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TF26 TOUCH TONE
CRICKET

LOGICAL SOLID
STATE SERVICING

SENCORE NEWS

FIELD ENGINEERING REPORT FOR JAN/FEB, 1974



ONLY \$140

HOP THROUGH SOLID STATE CIRCUITS IN SECONDS

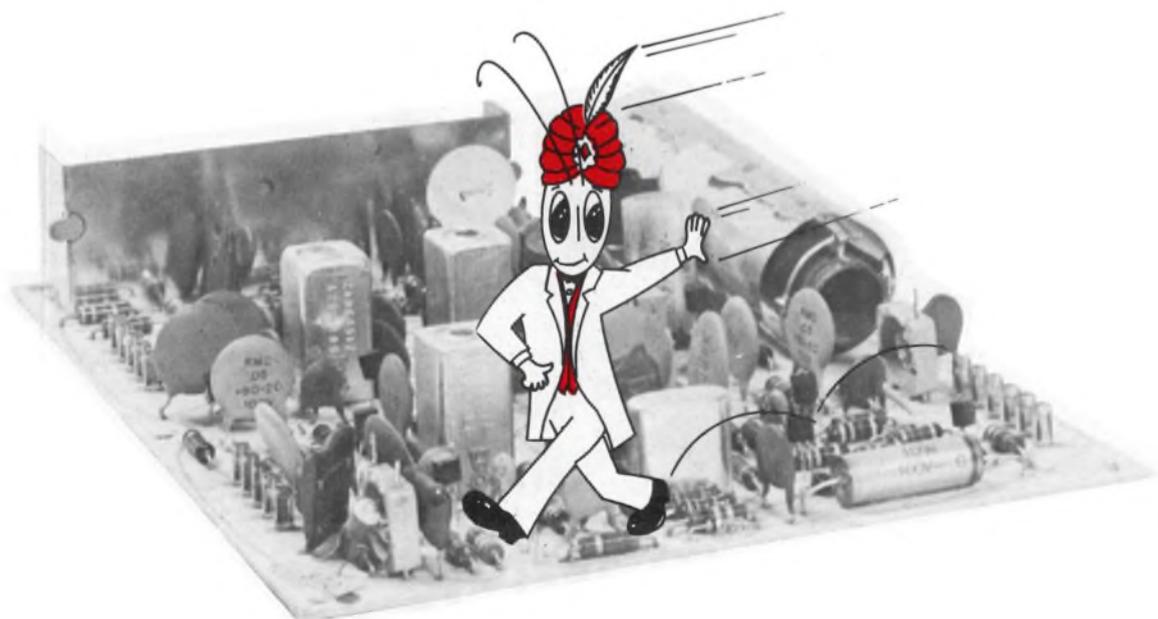
The Miraculous

TF26 TOUCH TONE CRICKET

WITH COMPUTER LOGIC CIRCUITS

FIX IT WITH THE CRICKET-FAST

THE NUMBER ONE MIRACLE SOLID STATE PROBLEM SOLVER



- ✓ COMPLETE IN-CIRCUIT PUSH-BUTTON TEST IN ONE SIMPLE OPERATION.
- ✓ CONNECT LEADS ANY WAY YOU WANT.
- ✓ NO REFERENCE BOOK NEEDED.
- ✓ CHECKS BOTH PNP AND NPN.
- ✓ BOTH TRANSISTORS AND FETS.
- ✓ OUT OF CIRCUIT LEAKAGE TEST TO BACK YOU UP.

Test in Circuit... in Seconds

TF26 TOUCH TONE CRICKET

The past few years have produced rapid changes in the electronics industry. The most dramatic of these changes has been the utilization of transistors. You just don't see vacuum tubes any more in modern electronics. The transistor was invented only 25 years ago, but in that short time it has been refined and developed to the point where solid state has revolutionized the industry.

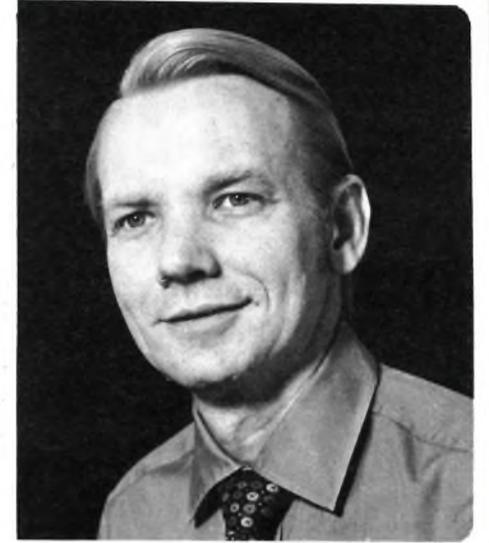
The transistor has not only changed the circuitry in existing electronics, but it has also opened completely new markets for electronic applications. We now find transistorized circuits in industrial control systems, household appliances, automotive controls, and in recreation applications such as the automatic pin-setters in your local bowling alley.

These new applications of transistors motivated Sencore engineers to take another look at transistor testing. Many service and maintenance technicians who we surveyed said they did not have the solid state electronic background to accurately troubleshoot these circuits. How could we

remove the uncertainty (and in some cases fear) of solid state troubleshooting for these persons? Could we design a tester with which anyone could test any transistor or FET, in or out of circuit, even if he had no technical knowledge or setup book data? How could we make solid state servicing easier?

This issue of Sencore News introduces our answer to these questions — the TF26 Touch Tone Cricket. Technicians tell us that the Cricket is the fastest, easiest to use transistor tester available today. They can't believe it — they think it's magic. You can now check any transistor or FET, in or out of circuit, with the same simple pushbutton test of the Cricket! No technical knowledge required.

We introduce the Cricket by the use of a filmstrip published in this Sencore News. This film can also be seen at Sencore Tech-A-Rama meetings scheduled across the country. Check the schedule inside and plan to attend the Tech-A-Rama in your area.



Marlin Westra
Technical Marketing

HERE IT IS --- THE MIRACLE SOLID STATE PROBLEM SOLVER

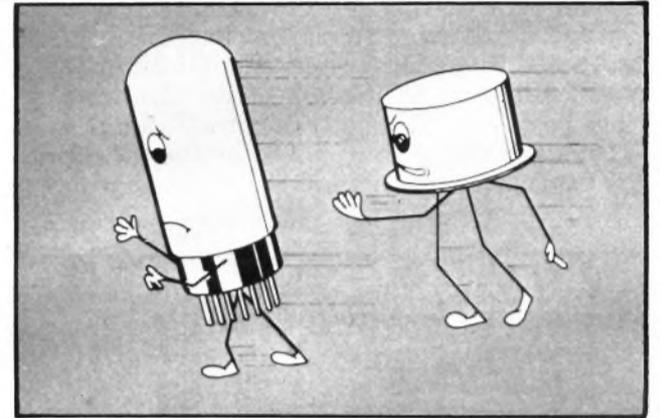
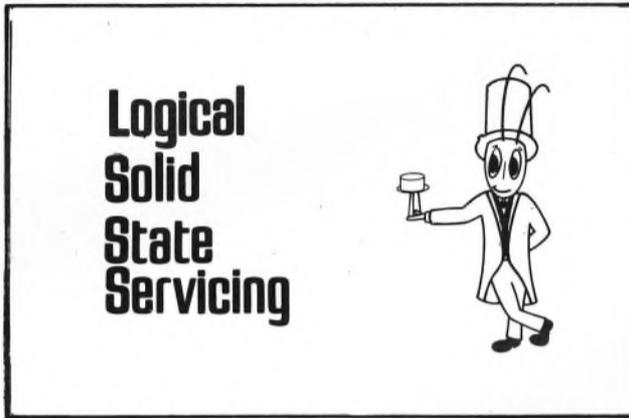
- Specially constructed meter movement designed to withstand on-the-go use. It's even lighted.
- Rugged acrylic case and sliding metal cover to protect meter glass during transit.
- Cricket chirps when proper button is pushed on a good transistor, to let you know everything is "Cricket".
- Checks all transistors NPN and PNP, N-channel and P-channel FET's with the same simple test.
- Built-in socket supplied for quick testing of those plug-in transistors.
- Simplified GOOD-BAD scale tells you what you need to know -- if the transistor is good or bad.
- Calculator-type pushbuttons pick out the proper lead connections for you.
- Leakage test with microamp sensitivity to back you up out of circuit.
- Built-in lead and line cord storage for safe and easy portability.
- Big, easy to handle spring-loaded connectors grasp the transistor terminals firmly.

