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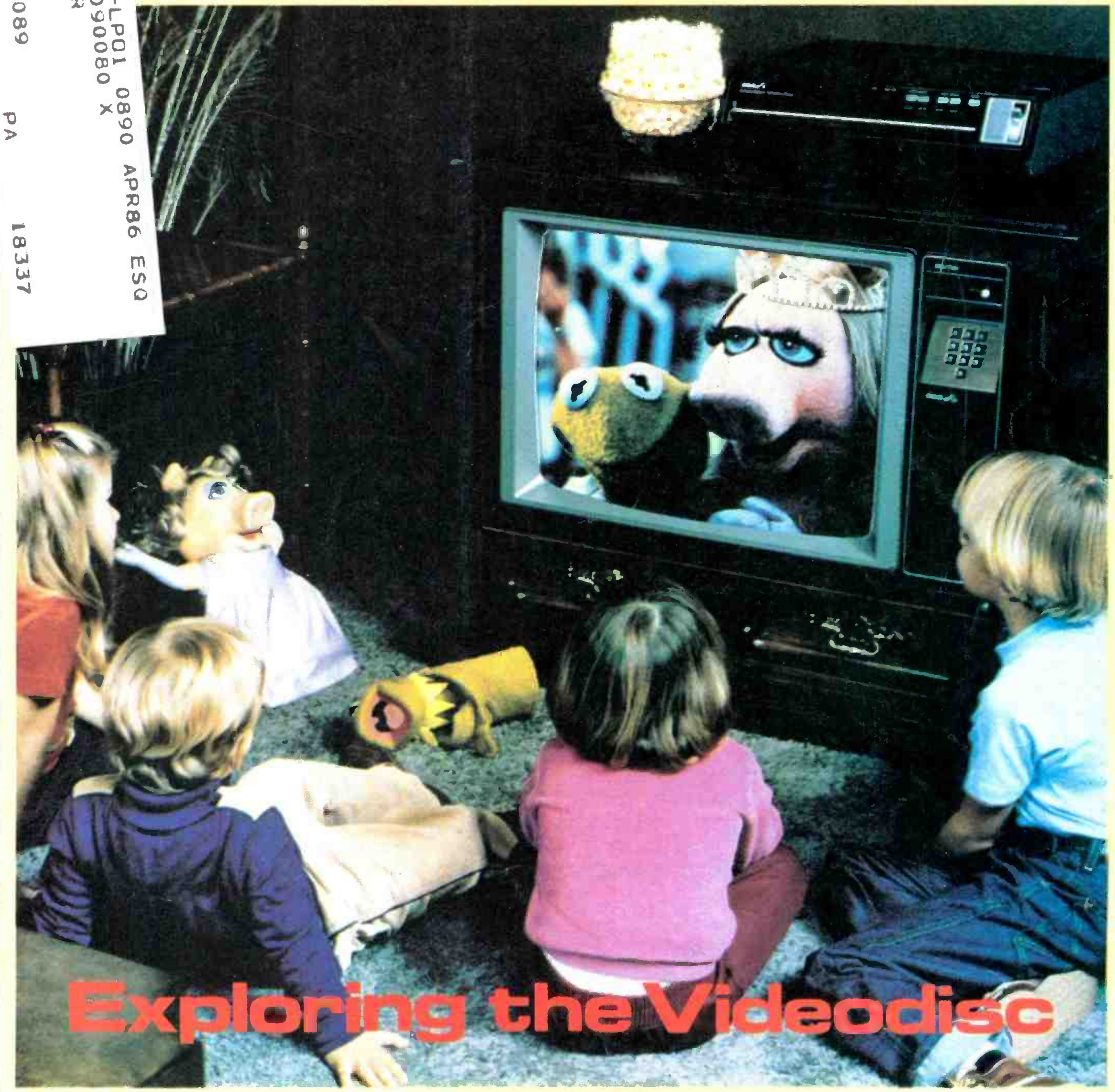
Computer chess makes its move



Exploring the Videodisc

ELECTRONIC
Servicing & Technology

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The how-to magazine of electronics...

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May 1982
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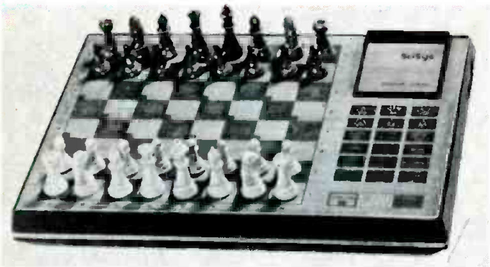
Advances in the field have brought the videodisc into the consumer market. See articles beginning on page 31. *(Photo courtesy of RCA).*



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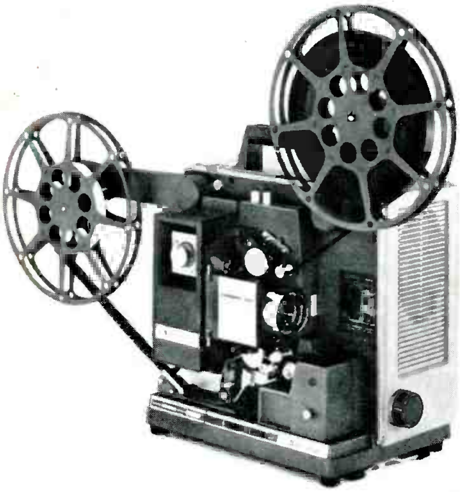

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DEPARTMENTS

ELECTRONIC SCANNER

NATESA urges action on copyright bill

In the February 1982 issue of **Electronic Servicing & Technology,** an item was published titled "NATESA urges action on copyright bill." Through an unfortunate editing error, the National Association of Television and Electronic Servicers of America's position on this subject was distorted.

We are publishing the following transcription of NATESA's position in order to correct that error. These views are those expressed by NATESA and do not necessarily reflect the opinions of the management of **Electronic Servicing & Technology** or Intertec Publishing Corporation.

The current order by Ninth Circuit Court of Appeals banning all recording of copyrighted video material, even for personal use, runs contrary to current recognition on personal recording of copyrighted audio material.

Unless this restriction is set aside by congressional action, the progress of video recorder/playback sets will be severely restricted, adversely affecting the public rights, and will greatly damage video equipment's capability to help the economics of the nation.

Though an appeal by Sony, backed by EIA, is in process, it will take years.

Concerned persons should write to Senators Dennis DiConcini of Arizona and Alphonse D'Amato of New York, sponsors of S. 1758, and the senators in their state urging passage of this bill.

Microprocessor troubleshooting covered in ICS course

Effective troubleshooting for microprocessor systems is covered in a course this summer offered by Integrated Computer Systems (ICS).

The 4-day course, titled "Hands-On Microprocessor Troubleshooting," provides participants with the opportunity to learn practical troubleshooting techniques that are reinforced by in-class training with test equipment specifically intended for microprocessor applications.

Prices at $845, the course will be held June 8-11 in Minneapolis; June 22-25, Washington DC; July 13-16, San Diego; July 20-23, Boston; Sept. 14-17, San Diego; and Sept. 21-24, Washington, DC.

For more information, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., P.O. Box 5339, Santa Monica, CA 90405, 1-213-450-2060.

Program teaches engineers to design custom ICs

ZyMOS Corporation has developed a comprehensive 3½-day training program for its ZyP design automation system.

The course, designed to show system engineers how the ZyP system simplifies custom IC design, completed its first session in February. Additional courses are being offered at regular intervals throughout the remainder of the year.

The course provides "hands-on" use of the ZyP design automation system for converting a logic design to a form ready for silicon implementation. For each training program, ZyMOS encourages participants to bring their logic designs.

Tuition for the program is $2000, and enrollment is limited. Contact ZyMOS at 477 N. Mathilda Ave., Sunnyvale, CA 94086 or call 1-408-730-8800 for more information and course scheduling.

Imports of audio-video products up in 1981

U.S. imports of major consumer audio and video products increased in the fourth quarter of 1981 and only phonographs recorded any noticeable decline for the full year, according to statistics released today by the Marketing Services Department of the Electronic Industries Association's Consumer Electronics Group.

U.S. exports of monochrome TV, auto radio and audio and videotape equipment increased in the fourth quarter and full year 1981. Videotape recorder/players showed the largest dollar value increase for 1981 imports, rising to $999,725,337, an increase of 100.6% over 1980. Dollar value of audiotape recorder/players imported in 1981 rose to $1,103,369,451, a gain of 30.4% over 1980.

ISCET to award VICA winner scholarship

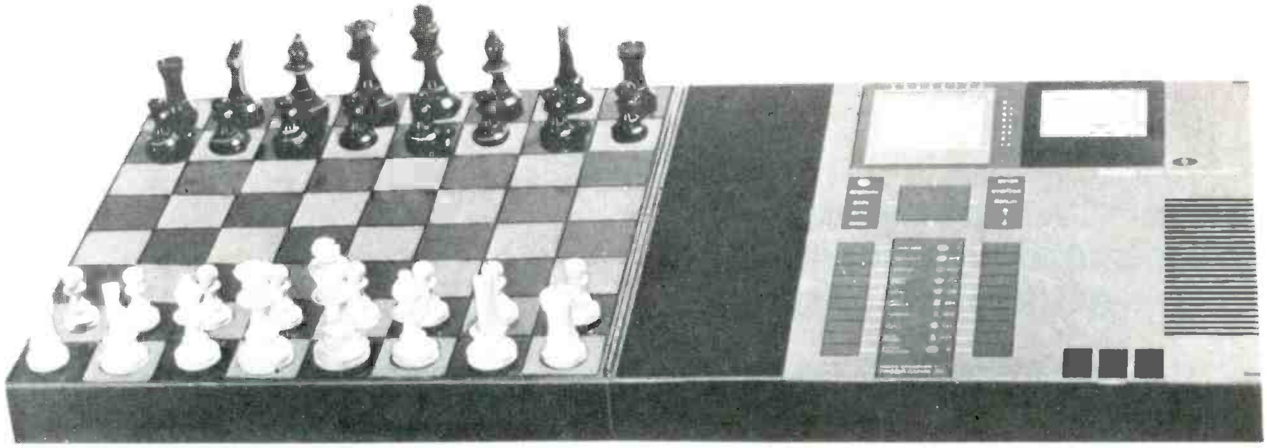
The high-school student who wins the VICA Skill Olympics for Radio and Television will receive a $250 scholarship to continue his education at a private or public college of his choice. The scholarship is being awarded by the International Society of Certified Electronics Technicians. (ISCET).

The Radio-TV portion of the 1982 US Skill Olympics will be held at the Kentucky Fair and Exposition Center June 24 in Louisville, KY. The Radio and Television Contest will consist of problems designed by representatives of the Electronic Industries Association Consumer Elecronics Group.

VICA (Vocational Industrial Clubs of America) is composed of state associations with a membership of more than 300,000 in 13,000 local clubs in high schools and junior and community colleges. Last year 34 high school and 14 post-secondary students competed in the Radio and TV Repair Contest. Contestants are expected to service both TV and audio products, and complete a set of digital experiments and a written test on safety problems. Also, the student is required to assemble a kit to test his skill in mounting, soldering and circuit board assembly.

The ISCET Board of Governors has established the scholarship both to encourage professionalism in electronic servicing and to encourage students to continue their career in electronics.

For more information, contact ISCET, 2708 West Berry, Fort Worth, TX 76109.



Chess Champion Mark V

Computer Chess makes its move

By David Levy*

In 1977 chess enthusiasts were able to buy, for the first time, small chess computers against which they could play chess (or something similar to chess). In fact many of these early machines were unable to play a proper game of chess, because the rules of the game had not been correctly programmed. Against the first machine, which appeared in the shops in Europe, I was able to give checkmate in two moves, playing the white pieces. This was accomplished as follows:

White (David Levy) 1. Knight from g1 to e5.

I moved the knight nearest my king to the square four in front of my king. Of course, this is an illegal move, but the computer allowed it.

Black (computer) 1. Pawn from d7 to d6.

The computer moved the pawn in front of its queen one square forward, attacking my knight.

White 2. Pawn from a2 to f7, checkmate!

*Levy is an International Chess Master and author of **Chess and Computers**.

I moved the pawn in front of my queen's rook to the occupied square diagonally adjacent to the computer's king. This move is also illegal, but the computer did not complain. Because this pawn is defended by my knight, the black king cannot capture it, and the king's only other possibility is also attacked by my knight. So the black king has no moves, it is in check from the pawn, and the pawn is protected. Black has been checkmated.

Black 2. Computer displays "I lose"

I shall not mention the name of the offending computer, nor the name of the products that allowed the user to take off its king in certain circumstances. Today most chess machines are far stronger and more accurate than those early ones.

True beginning

Even before the advent of the electronic computer, man was fascinated by the idea of producing a machine that could play chess. In fact, the idea of a chess-playing machine was born in 1770 when Baron von Kempelen built and exhibited his "Chess Automaton." Von Kempelen's machine was, of course, nothing more than a cleverly constructed hoax. It was wheeled into court by an attendant and what the bemused spectators saw was a life-sized figure dressed as a Turk, seated behind a large chest. In order to convince his audience that the device was entirely mechanical, Von Kempelen opened various doors in the cabinet to reveal a mass of cogs and levers. What his audience did not see was a small compartment in which a strong human chess player was able to hide, and the illusion was so successful that the Baron was able to travel throughout Europe, amazing his audiences and escaping detection.

Following Von Kempelen's success with the Turk, others built similar devices and some travelled as far as the New World, playing against all comers and winning almost every game. But it was not until 1890 that a genuine machine was built. This was an electromechanical device designed by a Spanish inventor, Torres y Quevedo, which could play the simple endgame in which one side has a king and a rook while his opponent has only a bare king. Torres' machine would play with the extra rook, and could always force checkmate though not in the most efficient manner possible.

The machine was programmed to recognize six different types of positions within the limited scope of these three pieces, and for each type of position the machine followed a particular rule. For example, if the defending king is not in the same zone as the rook and the vertical distance between the rook and the defending king is more than one square, then the winning side should move his rook one square toward the defending king.

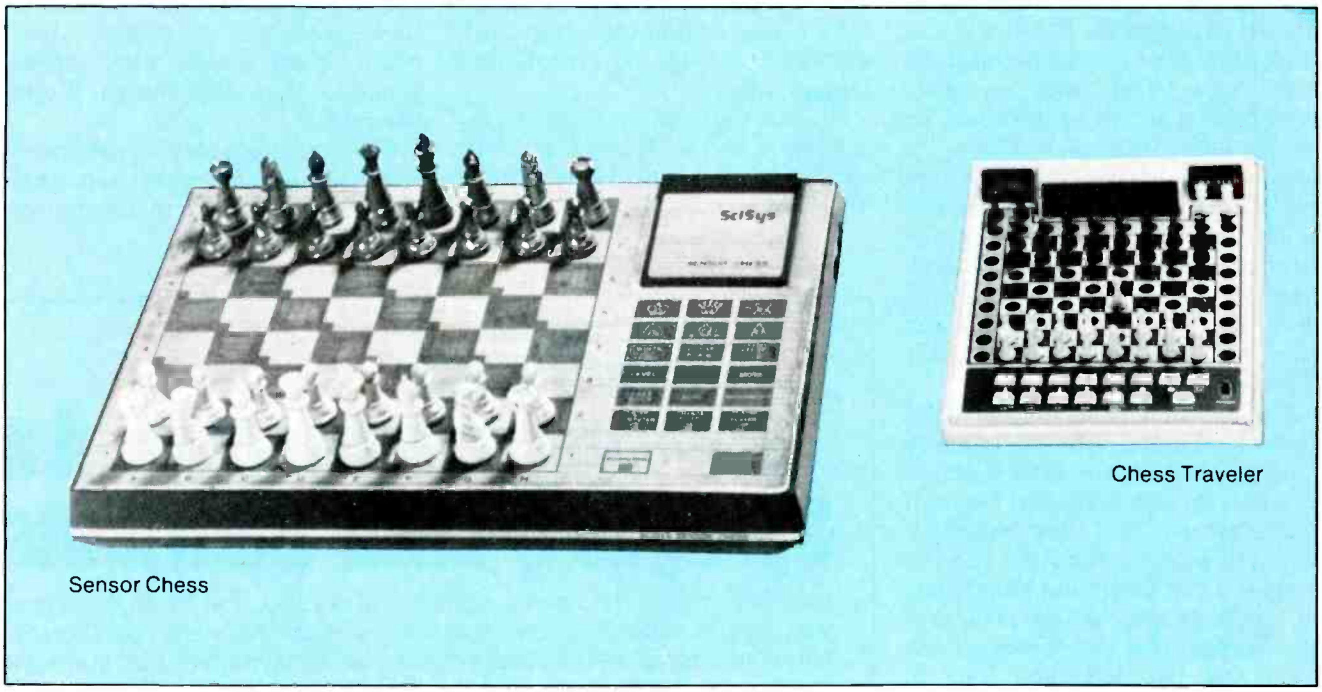
Although this method of following a number of rules does not lead to efficient play in chess, it is interesting to note that exactly the same concept forms the basis of the so-called "expert systems" that are now coming into vogue in computing and artificial intelligence. The human expert provides a number of rules, which are used by a computer program to perform such tasks as medical diagnosis and shape recognition.

Scientists enter the scene

Once man had invented the electronic brain, it was not long before computer scientists began to take an interest in the possibility of writing a program that could play a good game of chess. Why, one might ask, should a complex and extremely expensive machine such as a computer, be used for a frivolous purpose? This question has often been asked of chess programmers, and for the first 25 years of computer chess the most popular answer was that if a program could be written to play good chess, then similar programming techniques could be employed to solve other complex problems in long-range planning that are usually tackled by intelligent human beings.

A meeting of eminent personalities in the field of artificial intelligence once drew up a list of 10 goals that they declared were the targets of their science. One of these goals was to produce a program that could play chess stronger than the human World Champion!

The first chess-playing programs were written for computers that were large enough to fill one or



Sensor Chess

Chess Traveler

more rooms. In June 1958, *Scientific American* published an article describing a program written for the IBM 704 computer. The program played according to a number of simple chess principles, and it was not able to look ahead further than two moves by each side. It took about eight minutes to make each move and played an amateur game of chess.

Over the next decade a small number of enthusiasts devoted themselves to the task, and by 1970 there were sufficient chess programs in the United States for a tournament to be held in which all of the competitors were computers. This was organized at the New York Hilton as part of the annual conference for the Association for Computing Machinery (ACM), and the event was so popular that it has been repeated every year since then, with the number of participants growing from six in 1970 to 16 in 1981.

Computer chess tournaments quickly became so popular that the number of events held each year began to proliferate. There have been European, North American and World Championships for programs running on big computers, and similar events during the past three years for microcomputer-based chess programs. In fact the availability of microcomputers has completely changed the computer chess scene. Whereas a few years ago one really needed to beg, borrow or steal free computer time on a machine worth anything up to several million dollars, now it is possible to buy a $200 microcomputer and write your own program at leisure.

Micro vs. mainframe

An obvious question arises when comparing the playing strength of a chess program running on a multimillion dollar mainframe computer, with that of a program running on a micro. The big computer is usually much faster, and it certainly has a far larger memory to call upon. Having a faster computer obviously enables a program to look at more possible chess variations and moves, while having a larger memory permits the computer to store an enormous amount of information about the chess openings and the endgame. So do the micros have any chance at all when they are put up against the big guys?

At first the answer to this question was definitely no. One eminent computer science professor, Tony Marsland of the University of Alberta at Edmonton, even went so far as to advocate that in computer vs. computer games there should be a handicapping system that would give the smaller computers a time advantage to make up for the extra speed of the bigger ones. But size and speed are not everything in computer chess. It is true that this hardware aspect of the contest is important – after all, if you run the same program on two different computers, the faster computer will usually win – but much more important is the software, the program itself. It is in the software that the amateur programmer, working at home with his $200 microcomputer, can find the magic formula which will enable him to write a program that can beat Bobby Fischer or Anatoly Karpov.

Just to give one example, Tony Marsland's program "AWIT" runs on an Amdahl computer costing more than $7 million. At the 1981 ACM tournament in Los Angeles, it was wiped out by the English program Philidor running on an Osborne 1 microcomputer (less than $2000). No one would doubt the superiority of the Amdahl over the Osborne, but in chess it is not so much a matter of how fast you can think as how well you understand what is going on. And that, above all else, is the key to a strong chess program.

Brute force

There are two distinct ways in which programmers try to create a strong chess program. The older and more popular approach is known as the "brute force" method, because the programs simply try to look ahead as far as possible, in the hope of being able to sort out the wood from the trees and come up with the right move. Having the use of a fast computer is particularly important for a brute force program, because the faster the computer is, the more deeply it will be able to search the billions and trillions of possibilities that exist on the chess board.

The current World Computer Champion is a program called BELLE, written by Ken Thompson at the Bell Telephone Labs in New Jersey. In order to enable his program to search as deeply as possible, Thompson has actually built his own chess computer – the hardware does nothing else but play chess, but does it very quickly. BELLE has defeated a number of strong human chess players, particularly at quick games in which it can mercilessly punish the type of mistake often made by the human experts. But despite the fact that Thompson's program is clearly stronger than any other mainframe program, it can not, in my opinion, be called intelligent. What it does is something rather primitive, so quickly and so often that the end result is a good move in a chess game. Thompson's machine may very well get faster as hardware techniques improve over the next few years, but I feel certain that the brute force approach will not lead to a program that can defeat the human World Champion.

Selective search

The alternative philosophy of chess programming is called "selective search." As one would expect, selective programs try to employ some chess intelligence in order to enable them to discard certain obviously bad moves. The advantage of this approach is not difficult to spot, because less than 10% of chess moves are good moves. A brute force program that examines every possibility to a depth of say, 10 half-moves (five by White and five by Black) will actually be spending almost all of its time on stupid variations. Of the 1,000,000,000,000,000 or so variations that go 10 half-moves deep,

Graduate Chess

Executive Chess

only about 100,000 are worth serious consideration by the computer, i.e. one thousand-millionth of the total. The aim of the selective program is to spend all of its thinking time on this one thousand-millionth, and to discard the garbage.

Most chess programmers follow the brute force path, largely because it requires less understanding of the game of chess. It is interesting that among the human selective-search fraternity, the proportion of strong chess players is considerably higher than among those who believe in brute force chess programming. This is not surprising, when one realizes that humans think about chess in a highly selective manner. A grandmaster will normally examine only 50-100 chess positions when thinking about his move.

Chess programmers have argued the relative merits of brute force and selective searching almost since chess programming was in its infancy. This argument has permeated to the field of microcomputer chess and extends into the commercial area of dedicated chess computer such as those that sell for anything from $50 up to more than $1000.

The leading protagonists in this struggle are currently Fidelity Electronics, manufacturer of the "Chess Challenger" range of computers, and SciSys Computer, whose strongest chess computers are the "Chess Champion" range, currently headed by the SciSys Chess Champion Mark V. Fidelity's programs all follow the brute force approach and for a while their products led the field. But in the summer of 1981 the Chess Champion Mark V appeared on the scene, containing the Philidor program, which is far more selective in its search.

At the 1981 world Microcomputer Championships in Travemünde, West Germany, the selective Chess Champion Mark V won the commercial section, two full points ahead of Fidelity's brute force program running in the Champion Sensory Challenger. This was the first showdown of these giants of the micro world, and it was a stunning success for SciSys' program and the selective search strategy. From this competition, in which the world's strongest commercially available chess computers took part, the Chess Champion Mark V was awarded the title of World Champion in the commercial section. It will hold this title until the next World Championship competition, when SciSys' latest selective search program will once again aim to show the brute force guys who is boss.

An indication of things to come was seen at the ACM tournament in Los Angeles, when the latest experimental version of the Chess Challenger program (which tied with My chess, another brute force program written for micros). The performance rating for Philidor was 1925 on the U.S. Chess Federation scale, and this is the highest rating ever achieved by a microcomputer.

Because chess is such an intricate game, it is hardly surprising that the strongest chess programs are quite large beasts. The latest version of Philidor, for example, requires some 28,000 computer "words" of program, and needs a further 16,000 words in which to perform its analysis of the game. As microcomputer programs get stronger and stronger, they will almost inevitably get larger and larger. This is not necessarily bad news for the consumer who wants a chess computer for his regular opponent because the prices of computer memory components tend to go down as time progresses. But even so, if you do want the very best and latest in computer chess, you will need to spend about $375.

Low-priced systems

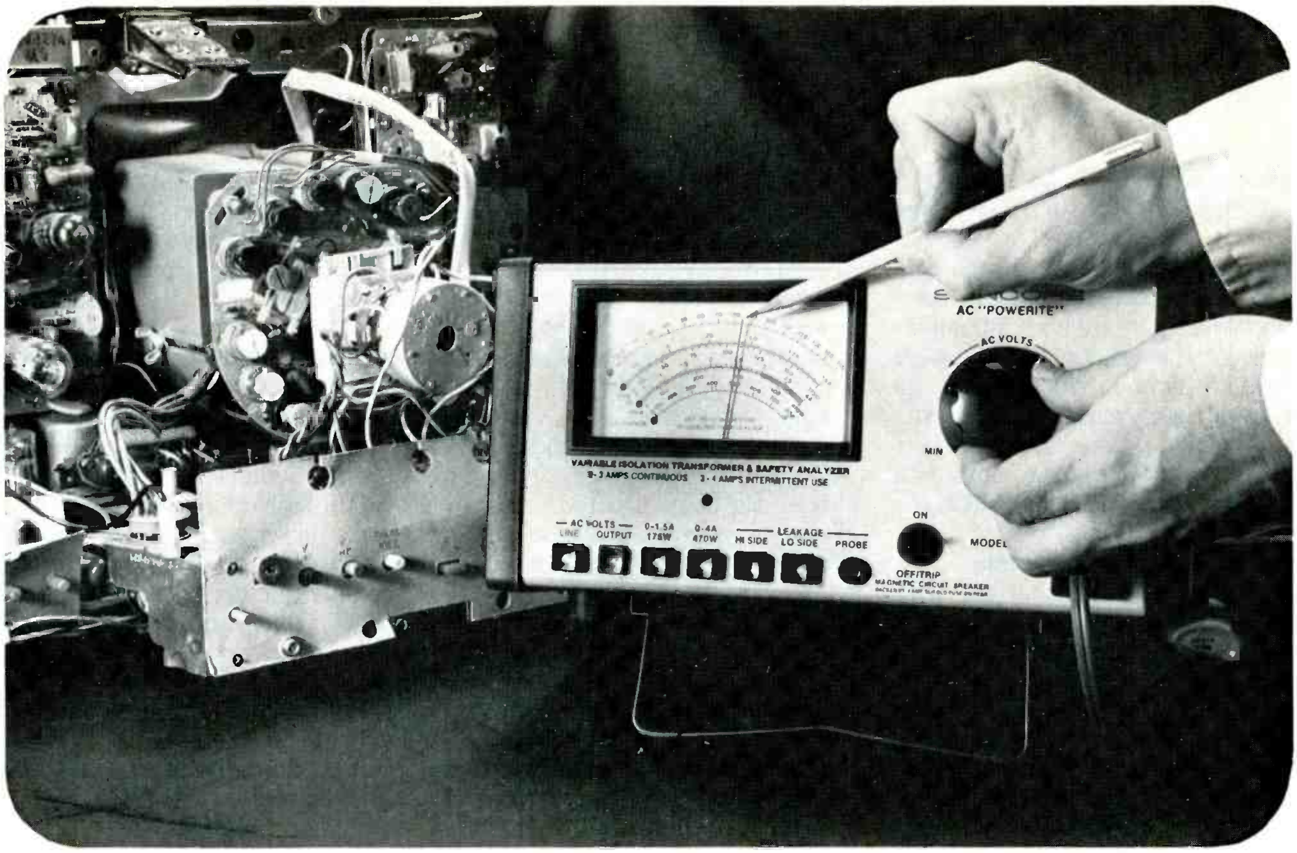
For the chess enthusiast with different tastes or a smaller wallet, there are computers at prices right down to $35 or thereabouts. In fact SciSys has a whole range (seven models), the World Champion SciSys Chess Champion Mark V down to SciSys Gradute Chess – the world's smallest chess computer program.

