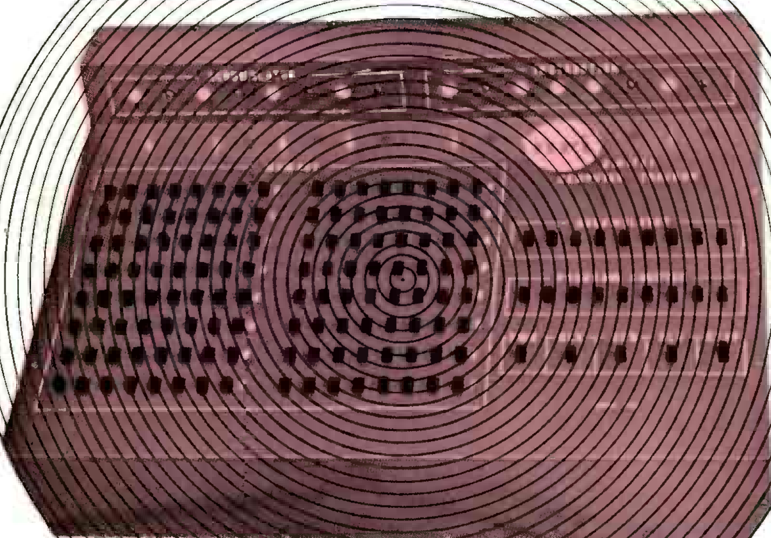
nri journal

ZERO IN ON COMPUTER TECHNOLOGY

WITH NRI'S NEW COMPUTER ELECTRONICS COURSE



July/August 1971

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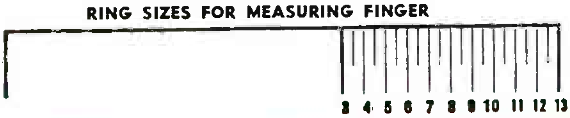

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The New NRI Course In Computer Electronics

WHAT The Course Is
WHY The Course Was Written
HOW The Course Was Developed

Have you ever wondered why NRI offers a particular course of instruction? Have you ever considered how an NRI course is prepared? As an NRI student or graduate, thoughts like these may have occurred to you at one time or another during your studies. We'd like to clear this up for you here.

There is a lot of planning and hard work that goes into the development of an NRI course. Preparing a home study course is a specialized job that requires the talents of a dedicated group of technically qualified people. We would like to tell you how an NRI course is developed. We think you will find it interesting, and we hope that it will make you feel proud of being a student or graduate of NRI.

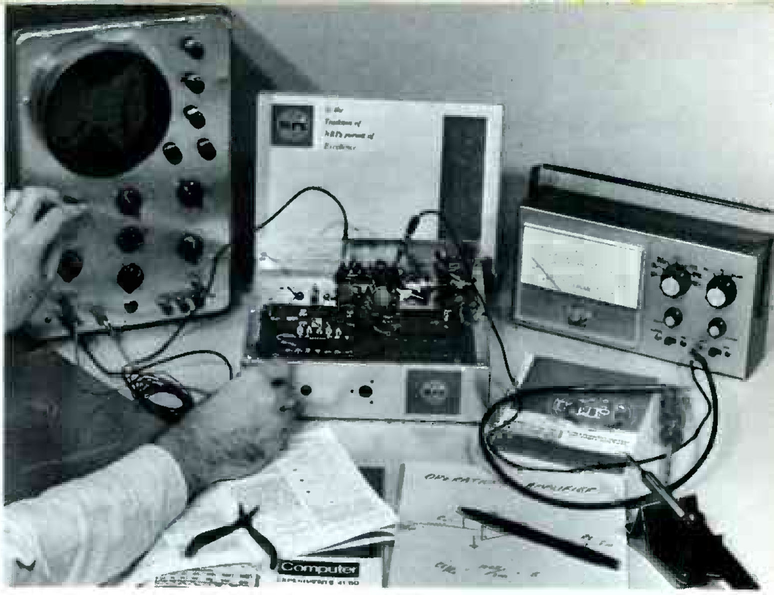
WHAT

The Computer Electronics Course is NRI's newest home study program. It is also the only home study course devoted explicitly to training technicians for work in computer and digital electronics. It is the most complete and up-to-date course covering this subject that is available today.

WHY

Why in the world did NRI develop the new computer course? Well, there are a lot of reasons. First of all NRI is an educational institution devoted to the training of persons in all fields of technology. NRI's home study programs fill a definite need in that they provide training to those persons seeking a new career in skilled technical fields, to those wishing to upgrade themselves in their jobs, or to those wanting to change fields. NRI courses permit a man to study in his spare time, thereby permitting him to maintain gainful, full-time employment. NRI's courses are also low in cost, so nearly anyone can afford them. Thus, the main reason for NRI's new computer electronics course is to continue to provide quality home study education to those who want it.

Second, we know that for the past several years the computer industry has been growing at a faster rate than any other phase of electronics. It is the hottest area in electronics, and one that will continue to grow at this rapid rate. This means that it provides fantastic opportunities for persons with the proper technical education and knowledge of computers. The demand for technicians trained in digital and computer techniques is tremendous and the needs of industry can not be filled by colleges and resident technical



This is the experimental chassis that the student uses to perform many of the experiments in the computer course kits. The transistorized volt-ohmmeter on the right comes with the course. The oscilloscope is the CONAR Model 250.

schools alone. NRI felt that it could provide an excellent course in computer technology to train men who want to enter this field and take advantage of the opportunities that are there. If you are looking for a way to *really* get ahead in the electronics industry, then the computer route is the way to go. If you are looking for *good* training in the computer field, then NRI is the way to go.

HOW

And now on to our story. Now that you know *what* we did and *why* we did it, we'd like to show you *how* we did it. We'd like to show you what's behind the NRI courses that you are so familiar with.

The Planning Phase

A couple of years ago someone at NRI said, "The computer industry is really growing like the devil. There are always many job ads in the classified section of the Sunday paper for computer technicians and people skilled in digital techniques. There's obviously a continuing demand for such people, but from what I've seen, there are very few technicians in industry today that are qualified to fill these positions. The reason for this is that they lack the specific knowledge and training of digital and computer techniques. Why don't we develop a computer course?"

NRI courses start just like this, with an idea. But there are a lot of ideas that get shot down in a hurry. This idea seemed to have a lot going for it, and we at NRI kicked it around for some time in the planning stage to be sure that we were doing the right thing. We had to determine whether there were enough people interested in such a course to justify the time and expense of developing it. Once we had determined that there was such a demand, we proceeded to plan a course that would fill the needs of the industry.

During the planning stage of the course, an initial outline was prepared and then discussed at length. We determined what subjects should be covered and how they should be covered. We considered the person who was likely to take our course, what his background and experience would be and what he would probably like to see in the way of a course. Then we looked at the jobs that a graduate of our course might fill. He may be a computer technician in a manufacturing plant or he may maintain a digital communications system for a satellite on some small, remote island. Then again, he might maintain a multimillion dollar business computer system for a large metropolitan bank. We tried to determine just what type of technical training such people would require, so we could work this into the course material.

Once an outline was established and we knew what we wanted the lesson texts to contain, we began to write them.

The Technical Writing Phase

NRI maintains a technical writing staff whose sole purpose is to write new NRI textbooks and to revise and update existing textbooks. The technical writers develop a text outline, thoroughly research the subject of their textbook, and then write it. NRI technicial writers are all trained and experienced technicians and engineers, as well as writers. They are well qualified to write the lessons. They know how to present complex theoretical concepts and, at the same time, are able to draw upon their own practical experience to give the student useful, down-to-earth information that he can use every day on the job.

All during the writing of the text, the author keeps one very important fact in mind. The NRI text is the only connecting link between the student and NRI. For that reason, the text must be clearly written, easy to understand, and interesting.

In some cases NRI uses outside freelance authors to write its textbooks. Where the NRI staff does not have the necessary specialized experience and background, we seek out a qualified technical man and have him write an authoritative text on the subject. By doing this we guarantee our students the most accurate and up-to-date technical material available from those people who are working in industry.

The Kit Development Phase

While the textbooks are being written, the training kits are also being developed. As you know, NRI's concept of training is to provide a man with not only the theoretical knowledge that he needs for his job but also the practical, hands-on training as well. If a man is going out to work on computer hardware, he should be familiar with computer hardware. He should have worked with it himself. We provide our student with training kits that permit him to learn all of the manual skills involved in being a computer technician. He learns how to solder, how to use test equipment and how to perform various tests and measurements and troubleshooting procedures. He does this as he builds and works with some of the most modern electronic and digital circuits in use today.

The NRI Computer Electronics Course is strictly a solid-state course. Transistor theory and circuits are thoroughly covered, and integrated circuits are introduced early in the course. Most modern computers are made up of integrated circuits, and today's computer technician must understand them.

This is the NRI Model 832 Digital Computer that the student builds in the computer course. The 128 switches make up a switched, diode matrix, read-only memory in a 16 word, 8-bit format. The program and data words are stored in this memory. An additional 16 words of memory is available as an option. An integrated circuit (MSI type) random access, read/write memory is used. The output is displayed in binary form on the read-out lights.

During the kit development phase we write many experiments that demonstrate theoretical concepts and practical techniques. The student performs literally hundreds of experiments on real electronic circuits similar to those that he will work with as a technician. When he finishes the NRI course, he will be a competent electronics technician.