\$140

TF26 TOUCH TONE CRICKET - IN OR OUT OF CIRCUIT TRANSISTOR AND FET TESTER

Sencore Presents

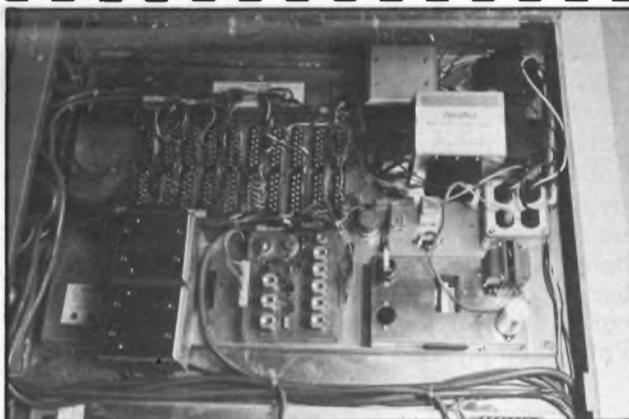
LOGICAL SOLID STATE SERVICING



1 Hello! This is your Sencore man. It is our pleasure to present this 25 minute film to show you some logical answers to solid state servicing.

2 We hope to show you that you can move ahead with greater efficiency, more confidence, and higher profits, if you can take a more logical approach to solid state service.

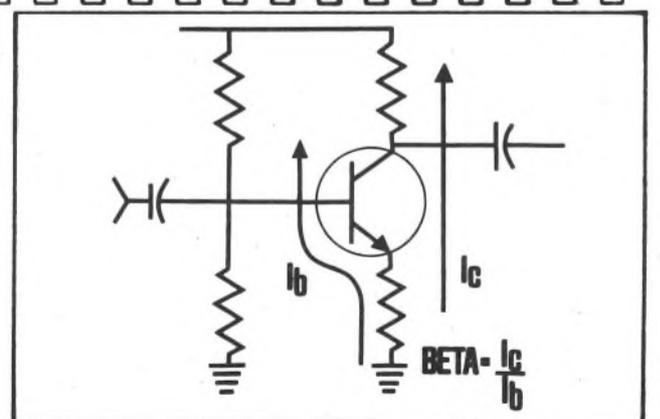
3 Let's start from the beginning so we can understand transistor testing just a little better. The transistor was invented only a short 25 years ago, but since that time the technology has been refined and developed to the point where it has revolutionized the electronics industry.



4 Transistors are now common as tube replacements in nearly all electronics such as radio and television,

5 - industrial control systems,

6 - medical electronics

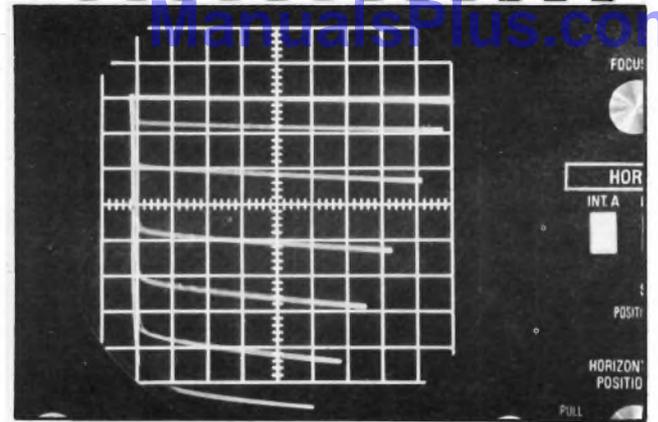
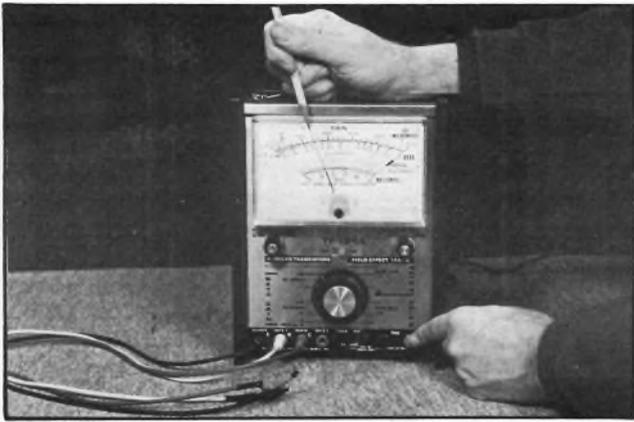


7 - in automotive control and safety systems, and even milking machines on the farm.



8 There are several different types of transistors that you contend with in your daily work. For example, there are NPN and PNP bipolar transistors of the low, medium and high power varieties. Add to this the N-channel and P-channel Field Effect Transistors and MOSFET'S. With the confusion of all these different types and polarities it is apparent that a simplified logical system is badly needed.

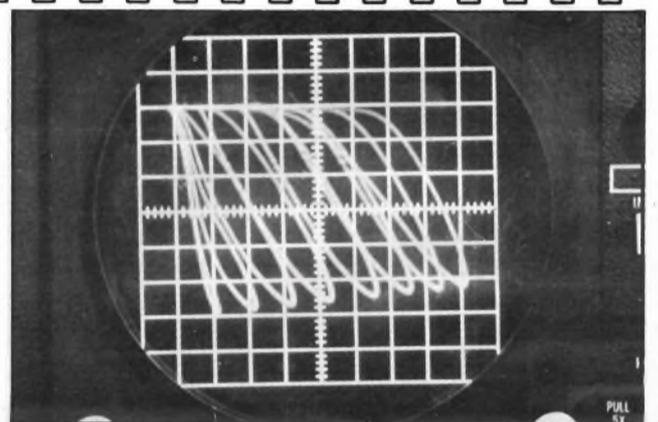
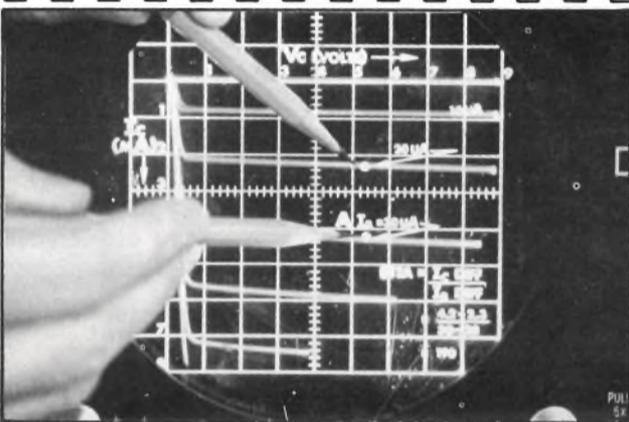
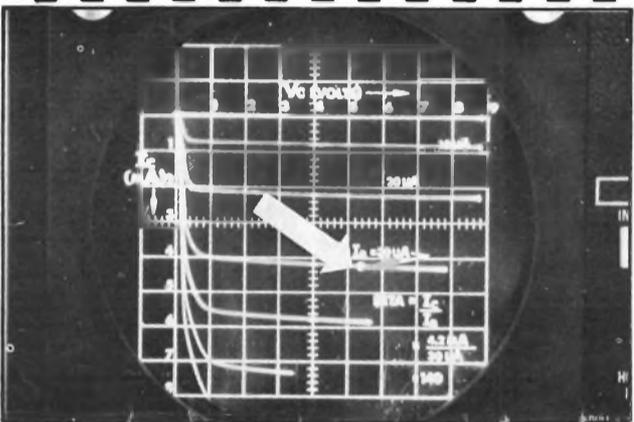
9 Let us look at some of the measurements you have reference to on your schematics and troubleshooting data. The most often referred to measurement is beta. What is beta? Beta is defined as the ratio of collector current, I_c , to the base current, I_b . This is a basic measurement of the current gain of a transistor. Typical values of beta are as low as 10 (for some high power types) to as high as 500 (for low power, high gain types).



10 Let's look at the beta measurements on an earlier Sencore model TF151 to see just how this measurement is made. The transistor is connected and the beta measured by first setting the collector current to full scale deflection. This sets a value of unity or one to measure against. Then base current is measured to see how little base current is needed to get the current amplification to full scale deflection in the collector. The scale can then be calibrated directly in current gain or beta. That's all there is to it, collector current divided by base current.

11 This later model Sencore TF166 uses the same ratio system, on either AC or DC to back you up in places where beta measurements are important. Basically, the TF166 is like the earlier model TF151 but has been simplified and made automatic in that it does not require a set-up book for most measurements, thus saving that valuable testing time.

12 Some of you may have been sold the idea that a curve tracer is your answer for measuring beta. Not only is the curve tracer cumbersome to use, open to interpretation and requires a scope, but it is complicated in every respect. Let's look at a family of curves, to see how the curve tracer works. First, to obtain the value of beta, one must determine the values represented by each division on the graph, and then perform some calculations from the graph to determine beta.

