journal

more on computers
by Louis E. Frenzel, Jr.

servicing experiences of
J. B. Straughn

Harold Turner builds an
IC Square-Wave
Generator

march/april 1971

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Build Your Own

If you own an oscilloscope, you already have half the equipment you need to make meaningful tests of the frequency and phase response of any amplifier. The other half is much simpler and much less costly than a scope. For a small investment of time and money, you can greatly extend the usefulness of your scope. How? By building this simple square-wave generator.

Square wave testing is incredibly simple, considering the wealth of information that can be obtained with only two connections to the piece of equipment under test. You merely connect the square-wave generator to the input of the amplifier and connect your oscilloscope to the output of the same amplifier. What you see on the oscilloscope screen will tell you much about how well the amplifier is working.

CONSTRUCTION

Fig. 1 includes a list of all the parts needed for the construction of the IC square-wave generator and a schematic diagram of the generator. The total cost of all these parts should run between $8

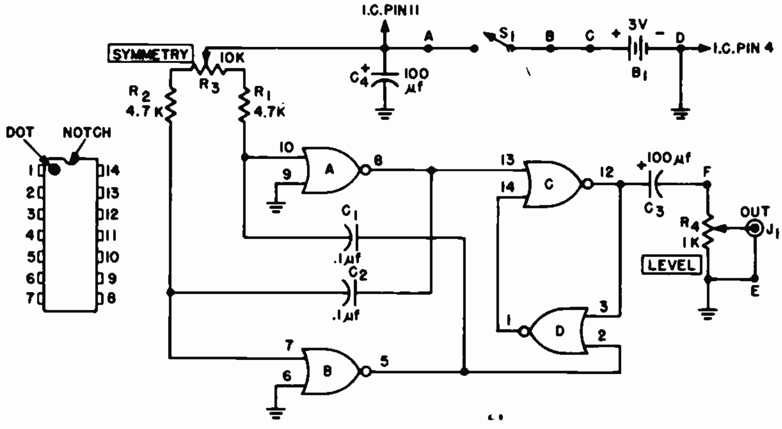
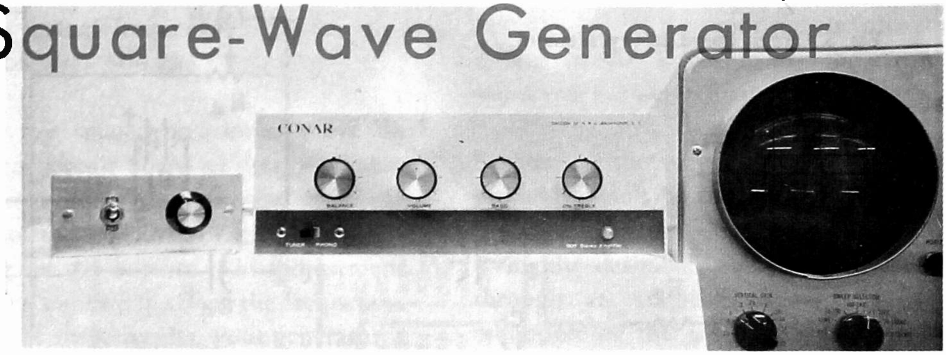


Figure 1.

B_1	2 penlite cells
C_1, C_2	.1 µF, 10 v disc (Centralab UK10-104 or equiv.)
C_3, C_4	100 µF, 10 v tubular electrolytic
IC	Motorola MC 724P or HEP 570 quad 2-input RTL NOR gate
J_1	Phono jack (Switchcraft 3501 FP or equiv.)
R_1,R_2	4.7k-ohm, 10%, 1/2 watt
R_3	10k-ohm potentiometer (CTS X201 R103 B or equiv.)
R_4	1k-ohm control, linear taper
S_1	SPST toggle or slide switch
Misc.	Circuit board, battery holder (Keystone #140 or equiv.), metal box (Bud CU-3004A Minibox or equiv.), knob, hardware, wire, solder

C Square-Wave Generator



by Harold J. Turner, Jr.

and $12, depending upon which IC you buy and what type of printed circuit supplies you already have on hand. All parts used are standard items available from your local distributor or from one of the large mail-order houses. They are not available from NRI.

Although the circuit is not very complex, the dual-in-line circuit is best mounted on a printed circuit board. If you prefer to avoid the bother of making a pc board, you can use a small (4-3/4" X 2") piece of perfboard. Use of an IC socket is recommended with perfboard construction. A full-scale foil pattern is shown in Fig. 2. You can either use photographic techniques to copy this layout or use the diagram as a guide in making your own pattern.

After the circuit board is etched, the next step is to drill the holes in the board for mounting the various components and attaching the connecting wires. Use a #67 drill bit for the IC holes and a #60 bit for the others. The drilling operation is very easy when done on a drill press. Manual drilling requires very close attention to where the bit is placed.

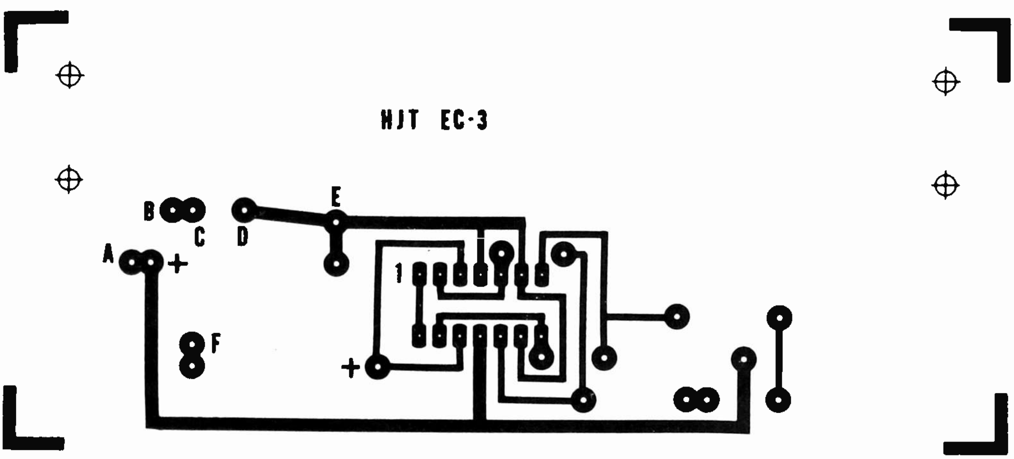


Fig. 2. A printed circuit etching guide.

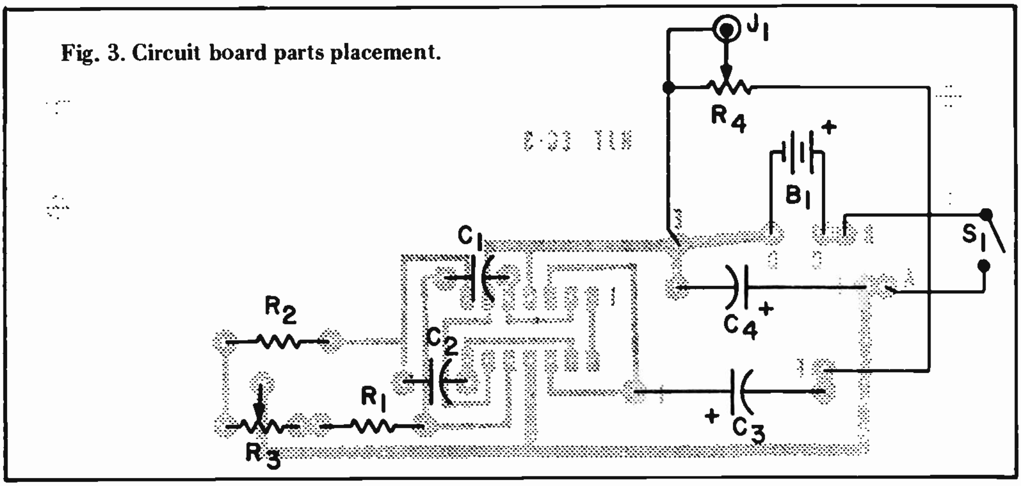


Fig. 3. Circuit board parts placement.

Being careful to install the integrated circuit in the right direction, mount all the components on the circuit board as shown in Fig. 3. The small dimple at one corner of the unit indicates pin #1. Notice that this pin is also identified on the foil side of the board. Of course, all components are to be mounted on the side opposite the foil.

The only other parts requiring special care in mounting are the two electrolytic capacitors. Make sure that the "+" ends of these capacitors match up with the "+" marks on the circuit board.

