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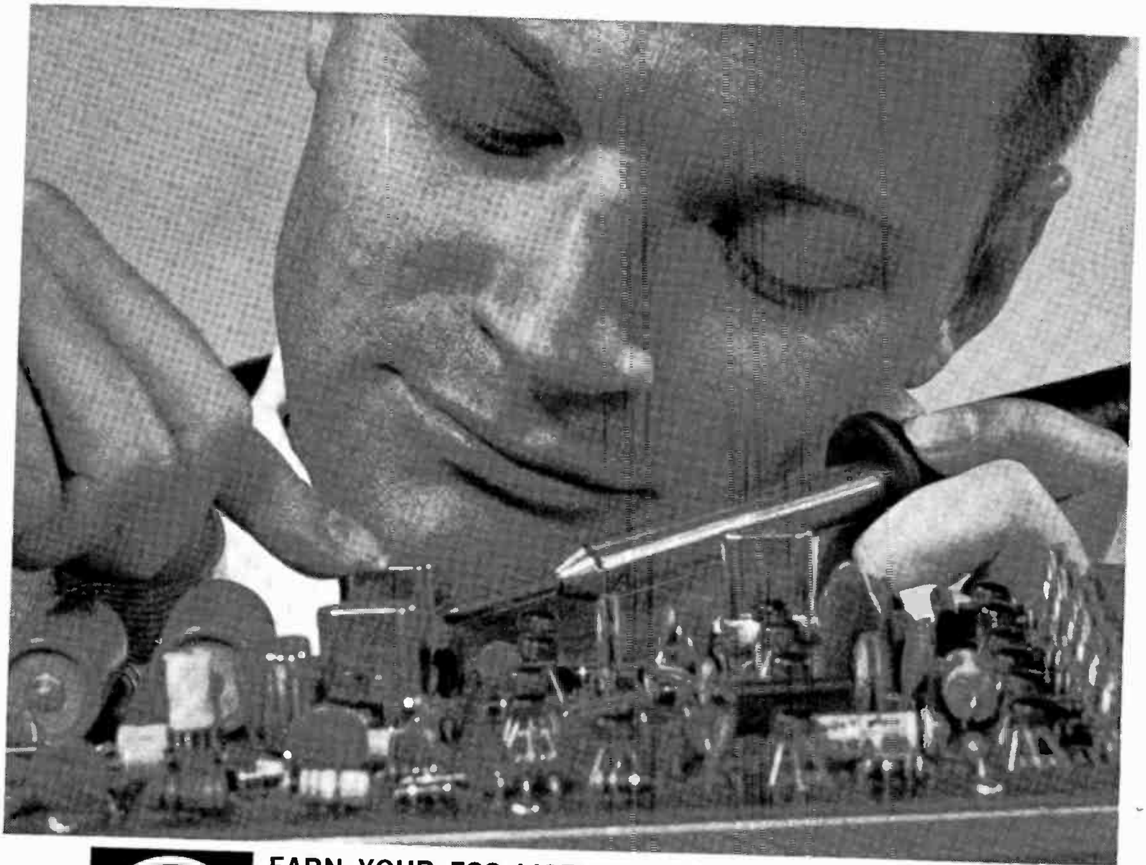

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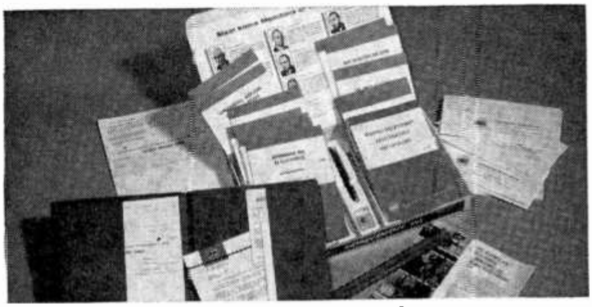