Best of all, the student builds a complete integrated circuit digital computer in NRI's computer training course. This is a real computer, not a toy. It is designed and built like any large-scale computer that might be encountered on the job. Only its size has been held to a minimum. This is to keep its cost low and to keep its organization and operation clear. The student learns every circuit in the computer and demonstrates its operation. He learns how to program the computer and how to troubleshoot it. A good computer technician should receive his training on a real computer.

The Publications Phase

As the textbooks and kit experimental manuals are written, they are given to the publications department, where they are prepared for the printer. As soon as the texts are available from the printer, NRI begins to think about offering the course.

It is at this time that NRI's advertising department prepares the ads that announce the course. When the ads appear, the word is out! Those desiring the best in computer training will know it.

This is probably where you came in. You answered an NRI ad and in return received the school's catalog describing the courses. You liked what you saw and enrolled.

It takes a lot of time and effort to prepare a course such as this. The NRI Computer

Electronics Course has been under development for over two years and NRI has spent well over $100,000 on its development. When you complete the Computer Electronics Course you will be a qualified digital computer technician, adequately prepared to hold many jobs in the computer industry. Don't forget that all NRI courses are accredited by the National Home Study Council. The courses must meet their standards of excellence. The courses must also meet the approval of the Veterans Administration, which approves the payment of many courses for veterans returning to civilian life. When you take an NRI course, you can be sure that you are getting the best that the home study industry can give you.

Perhaps the best way to tell you the details of the NRI course development is to introduce you to a few of the people on the NRI staff who influenced the computer course development.

Bill Dunn
Vice President and Director of Education

"We could see the potential of computers back in the early 60's. That's why we included ten lesson texts on computers in our Industrial Electronics course. Then in 1968, when we were preparing to update these texts, we made the decision to develop a separate computer course. It was pretty obvious that the computer industry would continue to boom along at its 15%-20% per year growth rate. We felt that we could provide a real service to the computer industry by supplying trained men and at the same time provide a sound basic technical education for those interested in the computer field. The industry is growing so fast that manufacturers and users have a tough time finding enough qualified men to fill the jobs available. This means that there are plenty of good jobs open all the time. As a digital computer technician or field representative, a fellow can make an above average salary and at the same time do some of the most interesting and challenging work around."

Lou Frenzel
Assistant Director of Education and Project Engineer for the Computer Course

"In 1968 we started in earnest to develop the NRI computer course. We took a close look at the jobs we would be training our students for. We wanted to be sure we would cover all of the pertinent material. Basically, we are training an electronics technician. Computers and other digital systems are electronic, so to work with them a man needs to know electronics. We start the course with a good basic electronics education then quickly work him into the computer related areas. When he completes the course, he can work as a computer technician in the development or testing of computers for a manufacturer or can install, maintain, and repair computers and related equipment as a field service representative. In addition, because of the great emphasis on digital circuitry in the course, a graduate of the NRI computer course can work as a technician on data acquisition systems, telemetry equipment, digital instruments, and the like.

"In the lessons we cover basic electronics and then digital logic theory. Next, we get into a very detailed analysis of the digital computer. We discuss its theory of operation and really get into the circuitry. We also cover computer programming and applications. We try to stick mainly to the practical side rather than the deep, theoretical aspects.

"In developing the computer course, we planned from the beginning to offer training kits in the NRI tradition. We believe that if a man is going to go out and work on electronic computer hardware he should get some practice at it beforehand. The kits are fully integrated with the lesson texts to form a complete package. They reinforce one another. The kits teach the student how to use basic test equipment for measurements and troubleshooting. He then uses these to perform many interesting experiments in basic electronics, digital logic, and computer operation. When a man completes these kits he is a hardware expert.

"Our basic concept at first was to offer a digital logic trainer kit like some of the other schools do. We felt that it would do the job, but we were hesitant since it offered such limited use afterward. We kept thinking that if we offered the student a color TV set in our TV servicing course and a radio transmitter in our communications course, then why couldn't we give the computer course student a digital computer? The idea wasn't popular at first; it seemed like an impossibility due to high cost and complexity.

However, the more we studied the problem the clearer it became that we *could* develop a computer for training purposes. With the new digital integrated circuits available and some clever design breakthroughs here and there, we designed what is perhaps the most unique device ever developed for home study training. It is literally a complete, general purpose, programmable digital computer. Unlike logic trainers, it contains a memory and is fully automatic. It's a small-scale model of larger, more expensive commercial computers. The darn thing is so versatile that it can drive you crazy playing with it. Once you learn how to program it, you just can't leave it alone. It took us a little longer to design the computer than it would have taken to do a simpler logic trainer, but we have achieved our goal of giving the student a kit with which he can truly learn his subject. And, to top it off, as the student builds the computer he performs all of the experiments he would perform with a simple logic trainer. He learns digital logic, as in the other courses, but with ours he puts it all together to demonstrate true computer operation.

"We also teach basic programming. After all, if you have a computer you need to know programming to be able to use it. Our graduates really get involved with all phases of the computer.

"We are just tickled to death about our computer course and we think that our students will be, too, since we have put extra effort into making it just for them. In fact, we're not so sure that our course doesn't give a man better coverage of computer fundamentals than an equivalent resident course. Compare the cost of resident training with the NRI course and you will see what a bargain the NRI course is. When you complete a resident course you won't have the solid-state voltohmmeter, the oscilloscope, the complete digital computer that you will have when you complete the NRI course. Beat that for the price!"

Doug Bonham
Technical Writer and Editor

"The NRI computer course textbooks are about as up-to-date as they can possibly be. We spent many months planning these lessons, researching the literature, and writing the texts. This means that you will get plenty of good background information. But we went farther than this. To make the course as practical and thorough as possible, we have read and studied manufacturer's literature, application notes, operation and main-

tenance manuals, computer and electronic magazines, and anything else we could lay our hands on. We tried to see that the student gets not only the textbook theory, but also the down-to-earth, practical information that he will need and use on the job. We've also spent a good bit of time talking to computer experts, attending conferences and trade shows, and haggling with salesmen. All of this gives us that ever-so-important background needed to write a good text. Writing a good home study lesson is a special project. It's sorta like an iceberg. There's a lot more beneath the surface than above; meaning that a good text has a lot of background behind it. We feel that if you haven't experienced some of what you write about, the writing is ineffective; so we set out to be experienced in all areas.

"We think that the computer course texts are tops, easy to read, and jammed with good practical facts. And most important, they reflect the latest thinking, ideas, and concepts in the computer industry. We show you what is really going on."

Tom Dukes
Technical Writer and Editor

"The NRI Computer course kits are designed to back up in practice all that we say in our lesson texts. We have chosen 100 experiments that demonstrate electrical principles, electronic component operation, circuit characteristics and applications, and some very interesting demonstrations of computer operation and programming. With the solid-state voltohmmeter that the student gets with the course and an oscilloscope, he learns how to make basic measurements. With this equipment he can demonstrate the operation of all the basic electronic components – resistors, capacitors, inductors, transformers, transistors (both bipolar and field effect units) and integrated circuits (both SSI and MSI). Next, he builds circuits and learns how they work – power supplies, amplifiers, regulators, oscillators, logic circuits, gates, counters, registers, decoders and many others. The experiments have been carefully chosen to illustrate key points or to demonstrate pertinent phenomena that a technician is likely to encounter in his work. We mix theory and practice to show both the why and the how.

"By the time a student finishes, he will have built hundreds of circuits. He will be a soldering expert and will really feel at home using common test equipment. He can feel confident of walking into a technician's job knowing what to do and how to do it.

"As for the training computer it is really something else. I've never seen anything quite like it before. It uses over 70 dual in-line TTL integrated circuits, many of them the newest medium-scale-integration (MSI) type. It's sophisticated but easy to use and understand. It does everything a bigger computer does, only it's laid out especially for learning computer organization, operation, and programming. Frankly, we've had a ball developing it and if the student gets half as much fun out of it as we have, we'll feel like we've done some good."

Ted Beach
Chief Technical Editor

"It is my job as Chief Technical Editor to see that everything the students get is as good as it possibly can be. That is, I see to it that the lessons are technically correct, that they contain information pertinent to the course, and that this information is as up-to-date as possible. Even more important, perhaps, is my job to see that the lessons are easy to read and understand. After all, this is how we communicate with our students. In fact, it is about the only way, so we've got to be sure that the lessons not only contain the proper subject material but also that this material is attractively presented and interesting to read.

"The kit experiment manuals get the same close scrutiny. We make sure that the experiments demonstrate useful theoretical material as well as practical facts and procedures. All of the wiring and assembly instructions are carefully reviewed to ensure their clarity. This is to help you build the equipment quickly and with no time-consuming or costly errors. Even the often-taken-for-granted drawings and illustrations are given close attention.

"Once a book has been edited and sent to the printer, we'd like to think we were through with it. But such is not the case. Once a book is printed, it automatically goes into a virtually unending updating and revision process. With the electronics and computer industries changing as fast as they are, we feel that regular revision is the only way to be sure the student gets the latest information available.

"We don't claim to be perfect, but we try hard and often come close. We feel that we have the best technical courses in the world."

Allene Magann
Publications Manager

"One part of the NRI operation that our students rarely see is our publications department. This is where the completed text manuscripts given to us by the technical writers are edited, typeset, laid out and pasted up, proofread and otherwise made ready for the printer. Publications work is what I do. My staff and I see to it that all NRI texts and other printed material are grammatically correct and attractively packaged.

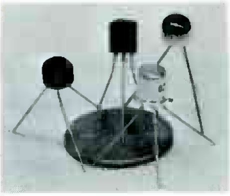
"Once the NRI technical staff completes a manuscript, it is given to us. First, we edit it carefully, making sure that we keep our technical writers honest with their spelling, grammar, syntax, and other such things. Next, we mark the copy for setting by our highly competent technical typists. They input the copy on our computer-controlled magnetic tape machines into rough galleys, which we proofread before they output it into final, justified type galleys. By then we have set headlines and captions, and prepared line art and photographs for final reproduction.