The next step is to drill the metal box to fit the parts to be mounted. The circuit board is then attached to the chassis with two small "L" brackets. These brackets can be fashioned from small pieces of aluminum or steel. Afterwards mount the control, switch, output jack, and battery holder. Connect them to the circuit board as shown in Figs. 3 and 4. Your square-wave generator is now complete.

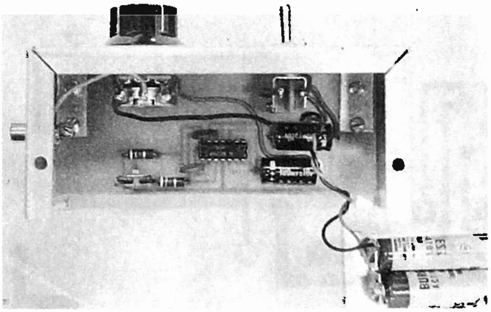


Fig. 4. An inside photo of the generator.

TESTING THE COMPLETE UNIT

To check the operation of your square-wave generator, connect a shielded cable between the generator's output jack and the vertical input of your oscilloscope. Make sure that you are using fresh batteries. With your vtvm ground lead connected to the metal box, you should measure about three volts at pin #11 of the integrated circuit. This is the center pin in the row opposite the dimple identifying pin #1.

Now turn up the output control until you see the square-wave signal on your scope. When the control is turned fully clockwise, the output level should be about 1 volt peak-to-peak. The generator frequency should be approximately 1,000

Hz; the actual frequency might be anywhere between 600 and 1,500 Hz.

Adjust the small potentiometer on the generator circuit board so that the square wave is symmetrical, i.e., so that the length of the top part of each cycle is just as long as the bottom. This adjustment will only somewhat affect the frequency. If you get these results, your generator is working perfectly.

HOW IT WORKS

As you can see from Fig. 1, the major components in the square-wave generator are the four NOR gates contained in the single integrated circuit. Gates A and B are connected as an astable (free-running) multivibrator. The frequency of oscillation is set by the time constants of R_1-C_1 and R_2-C_2 in conjunction with the resistance of the 10k-ohm potentiometer (R_3). The variable resistor provides adjustment of the circuit to compensate for differences in the exact value of the individual resistors and capacitors. This produces a symmetrical output waveform.

The waveform at the outputs of the astable multivibrator circuit is not a good square wave. If you check with your oscilloscope at these points (IC pins 5 and 8), you will find a very distorted signal. The remaining two gates are connected in a bistable multivibrator (flip-flop or latch) circuit to turn this poorly shaped signal into a perfect square wave output.

Since there are no capacitors in the bistable circuit other than the output coupling capacitor, the output has only two states: high and low. The circuit switches between these two states as commanded by the input signals from the astable circuit. Consequently the output waveform is a perfect square wave.

Because of the very short time rise, you probably won't be able to see the sides of the waveform on your oscilloscope. This is highly desirable; as the signal passes through an amplifier under test, any reduction of the steepness of the sides shows that the circuit has relatively poor high-frequency response. Since the rise time is very short at the output of the square-wave generator, even very slight reductions in high-frequency response can be seen on the oscilloscope.

When fresh batteries are used, the output voltage will be about 1 volt peak-to-peak at the maximum setting of the level control. As the batteries become weaker, the output level will gradually fall off. The batteries should be replaced after the level drops to .5 volt p-p. Since current drain is only about 20 ma, battery life should be fairly long.

HOW TO USE YOUR GENERATOR

Let's test a typical audio amplifier. You could leave the loudspeaker connected to the amplifier output, but the amount of noise produced would be most annoying and the speaker would cause some change in the appearance of the waveform. Since we are mainly interested in the characteristics of the amplifier, a load resistor should be substituted for the speaker while the test is being made.

The resistance should be equal to the impedance of the loudspeaker normally used (which should match the output impedance of the amplifier). The wattage rating of the resistor should be high enough to handle the maximum power capability of the amplifier. Since the amplifier output impedance is usually very low, you won't have to worry about hum pickup by the oscilloscope leads; ordinary wire connections to the scope are adequate. For testing in high impedance circuits, however, a low-capacity probe should always be used.

The output of the square-wave generator should be connected to the input of the amplifier. You will want to make a number of patchcords to provide convenient connections to the different types of amplifiers you will be testing. One cord should be equipped with a phone plug, one with a pair of alligator clips, one with a phone plug, etc. Make sure that the generator output level is high enough to ensure a good signal-to-noise ratio, but not high enough to overload the input stage. Fig. 5 shows a typical test setup.

After you complete the connections, adjust the oscilloscope to produce three or four complete cycles of the square waveform on the CRT screen. If the amplifier has good response, the waveform will appear similar to the one you saw when you tested the generator itself.

Fig. 6 shows how deficiencies in amplifier performance will affect the waveform. If the amplifier has tone controls, you can vary them to produce some of these effects. Rotating the treble control,

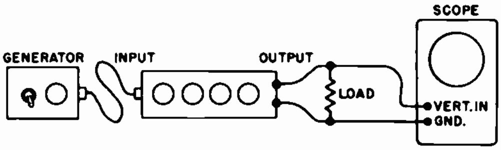


Fig. 5. A typical test setup.

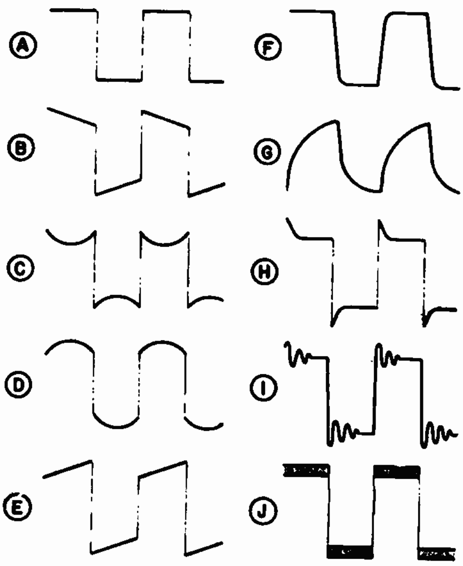


Fig. 6. Typical waveforms. (A) perfect response, (B) low-frequency phase shift – leading (bass cut), (C) loss at fundamental frequency, (D) boost at fundamental frequency, (E) low-frequency phase shift – lagging (bass boost), (F) moderate loss of highs, (G) severe loss of highs, (H) excessive highs, (I) ringing due to instability, (J) thickening of trace due to hum pickup or oscillation.

which affects the high-frequency response of the amplifier, will affect the rise time. With the treble control turned all the way down, the signal will take on the appearance of a sawtooth. When the control is set to the electrical flat position (which may or may not coincide with the mechanical flat position), the rise time will be very short but no overshoot will be noticed. Overshoot indicates excessive treble response. Likewise, curvature or tilt of the top and bottom of the waveform indicates the presence of low-frequency rolloff or phase shift.

How can square wave testing tell so much about the performance of an amplifier circuit? The answer to this question is in the formation of the square-wave signal. The perfect square wave is a combination of a fundamental tone and all its odd harmonics (multiples) – all the way to infinity. A 1,000-Hz square wave contains harmonic components of 3,000 Hz; 5,000 Hz; 7,000 Hz; and so on. The amplitude of the third harmonic is one-third the amplitude of the fundamental; the amplitude of the fifth harmonic is one-fifth that of the fundamental.

This distribution of frequencies means that the amplifier must have a wide bandwidth in order for the square wave to be passed through an amplifier stage without any noticeable change. A good rule of thumb is to assume that the amplifier has a flat frequency response from at least one-tenth to ten times the fundamental frequency if the square wave is passed without noticeable change. As you become familiar with the square wave and how it is affected by different types of circuits, you will be able to make rapid decisions on how well a circuit is performing.

This is only one simple example of square wave testing. You will find many more opportunities to use this technique in electronic servicing. Your generator can help you check the frequency response of television video amplifiers, hi-fi preamplifiers, power amplifiers, receivers, oscilloscopes and special-purpose amplifiers used in industrial electronic equipment. Once you try this technique, you will quickly sense its value. It will certainly become a favorite servicing tool.

FOR MORE INFORMATION:

Horowitz, Mannie. *Measuring Hi-Fi Amplifiers.* Sams 20561. $3.95
Lancaster, Donald E. *RTL Cookbook.* Sams 20715. $5.50
Middleton, Robert G. *Know Your Square-Wave and Pulse Generators.* Sams 20258. $3.25
Middleton, Robert G. *101 Ways to Use Your Square-Wave and Pulse Generators.* Sams 20562. $3.50

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SCHOLASTIC AWARDS

The winner of the $125 Hugo Gernsback Award (see November/December Journal) is **Garry W. Greenshields**, resident of Canada and student of NRI's TV-Radio Servicing Course.