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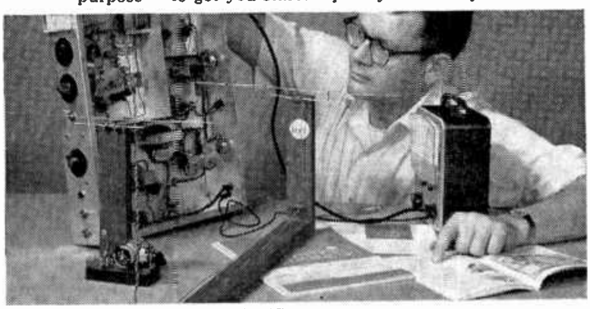

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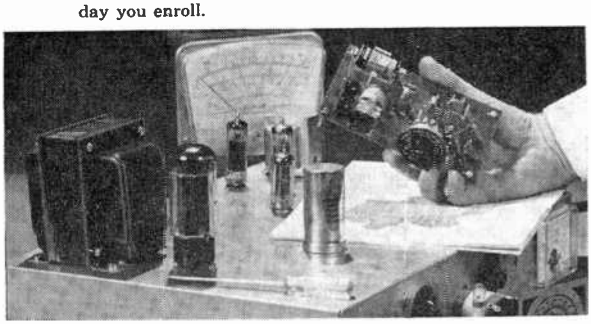

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VOLUME 1 NUMBER 4 APRIL 1972

Popular Electronics

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THE SCENES

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Editorial

By Milton S. Snitzer, Editor

DIGITAL CIRCUITS AND MODULES FOR THE CONSUMER

Just recently we attended a special press showing of a new Heath tuner. This component uses pushbuttons on the front panel to set the frequency of the station desired. Digital display tubes show the frequency selected or the frequency to which the tuner automatically scans. Digital circuits are widely used in the tuner for detection and other functions, and frequency synthesis is used to select the operating frequency of the tuner. All the circuits are fixed-tuned using filters and, as a matter of fact, there are only three simple adjustments to make for the entire alignment procedure.

Computer technology is widely used, including simple plastic cards that the user can cut out to permit him to preselect a number of stations he commonly listens to.

It goes without saying that modular techniques are used throughout and all the various integrated circuits and transistors are mounted on a number of separate computer-like plug-in boards. The tuner seems to be truly up to the finest state of the art, both in its features and performance. Construction time is estimated to be around 25 hours while the price is in the $500 range.

The Heath tuner, as well as new digital tuners from Scott and Sherwood, seem to signal the beginning of a new era for the consumer—an era of digital circuits in equipment that had used all linear or analog circuits in the past.

What are the implications of this type of equipment as far as the consumer is concerned? First of all, it offers many more features than could possibly be made available with simpler gear. Second, it is more complex than components we have been used to. Third, it advances the technical state of the art with digital circuits, pushing performance to the maximum attainable. Fourth, it recognizes the problems of construction and servicing by using the modular approach.

All of this makes us wonder about the kind of technician or electronics hobbyist we will have in the future to use this type of equipment. First, such a man will have to be more knowledgeable with respect to digital circuits. Second, he will have to be able to approach troubleshooting logically and systematically. And third, he will have to be assisted by manufacturers, such as Heath, Scott, Motorola, RCA, Zenith, and others, designing equipment that is modular in nature so that it can be serviced easily and conveniently.

So it appears that digital circuits, once found only in computers, are coming more and more into use for consumer electronic equipment, whether it is a digital electric clock or a hi-fi tuner.

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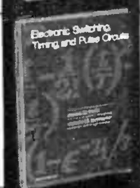

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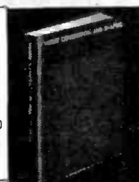

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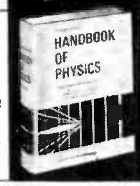

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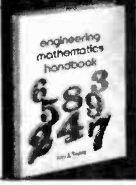

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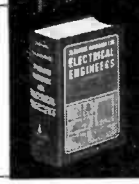

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CIRCLE NO. 19 ON READER SERVICE CARD

Letters

SUBSTITUTIONS VERBOTEN!

I'm building an amplifier from an old issue of POPULAR ELECTRONICS. I have been putting replacement transistors in right and left, but they keep burning up. I've checked the circuit for wiring errors and everything seems to be okay. Now I'm going to try putting in the transistors called for.