"The next step is to do a mockup of text and art, bearing in mind that the printer requires an even number of pages for his presses, usually a multiple of 16 or 8, depending on book as well as press dimensions. Then we do the mechanicals, an exact-size pasteup of everything in position, or what is called 'camera-ready copy.' The printer photographs these finished pages and makes the offset plates used to print the text.

"All of this publications work is not readily apparent to a student as he reads his lessons. There are a lot of subtleties here. For example, even small things like the selection of a type style can influence a student, although he doesn't realize it. Some type styles are easier to read than others. We try to find one that is easy on the eyes and looks good, too. Actual reading tests have shown that the right type style can make the going easier.

"Then, too, there is the problem of placing the illustrations with relation to the text material. As you read the text that refers to a figure or diagram, we want that diagram to be right there with the text, not two pages back or three pages up. It's little things like this that make NRI training materials the best. The next time you look at an NRI lesson, think of us in the publications department."

Understanding Field-Effect Transistors



by harold turner, jr.

Although the field-effect transistor (FET) is classified as a transistor, it is quite different from the bipolar transistor, the device that we normally think of as being a transistor. FET's have found their way into consumer electronic equipment only during the last few years, and are often the cause for wild advertising claims by equipment manufacturers. As a result, some technicians have come to regard the FET as somehow superior to the standard transistor. This is not necessarily true. Both types of transistor have their applications. The single factor that sets the FET aside from the standard transistor is its exceptionally high input impedance. This quality is used to advantage in many circuits. Let's take a look at the types of FET that are available, and how they differ from one another, and from standard (bipolar) transistors.

TYPES OF FET

Field-effect transistors are classified in four major ways: by sex, by construction, by mode of operation, and by the number of gates.

Just as bipolar transistors are made in two sexes, PNP and NPN, FET's are made in N-channel and P-channel styles. Both types work exactly the same, except that all supply voltage polarities are reversed. The N-channel FET normally operates with a positive supply voltage, so it is the more popular type.

Next, FET's are classified by construction. The two types of FET construction are: the junction FET (JFET), and the insulated-gate FET (IGFET). Another name for the insulated-gate FET is "MOSFET." The reason for this name will be explained later. At present, most of the FET's used in consumer electronic equipment are JFET's. However, the usage of MOSFET's is steadily increasing.

In addition, field-effect transistors are classified according to their mode of operation. There are two modes: depletion and enhancement. Junction FET's are always depletion-mode devices, while MOSFET's can be made to operate in either mode. More on this later.

Finally, FET's are classified by their number of input electrodes, or gates. Most FET's have only one gate, but some newer types have two independent gates, which can be used for independent control of the output.

JUNCTION FIELD-EFFECT TRANSISTORS

The N-channel JFET shown in Fig. 1 is constructed from a single bar of N-type silicon. This piece of semiconductor material is called the channel, and through this channel flows the output current. Normally, current flows through the channel from source to drain.

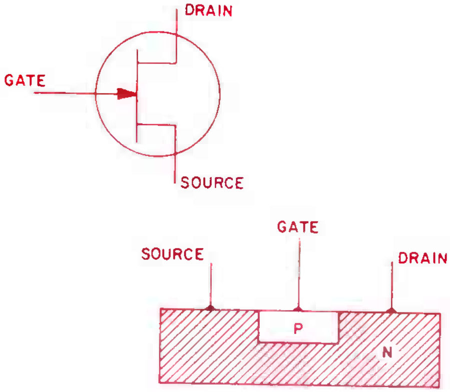


Fig. 1. N-channel JFET.

A small area of P-type silicon joined to the channel is used as the control element, called the gate. Note that the only difference between this transistor and the P-channel FET is the polarity of the semiconductor materials. In practice this means that all operating voltages are the reverse of those in the N-channel FET. However, the operation of the two types is otherwise identical.

Fig. 2 shows a correctly-biased N-channel FET. A positive voltage is applied to the drain, and a negative voltage is applied to the gate. Note that both voltages are applied in respect to the source. If a drain voltage is applied, but there is no gate voltage (that is, the battery is removed,

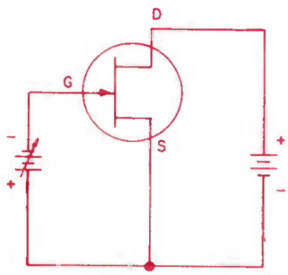


Fig. 2. Correct biasing of N-channel depletion-mode FET. Reverse all polarities for P-channel.

and the gate is connected to the source), there will be a certain amount of channel current (the current between source and drain). Now, if the variable voltage supply is connected to the gate, as the voltage is made more and more negative, the channel current will become smaller and smaller. This is called the depletion mode of operation, since adding a negative bias depletes the channel current. If the bias voltage polarity is reversed, the transistor goes into the enhancement mode, and the channel current becomes greater than it was during zero-bias operation. However, if the transistor is a junction type, the junction between the gate and channel will become forward biased, and the high input impedance of the FET is lost. Therefore junction FET's are never operated in the enhancement mode. However, as we shall see later, MOSFET's sometimes are operated in this mode.

One might ask, "How can the gate voltage control the channel current?" The answer to this question is the basis for the entire theory of operation of the field-effect transistor. As this name implies, the electrostatic field created by the gate voltage is used to control the current in the channel. This field has the effect of squeezing the current-carrying ability of the channel so that the effective resistance of the channel is raised or lowered. This is how the FET operates. However, it is not necessary for you to understand the physics of the transistor's internal workings to understand how it is used in a circuit.

INSULATED-GATE FET's

Fig. 3 shows the basic construction of an N-channel depletion-mode MOSFET. If we were to reverse the semiconductor materials and the polarity indications on

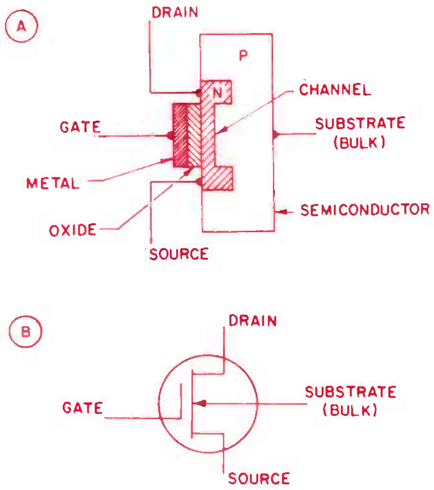


Fig. 3. N-channel depletion-mode MOSFET.

the semiconductor materials, this type would be a P-channel FET. As before, its operation would be identical, but all supply voltage polarities would be reversed.

The MOSFET differs from the JFET in that there is no diode junction between the gate and channel. Instead, the gate takes the form of a thin layer of metal which is insulated from the channel by a very thin layer of oxide. The abbreviation "MOS" comes from the words *m*etal-*o*xide *s*emiconductor.

Because of the absence of the diode junction, a MOSFET can be designed for depletion mode or for enhancement mode of operation. In fact, some types are designed to operate in both modes. However, most of the transistors that you will see in commercial equipment operate in the depletion mode. The biasing is therefore the same as shown in Fig. 2.

Note that the N-channel material is joined to a piece of P-type silicon, called the substrate or bulk. Normally, the substrate is connected to the source. However, in some circuits, the substrate is used just as the gate in the junction FET is used, so the FET actually has two inputs. This arrangement is sometimes used in a mixer stage, with the input rf signal applied to the gate, and the local oscillator signal applied to the substrate. The channel current would then be a function of both the inputs, and mixing would occur. However, there is quite a bit of capacitance between the substrate and channel, so this configuration cannot always be employed. The substrate is normally not an active part of the transistor, so it is simply connected to the source. In fact, sometimes the connection is made inside the transistor, so that the user has no choice.

The enhancement-mode transistor is very similar in construction to the one in Fig. 3. The difference is that there is no permanent channel between the source and drain terminals. A channel is created by the electrostatic field produced by the gate voltage. Thus, when the gate voltage is zero, there is no channel current. In an N-channel enhancement-mode transistor, a positive gate voltage would have to be applied to cause a channel current. The schematic symbol for this type of transistor shows a broken line between source and drain, which indicates that no channel current flows under zero-bias conditions.

DUAL-GATE FET's

All the field-effect transistors that we have seen so far are of the single-gate type. In fact, most of the transistors that you will find in commercial equipment have only a single gate. However, the dual-gate MOSFET is becoming increasingly popular. This transistor is really two single-gate transistors connected in series. The total channel current depends upon the bias voltage applied to each of the gates. Since popular transistor packages have a maximum of four leads, and since the substrate won't have to be used as a gate (there are already two gates in this type of transistor), the substrate is always internally connected to the source. If the transistor is constructed inside a metal case, the source and substrate are also connected to the case.

SOME PRACTICAL CIRCUITS

Fig. 4 shows a P-channel JFET used to drive a sensitive relay. Normally, only a small amount of current flows through the transistor and through the relay coil. However, when someone touches the plate connected to the gate of the transistor, 60 Hz hum picked up by the person's body causes the transistor to conduct much harder, so the relay contacts "make", and can therefore control an external circuit. A FET is used in this type of circuit because the input impedance must be very high. Since the value of R_1 can be made to be many megohms, the circuit will not load the source voltage (the hum voltage picked up by the person's body), so a large input signal is obtained. Incidentally, note that since Q_1 is a P-channel FET, the drain is

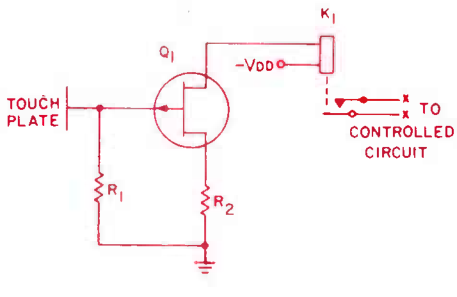


Fig. 4. Touch-controlled relay.