Awards of $25, in honor of NRI's founder James E. Smith, go to students **Robert L. Shields** and **Harry Wong**.

NRI also gives Honorable Mention awards to the following nominees:

Tracy W. Corke	**T/Sgt. Clarence J. Jackson**
Dennis V. Luck	**Norris McKee**
Joseph Molanda	

FLIP-FLOPS: digital

In the previous installments of this series on digital techniques we introduced you to logic gates: the digital elements that monitor binary voltage levels representing numbers or control signals and then produce outputs that are used to control and manipulate other logic elements. Logic gates such as the AND, OR, NAND, NOR and the inverter are decision-making elements. They look at other logic levels and produce a binary output that is a function of their inputs as well as their specific characteristics.

Now let's look at another type of digital logic circuit, the ***memory element.*** In order to perform digital operations, it is often necessary to store binary information. For this we need an element that can remember a particular logic state. The most commonly used device for this purpose is a ***flip-flop.***

WHAT IS A FLIP-FLOP?

Perhaps the simplest form of digital storage element is a switch. A switch normally has two distinct states: off and on (open and closed). Because of these two states, the switch can be used to store or represent binary numbers.

Suppose we let the on (closed) state represent a binary 1. Once the switch is set in that position, we can say that it is storing a binary 1; when it is off, it will be storing a binary 0. The switch can be easily changed to either state to store either value. A group of switches can be combined to form a complete word. A group of four switches, for example, could be used to store a 4-bit binary word.

Although switches are widely used to store binary data in digital equipment, another, more versatile, logic storage element is needed. We actually require a storage element whose state can be changed by inputs applied to it from other logic circuitry. In addition to its ability to store a single bit of information in one of its two states, the storage element must be extremely fast. High-speed operation is important in digital equipment.

The device that meets all of these qualifications is called a flip-flop. An electronic circuit with two stable states, the flip-flop can store one bit (binary digit) at a time.

A simple flip-flop circuit is shown in Fig. 1. It consists of two transistor logic inverter circuits made up of Q_1, R_1, R_2 and Q_2, R_3, R_4. If you look closely at the circuit, you will find that these two logic inverter circuits are connected so that the output of one is connected to the input of the other and vice versa. This particular arrangement of components causes the circuit to latch up in a specific condition whenever power is applied to it.

When supply voltage $+V_{CC}$ is first connected to the circuit, one of the transistors will begin to conduct before the other. Because of a higher gain and the various tolerances, Q_2 may begin to conduct before Q_1. Base current flows through the emitter-base junction of Q_2

memory elements

The fourth article in a series on digital techniques

by louis e. frenzel, jr.

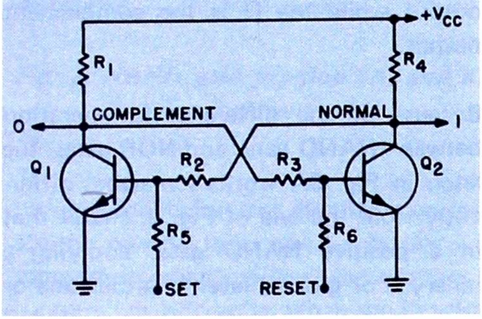

Fig. 1. A simple flip-flop circuit.

and through R_3 and R_1 to the supply voltage. This causes Q_2 to conduct hard or to saturate.

If it saturates its collector-emitter voltage is extremely low, generally only a few tenths of a volt. For most situations we can consider it zero volts. Transistor Q_1 would obtain its base drive from the collector of Q_2, but it is effectively cut off since the emitter-collector voltage of Q_2 is low. The flip-flop will remain latched up in this state until the power is removed or until external signals are applied to the circuit to change its state.

Notice in the circuit of Fig. 1 that there are two outputs; one is the 0 or complement output and the other is the 1 or normal output. If you were to measure the output voltage at the collectors of the transistors, you would find the voltage at Q_2 to be only a few tenths of a volt because it is conducting hard. On the other hand, looking at the output of the collector of Q_1 would show $+V_{CC}$ through R_1. With the flip-flop latched up in this state and producing these outputs, we say that it is *reset* and storing a binary 0.

Also in Fig. 1 are two additional input resistors that are connected to the bases of the transistors. These inputs are labeled "set" and "reset." If we apply a short positive voltage pulse to the set input, transistor Q_1 will begin to conduct. As it conducts, its emitter-collector voltage drops to a very low value and removes the base drive to Q_2. Q_2 cuts off and its collector rises toward $+V_{CC}$. This permits base current to flow in Q_1 through R_2 and R_4. The flip-flop is now latched up in its other stable state. With Q_1 conducting and Q_2 cut off, the complement output is near 0 volts, while the normal output is near $+V_{CC}$. In this condition the flip-flop is *set* or storing a binary 1.

To reset the flip-flop again, just apply a short positive-going pulse to the reset input. This forces Q_2 to turn on, thus removing the base drive to Q_1. The set and reset inputs are used to place the flip-flop in either state so that we can store either a binary 1 or a binary 0. This is the basic operation of a flip-flop.

HOW TO MAKE A FLIP-FLOP OUT OF LOGIC GATES

Now take a closer look at the circuitry used in the flip-flop of Fig. 1. Q_1 is a simple transistor switch that can be turned on by applying a voltage to its base through either resistor R_2 or R_5. Applying a positive voltage to either resistor will cause the transistor to saturate and its output to drop from $+V_{CC}$ to near 0 volts. This, as you may recall, is the definition of a NOR gate. Of course the circuit made up of Q_2, R_4, R_3 and R_6 is also a 2-input NOR gate. A signal applied to either R_3 or R_6 causes Q_2 to conduct and its output to go low.

Since the flip-flop circuitry in Fig. 1 is nothing more than a pair of 2-input NOR gates, we can redraw the circuit using the NOR symbols you learned earlier. Fig. 2 shows the NOR gate flip-flop. The circuit is identical to the one in Fig. 1 (except that here we don't show the individual components).

Because the flip-flop in Fig. 2 can assume, or latch up in, one of two states, it is often called a latch. Another name for the latch is simply an RS or reset-set flip-flop.

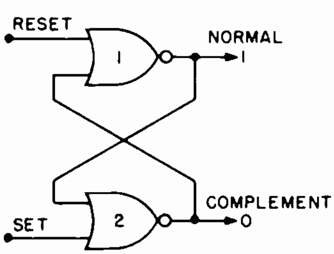

Fig. 2. A NOR gate flip-flop.

An RS flip-flop can also be constructed out of NAND gates as shown in Fig. 3A. Notice in this circuit that we labeled the two outputs Q and $\overline{Q}$. The Q designations are the standard output notations for flip-flops. The Q output is the normal output while the $\overline{Q}$ is the complement output.

Because of the difference in operation between NAND gates and NOR gates, the latch in Fig. 3A works somewhat differently from the one of Fig. 2. Recall that in a positive NAND gate, applying a binary 0 or ground level to either one or both of the inputs of a 2-input NAND gate causes its output to go high. If both inputs are binary 1's the output will go to a binary 0. Consequently, in order to set or reset the latch in Fig. 3A, we must apply a momentary low or binary 0 level to either the set or reset input. Applying a binary 0 to the reset input forces the output of gate 2 high. This high input, along with the high input at the set terminal, causes the output of gate 1 to go low. This low level at the other input to gate 2 keeps the gate 2 output high. In this state the flip-flop is reset and storing a binary 0.

Applying a momentary binary 0 level to the set input forces the output of gate 1 high and the output of gate 2 low. The flip-flop is then set and storing a binary 1.

Rather than the schematic as in Fig. 1 or the logic gate symbols for flip-flops as in Figs. 2 and 3A, the RS flip-flop is usually drawn as a simple box, labeled as shown in Fig. 3B.

The most important fact to remember with this circuit is that the normal output is at a binary 1 voltage level when the

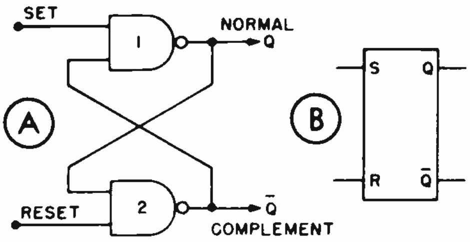

Fig. 3. NAND gate flip-flop (A) and RS flip-flop logic symbol (B).

flip-flop is set. For our discussion we will assume positive logic where a binary 1 is some positive voltage level and a binary 0 is ground or zero volts. When the flip-flop is reset the normal output is a binary 0. Therefore, it is possible to determine which state the flip-flop is storing simply by monitoring the normal output with a voltmeter, a light, or any other indicator.