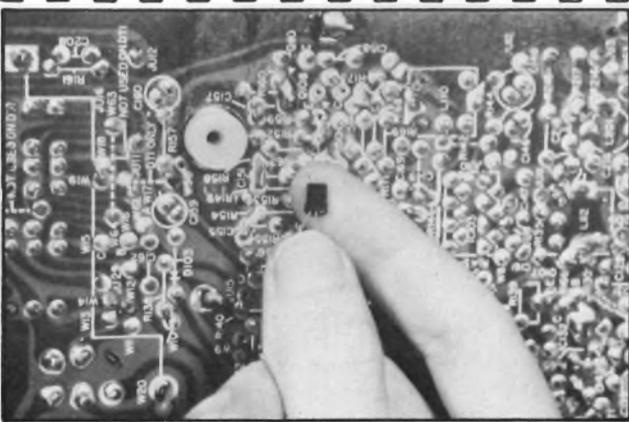
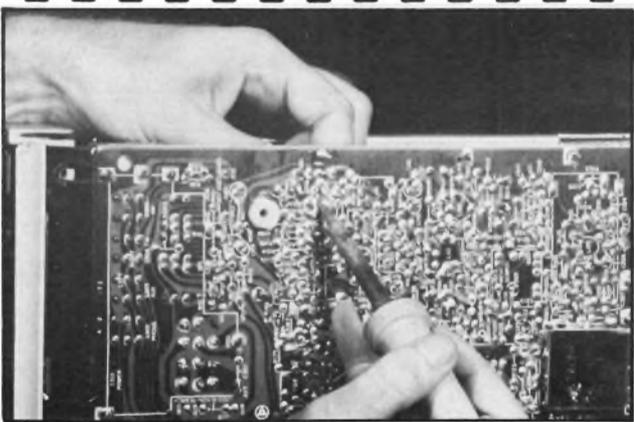


13 When values are obtained for a particular point on the graph, the ratio of collector current to base current must be divided to obtain beta. Note, too, that the value of beta will depend upon the point you choose to consider.



14 To obtain a more meaningful value for beta, the calculations become even more complicated. If you really want a value for beta that relates to the transistor's circuit performance, it must be a dynamic value and not the fixed point value. This means that you must consider two points as shown here. The dynamic value for beta is then the collector current difference divided by the base current difference between these two points. Pretty complicated and sticky huh!

15 This time consuming procedure wouldn't be bad if the information were reliable, but the information given by a curve tracer for an in circuit transistor is often meaningless. Take this one, for example, from a good preamp transistor in a Magnavox series R243 FM stereo chassis. How are you going to determine beta from this family of curves? How can you even tell if the transistor is good or bad? It doesn't even look like a set of transistor curves. Not very logical, is it? I am sure you can see why Sencore believes curve tracers belong in the lab and not in the field.

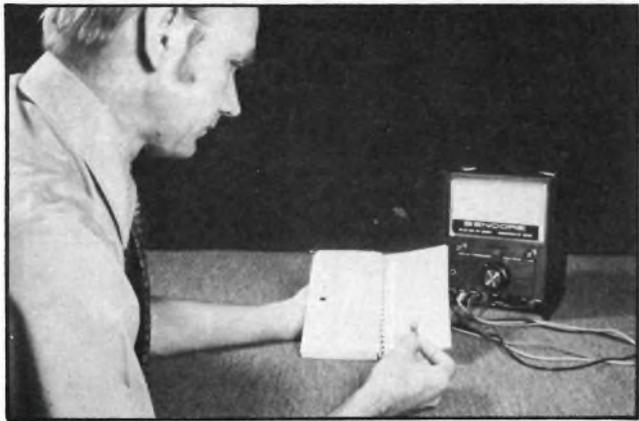


16 OK, so curve tracers aren't your answer and the Sencore TF166 is not quite as simple as we'd like to see for fast troubleshooting. Let's start from scratch and see what we can come up with. The number one problem in transistor testing is the necessity to unsolder the transistor and solder it back for simple testing purposes. All agreed?

17 In the process of unsoldering the transistor, you run the risk of damaging the transistor or FET with excessive heat or you may wind up breaking one of the fragile leads as we have done here. Up goes valuable time and cost of replacement.

18 Another common problem, they tell us, is that some of you forget which leads go where when the transistor is to be reinstalled. You know what happens then - a damaged transistor and more time wasted and dollars down the drain.



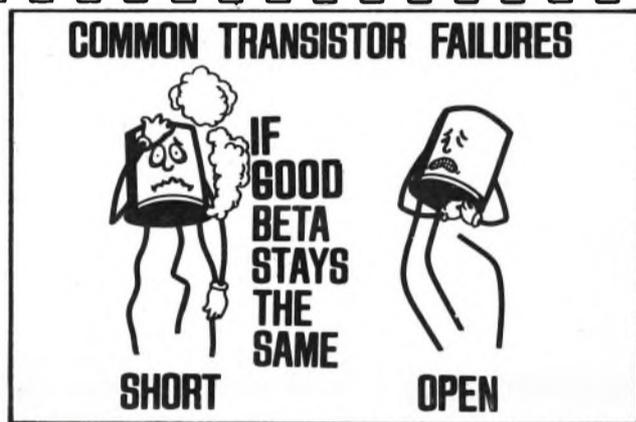


19 The number 3 problem they tell us, is the time required to look up values in the reliable old set-up book. This is to say nothing of time required to determine basing for proper lead connection.



20 Knowing these time consuming complexities, Sencore went to work with computer logic mathematics to see if it were possible to design a product that would do all of these things for you. Hang onto your seats because you will hear claims that will sound unbelievable to you. Ready? The Cricket will test any transistor, bipolar or FET, in or out of circuit, without a reference book. No need to know whether the transistor is NPN, PNP, a conventional or field effect transistor, and no basing information is necessary. A computer logic circuit automatically determines all of this information for you with the simple push of a button.

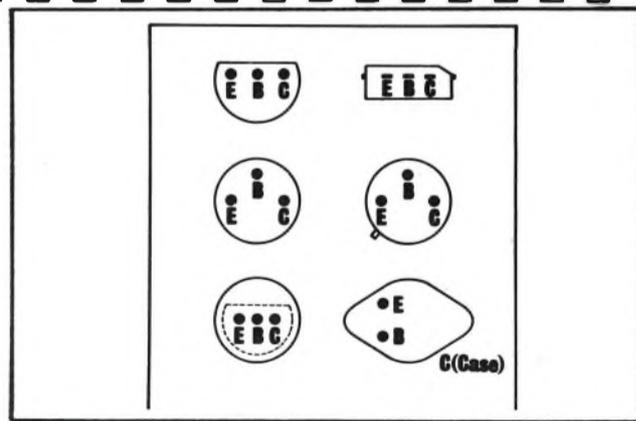
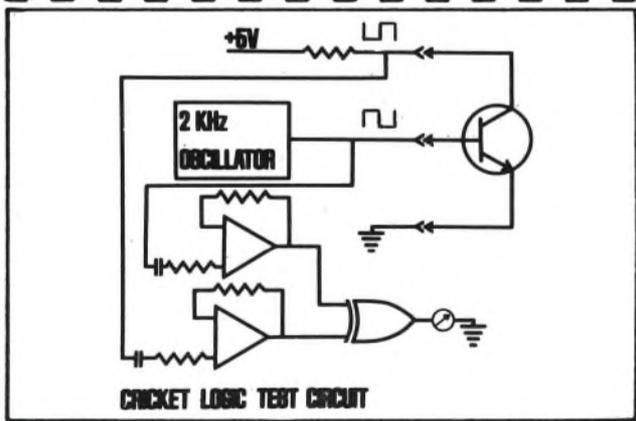
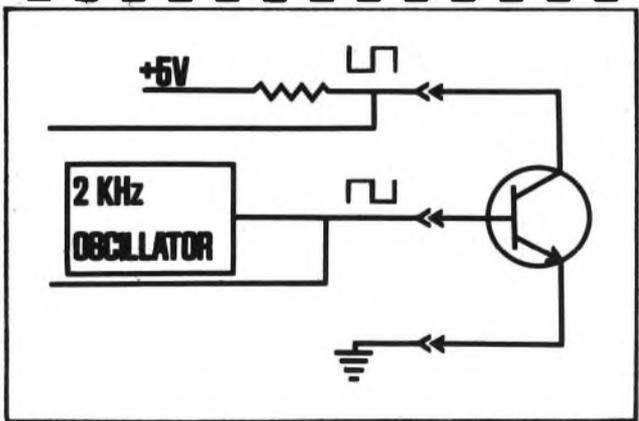
21 What does this mean? Let's say it again, in short. It means that no technical knowledge is required at all to test transistors or FET's. Quite a claim! Does it work? Can a completely non-technical man use the Cricket? To find out, we chose a completely non-technical maintenance technician. He was responsible for the maintenance on the solid state control system of this truck wash.