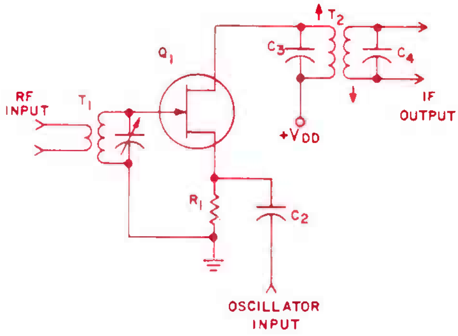


Fig. 5. FET mixer stage.

negative with respect to the source. As mentioned before, an N-channel FET could be used just as well, provided that the polarity of the drain voltage is reversed.

Fig. 5 shows a field-effect transistor used as a frequency mixer. The input signal applied to the gate of the transistor comes from the output of an rf amplifier stage, while the oscillator signal is coupled to the source. A FET makes an excellent mixer, since the nature of its transfer characteristic results in low cross-modulation and noise generation – superior, in fact, to either the vacuum tube or to the standard transistor. The output of this stage, of course, is at the intermediate frequency (i-f), and is passed by i-f transformer T_2 to the first i-f amplifier.

Fig. 6 is a simplified version of a circuit that is currently being used in the remote-control circuitry of some color TV receivers. This circuit takes full advantage of the extremely high input impedance of the MOSFET. The transistor is connected as a dc-coupled source follower. The output voltage is a replica of the charge on the 1.5 mfd capacitor. Since the leakage current through the gate of the

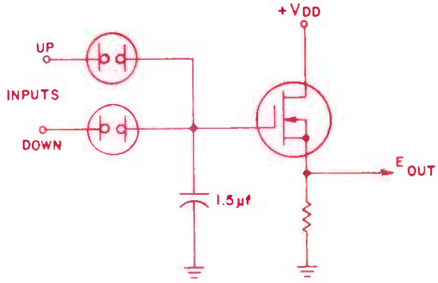


Fig. 6. MOSFET used in charge sensing circuit.

FET is extremely low, and the capacitor used is of very high quality, this circuit will hold a fixed charge for many hours. The function of the FET is to look at the charge on the capacitor and furnish a usable equivalent of this charge to external control circuits. These external circuits vary the audio gain (volume) of the color TV receiver in response to the charge across the capacitor.

When the user of the set wishes to change the volume setting, he pushes a button on his remote control transmitter which causes the remote control receiver to apply a chain of pulses to one of the neon lamps connected to the 1.5 mfd capacitor. Positive pulses are applied to the top lamp to increase the charge on the capacitor, which will cause the volume to increase, while negative pulses can be applied through the bottom lamp to discharge the capacitor, and reduce the volume.

This circuit might seem to be very simple, and indeed it is, but just a few short years ago it would have been impossible, since no previous device would permit monitoring of the charge on the capacitor without discharging it rapidly. If this circuit is any indication of things to come, we can certainly look for expanded usage of MOSFET's in consumer electronic equipment.

Fig. 7 shows a practical application of a dual-gate MOSFET in a television rf amplifier. This is the first amplifier stage in the entire receiver. It receives its signal from the antenna, and its output is fed to the mixer. In addition to amplifying the signal without adding any noticeable amount of noise, the rf amplifier must be able to have its gain controlled over a very wide range to prevent overloading of the receiver by very strong signals. The dual-gate MOSFET is ideally suited to this use, since one gate can be used for the rf signal input, while the other is used independently as a gain control element. The control voltage applied to the second gate comes from the receiver's agc system. Increasingly negative voltages applied to this gate cause the channel current to be reduced, and the gain of the stage to be lowered. For maximum gain, which is needed only when the received signal is very weak, the agc voltage is zero.

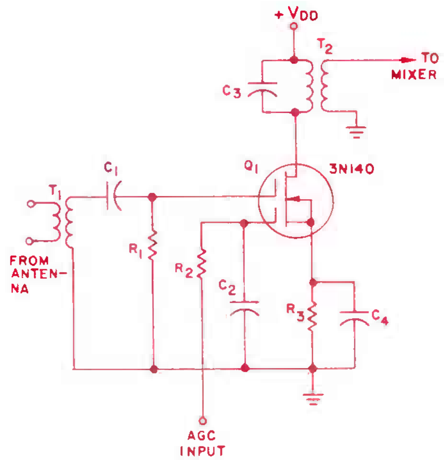


Fig. 7. Dual-gate MOSFET used as agc-controlled rf amplifier.

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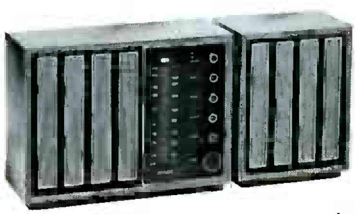

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60.01- 70.00	5.50	6.00	6.40	4.50
70.01- 80.00	7.00	6.50	8.00	5.00
80.01- 90.00	8.00	7.75	10.10	5.00
90.01-100.00	9.00	8.75	12 60	5.25
100.01-110.00	10.00	9.75	14.80	5.50
110.01-120.00	11.00	10.75	16.20	6.00
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200.01-220.00	20.00	18.50	29.80	11.00
220.01-240.00	22.00	20.00	32.40	12.00
240.01-260.00	24.00	22.00	35 20	13.00
260.01-280.00	26.00	24.00	38.20	14.50
280.01-300.00	30.00	24.50	41.20	15.50
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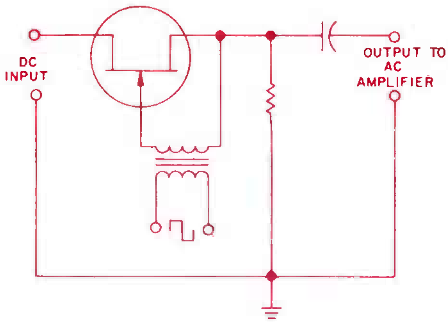

Fig. 8. Basic FET chopper circuit.

In some types of industrial control and measurement equipment it is sometimes necessary to amplify very small dc voltages. Direct-coupled amplifiers can be used for this purpose, but they are sometimes unstable, especially when the input voltage is very small. To get around this problem, engineers use what is called a chopper amplifier similar to the one shown in Fig. 8. The small dc input voltage is used to modulate a carrier signal (usually a few thousand Hertz), and the resulting modulated ac signal is amplified by a standard ac amplifier. The output is then demodulated by a detector that is synchronized with the signal that drives the input chopper.

Some types of field-effect transistor are optimized for switching operations such as this, and these FET's make ideal choppers. A square wave signal is applied between gate and source, and this causes the transistor to alternately assume the two states of completely *on* and completely *off*. When the transistor is off, no current flows through its channel. When it is turned on, its channel becomes a very low resistance, and the dc input voltage is supplied to the load resistor. Since the chopper frequency is fairly high, a steady square wave signal appears at the output.

The amplitude of the square wave depends upon the amount of dc at the input. The resulting square wave signal is easily amplified by conventional circuits.

The circuit shown in Fig. 9 is actually quite similar to the chopper circuit of Fig. 8, but the application is quite different. Here, instead of switching the FET on and off, a variable-voltage source is used to linearly vary the resistance of the transistor, to cause corresponding variations in the amount of output. Such a circuit can be used for remote control of various types of circuits. For example, this circuit could easily be substituted for an ordinary volume control. A long unshielded wire could be used to connect the circuit to the remote control point.

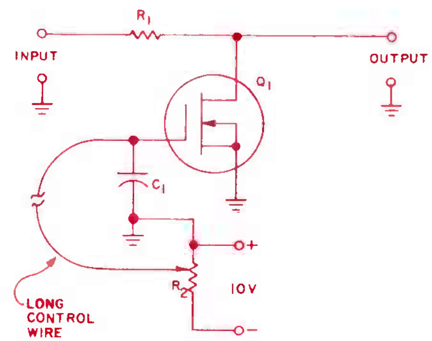

Fig. 9. Voltage-controlled attenuator.

Capacitor C_1 is used to prevent the wire from picking up any noise signals. In operation, R_1 and the drain-to-source resistance of Q_1 form a voltage divider. Since the effective resistance of the transistor can be varied by varying the bias voltage, the amount of output signal can be changed.

HANDLING FET's

Field-effect transistors are just as rugged and reliable as other semiconductors, so they rarely fail. However, you can expect to encounter a faulty FET once in a while. When you must replace a FET, take all the precautions that you take when replacing any transistor: make sure the power is off before you unplug the transistor or start unsoldering it, use a low-wattage soldering iron with a small tip, and keep the tip clean to ensure a good transfer of heat from the iron to the solder joint. In addition to the usual precautions, take extreme care in handling MOSFET's, since their very low gate leakage current makes them susceptible to damage from stray electrostatic fields. Replacement MOSFET's are supplied by the manufacturer with their leads shorted together to prevent this type of damage; don't remove the shorting wire or clip until the device is installed and ready to operate. Some newer MOSFET's have built-in protection diodes to bleed off any static charges and thereby prevent damage. If a MOSFET is supplied without a shorting wire or clip, you can assume that it has built-in protection diodes, and you can then handle this transistor just as you would handle a JFET or bipolar transistor.