THE D FLIP-FLOP

Fig. 4A shows the logic diagram and Fig. 4B the logic symbol of a D flip-flop. Notice that this circuit is made with positive NAND gates. It consists of a standard latch flip-flop made up of gates 3 and 4, combined with gates 1 and 2 for a very flexible input gating arrangement.

In the latch flip-flop both set and reset input signals are required to put the flip-flop in one of its two states. This often necessitates inconvenient input control signals. The D flip-flop in Fig. 4A overcomes this problem. The data, or D, input at gate 1 is used to accept a binary logic level for storage in the flip-flop. However, the input data bit will not be loaded into the latch portion of the flip-flop until the LOAD (T) input line is made a binary 1. In this way the LOAD input line can inhibit the input information and allow the flip-flop to retain a given state.

To store a binary 1 in the D flip-flop or to set it, the data input is made a binary 1. When the LOAD input line goes to a binary 1 level, the output of gate 1 goes low. This forces the output of gate 2 high. The output of gate 3 is also forced high, making the Q or normal output high. Now the flip-flop is set.

When the LOAD line goes back to a binary 0 level, the outputs of both gates 1 and 2 go high. These outputs have no effect on the state of the latch made up of gates 3 and 4. The latch remains set.

To store a binary 0, the data input is made a binary 0. Now whenever the LOAD line goes high, the output of gate 1 is forced high by the low data input. This high input has no effect on gate 3 of the latch. However, the high output of gate 1 is seen in the input to gate 2 along with the high LOAD input. This forces the output of gate 2 low, causing the output of gate 4 to go high. With the complement output high, the flip-flop is reset or storing a binary 0.

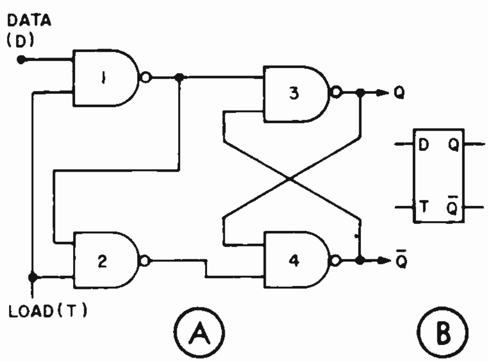

Fig. 4. D flip-flop made with NAND gates (A) and its logic symbol (B).

Keep in mind one important fact. The flip-flop will only recognize a data input when the LOAD input line is made a binary 1. With the LOAD input high, the state of the flip-flop merely follows the data input. With the LOAD input line low, the data input is inhibited and the flip-flop retains the last state determined by the data input. The LOAD control line permits convenient setting and resetting of the flip-flop from any binary data source.

STORAGE REGISTERS

One of the most common applications for either RS or D flip-flops is storage registers. A storage register is a group of flip-flops combined to store a complete binary word or number. Fig. 5 shows a 4-bit storage register made with D flip-flops. This flip-flop storage register is fed

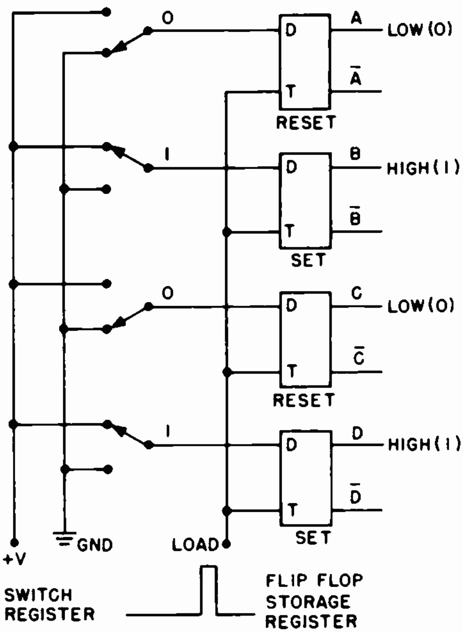

Fig. 5. A switch register and a D flip-flop register storing the binary number 1010.

from a switch register. Here a group of four single-pole, double-throw switches are used to store a binary number. The switch terminals are connected to +V and ground (binary 1 and binary 0 logic levels). The arm of the switch will be either a binary 1 or a binary 0, depending upon the switch position. The arm of each switch is applied to the D input of a flip-flop. Notice in Fig. 5 that the switches are set so that the binary number being stored is 1010. The least significant bit (LSB) position is the upper flip-flop. This number stored by the switch register is the binary equivalent of the decimal number 10.

The contents of the switch register can be transferred to and stored in the D flip-flop register simply by enabling the LOAD input line. Notice that the T input to each of the flip-flops is tied to a common LOAD pulse. As soon as this LOAD pulse is made a binary 1, each of the D flip-flops recognizes its D input and either sets or resets, depending upon the position of the switch feeding it.

Note that the state of each flip-flop is designated in Fig. 5. This is the condition of the flip-flops after the load pulse occurs, with the switches in the switch register set as shown. The contents of the register can be determined by monitoring the normal output of each of the flip-flops. Note that the flip-flops' outputs are marked with the letters A, B, C and D.

THE JK FLIP-FLOP

The most versatile of all flip-flop types is the JK flip-flop. It can not only duplicate the functions of the latch and D flip-flops, but also function in several other ways. The symbol for a JK flip-flop is

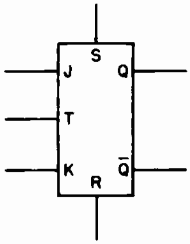

Fig. 6. Symbol for a JK flip-flop.

shown in Fig. 6. Since most JK flip-flops exist as integrated circuits, all you really need to know is how the outputs of the flip-flop respond to the various combinations of signal inputs.

The operation of the JK flip-flop can be summarized best by illustrating it with truth tables. Let's first consider the effect of the S and R inputs on the normal and complement outputs Q and $\overline{Q}$.

The S and R inputs on the JK flip-flop in Fig. 6 are the direct set and direct reset inputs. These inputs and the flip-flop outputs perform exactly as the latch shown in Fig. 3.

The truth table in Fig. 7A summarizes the operation of the JK flip-flop using the S and R inputs. Therefore, this truth table can also be used to define the operation of the latch in Fig. 3. On the left side of the table we show all four possible combinations of the S and R inputs. The outputs Q and $\overline{Q}$ are designated on the right.

INPUTS		OUTPUTS	
S	R	Q	$\overline{Q}$
0	0	1	1
0	1	1	0
1	0	0	1
1	1	X	$\overline{X}$

Fig. 7A. Direct set and reset operation.

Notice that when the set and reset inputs are both at binary 0, it forces the Q and the $\overline{Q}$ outputs to a binary 1. This is an unusual and generally undesirable state for a flip-flop. The two outputs on any flip-flop should always be complementary. When both outputs are at the same voltage level, it is impossible to tell which state the flip-flop is in. It is in some ambiguous state, neither a binary 1 nor a binary 0, that generally has no useful purpose. For that reason the S and R inputs to the flip-flop should normally be held at a binary 1 level.

Whenever the set input is made a binary 0 while the reset input is a binary 1, the flip-flop will become set and its normal output Q will become a binary 1. Applying a binary 0 to the reset input and a binary 1 to the set input resets the flip-flop, causing the complement output $\overline{Q}$ to go to a binary 1. The flip-flop stores a binary 0 in this state. When both the set and the reset inputs are high, the outputs are undefined (X, $\overline{X}$). With the inputs both at binary 1, the flip-flop could possibly be in either the set or reset state. Determining the precise output condition depends upon the conditions existing at the set and reset inputs previous to the time when both inputs are at binary 1.

The operation of the JK flip-flop, using the J, K and T inputs, is represented in the truth table of Fig. 7B. The main difference between these inputs and the S and R inputs is that the signals applied to the J and K inputs do not directly affect the state of the flip-flop. When the proper

INPUTS		OUTPUT	
J	K	Q	$Q_{(T+1)}$
0	0	X	X
0	1	X	0
1	0	X	1
1	1	X	$\overline{X}$

Fig. 7B. JK operation.

voltage levels are applied to the J and K inputs, the flip-flop will not immediately change state; the T input must be triggered in order to cause the flip-flop to change state. The flip-flop will change state when the T (toggle) input switches from a binary 1 to a binary 0 voltage level.

When both the J and the K inputs are binary 0, the flip-flop will not change state even though a signal is applied to the T input. This operation is designated by the output state shown in Fig. 7B. Notice that only the normal output is shown.The Q output is X, where X can be either the set or reset state. The column in the truth table designated $Q_{(T+1)}$ shows the state of the flip-flop after the T input switches from binary 1 to binary 0. Notice that when the J and K inputs are binary 0, the Q and $Q_{(T+1)}$ states are identical.