Instead of the 28,000 words of program in the Mark V, the Graduate requires only 2,000. Whereas the Mark V needs 16,000 words to grow and search the chess tree, the Graduate uses an incredible 160 words, which are only half the size (so the comparison is actually 16,000 to 80!). How is it possible to cram the program for such an intricate and complex game as chess into such a small space? The British software house Philidor Software, which wrote these programs for SciSys, has come up with a new program algorithm for playing chess by computer, and it turns out that this new method is much more compact than any existing technique.

The obvious advantage of producing the world's smallest chess computer is its price. Although the Graduate takes only about 10 seconds for each of its moves, it can match and defeat the fastest playing levels of most other chess computers, including those costing hundreds of dollars. It is not a machine designed for top class tournament chess, but for the younger members of the family and those learning chess or refreshing their memory of the game. Judging from the sales of the Graduate since it appeared on the market in June 1981 (just fewer than 200,000 worldwide), there are enormous numbers of people wanting to learn chess and improve their game to the stage when they will be ready for one of the stronger machines.

This widespread sale of chess computers is doing wonders for the game itself. Ever since the start of the boom created by Bobby Fischer's assault on the human World Championship in 1972, the number of chess players in the world has soared. The more people there are who play chess, the more there are who hear about the game and want to learn. Far easier and more fun than learning from a book is having a computer to teach you. The computer is patient and will never complain when you want to start another game. It will even help you learn the moves by telling you when you try to make an illegal or impossible move.

SciSys is currently a leader in the smaller and less expensive machines. Before the Graduate, SciSys launched the Chess Traveller – also 2000 words of program but 320 words of working memory – which to date has sold over 170,000 units worldwide. It is partly in recognition of SciSys' contribution to the growth and popularity of chess throughout the world, that the International Chess Federation (FIDE) has given its endorsement to the SciSys range of chess computers. Far from being a menace, the electronic computer has now become one of man's best friends!



Walking troubles out of a power supply

By Jim Smith, Sencore

The manager of a large service organization recently said, "Power supplies are so simple that they're complicated. Most technicians can explain how a power supply works and can draw a schematic of a basic supply if asked. But, most technicians waste a great deal of time when trying to find a power supply problem."

The manager then explained some of the problems his technicians encounter. First, he explained, it is tough to tell if there is really a problem, or whether the fuse or circuit breaker is simply opening too soon. Second, most problems cause the protective device to open as soon as the power is applied, which makes it tough to make any circuit measurements. You can't just jumper across the fuse or circuit breaker without risking extensive damage to other components and circuits that are drawing too much power. Third, it is often tough to tell whether the problem is in the power supply or the load connected to its output. A section of a supply with low voltage could be caused by either problem.

With the increasing use of "hot" chassis power supplies, SCR B+ regulators and high voltage shutdown circuits, the variable isolated ac power supply with current and voltage meters has become a necessity in the service shop. Without a variable isolated power supply, the technician is often left guessing as to the source of many problems. This leads to lost time substituting parts and modules with the shotgun technique.

This article covers the use of the Sencore PR57 to troubleshoot the five basic power supplies encountered in today's consumer products.

Conventional solid-state power supplies

Power supplies used in most solid-state equipment are simple, basic supplies consisting of a power transformer, rectifier circuit and a filter network. A resistive voltage divider is often used to supply the different voltage levels required by the internal circuits in the equipment. The power transformer generally reduces the ac line voltage to a lower value for proper circuit operation. The rectifier and filter network change the ac voltage to a smooth dc voltage.

Only two instruments are required to troubleshoot problems in the conventional solid-state power supply: the PR57 and a DVM. The PR57 will be used to vary the ac input voltage from 1 to 130V, while monitoring the ac current meter will quickly tell us if the supply is drawing too much current and if the problem is a short in the supply or excessive current drawn by a circuit connected to the supply. The DVM will be used to monitor the dc output voltage to see if it increases as we increase the ac voltage or if it is missing completely. Here is how the PR57 and DVM are used to isolate a problem.

1. Note the rating of the protective device used in the equipment that you are troubleshooting. This is the maximum ac current that you should allow on the PR57 meter during the following tests. (Note: Most manufacturers overrate the protective device by about one-third to prevent it from opening on turn-on current surges or small transient spikes that will not harm the equipment. The normal operating current level is about two-thirds the rating of the protective device.)

2. Place a jumper across the protective device in the set. The protective device is not required during the test as the PR57 variable output transformer and current meter will allow you to keep the ac current at a safe level as you raise the PR57 output voltage.

If the current rises slowly as the voltage is increased and stays within the rating of the protective device, continue to increase the ac voltage as described in Step 4.

If the current rise is rapid as you increase the voltage, continue to increase the voltage until you reach the maximum allowable current level. Check the ac voltage at the PR57 Isolated Output by pressing the "ac Volts Output" button and reading the PR57 meter. Proceed to Step 5 and use this value of voltage for the dc measurement level as described.

If the PR57 cannot be adjusted to at least 24Vac input before the ac current reaches the maximum level, there is a short in the power supply or circuits connected to its output. Check the power supply and circuit load points for shorts with an ohmmeter.

4. If possible, slowly increase the ac input voltage until the full 117 volts ac is applied to the equipment being tested.

If the ac current level is about two-thirds that of the maximum level established in Step 1, the power supply and connecting circuits are good.

If the ac current reaches a level of 90% or greater of the level of the protective device, proceed to Step 5.

5. If the ac current is too high, adjust the PR57 ac output to a lower voltage that will allow the equipment to operate below the maximum current level. Use the DVM to measure the dc voltages in the supply to see what voltage divider section is being loaded. Be careful of your voltage reading if you compare them to schematics as they will be lower. You will need to multiply your DVM reading as follows for correct comparisons.

60 volts ac, multiply dc by 2
40 volts ac, multiply dc by 3
30 volts ac, multiply dc by 4
24 volts ac, multiply dc by 5

For example, a 12V supply should measure about 6V with 60V ac applied, 4V with 40V ac, 3V with 30V ac, and 2.5V with only 24V of ac applied. If a voltage divider point measures less than the expected value, remove the load from that point to ground and remeasure the voltage. If the voltage increases to the expected level or higher, the load is defective. If the voltage remains low, the power supply is probably at fault. The first suspect would be the filter capacitor, which should then be checked for leakage with the "Z METER".

If you suspect an intermittent problem, you can sweat it out by increasing the applied ac voltage to 130 or 135V ac. The higher ac voltage will stress the parts in the power supply a little harder, which could cause the intermittent part to break down. This reduces the possibilities of a callback at a later date.

Only a continuously variable isolation transformer, such as the Sencore PR57, will allow you to troubleshoot a power supply when you have a problem where the input voltage must be lowered to allow you to make measurements in the circuit. No step-type isolation transformer has enough steps to troubleshoot all power supplies and does not allow you to reduce the ac input to the 60V or less as needed to locate defects.

Tube-operated equipment

Power supplies in tube-operated equipment are serviced in the same manner as in solid-state with one important exception. The applied ac voltage must not be set lower than 85V or damage to the tubes in the equipment may result. A lower applied ac voltage may reduce the bias on the tubes, causing them to conduct too hard and strip the cathode emitting material from their surfaces.

The ac current drain of the power supply, read on the PR57 ac current meter, is dependent upon the conduction of the vacuum tubes. The tubes will take about 12 to 15 seconds to warm up and come up to full conduction in a normally operating set. If the ac voltage is lowered, warm up may take an additional 2 to 3 seconds. If the supply uses a solid-state rectifier, the PR57 meter will "kick" upward, indicating that the filter capacitors are charging, and then drop back to a low level of current. If the supply uses a vacuum tube rectifier, the current will start from a low value and rise slowly to the operating level as the tubes begin to conduct.

If the PR57 ac current meter rises sharply when the unit is first turned on and does not drop back to zero, there is a problem in the power supply. If the meter drops back to zero, but rises to a value above the protection device in the equipment being tested, after the tubes have warmed up, there is a problem in a tube or its circuit.

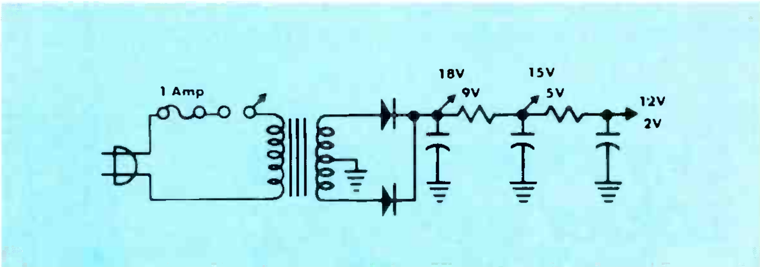


Figure 1. Typical power supply used in solid-state equipment. The voltages shown in red indicate excessive loading on the 12V line with input from the PR57 set to 60Vac.

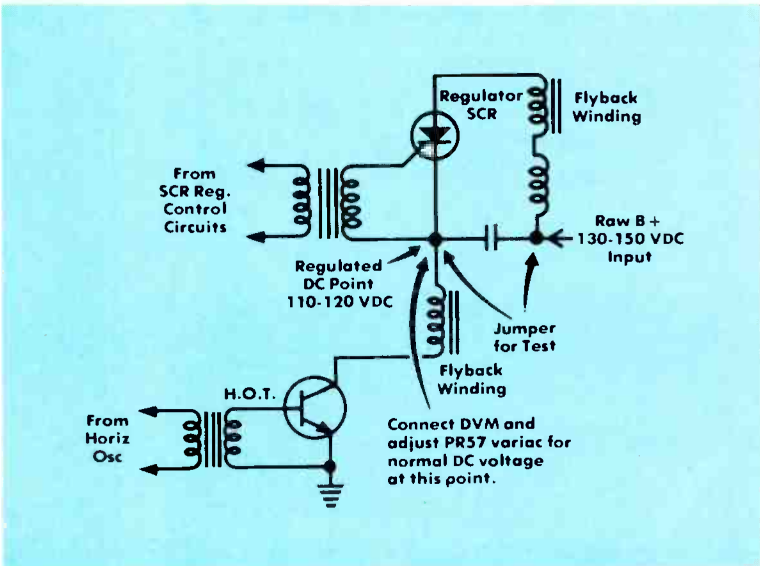


Figure 2. The output meter on the PR57 allows you to reduce the operating voltage to the tube set being tested so that you do not go below the critical 85V level and damage the tubes in the set.

Constant-voltage transformer

The constant-voltage transformer looks like a conventional power transformer, but is electrically different. The constant-voltage transformer saturates the core with very little applied ac voltage so that the secondary output voltage is almost a square wave. A special oil-filled tuning capacitor of 2 to 5μF is placed across a secondary winding on the transformer to hold the output voltage from the secondary nearly constant with varying ac input voltage. The output of the secondary will vary just like a conventional transformer and will not be regulated if the tuning capacitor is removed.

If the ac input voltage from the PR57 is varied from 0 to 130V, the constant-voltage transformer primary current will rise to a peak at about 80V, dip as the voltage is increased to 117V, and then rise sharply as the voltage is increased to 130V. The normal primary current curve is shown in Figure 3. The straight line on the same graph is from the same transformer without the tuning capacitor connected.

The ac current action is very helpful when troubleshooting a power supply that uses the constant voltage transformer. By observing the ac current meter and varying the ac input voltage, you can quickly tell if the transformer is operating properly or if the tuning capacitor or its transformer winding is open.

You may use the same basic procedures as with the conventional solid-state power supply to troubleshoot a power supply using a constant-voltage transformer. The PR57 should be set to monitor the ac current while varying the input ac voltage. A DVM is connected to the power supply output to monitor the dc voltage as the ac voltage is increased. A normally operating power supply will show the ac current of Figure 3. The dc voltage will rise rapidly to within 5% of the normal output value at about 80V ac input. If the input current goes higher than the 120 to 125% at the 80V point (or sooner), a problem is indicated.

A short in the power supply or a shorted tuning capacitor, for example, will cause a rapid rise of current as soon as the voltage begins to increase. An excessive current drain caused by the load circuits will show a higher current level at both the 80V peak and 117V dip points.

If the ac current does not rise rapidly and peak at the 80V point, but follows the straight line of Figure 3, the tuning capacitor or transformer winding is open. An open tuning capacitor or transformer winding may go unnoticed at the normal 117V line as the transformer will deliver enough voltage for apparently normal operation. If the ac input voltage is reduced, however, the operation will change drastically. In a TV set, for example, the sides of the raster will pull in, generally before the ac voltage is reduced to 110V. In any power supply, the dc output voltage will not be regulated and change with a change in ac input voltage.

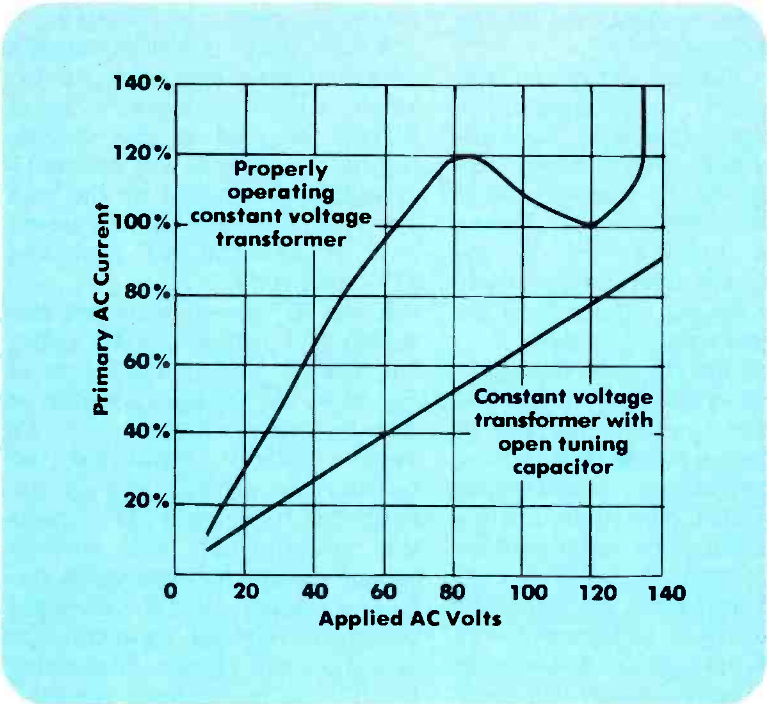


Figure 3. Typical current drawn vs. applied ac voltage of a properly operating constant voltage transformer and one with open tuning capacitor.

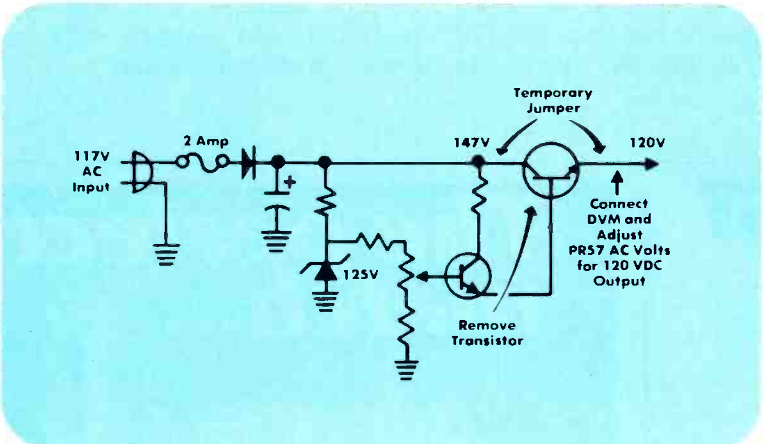


Figure 4. Typical regulated supply. Note an isolation transformer should be used to prevent damage to test equipment and shock to the technician troubleshooting the supply.

Transistor-regulated power supplies

A regulated power supply provides a constant dc output voltage over a wide range of ac input voltages. The regulated power supply is used where a varying dc voltage, such as that from the conventional solid-state supply, would affect circuit operation. The regulated power supply may have the same basic problems as the conventional supply with additional problems associated with the regulator circuit. A defect in the regulator may cause excessive output voltage, or no voltage at all, depending upon the defect and type of regulator used.

The PR57 variable ac output and ac current meter speeds up and simplifies regulated power supply troubleshooting. The PR57 and the DVM are used in the same manner as in the conventional solid-state power supply. The PR57 is used to vary the ac voltage input while monitoring the ac current and the DVM will monitor the dc output of the supply.

To use the PR57 to troubleshoot a regulated power supply:

1. Plug the power supply into the PR57 and connect a DVM to the supply output. Slowly turn the ac volts control to increase the ac voltage while monitoring the ac current and the PR57 meter. Also monitor the dc voltage on the DVM.

If the ac current rises sharply to or above the level of the power supply's protective device, there is a short in the power supply. Proceed to Step 3 to isolate the defect.

If there is no dc output as the ac voltage is increased, the regulator or rectifier diodes are defective. Move the DVM to the output of the rectifiers. If there is voltage at this point, the regulator transistor is bad. If there is no dc voltage, the rectifiers should be checked.

2. If the ac current appears to rise normally, and the dc output voltage is also increasing, continue to increase the ac input voltage.

If the dc voltage rises above the normal regulated voltage level, the regulator or regulator circuit is defective.

If the ac current rises above the protective device rating, proceed to Step 3 to isolate the defect.

3. Turn the PR57 OFF and set the AC VOLTS control back to zero output. Remove the regulator transistor and place a jumper between the emitter and collector points in the circuit. Keep the DVM connected to the output of the supply. (Note: If the transistor is not removed and the jumper is connected between the emitter and collector, possible damage to the regulator transistor may result during the following tests. This is due to the voltage difference that will occur between the base and emitter of the transistor.)

4. Slowly increase the ac voltage to the supply until the DVM reads the normal dc operating voltage. Observe the ac current on the PR57 meter as you increase the voltage to be sure you do not go above the limit of the protective device.

If normal operation is restored, the regulator transistor or control circuit is at fault. Check the dc voltages in the regulator circuit to locate the defect.

If the ac current rises above the limit of the protective device, the circuit or circuits connected to the supply are drawing too much current or the filter capacitors may be leaky. Disconnect the loads one at a time to locate the excessive current drain and check the filter capacitors with the "Z METER" for leakage. ES&T

PHOTOFACTS

These Photofacts for TV receivers have been released by Howard W. Sams & Co. since the last report in ES&T.

MGA
CS-1303 2048-1
CS-1902U/933U 2050-1

JCPenney
685-2042F,-00,
685-2044F,-00 2047-1
685-1028F, -10/29F, -10 2055-1
685-1033, -00 (855-2037) 2060-1

PORTLAND
TC-401P/03P 2051-1
TC-2003P 2053-1

RCA
Chassis KCS206A,C 2048-2
Chassis, KCS204A,N 2049-1

SAMSUNG
CT-501AL 2055-2
CT-332TM 2060-2

SANYO
Chassis A4W-45N00/46N00 2049-2
Chassis A2M-51-20/2N0 2053-2
Chassis A2C-91000 2056-1

SEARS
564.44051150 2056-2
564.48261150 2058-1

SHARP
13F38 2048-3
19F76 2049-3
19F88 2052-1

SONY
FX-414 2047-2
Chassis SCC-340A-A 2050-2
Chassis SCC-265L-A 2052-2
Chassis SCC-342A-A 2055-3
Chassis SCC-265N-A,P-A 2057-1
Chassis SCC-355A-A 2060-3

SYLVANIA
MW0130WH/38W 2051-2

ES&T

READERS' EXCHANGE

Needed: Operation manual and schematic for Jackson Dynamic tube tester 648-TT. *Boyd's TV, 1351 Sigur Ave., Metairie, LA 70005.*

Needed: 9V drive motor for Audio Sonic FM stereo cassette recorder (also has SW1, SW2, MW bands). No model number available. Suggested source of supply would help, also. *Mike's Repair Service, P.O. Box 217, Aberdeen Proving Ground, MD 21005.*

Needed: Schematic and operating manual for National Radio Institute RC tester, model 112. Will buy or copy and return. *Joseph Ososky, 722 Kimball Ave., New Kensington, PA 15068.*

Needed: Yoke for Philco color television, model #21KT40, part #76-14302-1, Thordarson equivalent Y164. *Clifford Hayes, P.O. Box 104, Alplaus, NY 12008.*

Needed: Schematic for Admiral television, model 17T1. Will buy or copy. *Sherman Austin, 2845 Monogram Ave., Long Beach, CA 90815.*

Needed: Service data for Jin Yung model JCS-506 auto AM/FM MPX radio/cassette player. Will buy or copy and return. *W. C. Walker & Sons, 725 Coral Drive, Melbourne, FL 32935.*

Needed: Sencore PR57 Powerite variable output isolation transformer and RCA stock #157 and 9572 crystal calibrators. *Paul Capito, 637 W. 21 St., Erie, PA 16502.*

Needed: Manual for Wayne model WT2A transistor checker. Will buy or copy and return. *Paul Bachman, 605 Cynthia Drive, Fayette, OH 43521.*

Needed: All back issues of **Electronic Servicing** from January 1972 through February 1981. *Jim Stefka, 6714 Forman Ave., Cleveland, OH 44105, 1-216-441-2938.*

Needed: Vertical output transformer (part #TLV5204-2) for a Panasonic television, model #CT 66N. *K. J. Aagard, Martha Lake Electronics, 16521 13th Ave. West, Lynnwood, WA 98036.*

Needed: Service schematic for stereo system manufactured by Dynaco. (Dynaco stereo 120 amplifier, Dyna stereo preamp model PAS, Dyna FM tuner model FM-3.) *Edward Juzumas, 3908 Jerusalem Ave., Seaford, NY 11783.*

Needed: Schematic for Philco radio, model 42-1012, code 121. *Johnson Electronics, 510 4th St., Kenyon, MN 55946.*

For sale: Meissner radio analyst with manual, looks like new, $50. Wilcox-Gay recordio recording discs, 4-10 inch and 2-8 inch in original albums, $10. RCA triac tester, $15 plus postage. *Kenneth Miller, 10027 Calvin St., Pittsburgh, PA 15235.*

For sale: Johnson Viking II with VFO. Gonset Communicator IV for two meters. Both in good condition and with manuals. *George Robinson, 7155 Walden Rd., Newburgh, IN 47630.*

For sale: RCA Super Chro-Bar color generator, model #WR538A, never used (still in original carton with warranty and instruction book). Book: A Programmed Text – Use of the Oscilloscope, by Charles H. Roth. Best offer. *Raynham TV, 803 Orchard St., Raynham, MA 02767.*

For sale: RCA video multimarker, type WG-295C, $10; Simpson model 311 VTVM, $90; Heathkit model BE156 dc bias supply, $35. *William D. Shevtchuk, 1 Lois Ave., Clifton, NJ 07014.*

For sale: B&K Precision 3020 sweep/function generator, new, $275. *Al Rose, 650 Daphne St., Broomfield, CO 80020.*

For sale: B&K 667 tube tester, $60; B&K 466 CRT tester/rejuvenator, $60; B&K 2910 R/C sub. box, $20. *Mike Shepherd, General Delivery, Onyx, CA 93255.*

For sale: B&K receiving tube tester, model 707, and two tube adapters, $75. Call 1-512-968-3913 or write *Max Emerson, Rt. 2, Box 345, Weslaco, TX 78596.*

For sale: B&K 1471B dual-trace oscilloscope, used two years, $300. Sencore PR57 Powerite, $200; and DVM 56 Microranger, $400, both used six months. All include manuals. *Frank Knight, 1-207-926-3323.*

For sale: Sams Photofacts 100-716. Make offer. *Johnson Electronics, 510 4th St., Kenyon, MN 55947, 1-507-789-6845.*

ES&T

Coming in

ELECTRONIC
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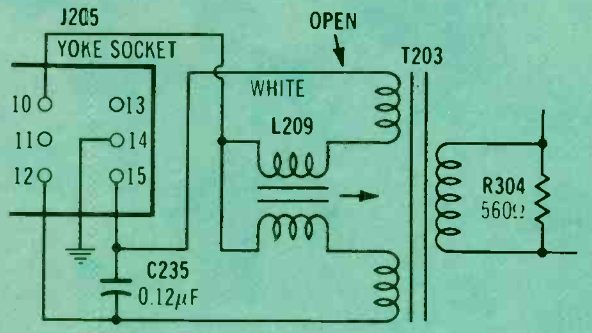
The widespread use of AM stereo is in sight. As soon as the legal battles and technological details are ironed out, the system will be here, bringing a new challenge to electronic servicing.

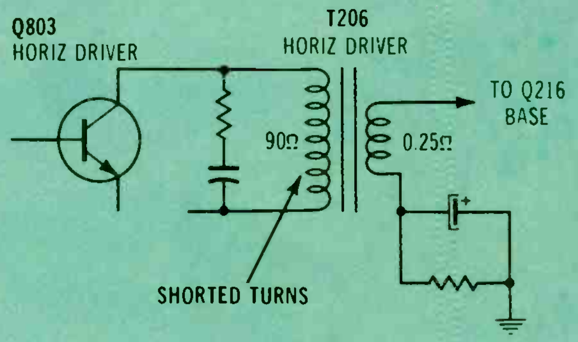
SYMCURE

Chassis—Zenith 25DC56 1
PHOTOFACT—1312-3



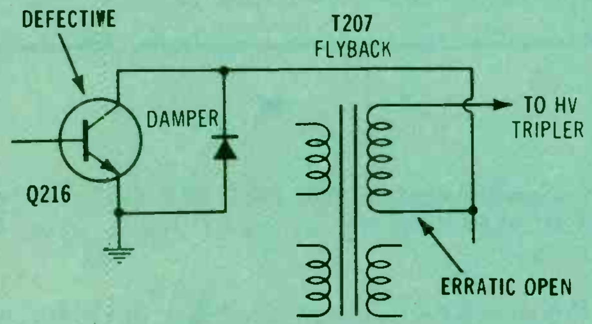
Symptom—Trapezoidal raster about 3 inches high
Cure—Check continuity of T203 for an open winding; replace T203 if defective

Chassis—Zenith 25DC56 2
PHOTOFACT—1312-3



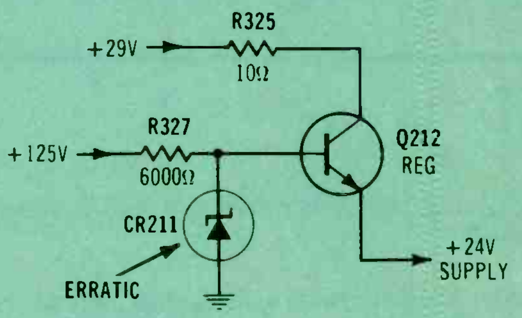
Symptom—Narrow picture, foldover and reduced HV
Cure—Check winding resistance of T206, and replace it if primary has low resistance

Chassis—Zenith 25DC56 3
PHOTOFACT—1312-3



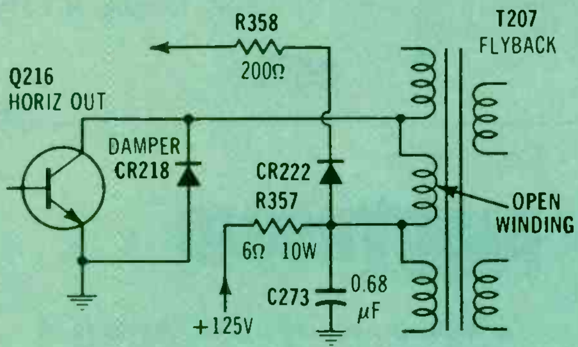
Symptom—Excessive failure of Q216 horizontal-output transistor
Cure—Check for erratic continuity in T207 flyback; replace if defective

Chassis—Zenith 25DC56 4
PHOTOFACT—1312-3



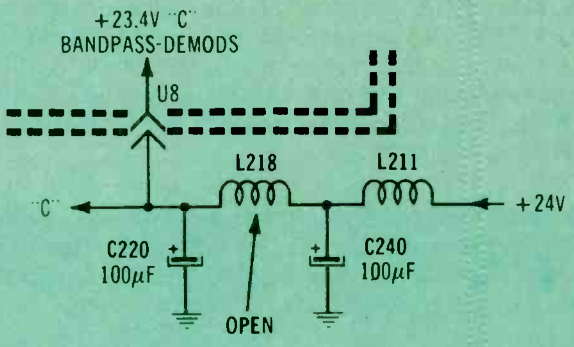
Symptom—Picture overload with hum bars and weak locking
Cure—Replace zener CR211 as test of intermittent operation

Chassis—Zenith 25DC56 5
PHOTOFACT—1312-3



Symptom—No or low HV, and R358 overheats
Cure—Check flyback between blue and orange wires for continuity; replace T207 if a winding is open

Chassis—Zenith 25DC56 6
PHOTOFACT—1312-3



Symptom—Black raster, but sound and HV are normal
Cure—Check coil L218, and replace it if open

CALENDAR OF EVENTS

May

10-12
The 32nd Electronic Components Conference, Sheraton Harbor Island Hotel, San Diego, CA. Contact program chairperson D. J. Bendz, IBM Corp., Dept. 649/014-4, 1701 North St., Endicott, NY 13760.