22 First, we got his story; it went like this: "This automatic system is full of those three-legged monsters. All I want to know is, is the transistor good or bad? I want to know if they are going to work in the circuit or not. I don't care about those engineering terms. I have trucks jammed up and those license and permit numbers have to show or these trucks get stopped.

23 One more meeting of our engineering staff to be sure the Cricket would work under all conditions like it worked in the truck wash. Further testing at leading service companies proved that we had designed a miracle problem solver that a technician can connect to those three legs any way he wishes and simply push the buttons for a complete computer logic read-out. Eureka, we had eliminated the setup book and those engineering parameters!

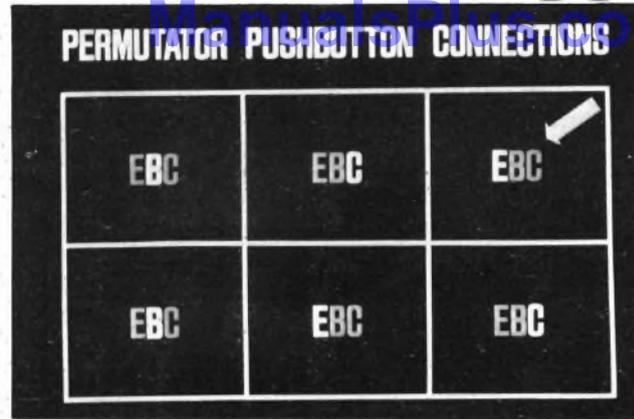
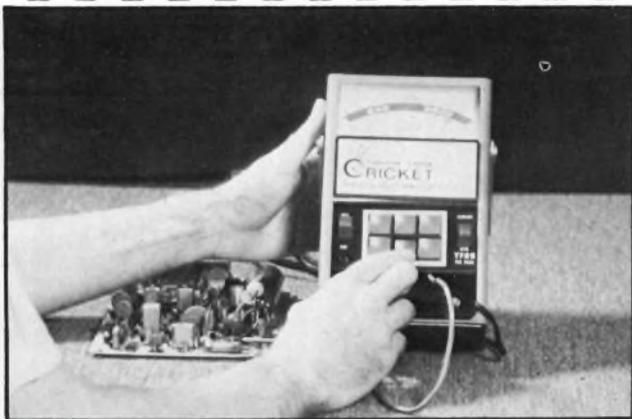
24 Now wait a minute, do we mean that we have eliminated the need to read beta too? You bet—we just read good or bad, that's what you want, right? Let's see why we do not need to know beta for most service problems. When a transistor fails, it is usually a complete catastrophic failure. A good transistor in a circuit will usually have the same value of beta as the day it was installed. Transistors don't get weak before they die, like tubes do, they break down completely, they either amplify or they don't.



25 Let's look at the basic circuit of this miracle problem solver so that you may better understand the test that we are making. This diagram shows a normal common emitter configuration of a transistor. When a good transistor is connected as shown, a signal injected into the base will cause an amplified collector signal 180 degrees out of phase with the base signal. A bad transistor will not show this phase shift. You should be familiar with the fact that you get 180 degree phase shift in any good amplifier, this is what we are testing.

26 Now, how do we compare the phase of these two signals? First the signals are amplified to logic levels. Then we use a special computer logic integrated circuit which will give an output only when the two inputs are of opposite polarity. This output produces a good reading on the meter. How about that? We get a check on gain as well as phase. If a transistor amplifies and inverts the signal we can be pretty sure it is not our problem.

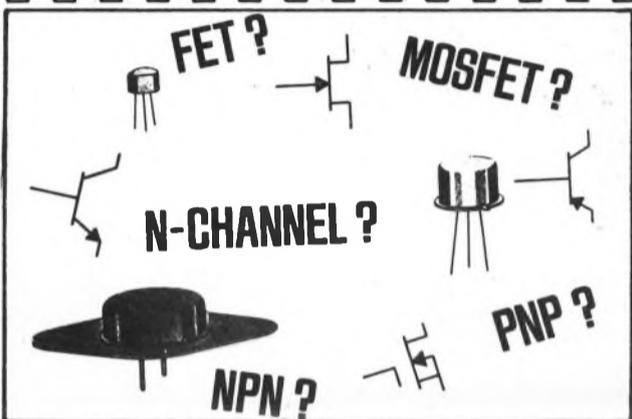
27 Let's go over basing and lead connections again. How are you to know which lead to connect to each of the three transistor terminals without a setup book? Let's say it again. You don't need to know. That's right, you can connect the leads any way you want! The Cricket will tell you when the leads are connected correctly for test as you press the test buttons that cause the Cricket to chirp.



28 This set of six logic permutator pushbuttons does all the work for you. By pushing each button in turn, you automatically connect the test circuit to the transistor leads in all possible configurations. When the correct button is pushed on a good transistor, the Cricket will chirp and read good on the meter. That's right, the Cricket chirps to let you know the transistor is alive and you are connected correctly. That's why we call it the Cricket, because of the chirp. If you are wondering what it sounds like, you've been listening to it as a signal to change the slides in this film.

29 Why the chirp? Because in our experimenting with the Cricket, we found the operation became so fast with experience that one would push the correct button and go on to the next before the meter had a chance to respond and read upscale. You will know instantly that the correct button is pushed and the transistor is good with the chirp. Also, the chirp saves you from looking at the meter if you wish to concentrate on the circuit, to be sure leads aren't shorted or some such thing. It gives you a third hand, or should we say third eye.

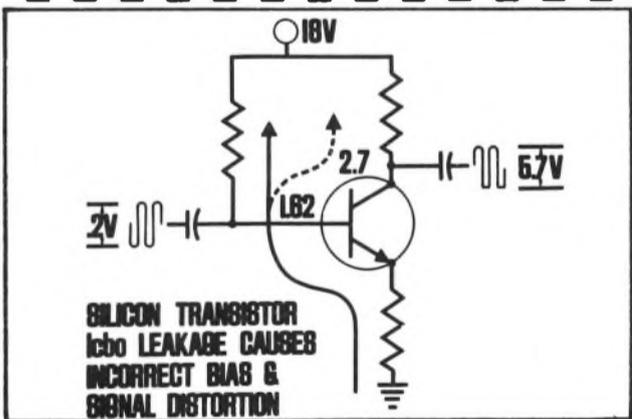
30 What do you mean, permutator? Can't you simplify that a little bit? Sure we can. Let us show you how the miraculous Cricket determines the basing for you. This slide represents the six pushbuttons on the Cricket. As an example, when a transistor shows a good reading with the upper right button depressed, you have actually connected the yellow lead on the Cricket to emitter, red to the base, and green to collector. You guessed it, the Cricket logic does this work for you. But you don't need to know all that, you just push the button and listen for the chirp. The lead identification is there if you want it.



31 We haven't said much about polarity. The Cricket determines that for you too. That's right! If you don't know the polarity of the transistor you are testing, simply try either NPN or PNP and press all six buttons. If you don't obtain a good reading on that polarity, try the opposite one and press the six buttons again. The Cricket will determine the transistor polarity for you. Pretty handy when you want to know the polarity of a general replacement transistor, isn't it? That's why we call it the magic Cricket.

32 How about these other types? The Cricket tests field effect transistors too, with the same fast simple test. The same signal inversion must take place when the input signal is applied to the gate of a field effect transistor. Hook it up any way you wish and just push the buttons. If the transistor is good, the Cricket will chirp and read good when the proper button is pushed. The Cricket logic tests them all with the same simple logical test.

33 Okay, so the Cricket is really magic when it comes to finding defective transistors. But what about the cases where the transistor is shorted directly by the circuit? The Cricket won't chirp then will it! That's right, without a leakage test you wouldn't be able to determine whether the trouble was the circuit or the transistor. Throw this switch to the leakage position and you have a sensitive out of circuit leakage tester, just like the TF166. Saves making a wasted trip to the store for a replacement, doesn't it?