When the J input is a binary 0 and the K input is a binary 1, toggling the flip-flop will cause the Q output to go to a binary 0. The flip-flop is reset in this state and storing a binary 0. Notice that the state of the flip-flop prior to the application of the T pulse may be anything, as designated by the X; after the clock pulse occurs, the flip-flop will be reset.

Applying a binary 1 to the J input and a binary 0 to the K input causes the flip-flop to set when the T pulse occurs. Again the state of the flip-flop prior to the application of the toggle input could be either a binary 1 or a binary 0. In either case the flip-flop will set when the T pulse occurs.

When both the J and K inputs are made a binary 1, applying a T pulse will cause the flip-flop to complement itself. If the state prior to the clock pulse is X, the state will be $\overline{X}$ (the complement of X) after the clock pulse occurs. This means that if the flip-flop is initially set, it will reset upon the application of the T pulse; if it is reset, it will set when the T pulse occurs. This particular mode of operation is known as the toggling or complementing mode since, for each T pulse that occurs, the flip-flop toggles or complements itself.

This toggling operation is illustrated by waveforms as shown in Fig. 8. Notice that the top waveform is the input T pulse often called a clock pulse. With both the J and K inputs at a binary 1, the flip-flop outputs will appear as shown. Notice that the flip-flop changes state on the trailing edge (binary 1 to binary 0 level transition).of each clock pulse. Also notice that the Q and Q outputs are always complements or opposites of each other.

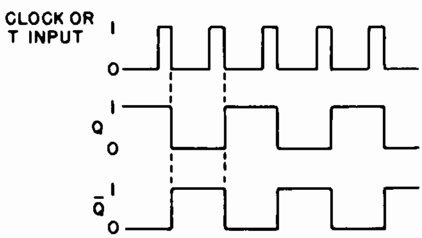

Fig. 8. Waveforms illustrating the toggling of a JK flip-flop.

If you will observe the waveforms in Fig. 8 you should notice that the flip-flop output is occuring at a frequency that is one-half that of the input clock signal. This means that the flip-flop is a divide-by-two frequency divider. The flip-flop will divide any input square-wave frequency by two. If the input square wave occured at a 100-kHz rate, the flip-flop output frequency would be 50 kHz.

Frequency dividers are widely used in digital equipment. Flip-flops can be cascaded so that the Q output of one flip-flop drives the T input of another. Cascading flip-flops this way can produce frequency divisions by any power of 2. With each flip-flop dividing the frequency by 2, the output frequency from the last flip-flop in the chain will be the input frequency divided by 2^N (where N is the total number of flip-flops cascaded). With four flip-flops the input frequency will be divided by 2^4 or 16.

Cascading flip-flops the way we do to form a frequency divider also lets us perform binary counting operations. The flip-flops can change state in such a way that the binary numbers they store indicate the number of input pulses that have occurred.

But all this is just part of another exciting story – one that we will cover in the next and last article of this series.

• • •

NRI honors program awards

For outstanding grades throughout their NRI courses of study, the following November and December graduates were given Certificates of Distinction with their NRI Electronics Diplomas.

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Thomas L. Sego, Bellevue, Neb.
Kurt Stegers, Freehold, N.J.
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Jack Thompson, Visalia Calif.
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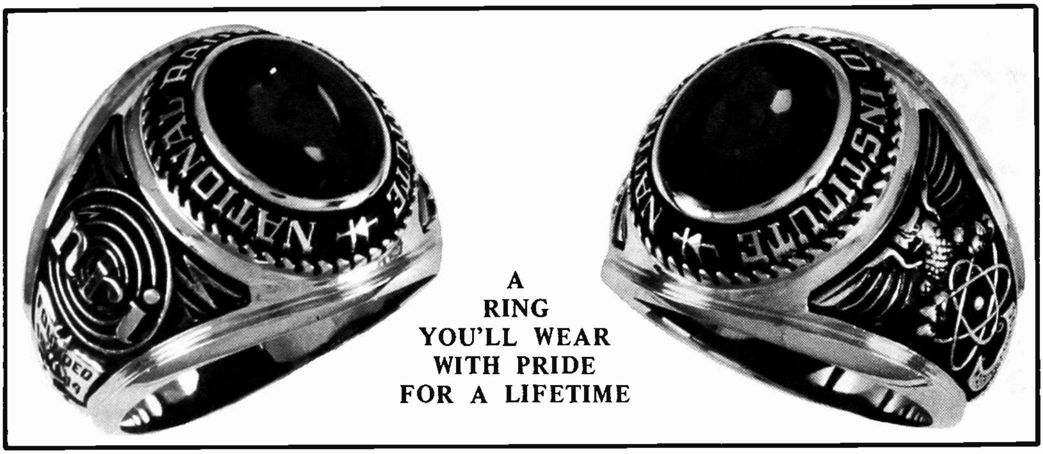

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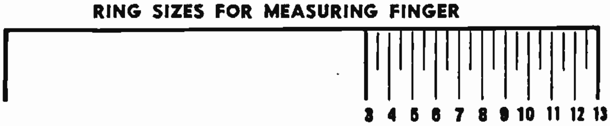

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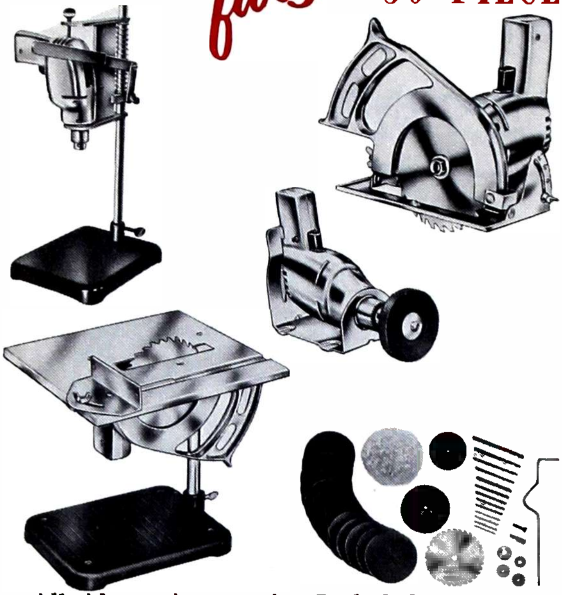

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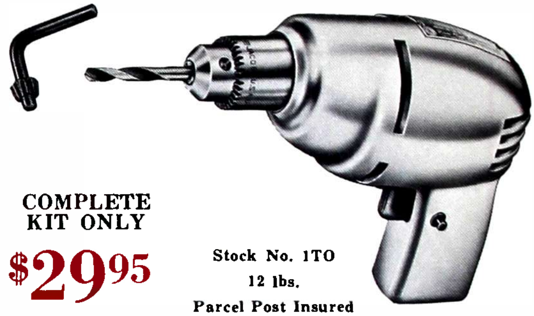

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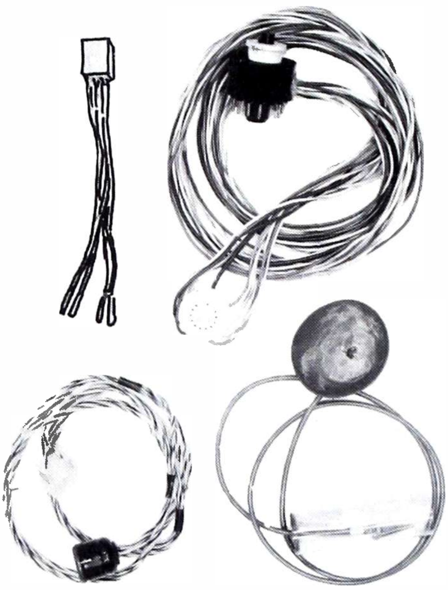

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City & State .... How long at this address? ....

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Credit Acct. with .... Highest Credit ....
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Credit Acct. with .... Highest Credit ....
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by J. B. Straughn

As some of you may know, I worked for NRI from 1929 to 1967, resigning to buy a farm, raise beef cattle, and go fishing. Quitting a regular job takes some adjusting and in about six months my wife found me walking around on the ceiling, much to her dismay. I was in such a bad state that I got in my car, drove a thousand miles and went back to work at NRI, but a month later a job opened up in my new home county for a Civil Defense coordinator. I applied for and got the job, which is part-time – 20 hours per week. This stopped the walking on the ceiling but I found I still had time on my hands.