18-20
Northcon/82 Show and Convention, Seattle Center Coliseum, Seattle, WA. Call 1-800-421-6816 for more information.

25-27
Electro '82, Hynes Auditorium, Boston, MA. For more information, call 1-800-421-6816.

June

6-9
Summer CES '82, McCormick Place, Chicago, IL. Contact Consumer Electronics Shows, Two Illinois Center, Suite 1607, 233 North Michigan Ave., Chicago, IL 60601, 1-312-861-1040.

7-10
National Computer Conference '82, Astro Arena, Houston, TX. For more information call 1-703-558-3600.

August

2-7
Joint convention of National Electronic Service Dealers Association, International Society of Certified Electronic Technicians, The Texas Electronics Association, the Louisiana Electronic Service Dealers Association and Television Service Association of Arkansas at the Hilton in New Orleans, LA. Contact The National Electronic Service Dealers Association, 2708 W. Berry St., Ft. Worth, TX 76109, 1-817-921-9061.

26-29
National Association of Television & Electronic Servicers of America (NATESA) Annual Convention, Indian Lakes Resort, Bloomingdale, IL. Contact Frank J. Moch, 5930 S. Pulaski Road, Chicago, IL 60629, 1-312-582-6350.

September

14-16
Wescon '82, Anaheim Convention Center, Anaheim, CA. For more information call 1-800-421-6816.

October

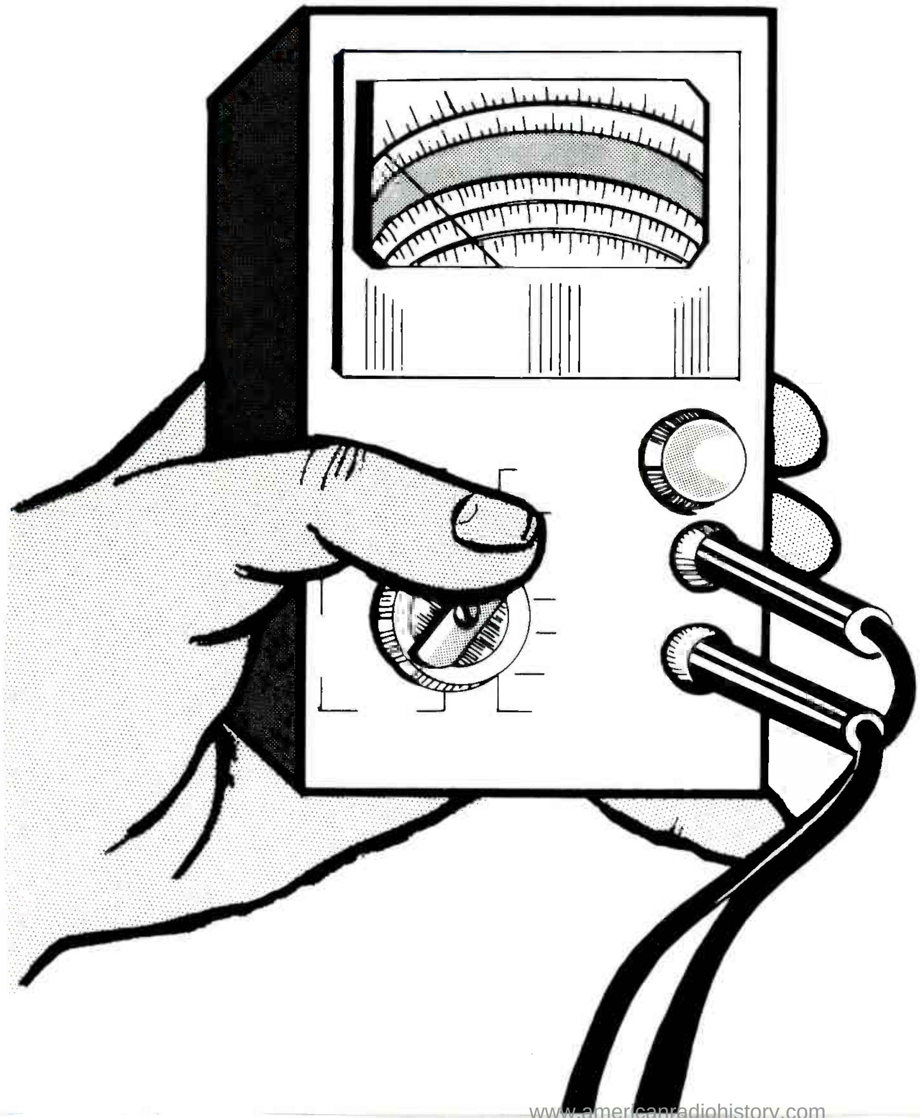
11-13
EIA Fall Conference, Century Plaza Hotel, Los Angeles, CA. For more information, contact the Electronic Industries Association, 2001 Eye Street N.E., Washington, D.C. 20006.

November

1-2
15th Annual Connector Symposium, sponsored by the Electronic Connector Study Group with cooperation of more than 50 connector manufacturers, Franklin Plaza Hotel, Philadelphia, PA. Contact Electronic Connector Study Group, P.O. Box No. 167, Fort Washington, PA 19034.

Using a VOM for diagnosis

By Ron C. Meyer, CET



Early in the troubleshooting of each TV problem, a technician is faced with the important decision, "Which test instrument will help me complete this diagnosis in the shortest period of time?"

To answer his own question, the technician observes all preliminary symptoms and compares them to those observed previously in other cases. From this information and his knowledge of circuit operation, he makes a preliminary guess about the possible defect, then chooses the most logical piece of test equipment for making the initial measurements.

After the testing has proceeded for a short time, an experienced and competent technician usually will know whether the test instrument is appropriate for the specific situation.

Most troubleshooting articles are concerned with analysis by oscilloscope, because waveform evaluations and scope manipulations usually require technicians to use higher skills. Nevertheless, the best test instrument for a specific analysis is the one that identifies the defective stage or component in the shortest time, consistent with highest accuracy. Often, depending on the situation, uncomplicated troubleshooting techniques and simple test instruments provide the most efficient analysis.

The following five case histories illustrate the advantages of unsophisticated multimeters, such as volt-ohm-meters (VOMs), for *certain* TV repairs.

Sharp TV with erratic blank raster

At unpredictable times, the Sharp model C2010 color receiver (Photofact 1191-2) showed symptoms of AGC overload. Picture pulling occurred often, and occasionally the picture and raster would disappear.

Video problems should be tested by a scope, but most AGC problems can be identified easily by VOM voltage and resistance tests. Therefore, a VOM was used.

During one period when the raster blacked out, I measured the high voltage, but it was normal. Of course, no raster or picture is possible without high voltage. But the reverse is not always true;

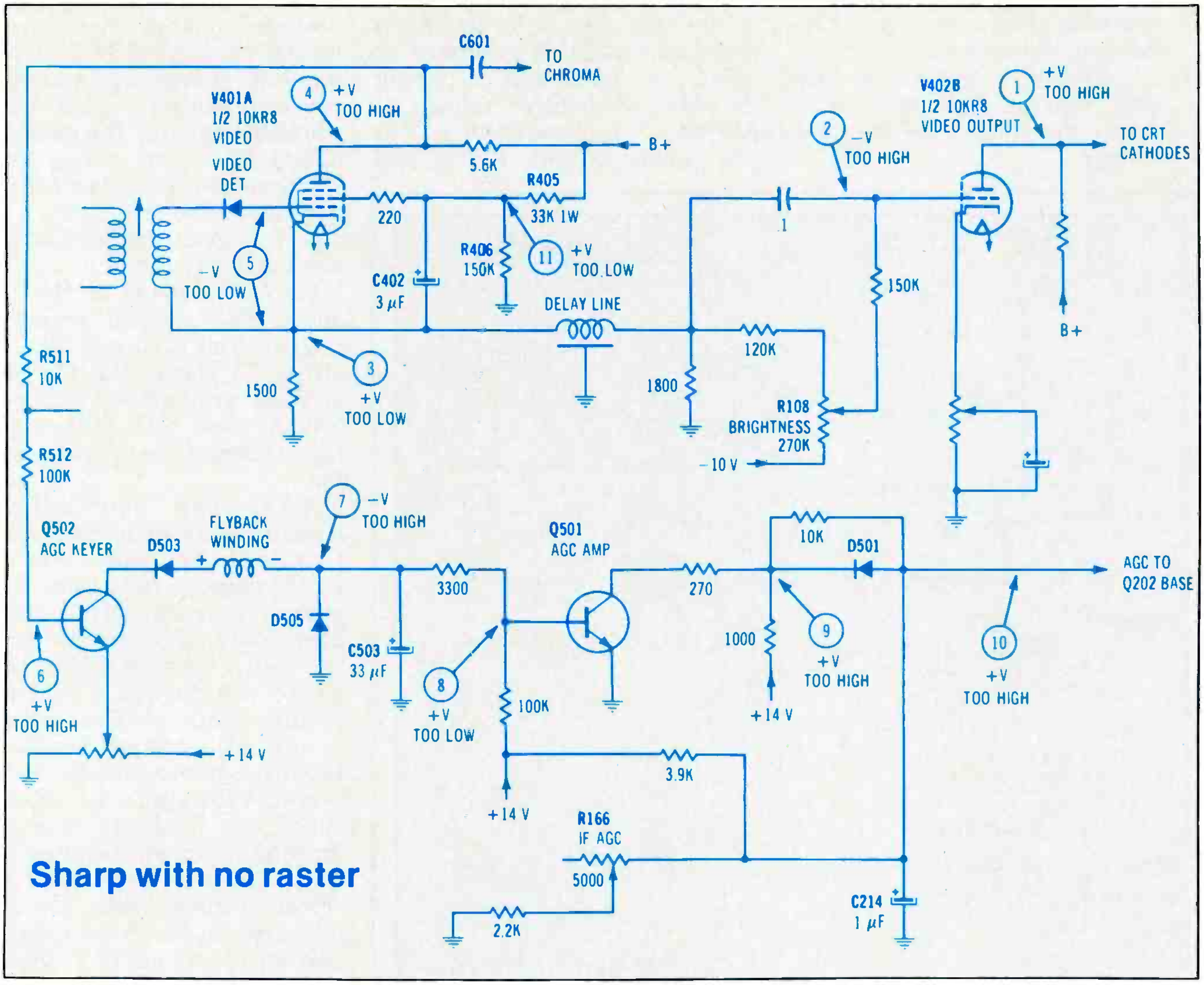


Figure 1 Erratic AGC and intermittent loss of raster required measuring dc voltages in a long sequence that covered about half the receiver. The numbers in circles show the order of tests.

many other defects can eliminate the raster, although the high voltage is present. A picture tube fault, a loss of heater voltage to the CRT, a loss of focus voltage (with some types of CRT) and incorrect dc voltages at other CRT-socket pins also can remove the raster. For example, control-grid dc voltages that are negative or insufficiently positive, screen-grid positive dc voltages that are too low, or cathode positive dc voltages that are too high can cut off all picture tube current and black-out the raster.

Voltages at the CRT socket measured in tolerance, except for the cathodes that had excessively high positive voltages. This explained why the raster was missing, but it did not pinpoint the guilty stage or component.

Analysis by dc voltages usually requires following a trail until an incorrect voltage is found. The following list shows the various logical steps, working backward from the picture-tube cathodes.

1. In Figure 1, excessive positive voltage was measured at the 10KR8 V402A video-output tube's plate (which drives the three CRT cathodes through the video-drive controls). In stages with large plate resistances, excessive plate voltage can be caused by too much negative grid bias.

2. The dc voltage at the V402A control grid measured excessively negative; therefore, V402A was biased to cut-off, producing a high plate dc voltage. The grid dc voltage is a mixture of a low negative voltage (obtained from the -120V supply) and a higher positive voltage through the delay line from the V401A cathode. Either the cathode voltage is low, or the -V sample is high.

3. Voltage at the V401A cathode was about +11V; about half the normal reading. Such a low reading could be caused by a decreased resistance between cathode and ground (which would reduce the plate voltage). Or, it might result from insufficient plate current (bringing higher plate voltage).

4. The V401A plate voltage measured too high, indicating something was dropping the plate current (perhaps excessive negative dc and video from the video-detector diode).

5. Grid-to-cathode dc voltage of V401A checked slightly below the -0.8V obtained by subtracting the

schematic cathode voltage from the grid voltage. This was dismissed as being a side effect of the defect (a serious mistake).

6. Positive voltage at the Q502 base was too high, as expected from the high V401A plate voltage.

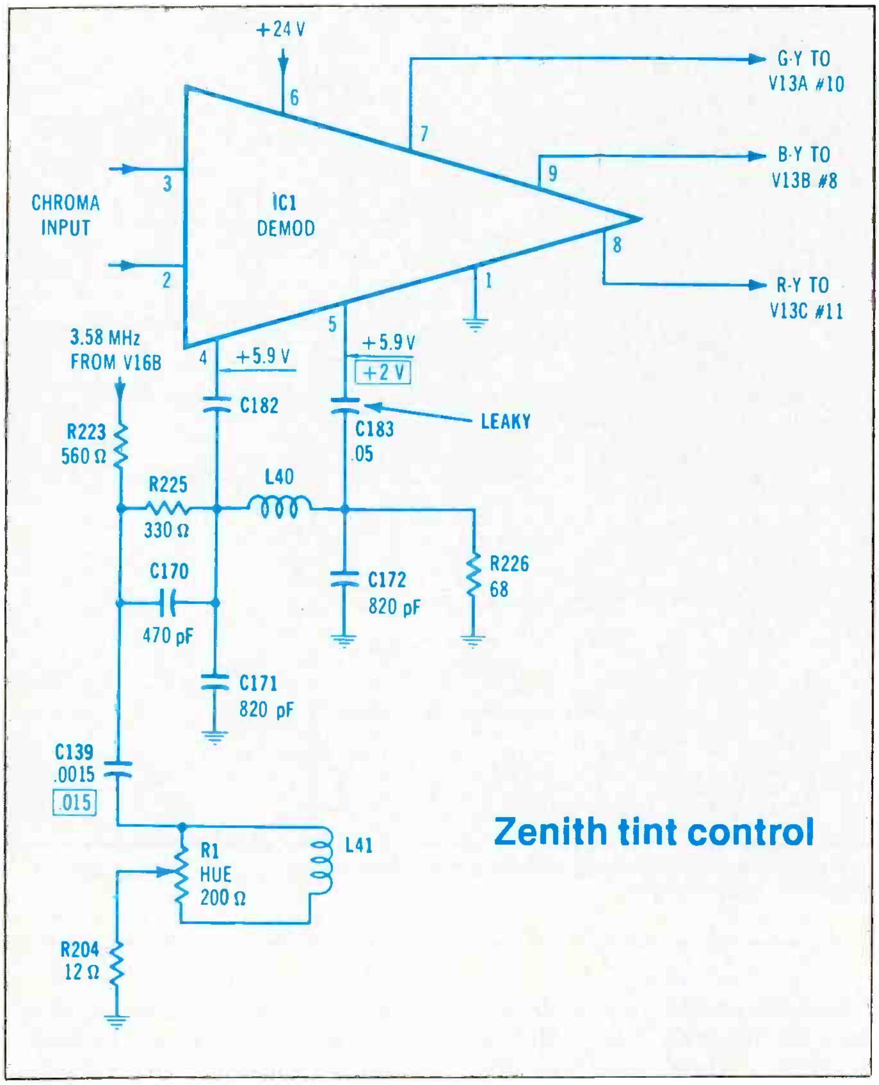


Figure 2 An old defect and a previous technician's mistake produced a Zenith with proper tint in the color but without any adjustment of hues.

7. Rectified AGC-control voltage at C503 was negative (normal for strong signals) but much too high. This decreased the Q501 base voltage.

8. As expected, the Q501 base voltage was insufficiently positive. Therefore, Q501 was cut off, without C/E current. This should raise the collector's positive voltage.

Note: At this point, an explanation is needed about how the IF AGC operates. When the TV-channel signal is weak, Q502 is biased to cut-off, thus preventing diode D503 from rectifying the horizontal pulses at its anode. No negative voltage is generated at C503, so Q501 has a strong forward-bias positive voltage at the base. This places about +3V at the D501 cathode (270Ω and 1000Ω voltage divider action from +14V supply). The D501 cathode voltage is negative relative to the higher positive voltage at its anode, so D501 conducts, reducing the positive-voltage AGC supply at the Q202 base to the value that gives maximum IF gain (needed for weak signals). At the other extreme, a strong TV signal forces Q502/D503 to increased rectification of the horizontal pulses, producing a negative voltage that cancels most of the Q501 positive-voltage base bias and thus supplying cut-off bias to Q501. When Q501 is cut-off, its collector positive voltage rises, which reverse-biases diode D501, forcing the AGC voltage at its anode to rise sufficiently to reduce the IF transistor gain (by the saturation effect). Therefore, *a very strong TV signal should produce a higher-positive AGC voltage.*

9. Voltage at the D501 cathode measured too positive.

10. AGC voltage at the D501 anode also checked excessively positive. This is normal for a very strong TV signal. But the raster and the grid/cathode voltage of V401A tube both indicated *no* signal output from the video detector.

Note: The contradictory measurements brought a suspicion that one or more previous measurements had been interpreted incorrectly. After a short study of the schematic, I noticed the V401A readings pointed to opposite conclusions. The high positive plate voltage indicated reduced plate current, but the low negative grid-to-cathode voltage proved V401A was not biased to cut-off, so it should have been drawing maximum plate current. Then I noticed that the V401A screen voltage had not been measured (in the rush to examine only input and output voltages of each stage).

11. Positive voltage at the V401A pin-8 screen was far below the rated +109V. There were three possibilities: R405 might have increased resistance, R406 might have partially shorted or C402 could have excessive leakage. A quick resistance check with the VOM revealed *R405 varied between about 500K and open.*

Installation of a new 33K 2W resistor for R405 produced normal performance after the AGC was readjusted.

Several important suggestions about TV troubleshooting can be given from this case history. Several erratic symptoms were observed before the receiver developed a missing raster. The first of these symptoms indicated AGC problems, which could have originated in the IF stages, the noise inverter stage, the AGC stages, the video detector or the first-video stage. At that time, a proper choice of a test instrument would have been difficult; perhaps a scope, signal injection or a digital multimeter.

Before the primary test instrument was selected, the symptoms changed to a complete loss of raster. A simple VOM often is sufficient for this because a dc voltage usually is the cause. Therefore, when several symptoms are evident, concentrate of the one that is the least puzzling.

Also, rapid tests of a tube or transistor stage can be done easily by checking the input bias and the output dc voltage. Input bias with tubes always is between grid and cathode, while with transistors the input bias is between base and emitter. Tube output usually is from the plate, but transistor output dc voltage usually is taken from the collector.

By following a trail of measurements (as was done in this case) the defective stage often can be located rapidly, using only a DMM or VOM.

Incidentally, don't be intimidated by the long list of measurements made on the Sharp (or the long explanations for circuit operation). An experienced technician (who thoroughly understands how the stages operate) can make these tests rapidly. Less than 30 minutes were required for me to perform all 11 voltage tests plus several resistance tests to find the one defective component.

No tint adjustment

The Zenith 14A9C50 (Photofact 1097-3) had fair skin hues, but rotation of the tint control did not change the color hues.

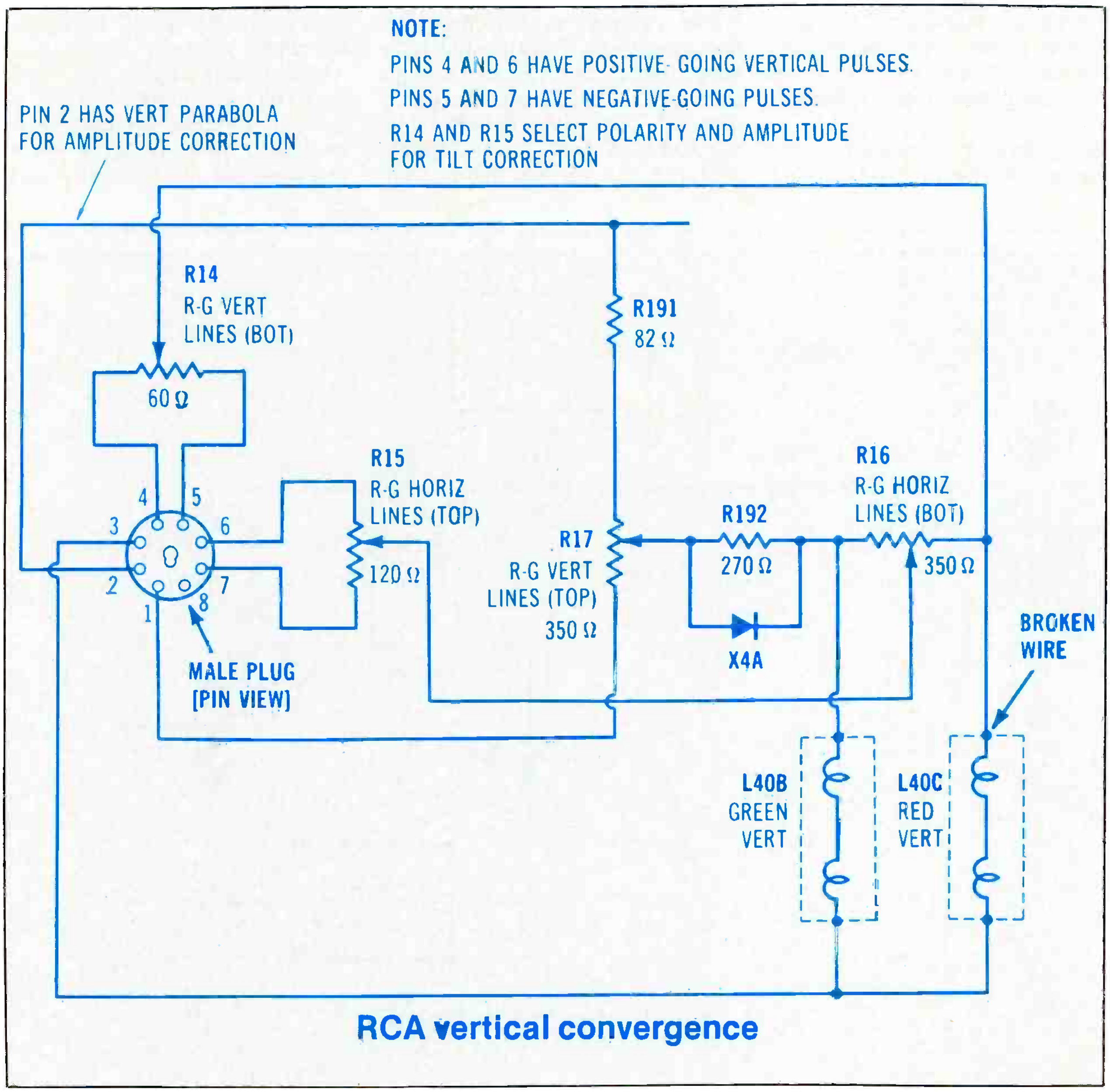


Figure 3 Observations of changes to the crosshatch pattern plus logic enabled the technician to locate the defect more quickly than if a scope or other complex instrument had been used.

According to Figure 2, hue is adjusted by phase variations of the 3.58MHz continuous carrier applied to IC1 pin 4. Specifically, the carrier passes through R223 to R225/C170 and on to pin 4. However, a phase-sensitive voltage divider is formed by R223 vs. the series connection of C139 and L41. Adjustments of the phase are produced by hue control R1, which has the effect of varying the L41 inductance.

A second phase-shifted carrier for the color-demodulator input at pin 5 is obtained from the carrier at pin 4 (actually the junction of R225, L40 and C182). There is a phase difference of about 105° *between* the pin-4 and pin-5 carriers, and this phase does not change when the R1 hue control is adjusted (the phase of each varies in step).

These circuit actions are true for a normally operating receiver, and thus form a background for troubleshooting a defective circuit.

Dual-trace scopes can show relative phase differences between two continuous 3.58MHz carriers. A scope would seem to be the logical instrument to choose for *all* hue problems, however phase measurements by scope can require considerable time. Also, the waveforms are not likely to locate the one defective component, but rather only prove or disprove an incorrect phase condition, so it is wise to perform a careful visual inspection of the suspected area. If the visual search locates nothing wrong, then the scope should be used.

One component obviously had been replaced. C139 should have been 0.0015µF, but a previous technician had substituted a 0.015µF. With the 0.015µF value, the tint had been approximately centered, but without any tint adjustment. With the correct 0.0015µF value, the tint was wrong by about the equivalent of two or three color bars. Also, the tint still could not be changed by the hue control. In other words, the previous technician did not locate the defect, but merely substituted values until the tint was *almost* right.

Now that a mistake had been identified, it was time to locate the original defect that prevented hue-control operation. The integrated circuit was a plug-in type, so it was replaced as a test and hue operation remained the same.

Next, the VOM was used to measure voltages and resistances around the IC. All IC pins had in-tolerance voltages except pin 5, which tested about +2V rather than the normal +5.9V. C183 was the only external component connected to pin 5. When C183 was disconnected and tested, it had a

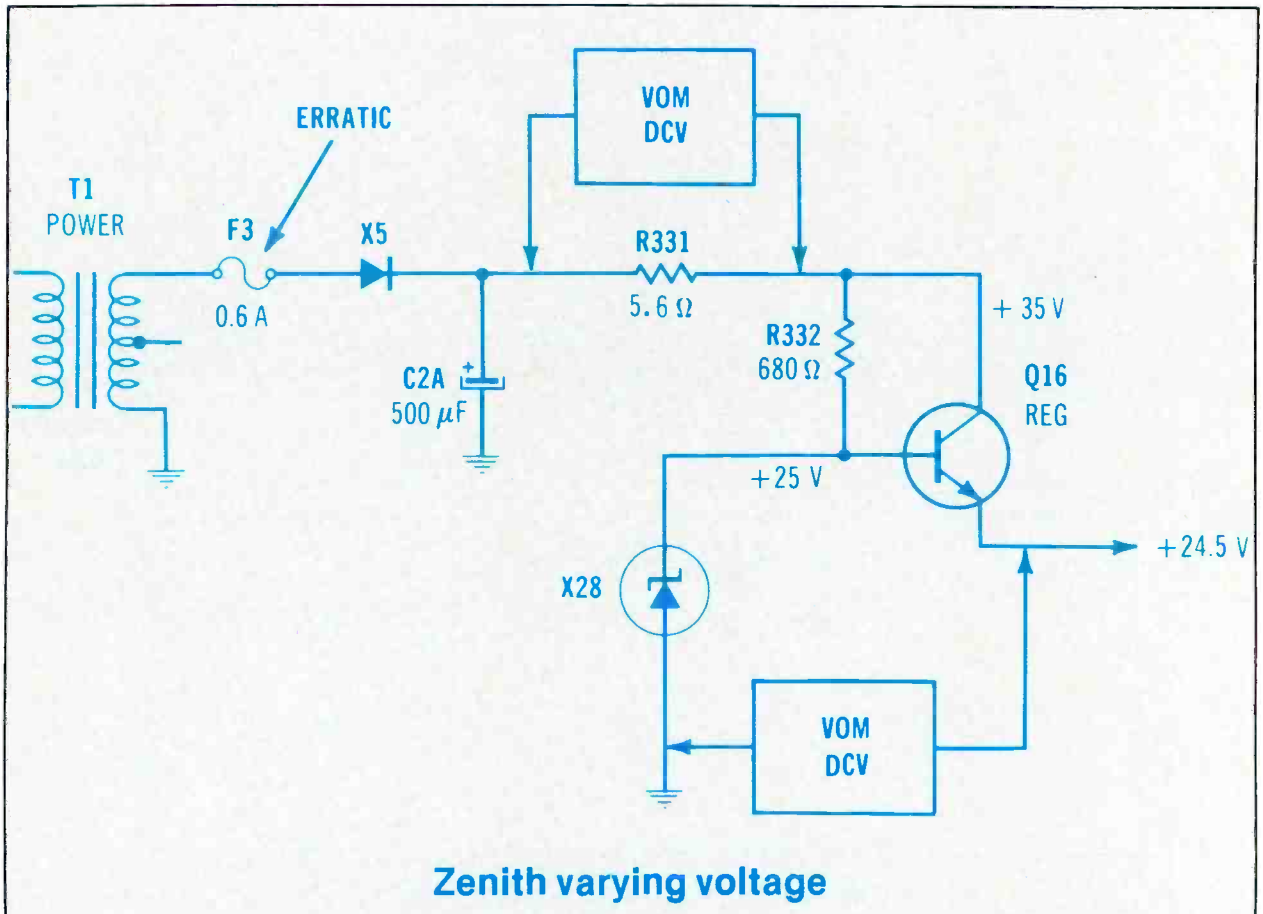


Figure 4 A reduction of supply voltage when the symptom occurred led the technician to this method of monitoring the current and voltage of the +24V supply.

leakage of several thousand ohms. Replacement of C183 restored normal hue variation in the Zenith 14A9C50.