Name Withheld

This letter shows what can, and often does, happen when the builder indiscriminately substitutes parts for those specified. This is not to say that substitutes cannot be used; but careful consideration should take place and the risks weighed whenever substitutions are contemplated. If you cannot get the components specified in the Parts List, reasonable care should be taken when attempting a substitution. Just because one transistor may look like another is no reason to assume that it will behave in a similar manner.

IT'S MECK, NOT KWAJALEIN

I read with interest and enjoyed "Giant Billboard Antennas For Space-Age Radars" (December 1971). The story was basically well written by Mr. Lacy and was quite factual. I would, however, like to point out one small error in the article; that was the mention of the radar at Kwajalein Island. The MSR, or Missile Site Radar, is located on the island of Meck in the Kwajalein Atoll.

RICHARD V. DUTCHIK
Kwajalein Missile Range,
Marshall Islands

HANDS ACROSS THE BORDER

I find POPULAR ELECTRONICS Including ELECTRONICS WORLD the most informative and interesting of all electronics magazines published. The articles I most enjoy are those on audio hi-fi amplifiers and preamplifiers. At school, I have built several of your audio construction projects—most of them from scratch. We are even able to make exact replicas of the printed circuit boards. The only problem we encounter with any regularity is in obtaining some of the parts specified, mainly transistors and transformers.

If at all possible, would you please try to give consideration to the Canadian students who are trying very hard to build your projects? It would help enormously if you would list parts availability in Canada.

We all enjoy the projects which are challenging to build and sometimes require a little thinking to get to working properly. Please keep these projects coming and you will have a lifetime subscriber.

DOUGLAS J. KISS
Edmonton, Alberta, Canada

Wherever possible, we have during the past year or so tried to list Motorola HEP equivalents for most of the transistors specified in our Parts Lists. These are readily available through most of the Canadian mail-order houses and many local suppliers. Transformers are another story; it has been our experience that all the builder need do is use any transformer that has the proper primary and secondary impedances as the one specified in the Parts List, giving due consideration to the power-handling capacity.

ELECTRONIC MUSIC CLUB UNDER WAY

Due to the high level of interest in electronic music, as evidenced by such construction projects as your "Psych-Tone" (February 1971) and "Drummer Boy" (July 1971), I am at present forming an electronic music club. It will feature a newsletter for the exchange of circuits and other information. Plans are in the works for exchanging tape recorded electronic music composed by members. I invite interested readers to contact me directly for details.

BERNARD A. HUTCHINS
508 Highland Rd.
Ithaca, NY 14850

NOW IT'S ANIMAL GUIDANCE SYSTEMS

Mr. Lawrence's article "Animal Guidance Systems" in the December 1971 issue of ELECTRONICS WORLD is an exquisite piece of satire loaded with irony. It now seems that our weapons specialists have decided that future human survival will depend on jam-proof delivery of nuclear warheads. But with the rapidly approaching stalemate in the game of electronic countermeasures (in which I have some military experience), man is forced to turn to the animal world to solve his problem.

In the early part of this century, the passenger pigeon was systematically exterminated by man; so, now his surviving cousins are being recruited to help develop a more efficient means of systematic human self-destruction in the latter part of this century. A better example of poetic justice would be almost impossible to find, pathetic as it is.

WILEY W. KNIGHT
New Orleans, La.

Stereo Scene

By J. Gordon Holt

The Battle of the Tapes

IN THE LATE 1940's, the recording industry was in the throes of what came to be called the battle of the speeds, with Columbia's LP record and RCA Victor's 45-rpm "donut" disc vying for public acceptance. Now, only pop recordings are released on 45's, while every recording of every kind of music is available at 33⅓ rpm. The LP didn't kill the 45; it just put it in its place.

Today we are seeing the start of another such engagement, but this time the contenders are tapes, in cartridges or in cassettes. As before, one medium will probably prevail, and the other will take a back seat. But which will be which?

Why did the LP become the leading home-music medium and the 45 a runner-up, limited to the pop field? Certainly, their relative fidelity had nothing to do with it, for the first 45's were clearly superior to the early LP's in this respect. And although it was later proven that most of the distortion that plagued early LP's was more the fault of pickups than of the discs themselves, the LP never did match the sheer cleanness of a good 45.

