vcc x 10^8 / [4.44 x (A) x (f) x (BM)],

where Vcc is supply voltage; A is core area in square inches; f is the lowest frequency to be passed without loss; and BM is flux density in gauss/square inch.

Step (7). Determine the number of secondary turns required. If the transformer is to be an impedance -step up type, multiply the turns ratio by the number of primary turns calculated; if step-down, divide the primary turns by the turns ratio.

Step (8). Calculate the secondary wire size by the turns ratio method. Current transfer is inversely proportional to the turns ratio. Hence, if the transformer is a 10:1 step-down type, the secondary should be capable of handling ten times as much current as the primary. Once the current capacity is determined, you can refer to the Wire Table to find the smallest diameter wire that will suit your needs. It is, however, advisable to use the largest practical size wire to obviate a large d.c. voltage drop in the windings.

Step (9). If the center tap is required, use the "bifilar" method of winding (see text). For multi-impedance outputs, recalculate the turns ratios, secondary currents, etc., for each output impedance.

AWA CW ACTIVITY DAY

The aim of the CW Activity Day is for participants to contact as many amateurs as possible on the 20, 40 and 80 m amateur bands.

Date:
04 February 2024 From 13:00 UTC (15:00CAT) to 15:00 UTC (17:00 CAT)

Frequencies
14,000 to 14,060 MHz; 7,000 to 7,035 MHz; 3,500 to 3,560 MHz

Categories
a) Single Operator All Band – Low Power (maximum 100W)
b) Single operator All Band – QRP (Maximum 5W)
c) Single Operator Single Band - Low Power (maximum 100W)
d) Single operator, single band – QRP (maximum 5W)
g) Short Wave Listener (SWL)

The exchange is RST, operator name and Grid Square locator and the scoring is
1 point for low power, 2 points for QRP.

Certificates are awarded to the first three places and the highest single band score.

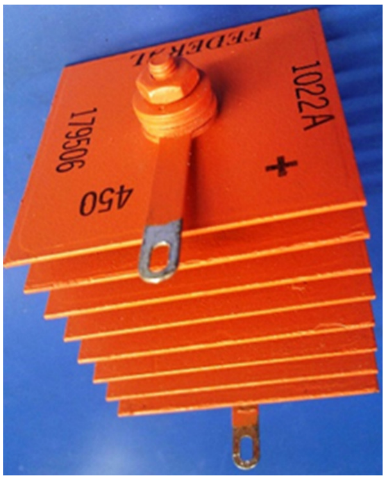
Log sheets in Excel should be sent to: andyzs6ady@vodamail.co.za. A log sheet is available on the AWA Website or the SARL contest page.

Closing date for log submission is Friday 09 February 2024

When the rectifier looked like a heatsink, and it was a heatsink

by Daniel Romila, VE7LCG

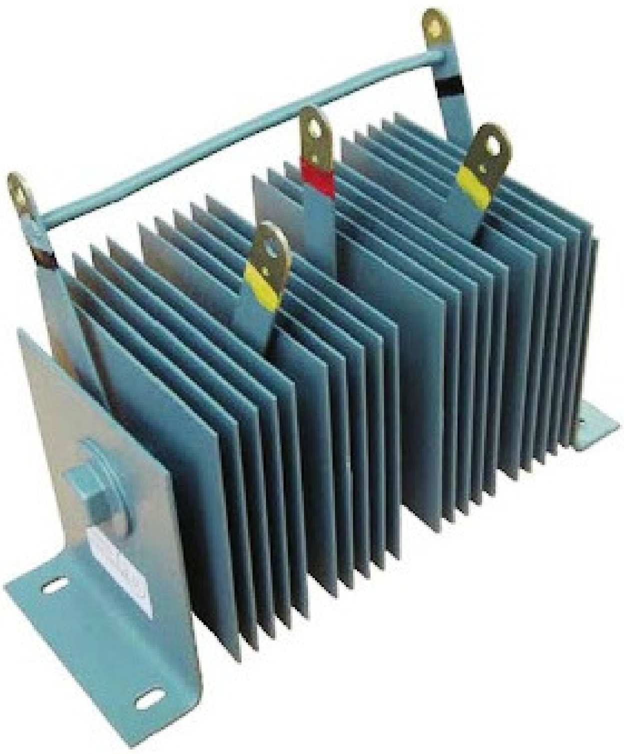
A selenium rectifier is a type of metal rectifier, invented in 1933. They were used in power supplies for electronic equipment and in high-current battery-charger applications until they were superseded by silicon diode rectifiers in the late 1960s (from Wikipedia, as also the picture below, from Wikipedia).