TYPICAL TRANSISTOR LEAKAGE CHARACTERISTICS

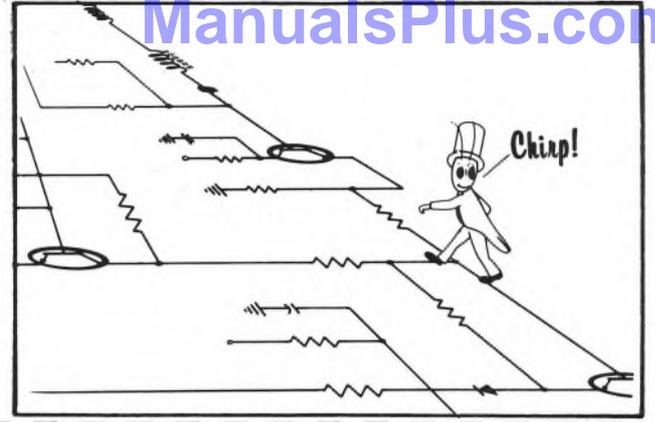
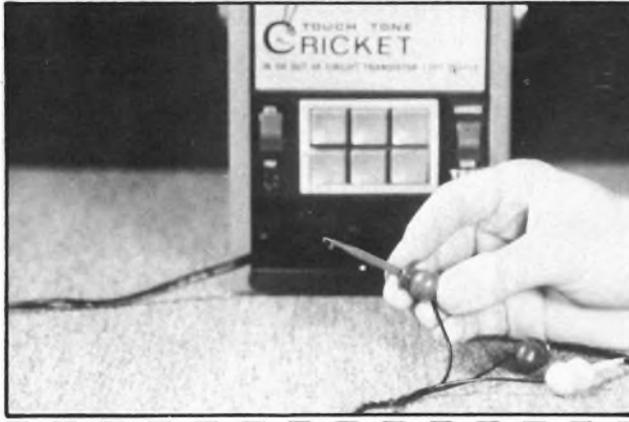
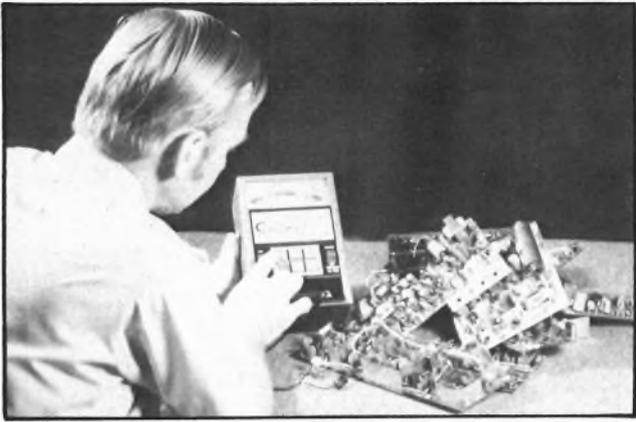
GERMANIUM		SILICON	
RF-IF	0-5 μA	RF-IF	0-5 μA
LOW PWR.	5-50 μA	LOW PWR.	0-1 μA
MED. PWR.	50-500 μA	MED. PWR.	1-300 μA
HIGH PWR.	500-5000 μA	HIGH PWR.	UP TO 600 μA



34 There is another very good reason why leakage must be on this quality tester. In testing over 3000 transistors, we found the gain alone would locate over 96% of all faults in circuit. There are certain odd situations where a transistor will read acceptable gain, but leakage will interfere with the bias enough to cause the circuit operation to be unreliable. Even though this is less than 1% of the tests you make, we add the leakage test to back you up for these suspected cases. We want the Cricket to be as near 100% as possible.

35 How are you to know how much leakage is allowable? The chart shown here, available in the service manual with the Cricket, gives you some maximum limits for I_{cb0}, leakage. From a practical standpoint you don't have to refer to the chart for anything but power transistors. Any noticeable leakage measured on silicon transistors, the type you will encounter most often, is a sign of a bad transistor. Larger values of leakage are tolerable for power transistors and you may want to refer to the chart for them before making a replacement.

36 Let's talk about this outstanding reliability of the Cricket. How many times am I going to be fooled by the Cricket? It is logical that this would be a concern because this method is a new concept in transistor testing. It was our concern also. Before the unit was released, and before a patent was applied for, we had to be sure of reliable in circuit testing.

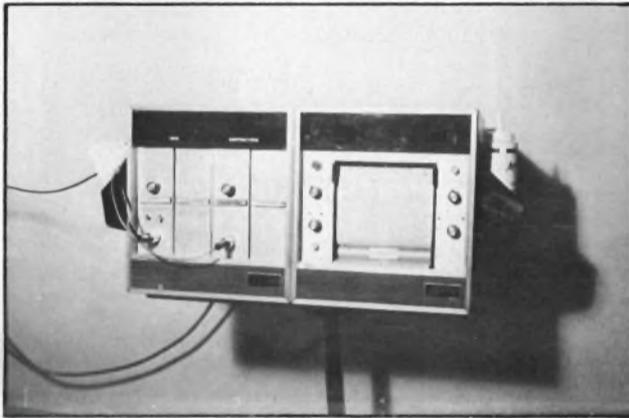


37 Sencore engineers and technicians tested the Cricket on hundreds of in circuit transistors from radios, TV chassis, and test equipment. In all our testing, it was found to give us over 96% in-circuit reliability. With the out-of-circuit leakage test to back you up, the Cricket is 99.9% reliable. That's more reliability than most lab gear.



38 Let's talk about connecting the leads to the transistors. Don't tell me that's automatic too. Not really but we have made it as simple as possible. The Cricket comes equipped with special connectors to really grab on to the transistor terminals. Simply grasp the connector as shown here and squeeze with the thumb. Hook on to the transistor lead and release for a solid connection. This may seem to be a small point but have you ever attempted to test a transistor and have the connector slip off half way through the test? Frustrating isn't it?

39 The fast simple test of the Cricket and these quick connectors make him able to hop through your tough circuits with ease. Technicians tell us the Cricket can go through their circuits faster than any other tester. Our test stations tell us the Cricket saves more than 25 percent of their testing time, and pays for itself the first week or two weeks at the most.



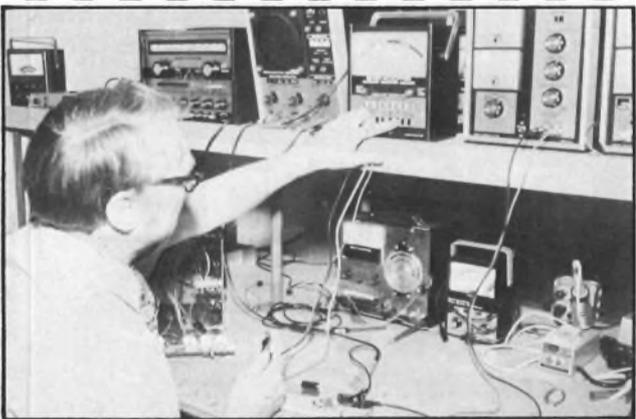
IS MEASURING BETA REALLY NECESSARY?

40 There are many other uses for the Cricket other than radio and TV service. Consider the situation of this medical electronics technician in this new large hospital. This technician tells us that it usually is a rush situation in this business when something goes wrong with the equipment. He must get into the trouble and get it corrected fast for those life and death applications.

41 This medical equipment is some of the most modern in the country. Most of it is completely solid state, and the technician needs a tester to get the unit back into operation quickly. This is just a typical case, we know you can think of hundreds of others.



42 Now that we have seen how the logic of the Cricket can help you with your quick troubleshooting, let's go back to our basic question. Is the value of beta ever really necessary? Will there ever be a situation where you will need to know the exact value of beta?



43 Yes there are times when beta must be measured. For example, the engineer in the lab wants to know more about a transistor. He may need to know if a particular transistor will operate in a new circuit he is designing. He must know the values of transistor parameters in order to calculate other circuit values.

44 Then there are production lines and incoming inspection applications, shown here, where some circuits require the matching of transistors to maintain circuit balance. This is particularly true for output transistors in stereo systems, push-pull amplifiers, and balanced bridge circuits. The values of beta should be matched in these circuits for satisfactory performance. The replacements that you install should also be matched to the existing good transistor when servicing these types of circuits. So there are occasions where beta should be measured.

45 The TF166 will automatically give you those engineering - type parameters which you might need. The test procedure is almost as simple as it is on the Cricket. Simple pushbutton testing has been designed into this unit as well. All you need to do is connect the transistor leads and push the button for the specific type transistor and you're all set up.



16 Next, set the base current by adjusting the gain CAL control until the meter reads on the gain CAL line.



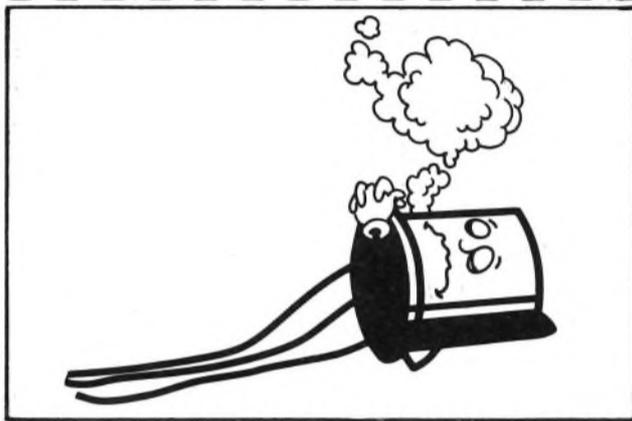
17 Then push the gain button. When the gain button is pushed, beta is read directly on the meter.



18 Any value of beta up to 500 can be read directly on this large 7 inch meter. You'll never need to squint or use your bifocals on the TF166.