Some troubleshooting procedures *demand* the use of sophisticated test equipment (such as scopes and generators). However, simple visual and VOM tests can find many defective parts and shorten the time needed for operation of the more complex equipment. They should be done first.

Perform these simple tests rapidly, collect whatever data is possible, and then quickly go on to sophisticated methods and test equipment.

RCA with misconvergence

A 14-inch RCA of the CTC22-chassis series (Photofact 917-1) exhibited misconvergence of the vertical crosshatch lines at both top and bottom. Otherwise, the picture was very good.

After checking the schematic carefully, I decided to use my scope and check for missing waveforms. However, the parabolic waveform at pin 2 (Figure 3) was normal, and the sawtooth/pulse waveforms from the vertical-output transformer were all proper. That is about the end of a scope's usefulness in the convergence circuit. All other waveforms vary wildly according to various adjustments.

Could the R15 or R17 vertical-lines control be open? I noticed that only the green vertical lines moved – the red vertical lines were motionless – when the controls were rotated from end to end. This total lack of movement indicated just one defect: the red vertical-convergence coil must be inoperative. I attempted to check the coil resistance, but it was open.

After I removed the convergence assembly from the neck of the picture tube and looked at it carefully, I noticed one wire was loose and not touching the lug. Resoldering the joint and installing the convergence yoke assembly restored movement of both red and green vertical lines. An easy convergence sequence completed the repair.

Zenith with varying picture

Symptoms of what appeared to be oscillations in IF or AGC circuits appeared on the 19DC22 Zenith raster. Sometimes the picture would pull slightly and a humming noise appear simultaneously in the audio.

A tuner substituter was connected. The performance was not improved, so the tuner or the tuner AGC was not causing the problems. Next, I suspected the IF module, but before replacing it, I measured the +24V supply and found it was varying between +18V and +24V. At +24V, the performance was normal; at +18V, the humming and picture pulling began. This caused me to suspect an intermittent heavy drain on the +24V supply. One at a time, I disconnected the various loads from the +24V supply, but the erratic voltage and operation continued. It appeared that the problem was in the +24V supply itself.

Zener diodes (such as X28 in Figure 4) can become intermittent, and X28 received attention first. However, the dc voltage across it did not vary enough to be the source of the problem. The X5 diode and the Q16 regulator were tested in-circuit and found to be normal.

After some thought, I decided to monitor both the input to the regulator and the output voltage. Two VOMs were connected as shown in Figure 4, and each meter was set to an appropriate dc-voltage range. The meter across R331 tested the regulator current by the resulting voltage drop. Of course, the second VOM monitored the +24V supply voltage.

Excessive drain on a power supply can reduce the output voltage. Therefore, if the voltage across R331 increased when the output voltage decreased, some abnormal load on the +24V supply was responsible. If both meters simultaneously indicated lower voltage when the symptoms appeared, the defect was in the ac supply or rectifier circuit ahead of R331.

When the intermittent problem occurred the next time, it was easy to see on the two meters that *both voltage readings decreased.* Therefore, the defect was before R331.

The only components before R331 were the power-transformer winding, the fuse and holder, X5 diode and C2A input filter capacitor. Additional tests and light tapping on components identified the fuse as the erratic component. (Of course, the fuse holder might be the trouble in similar cases.) The fuse showed many carbonized arc marks, evidently from poor contacts over a long period.

A digital multimeter could have measured the ac and dc voltages, but varying readings on digital readouts are very confusing. A dc-coupled scope could have measured all ac and dc voltages, but a scope probably would have given *more* data than was needed. If a scope had been first choice of instruments, it is likely I would have started at the video detector. That would have wasted much time.

In this specific case, VOMs proved to be the most efficient test equipment.

Excessive brightness

The 16Z8C50-chassis Zenith (Photofact 1097-3) would bloom and lose the raster even with moderate brightness-control settings. If the brightness control was adjusted carefully near the minimum position, the picture appeared to be almost normal in quality and brightness. But sometimes a station change to a different type of scene would trigger the blooming, often with a total loss of raster.

Cases of blooming require extra care in the preliminary diagnosis. Two questions must be answered. First, is the chassis forcing the picture tube to draw excessive current? Second, is the picture-tube current normal, but the high-voltage regulator ineffective, thus allowing extreme blooming? Either condition can produce blooming.

A weak 3DC3 high-voltage rectifier tube can cause similar blooming. High voltage regulation is accomplished by the 6HV5 tube, which is caused to vary the amount of current drawn from the horizontal-sweep pulse tips. Excessive current through the 6HV5, therefore, can cause blooming. There is no easy method of measuring the 6HV5 current, but the tube can be unplugged from its socket, and then the receiver operated for a test. If the 6HV5 had been responsible, the blooming

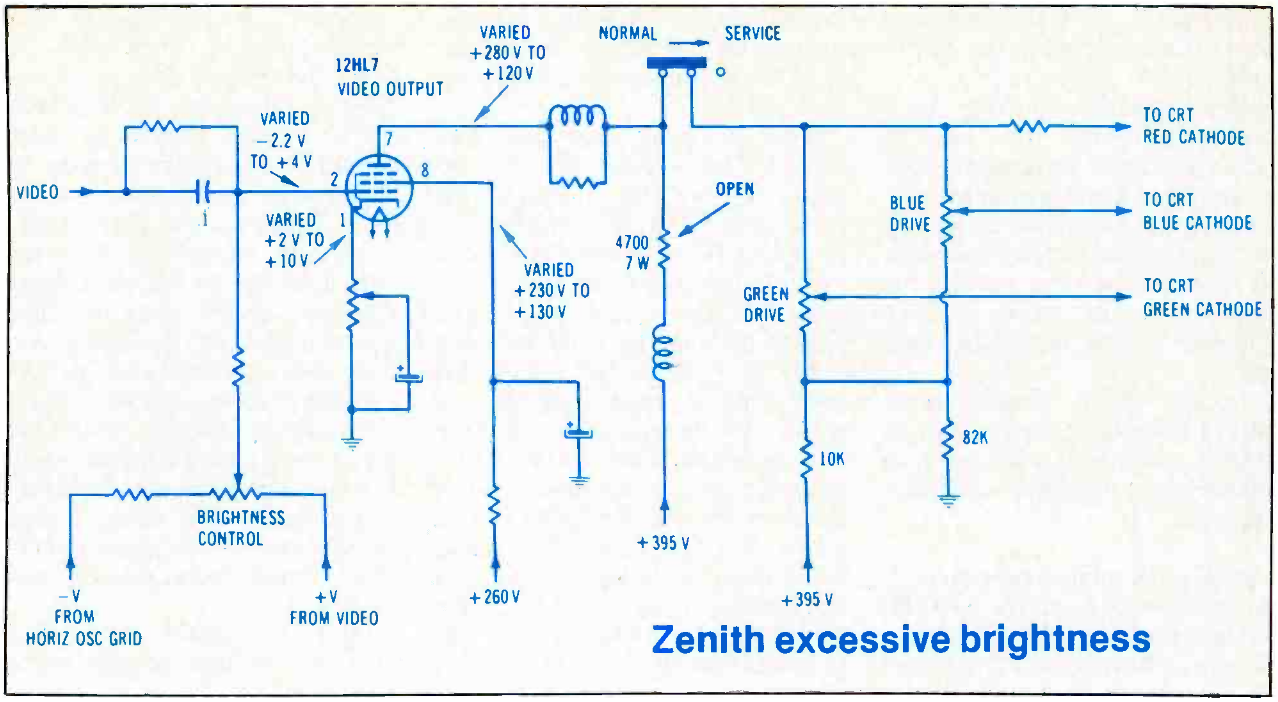


Figure 5 Several voltage measurements and intuition enabled an experienced technician to find the bad component in a very short time.

will be gone; but of course, the regulation at low brightness also is missing. (Other models with a 6BK4 can have the regulation current checked to determine whether it is excessive. This is recommended, where possible.)

With this Zenith, removing the 6HV5 did not prevent the blooming. In addition, the picture appeared to have normal *visible* brightness before the blooming occurred each time.

These symptoms convinced me that something in the video system was forcing the brightness too high. Also, the picture brightness appeared to vary more than the normal amount when I slowly rotated the brightness control, so I investigated the exaggerated response to brightness changes.

Brightness problems that originate in the luminance or video stages can be located fastest (in my opinion) by an analysis of the dc voltages there. However, the analysis is complicated by the large variations of dc voltages that occur from adjustments of the brightness control and changes in the station video. Therefore, a technician needs a knowledge of average voltages.

It is very helpful, for example, to know the range of dc voltages when the brightness control is rotated from end to end. Figure 5 shows the voltages measured at vital points when the brightness control was rotated first to full CCW position (giving a dark picture) and then to the CW position (for maximum brightness). I remember that a video-output plate voltage (in other receivers of the same model) of about +280V provided normal brightness. Of course, a higher voltage darkens the picture, while a lower voltage produces too much brightness.

This receiver could force the plate voltage no higher than the normal +280V, even with the brightness control turned down completely. Because the control-grid and screen-grid voltages varied properly, suspicion changed to the plate circuit. Increased resistance of the plate-load resistor, or a reduced voltage supply to it, is one of the few conditions that can produce low plate voltage.

I started to measure the plate resistor, and then I noticed an extra path (through the drive controls) from B+ to plate. Only a few resistance measurements were necessary to discover that the 4700Ω plate load resistor was open. However, the output stage operated (incorrectly) on the voltage brought in by the 10K resistor and the paralleled drive controls. (This is part of the system of adjusting the screen controls while the vertical sweep is eliminated. Notice the one section of a service/normal switch in the schematic.)

It was no surprise when replacement of the 4700Ω 7W resistor banished the critical brightness adjustments.

General comments

Simple multimeters have definite limitations. They often add excessive capacitance and resistive loading to critical stages, and the accuracy is not very good. However, a knowledgeable technician who understands both the limitations and the advantages of VOMs can troubleshoot a surprisingly high percentage of color receivers efficiently.

There is one important warning: Use a VOM for preliminary measurements, but change to a more sophisticated instrument (such as a good scope) when it soon becomes clear that the VOM is not capable of solving the problem at hand.

Exploring the videodisc

·The early days ·Player design ·The system

When Thomas Edison invented the phonograph in 1877, it was the only device available for playing sound recordings. Today, little more than 100 years later, videodiscs are available for playing back not only sound, but pictures. In the case of video, however, there are a number of manufacturers involved, and consumers will be faced with a choice of several non-compatible systems. Two videodisc systems are currently on the market and another is under development.

One of the available systems, developed by N. V. Philips of the Netherlands and MCA of Los Angeles, CA, is an optical pickup system. In this system, the information is read from the disk by a non-contacting stylus that is driven across the surface of the disk by a servo.

The other system currently on the market is a capacitance electronic disk (CED) system introduced by RCA last year. In this system a diamond and metal stylus follows the signal track on the surface of a disk, sensing variations in capacitance.

A third system, a video high density disk (VHD), is being developed by the Victor Company of Japan (JVC).

The following three articles describe the effort involved in designing and developing one of these systems. It is not intended as an endorsement of that system, but merely illustrates the many factors that must be considered in bringing a high technology system from concept to marketplace.

The early days

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Before 1965

In the 1950s, fresh from helping launch color TV, some people at RCA Laboratories turned to the challenge of home video recording. In 1956, they demonstrated to RCA's Board Chairman, General Sarnoff, an experimental "hear-see" player that used magnetic tape. Magnetic tape appeared to be well-suited for home recording and playback of off-the-air programs. Because it could be erased and used again, its initial cost could be spread over a number of programs, making the cost per program quite reasonable. For prerecorded programs, however, the total cost per program – for the materials plus the recording process, plus the program content – seemed to be too high for mass acceptance. Thus, there appeared to be a need for a less costly way to deliver prerecorded video programs to homes, programs that could be selected by a consumer and viewed at any time.

During 1953, RCA Laboratories began a small effort to look into extending audio phonograph technology to video storage and playback. Disk material and replication costs both would be significantly less than for videotape. However, recordings would require much smaller signal elements than audio recordings, signals with smallest dimensions of less than one micrometer – about the same as a wavelength of visible light – and it was not clear that they could be made and reproduced. A report following this, and other work concluded that plastic disks with such small signal elements probably could be pressed, but no practical means then existed for recording or for recovering signals from such small signal elements.

In 1960, however, a new concept for signal readout was proposed. By electronically sensing variations between the disk and the edge of a thin conducting film on a special stylus, very small signal elements theoretically could be detected. With this concept it appeared that the player as well as the disk could be cost effective.

In 1964, RCA Laboratories organized a 4-man team to develop a home videodisc playback system. The system would:

- produce a high quality picture

on a home TV set
- be capable of high quality sound reproduction
- use low-cost, long-play program disks
- use a low-cost player

The team, at the outset, decided that a player cost of not more than half the cost of a home videotape recorder would meet the "low-cost" requirement for the player.

In spite of the earlier work, members of the team knew they had a Herculean task before them. They faced many alternate, undeveloped paths. They would need to push the state-of-the-art in new technologies, just to get started. They could get bogged down easily by following too many paths, following the wrong paths or meeting enormous difficulty with a critical path. Colleagues understood the problems. About 90% of them thought the project never would succeed. Even later, after some initial progress had been shown, one colleague offered to "eat his hat" if the system worked.

The team undertook a 2-step program to test and develop the basic signal recovery method; then, based on the signal recovery, develop technology to implement a basic full-scale system, continuously improving the signal channel and its use.

Gradually involving more people, this program lasted for about five years (1965-1970). Much of it was "blind" because individual parts of the system couldn't be tested until the full system had been implemented.

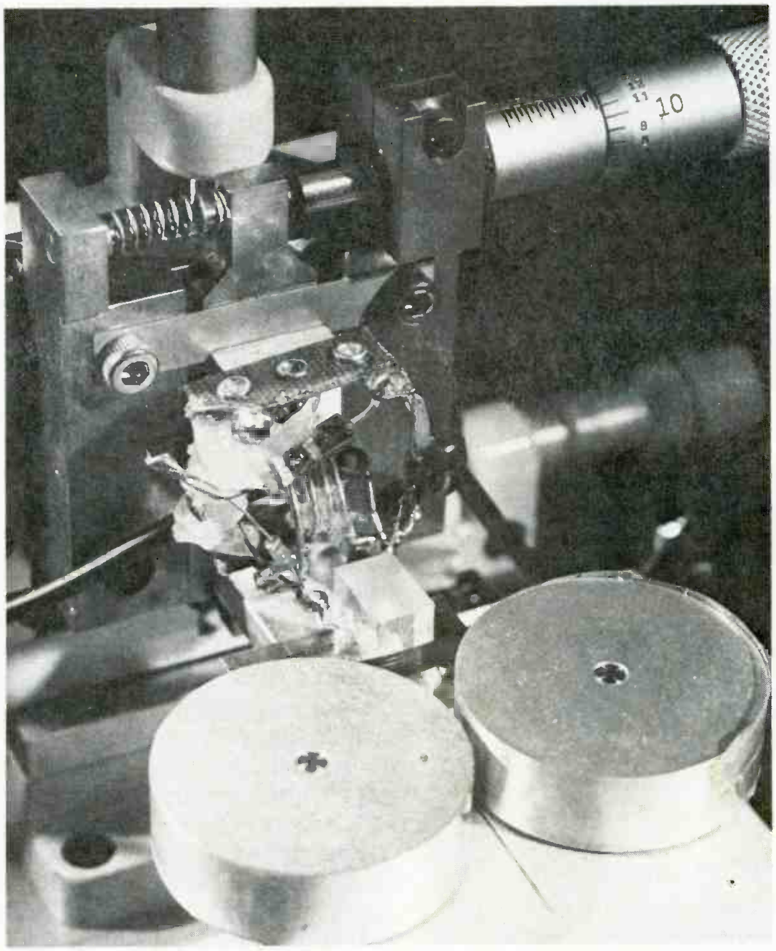
1965-1971

Tests of the basic readout method paced the entire project because the form of implementation of all parts of the system depended on the results. Difficulty with attempts to test readout with small signal elements led to tests with model styli and disk signal elements scaled up from proposed sizes by a factor of 10,000.

These tests gave definitive results. Along with concurrent theoretical analysis, they showed that best results would be obtained with a single-electrode stylus configuration and with dielectric-coated conductive disks. They confirmed that the capacitance readout technique with a conductive disk should have enough resolution and sensitivity to recover a prerecorded video signal.

Following the initial tests, the researchers concentrated on developing real-scale technologies so a complete system could be tested. During the late 1960s, they developed:

1. A method of recording spiral grooves with fine pitches of thousands of turns per inch.
2. Optical, mechanical and electron beam techniques for recording signal elements as short as 1 millionth of a meter (1/25,000th of an inch) in a disk master.
3. Signal systems for providing TV picture and sound signals at uniform, slowed-down rates, precisely synchronized for either mechanical or electron-beam recording of a disk master.



Embossed with a microscopic signal pattern, a metallized Mylar tape moves back and forth across a stationary "stylus" to test capacitive pickup in this 1967 setup. To make the "stamper" for embossing the Mylar, the electron beam of a scanning electron microscope exposed a line pattern in a "resist coating" on a half-inch diameter metal substrate. After chemical development of the resist, the resulting contour pattern served as a mask during an RF sputtering process by which corresponding contours were formed in the substrate itself, which then was used as the "stamper."

4. Methods for making metal stampers and plastic disks from the masters.
5. Processes for putting conducting, insulating and lubricating coatings on the disks.
6. Technology for fabricating new, composite types of styli, with tips 10 times smaller than tips on audio styli.
7. Ultra-sensitive circuitry to detect capacitance variations.
8. Player mechanisms that include accurate tracking of the fine-pitched groove.
9. Player signal systems that reprocessed the signals recovered from full-color pictures and high quality sound.

In 1970, the system produced its first pictures–barely recognizable monochrome pictures that took 200 times as long to record as to play back. In 1971, it produced better ones and even fairly good color pictures by the end of the year.

The 1971 system used a disk the same size as an audio record, but with finer grooves. The disks were coated with conducting, insulating and lubricating films. They were played back using the capacitive pickup technique, with electroded sapphire styli. The disks were made from either electron beam or electromechanical recordings.

As developed, the capacitive pickup technique could detect submicrometer-sized signal elements. Resolution was limited only by the thickness of the electrode along the groove and the distance between the edge of the electrode and the recorded signal elements. Resolution did not change significantly with wear. The stylus body could wear, but the electrode edge dimension along the groove remained nearly constant. The high resolution of the pickup relative to other pickup types permitted use of lower player turntable rotation speed, which translated into longer play time for a given groove pitch.

The signal encoding system used an FM carrier for the video information and separate FM carriers for the audio information, the video and audio carriers being combined to form a single information track. A buried-subcarrier, color-multiplexing system was devised. Using comb-filter technology, it placed the color signal in the same frequency band as the luminance signal. This allowed use of a lower frequency for the video FM carrier, which increased playing time.

By 1971, a number of systems using alternate technologies had become known. As they were recognized, they were carefully assessed, often by an extensive building and testing effort. Ultimately, RCA decided that the capacitive pickup system, now known as the "CED" system, would provide the lowest-cost, longest playing time of any known system, and would best meet its guidelines for a home prerecorded video player.

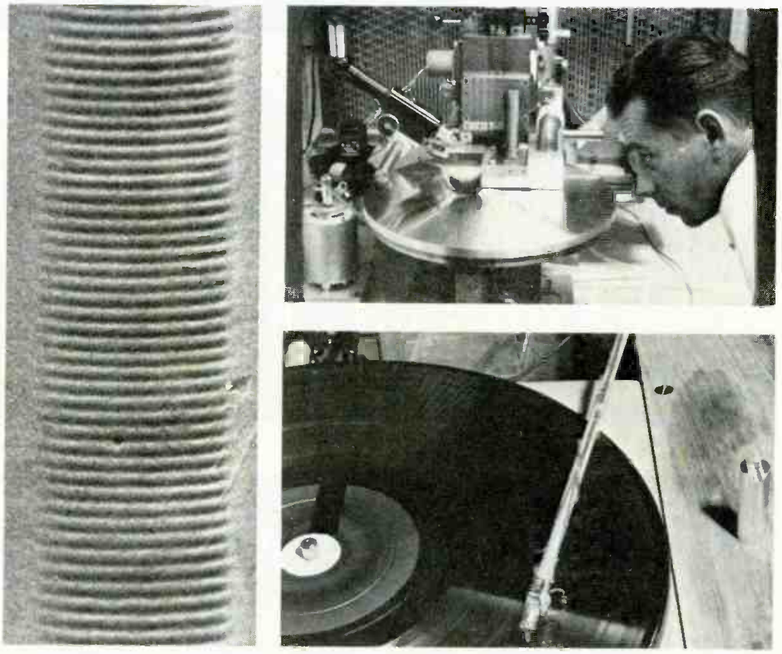
1971-1976

High priority product development followed the system decision. Additional people were assigned to the research teams in Princeton and the small supporting-type efforts at Indianapolis in the Record Division and Consumer Electronics Division soon became substantial co-efforts.

Recording technology

In one of the larger team efforts, the following years saw step-by-step improvements in electron beam mastering speed. The speed doubled every seven months until 450rpm real-time recording was achieved in 1974.

During the same period, a small but persistent effort was continued on electromechanical recording. In 1974, tests showed that copper could be cut more smoothly than lacquer, and with less loss of high frequencies. This,

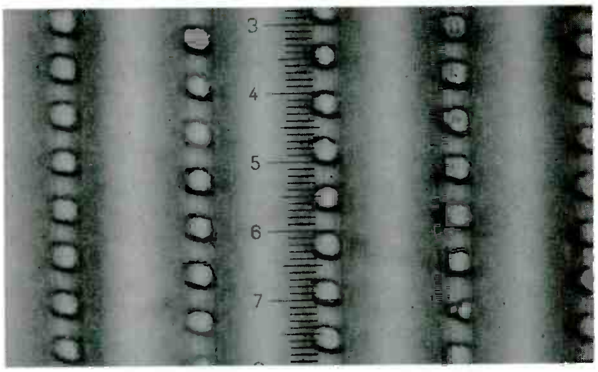


Developed from a commercial jigbore, the precision disk lathe shown at the upper right proved to be of great use throughout the project. Normally equipped for machining ultrasmooth surfaces on 14-inch diameter substrates, it easily was adaptable for other uses, including slow-speed optical recording of test signals. Equipped with high quality optics, a high pressure mercury vapor lamp and a mechanical light-beam chopper, it generated a circular track of high resolution test signal contours with wavelengths as short as 0.6μm. These patterns were replicated in metal and used in an audio record press to make vinyl records. At the upper left a scanning electron microscope photo shows the surface of such a pressed disk, with a segment of a full turn of signal pattern that had been pressed into the disk. After the disk was coated a capacitive pickup of the type shown at the bottom of the composite figure retrieved the signal. In the first such recording, a handling slip caused a deep scratch that cut right across the signal path. Surprisingly, the pickup with its long, lightweight tone arm was not derailed by the scratch and successful pickup of a 4MHz signal was achieved at a turntable speed of 360rpm.

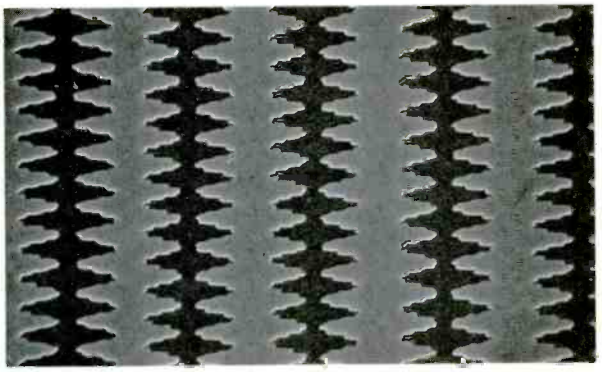
Patterns

The array of signal patterns, shown in Figures A-F, illustrates the shifting focus of the project. In the early stages, patterns such as A and B served to test the signal pickup technique. The progress in recording technology permitted flexibility in the types of patterns that could be generated, as well as ability to generate them in full-sized grooved masters. Patterns such as C and D supported the concurrent investigation of alternative signal modulation schemes for the videodisc system; frequency modulation was the winner. Patterns E and F illustrate electron-beam and electromechanically generated patterns, respectively.

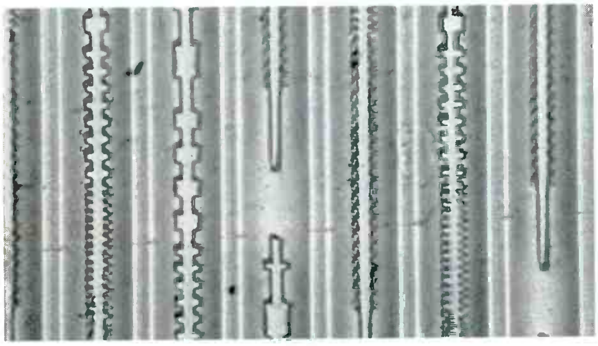
Although high-power optical microscopes were very useful in inspection of signal patterns, scanning electron microscopes provided the greater resolving power and depth of focus needed for evaluation of micrometer-sized contours. It was fortunate, then, that scanning electron microscopes became available commercially just in time to be used in the development of videodisc technology. The demand for their use was such that several of them were purchased for, and used full-time on, the videodisc project.