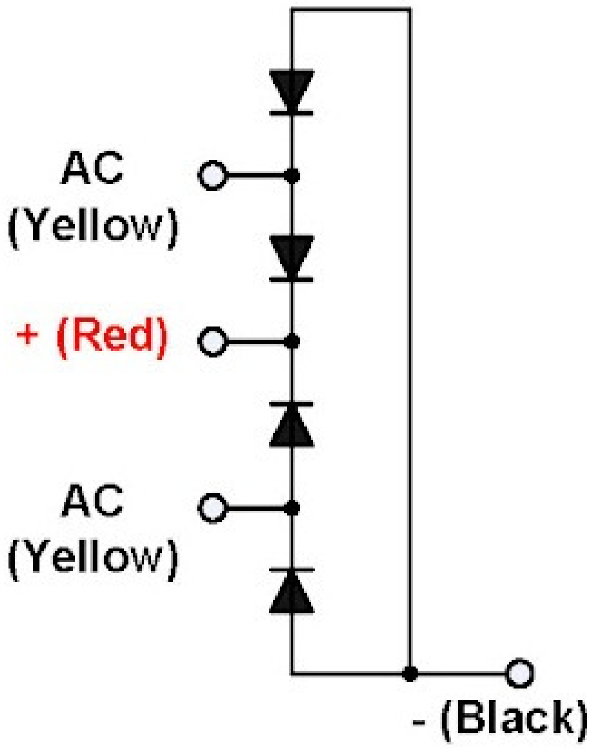


Those Selenium rectifiers were meant to replace vacuum tube diodes in the power supply block. They came in different shapes and sizes, but really looked like heatsinks, and they did need fins to radiate the heat. I can still find plenty of such devices in 2023, for example at Indiamart.com.

Of course, since it is possible to have separate diodes, the bridge rectifier, with four diodes, could be easier to be implemented than it would have been with tubes.

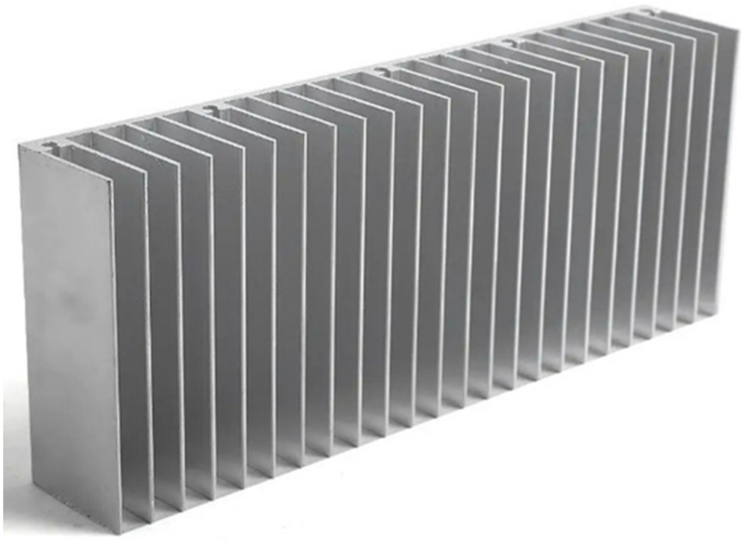
From: https://philcoradio.com/phorum/archive/index.php?thread-22542.html

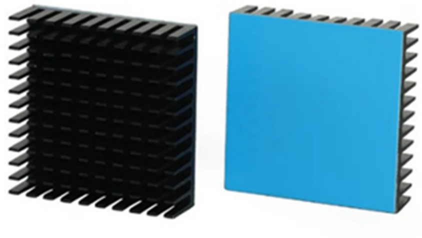


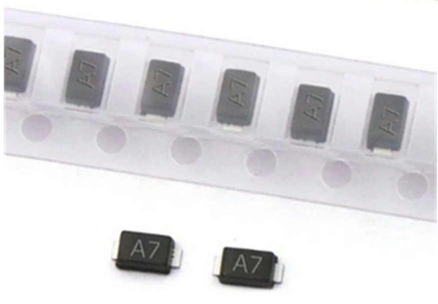


Just look, for comparison, at some heatsinks:

One might think the Selenium rectifiers were invented for Halloween. No, they were doing very well their job. Anyhow, nowadays things are much smaller for the same performance. The rectifier diodes used in 2023 modern electronic equipment:







JOHN T. FRYE W9EGV

Carl and Jerry

A Low Blow

By John T. Frye W9EGV

It was two whole weeks since Carl and Jerry had talked face to face. Jerry had been home from school sick with influenza, and the boys' parents had kept them apart to prevent Carl's catching the virus infection. The two had managed to keep in touch by chatting on the phone, by talking over their ham stations, and -since their bedroom windows faced each other -even by blinking Morse code on flashlights from one window to the other. But Jerry had finally recovered sufficiently to be down in his basement laboratory this warm, windy Saturday morning, and to have Carl visit him.

"Hi, Jer," Carl said gruffly as he came in through the outside basement door. "How's my puny pal? You look kinda pale around the gills."

Jerry turned away from the large, wide-mouthed glass jar sitting on the workbench in front of him to bestow a fierce scowl on his friend.

"Don't 'puny pal' me, you big ox! Disgustingly healthy people make me sick!"

"Now, now, there" Carl murmured with mocking solicitude. "We mustn't get upset. Remember: we are not well. And what are we doing with that goldfish bowl ?"

"I am getting ready to test my infrasonic microphone," Jerry said curtly, turning back to the fishbowl that had a thin membrane of rubber stretched over the top. Inside was a small, brass-topped glass jar containing some transistors and other components mounted on a little circuit board. Two tiny twisted wires of the sort used in record-player tone arms came out of a wax-sealed hole in the bottom of the jar, ran up over the edge of the bowl beneath the rubber membrane, and were connected to the input of a tape recorder sitting on the workbench.

"I need more information than that," Carl cheerfully confessed. "What is this 'infrasonic' jazz? I've never heard you mention a project like that before!"

"In physics you should have learned that sound recognized as such by the human ear goes down in frequency to about 12-15 cycles," Jerry explained; "but there are other compression and rarefaction waves in the atmosphere at much lower frequencies. These are called 'infrasonic waves,' and we are surrounded by them even when our ears hear nothing.

They obey the same laws as sound waves: their speed varies as the product of the square root of the absolute temperature and a constant related to the conducting medium.

"At 32°F," he continued, warming to the subject, "sound travels about 1087 feet per second in air, and the speed increases as the temperature rises. The rate at which sound power is absorbed and dissipated into heat depends on the frequency. The fraction of sound power absorbed per unit distance of propagation is roughly proportional to the square of the frequency. That explains why you hear the bass drum of an approaching band first, and it also means that only low inaudible frequencies can be propagated great distances."

Carl started to say something, but Jerry didn't give him a chance.

"When the volcano Krakatoa exploded in 1883 in the East Indies, inaudible waves from this disturbance traveled around the world several times with a pressure so great that it produced readable deflections on barographs. The impact of the great meteor that fell in Siberia in 1908 had the same result. During World War I, it was noticed that cannon fire could be heard within a radius of 100 kilometers, and often beyond 200 km., but not between 100 and 200 km."

"The sound waves must have been skipping the way our radio waves do," Carl noted.

"Exactly! Observers figured that something far above the earth must be deflecting the sound waves back down. The only thing that could do so would be a layer of air warmer than the air at the earth's surface which would speed up the top edge of the sound wave entering it at an angle and bend the wave back toward the earth. By listening for the lowest audible frequencies and by checking the transit time of the wave from the source to the distant observer, those smart cookies figured out where and how warm that layer of air had to be! Very recent information gathered by our space probes confirmed their calculations.

"As you go up in a quiet atmosphere," Jerry went on, "the temperature falls sharply at first and then zigzags back and forth until you reach an altitude of about 105 km. From that point on up, for at least a considerable distance, the temperature increases steadily, reaching much higher values than here -"

"Just a cotton-picking minute," Carl interrupted. "You didn't know all this when you got sick. How did you get so smart?"

"Some time back," Jerry explained, "I noticed a newspaper article about how the National Bureau of Standards was carrying on experiments on the detection and recording of infrasonic waves. I wrote the Bureau asking for more information, and Mr. Paul Walsh and Mr. Donald M. Caldwell kindly sent me a lot of interesting information about their installation near Washington, D. C."

"How do they work it?"