There must have been other reasons, then, why the buying public showed so unmistakably how it felt that RCA Victor announced after only two years that it was going to produce LP's "for classics." Then, Columbia, just a year later, said that it would release pops on 45's. The reasons were simple, and really should have been obvious to everyone concerned before the whole petty "battle of the speeds" ever got started. The LP was ideal for long musical works—and really impractical for short works. Also, while a symphony on LP's was a lot more compact than the same work on 78's, the LP could not really be considered a portable music medium—in the sense that a pocket book is portable.

The 45, on the other hand, was no better suited for long musical works than was the 78, no matter how rapidly the cute little record changer went through its change cycle. To a listener of classical music, a pause of a fraction of a second is enough to interrupt the flow of the music; so it was academic that RCA's changer could cut the side-break time from 10 to 5 seconds. But the 45 was ideal for short musical selections, and it was very nearly as portable as a pocket book. In other words, it was a natural for pop records, most of which run less than 3 minutes; and most of whose buyers consider transporting them to friends' homes as part of the fun.

Then There Was the Juke Box. America was juke-box crazy during the 40's and 50's. Practically every place where people gathered, there was a juke box; and all those nickels and dimes added up to a multimillion-dollar business. When juke boxes went microgroove, they went the 45 route, because just about all juke box customers wanted to hear pop; and all pop was short. LP's were nice, but how do you design a juke box that will pick out band 3 on side A in record 24? Columbia's answer to this was the 7-in. LP, with one short piece per side. But this time RCA had the advantage of being there first; the 45 was already established for pop music, and it was better than the small LP in every way in which it wasn't just as good.

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* Copies of the Audio Engineering Society paper, 'ON THE DESIGN, MEASUREMENT AND EVALUATION OF LOUDSPEAKERS', by Dr. A. G. Bose, are available from the Bose Corp. for fifty cents.

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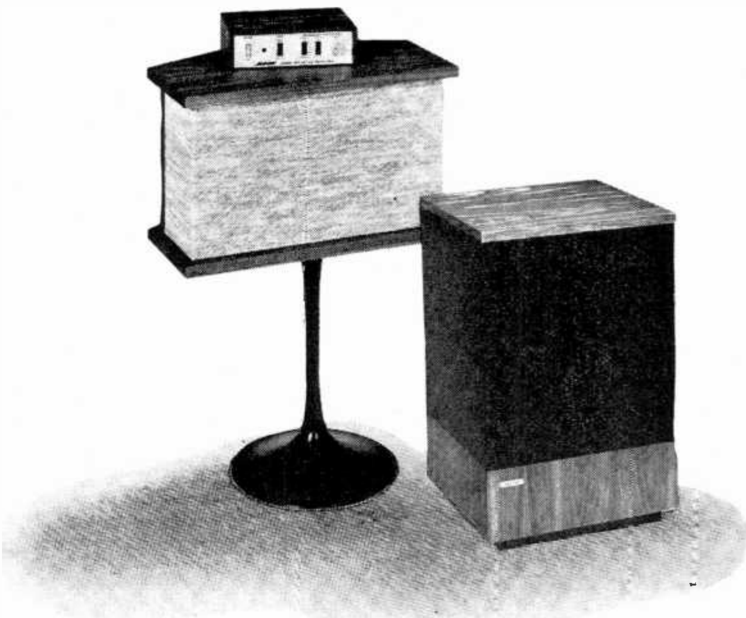

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CIRCLE NO. 9 ON READER SERVICE CARD

Although nobody had even begun to think about something called a classical-recording crisis in the late 40's, sales of classics even then were a tiny proportion of total record sales. The pop divisions of the record companies quite literally paid the bills for the classical divisions, and no one thought anything about it. Classics were a prestige line, good for the record company's corporate image —and that was that. It was doubtful, though, that the LP's suitability for a prestigious money loser could have saved it, had it not been for the hi-fi press.

Maybe it was just dumb luck, or maybe someone at Columbia Records had a genius for timing; but the LP record hit the market just as the hi-fi mania was getting off the ground. Perhaps it was also merely fortuitous that practically all record reviewers and the one magazine being published then for the hi-fi fraternity were oriented exclusively to the classics. They saw what the LP could do for classical recordings, and the long uninterrupted playing time alone was enough to send them into fits of unbridled enthusiasm for Columbia's invention.