If you must replace a FET, it's usually best to get an exact duplicate from the equipment manufacturer. If this isn't possible, check the RCA, Sylvania, G.E., Motorola, or International Rectifier semiconductor replacement guides to see if a suitable "general replacement" is available.

TESTING FET's

Sooner or later you will probably have to test a field effect transistor, and you probably won't have a tester designed for this purpose. Fortunately, most FET's can easily be tested with an ordinary ohmmeter. If a transistor can be safely handled without the need for any shorting wires, it can be safely tested with an ohmmeter. This means that this type of test is safe for all but unprotected MOSFET's. Since most of the FET's that you will encounter will be N-channel JFET's, we'll discuss the testing of this type of transistor in detail. Since all JFET's are depletion-mode devices, if you measure the resistance between source and drain, you will find a fairly low resistance: probably on the order of 1000 ohms. The resistance will be the same no matter which way the meter leads are connected to the source and drain. This shows that the channel has continuity. After you make this check, check the diode junction between the channel (either the drain or the source terminal will do) and the gate. Since you are measuring a diode, you will find a low resistance in one direction, and a very high resistance when the meter leads are reversed. If you find infinite resistance in both directions, or zero resistance in both directions, the transistor is faulty.

As long as you keep in mind the sex and mode of operation of the transistor you wish to test, the same checks can be made on any FET that can be safely handled. Of course, all of these checks are made with the transistor under test removed from the circuit. And, you must be sure that the voltage applied to the transistor by the ohmmeter does not exceed the transistor's maximum voltage ratings. A typical VTVM or TVOM will apply only 1.5 volts, so there is no danger. But beware of VOM's that use higher-voltage batteries. Use a VTVM or TVOM for this type of test, and use its R $\times$ 1k ohm range to avoid excessive current through the FET under test.

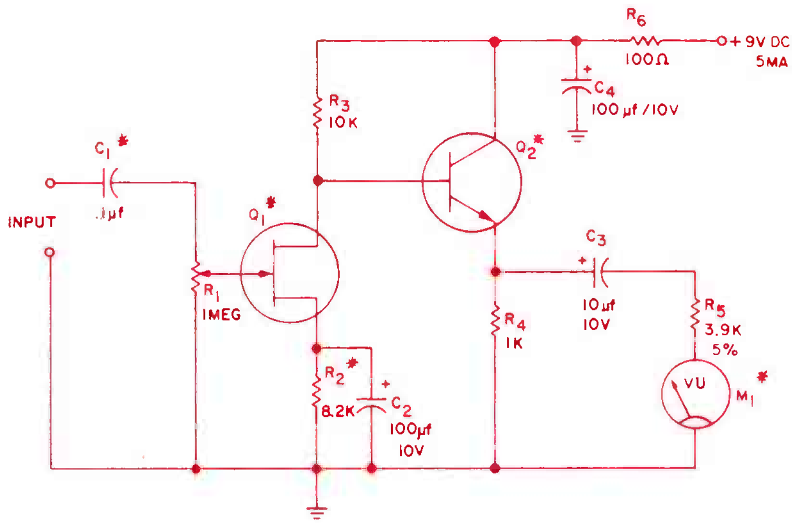

Fig. 10. VU-meter driver. See text for parts marked with *.

FOR THE EXPERIMENTER

A practical VU-meter driver circuit is shown in Fig. 10. You can use this circuit to monitor the audio level in any hi-fi circuit.

The VU-meter driver circuit is used, of course, to drive a standard VU (Volume Unit) meter. Such a meter has precisely defined ballistics, which are optimized for response to normal audio program material. However, the meter will have correct ballistic response only when it is loaded by very close to 3.9k-ohms. Remember, the impedance of the circuit that drives a meter affects the damping of the meter movement. A meter could be designed to have good ballistics at any value of load impedance, but the standard VU-meter happens to have been designed with a 3.9k-ohm load in mind.

This particular circuit uses an N-channel JFET as a common-source voltage amplifier. The input impedance of this amplifier is equal to the resistance of the 1 megohm control, so the loading on the circuit being measured is very slight. The voltage amplifier amplifies the signal about ten times, and the resulting output is fed to an emitter follower, which serves to match the fairly high output impedance (10k-ohms) of the FET to the low impedance required to drive the VU meter. An emitter follower produces no voltage gain, and 2.5 volts peak-to-peak must be applied to the meter (in series with R_5), so there must be at least .25 volts peak-to-peak at the input terminals for full-scale deflection of the meter.

Since not much input voltage is required, and the input sensitivity is adjustable, this circuit can be used in just about any application calling for a VU-meter driver circuit. You might, for example, wish to add such a meter (or a pair of them) to your tape recorder.

The voltage rating of C_1, the input coupling capacitor, depends upon the amount of dc voltage present at the point from which the input signal is taken. If

(continued on page 24)

Ham News

BY TED BEACH, K4MKX

You know what? After seeing how many people have expressed such an interest in this QRP bit, I think that perhaps the bug has bitten me. I have read some of the articles in the various magazines, looked at the rigs in the handbook, and read the ads for Ten-Tec. So, the other day I went out to our local Ten-Tec distributor and latched onto one of their MR1 kits. This package, in case you haven't seen it advertised, contains the "guts" of their PM2 transceiver. The kit has four assembled circuit boards, and all you have to do to get the thing working is make a few interconnections, hook up a battery and antenna and you're on the air. Fantastic! Right now the whole deal is spread out on a real breadboard, but it works like a champ.

The direct conversion receiver module works on 80 and 40 meters, and the sensitivity is really amazing. I hooked up the SX100 and the Ten-Tec to the same short-wire antenna (thrown carefully out the nearest window) and was able to read all cw signals equally well on both receivers. This is on 80 meters only, as I was in such a hurry to try the thing out that I didn't get around to tuning up the 40-meter coils.

Since I didn't want to blow the "final" of the transmitter by trying to load my untuned "antenna", I was limited to a No. 47 pilot lamp dummy load for the transmitter tryout. It too worked real well, and the lamp lit almost to full brilliance. By separating the SX100 from the transmitter I was able to listen to the keying quality of the little rig – T9 all the way. This, mind you, is using the VFO (which is also used with the receiver) and not a crystal.

Now all I've got to do is get that antenna up and an antenna tuner hooked up to try it out on the air. (I don't think that 1 watt will work my SWR indicator too well on 80, so I'll probably have to build a nice sensitive QRP indicator, too!) Anyway, it looks like this little peanut-whistle could really be a lot of fun and put some excitement back into Ham radio. It will be real cool to say "rig hr runs 1 watt"! I can't wait.

One thing that I did do while I was playing around with this cutie was to tune for many, many hours up and down the various bands with the SX100. Just listening. It has been so long since I've been on the air that I had forgotten just what goes on, and how many operators are POOR operators – approaching the Lid category. And the bad habits are not restricted to the Novice frequencies. Even up in the Extra territory there are a number of people whose operating techniques are not only atrocious but also downright rude on occasion.

Although I am a self-professed cw man, I did read the mail of some of the sideband types, also. I listened to one roundtable for the better part of an hour one evening, and not once during that time did I hear one station identify. The conversation itself was innocent enough, but as the group drifted up the band they passed through several other QSO's that were in progress, and they would make nasty remarks about the others they were interfering with! That takes a lot of gall. I'm still not sure exactly how many stations were in that little group, because they popped in and out without ID just like on 11 meters. In fact, I'd say these boys would probably be just as at home on 11 as they seemed to be on 20.

Back home in the cw segments again, I heard time after time the same old bad procedures from Novice and old-timer alike. Perhaps the worst practice is not listening. Once, for example, I counted five stations within 6 kHz of one another on 80, all calling CQ. Now I know that if I can hear them with my "antenna" on 80 meters, every one of them could have heard every other one, too; so how come all the CQ calling? One young lad (he must have been young!) strung out 36 consecutive CQ's and signed twice. Three seconds later he was back at it again, even though 2 kHz up there was a station calling him. Maybe he was just practicing.

Then there is the type that raps out a nice three by three call at 20 WPM, gets a reply and then proceeds to have a QSO at a halting 6 or 8 WPM. Now I ask you – would you like that kind of QSO? DON'T try to impress people with your first while calling CQ if you can't keep it up. I know I always look around for someone calling who is going about the speed that I like, and if I get a QRS or QRM? when I reply at the same speed, that QSO ends very quickly.

And how about DX? Wow! I never really got into that rat race, but by doing a lot of listening I'll bet that I would have a better time of it than some of the DX chasers I have heard recently. For instance, one night at the bottom end of 40 I heard a very weak HC calling CQ DX and when he signed it sounded like a swarm of angry hornets or a Russian jamming station had taken over the frequency. Bedlam! I tuned 2 kHz up the band and heard a W3 calling the HC at a nice leisurely pace. When he signed, the noise had abated 2 kHz lower down, and there was the HC calling the W3. With that kind of mess on all DX portions, I am amazed that any DX station will talk to United States Hams.

OK, so I'll get off of the soap box now. I hope I have made a couple of points. Like:

1. Good ops LISTEN more than they send.
2. Follow the rules (Part 97, that is).
3. Don't try to impress people with your blinding speed.
4. Keep CQ's short – 3X3 is recommended, CW or AM.
5. Be considerate of the other fellow.
6. Good ops LISTEN more than they send.

(This one is so important it NEEDS to be on the list twice.)