They have four infrasonic microphones set up at different locations several miles apart. Signals from each mike are fed to a central location where they are amplified, bandpass-filtered, and recorded as ink-on-paper traces. By noticing the difference in time of the signal's arrival at various mike locations, its speed and source-direction can be determined."

"I can't imagine what sort of mike you'd use to pick up signals of one or two cycles per minute," Carl muttered with a thoughtful frown.

"Neither could I," Jerry agreed, "but the dope I got says the mike is a condenser type with a diaphragm of thin, specially-formed brass mounted on a reference volume. One side of the diaphragm connects to a noise-reducing pickup pipe. Movements of the diaphragm modulate the frequency of an oscillator."

"I see - I think," Carl said doubtfully, "but what's this about a noise-reducing pipe ?"

"When the mike diaphragm is exposed directly to the open air, pressures produced by the wind develop a lot of signal-masking noise. These specially designed metal pipes lie on top of the ground and are each about 1000 feet long. Each pipe has 100 small holes distributed along its length. A signal traveling toward the microphone along the length of the pipe is attenuated very little, but random variations in pressure caused by wind turbulence are greatly reduced."

"What sort of sounds, or whatever you call 'em, are picked up?"

"Well, on May 5, 1960, when the weather bureau reported 19 tornadoes and funnel clouds in Oklahoma, Texas, and Kansas in a four-and-a-quarter-hour period, the microphones recorded waves of periods between 12 and 50 seconds with speeds about equal to that of sound in air and with pressures slightly less than one dyne per square centimeter. Hearing a tornado 1000 miles away is sharp listening! A system of detectors like this could track tornadoes. In fact, another installation is planned near Boulder, Colorado.

"On August 18, 1959," Jerry continued, "sound pressure produced by the big earthquake in Montana was observed at the NBS Washington laboratories. An earthquake wave traveling along the earth's crust moves the surface up and down like the cone of a giant speaker and sends sound waves almost vertically into the atmosphere. Information gleaned from these waves valuably supplements data gathered by seismographs regarding the nature of a quake and its original source.

"Magnetic storms also produce strange 'sound' waves of periods greater than 20 seconds with a trace velocity up to three times the speed of sound. These waves usually arrive from the north during magnetic storms, and they have a large angle to the surface of the earth. The Bureau hopes to study them to learn more about the interaction of the sun and the earth's magnetic field."

How did you make your mike, and what are you going to do with it ?" Carl asked as the ground shook with a low growl of distant thunder.

"I stretched a diaphragm of very thin brass shim stock tight over a little steel hoop. Another disc of brass mesh wire is separated from the shim stock one by a thin insulating washer. This assembly, mesh disc down, is mounted on top of the little glass jar with an airtight seal. The homemade printed-circuit board inside the jar contains two transistorized crystal oscillators and a diode mixer to combine their outputs. The capacitor formed by the diaphragm and the screen is across one of the crystals. The two oscillators are tuned - you can tune a crystal oscillator a little, you know so that their frequencies are only one kilocycle apart; and this means that the difference frequency of 1000 cycles comes out of the mixer. Any movement of the brass diaphragm produced by pressure waves against it is translated into a frequency shift of the crystal oscillator associated with the condenser mike, and an accompanying change in the beat-frequency tone coming out of the mixer."

"Hey, old buddy, that's pretty sharp!" Carl applauded.

"Nothing any bored American boy shot full of antibiotics couldn't do!" Jerry replied modestly. "The roughest job was drilling two holes through the bottom of the glass jar without breaking it. Leads from the mixer come out one, and the other is covered with a brass disc with a very tiny hole punched in it with a needle. That keeps our mike from responding to very slow pressure changes caused by barometric variations, yet allows it to respond to waves with periods up to several minutes in length."

He switched on the tape recorder, and soon a 1000-cycle note was heard from the speaker. At the same time, a meter connected across the recorder speaker rose to half-scale.