19 Since the TF166 is a transistor analyzer, can it read beta accurately in circuit? You bet! The TF166 is a reliable in-circuit transistor tester too. But, when testing transistors in circuit, you only want to know if the transistor is good or bad, don't you? You can check in-circuit transistors by reading the simplified good-bad scale instead of the beta scales. Only Sencore transistor testers have this simplified patent applied for approach. The TF166 provides AC for in-circuit beta testing, and DC for more accurate out of circuit beta testing.

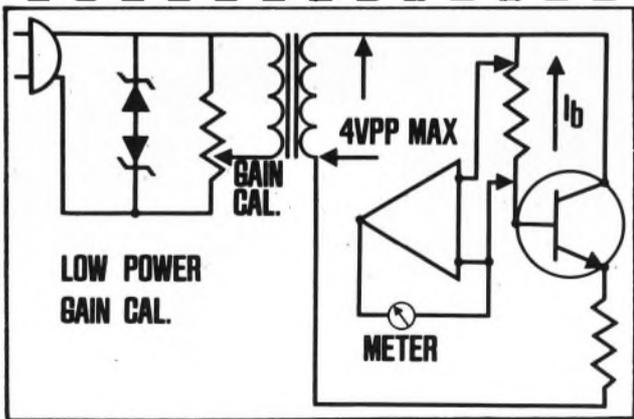


20 Can the transistor or FET be damaged during test? No, but there are some testers on the market that will. For example, one competitive tester supplies currents up to one amp for testing the transistor gain. These testers are of the brute force variety because they use the test currents to drive the meter directly. Not too logical, is it? Not very profitable either!

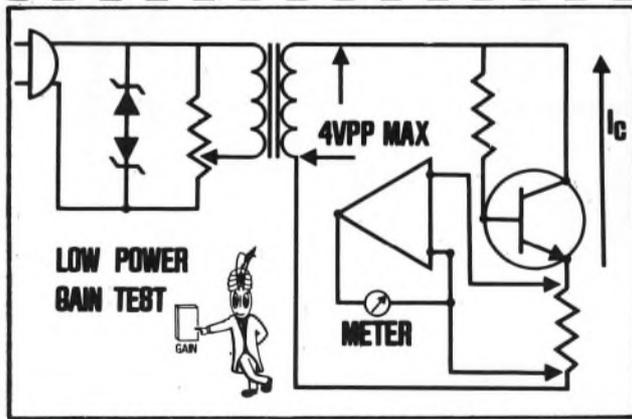
TF166 BASE CURRENT LEVELS			
RF-IF	LO	MED	HI
10 μ A	30 μ A	100 μ A	300 μ A

TF 26 BASE CURRENT 2 mA max.

21 Not so with the Sencore testers. The maximum base current possible on both testers is 2 milliamps. These low-level signals test the transistors accurately and safely. They are possible because the meter is driven by expensive internal amplifying devices in both Sencore testers.



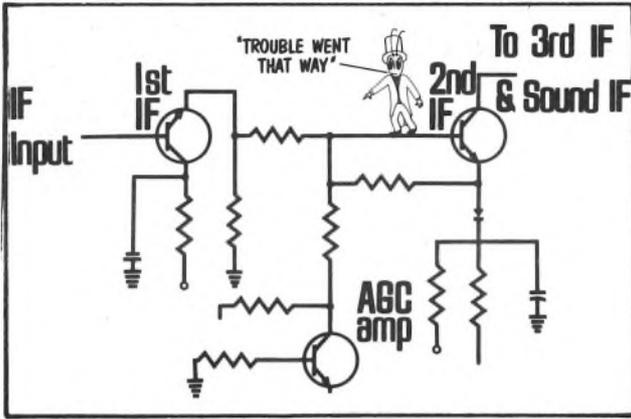
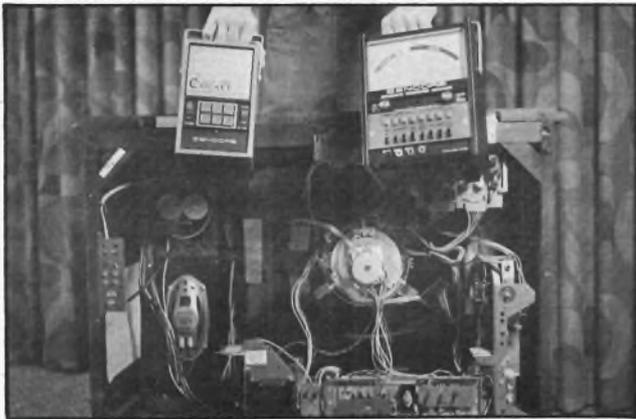
22 Let's see how this is done on the TF166. A sensitive "op amp" is used to measure very small voltages across precision resistors in the current paths. Base current is calibrated, with the gain CAL control, to a particular value on the meter.



23 Then when the gain button is pushed, the emitter-collector current is measured by monitoring the voltage across a precision resistor in the emitter circuit. In this way the transistor you are testing is protected at all times because the meter current doesn't go through the transistor at all.



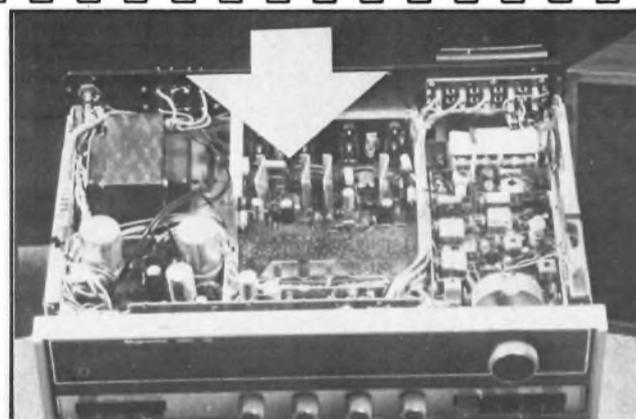
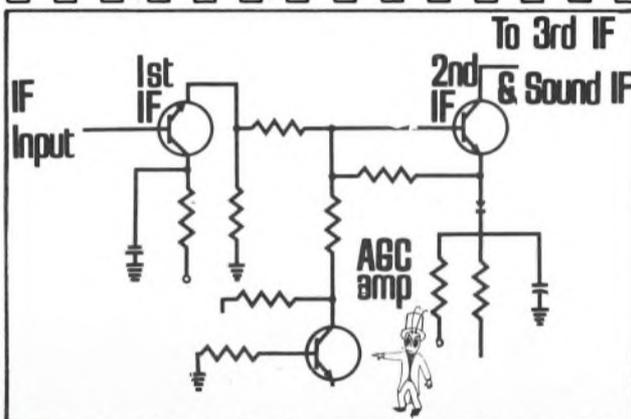
24 What about field effect transistors? The TF166 tests field effect transistors with a separate dynamic test. Simply push the proper buttons for the type field effect transistor you are testing. Adjust the gain CAL control, and push the gain button. Transconductance, the gain measurement for an F.E.T., is read directly on the meter to values up to twenty-five thousand micromhos, just like a mutual conductance tube tester.



55 Which tester do you need? Let's take a look at some specific applications of the Sencore transistor testers and perhaps you can decide. Consider this Magnavox T979 chassis for example. Customer's complaint is that the set is dead --- no picture or sound. Raster is good so it appears that there is no signal getting to the video or the audio stages.

56 The problem must be located pretty close to the front end of the set. Sound is taken from the output of second I.F., so the trouble must logically be ahead of that. It is now a simple matter to hop through the I.F. strip from that point back to the RF amp with the Cricket.

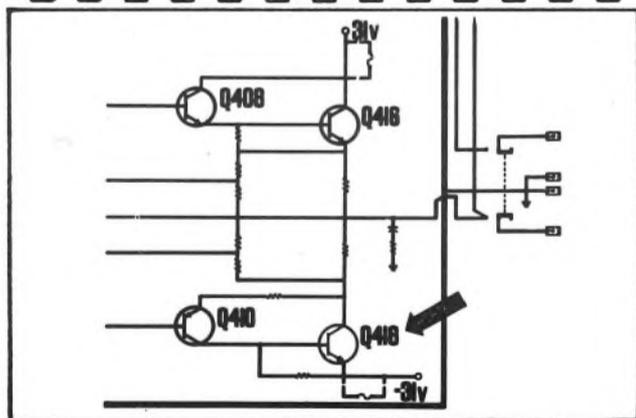
57 The second I.F. transistor is a plug-in type. This gives us a chance to demonstrate the transistor socket, although transistors are wired into the circuit boards on most sets. We remove the transistor and insert into the socket supplied on the Cricket for simplification. We push the buttons and find it good.



58 Next logical step is the first I.F. It is soldered into the circuit, so we attach the connectors to the leads --- anyway we wish. Again by pushing the buttons we find it good.