Initially, the only real advantage of the LP was its extended playing time. But once the die was cast, with 45's being aimed at the pop market and LP's at the hi-fi enthusiast and classics listener, evolution took over and made the schism irreversible. Since juke boxes don't have readily accessible volume controls, and people don't usually bother to adjust volume between sides of a stack on a record changer, the production of 45-rpm records became a contest to see who could ram the highest modulation levels on them. All other considerations, including any pretense of fidelity, took a back seat to volume; and this is still the case today.

The LP (now in its stereo phase), on the other hand, became the medium for improvement, where fidelity-enhancing developments like Dolby mastering, predistortion (to compensate for playback tracing distortion), and improved cutting amplifiers and cutterheads are employed as soon as they become available. Today, most audio perfectionists maintain that a good 33⅓-rpm stereo disc can provide the highest fidelity obtainable from anything but an original master tape.

Unfortunately, we can't buy master tapes, nor can we obtain direct copies of

NEWS ITEM: New government rules put Cable TV in direct competition with commercial TV in 100 largest cities.

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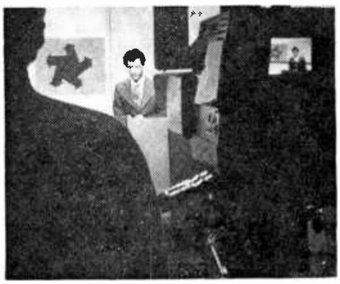

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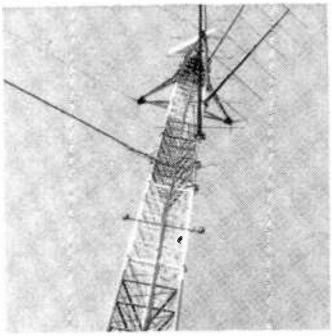

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APPROVED FOR TRAINING UNDER NEW G.I. BILL them. But we can go into a store and buy a high-speed-duplicated copy of a copy of the original master on open-reel, cassette, or cartridge.

The Tape Formats. Open-reel prerecorded tapes appeared in the late 50's as the first medium for stereophonic sound in the home; but they never became competitive in price with discs. Although they still have an ardent following, mainly among hi-fi enthusiasts, the general public simply couldn't be bothered with threading them. Cartridges would, it was hoped, remove this last objection to tapes in the home.

The whole idea of the cartridge is that anyone can learn to use it and can hardly damage it. Push it in a slot and it plays. Pull it out and it stops, to resume exactly where it left off when it is plugged in again —no complicated threading, no confusing controls like rewind, fast forward, or pause. It was thus ideal for an all-thumbs housewife (or hubby) and perfect for someone who's driving a car or piloting an airplane and would rather not take his eyes off his course to thread an open-reel tape and press the appropriate button to start it running. Along with the idea of utter simplicity went the assumption that the cartridge was to be a playback-only medium, like discs. There were no VU meters on early cartridge machines and no little red button marked RECORD.

Then came the cassette, which was just like the cartridge except that it ran at half speed with half the tape width. It used a length of tape shuttling between two tiny reels (instead of the continuous loop in a cartridge), and it could be moved at fast forward, rewound, and recorded by the user. Then, suddenly, we started seeing cartridge machines with a fast forward control, recording level indicators, and the little red button for RECORD. It was obvious that both formats were aimed at the same market and were going to compete with one another. In other words, another battle of the speeds seemed (and seems) in the offing—if it hasn't already started. So, which will win? Maybe we can hazard an educated guess, based on the facts, and with an eye on what happened last time.