Here are the Hams we have heard from most recently who are enrolled in or are graduates of our Course for Amateur Licenses:

George	WN1NZW	N	E. Sandwich, MA
Norm	WN1OCZ	N	Springfield, MA
Mike	WN2SQD	N	Lawrenceville, NJ
Milt	WA4GZZ	G	Nashville, TN
Flo	WN4PGZ	N	Sarasota, FL
Eric	WN4SGT	N	Ft. Meyers, FL
Ed	WN4TRI	N	Tampa, FL
Tom	WN4UMU	N	Odessa, FL
Glenn	WN4UNW/6	N	Vandenberg AFB, CA
Earl	WN5ECQ	N	Bay St. Louis, MS
E.J.	W5QIB	A	Bridge City, TX
Mario	WN6HJX	N	North Hollywood, CA
Eleno	WN6IXS	N	Huron, CA
Earl	WN8IQX	N	Cincinnati, OH
Bruce	WN8JFE	N	Columbus, OH
John	WN8JMS	N	Lima, OH
Tommy	WN9GQB	N	Indianapolis, IN
Doug	WBØCUV	C*	Berthold, ND
Bill	WL7HGL	N	Ft. Wainwright, AK

*Just upgraded – congratulations!

WN1OCZ is a graduate of our amateur course and is presently taking the Communications course, with a commercial ticket in mind. Norm is another "second time" Novice and has also held a General before, but wanted to start all over again "from the bottom" as he says. Norm's rig is all home brew and he would like information on an ac powered field strength meter. Any help available?

The photograph is of WN4SGT at his operating position. Rick hastens to mention the HW100 is being used for receiving only, but since he has passed his General Test he will soon be using it all the way. Rick operates mostly on 15 in the afternoons and would like to talk to other NRI Hams, particularly those with DX calls.

Glenn, WN4UNW, is presently stationed in California, but his home QTH is Randelman, NC. He operates an Eico 720, Heath SB310 and 40 and 80 meter dipole and beam, presently. Glenn says

that the NRI training has really made the Ham game fun for him and he really appreciates his Novice call.

WBØCUV is very proud of his new call. So are we. It seems Doug is still in high school and is involved in all sorts of activities, so he finds little time to study his NRI Ham course. Not only that, but even with the new call he is stuck in the Novice band for lack of funds. Doug has a new SB303 but can't afford the SB401, so he's stuck with his Conar 400 and Novice rocks. I'm sure that anyone who is as busy as Doug seems to be won't find it too rough saving for the SB401. Have patience, Doug.

Now for the Rogues in the gallery of other NRI amateurs:

Jeri	K1BOL	C	Marshfield, VT
Dave	WN1MRZ	N	Essex Jct., VT
Al	WN1NUT	N	Malden, MA
George	WB2FRG	A	Spencerport, NY
Mike	WN3NXP	N	Baltimore, MD
Jim	WA3MIE	?*	Pittsburgh, PA
Bill	WA4IBP	A	Jacksonville, FL
Will	WB5BOS	?	Albuquerque, NM
Gregory	W5RHB	G	Las Cruces, NM
Joe	WA5UNK	T	Olton, TX
Bill	WN6HBM	N	Hamilton AFB, CA
Jack	WB8FUG	A	Conway, MI
Ronald	WB8HVT	?	Dearborn Hts, MI
Ralph	K8IEC	G	East Detroit, MI
George	WN8JIX	N	Muskegon, MI
Ray	W8KJB	A	Delaware, OH
Jeff	WN9CYI	N	Algonquin, IL
Al	VO2AW	-	Labrador City, Can.

* Just upgraded – congratulations!

WN3NXP likes the idea of a 40 meter net, and has these crystals: 7155, 7165, and 7190. Mike is also actively working for a Novice WAS and is having trouble snagging Rhode Island, Delaware, and the New England States. Mike also works 80 and 15 and would like very much to set up a sked with someone if possible. You can write him at:

638 N. Belnord Ave.
Baltimore, MD, 21205

Good luck, Mike.

WA4IBP is a man after my own heart. He is a strictly cw man and works mostly 20, 40, and 15 from northeastern Florida. Charles uses an Apache and SX71 along with an inverted VEE on 40 and 15 and a three element beam on 20. Charles says that he, too, is interested in a 40 meter cw net so let's see what we can do this time. I guess I'll just HAVE to get that antenna up soon!

Anyone who happens to be in the Albuquerque, NM area on September 17 – 19, 1971 has an invitation from WB5BOS to attend their Hamvention. Will says their first Hamvention last year was a real success even though he didn't win the first prize Swan 500CX. You can hear Will infrequently when he cranks up his own TR4 on 20 and 15 sideband, so give him a shout and get all the details about the shindig.

WB8FUG says that he travels so much that he has very little time for hamming at the present time. That is why you will see his rig for sale in the Ham Ads this time. Jack also has a lot of other goodies for sale, but as we originally set up the Ham Ads, we will publish no more than TWO items per ad. Some of the things Jack listed look real good, so write him for more information.

K8IEC is also a traveler, but at least Ralph is not disposing of his rig. He runs a TR4 mobile, and is able to work 80 through 10 meters on his trips with the U. S. Army Engineers.

Anyone know when the SX28 was manufactured? WN8JIX has one as a companion to his Communications Course transmitter (2E26 final) and would like to know. It seems to me, George, that the SX28 was a WW2 development and showed up on the surplus market in the late 1940's. Can anyone get any closer than that?

VO2AW, our second Newfoundland Ham, informs us that there is yet another NRI Newfoundland Ham, VO2AL, Marcel. Al says that there are quite a few hams in Labrador City who would like used ham equipment from stateside or Canadian Hams willing to get them "on the air" with as little investment as possible. Al's rig is an ART13 and HQ129A which he uses on 80, 40, and 20.

And I guess that about wraps it up for this time. I hope to have the antenna up and the QRP rig going so that I can give you a report on how it feels to operate a 1 watt rig on 80 and 40 (in the summer-time? I must be nuts!).

73 for now, and keep writing!

Ted – K4MKX

HAM ADS appear on the next page

HAM ADS

Sell – Globe Scout phone/cw transmitter with VFO, $75.00; Heath "Twoer", $15.00. K1BOL – Jeri Healey, Marshfield, VT, 05658.

Sell – Mint reconditioned NC-303, $225.00; new Heath SB401 with xtal pack, factory aligned, $300.00; also have other gear. WB8FUG – Jack White, P. O. Box 23, Conway, MI, 49722.

Wanted – Inexpensive rigs for Canadian Ham Club members. VO2AW Al Christie Jr., 317 Viking Cr., P.O. Box 430, Labrador City, Labrador (Nfld), Canada.

Wanted – Grid block keyed VFO for Heath DX60B. WN4SGT – Eric Nielsen, 329 Rosemont St., Ft. Myers, FL, 33901.

Wanted – Tube chart and manual for B&K Model 500. W3CZL – John Walter, 2008 Grace Church Rd., Silver Spring, MD, 20901.

(FET continued from page 19)

the circuit from which the signal is removed is a vacuum-tube amplifier, it would be best to use a capacitor rated at 400 volts or perhaps 600 volts. On the other hand, if the circuit is a transistor amplifier, the supply voltage may be only 10 or 15 volts, so a low-voltage coupling capacitor can be used.

The FET, Q_1, can be a 2N4303, a 2N5457, an MPF103, or an HEP801. The NPN bipolar transistor, Q_2, can be a 2N5133, an SK3018, or an HEP50.

Since the two amplifier stages are direct-coupled, dc voltages in the first stage will affect those in the second stage. For best operation, the voltage across R_4 should be about 4.5 volts. Adjust the value of R_2 as necessary to bring this voltage to exactly 4.5 volts.

SELF-TEST QUESTIONS

Test yourself to see what you have learned. Answer the five TRUE-FALSE questions below. Answers are on page 26.

1. The junction FET can be used in both the depletion and the enhancement modes of operation.
2. The substrate element of a MOSFET is sometimes used as a gate.
3. The circuit shown in Fig. 5 operates in the enhancement/depletion mode, since there is no bias voltage applied to the gate.
4. If C_2 in Fig. 7 becomes shorted, the gain of the rf amplifier will be at maximum.
5. R_1 in Fig. 10 varies the gain of Q_1 by varying the dc bias voltage applied to the gate of this transistor.

SUGGESTED READING

For more information on the subject of field-effect transistors the following publications are recommended:

RCA Transistor, Thyristor, and Diode Manual, SC-15, $2.50
RCA MOSFET Product Guide, MOS-160C, .25
ABC's of FET's, by Rufus P. Turner, Sams 20789, $2.95
FET Circuits, by Rufus P. Turner, Sams 20585, $3.25
FET Principles, Experiments, and Projects, by Edward M. Noll, Sams 20594, $4.95

RCA books and leaflets are available from your local RCA dealer, or by mail from RCA Commercial Engineering, Harrison, NJ – 07029.
Sams books are available from your local Sams distributor, or by mail from Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, IN – 46268.

NRI honors program awards

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

HIGHEST HONORS

Ralph A. Athay, Fort Lewis, Wash.
Thomas Ellis, Washington, D.C.
John T. Gibbs, Hannibal, Mo.
Lynn Autry Gibson, Decherd, Tenn.
Henry C. Giltin, APO New York
Bobby M. Hawkins, Newark, Ark.
Herbert E. Lawrence, Jr., Beaver Falls, Pa.
Larry J. Pearson, Centerville, La.
Robert C. Radcliffe, Bethlehem, Pa.
Timothy Ray, Bridgeton, Mo.
Fernando Roca, Rio Piedras, Puerto Rico
Erville G. Smalley, Blossvale, N.Y.