Not being able to keep my big mouth shut I talked about my former work as Chief of NRI's Consultation Service and the first thing I knew a friend begged me to come over and "fix" their new Color set. I found they just didn't know how to operate it. This started the ball rolling, however, and requests for TV repairs grew to the point that I knew I was hooked into moonlighting.

I still had a Conar Tube Tester, Scope, Picture Tube Tester, Pocket Meter, and vtvm, all of which I had designed while working at NRI. With all this equipment, I was ready to set up shop. Except for one small detail...I had no shop. I am presently using a desk in my bedroom as my workbench. I wouldn't mind it so much if customers would only pick up their work promptly.

I quickly learned that credit was fine for banks and the government but not for yours truly. People get their sets when they pay for repairs and not before. Also, I had to decide what to stock in the line of tubes and parts. A person could easily invest $500 in tubes for a part-time operation, and still not have all the tubes he needs. There are trade magazines that publish lists of the most used tubes, but requirements usually vary with geographical location. Although I live in the country, I work in the small county seat which boasts two service shops and I am near a medium-sized city where there are three electronic wholesalers. I made it my business to get acquainted with them and arrange for an open account so I could charge parts. If you do the same, pay your bills regularly because they add up fast.

I still did not stock up on tubes, however; I just ordered them as needed at the start of a project. Since it was out of the question to drive so far for just one or two tubes, I called in my order and had what I needed sent to me by bus. If I placed my order early in the day, I could pick up my order at the bus stop the same day. If there was no hurry, I had the parts sent by mail. I soon learned what was needed in the way of tubes in my community and I started doubling up on some orders. For example, if I needed a single

1B3 or 12DQ6 tube, I would order two of each. This does not tie up funds, as there is a 60% discount on tubes and the current job will pay for future work and still net some profit. I now have accumulated a stock of about $300 worth of tubes at the wholesale price, but I still order quite frequently.

I don't make house calls. I have my customers well trained and they bring me sets from far and wide. This is no trouble in the case of portables, but I even have large color consoles delivered to my door and carried into my "shop" with as little help from me as possible. I have reached the ripe age of 62 without killing myself, and I am not going to wrestle these monsters any more than necessary. In the city, where people don't have trucks, you would either have to haul sets or specialize in portables.

I keep a small stock of electrolytics on hand, but paper capacitors and resistors are purchased as needed. My small supply has come mainly from parts I have cut out of old sets customers decide to junk. I do carry about ten fusible resistors of 4.7 ohm, 7 watts or so. These will "pop" on line voltage surges and with trouble in the horizontal sweep circuit. Their value is not very critical. I keep an assortment of CRT brighteners on hand, and am thinking about getting a resistor-capacitor decade box to use for substitution testing.

My biggest trouble and expense is in getting diagrams for the sets that I service. Lots of servicemen say they don't need schematics, but I am not one of them. With today's printed circuits it's too hard to see just what is in the set. Furthermore, schematics help me to reason out what could be causing the trouble I am trying to diagnose. When I am in a real hurry, I order a set of diagrams containing the one in which I am interested. They generally run around three dollars. I add this to my service bill without a mark up, because once you service a set you will have the diagram on hand, and never need to order it again. Sometimes, but very seldom, the additional schematics of other receivers in the set may be of use to you on some future service job. When I can't get a schematic locally and must have one, I remember NRI's Consultation Service and send a request for a copy of NRI's file diagram. This takes a little more time, but they have everything; and it is the best buy you will ever make, as this is a service of NRI and not done to make money.

Strange as it may seem to the beginner, 90% of TV troubles are due to defective tubes. This may lead you to think that owning a tube tester will enable you to solve 90% of the TV problems you encounter. Not so. While the tube tester is a handy piece of equipment which is needed by every serviceman, its limitations must be realized. If a tube is very weak, has no emission, or has shorted electrodes, the tube tester will inform you of this fact. Many times, however, tubes which check "bad" will actually work in the circuit in which they are used. Unless a study of the circuit or consideration of the complaint indicates differently, don't discard a tube just because it has a cathode-to-heater short. In this particular circuit both the cathode and heater may be grounded – so who cares if they are shorted together? A "weak" tube may work fine, as proved by no change in operation when a new one is inserted in the set. Sometimes you will note snivets (dark vertical lines and splotches which move up through the picture) which usually appear on uhf stations. You may have to try several new tubes in the damper or horizontal output circuit before you find one that will not produce this condition. In other cases you may need to try several tubes as mixer-oscillators in front ends before you get one whose internal capacities are satisfactory for a particular circuit. In some cases, where trouble occurs in the color section of sets, just switching tubes of the same type number to different positions in the circuit will clear up the problem. Installation of new tubes only when absolutely necessary enables you to put more of the repair bill in your pocket. With experience you will know when a tube is a likely cause of trouble. The final check is to install a replacement and note the change in operation, if any. When in doubt, the rule to follow is to try another tube in the circuit.

I had a case of this sort recently. The county clerk, who works with me in the courthouse, came to me quite upset. There was a football game that night that he just had to see and his set had started acting up. The sound and the picture were both very weak. We drove out to his house with a tube tester he had borrowed from a local merchant and I confirmed the complaint, noting that there was no snow. This indicated to me that the trouble was in the video i-f section. I tested all of the i-f tubes, however, and they seemed to be good. I had the horrible thought that I might have to take his color console to my place in the back of my station wagon. I did not trust the tube tester completely, so we took the tubes to a local service shop and tested them on a high-quality mutual-conductance tester. Again, nothing seemed to be wrong. We put the tubes back in the set and while it was operating I lightly tapped the i-f tubes with the handle of a screwdriver. Sure enough, I saw a slight arc in the first i-f tube. We went back to the service shop and purchased a replacement tube. This fixed the trouble. There was no money in it for me this time, but the word-of-mouth advertising that resulted brought in more work than I really wanted.

VERTICAL TROUBLE IN A PANASONIC AN29

Parts from junked sets come in handy. Not long ago I fixed the horizontal instability in a set – defective diodes in the horizontal afc circuit. A pair of diodes from a junked set cleared up this problem. Then the set developed another problem. It showed about a four-inch vertical picture when first turned on; then after about five minutes of operation, the raster would grow until it almost filled the screen. The circuit in question is shown in Fig. 1. I suspected the boost voltage, the vertical tube V9, the clamp diode in the cathode circuit of V9A, or perhaps a resistor which was changing in value with heat.

Since I had been having trouble with some diodes in the horizontal circuit, I checked the clamp diode first. It was working satisfactorily, though. I found this out by unsoldering one of its leads and comparing its forward and reverse resistance with that of a power diode I had pulled out of a junked receiver. I discarded my improper boost voltage hypothesis because this voltage is a function of the horizontal sweep, which was normal at all times. Measurement showed the screen voltage, Pin 7, to be normal, but the plate voltage on Pin 1 was low and gradually increased as the set warmed up and the vertical

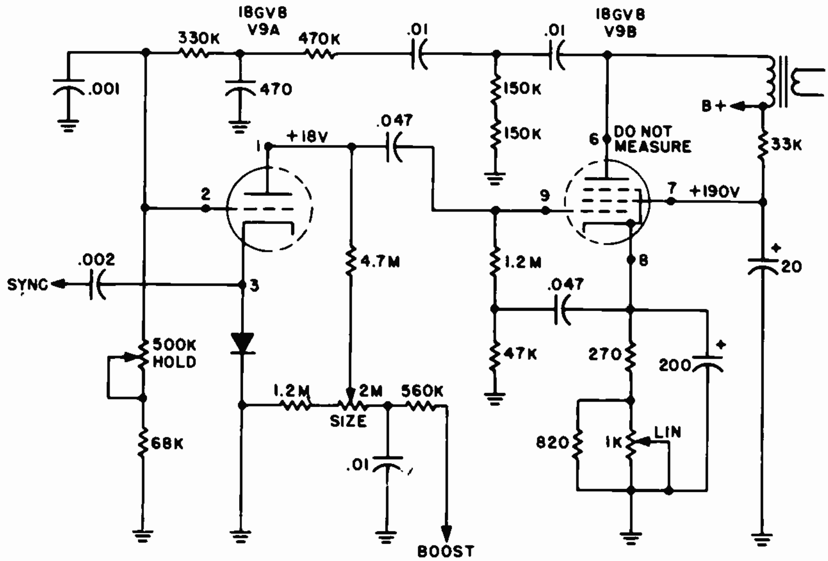

Figure 1

size of the picture increased. This could have been due to a defect of some kind in the 18GV8 tube, but as I did not have one on hand and would have had to order one from the set distributor in Atlanta, I bypassed this thought for the time being. I measured the resistance values in the plate circuit of V9A, and sure enough there was the trouble. The 4.7 meg plate load resistor measured about 8 megs, which was far too high and which accounted for the low plate voltage – about 5 volts on Pin 1. I tried putting a hot soldering iron on the resistor body while the ohmmeter was connected. As the resistor heated up, the resistance dropped. I looked around in my parts box for a yellow-violet-green resistor and just happened to find one. When installed, the trouble was a thing of the past, and I felt a little extra satisfaction.