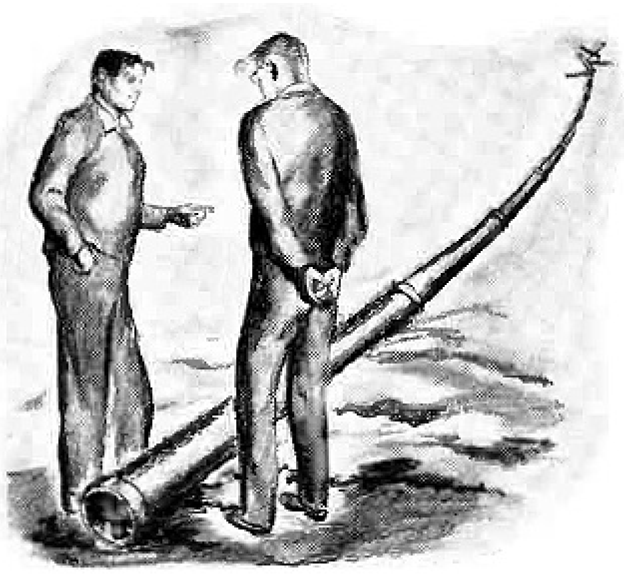
"That's a simple audio frequency meter I've calibrated to indicate frequencies between 100 and 5000 cycles," Jerry answered Carl's questioning look. "We don't have any ink-on-paper recorders, but that meter pointer will swing back and forth in step with any low- frequency waves received. Tape-recording the changes in tone will give us a chance to double-check on any waves we think we observe. Now, let's see what happens when we test it out.

"I drop this little steel ball on the rubber membrane, like so, and this causes a very small increase in the pressure inside the bowl. See that meter kick down? If I've calculated right, it will start creeping back in a couple of minutes as air leaks through the tiny hole to equalize the pressures on both sides of the diaphragm."

The microphone passed the test with flying colors. It responded to very small changes in pressure; yet, if the pressure was left applied, the tone returned to 1000 cycles in the space of a few minutes.

"Now all you need is that pipe pickup," Carl remarked.

"We've got it!" Jerry said promptly. "Didn't you notice that the men laying that new 8" gas line in the street stopped directly in front of the house last night? Welders will weld the joints together Monday and put the pipe down in the trench, but right now it stretches cut to the west on top of the ground for a couple of thousand feet with the joints all neatly butted tight together. I'm hoping small air leaks at these joints will serve as the holes in the pipe used by the National Bureau of Standards.



"The beauty of it all is that the weather bureau has a tornado alert out for the area to the west of us. We may be lucky enough to hear a tornado! Suppose you go out, Carl, and fasten our mike in the end of the pipe with this wooden collar, and run this twisted pair from it into the cellar window."

Carl carried out the assignment quickly because huge drops of rain had begun spattering down. When the wires were connected to the input of the tape recorder, the meter pointer immediately began to hunt restlessly up and down the scale.

"What we're looking for is a slow, rhythmic swing of the meter pointer," Jerry shouted above the roar of the wind outside, which had begun whipping up the trees and was now pounding furiously at Jerry's house.

But there was nothing slow or rhythmic about the pointer as it swung wildly up and down. Suddenly it began to go up and up, hesitated for a moment, and then fell back to zero and stayed there. The tone disappeared.

"Something's happened to our mike," Jerry shouted as he grabbed up his jacket E. id headed for the door. At the top of 'he steps he stopped dead in his tracks and stared up into the northwestern sky. Carl, looking over his shoulder, saw the writhing, twisting, unmistakable shape of a small tornado funnel high above the ground and moving off to the north. Even as the boys watched, the little tornado disintegrated.

They raced over to the pipe and pulled out their mike. The thin brass diaphragm was ruptured, with the jagged corners curled outward somewhat like the petals of a flower.

"Jer, look way down there at the other end of the pipe," Carl said in awe. Jerry followed his pal's pointing finger and saw that the straight line of the pipe was broken four or five blocks away, and the sections of pipe were scattered over the street like jackstraws. A small temporary tool house nearby had been smashed to kindling and the tools strewn about like scraps of paper.