HIGH HONORS

Donald S. Allen, Dahlgren, Va.
Terry D. Allen, Moline, Ill.
Alden P. Anderson, Ellsworth AFB, S.D.
Edell J. Anderson, Dawson Creek, B.C., Canada
Roger L. Andrews, Clarksburg, W. Va.
Neal C. Baker, Chelsea, Okla.
William L. Beane, Rockville, Md.
George F. Bebout, North Charleston, S.C.
Larry G. Bellinger, Beldenville, Wis.
Peter M. Boehm, Jr., Garland, Tex.
Cyril J. Boudreau, Halifax, N.S., Canada
Alvin C. Chaves, Aiea, Hawaii
Herbert W. Cribb, Merritt Island, Fla.
J. C. Criner, Nicholasville, Ky.
Harry W. Dawes, Berea, Ohio
Richard L. Dellinger, Jr., Spruce Pine, N.C.
Wayne M. Dinkelman, APO San Francisco
Ismail H. A. Al Dossari, Kuwait, Kuwait
William S. Duncan, Piney Flats, Tenn.
Andre N. Forest, Tallahassee, Fla.
J. Arthur Frazier, Ashtabula, Ohio
Clyde R. Gingrich, Falls Church, Va.
John S. Goodale, Aston, Pa.
Wilmer L. Guynn, Sioux City, Iowa
Hubert R. Hamblin, Middletown, Ohio
Donald W. Hermany, Allentown, Pa.
Ira E. James, Jr., Wichita, Kansas
David B. Johnson, Spokane, Wash.
Eldon D. Lashbrook, Mt. Sterling, Ill.
Thom A. Lemaster, Irving, Texas
Paul R. Letourneau, Rochester, N.H.
John Malinak, Columbia, Mo.
Charles C. Marshall, Grand Forks AFB, N.D.
Richard Moore, Wallingford, Conn.
Luc Morel, Brooklyn, N. Y.
Lyle A. Morris, Jr., Houston, Tex.
Paul C. Newkirk, San Luis Obispo, Calif.
Roger W. O'Malley, Hutchinson, Minn.
Cyril Dean Osborne, Grayson, N. C.
Forest D. Payton, Martinsville, Ind.
Horace J. Phillips, Buckhannon, W. Va.
David Pryde, Allport, Pa.
Victor Quinones, Brawley, Calif.
Donald F. Rehrer, Anchorage, Alaska
Roger D. Richmond, Harrisville, Pa.
Robert A. Ruby, Enid, Okla.
Martin J. Shunkwiler, Grand Island, Neb.
Robert W. Skrdlant, Harrisonville, Mo.
William Stough, Pasadena, Calif.
Timothy T. Taylor, Kansas City, Mo.
James B. Tippetts, Lovell, Wyo.
Johan A. Trugler, Perth Amboy, N. J.
Robert G. Warren, Iowa Park, Tex.
Jack T. Waynick, Charlotte, N.C.
Billy W. Williams, East Greenwich, R. I.
Charles R. Williams, Wichita, Kansas

HONORS

William S. Adamec, Matawan, N. J.
Ronald L. Anderson, Iverness Co. N.S., Canada
Darrel G. Ausmus, St. Paul, Minn.
Harold N. Austin, Lauderdale Lakes, Fla.
James Maury Baggett, Dallas, Ga.
A. P. Balza, Vallejo, Calif.
Albert J. Bartley, Kingston Jamaica, West Indies
Albert C. Beck, Bradenton, Fla.
Glen H. Beck, Big Bear Lake, Calif.
Edwin L. Benner, Waldoboro, Maine
Joseph Budzinski, New Castle, Pa.
Bobby L. Campbell, Albertville, Ala.
Linwood Carter, Sedgwick, Maine
Neil P. Caruthers, Greenbrier, Ark.
J. E. LaChance, Seattle, Wash.
J. A. Chapman, Sapulpa, Okla.
Samuel P. Chavez, Austin, Tex.
Lloyd E. Cherington, Santa Rosa, Calif.
John E. Clifton, Jr., Glassboro, N. J.
Frederic E. Cutter, McGuire AFB, N.J.
Harry Delozier, Jr., Osseo, Minn.

George D. Dickerson, Hazelwood, Mo.
Arlo D. Dumke, Omaha, Neb.
Norris L. Durrell, Glen Burnie, Md.
Joseph W. Felix, Jr., Sidman, Pa.
Richard E. Fogle, Sandy, Ore.
William G. Fortner, Stockbridge, Ga.
Robert Fowler, Jr., Pleasantville, N.J.
Ashton B. Franklin, Jacksonville, Fla.
Fred J. Garcia, Pittsburgh, Pa.
Donald Grange, Choctaw, Okla.
John C. Gray, San Antonio, Tex.
J. A. Griner, Savannah, Ga.
John J. Hardy, Jr., Baltimore, Md.
Richard E. Harrell, Fort Worth, Tex.
Michael J. Hile, Lincoln, Neb.
Stephen Hilliard, Codroy, Nfld. Canada
Jack Horskey, Pompton Lakes, N. J.
Ronnie L. Hughes, Port Hueneme, Calif.
Michael L. Humphry, Oak Lawn, Ill.
Andrew M. Inso, FPO New York.
Evans Jackson, Los Angeles, Calif.
A. K. Jacobs, Pompano Beach, Fla.
Donald E. Janes, Lawrenceville, Ga.
Richard E. Jarrett, Falls Church, Va.
William J. Kiddy, Clarksburg, W. Va.
Richard P. Knapton, St. Simons Island, Ga.
Ray A. Kosbau, Scott AFB, Ill.
Frederick G. Kreh, Traverse City, Mich.
Edmund W. Kuykendall, Martinsville, Va.
C. L. Lafferty, Cambridge, Ohio
Lucien Lafrance, La Tuque, P.Q., Canada
Theodore A. Laurin, Kirkwood, Mo.
Joseph R. Lensbower, Hampton, Va.
Robert G. Lockwood, Virginia Beach, Va.
P. R. MacDonald, Campbellton, N. B., Canada
William W. Marshall, Otis AFB, Mass.
G. H. Mattock, Edmonton, Alta., Canada
Charles R. McCameron, Victoria, Tex.
Edward M. McFadden, Glenns Ferry, Idaho
John R. Morris, Raymond, Wash.
Ralph W. Morton, Coraopolis, Pa.
Vance Theodore Moseley, St. Philip Barbados, W.I.
Gerald B. Mungan, Cincinnati, Ohio
Glenn L. Odom, Sacramento, Calif.
James H. Parker, Keyser, W. Va.
Peter Pavleas, Toronto, Ont., Canada
Wayne P. Pendergrass, Riverside, Calif.
Andrew G. Perra, Northfield, Vt.
David C. Puryear, Clinton, Md.
John T. Rhuark, APO Seattle
Darrell M. Riddle, Rowlesburg, W. Va.
Peter M. Schumacher, Independence, Mo.
Clyde E. Seid, Plattsburgh AFB, N.Y.
Jalaluddin Shamas, Chicago, Ill.
John Sharp, Fort MacLeod, Alta., Canada
Charles J. Shepherd, Hauppauge, N.Y.
Pietro Silla, Asmara, Ethiopa
T. S. Terrill, Sunnyvale, Calif.
Paul J. Timberlake, Lewiston, Maine
Robert L. Tolbert, Muncie, Ind.
James S. Tomb, Runnemede, N. J.
William J. Utz, Greenbelt, Md.
Pasquale Vacchio, Berwyn Heights, Md.
Bravel L. Watson, Whitley City, Ky.
Edward W. Webb, St. Clair, Mich.
Michael Wells, Maynard, Mass.
Gerald D. Wilkins, West Palm Beach, Fla.
William B. Woodward, Virginia Beach, Va.

ANSWERS TO SELF-TEST QUESTIONS

(questions on page 24)

1. FALSE. All JFET's are used in the depletion mode only. To operate a JFET in the enhancement mode would forward-bias the gate-channel junction, and the input impedance of the FET would be greatly reduced, thus destroying the usefulness of the stage. In a MOSFET, there is no diode junction to become forward-biased, so either mode of operation is permissable.
2. TRUE. The substrate can be used as a second input to a mixer stage.
3. FALSE. All JFET's operate in the depletion mode. Operating bias is supplied by the voltage drop across the source resistor.
4. TRUE. This would reduce the applied agc voltage to zero. The gain of this stage is normally reduced by applying a negative agc voltage. As the negative voltage is increased, the gain is reduced.
5. FALSE. There is no gate current, so there is no dc voltage drop across the sensitivity control. The bias voltage is determined by the size of R_2. The gain of Q_1 is constant, but the output level applied to the VU-meter can be varied by changing the amount of input signal applied to the gate of Q_1.

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 Continues Discussion of Service Problems

Mr. Ray Berus brought in a commercial SCR and showed how similar it was to the peg board kit that the Chapter owned.

Mr. Kelley brought in his color bar generator that he assembled and explained to the Chapter members the various steps in kit assembly.

Charles Cope had an amplifier that was not functioning. John Nagy showed the members how to troubleshoot amplifiers and soon located the trouble as a cold solder joint. At this same meeting a group discussion on service problems was held.

At our April meeting, Mr. A. Alexander brought in his Conar color TV set to have the membership help him locate a problem. The sync circuit was checked and found to be functioning perfectly. However, time ran out before the actual problem was located.

Mr. Roosevelt Paton, Jr., who traveled more than 60 miles one way to attend the meetings, has moved to Pensacola, Florida. We will sure miss him at the meetings and want to wish him lots of luck at his new location.