59 Next we go to the AGC amp and find this transistor shorted, we have located our culprit! This type of logical troubleshooting takes no more than a few minutes from the time the back is taken off the set. The problem can be isolated in a matter of minutes, and you can be on your way to the next job.

60 Let's look at another example, this time from the output of a stereo amplifier. The amplifier is dead on one channel.



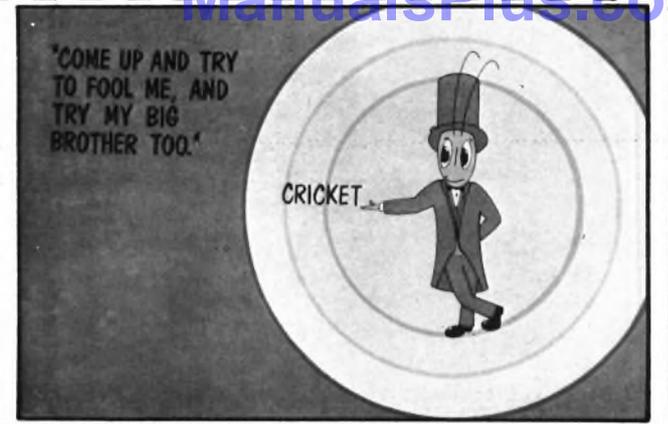
61 We find that one of the balanced output power transistors is shorted. Since a factory transistor is not readily available, we consider the use of a general high power replacement. However, the new transistor which is to replace the defective Q418 must be matched to transistor Q416 to maintain the balance of the output. The values of beta on these two transistors should be close to eliminate any distortion due to unbalance.

62 You can be sure of proper, distortion-free quality only if you can match the beta values. Here we need our trusty TF166 Automatic Transistor Analyzer. The TF166 measures beta, transconductance, I_{dss} , I_{gss} , in addition to I_{cbo} . You might say that the TF166 analyzer is just like a mutual conductance tube tester because it tests a transistor or FET completely, in or out of circuit. It too, has a patent application, but for a different reason. That means only Sencore will have it, however.

63 Your Sencore FLPD distributor has this special --- made demonstrator that will help you decide whether you need a Cricket for speed or the TF166 for complete analyzing. The Cricket is like the Mighty Mite. It's fast and finds the trouble in a hurry. It's reliable too. The TF166 is available for those more sophisticated tests. It's your decision: are you looking for speed in troubleshooting or do you want to know more about the transistor or FET? Many decide they need a TF166 for their bench, just like a mutual conductance tube tester and a Cricket where they would ordinarily use their Mighty Mite.



Why not step up and try these two testers on the demonstrator? We're sure that you'll convince yourself that there is nothing like them and only Sencore will have them for you. Try to fool the Cricket by testing in circuit, out of circuit, and with or without troubles in six typical transistor and F.E.T. circuits. You gotta admit, that's Cricket, man!



Bob Baum



Norm Pedersen

BOB AND NORM'S

SHOP

- SERVICE TIPS
- SHORT CUTS

"Good morning, Norm. What's on the agenda today?"

"Well, Bob, we have a set to deliver and then we need to get to work on that Magnavox over there with the weak color."

"OK. That's the T979 chassis that's completely solid state, right?"

"That's right. There's probably something wrong in one of the bandpass amps."

"Say, Norm, that reminds me of a question. What's the best procedure to use when troubleshooting direct coupled transistor circuits? Last week I had a real dog problem on a stereo receiver. It seemed that everything I checked was ok, but it still had a poor output from one channel. I finally found the problem, but it certainly took a lot of time. I just went around in circles with all that direct coupling and those feedback networks. Here, take a look at the schematic for yourself. Let's see how you would have handled it. Maybe we can work out a troubleshooting procedure for such systems."

"Yes, this type of circuit is really quite conventional in these systems. It's three stages of audio amplification followed by a balanced complementary output. I see what you mean by the feedback --- it goes back to both the second and third audio amps. I suppose you started by checking the output transistors, right?"

"Right, I checked them with my TF26 Touch Tone Cricket, and they were found to be good. I checked the three audio amp transistors too, and they were all good."

"OK, then what?"

"Then I plugged the speakers in and turned the unit on to measure voltages. They all appeared to be correct, except for the voltages on transistor Q16. The emitter and base voltages were incorrect, but by about the same amount. The emitter was at -1 volt and the base was about -28 volts. This still made the emitter-base voltage about right for this germanium transistor, so I assumed the voltage error was not serious."

"Assumed -- that was your first mistake. In solid state circuitry, we cannot disregard small voltage errors as we could in tube electronics."

"Well, I didn't disregard it altogether. I thought that maybe the transistor was leaky, so removed it from the circuit and retested for both gain and leakage. Did you know that you can test all types of leakage on the Cricket just by pushing different buttons?"

"That's right, you can check I_{cbo} , I_{ebo} , and I_{ceo} both forward and reversed biased just by pushing the six buttons."

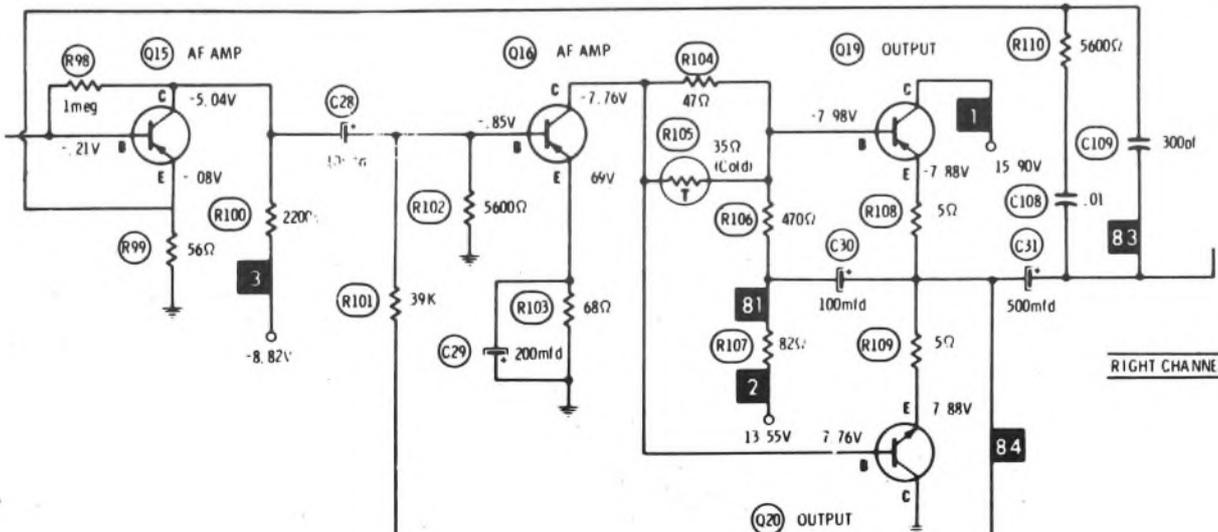
"Now I was baffled, because everything appeared to be ok. I reinstalled Q16 and resorted to signal tracing, using the SG165 AM - FM Stereo Analyzer as a signal source and the PS163 Dual Trace Triggered Sweep Scope. The output of the first audio amp looked good, but from that point on the signals were distorted."

"That's not surprising, considering all those feedback paths. Distortion caused by the second or third audio amps or the outputs will be seen in all the other amplifiers in this section."

"That's right, that's what I found. Instead of looking at distortion, I checked the gain of each section, comparing input to output of each transistor on the PS163. This led me to the third audio amp again. Distortion at the output was greater than at the input and the gain was poor. So I pulled Q16 again and checked it for gain and leakage. Then, before I replaced it, I checked R102 and R103. R103 measured about 1 ohm. When I took the resistor out of circuit, it measured the correct resistance. This isolated the problem to C29 which was found to be shorted. Replacement of C29 brought the system back into normal operation, but it sure took a lot of wasted effort to find the problem."

"Well, your troubleshooting procedures were correct, except you can't ignore those small voltages in solid state circuitry, even if the emitter - base voltage difference appears correct. The sequence of tests should be just as you performed them."

1. Hop through the circuit with the Cricket to find any bad transistors first. You can do this quickly without re-



COURTESY OF SAMS PHOTOFAC

moving anything from the circuit because the Cricket is a reliable in-circuit transistor tester. If a transistor tests bad in circuit, remove it from the circuit and check it again, both for gain and leakage, just to be sure before getting a new part. If a transistor checks bad in circuit and good out of circuit, look for shorts or very low resistances (less than 100 ohms) between the transistor elements. These may make the transistor appear bad when testing in circuit with the Cricket.

2. If all transistors check good on the gain test, turn the unit on and check voltages on each element of each transistor. Note particularly the base-emitter voltage drop -- it should be about .15 volts for germanium transistors and close to .6 volts for silicon transistors. Be sure not to ignore small voltage variations from those given on schematics.