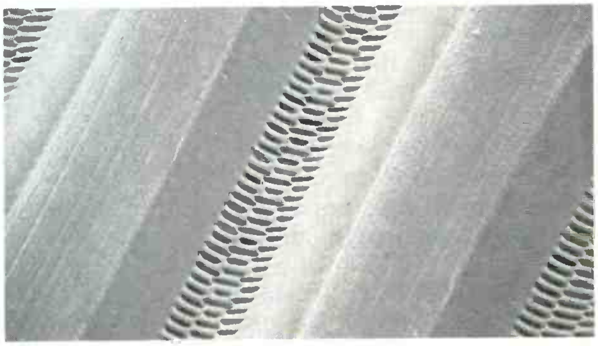
A



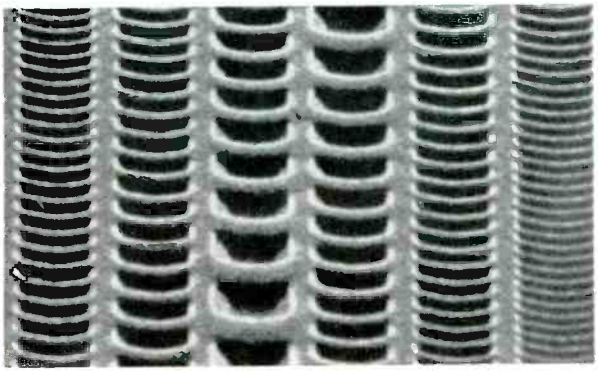
B



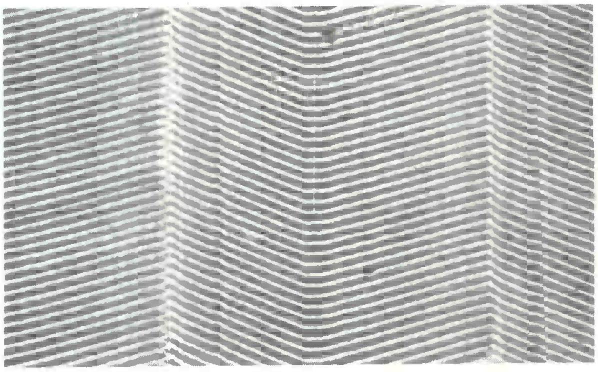
C



D



E



F

A. Pattern produced in 1967 on the ridges of a smooth groove nickel stamper by optical exposure through a thin resist coating. The "signal elements" were then built up on the stamper by electroplating through the exposed areas after chemical development had removed the resist from those areas. **B.** Variable-width signal pattern produced in a scanning electron microscope by scanning the beam from side-to-side. **C.** Modulated variable-width pattern produced in 1970 in the first full-scale electron beam recorder. **D.** Electron-beam generated signal pattern used in 1971 to test a balanced amplitude-modulation signal system. **E.** Electron-beam generated sweep frequency pattern used in 1972 system tests. **F.** Electromechanically generated pattern. Note V-shaped groove used once choice was made to use electromechanical recording for production mastering.

and development of increasingly smaller piezoelectric cutterheads, led to few experimental real-time electromechanical recordings being made in 1976.

In the mid-1970s, using the latest laser technology, optical mastering was explored vigorously. From the beginning, it achieved real-time recording speed. However, there were technical difficulties in obtaining the optical resolution to make 0.25μm signal elements and in avoiding undesired standing wave patterns caused by optical reflections from the bottom of the grooves.

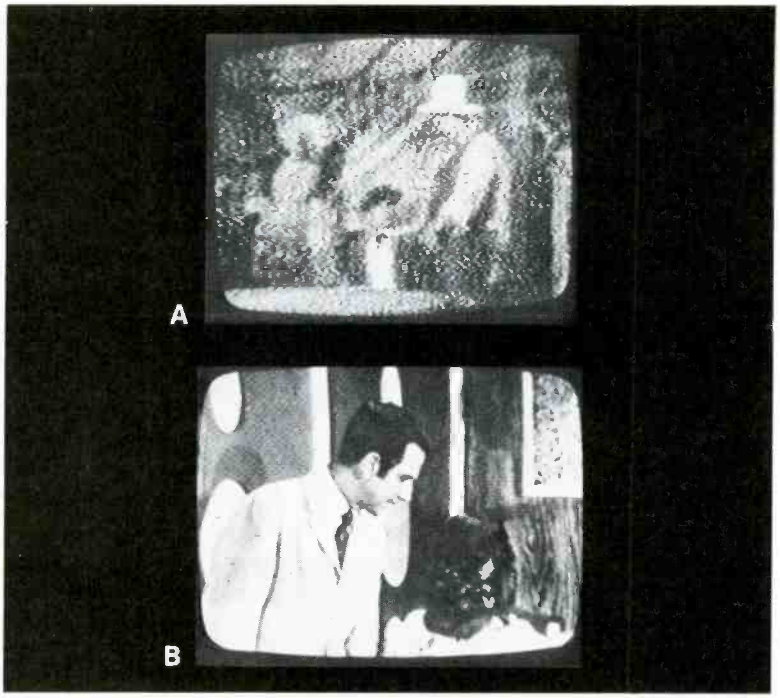
Disk pressing methods

Throughout the early stages of the project, all test disks had been pressed by compression molding, the standard production technique for 12-inch diameter audiodiscs. For videodiscs, with their shallower grooves, injection molding had several possible advantages. Thus, in 1973, injection molding was chosen for production. The first injection press was installed in the RCA Rockville Road plant in July 1975.

Disk coating processes

In 1971, disks were made by first pressing them from a standard vinyl compound, then coating them in sequence – with a thin metal layer to provide conductivity, with a thin durable dielectric layer, and finally with a lubricant layer to prolong the life of the stylus and disk. Evaporated aluminum, used initially, proved too grainy. Evaporated gold produced better pictures, but was too expensive. In 1972, evaporated or sputter-deposited copper replaced the gold. By 1975, however, it was confirmed, as feared, that under certain conditions, the copper would corrode in spite of being coated with a dielectric. With considerable effort, a copper-inconel bimetal sandwich conductive layer was developed that passed all corrosion tests.

In early disk-coating experiments, coatings were applied layer by layer, one side at a time, in individual belljar setups. Soon it was clear that coating of disks this way would be a bottleneck in production. To coat disks economically, a highly automated process was needed. After engineering studies with an outside firm showed such an "Autocoater" was feasible, it was ordered in 1974. During 1976, Indianapolis teams pressed 240,000 experimental disks and coated about 120,000 of them.



A is a photograph of a picture reproduced in October 1970 on a TV screen while playing a disk made from an electromechanical recording. **B** shows the progress made by April 1971 (electron-beam recording). Whether made by electromechanical or by electron-beam techniques, early recordings were time-consuming. At first, each minute of play time required several hours of recording time. To supply signals at the slow rate, special signal generating and processing equipment was developed. A flying-spot scanner provided high quality signals from 35mm film at rates slowed down by factors in the range of 20 to 400. Later, a video slow-down processor, developed for the videodisc project by RCA's Missile and Surface Radar Division in Moorestown, NJ, was used for recording rates slowed down by factors of 5 to 20. These were not needed for electron beam recording after 1974. For production electromechanical recording, a 2:1 slowdown was chosen; a third type of slow-down equipment was developed for this rate.

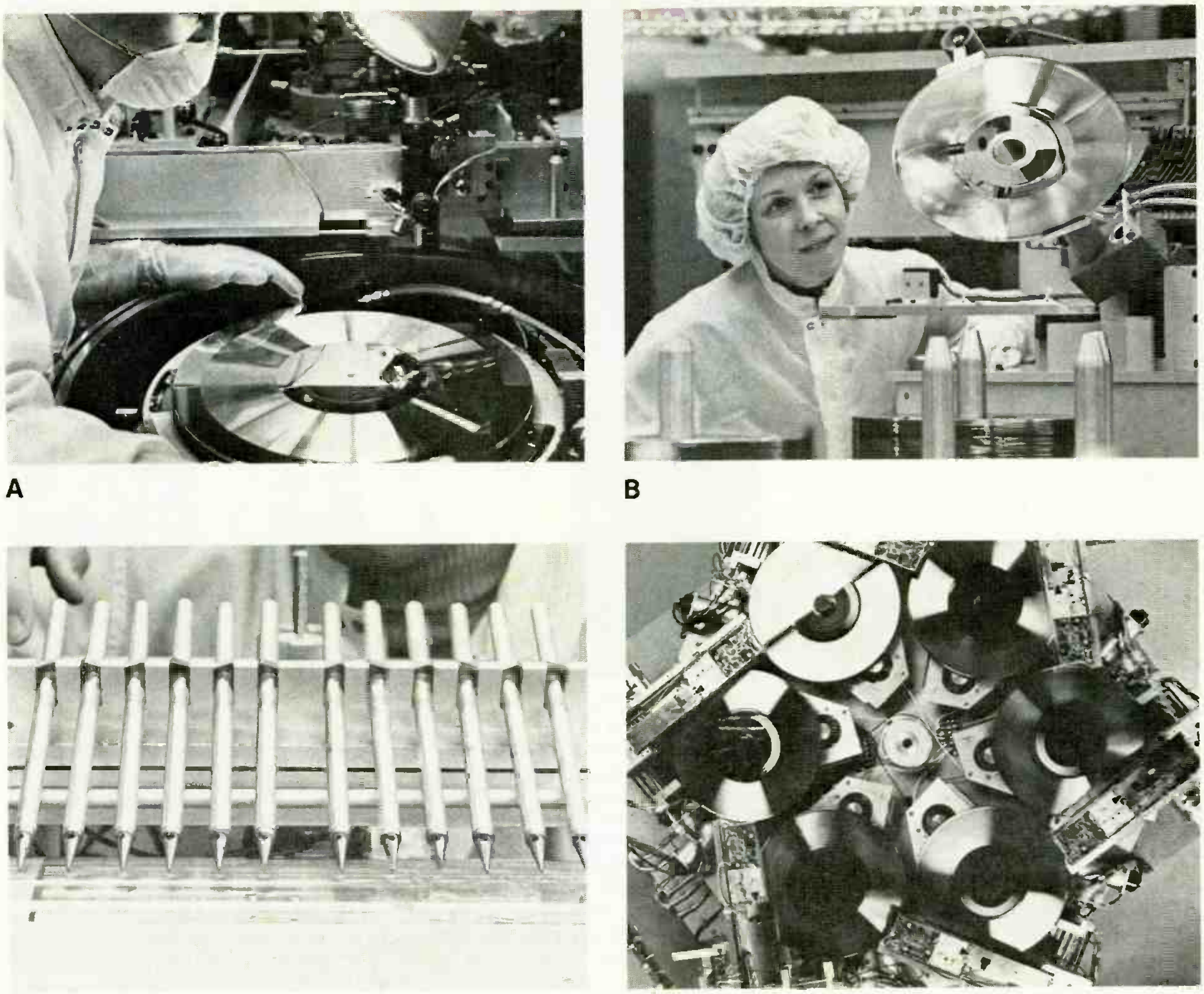
Dust and environmental problems

In 1976, using 25 players from an engineering pilot run and disks with durable coatings, Indianapolis conducted a private field test. This test uncovered field problems sufficient to cause an intensive reassessment of production readiness. After exposure to dust, high humidity and high temperature, the dust bonded to the disks, creating a plethora of defects that caused severe stylus mistracking, even stylus breakage, as well as episodes of signal loss due to debris under the stylus.

Later in 1976, intensive work began on a protective sleeve or "caddy" for the disk. A disk would always be in its caddy except when automatically extracted for play within a dust-protected player compartment. In laboratory tests, caddies protected disks even against prolonged exposure to wind-driven dust.

1976-1979

The 1976 reassessment dealt with the whole system, with particular emphasis on manufacturing costs and product reliability, and important system decisions were made. Electronbeam recordings were made with a nearly doubled groove density, extending the playing time to two hours per disk. Studies had shown that 90% of all feature-length movies could be contained on one such disk. The economic advantage was compelling and the finer groove pitch (of nearly 10,000 turns per inch) became the "standard." However,



A B C D

State-of-the-art in 1976 at the RCA "SelectaVision" videodisc facility in Indianapolis. **A.** A pre-grooved master is mounted in an electron-beam recorder for mastering. **B.** Finished disks are stacked by a mechanical arm after leaving the coater, where metal, dielectric and lubricant layers were automatically deposited on the surface of the disks. **C.** A bank of pencil-like devices holds sapphire rods that are being shaped into stylus tips. RCA was growing its own supply of sapphire rods at the time. **D.** An automated tester screens finished disks in one of several methods of playback performance evaluation, which also included field tests with engineering model players.

since it cost less and could produce recorded masters with less noise and fewer defects, electromechanical recording was selected as the production recording method.

The narrowed groove required a smaller tip on the stylus, making it more likely to break or wear out. Sapphire styli, for which elegant technology had been developed, were replaced by diamond styli. The main benefit of the switch was the much greater resistance to breakage of diamond styli.

In January 1977, the first successful disks using conductive compound were pressed. With good dispersal of tiny, 300A diameter, carbon particles throughout the vinyl, disks with adequate conductivity characteristics could be pressed. The signal-to-noise of signals recovered from these disks was within a few decibels of that from coated disks. The main advantage of the conductive disk resulted from the elimination of all coatings except the lubricant. The need for the expensive Autocoater was thus eliminated. However, the carbon-loaded vinyl was too stiff to be injection molded, so pressing again was done by compression molding.

Beginning in the early 1970s, many succeeding generations of experimental players were built—several hundred players in all. Each generation came from intensive engineering efforts to make the player better, simpler, easier to use and more reliable than its predecessors. By the late 1970s, when home videotape recorders were being marketed nationally by RCA, it was clear by comparison that videodisc players could be built with fewer parts, especially fewer critical parts, and should cost only about half as much to build.

By the end of 1978, RCA had made arrangements for a varied and extensive catalog of programs to record. In January 1979, after more than a decade of homework, RCA announced its plans to make SelectaVision videodiscs and players and market them on a nationwide basis starting early in 1981. ES&T

The system

By H.N. Crooks, director, technical liaison,
Selectavision Videodisc Operations

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The videodisc program has been under way at RCA for about 16 years. The system that has evolved from this work has resulted from many trade-offs, including technical, marketing and economic considerations. The system, introduced to the American market in March 1981, is RCA's best estimate of what will be the basis for a major consumer electronics product.

The disk

The videodisc system is a flat circular plastic disk, 12 inches in diameter, as shown in Figure 1, upon which TV signals are recorded in a spiral groove. Although similar in appearance to an audio LP disk, the details of the recorded information are quite different. For example, there are nearly 10,000 grooves per inch of radius, which is about 40 times that of an audiodisc. Information is recorded as vertical undulations of a V-shaped cross-section groove, as shown in Figure 2. These undulations are about 1500 times smaller in amplitude and 15 times smaller in wavelength than those on an audiodisc. Because of the very small dimensions of the information elements on the disk and in order to protect the surface from dust, fingerprints and other contaminants, we have chosen to encase the disk in a plastic cover, or caddy, as shown in Figure 3. The disk is kept there at all times except when it is being played in a player.

Recording and pressing

In the recording operation, TV signals read from a magnetic tape are encoded into two FM signals, one for video and one for audio, which are added together to provide a composite signal that is used to drive a recording cutterhead. The cutterhead, fitted with a super-sharp diamond cutting stylus, cuts the undulating V-shaped groove in a copper-coated aluminum substrate. To increase reliability, the recording operation is done at half the real-time rate; that is, two hours are required to record a 1-hour program. The end result of the recording operation is a copper-plated disk containing the same topographic signal pattern as desired in a finished disk.

To press the signal patterns into a plastic disk, a negative of the pattern recorded in the copper substrate is required. This negative is provided by electroforming nickel on the copper. As in the audio recording industry, we call this negative a "master." When the master is heated and pressed into hot vinyl, the topographic pattern of the copper substrate is reproduced in the vinyl surface. If the master is cooled before being removed from the vinyl, the pattern is retained permanently in the vinyl.

Because only a limited number of disks can be pressed from a set of metal negatives (one for each side), we normally make positive metal copies, called "mothers," from the masters by nickel electroforming. From these positive mothers, we make negative replicas by nickel electroforming, which we call "stampers." The stampers are then used for pressing disks. The reason for using the master-mother-stamper sequence is to enable a greater number of disks to be made from one recording operation. At each stage of the process several electroformed copies of the earlier part can be made. The fan-out is such that a large number of stampers result from one recording operation.

The vinyl compound from which the disks are pressed is especially formulated for the videodisc. It includes finely dispersed carbon to make it conductive and various additives to aid in the molding operation. After the disks are pressed in a multiton automatic record press, they are washed and then covered with a thin film of oil to provide lubrication and long playback life of both stylus and disk.

Playback

In playback, information is retrieved from the topographic signal patterns pressed into the vinyl through the use of a capacitive stylus, giving rise to the system descriptor "Capacitance Electronic Disc" or CED. The capacitive stylus consists of a pointed diamond, the end of which is shaped to fit the grooves on the disk, and a thin metal electrode affixed to one surface, as shown in Figure 4. The foot of the stylus that rides in the groove is long enough to cover several of the longest recorded wavelengths. As a result, the stylus rides on the crests of the waves pressed into the grooves and, ideally at least, suffers no high-frequency motion either vertically or horizontally as the disk is played. As a consequence, the disk surface rises and falls under the stylus electrode, giving rise to a stylus-disk capacitance variation which can be calculated to be about 1×10^{-16} farads, or one ten-thousandth of a picofarad, peak to peak. This very small change in capacitance constitutes the disc readout signal.

The stylus-disk capacitance is made part of a resonant circuit with a resonant frequency of about 910MHz, as shown schematically in Figure 5. This circuit is excited with a signal from a 915MHz

Figure 1. The videodisc is 12 inches in diameter and 70-mils thick. The TV signal is recorded in a spiral groove (10,000 grooves per inch—about 40 times as many as on an audio-LP record). The disk material is made electrically conductive by the addition of 15% of finely divided carbon. In playback, the disk rotates at 450rpm.

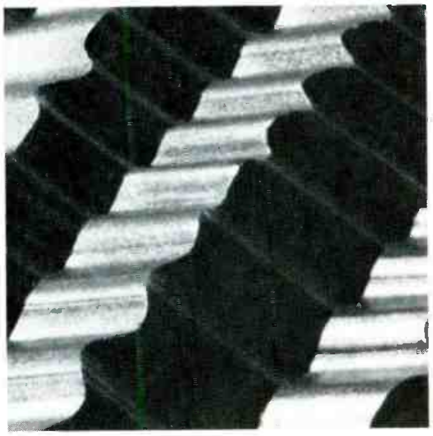


Figure 2. Photograph of a model of the videodisc surface. Center-to-center spacing of the grooves is 2.5μm. Information is recorded as frequency-modulated vertical undulations in the bottom of the V-shaped groove. On playback, the frequency varies from 4.3 to 6.3MHz.

Figure 3. Videodisc caddy. Because of the very small dimensions of the recorded information, the disk is kept in a protective plastic sleeve, or caddy, at all times except when being played in a player. The plastic frame surrounding the disk, called a spine, serves to move the disk into and out of the protective sleeve when the disk is inserted into and retrieved from a player.

oscillator. As can be seen in the figure, the 915MHz signal falls at about the half-amplitude point on the resonance curve. As the stylus-disk capacitance changes, the frequency of the resonance peak also changes, causing a change in the response of the resonant circuit to the 915MHz oscillator signal. As a result, the 915MHz passed through the stylus' resonant circuit is amplitude modulated by the capacitance variation. Demodulation with a diode detector recovers the modulating signal from the amplitude-modulated wave. This signal rises and falls as the disk surface rises and and falls under the stylus and thus reproduces the signal that drove the cutterhead during recording. The video and audio signals are recovered from the composite FM signals by FM demodulators, compensation for disk defects is applied to the signals, and the signals are then converted to NTSC format (U.S. television standard) to drive television sets on either Channel 3 or 4.

A disk is played by inserting the caddy (containing the disc) into a slot on the front of the player (Figure 6), removing the caddy, and then throwing the function lever to the PLAY position. At the conclusion of play, the disk is retrieved by throwing the function lever to LOAD/UNLOAD and reinserting the caddy into the player. When the caddy is withdrawn, it brings the disk with it, locked inside the protective cover.

Other features

Mechanisms and circuits in the player provide for the disk's removal and retrieval, indicate which side of the disk is uppermost in the player, rotate the disc at the proper speed (450rpm), use time-base correction to correct for non-centered disk conditions and use locked-groove correction to counter the effects of unavoidable disc defects. LED playing-time indicators, together with controls for rapid (150 times normal advance speed), visual search (16 time normal advance speed), and pause (for program interruption) are also included. The player measures 17"x5¾"x15½", weighs 20 pounds, and draws 35W from the power line.

ES&T

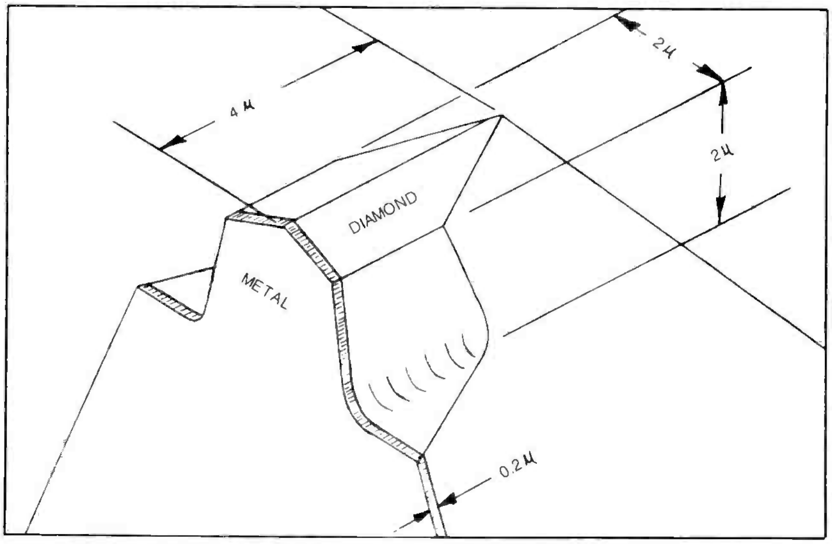


Figure 4. The stylus is made of diamond with a thin metal electrode on one face. The end of the stylus is shaped to fit the groove and long enough to cover several of the longest recorded waves. The sides are cut away to provide a "keel-lapped" shape which gives long-play life as the end of the stylus is worn away. The end of the metal electrode is one plate of a capacitor, the disk is the other plate, which varies in value as the disk is played and provides the read-out signal.

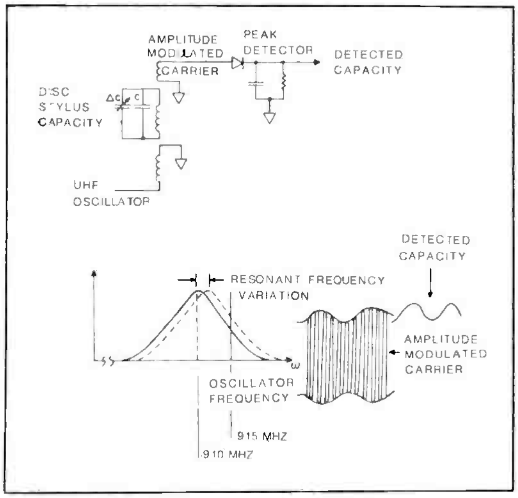


Figure 5. Disk-stylus capacitance is made part of a circuit resonant at 910MHz. As the capacitance changes, the resonant frequency changes, giving rise to a variation in the response of the circuit to a 915MHz signal and providing amplitude modulation of this signal. The modulation is stripped off by a diode detector to provide a voltage that rises and falls as the disk surface rises and falls under the stylus.

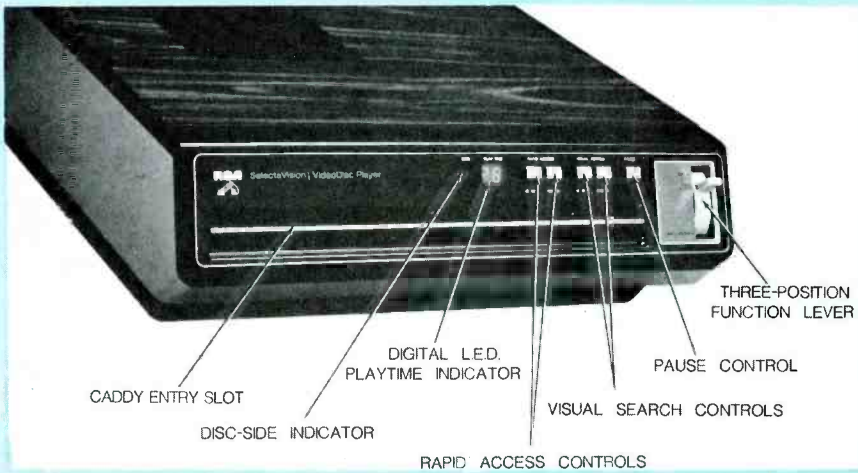
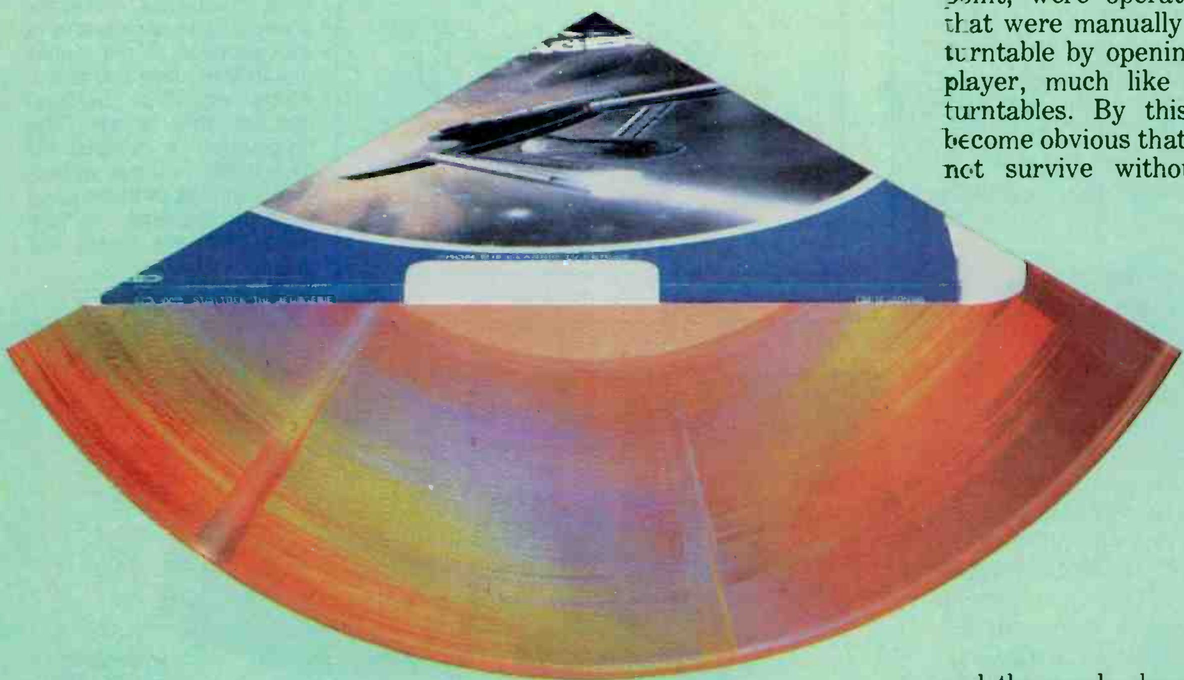


Figure 6. Videodisc player SFT-100. The controls and indicators on the videodisc player make it simple enough that even a child can operate it.

Player design

By W.M. Workman, T.J. Christopher, F.R. Stave, M.E. Miller and A.L. Baker *



Before examining the details of the first production player, it might be interesting to quickly review some of the key development steps in the evolution of the player design (Figure 1).

1973. The first model that had multiple engineering samples was built. Known by the engineering personnel as "the February player," it was the first to use 900MHz arm electronics and had a playing time of 20 minutes per side using disks with 4000 grooves per inch.

1975. A second engineering model (EM-2) was built and had automatic pushbuttons to replace the manual controls in the first model. The EM-2 featured a line-locked turntable, velocity-error correction, and defect correction. Playing time had been increased to 30 minutes per side using disks having 5500 grooves per inch.

1976. The EM-3 was the first player to use a cartridge close to the final form. This family of players was built in quantity using soft tooling.

1977. A design release for hard tooling was completed, and 35 players were built and designated as the SDT250. Players, up to this point, were operated with disks that were manually placed on the turntable by opening a lid on the player, much like manual audio turntables. By this time it had become obvious that the disk could not survive without protection, and the newly developed concept of a caddy allowed the disk to be handled in the player without exposing the disk to damage.