FLINT-SAGINAW Chapter Enjoys Student Participation in Lectures

This is the second series of lectures put on by the members. This is one of the reasons why it is not difficult to obtain new members. It is the kind of program they like to see, and they are able to participate in actual troubleshooting. Many students come and learn by actually working with problems in a TV chassis. In this way, they understand their lessons better and advance faster in their course.

Mr. Robert Poli, our Sergeant-At-Arms, gave an interesting talk on Camper Trailer Antennas which fold up and store easily.

Joe Washington, our Good Will Ambassador, presented his talk on service tips that he will carry to other Chapters in the near future.

Flint-Saginaw members learn how to locate TV troubles with an oscilloscope.

Cash Laferty, our honorary member, spoke on industrial trends toward automation, and how we should use our TV experience in automation. He also noted that many of our past members are holding good jobs after graduating in TV. At the April meeting Richard Moore, a student, brought in his Conar color TV chassis. He needed a little help finding the sync pulse with a Conar scope. The members gave him a helping hand. Mr. Moore also brought along his son, who is building a Conar radio and was having trouble getting it to operate. Before the meeting ended, the old-timers had found a dead tube and, upon replacing it, the set operated beautifully.

Mr. Lawrence Huck, another student, was also visiting for the first time.

Mr. William J. Pritchard, from Canada, stopped by to see why the Saginaw Valley Chapter is so popular. He was disappointed that we did not have any amateur radio operators as members, as he would like to talk to them by radiophone from Canada. Mr. Pritchard, next time we may have some operators.

The Chapter has purchased a new color TV set to be used for instruction.

Also, the Chapter has a new member whose age sets something of a record for us. Bruce Moore is thirteen years old and has joined the Chapter. This is a father and son team (Richard Moore) learning together through NRI courses.

NEW YORK Chapter Discusses Troubleshooting and Alignment

At each and every meeting the New York Chapter does some troubleshooting. For example, Mr. Bimstien has a portable Zenith Model 13A5 with a hard-to-find trouble. It was finally found that the choke had a short. Replacing the choke took care of the problem. Also Pete Carter had a new color bar generator which checked out on our color set very well.

Mr. Ferruggia had a problem in his color set which caused a green screen. Mr. Eaddy explained the demodulators used in the set and showed how to check them for problems of this nature. Mr. Robert White brought in a set with vertical lines. The damper problems which could cause such vertical lines were explained in detail.

Mr. Eaddy then started his basic color course on colorimetry. It was very interesting to know that all of our eyes do not see the same things. Each person sees color a little differently.

Mr. John LaPinta was introduced to the membership and is expected to join the Chapter and the Alumni at the next meeting.

Mr. LaPinta explained about the course he is taking in aircraft communications. He described the theory of AM and FM modulated transmitters.

Pete Carter then continued on in the basic color lecture and explained how the colors mix to form various other colors. Everyone learned something from Pete's lecture.

NORTH JERSEY Chapter Plays Host to Speakers

At the March meeting, Mr. D. Watterston lectured on the Quasar Motorola TV. Also Mr. T. Nealon explained operation of electronic door controls.

Both speakers made the evening very interesting and informative. We hope to learn even more in the future on door controls, as sales have been heavy in the area and service is inevitable.

At the April 30 meeting, 38 members were present to hear Tom Nolan, Executive Secretary of the NRIAA, deliver a lecture on solid-state testing and solid-state color alignment.

Tom showed simple methods of checking transistors by ohmmeter, also by transistor testers, and finally by transistor curve tracers.

The final part of the lecture was devoted to the alignment of an Admiral K10 solid-state tuner i-f and color section. A Sencore sweep generator and Sencore oscilloscope were used for this demonstration.

The main thrust of Tom's lecture was to try to dispel the fear of transistor servicing. Tom reminded us that transistors are not as complicated as vacuum tubes and we are able to live with tubes.

This is the third year Tom Nolan has

There was a good turnout for Tom Nolan's annual visit to the North Jersey Chapter.

shown his skill in completely captivating his audience. His lecture and demonstration on solid-state was both interesting and educational. Many favorable comments were heard from the audience on his way of simplifying and thoroughly explaining things so that they could easily be understood. His information regarding test equipment was greatly appreciated, too. Questions and answers were exchanged throughout the lecture. Some guests traveled as many as 60 miles to attend the meeting. Coffee and homemade cake were served. It was a great pleasure to see Tom again.

It was indeed with deep concern that the Chapter learned that Jeffery Stoll, son of Chairman George Stoll, was critically injured in an auto accident last week, and is still in Intensive Care, improving slowly. We all wish him a speedy and complete recovery. We miss George, too.

PITTSBURGH Chapter Enjoys Technical Lectures, Good Speakers

At the April 1 meeting twenty-one members and four guests were present to see a program supplied by the Howard W. Sams Company, Inc. The program consisted of two sets of slides and audio tapes entitled "Semiconductor Fundamentals" and "Circuits and Associated Components".

A new member was welcomed into the Chapter, Mr. Richard W. Smith of Pittsburgh.

At the April 15 meeting, 27 members were present to hear Mr. Jerry Ryan, a Motorola representative, talk on the Instamatic Quasar and its associated circuitry. Mr. Ryan explained the operation of the automatic tuning and the circuits that are responsible for its operation. He also explained how to adjust the color controls for the customer, then he proceeded to demonstrate it on the Motorola Quasar set that he had brought with him for the demonstration. He then showed how the circuit boards were removed and replaced.

At the May 6 meeting the Chapter played host to the NRIAA National Secretary, Mr. Tom Nolan. A steak dinner was held, with all the regular members attending.

Tom's lecture dealt with the fundamentals of transistors, including various methods of testing and also methods of in-circuit testing using a transistor curve tracer.

Along with the talk, Tom gave a practical demonstration of solid-state alignment techniques.

SAN ANTONIO Chapter Fetes Tom Nolan During San Jacinto Fiesta Week

The annual visit of Tom Nolan, National Executive Secretary of the NRIAA was held on April 21, which coincides with the yearly fiesta week in old San Antonio, Texas.

Tom's lecture on solid-state fundamentals, testing, and alignment was well received, and attended by a large crowd.

Editors Note: San Antonio Chapter members went out of their way to make the stay of Janet and myself a most memorable occasion. There was always at least one member of the Chapter who was available to take us to all of the various parades and events during this memorable week, which was culminated on Friday evening by a real Mexican dinner attended by the majority of the Chapter. These arrangements were made by the Chapter Chairman, Joe Garcia, and his lovely daughter.

Tom and Janet Nolan enjoyed a week of activities with the San Antonio Chapter, including a Bar-B-Que at Sam Stinebaugh's (left) and an authentic Mexican dinner attended by most of the Chapter members.

Bob Bonge and his wife, Ann, made most of the arrangements which contributed to the enjoyment of our stay. Sam Stinebaugh and his wife, Jo, played host for us and the other Chapter members at a real outdoor Texas Bar-B-Que. We enjoyed a night with a parade of bands hosted by Sam Dentler and his wife, topped off by a party at a real German garden with beer and bratwurst.

Betty and Jim Rivet hosted the river parade which starred "Red" Skelton; this was really a most memorable evening.

C.W.A. Hoffman (Hoffy) and his wife were hosts for the big parade of the flowers, which was something to behold. Also, Hoffy was our chauffeur and all around guide while we were in San Antonio. I understand also that he was the one who delivered the most circulars to the most wholesale houses announcing my pending talk. This is much appreciated by the secretary. Finally, the Flambeau Parade, held at night with lighted floats, was hosted by Sam Stinebaugh and his wife.

These are a few of the wonderful people who were so nice to us while we were in San Antonio. It is a trip that we will long remember and our thanks go out to all of the members and friends of the San Antonio NRIAA Chapter. Thanks for everything.

SPRINGFIELD Chapter Concentrates on Color TV Alignment

The last two meetings concentrated on alignment. Ever since Executive Secretary Tom Nolan's visit to Springfield last December, members have been keyed up to learning all they can on the alignment of color television.

In order to continue this program, the club obtained a B&K marker generator and Heath triggered scope. Bob Allan, being the most familiar with alignment, conducted the clinic. After his discussion, the members tried their hands at tuning, observing the results on a scope. They paid special attention to the marker position on the curve. They all watched marker movement, as well as wave distortion, as a particular coil was being tuned.

At the April meeting Chairman Al Dorman continued the alignment clinic, allowing the members who were not at the previous meeting to take turns detuning several stages and then retuning to obtain the proper wave shape. The programs conducted on alignment were very helpful in allowing members to get the practical training to recognize the wave shape and marker positions.

The Chapter wishes to thank Al Dorman for securing the equipment to enable the Chapter to continue in this educational venture. Also, the Chapter wishes to thank Tom Nolan for sparking the interest in the alignment phase of servicing.

The Chapter welcomed two new members, Mr. Preston Atwood and Mr. Norman B. Withers. This brings the total membership to 35 members. We look forward to many more enjoyable meetings with this large number of members.

DON'T FORGET

The Deadline For Nominations
Is July 23

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. 841-4972.

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

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., 662-3759.

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 Tuesday of each month at 218 E. 5th 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.

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.

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.

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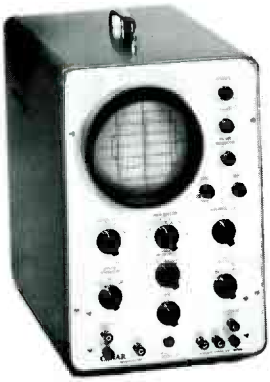

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