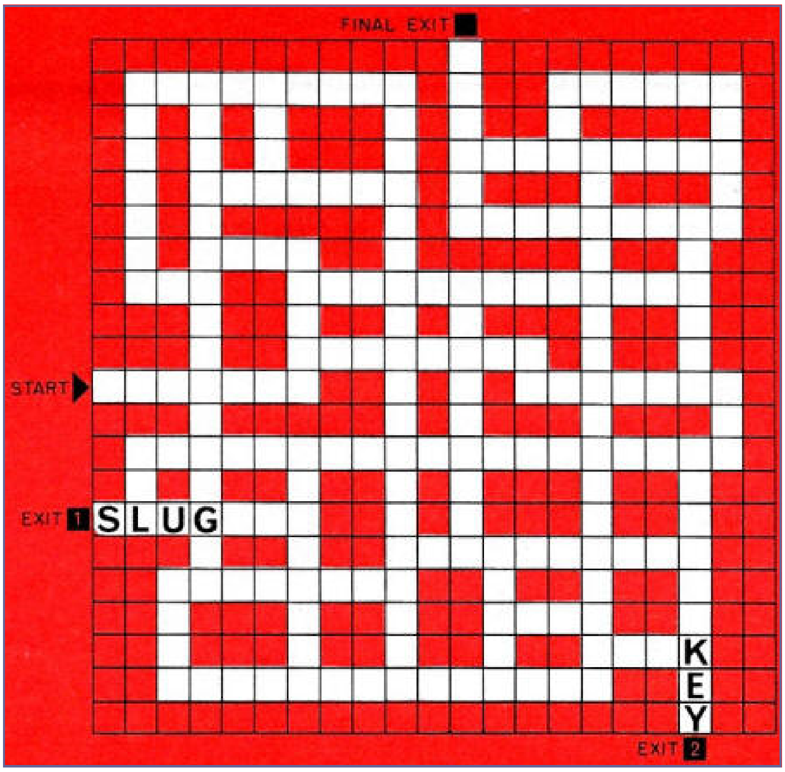
"That little twister must have dabbed down squarely on top of the pipe and then hopped back up," Carl said thoughtfully.

"Yeah, and it sucked on that end of the pipe hard enough to bust our mike diaphragm at this end," Jerry finished. "The tornado dealt us a low blow. We aren't really sure our infrasonic mike works."

"I'm not complaining," Carl said philosophically as he started back for the house. "We're mighty lucky the twister was sucking on that end of the pipe and not on our end!"

By Robert C. Radford

Here's a new kind of crossword puzzle designed to test your knowledge of electronic terminology. Refer to the clues given and fill in the word called for by the first clue. Start at the arrow. Thereafter, fill in each new word called for by the following clues perpendicular to each preceding word. The last letter in each preceding word will be common to the first or lost letter of each new word, and all words will read vertically downward or from left to right. The tenth word will have a letter in common with the word at the first exit. Nine more correct entries will take you to the word at the second exit, which will also share a letter with the last of these nine words. In each case, the first or last letter of the exit word will be the first or last letter of the next word. An additional nine correct entries will put you at the final exit for a perfect score. The Editors invite your comments on this type of puzzle.



Clues:

1 A component that introduces inductance in on a.c. circuit.

2 Single unit of a device that converts chemical energy into electrical energy.

3 A luminous glow formed by the difference of potential between two electrodes.

4 Conductors used for transmitting and receiving r. f. energy.

5 Antennas specifically arranged or grouped together so as to produce a desired directivity pattern.

6 High-gain VHF antenna array whose directors are made progressively shorter toward the front of the array.

7 The video information reproduced by a television receiver.

8 Conductor used to establish electrical contact with a non-metallic part of a circuit.

9 Lines produced by a TV receiver flyback pulse.

10 Slang term for ham radio equipment.

Exit 1. The adjustable iron core of a coil.

11 A circuit operating as a switch. The presence or absence of a control voltage can apply or eliminate a signal.

12 Abbreviation for the force that causes current to flow in a circuit.

13 Narrow metallic strips used to produce clutter on enemy radar screen to obscure targets.

14 A The paper diaphragm of a loudspeaker.

15 Waveform of a modulated carrier.

16 Two-element electron tube.

17 The unit used to express power ratio.

18 Path of a completed circuit, especially in servo systems.

19 Maximum amplitude of a sine wave.

Exit 2. A hand-operated switch used in radio telegraphy.

20 System of interconnected electrical circuits.

21 Flow of electrons in a vacuum tube.

22 A three-element electron tube.

23 Group of three phosphor dots on a color television picture tube.

24 Slang word for a parabolic reflector.

25 In solid-state technology, empty space in the valence bond of on impurity atom.

26 Preparation of a computer routine in machine language.

27 To remove gases from on electron tube envelope.

28 A secondary emission electrode in a multiplier-type photo-tube

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Saturday 08:30 (06:30 UTC)— National SSB Net— 7.125;
Sandton repeater 145.700
Echolink—ZS0AWA-L
Kempton Park Repeater—145.6625
Relay on 10.125 and 14.135 (Try all and see what suits you)
Saturday 14:00 (12:00 UTC)— CW Net—7025; 14:20 10.115

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