1978. A modified player, designated the SDT200, accepted a disk with a caddy. Playing time had been increased to one hour per

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*The authors are respectively, director of player engineering, manager of player electrical design, manager of mechanical design, manager of stylus/cartridge player design and manager of player project engineering, Consumer Electronics Division, RCA.

side, and a diamond stylus was developed for improved life to replace the sapphire stylus used previously.

The cost and complexity of the SDT200 required one more design iteration to shrink the size mechanically and to reduce the electrical parts count by designing several custom integrated circuits. This program was accelerated in January 1979 with the decision to go to market, and resulted in product delivery on schedule on March 22, 1981. There were three primary design goals for consumer use: affordability, simplicity of operation and reliability.

The RCA "SelectaVision" videodisk player, shown in Figure 2, is a compact instrument measuring 17"x5¾"x15½". Its weight is 20 pounds and power consumption is less than 35W.

Installation of the player by the consumer is easy – rear-panel connections provide ac power, an antenna output connects to the TV receiver, and an antenna input provides signals to the television when the player is not in use. A channel switch on the rear allows the user to select Channel 3 or Channel 4 for viewing videodisc programs.

To play a videodisc, the function lever is placed in the LOAD/UNLOAD position, which opens the caddy entry door. A videodisc, contained within its protective caddy, is inserted into the front-loading slot and pushed to the rear until fully seated within the player. The empty caddy is then withdrawn, leaving the disk in the player and the caddy jacket available for reference during play.

After moving the function lever to PLAY, the program will appear in approximately six seconds on Channel 3 or 4, as selected by the viewer using the player's rear-panel switch. When viewing is completed, the function lever is returned to the LOAD/UNLOAD position, the empty caddy is reinserted into the player to recover the disk, and the process is repeated to play the second side or to view another disk. Returning the function lever to the OFF position will remove power and reconnect the external antenna input through the player's antenna output to the TV receiver.

Engineering model 3 | **SFT100 in production**
Engineering model 2 | **SDT200 design tooled**
February Player | **SDT250 design tooled**

Other front-panel controls provide user convenience during viewing. PAUSE provides muted audio and video until either the button is depressed again or one of the other customer controls is activated. Visual search, forward and reverse, allows visual searching of the disk program at approximately 16-times real time with the sound muted. Rapid access, forward and reverse, allows the user to quickly move across the disk at approximately 150 times normal speed with picture and sound muted, thus allowing any portion of a 1-hour disk to be accessed in less than 30 seconds. Visual indicators on the player's front panel provide the disk playing time in minutes, referenced from start of play. Side identification is also provided for the disk being played.

Capacitance pickup

The RCA player uses capacitance pickup techniques to recover signals from a conductive disk. The audio and video FM carriers are cut as vertical modulation in a 140-degree groove (Figure 3). Groove density is less than 10,000 grooves per inch, which allows one hour per side of playing time.

A mechanical stylus, whose length is several times the shortest

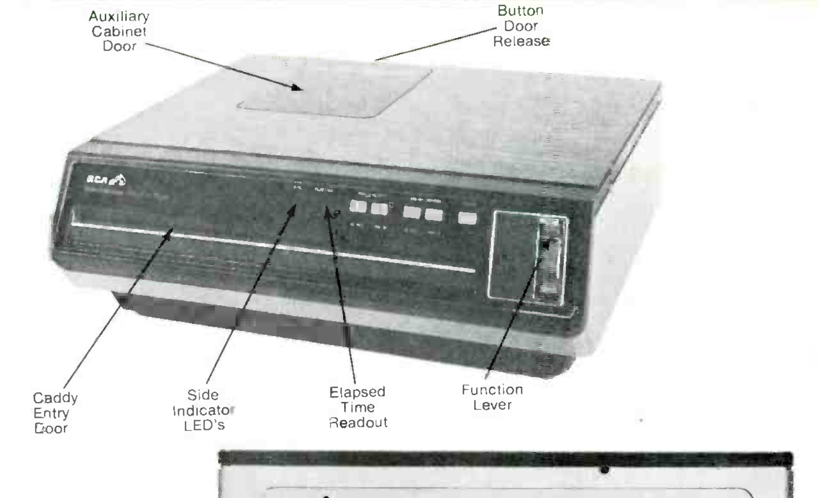


Figure 2. The front-panel user interface features stylus-cartridge access locations. Rear-panel antenna-hookup locations are shown.

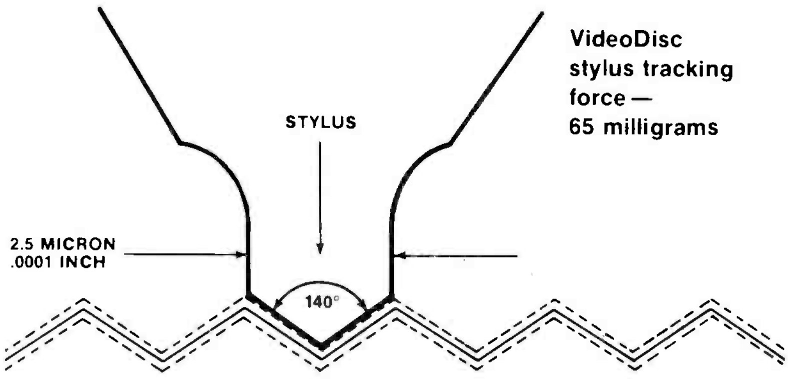


Figure 3. Disk, groove and stylus geometry is shown at approximately 10,000 magnification. Tracking force of the videodisc stylus is 15 times less than that of an audio system.

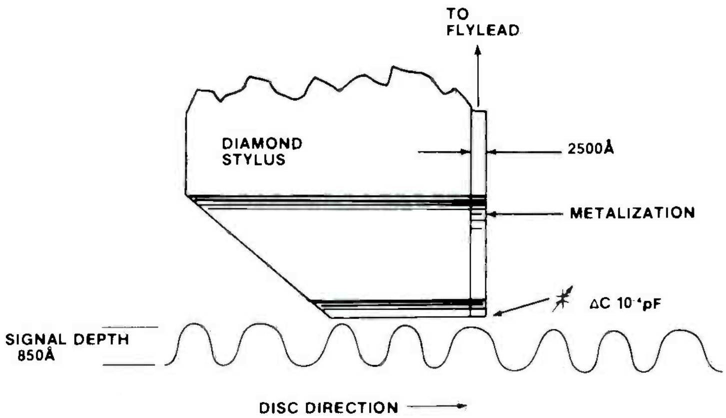


Figure 4. Enlarged side view of the diamond-stylus/disk interface. Details of the metallization and signal depth are also shown. The signal generation, ΔC, is only 10^{-4}pF.

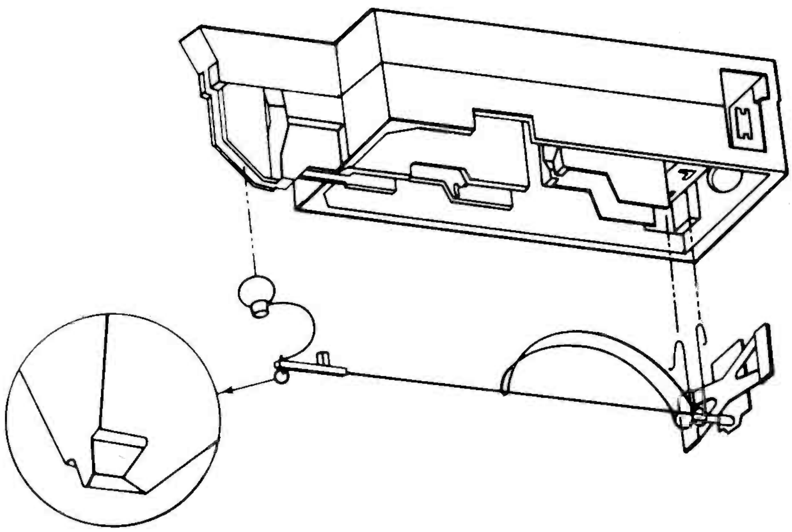


Figure 5. The stylus cartridge is composed of the diamond stylus, the flylead, the tipholder, the aluminum tube, the arm-stretcher coupler and a clamp spring. This assembly is user-replaceable.

wavelength of the signal elements, rides along the crests of the carrier (Figure 4). An electrode is deposited on the trailing edge of the stylus. As the disk rotates, variation in the distance from the bottom of the stylus electrode to the disk surface changes the stylus/disk capacitance at the FM carrier rate.

Stylus cartridge

The stylus cartridge (Figure 5) fits within an arm assembly that is mounted over the turntable and is driven radially by a dc motor across the disk from the outside to the inside.

The stylus is mounted on a small plastic tip holder attached to the end of a 3-inch aluminum tube. Controlled tracking force is provided by a beryllium-copper flylead, that also provides the electrical connection of the stylus electrode to the electronics located within the arm assembly. The rear of the aluminum tube is connected through a compliant rubber member to a flat metal plate that is magnetically latched to the arm-stretcher transducer in the arm assembly. The arm-stretcher transducer imparts tangential motion to the stylus. This motion partially corrects for time-base errors that are encountered during playback. Signal retrieval and groove skipping are sensitive to side forces exerted on the groove wall by the stylus. These forces are minimized by the arm servo and a very accurate stylus-centering adjustment.

A small permanent skipper magnet is located on the plastic tip holder. Stylus skipper coils, located on each side of the stylus inside the arm assembly, produce magnetic fields that impart a force on the skipper magnet that moves the stylus in controlled groove-to-groove motion radially across the disk.

The stylus cartridge assembly is designed for simple consumer replacement and is accessible through a door in the top of the cabinet (Figure 2).

Videodisc caddy

The RCA videodisc caddy (Figure 6) is a component of the "CED" system allowing fulfillment of several basic design goals. First, the caddy provides a convenient means for handling and storing the videodisc while protecting the disk from dust, debris and other damage which might impair playback. Secondly, the caddy design makes possible a relatively simple mechanical player interface to the disk.

Contained within the caddy is a plastic spine that surrounds and captures the disk during insertion into the player. The spine has visual side identification molded into the front face with side reference always maintained between the disk and spine. A molded-in key at the front edge of the spine provides a means for mechanically identifying, within the player, the side being played. At the outer front edge, locking tabs retain the spine, thus holding the disk inside the caddy when it is not inside the player.

Mechanism

The mechanical design of the player involves approximately 300 uniquely tooled items. Extensive use of molded plastic parts in the mechanism both minimize weight and, on a number of parts, achieve the needed precision tolerances that are inherent in injection molding.

The player is a compact mechanism built around a structural foam injection-molded centerplate. The mechanism incorporates a number of disk- and spine-handling systems to accurately position the disk during operation. The pickup arm assembly is mounted above the disk at the rear of the centerplate and moves on a carriage driven by a bi-directional dc motor and gear reduction assembly. The turntable is driven by an ac motor and rotates within two bearing assemblies. The electronics are attached to the centerplate above and below the mechanism.

For ease in manufacturing, only the player's signal processing circuit board and three other parts attach to the bottom of the centerplate. All others are topside, mounted and serviceable (Figure 7).

The centerplate foam-molding process was chosen for its ability to produce parts with closely repeatable dimensional accuracy combined with favorable thermal stress characteristics. In addition to providing molded-in rails that control the vertical and lateral motion of the caddy during insertion, the centerplate provides molded-in references and attachment points for all components in the player including the cabinet.

Consistent with the end goals of simplicity and minimum cost, most of the driving forces needed to interface the mechanism to the disk are provided by the user. This is partially illustrated by the view of the function lever linkage (Figure 8). Manual operation of the function lever engages/disengages the arm servo clutch, opens/closes the caddy entry door, raises/lowers the turntable and connects/disconnects the antenna switch. Also, ac and dc mechanism position switches are activated in the correct sequence to ensure proper switching of the electronics.

Other moving components of the mechanism that are activated during caddy insertion include spindle pull down, spine latching, pushback of the arm assembly to the start position, side-identification switching, arming of the stylus sweeper, and activation of spine-sensing switches to prevent operation unless a disk is present.

Two major portions of the mechanical assembly deal with handling of the caddy, disk and spine, both during insertion and extraction and during the transition modes of LOAD-to-PLAY and PLAY-to-UNLOAD. Varying forces, speeds and caddy-entry attitudes are carefully considered. First, the front, side and rear receiver pads are designed to accurately maintain the vertical location of the spine and disk while the turntable spindle controls the lateral position. The spine remains in a fixed position while the turntable raises the disk to the PLAY position. This allows the arm assembly to be vertically fixed and placed into the initial start position during caddy insertion.

The second handling system consists of the defeat tabs, the latch arm and the caddy retainer, controlling the spine latching and unlatching. Synchronous engagement of each element in this system was a complicating factor in its design, but recognized to be needed to avoid failure modes associated with only partial caddy insertion and extraction by the user.

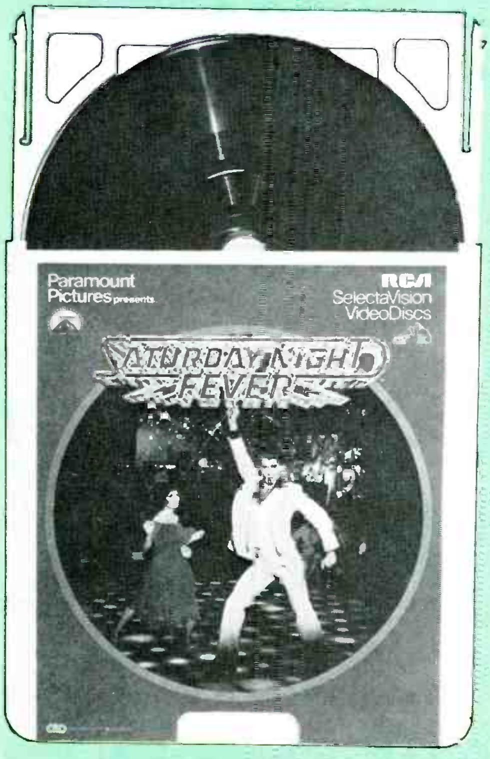
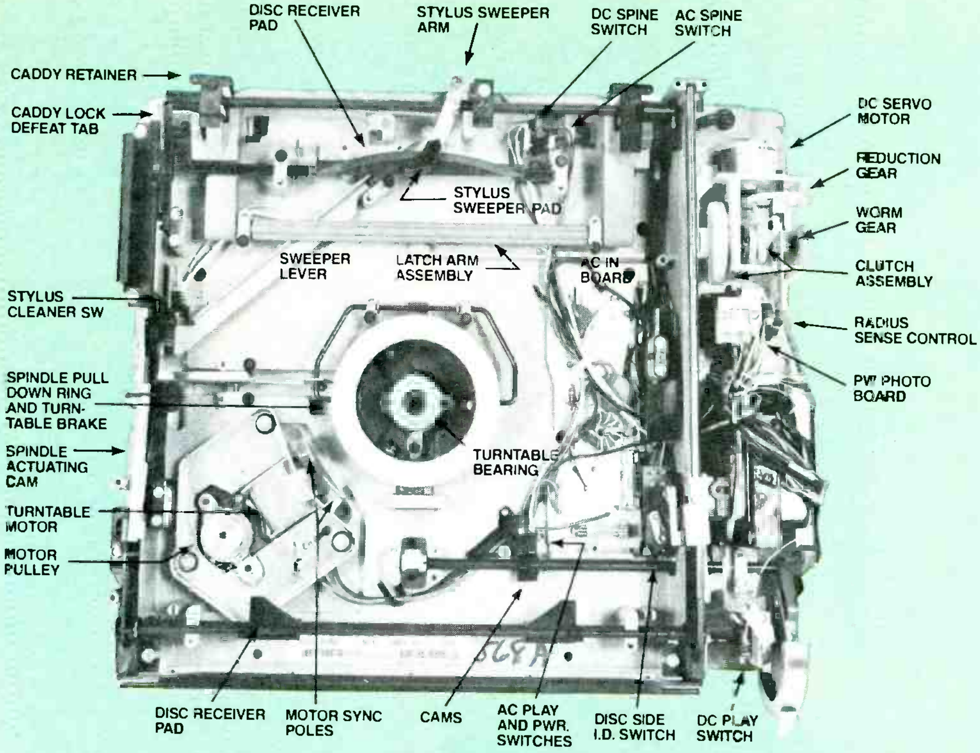


Figure 6. The videodisc caddy is the key element providing protection for the disk from environmental and handling-induced damage. Program information is provided on the front and rear faces.

Turntable drive

In the RCA player, the rotational speed is 450 rpm. With a 60Hz vertical field rate, there are eight fields per revolution with sync aligned radially on the disk.



SFT 100—VIDEO DISC PLAYER (TURNTABLE AND PW 500 REMOVED)

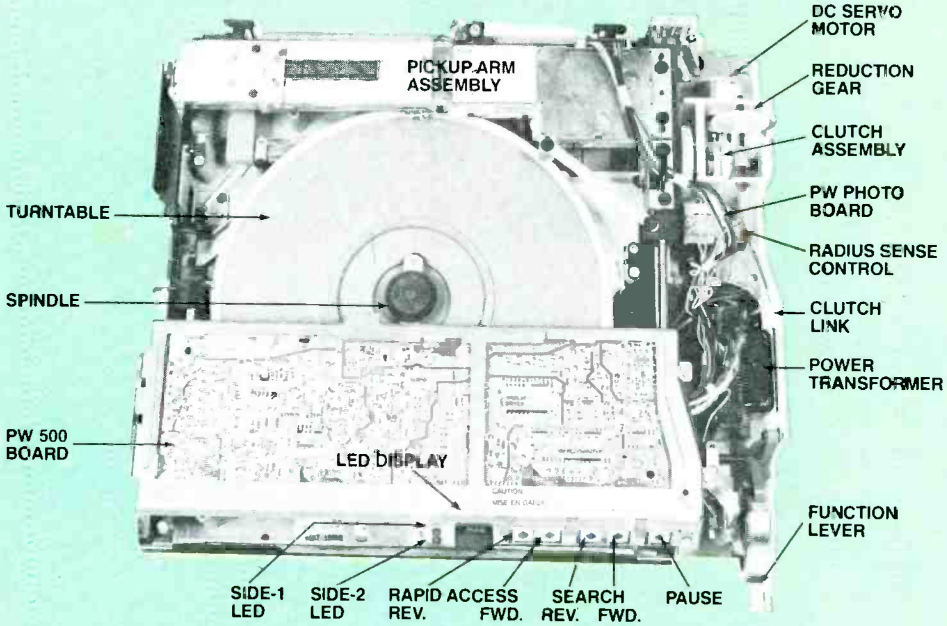


Figure 7. Top view of the videodisc player with the cabinet shell removed. The upper view also shows the control board (PW500), turntable and pickup-arm assembly removed (for clarity).

The constant angular velocity system does not require a complex turntable servo control, and results in minimal picture disruption as the stylus is moved from groove to groove.

A 2-pole, shaded-pole synchronous ac motor drives the turntable via a silicone rubber belt. A small squirrel cage fan mounted to the bottom motor shaft provides cooling to the motor and electronics. Accurate dimensional control of the turntable pulley, turntable-drive step diameter and belt length ensure a free running speed of 450 ± 2 rpm. Precise speed control is then achieved by coupling the stray ac motor flux through two magnetic poles to a 16-pole magnetic strip located within the interior diameter of the turntable drive step. This magnetic synchronization has sufficient torque to ensure that the turntable runs at 450 rpm ± powerline frequency tolerance. This operation is illustrated in Figure 9.

Videodisc signals

The video information recorded on the RCA videodisc is a frequency-modulated 5MHz video carrier (Figure 10). Sync tip causes the carrier to deviate to 4.3MHz, peak white causes the carrier to deviate to 6.3MHz, and black level corresponds to zero deviation. The video information bandwidth of 3 MHz results in FM-modulation sidebands that extend from 2MHz to 9.3MHz.

In order to limit the video spectrum to less than 3MHz, the chrominance subcarrier is at 1.53 MHz. This composite video signal is referred to as a buried-subcarrier signal.

Audio information on the videodisc is contained in a second carrier at 716kHz, which is frequency modulated with a deviation of ± 50kHz.

To optimize signal-to-noise ratio, both audio and video signals are pre-emphasized in recording. Complementary de-emphasis is provided during playback.

Arm electronics

The electronics that interface with the stylus are contained within the arm assembly. The resonator circuit contains the 915-MHz capacitance detection electronics. Inputs from the signal processing circuits drive the arm-stretcher transducer as part of the time-base correction function. Stylus skipper coils are located on each side of the cartridge and are pulsed by the control electronics when groove skipping is desired. The stylus lifter is a small solenoid that causes the stylus to be raised within the arm housing when the disk is not being played.

Capacitance detection

The FM carriers modulate the stylus/disk capacitor, which terminates a resonant line tuned to approximately 907MHz. When a fixed 915MHz oscillator is loosely coupled into this tuned circuit, the changing capacitance between the stylus and disk varies the tuned-circuit's center frequency and causes amplitude modulation of the 915MHz signal at the FM-carrier rate. Envelope detection of the 915MHz signal provides recovery of the original FM-modulated signals on the disk.

The detected output contains the video FM carrier, the audio FM carrier, and a 260kHz arm servo signal. The preamplifier raises the signal level from a few millivolts to several hundred millivolts. AFT circuits ensure stable operation of the detector at the specified point on the 907MHz tuned-circuit selectivity characteristic.

Audio demodulation

The 716kHz FM audio carrier is separated from the arm output by a bandpass filter and then amplified, limited, and demodulated within the audio demodulator IC.

The recovered audio is then fed through a squelch switch and amplifier. To minimize ticks and pops, a track-and-hold circuit is activated by a defect detector whenever a carrier dropout occurs. Audio is muted during visual search, rapid access, pause and load functions.

Pickup arm servo system

The maximum lateral force exerted on the stylus by the groove ($\simeq$23 mg) is inadequate to pull the pickup arm assembly along with the stylus. A bidirectional dc motor, through a gear reduction assembly, drives the arm across the disk under control of a servo that matches the arm-drive rate to the stylus position.

Equal and opposite-phase 260kHz-rate capacitance modulation of varactor diodes is coupled from sensors on either side of the stylus to the flylead in a balanced operation. This capacitance information is detected along with the disk information. The 260kHz signal is separated from the arm output signal with a bandpass amplifier and is synchronously detected. When the stylus is in the center of the servo sensors, the 260kHz signal recovered by the stylus will be zero. As the stylus moves closer to one of the pickup sensors, a 260kHz error signal of a particular phase will be detected. This error voltage is used to drive the arm servo motor to reduce the error signal to zero. This maintains the correct relative stylus-arm position to ensure optimum stylus tracking.

Baseband video recovery

The additive low-frequency audio FM carrier on the disk causes a modulation of the spacing between the stylus and video signal. Because of the unsymmetrical fields at the stylus/disk interface, phase modulation of the video carrier at the audio carrier rate can occur, which causes an objectionable 716kHz beat in the picture if not eliminated. The nonlinear aperture correction (NLAC) circuit introduces phase modulation of the video carrier by the sound carrier, which cancels modulation introduced at the stylus/disk interface. Any residual 716kHz component in the demodulated video output is synchronously detected and used to adjust the amplitude of the canceling signal.

The FM video carrier from the NLAC circuit is demodulated in the video demodulator IC and passed through a squelch switch that blanks the video whenever the stylus is not on the disk. Defect detection is accomplished by sensing carrier irregularities, producing a defect-gate signal used to control the defect corrector.

Comb filter

Demodulated video is supplied to the CCD comb-filter and defect-corrector IC. A CCD 1-H delay line is used in a comb filter to separate the interleaved luminance and buried-subcarrier chrominance information. When a defect is detected, the 1-H delayed signal from the delay line is recirculated to produce defect-free video.

Vertical detail information is extracted from the combed chroma signal by low-pass filtering and added to the combed luminance signal.

Video conversion

The luminance signal is de-emphasized in the video converter

(Continued on page 58)

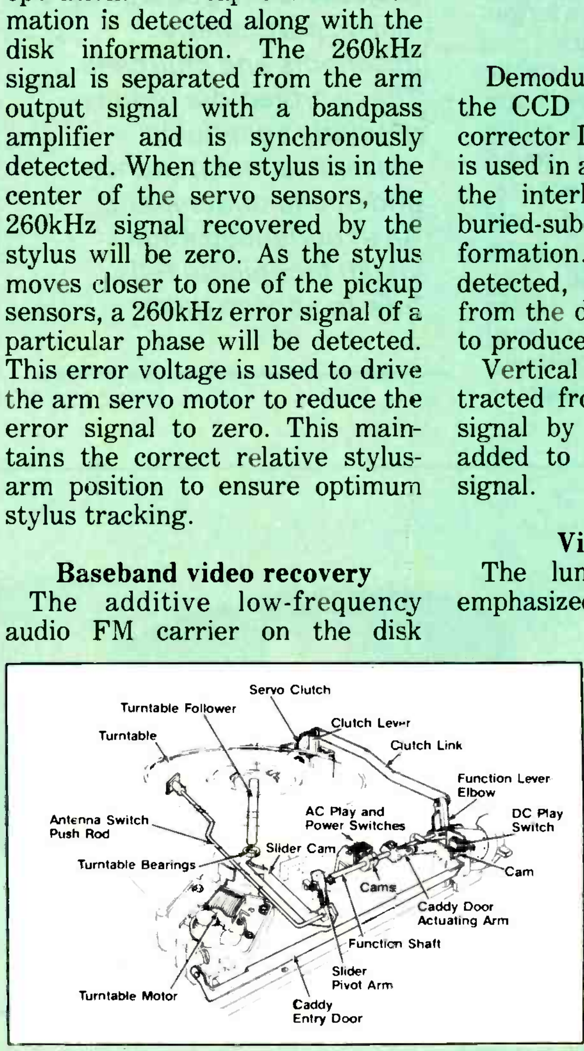
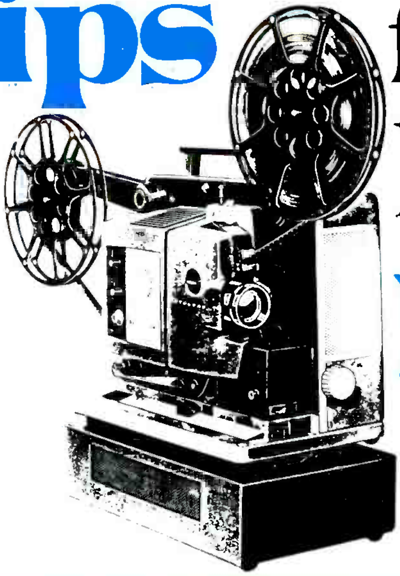


Figure 8. The activation force of the mechanism and disc interface is provided by the user. The function lever as well as the major components are illustrated.



Tips for repairing 16mm film projectors

By Phillip M. Jones, CET

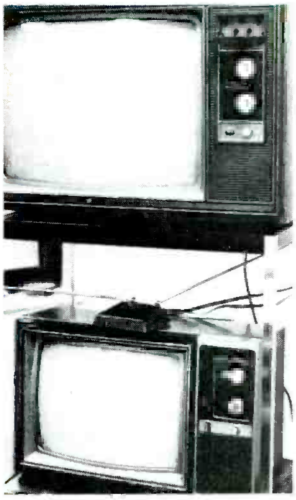
Millions of 16mm sound-on-film movie projectors are constantly in use, particularly in schools and churches. These projectors require regularly scheduled preventive maintenance and occasional repairs. An experienced audio-visual technician tells how to service them.

Repairing audio-visual equipment in public schools is different from servicing other types of electronic merchandise. More preventive maintenance is needed and less emergency repairing. Also, mechanical repairs occupy a larger percentage of working hours.

In the Henry County public schools of Virginia, where I am employed, the audio-visual equipment includes silent and sound 35mm film-strip projectors, cassette tape players and recorders, reel-to-reel tape recorders, videocassette tape recorders, TV receivers, color video cameras, small single-record audio players, public-address systems, intercommunication units, 8mm film projectors, 35mm slide projectors, Hoffman Readers (record players and 35mm film-strip units for individual uses), and DuKane projectors (combination film-strip projectors and record-player/cassette-player units).