Consider the following points:

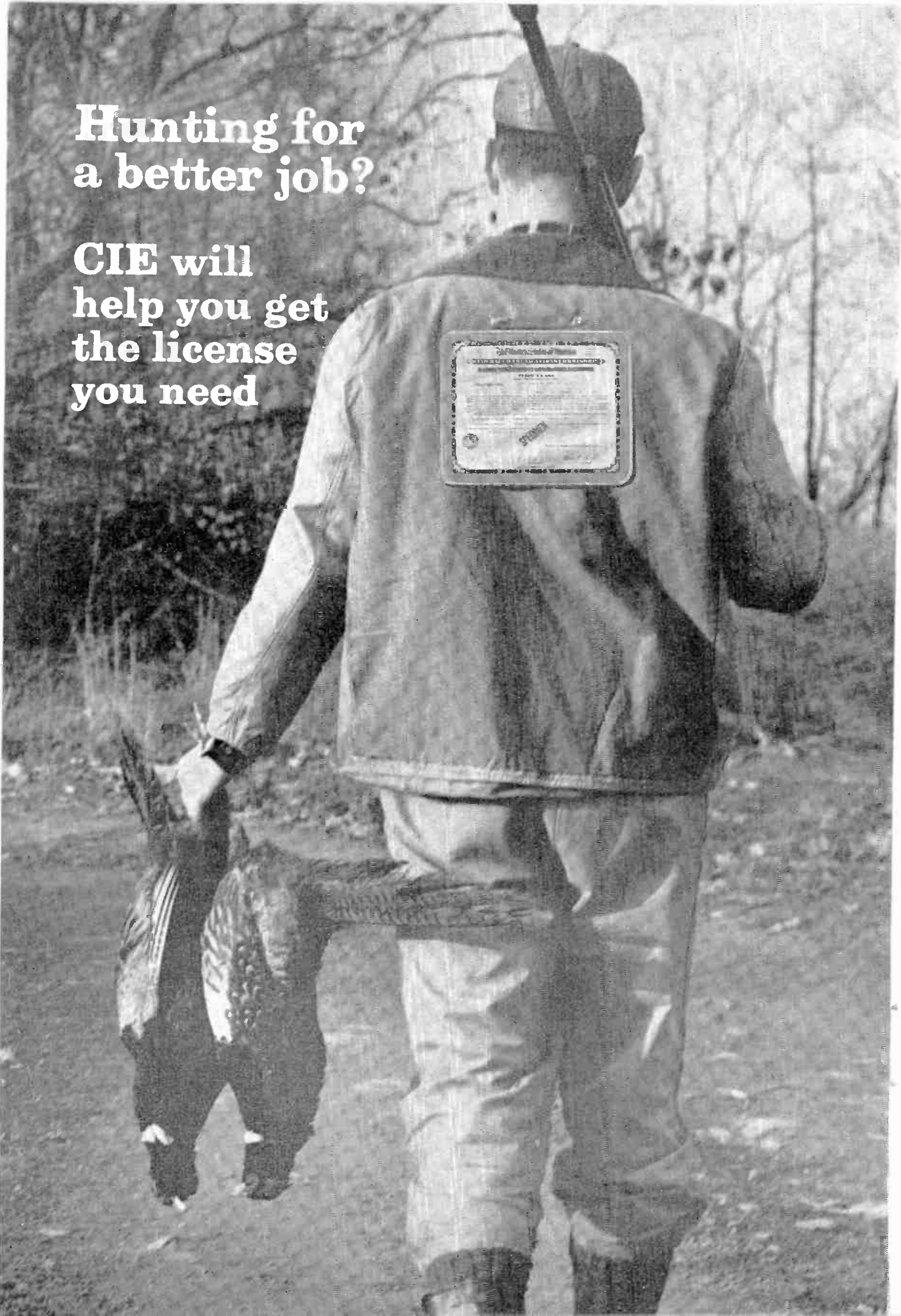
- Both formats are eminently portable, with cassettes having a slight edge.
- Both are equally capable of

accommodating long musical works, of up to 90 minutes duration. However, while the cassette will have a single track change half way through the work, the cartridge must change tracks three times. (Cassettes are available with a running time of 120 minutes but the extremely thin tape is too fragile for many transports.)