DIODE MIXER IN UHF TUNER

In another set, I located a defective diode mixer in the uhf tuner. The diode was checked by comparing its forward and reverse resistance with that of an electrically similar unit known to be in proper working order. The difference in the forward and reverse resistance measurements is obtained by reversing the ohmmeter probes. The forward reading is the one with the lowest resistance and the reverse is the highest reading in ohms. The unit I used for comparison was not suitable to install, so I got the proper type from a wholesaler. When installed, the tuner was just as dead as before. I sadly contemplated installing a new transistor in the uhf oscillator section – a very messy job and one to be avoided if possible. I removed the plug-in diode I had just installed and checked it with the ohmmeter. It was just as bad as the one I had discarded! The next time I had to go to town I returned the defective unit. This time I asked for their ohmmeter and proceeded to check a number of units – about half of their stock tested bad. I got the impression the stock was from some surplus house. Surplus is obtained from a manufacturer that has had an overrun or whose parts did not come up to specs. In the latter case you may be getting junk, which was the case here. Wholesalers only carry surplus if they cannot get the parts they need directly from their manufacturers. This little tale was told to show you that you should not trust anything too much, and when in doubt you should use your own judgment and knowledge. This applies to anything in electronics including schematic diagrams, which are sometimes at fault. This is why it is so important for you to get all you can out of your NRI course. You need real knowledge to know how circuits are supposed to work.

POORLY SOLDERED CONNECTIONS

Be careful when soldering in new parts. About a year ago I installed a new yoke in a Motorola. For some reason, probably humidity, fall seems to be the time for yoke failures. I had soldered one of the vertical yoke leads to a resistor lead that was in a handy position. The other day the customer brought the set in. As a raster it had a curled up, barrel-like object on the picture tube screen. This is ordinarily caused by cathode-to-heater leakage in the vertical multivibrator tube. The short stops the oscillation, killing normal vertical sweep but at the same time injecting a 60 Hertz signal into the circuit. This is what produces the barrel-like thing already mentioned.

In this case the tube was all right and I spent about four hours looking before I located the rosin joint I had made a year ago! A proper connection cleared up the trouble.

Rosin joints, when first made, work in a normal manner. With time, however, a chemical reaction takes place between the two leads and the rosin, which should have been boiled out by heat when the joint was first made. The joint ceases to act as a conductor and instead acts like a semiconductor, passing current in one direction but acting as an open when the current reverses direction. In other words it acts like a rectifier. Because of this action my scope showed the vertical circuit waveform to be normal right up to the yoke where the waveform became similar to a sine wave at 60 Hertz. At any rate the customer was happy because there was no charge to him.

Be on the lookout for rosin joints, especially in connections made at the factory. Otherwise you may waste hours of time. Often such connections will be found on printed circuit boards. It is an easy matter to apply a hot iron (not a gun) and watch the rosin boil out of the joint. Just make sure you don't pick up all the solder and leave a loose lead in the hole making intermittent contact to the board foil!

This spare-time work can be very rewarding if you have the energy and charge properly. An ambitious man could easily clear $100 a week. I have grossed this much on a weekend but I am doing it mainly as a hobby and not charging as I should.

If you want to hear more about my experiences with specific sets and how I arrive at my diagnoses, write to the editor of the Journal. If there is enough interest, I'll write future articles.

● ● ●

Ham News

BY TED BEACH, K4MKX

It certainly slipped by me last time, but I wonder how many of you noticed the equipment in the photo on the cover of the January/February Journal? They set up this picture of Tom Dukes working on his metal detector in our Development Lab here at NRI. This lab also happens to be our "shack", and you can see that we really do have an SX100 and NC200. Now all we have to do is use them!

As I was afraid would happen, the last Journal has not been out long enough for us to get any response on the proposed Ham Classified listing. Next time I'm sure we'll have some for you. Also, we forgot to mention that you might also advertise if you *want* some specific piece of gear. I'm sure that there is plenty of used equipment gathering dust in many basements that someone would like to dispose of.

Even though I indicated last time you would be reaching NRI students and graduates only, this really isn't so bad. If you will take a look at page 21 of the last Journal you will see that this means about 45,000 people!

I would like to thank the many NRI Hams who took the time to send me personal Christmas greetings. Your cards were very much appreciated and I hope you will forgive me for not writing to each of you to thank you for them.

Here is the letter from Duane Schnur, WB8EEJ, 125 Gardner St., Caro, MI 48723, which arrived too late for the last Journal. Hope he can get something going.

The forty meter CW net, to my disappointment, is dead. I was QRT for several months due to remodeling being done here and forty must have folded in the meantime.

I've a new idea to get some sort of net going, at least if only token at first. Novices seem to have the bug the hardest for Ham radio. If you will publish this notice in the next issue of the NRI Journal I think we can scare up a net.

Have all novices interested in starting a net contact me. Have them give me a complete list of their forty meter crystals.

I think the old net just didn't appeal to hams because of the foreign BC station competition. Maybe an afternoon net with novices will work. If you will publish this notice, I'll give her a shot.

We heard from only 13 new NRI Amateur Course Novices this time – they are:

Raymond	WN1MUR	N	Amesbury, MA
John	WN1NTI	N	Greenfield, MA
Bob	WN4OZM	N	Yorktown, VA
Billy	WN4SUB	N	Portsmouth, VA
Cres	WN4SXM	N	Nicholasville, KY
Bryan	WN4SYJ	N	Orangeburg, SC
Dan	WN5DBS	N	Waco, TX
Carl	WN5DDP	N	Sweetwater, TX
Dick	WN6ANL	N	Long Beach, CA
Morris	WN9FTG	N	Shelbyville, IN
Jim	WNØCYP	N	Independence, MO
Chuck	WNØDEH	N	Arkansas City, KS
E.P.	WNØDGG	N	Lakewood, CO

Nearly all of these calls came to me from our lesson grading section as reported on the 3R Training Kit Report. As a result, the students rarely write notes or anything else of interest for the Journal on the report sheet.

WNØDEH, however, did send me a letter, and guess what? I now have another license photocopy to add to my collection. Chuck's makes about six, now.

I don't know whether WNØDGG is bragging or complaining. A note at the bottom of E.P.'s answer sheet for lesson B106 says "I guess I am out-of-phase with this course. I just got my Novice license." I mean, after all, just because lesson R102 is for the Novice license, B106 is only *slightly* past it, so what's "out-of-phase"?

Other students and graduates we have heard from are:

George	W1EPN	C	Presque Isle, ME
Bob	WA3PQO	G	Aberdeen, MD
Jim	K3YND	T	Riegelsville, PA
Al	WN6BTF	N	Eureka, CA

John	WN6CKN	N	Gonzales, CA
Bob	WNØAUQ	N	Lawrence, KS
Jerry	WBØBEK	A*	Iowa City, IA
Richard	WØMM	-	Minneapolis, MN
Hank	KZ5HK	G	Balboa, CZ

*Just upgraded – Congratulations!

For those of you who think you need high power, consider what W1EPN accomplished in his six months as a novice: over 500 stations worked with a Heath AT1 (25 watts) on 80 and 15 meters. Of those QSOs, 412 were on 15 meters with only 12 watts input! George currently runs a Viking II and a HQ129X.

WA3PQO runs an HW100 from his own shack and uses the base club (K3WAS) Collins rig also. Some people have all the luck. Bob wanted some information on a 6 and 2 vfo for use with a mobile rig. About all I can come up with is the ARRL Handbook and a couple of circuits in "The VHF Manual" (also ARRL). If anyone has a pet circuit for an 8 MHz output vfo, please let Bob know. I get a nosebleed just thinking of frequencies above 21 MHz!

WNØAUQ informs us that he was one of two out of five applicants to pass the General test in November and is just *waiting* to change that N to a B. Bob gives his NRI Communications Course the credit for most of his success in passing the test.

Jerry, WBØBEK, jumped from Novice to Advanced and has graduated from his Conar rig to a mighty Ten-tec (2 watt!) PM1 transceiver. Sounds like a step backwards, but not for an avid QRP man like Jerry. He knows that you really have to be a sharp operator and technician to compete with the "big boys" on 80 and 40 CW, when you're only running 2 watts. There is a bi-monthly publication, ***The Milliwatt***, for anyone who would like to know more about low power operation. For more information, Jerry says you can write Wes Mattox K6EIL/2 at: 115 Park Avenue, Binghampton, NY 13903.