Henry County has 25 schools that I visit at the rate of two per day, doing preventive maintenance and all repairs possible at the school. Items needing more extensive repairing are sent to my shop in the County Administration building.

The subject of repairing audio-visual equipment can be expanded to cover the entire field, but this article is confined to 16mm sound movie projectors.



A wide range of audio-visual equipment is used in public schools. Left, color TV receivers on roll-around tables can be moved to any school room. Right, simple single-play record players continue to be used in schools. However, videocassette recorders and color video camera systems also are being employed increasingly.

Tools needed

Tools required for audio-visual repairs are almost the same as those needed for radio and television servicing (Figure 1). These essential tools include two diagonal-cutting pliers, one large and one small; two long-nose pliers, one small and one medium size; one pair of needle-nose pliers with long slender blades; a large assortment of screwdrivers, both standard chisel and Phillips types; a complete set of nutdrivers from number 6 to number 20; solder (I prefer 63/37 type, which has a lower melting temperature); and a temperature-controlled soldering iron.

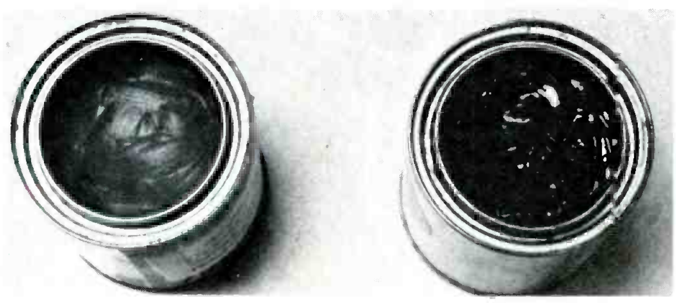
Also, the specialized tools needed are one pair of internal and one pair of external retainer-ring pliers, with a complete set of bits; a complete set of Bristol (multiple-spline) wrenches; a complete set of hex Allen wrenches; threading tools; and a set of Scrulox wrenches.

Test-equipment needed

Test equipment for radio and TV servicing is suitable for audio-visual repairs also. A good-quality VOM is excellent for testing away from the shop. If analysis of Hoffman Readers or videocassette recorders is performed, a wide-band triggered scope and a digital

Figure 1 A wide assortment of tools is required for servicing audio-visual equipment. Left, this tool case with its tools is taken on regularly scheduled calls to schools all over the county. Below, another set of tools is kept at the repair shop in a central location.

Figure 2 Many types of greases, lubricants and chemicals are required for servicing mechanical and electronic machines. Left, lubricants for most applications do not require critical specifications. However, for Bell & Howell 16mm projectors, these two greases are essential. At the left is Bell & Howell number 070034, a general-purpose grease. Notice the lack of shine. Number 070043, at the right, is a special-purpose grease for all plastic worm gears. It does not harden with age (notice the shiny surface). Do not substitute this grease with anything else, if at all possible. Right, many other chemicals and lubricants of less critical characteristics are needed.



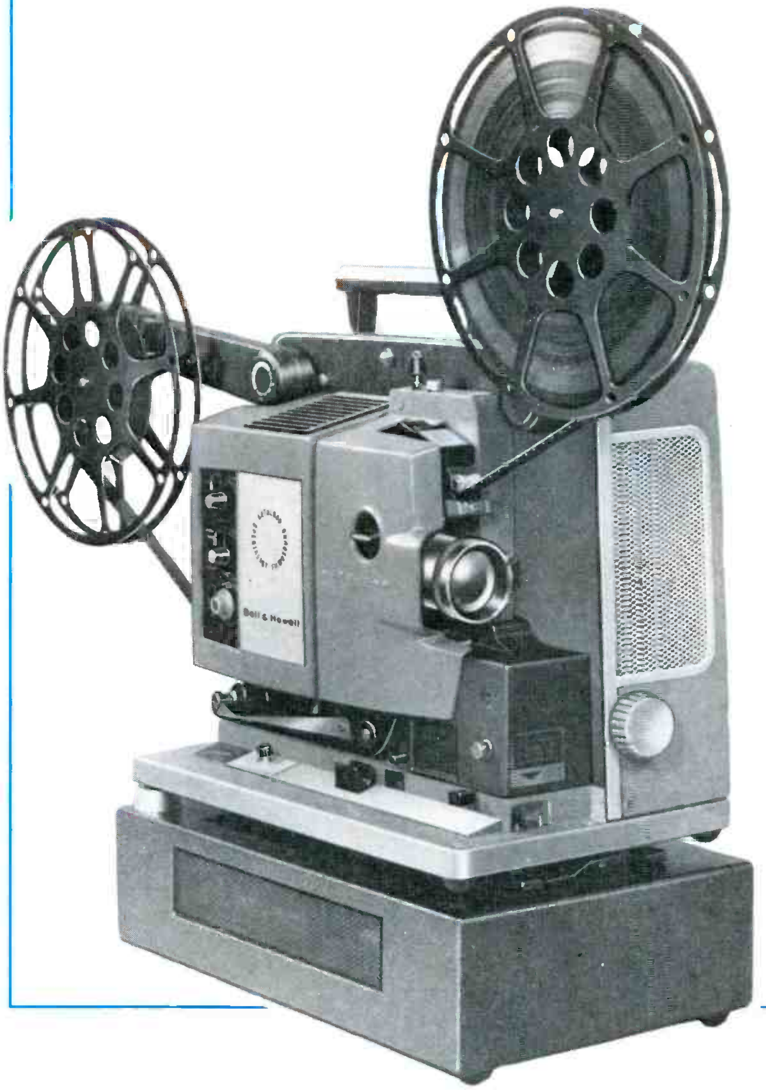
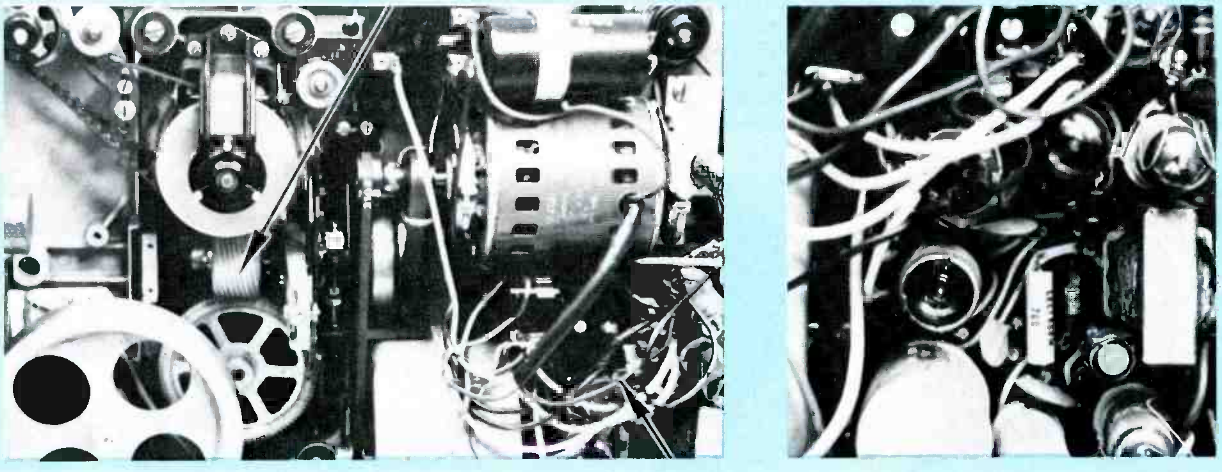


Figure 4 A Bell & Howell model 566T is shown ready to project a sound film. This is an auto-loading late-production 500-series. (*Courtesy of Bell & Howell*)

Figure 3 Several critical areas in older 500-series Bell & Howell projectors are identified here. Left, the arrow to the center locates the important worm gear (the one needing special-purpose grease). The tube-equipped audio board is pointed out by the arrow at lower right. Right, this closeup photograph shows the audio board, which is located below the motor in 500-series machines.



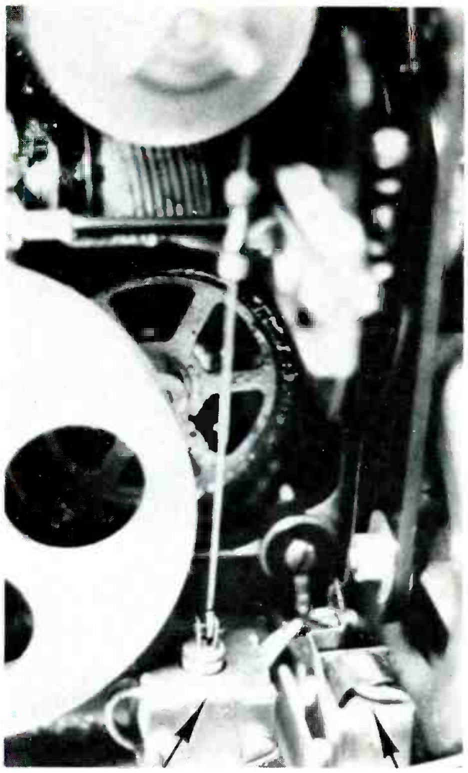
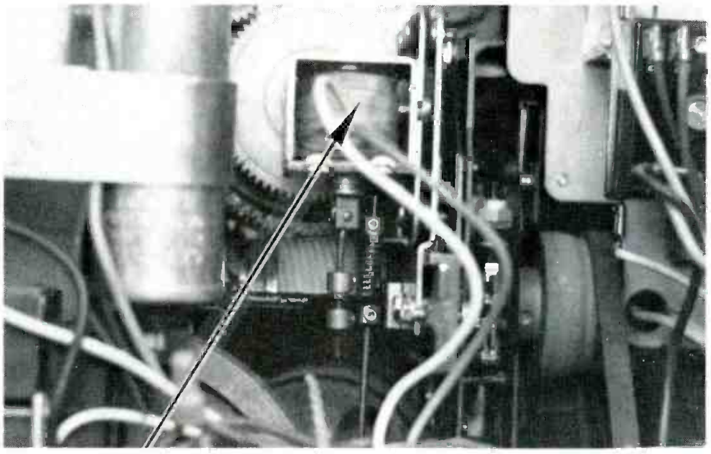


Figure 5 Locations of *Directamotion* solenoids are shown. Left, two solenoids (shown by arrows) were supplied with early 500-series Bell & Howell machines. Below, one solenoid at a higher location was used in 1500-series machines.



frequency counter are essential.

Greases, oils and chemicals

The chemicals (or their equivalents) needed for mechanical and electronic maintenance are cement, such as Pliobond or GC Bond; Plas-T-Pair; WD-40; VITA-Drive rubber-drive cleaner; freeze mist in cans; tuner cleaner; a good solvent such as GC Chloro-Kleen; Lubriplate; Phonolube; and Crazy Glue (Figure 2).

Also, two special greases should be obtained from Bell & Howell for use on their machines. Bell & Howell part number 070034 is an excellent general-purpose grease for all projectors and number 070043 is a special-purpose grease highly recommended for use on plastic worm gears and gears that mesh with worm gears. *Warning:* never apply general-purpose grease to worm gears, because it hardens with age and makes the projector operation sluggish. I prefer Bell & Howell greases but if they are absolutely not available, the 070034 general-purpose grease can be substituted by Lubriplate, and STP oil treatment can be used instead of 070043 special-purpose grease. However, they do not protect as long, so the time between applications should be reduced when these substitutes are applied.

Use tuner cleaner periodically to wash out dust, film chips and film emulsion from all areas of the film path. This also lubricates the film path, and minimizes damage to the film.

Air compressor

An air compressor is essential for blowing out debris from all mechanical equipment. A new commercial type can be purchased, of course, or a technician can build his own and save money. Directions for building an air compressor from an auto air-conditioning compressor are provided later in this article.

16mm film projectors

Although there are many different brands and models of 16mm projectors on the market, our school system uses only Bell & Howell models because they are not expensive, and the parts are readily available. Therefore, the material presented here is about Bell & Howell units only.

Bell & Howell machines are manufactured in five basic types: manual threading; automatic threading; manual threading with *Directamotion* (a type of manual single-frame advance); automatic threading with *Directamotion;* and slot threading of the film.

Our school system has one or more projectors of models 200, 300, 500 and 1500 series. The 200 and 300 models are obsolete, with parts on special orders. The 500 series were manufactured between 1962 and 1970, while the 1500 series are in current production. The 500 and 1500 series look much alike (except for cabinet designs) and they operate about the same. However, there are differences internally.

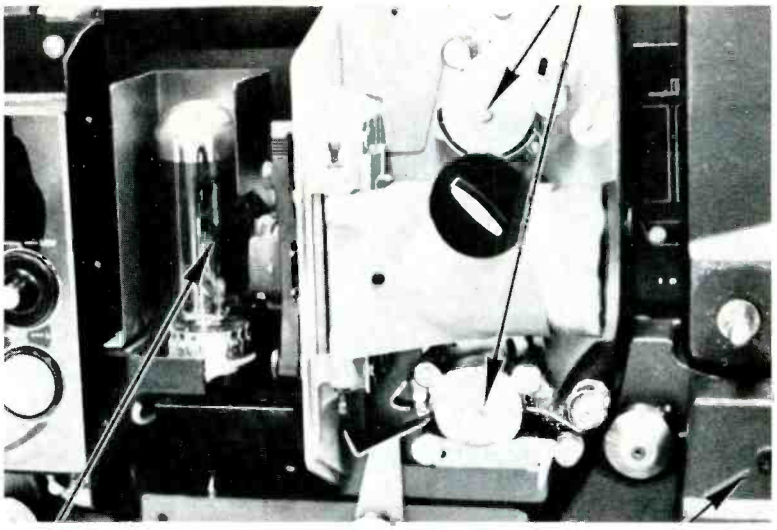
Notice that slot loading is incorporated only in some 1500 and 1600 series units.

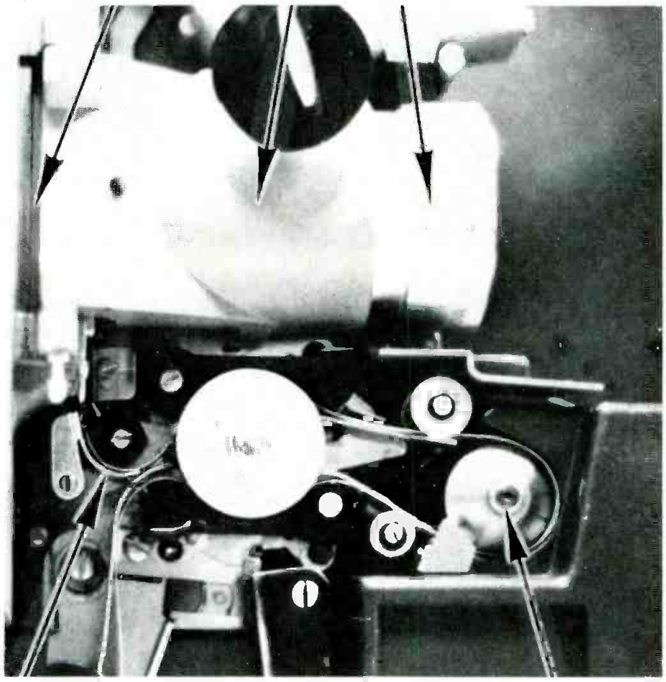
The 500-series projectors

Early production 500-series sound projectors used selenium photodiodes to pick up audio signals from the film. Selenium photodiodes tend to become weak with age, as selenium power-supply diodes become weaker from aging. Most early 500s had vacuum tubes in the amplifiers.

Later production 500-series projectors (Figure 4) had silicon photodiodes, which are not

Arrows point out bulbs and other important components around the film path. Above, at the left, an arrow indicates the plug-in projector bulb in a 500-series machine. Later models had bulb and a circular reflector combined. Two arrows near the center point out the film-drive sprockets that have teeth to prevent slippage. At the lower right, another arrow points to the location of a BAK sound exciter bulb that is inside a lightproof compartment. Below, the three arrows at the top identify in order from left to right: the film gate, housing for the lens and focusing mechanism (notice the focusing knob above), and the lens that is moved forward or backward to achieve sharpest focus of the picture. At the left below, the arrow shows the bottom loop. The loops are necessary because the film travels at a constant and steady speed *except* at the film gate. In the film gate, a shuttle plate with three prongs (that engage the film sprocket holes) holds the film motionless while the light shutter opens twice (to prevent visual flicker), then the plate moves the film downward rapidly to the next frame before stopping again for two shutter openings (when the projector bulb light passes through to the lens and on to the screen). This procedure is continuous during a film showing. However, the jumpy film movement must be smoothed before it reaches the sound light beam. Smoothing the film movement is performed primarily by the sound capstan (arrow at lower right).





weakened by age, and transistors in the amplifiers. Early production machines can be changed to silicon photodiodes (highly recommended), but the photodiode preamplifier must be replaced at the same time with one designed for use with silicon photodiodes.

All internal mechanisms in the 500-series machines (except the film-sprocket gears) were belt driven. Some early manual-threading models did not have automatic loop restorers. (However, on those that had loop restorers, only the bottom film loop was corrected.)

In early version *Directamotion* models, both the animation clutch and the fire-prevention shutter were solenoid-operated. Figure 5 shows old and new solenoids.

The 1500-series projectors

Newer 1500-series projectors (Figure 6) continue in production. The audio amplifiers have ICs and transistors on modules that plug in. Therefore, a malfunctioning amplifier either can be repaired by the technician or returned to the factory in exchange for a rebuilt module.

These Bell & Howell circuit boards appear to have been manufactured by a low-temperature process. Do not use too much heat during soldering on them, or the copper wiring will lift from the board.

Only one belt is used in each 1500-series projector. A belt drives the cooling blower from the same motor that powers the film advance. All other belts have been replaced by gears.

The 1580-series projectors

Although internal operations of 1580 series Bell & Howell projectors (Figure 7) are similar to previous models, the slot threading of film is new.

Slot threading often can be performed faster than by automatic threading, when this method is used with slot-threading models.

With the film on the supply reel, move the load lever to the *load* position. Grasp the film's end and pull it through the film-channel slot to the take-up reel, threading it on the reel. Gently rock both reels back and forth several times to make certain the film is properly seated. Turn the load lever back to *operate* (which positions the loops), and turn on the power.

Fewer internal and external parts are used in these slot-loading models, and the general operation is simplified.

Selecting a projector

Additional features can be a drawback unless they are actually needed. A manually threaded model sells for a lower price and usually has a lower cost of repairs. These are excellent for organizations that use projectors less than ten times per year. However, lost film loops must be corrected manually.

Automatic threading models provide convenient operation. Thus, they are good choices when the projector will be used often by unskilled operators. But they are more costly to buy and maintain. Severe film damage can occur if the mechanism malfunctions while the film loops are lost. These models have automatic loop correction.

Although the slot-loaded machine is slightly more complicated to load, it can be loaded rapidly after the technique is learned. A manually operated loop restorer is used, and it provides better film protection. Design of the slot-loading film channel probably prevents many cases of film damage from film stretching or tearing of sprocket holes. These advantages make slot loading a good choice for many applications.

Animation (starting and stopping of film travel without damage or burned film – Bell & Howell calls it *Directamotion)* is available in all series except those machines with slot loading. Animation is a helpful feature for classroom uses, but it does add complications that are not desirable unless the animation is necessary.

Typical projector repairs

Finding the general area of a defect is obvious in the majority of film-projector repairs. A frozen shaft or a slipping belt on the take-up reel assembly will force the film to fall in a pile on the floor when the projector is operated. Hum, flutter, distortion or weak volume of the sound is easy to hear. Total loss of light from the projector bulb indicates a bad bulb or loss of voltage to it. More time will be required to repair these obvious defects than to identify them.

Replacement of various belts is probably the most common film-projector repair. With Bell & Howell machines, be certain you select the proper belt according to the corresponding color of the motor pulley.

Figure 6 Model 1579C Bell & Howell sound film projector has manual threading of the film. Notice the film-path chart at the lens' right. The film reel at the top is the supply reel where the film is placed before projection. At the lower left is the take-up reel that accepts the film during projection. *(Courtesy of Bell & Howell)*

Projector models that have tubes in the amplifiers always require periodic maintenance tube tests plus emergency replacements when unexpected failures occur.

Sound-exciter lamps and projection lamps (such as BAK sound and CTT/DAX or EMM/EKS projection in Figure 8) require regular replacements. Most projection bulbs are rated at about 50 hours of operation, while the BAK sound-exciter bulb is rated at 300 hours. A good maintenance schedule can be built around those figures.

Excessive mechanical noise usually can be corrected by adjustment of the shuttle-ball-and-stud assembly, and wetting the felt wiper pads with light oil. When a machine is operated without film, but these repairs are needed, distinctive rapping noises (similar to sewing-machine noises) are produced. Normal projector noise is composed largely of gear sounds plus some film slap.

Automatic-threading mechanisms require occasional adjustments or repairs.

Unusual projector repairs

The complaint against one 500-series projector was excessive noise, apparently from gears and belts but much too loud, and coming from the speaker, not the mechanism. The noise did not interfere with the normal film sound.

A few taps with a screwdriver handle on the machine verified the suspicion that something in the sound system had become microphonic. Tubes are susceptible to this problem. Evidently the bracing of the control grid becomes loose, allowing the grid to move sideways. Movements of the grid also changes the plate current, which produces an audio signal. Microphonic tubes often ring with a bell-like tone when tapped. Transistors seldom become microphonic, but resistors and capacitors can in rare cases.

However, new tubes did not stop the noise this time. When I changed the BAK sound-exciter bulb, the microphonic was gone completely. A careful visual inspection of the lamp disclosed a loose mounting collar that originally had been soldered to the bulb's base. The loose collar al-

Figure 7 Bell & Howell model 1580C has the film path enclosed except for a channel where the film is inserted in this slot-loading machine. *(Courtesy of Bell & Howell).*

lowed the bulb's light to flicker slightly when the machine was vibrated, thus changing the photodiode current and producing audio signals that could be heard from the speaker.

Another machine had a constant bumping noise along with the film sound. This noise was not audible when the machine was operated without film. Therefore, the problem must originate in the sound-gate assembly. During inspections of all nearby parts, I found a large scratch on the drum (in the film channel) that positions the film relative to exciter lamp and photodiode. In normal operation, the film is drawn tightly around the drum to prevent wow and flutter speed variations in the sound signal. This scratch raised the film slightly, thus varying the film-to-photodiode distance. The varying distance changed the photodiode current, adding the bumping noise to the film sound.

In 500-series projectors equipped with amplifier tubes, an open 7.5Ω resistor eliminates both the tube-heater voltage and the BAK exciter-lamp voltage. Of course, this completely eliminates all film sound.

Worm gears crack or break (Figure 9) when they are not lubricated often enough, or when the wrong type of grease is used.

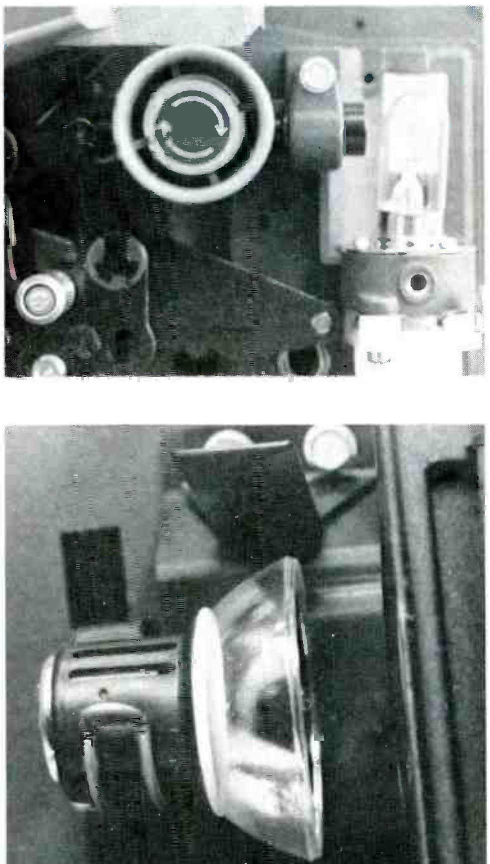


Figure 8 Sound and picture bulbs are shown. Above, when the cover is removed from the light-tight sound-exciter compartment, the BAK bulb and its mounting is accessible in the 1580-series projectors. Below, the 1500-series machines have a round bulb with internal reflector. They are held tightly by the spring clamp. Removal is easy; just snap down the clamp and pull the bulb's two prongs from the socket. Use care if the bulb is hot.

Routine maintenance

Maintenance of 16mm projectors is uncomplicated and fairly easy, but it should be done on a regular basis. You should have a test film (perhaps an old film is available because it is obsolete or damaged). Cut out the damaged portion and splice the good sections together. The subject matter is immaterial.

The following procedure should be followed once each year:

- Open all doors, lens carriers, and film channels.
- Remove the back and all covers.
- Using compressed air, blow out all dust, film chips, bits of emulsion, and dirt. Alternately, brush the film channel with a soft-bristle brush.
- With an extension nozzle on a can of tuner cleaner, spray the film channel liberally. Again, blow out the channel with compressed air. (If a safe area for storage is available, naptha is a

good cleaner for both inside and outside.)

- Inside the projector, wash all gears and shafts with Chloro-Kleen or an equivalent cleaner (naptha is good, also), and dry them with compressed air.
- Carefully inspect all nylon gears for chips, breaks or cracks. If these defects are severe, order new parts and replace the bad ones.
- On all gears and shafts (except the worm gear and the two sprocket-drive gears), apply B&H 070034 general-purpose grease sparingly.
- On the worm and sprocket-drive gears, use a liberal coating (but not enough that it will be thrown by the rotation) of B&H 070043 special-purpose grease.
- Thread the projector with test film and operate it, noting any defects or misadjustments while the covers are removed.
- Make any necessary adjustments or repairs and clean up excess greases.
- While the machine is running, take an oil can with a long spout and oil the shuttle-ball-and-stud assembly with 10-weight sewing-machine oil. Do this slowly and carefully until the point of quiet operation barely is reached.

In addition to this extensive annual procedure, the film channel should be opened and sprayed with tuner cleaner about once a month or during each repair.

If these precautionary steps are followed, the projector should last for 15 to 20 years.

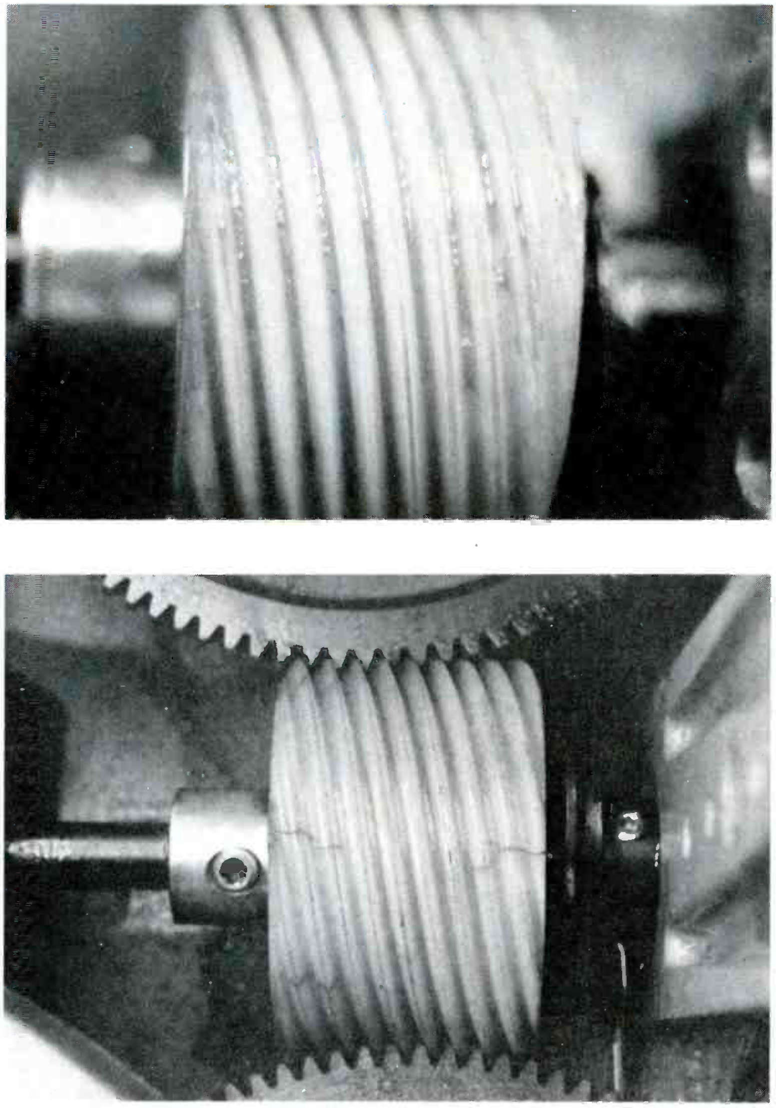


Figure 9 The effects of correct and improper lubrication of the main worm gear are shown. Top, a correctly lubricated (with Bell & Howell 070043 grease) worm gear has an even coating of grease. The gear is not cracked or chipped. Above, a similar worm gear having insufficient, infrequent or incorrect lubrication is likely to have cracks requiring replacement of the gear.