3. If voltages are incorrect on a particular transistor, remove the transistor and test it for gain and leakage. Remember the Cricket will test all different types of leakage. A transistor may show good gain but leakage may cause it to not operate in circuit.

4. On a suspected transistor where voltages are incorrect, check all values of resistors in this part of the circuit. It is best to do this with the transistor removed, which you have just done in step 3. If the transistor is not removed from the circuit, it is necessary to use an ohmmeter with LO-power ohms (.08 volts as an ohms supply) so that you will not cause a transistor junction to conduct and give an incorrect reading. The Sencore FE20, FE21, and FE160 Field Effect Multimeters come equipped with such a lo-power ohms function. These steps, followed in the order given, should find the problem. In fact, if the problem originates from a bad transistor, step 1 will find it 99.9% of the time."

"Let's see now if we can use what we learned on this Magnavox. Let's start by checking the three bandpass amps with the Cricket. Say, these transistors are all plug-in types, so we can remove them from the circuit easily and insert them into the socket on the Cricket. That way we can check leakage too."

"OK, let's start with the third bandpass amp. Here, just plug it in."



Just push the buttons.

"Looks like it has good gain. I'll switch to leakage and see how that checks. Looks OK. No leakage on the buttons that gave good gain, so that means I_{CBO} and I_{EBO} are zero.

"To check it, you just need to push the other four buttons. Two of these buttons should read I_{CEO} to be zero leakage and the other two should be full scale because they show a forward bias current across a junction."

"That's pretty easy -- and that's just what it shows. This transistor is good so put it back in the circuit and let's see the next one -- the second bandpass amp."

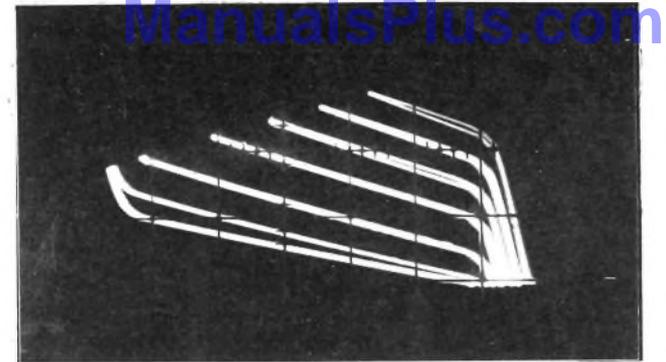
"OK, here you are."

"Thanks, I'll plug it in and check it. Aha, look at that. No chirp on any of the buttons. Looks like we found the trouble. Look at these leakage readings. I get upscale leakage readings on four buttons instead of two. This must be a shorted transistor. Let's replace a new one and see how the set responds.

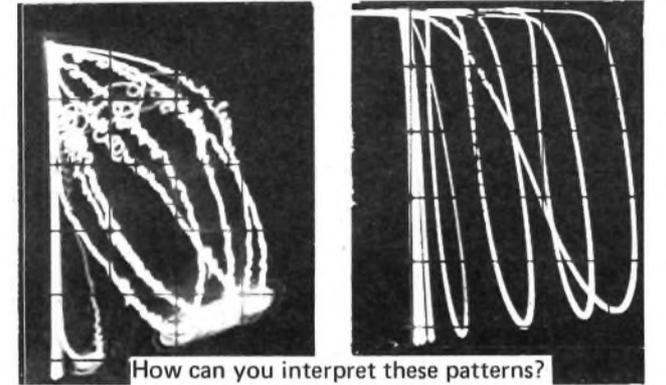
"Wait a minute. While we have the transistor out, we should look for a cause of the transistor shorting. Maybe a capacitor shorted, or a resistor changed value, causing too much current to go through the transistor. Check the resistances in each part of the circuit connected to the transistor plug, while I get a replacement."

That suggestion was a good one, because it tied down the real problem. Resistance of R11 from base terminal was about 5K rather than 15K shown in the schematic. Evidently that pulled the base voltage too high, causing excess current through the transistor. When R11 and Q2 were replaced, and color killer readjusted, the set was returned to normal operation.

"Norm, that Cricket is really handy for testing these new solid state sets. It sure beats that curve tracer we have setting over there on the shelf. I never could figure that out. It seems like every family of transistor curves looks different when testing in circuit. How do you interpret all those fancy pictures?"



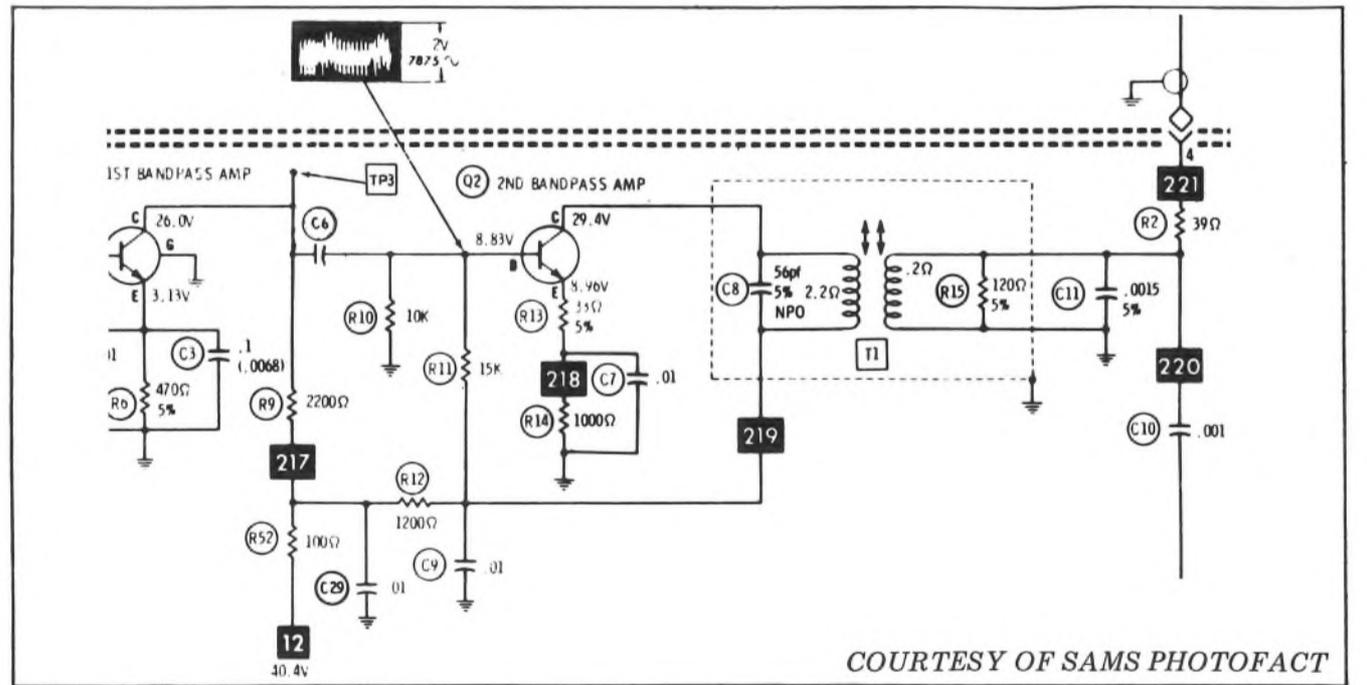
Actual curves of good in-circuit transistors.



"Don't know, Bob. I guess what one needs is a complete set of scope photos for every transistor in each chassis. Only then could you really compare your scope trace with what it is supposed to look like. That would pretty much fill a shelf of books. It might look impressive, but doesn't seem to be very practical."

The curve tracer may be ok for lab applications but even then it requires a lot of calculation to get a true beta value. It's so much simpler to obtain beta with our TF166 Automatic Transistor Analyzer, but who needs a beta value for troubleshooting anyhow?"

"Right. Our curve tracer hasn't seen much action since we got the TF166 and the Cricket. The Cricket finds those bad transistors in less than half the time and it doesn't tie up a scope. That's why it's the tester for me."



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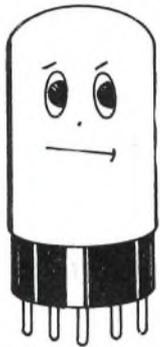
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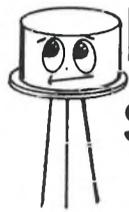


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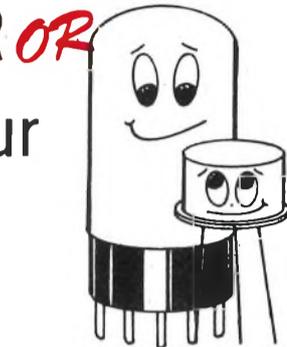
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