WØMM presents us with a real mystery. I have a blank QSL card with name and address imprinted thereon from Richard, but that's all. From the two letter call, he is an old timer, but his call is not listed in the latest callbook! Must be at *least* Advanced, but who knows? Please write and let us know, Richard.

KZ5HK thinks perhaps I aroused a few real hams when I referred to the 11 meter QRM generators as "Hams". Believe me fellas, I didn't mean it. Just try to interest some of them to go legit by doing a little honest work and getting a *real* radio license.

And that's about it for this time. Let's hope we'll have heard from some of you for our HAM-ADS for the next time. Keep those QSLs coming in – we enjoy hearing from you.

Vy 73, Ted K4MKX

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Appliance technicians (and apprentices)

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2. Present enrollee who has completed 2/3 of the course and maintained at least a B average.

Alumni News

James Wheeler	President
Robert Bonge	Vice-Pres.
Graham Boyd	Vice-Pres.
Br. Bernard Frey	Vice-Pres.
Thomas Schnader	Vice-Pres.
T.F. Nolan, Jr.	Exec. Sec.

DETROIT Chapter holds Auction

An auction was held in November to dispose of surplus parts that were gathering dust on the shelves. It gave members a good buy and helped build up the treasury. At the same meeting Mr. John Nagy showed the proper way to add extension speakers to PA systems.

At the December meeting John Nagy again gave a good demonstration on the use of a wireless FM mike as used in PA work. Also at this meeting, Jim Kelly brought in an SCR (silicon controlled rectifier) set-up to demonstrate the action of the popular semiconductor.

At the January meeting, Jim continued with his lecture using a demonstration board and the blackboard to show how SCRs could control motors and do various other electronic chores. Sam Peri and James Collins visited this meeting.

The Chapter is very anxious to meet the students now taking or completing the color course as both the students and the old-timers are able to learn something from these meetings.

John Nagy demonstrating the wireless mike.

Jim Kelly demonstrating the SCR.

FLINT-SAGINAW has Talk by University Teacher

Mr. Bill D. Jenko gave a talk on TV servicing. He was able to locate two color TV problems which had been eluding the membership. The members had been working on the problems for several days and with Bill's help the trouble was located in a broken printed circuit board.

Mr. George Rashead was reinstated into the Chapter after 10 years. Welcome back again, George. George was the Chapter chairman 12 years ago.

We also had an NRI student stop in for one of our meetings. He was Joe Washington and the information he obtained from the meeting helped him considerably with his NRI lessons.

The January meeting was devoted to the election of officers. The new officers are: Chairman – Andrew Jobbagy; Vice Chairman – Steve Avetta; Secretary – Gilbert Harris; Treasurer – Arthur Clapp; Photographer – Richard Jobbagy; Sgt. at Arms – Robert Poli; Good Will Ambassador – Joe Washington; Entertainer – George Maker; Entertainment Committee – Leslie Carley, Fredrick Malek, Cash Laferty; Membership Committee – Robert Newell; George Rashead.

At this same meeting Joe Washington, Fredrick Malek and Cash Laferty became members. Welcome to the Chapter fellas.

Andrew Jobbagy will be in San Francisco as the Good Will Ambassador to the San Francisco Chapter on February 13, 1971. We will be looking forward to a report from Andy when he gets back from San Francisco.

NEW YORK Chapter has Visit from Tom Nolan

Mr. Tom Nolan, Executive Secretary of NRI Alumni Association, was introduced at the December meeting. Tom installed the new officers of the New York City Chapter. They are: Sam Antman – Chairman; Al Bimstein – Vice Chairman; Pete Carter – First Vice Chairman; Ontie Crow – Second Vice Chairman; Ted Freije – Secretary; Roy DeSilva – Treasurer.

With operating equipment and photographic slides Tom was able to give a very good demonstration of Color TV Alignment. He showed what to look for on the oscilloscope and what coils to adjust to get the proper waveform. After the lecture all of the members were allowed to misalign the equipment and then realign it to the proper curve.

At the following meeting Sam Antman read a letter from Brother Bernard Frey, who is a past member of the Chapter. He told about his adventures in May and June in Honduras, installing Amateur Radio stations for his mission. In September he traveled through New York and New England interviewing young men who wished to join the order. In October he attended the International Radio Association Conference near Cuernavaca, Mexico.

NORTH JERSEY Chapter holds Elections

At the December meeting new officers were elected and they are as follows: Chairman – George Stoll; Vice Chairman – Franklin Lucas; Treasurer – Leroy Frienschner; Secretary – Harry Weitz.

DIRECTORY OF CHAPTERS

CHAMBERSBURG (CUMBERLAND VALLEY) CHAPTER meets 8 p.m. 2nd Tuesday of each month at Bob Erford's Radio-TV Service Shop, Chambersburg, Pa. Chairman: Gerald Strite, RR1, Chambersburg, Pa.

DETROIT CHAPTER meets 8 p.m., 2nd Friday of each month at St. Andrews Hall, 431 E. Congress St., Detroit. Chairman: James Kelley, 1140 Livernois, Detroit, Mich. VI 1-4972.

FLINT (SAGINAW VALLEY) CHAPTER meets 7:30 p.m., 2nd Wednesday of each month at Andrew Jobbagy's shop, G-5507 S. Saginaw Rd., Flint, Mich. Chairman: Andrew Jobbagy, 694-6773.

LOS ANGELES CHAPTER meets 8 p.m., third Friday of each month at Graham D. Boyd's TV Shop, 1223 N. Vermont Ave., Los Angeles, Calif., NO-2-3759.

NEW ORLEANS CHAPTER meets 8 p.m., 2nd Tuesday of each month at Galjour's TV, 809 N. Broad St., New Orleans, La. Chairman: Herman Blackford, 5301 Tchoupitoulas St., New Orleans, La.

NEW YORK CITY CHAPTER meets 8:30 p.m. 1st and 3rd Thursday of each month at 264 E. 10th St., New York City. Chairman: Samuel Antman, 1669 45th St., Brooklyn, N.Y.

NORTH JERSEY CHAPTER meets 8 p.m., last Friday of each month at The Players Club, Washington Square. Chairman: George Stoll, 10 Jefferson Avenue, Kearney, N.J.

PITTSBURGH CHAPTER meets 8 p.m., 1st Thursday of each month in the basement of the U.P. Church of Verona, Pa., corner of South Ave. & 2nd St. Chairman: Tom Schnader, RFD 3, Irwin, Pa.

SAN ANTONIO (ALAMO) CHAPTER meets 7 p.m., 4th Friday of each month at Alamo Heights Christian Church Scout House, 350 Primrose St., 6500 block of N. New Braunfels St. (3 blocks north of Austin Hwy.), San Antonio. Chairman: Joe R. Garcia, 8026 Cinch, San Antonio, Tex., 694-3461.

SAN FRANCISCO CHAPTER meets 8 p.m., 2nd Wednesday of each month at the home of J. Arthur Ragsdale, 1526 27th Ave., San Francisco. Chairman: Isaiah Randolph, 60 Santa Fe Ave., San Francisco, Calif.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets 8 p.m., last Wednesday of each month at the home of Chairman John Alves, 57 Allen Boulevard, Swansea, Massachusetts.

SPRINGFIELD (MASS.) CHAPTER meets 7 p.m., 2nd Saturday of each month at the shop of Norman Charest, 74 Redfern Dr., Springfield; and 4th Saturday at the shop of Chairman Al Dorman, 6 Forest Lane, Simsbury, Conn.

PHILADELPHIA-CAMDEN CHAPTER meets 8 p.m., 4th Monday of each month at K of C Hall, Tulip and Tyson Sts., Philadelphia. Chairman: John Pirrung, 2923 Longshore, Philadelphia, Pa.

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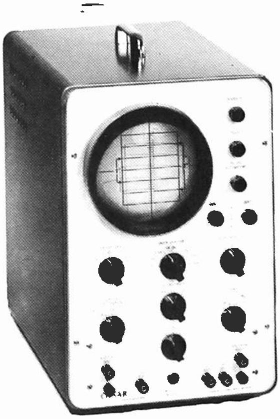

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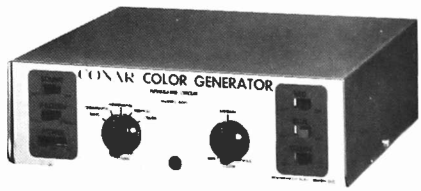

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