Replacing belts

Use this procedure to replace a drive belt in a 500-series projector:

- Remove the rear cover, and loosen four screws holding the blower in position.
- Slide the blower upward, and remove the blower belt.
- Work the drive belt off the drum-type pulley.
- Fish the belt out through the sound/silent control guide, and remove it from the motor pulley.
- Install the belt by using this procedure in reverse order.

The belt-changing procedure for 1500-series B&H machines is different.

- Remove rear, top and side covers.
- Loosen all Bristol screws holding the blower to the shaft and on the motor pulley the drive belt rides on. Remove all ¼-inch head screws holding the blower halves together and to the frame.
- Work the belt off the pulley drum, next to the worm gear first, and then off the bottom pulley.
- While these are disassembled, clean and lubricate all blower parts that are designed for lubrication.
- Work the new belt on top of the drum-type pulley first, and then on the bottom.
- Reassemble in reverse order.

If replacement of blower, blower belt, or motor pulley is necessary, write down model and serial numbers of the machine. Also, it is very important to include the color of motor and blower pulleys with the order for a new belt or part. Different production runs used various components in 500-series machines, and these must be custom-matched by colors.

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Troubleshooting Tips wanted

Electronic Servicing and Technology needs additional consumer-product Troubleshooting Tips. Most types of case histories are suitable, especially those with unique, puzzling or misleading symptoms.

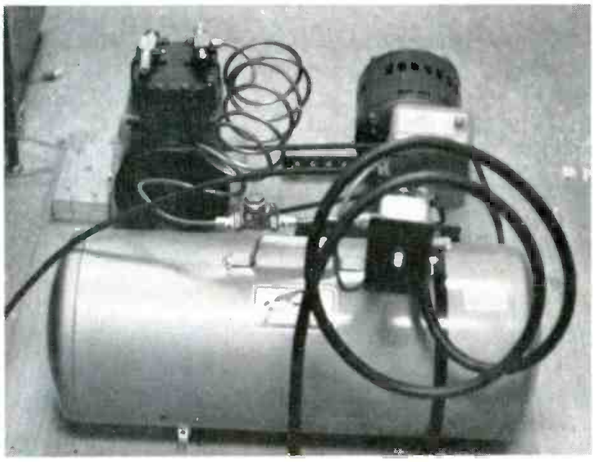
List the brand, model and Photofact number followed by a narrative telling the original conditions or symptoms, the various troubleshooting steps, and the components replaced to restore the original performance. Please include a simple hand-drawn schematic of the stage that has a defect.

$10 will be paid for each Troubleshooting Tips published. Your name and city will be listed, unless you ask to remain anonymous.

Send all Troubleshooting Tips to:

Troubleshooting Tips Department
Electronic Servicing and Technology
P.O. Box 12901
Overland Park, KS 66212

Building an air compressor



A dependable source of high-pressure air is helpful when movie film projectors are lubricated and repaired. Of course, commercial air compressors can be purchased, but it is not difficult for a technician to construct his own for about $100. The one built and used by the author is shown in the picture. These major components are required:

(1) A York automobile air-conditioner compressor sold in Ford cars. This one was purchased reasonably because the clutch was broken. However, for use as an air compressor, the clutch must be welded, silver-soldered or brazed so the pulley is engaged at all times. Such compressors can be obtained in auto junk yards.

(2) A 120Vac ½-horsepower washing-machine motor in good working condition.

(3) A portable air tank, available in most auto-parts stores.

(4) A pressure switch with contacts. At low tank pressures, the contacts are closed, allowing the motor to run. When the pressure reaches the preset value, the contacts open and stop the motor. A type with adjustable pressure is advisable. A satisfactory range is motor-on at 90PSI and off at 125PSI. Install a heavy-duty on/off switch if the pressure switch does not have one.

(5) A check valve that allows air flow in one direction (toward the tank). This prevents any back flow to the compressor, which might damage it.

In addition, these minor components are needed: a plywood platform for the air compressor assembly; two pieces of angle iron with slots (allowing movement of the motor to tighten the belt properly); a pulley for the motor shaft (it should be smaller than the compressor pulley); a kit of copper tubing and connectors, such as used by refrigeration repairers; and a V-belt having proper length and angle for the pulleys and the distances between compressor and motor.

ES&T

BOOK REVIEWS

***Editor's note:** Periodically **Electronic Servicing & Technology** presents reviews of books dealing with subjects of interest to our readers. Please direct inquiries and orders to the publisher at the address given in each review rather than to us.*

The Book; Atari; 186 pages; $39.

A comprehensive, practical guide to servicing and operating Atari coin-operated electronic video games is now available by order from the company's authorized distributors or directly from its customer service department.

"We feel that *The Book* is one of the most complete and concise service manuals on game operation ever produced," said Fred McCord, field service manager. "It is intended for use by operators, distributors and service technicians."

The illustrated guide contains sections on tool selection and use, soldering, general troubleshooting, display monitor repair, printed circuit board components, integrated circuits and digital and analog devices. Also included is an 8-page glossary of electronic terms.

Published by Atari. Direct inquiries to local distributor.

Microcomputer Dictionary, by Charles J. Sippl; Sams Books; 608 pages; $15.95.

This dictionary is a valuable resource for anyone who is or who wants to be involved with microcomputers – from students and hobbyists to engineers and technicians.

Author Charles J. Sippl provides an understandable, deeper treatment than mere dictionary phrasing. He emphasizes how terminology is used in today's industry by product manufacturers, system designers and application developers.

Such terms as Ada language, compilers and silicon-on-sapphire are fully explained, as are some non-computer words and phrases, such as optical cable and laser annealing.

More than 100 drawings and photographs are included to enhance the usefulness of this carefully researched work.

Appendix A focuses on microprocessors, with coverage ranging from semiconductors and 16-bit microprocessing units to 32-bit microprocessors and bubble memory boards.

Appendix B takes a close look at microcomputer markets, handheld computers, computers in education and business, robotics, viewdata and teletext services, and more.

Published by Howard W. Sams & Co., 4300 W. 62nd St., Indianapolis, IN 46268.

Basic Electronics Theory – with projects & experiments, by Delton T. Horn; 532 pages; $19.95 hardbound, $11.95 paperback.

Beginning electronics hobbyists looking for an introduction to fundamental electronics concepts or experienced experimenters and technicians in search of a quick-but-comprehensive reference source will discover this book was written especially for them. It's a data-packed guide to all the basics of electronic theory – atoms, electrons, conductors, insulators, resistance, Ohm's law and voltage sources, and it's a manual on the most up-to-date electronics applications, including space-age calculators and computers.

This is the kind of guidance that makes it simple for anyone to grasp basics such as capacitors and capacitance, magnetism, resonance and transformers, and a series of 11 experiments reinforces this knowledge. The author also explains vacuum tubes, semiconductors, LEDs, general and special purpose transistors, with lots more experiments to help readers gain clear understanding of FETs, MOSFETs, SCRs, Diacs and Triacs.

There is even a full explanation of stereo technology and explanations of recording with magnetic tape, how phonograph records work, about stereo broadcasting, quadraphonic sound systems and more. Equal attention is given to television, and the final chapter deals with calculators and computers.

If someone is just getting into electronics experimentation and wants a learn-it-quick guide to all the essentials of theory and practice, or if they are experienced hobbyists searching for a complete reference, they will find it in this comprehensive sourcebook.

Published by Tab Books, Blue Ridge Summit, PA 17214.

Webster's Microcomputer Buyer's Guide, by Tony Webster; Hayden Book Company; 326 pages; $25.

This detailed reference guide lists approximately 113 private vendors for microcomputer users. The book's 16 chapters contain four parts: theory and application, independent software vendors, microcomputers and microcomputer systems, and CRT displays, printers and printing terminals.

Part I covers theory and application and outlines the differences between microprocessors, microcomputers and microcomputer systems. The author also examines the future potential of microcomputers and provides guidelines for selecting microcomputers and the capabilities of microcomputers in word processing and education.

Part II provides descriptions of many software operating systems, utilities, languages and application packages from independent vendors.

Part III provides a summary of many major microcomputer systems available, in the categories of overview, central processing systems, peripherals, software, pricing and head office.

Part IV lists in detail the specifications of some of the popular CRT displays, printers and printing terminals available for connection to microcomputers.

Published by Hayden Book Company, 50 Essex St., Rochelle Park, NJ 07662.

ES&T

Player design

(from page 47)

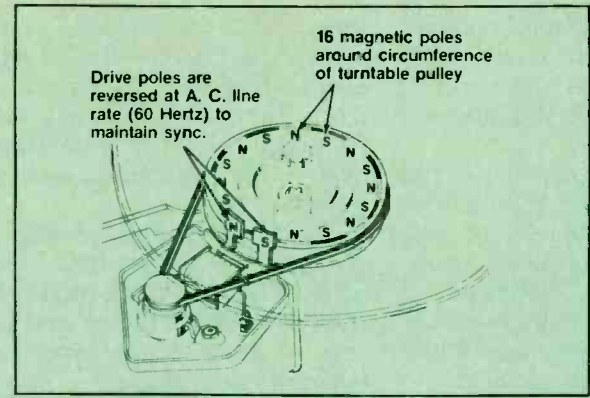


Figure 9. The major drive components in the disc rotating system. Included are the ac motor, compliant rubber belt, drive poles and magnetic strip.

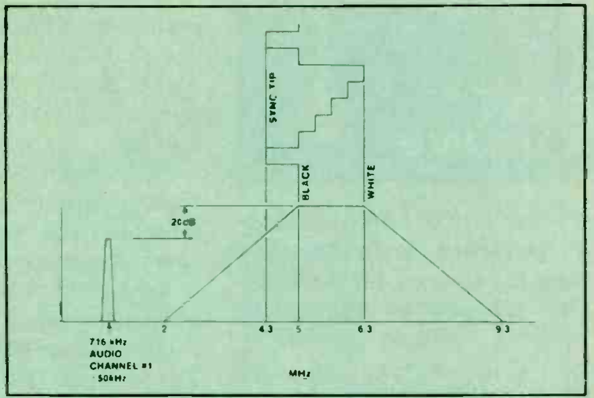


Figure 10. "CED" videodisc signals. The audio FM carrier is centered at 716kHz, and the video carrier varies from 4.3MHz to 6.3MHz.

IC and added to regenerated 3.58MHz chroma to create a standard NTSC composite video signal. Inverted low-level luminance is added to cancel high-frequency noise before being fed to the RF modulator.

NTSC standard 3.58MHz chroma is produced by mixing the combed 1.53MHz chroma with the output of a 5.11MHz voltage-controlled crystal oscillator (VCXO). A gated phase detector compares the up-converted 3.58MHz burst signal to a 3.58MHz crystal reference oscillator, producing a phase-error signal that controls the VCXO. This signal is also used to control the arm-stretcher transducer in the arm assembly, which drives the stylus tangentially along the groove in a direction to reduce time-base errors.

RF modulator

The RF modulator contains a 4.5MHz oscillator that is FM modulated by the audio signal. The regenerated NTSC video and the 4.5MHz FM audio modulate a VHF oscillator producing an RF signal on Channel 3 or Channel 4.

Control system

A microcomputer IC controls overall operation of the player. In response to inputs from the user controls and signals read from the disk, it operates the stylus lifter, the stylus skipper and the pickup arm servo, and also provides status information on an LED display.

The signal read from the disk is a 77-bit digital auxiliary information (DAXI) code that provides field and band number identification. The DAXI code is recorded on line 17 of each vertical field, in a NRZ (Non-Return-to-Zero) format synchronized with the 1.53MHz chroma.

The data is detected, stored and checked for errors by a DAXI buffer IC. On command, it is shifted into the control system microcomputer IC. The field number is converted within the control system microcomputer to a playing time in minutes and is displayed on the instrument's front panel. The field numbers are also checked to verify that they are progressing in the proper sequence.

Occasionally the stylus may encounter a disk defect or debris within the disk groove that will cause the stylus to jump to a previously played groove. If the defect is severe enough, this could actually become a repetitious or locked-groove condition. When the field number sequence indicates that a groove is being replayed, the stylus skipper is activated to move the stylus forward past the defect.

When the visual search feature is activated by the user with one of the player front panel buttons, the control system microcomputer again outputs pulses to the stylus skipper coils. The pulse is applied so that a nominal skip of two grooves occurs during the vertical interval where it is not visible in the picture. This provides approximately 16-times real-time motion in the picture.

When it is desirable to move more rapidly, the user activates one of the rapid-access buttons, causing the microcomputer to lift the stylus and move the arm at approximately 150 times real time. Because the DAXI information is not available in this mode, an opto-interrupter coupled to the arm assembly provides pulses to the microcomputer. These pulses are used to update the instrument's front-panel display.

If the pause button is pressed during the play of a disk, the microcomputer raises the stylus, and stops the arm drive. The end of the disk program is recognized from the decoded band number, which also causes the stylus to be raised, and the arm drive to be disabled.

Summary

A general description of the key mechanical and electronic systems within the RCA SelectaVision player has been presented. The CED system parameters have been carefully chosen to ensure that the player can be manufactured at a cost that will make it available to the mass consumer market. The player is designed to be easy for the average consumer to operate, with features that will be useful in the playback of all video program material.

ES&T

NEW PRODUCTS

Nut driver set

There has been a great demand for a set of 6-inch shaft nut drivers to accommodate the many applications in which added length is necessary. In response to this demand, *Vaco Products Company* has introduced this 7-piece pouched set, which contains the most popular hex sizes, including 3/16, 1/4, 5/16, 11/32, 3/8, 7/16, and 1/2 inch.

The drivers in the Extra Long Nut Driver Set No. 89904 have a patented shaft construction that enables them to withstand high torque, even at elevated temperatures. Their all-hollow shaft will accommodate the longest stud.

Circle (48) on Reply Card

Antenna amplifiers

A new generation of outdoor antenna amplifiers – Spartan 2 from *Channel Master* – features new circuitry for higher gain, wide range stability and lower noise.

The 11-model Spartan 2 line offers optimum UHF/VHF/FM reception in high input as well as deep fringe areas. Special feedback circuitry provides constant, flat gain that boosts distant signal strength up to 23dB. High VHF input signal levels – up to 200,000µV – are accepted with no harmonic distortion or cross modulation interference effects.

To control FM interference, all UHF/VHF/FM amplifiers use a combination of switchable and tunable FM traps. A contactless plug is raised and rotated to switch the trap in or out. Although this switch provides a typical attenuation of 25dB across the entire FM band, additional attenuation is possible by means of a simple screw adjustment. Other unwanted radio frequencies, such as marine, air traffic and CB, are blocked by powerful out-of-band rejection filters.

Circle (44) on Reply Card

Home satellite television

Downlink has unveiled a line of low-cost home satellite TV receivers, an innovative hobbyist's satellite TV system and a modular parabolic antenna.

The new receivers now make it possible to own a home satellite TV system – with 12-foot antenna, 120° LNA, D-2X receiver, RF modulator and cables – for only $3595. Known as the Skyview I System, "this is the lowest-priced completely turnkey system on the market," said Portus Barlow, Downlink president.

For hobbyists who prefer to build or buy their own antenna, Downlink has introduced the EP-2000 Electronics Package, offering all the electronics needed to watch satellite TV, except for the antenna.

And for those who prefer the parabolic antenna over the spherical, Downlink is also offering the Skyview III modular fiberglass parabolic antenna. The antenna can be shipped air freight anywhere in the world and assembles without training or special tools.

Circle (45) on Reply Card

Record cleaner

Allsop has entered the record care market with the Allsop 3 Orbitrac record cleaning system.

Under development for more than two years, the Orbitrac uses a patented dual disk cleaning action that makes record cleaning simple and foolproof.

According to Ivor Allsop, company president, the Orbitrac cleaning pad's fibers are perfectly aligned with record grooves when

its pivot arm is placed into the record spindle hole.

The cleaning disk is attached via a precision internal bearing to a control disk. As the user spins the control disk around the record, the cleaning pad remains in perfect contact with the record grooves while the control disk pivots freely with the hand motions.

Circle (46) on Reply Card

Digital multimeter

Leader Instruments Corporation now offers a 3½-digit digital multimeter that fills the need for both laboratory and field work.

The LDM-855 offers automatic ranging, semi-automatic zeroing and an LCD display for hands-free operation.

When manual range or function selection controls have been changed, a momentary audible tone is heard. When used in the resistance mode, or for checking continuity, the tone is sounded continuously when short-circuit conditions occur. This enables the

operator to make tests without having to constantly look at the meter to see if continuity is present.

Other unique features include an automatic polarity indicator, ac and dc measurement functions, a Lo-Ohm mode to provide a lower test voltage and a low battery warning incorporated into the liquid crystal display.

Circle (42) on Reply Card

RF microwattmeter

Boonton's new 4210 RF Microwattmeter is microprocessor based, but with a difference. Designed to replace older power meters in non-programmable applications, the 4210 avoids the complexity of programmable instruments by combining the power of microprocessor technology with the simplicity of 5-button control.

Zeroing is automatic; one button stores and corrects for zero off-

sets. Ranging is also automatic; a 3½-digit display with annunciators indicates in either power or decibels referred to 1mW. Offset readings are automatic; any dBm display can be used as a reference and all further readings displayed in decibels relative to that reference.

Circle (43) on Reply Card

ES&T

NEW LITERATURE

Copies of the 1981 Telecommunications–Trends and Directions proceedings are available from the **Electronic Industries Association's Communications Division.**

A compilation of papers presented by twelve industry leaders at this spring's Hyannis Conference, the book presents an up-to-date overview and detailed projection of numerous segments of the telecommunications industry.

A few topics covered in the 1981 edition include: Worldwide Telecommunications Markets Through 1990, Premium Broadband Services, Satellite Data Communications, Electronic Mail and The Bell System as a Market.

Circle (59) on Reply Card

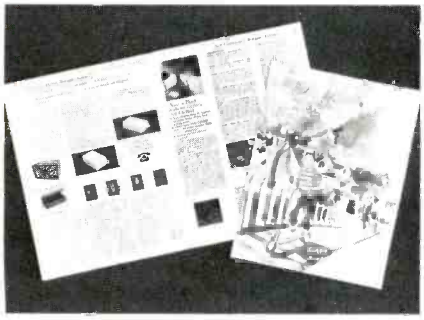
Micro Electronic Systems Inc. is offering a 20-page catalog covering IC insertion and extraction tools and a large variety of IC and PCB handling systems.

New products featured are SLIT-N-WRAP wire guns, the digital HEAT-A-DIP rapid IC removal/replacement system, the model KB2 PCB drill and accessories, and HOT-SPOT and KWIK-CHEK soldering iron tip temperature measuring systems and the SUPER VAC III solder sucker operating from a Freon can.

Circle (57) on Reply Card

Mountain West has introduced its 1982 security and alarm products catalog featuring more than 1600 items. The catalog also provides technical information on system design, as well as alarm application and installation procedures with connection diagrams.

The 68-page catalog contains product lines broad enough to provide a 1-step supply source for alarm installers, businesses, industry, government agencies and do-it-yourself individuals who demand the highest quality alarm systems, components and accessories at affordable prices.



Burglar equipment ranges from relatively simple magnetic door switches, control and bell systems to the latest in radar, ultrasonic and infrared motion detectors.

Circle (69) on Reply Card

Radio Shack, a division of Tandy Corporation, now offers programmers of their TRS-80 Model I, Model II and Model III computers a comprehensive volume of advanced information on techniques for effective and efficient programming in BASIC called *BASIC Faster and Better & Other Mysteries.*

The author, Lewis Rasenfelder, a recognized programming authority, reveals innumerable shortcuts, secrets, bits of what the author calls "trickery" and helpful hints for high efficiency, plus other advanced programming techniques. He offers extensive information on many topics, including shell programs, USR routines,

Circle (18) on Reply Card

"magic" arrays, strings, searches and sorts, utilities, number crunching, overlays, bit manipulation, memory mischief and more.

Circle (70) on Reply Card

Household appliances and other electrical equipment in the home and office can now be effectively converted to solar power, according to a **U.S. Department of Energy** technical report. The *Photovoltaic Product Directory and Buyers Guide* is available from the National Technical Information Service (NTIS).

Photovoltaics (PV) is simply the use of solar cells to supply power to equipment. The directory includes a comprehensive listing of sources of PV products and their applications.

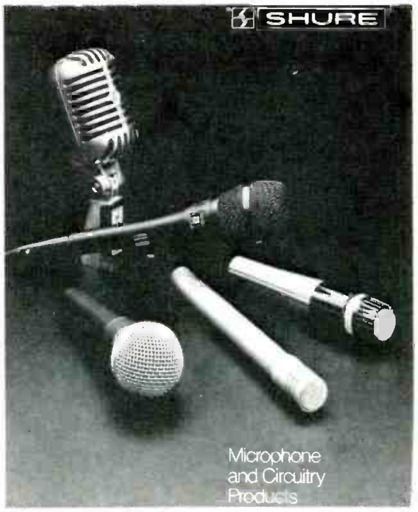
In addition, the guide provides information on financial incentives available from state and federal governments when solar equipment is installed, sources of additional information on photovoltaics, a matrix indicating sources of various products and a listing of addresses of suppliers. To receive the guide, send $13.50 and request DE8103083 from NTIS, 5285 Port Royal Road, Springfield, VA 22161.

Circle (71) on Reply Card

Shure Brothers has announced the release of their newest Microphone and Circuitry Products Catalog. The introductory and closing editorial of the new catalog creatively explains Shure's commitment to excellence, detailing the rigorous testing and retesting involved in maintaining the company's high standards of quality.

For ease of production selection, the catalog explains in detail "microphone specifications...what they mean," and has an easy-to-use selection guide offering suggestions for application. The catalog also implements a new indexing style that cross references each product by model, and it also contains a data sheet reference guide for easy ordering.

The 72-page catalog describes



more than 150 microphones, including professional, general purpose, communication and special purpose models. The catalog also covers microphone accessories, circuitry products and their corresponding accessories.

Circle (65) on Reply Card

Accurate Screw Machine Company, producers of a wide range of electronic hardware components, has announced the availability of their new 185-page catalog detailing their extensive product inventory.

Included in this publication is information on such products as fasteners, ferrules, handles, nuts, retainers, screws, spacers, standoffs and washers. Each product is given an individual section of general specifications and finishes; mechanical drawings; photos; tables indicating sizes, lengths and diameters; plus examples showing how to establish part numbers. In addition to this, new products are flagged in the table of contents for instant reference and a pictorial index to aid in product recognition.

Also provided are metric conversion tables, a fraction-to-decimal equivalency chart, thread and tolerance data and a summary of the materials and finishes available from Accurate Screw.

Circle (66) on Reply Card

A new 8-page catalog has been published by **Multicore Solders** that illustrates and describes their complete line of products. The products include wire core solders, soldering fluxes, bar solder, cleaning solvents, special-purpose chemicals, PC board fabricating materials, soldering wick, solder creams, preforms and tapes, solder resists and Xersin, the new cost-effective chemistry system that eliminates the need to clean PC boards.

Circle (67) on Reply Card

The new Dremel Guide to Compact Power Tools just released by **Dremel**, a Division of Emerson Electric Company is a bound manual that thoroughly describes the setup and operation of the company's Moto-Tool and attachments, disc/belt sander, table saw, moto-flex tool, moto-lathe, moto-shop, scroll saw/sander, and D-vise.

Included are many "quick fix" pages that show practical applications of the tools, plus how-to-do-it chapters on building a mini-power workshop, design and lay out a project, service and maintenance, and materials and how to use them. The chapter on materials contains a comprehensive materials guide on woods, marble, glass, plastics, adhesives, soft metals and fasteners for the hobbyist or do-it-yourselfer.

Circle (68) on Reply Card

In the 1982 Battery Cross-Reference Guide, published by the **National Electronic Distributors Association** (NEDA), 12 lithium batteries are listed for the first time.

Two additional battery suppliers are included among the 10 participants for the first time: Gould and Maxell Corporation of America. The others include Battery Technology Company (Duracell), Berec, Bright Star Industries, Burgess, Eveready (Union Carbide Company), General Electric, Panasonic and Rayovac Corporation.

The guide lists 221 battery numbers in non-rechargeable and rechargeable categories, with cross-reference designations from the 10 major battery manufacturers. The guide is not a standards, testing or evaluation listing, but is a guide to the most commonly used comparative and interchangeable batteries.

Circle (62) on Reply Card

Circle (20) on Reply Card

Circle (21) on Reply Card

Circle (22) on Reply Card

THE MARKETPLACE

Advertising rates in the Classified Section are 50 cents per word, each insertion, and must be accompanied by payment to insure publication.

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AUTOMOBILE RADIO and tape replacement parts: Delco, Chrysler, Philco-Ford, Motorola, Panasonic and many others. Large inventory. Laran Electronics, Inc., 3768 Boston Road, Bronx, NY 10469. (212) 881-9600, out of New York State (800) 223-8314. 5-79-tf

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PRINTED CIRCUIT boards from your sketch or artwork. Affordable prices. Also fun kit projects. Free details. DANOCINTHS INC. Dept. ES, Box 261, Westland, MI 48185. 5-81-tfn

RADIO-TV TUBES INCLUDING ANTIQUES! Many tubes thought to be obsolete are still being manufactured. Write for free discount price sheet of over 1,800 types. Electronic Parts Co., 1015 S. Escondido Blvd., Escondido, CAL 92025, (714) 741-2300. 1-82-6t

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B&K 747—$210.00. **LECTROTECH BG-20**—$110.00. More. Miller, 10027 Calvin, Pittsburgh, Penna. 15235. 5-82-1t

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SAMS PHOTOFACTS. RARE VOLUMES 1 TO 816. Good investment. Repair those profitable antique sets. All for $2,200, less than $3.00 each. Most cannot be had from publisher. Would cost $7.95 each or $6,487.20 collection. Daoud, Box 93864, Atlanta, 30318. (404) 355-8759. 5-81-1t

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REPLACEMENT COLOR YOKES—DEALERS ONLY. Zenith 95-2501-2532-2887 etc. $22.95. Magnavox 36180-1 etc. $24.95. Sylvania $24.95. American-made fuses in bulk. Request circular on your letterhead. David Sims Enterprises, Inc., 665 East Jericho Tpke., Huntington Sta., NY 11746. 800-645-5030, NY State (516) 549-3925-1592. 5-82-tfn

PICTURE TUBE REBUILDING EQUIPMENT capable of producing four high quality tubes per day (WILL TRAIN TO OPERATE). Call or Write Atoll Television, 6425 Irving Park, Chicago, Illinois 60634, ph. 312-545-6667. 5-82-3t

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TV and 2-way Technicians wanted. $15K to $22K per year. Benefits include employee stock purchase plan, in the largest Retail Service Center in Northwest Kansas. Friendly community, good schools, short drive to the Rockies. Equal Opportunity Employer. Miller's Electronics Inc., Goodland, KS 67735. 913-899-2386. 10-81-tfn

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