- Cartridges, having no definite beginning or end, are not as good for recording compositions—like symphonies—which start here and end there. Specific locations on the tape can be found only by trial and error (in one direction only) or by using a system of signal tones on the tape and a sensing circuit in the transport mechanism. They do, however, play over and over—without rewinding or track switching—a program of 40 minutes or less.
- Cassettes, having a definite start and end, are ideally suited to music with a beginning and end and allow for the use of a resettable digital counter plus rewind and fast-forward facilities for locating specific selections on the tape.
- Neither format is ideally suited for single, short selections. Three minutes in each direction would use so little tape that the housing would constitute a major part of the cost, making the price per minute too high and not competitive with 45-rpm discs. (Would you pay $2.95 for 6 minutes of music?)
- Since the pop single has been waning as a significant factor in record sales, this field will probably be left to the 45-rpm disc. (Most big-selling releases now are "albums" of several songs per side.) Thus, the prospect of juke boxes loaded with cartridges or cassettes does not appear to be promising.
- Despite the potentially superior fidelity implicit in their higher speed, early 8-track cartridges did not sound substantially better than early cassettes. Since then, cartridge sound has been improving (marginally), while the cassette has been steadily and sometimes dramatically improving in fidelity. Chromium dioxide tape was introduced to the consumer market in cassettes, and the first pre-Dolbyed recordings (for subsequent noise-reducing deprocessing at home) were on cassettes.
- Matrixing systems, for recording and extracting quadraphonic signals from two channels, are fine for reproducing concert-hall ambiance and the rear half of antiphonal music; but it is generally agreed that 4 discrete channels do the best job of reproducing sounds from specific rear locations—like a guitar from rear left and a singer from rear right. Both tape formats use recorded tracks of about the same width, and narrower tracks are deemed impractical; so any attempt to record discrete quadraphony must halve the tape's total running time. Since discrete quadraphony is likely to find more application in pop music than in other types, it is a happy coincidence that it can be done in cartridges without impairing their compatibility (with 2-channel stereo reproducers). Quadraphonic cassettes will probably be matrixed, thus retaining their full potential running time.
- The useful life of a cartridge is limited by the durability of the lubricant between its tape layers. Cassettes have a life expectancy equal to that of open-reel tape, and are thus obviously better suited to building a music "library."

In other words, although there are fewer differences between the two tape formats than there were between the competing disc systems, the present situation is not unlike that in the early 50's. One medium—the cartridge—is ideal for pop music and will probably come to dominate that market. The other medium—the cassette—has more to offer the classics listener, the casual hi-fi buff, and the average person whose taste runs to background music, Broadway shows, and movie sound tracks. And except for its poor suitability for discrete quadraphonic reproduction (whose sales appeal has yet to be determined), the cassette also has as much to offer the pop music buyer as does the cartridge. It is also ideal for portable recording, dictation, and use in autos, boats, and private airplanes.

Thus, while the cartridge undoubtedly has the pop music market pretty well sewed up at present, the cassette has more to offer to a much wider, if temporarily smaller, market. And since wide appeal was apparently what put the LP in the driver's seat, it could eventually do the same for the cassette. However, I wouldn't throw away my disc equipment yet. This is still the favored medium for people who collect recordings; and its popularity among them, and among critical hi-fi enthusiasts, shows no sign of waning. ◈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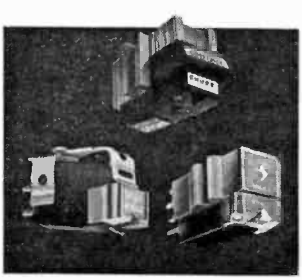

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News Highlights

Sears to Market Home Video Recorder

At a recent press showing, Sears Roebuck announced plans to market the first integrated videotape cartridge recording-playback unit for the home. The system includes a 25-in. color TV console, which houses the videotape deck, and a lightweight black and white camera. The unit will go on sale in the Chicago area for $1600. TV programs can be taped in color off the air and prerecorded tape cartridges can be played back in color. Cartridges, either blank or prerecorded, will sell for $13 to $40, depending on length and content. The longest tapes offer programs up to 114 minutes. Full-length motion picture tapes can be rented for about $6 for a single showing (tape cannot be rewound by the user). The tape deck is made for Sears by Avco and uses the company's Cartrivision system. A portable color TV camera is in the works and is expected to sell for around $400.

Ampex Quitting Consumer Equipment Market

Because of inadequate profits, Ampex is discontinuing operation of its consumer equipment division. The division markets tape recorders for the consumer. The company will continue to sell prerecorded and blank tape and will honor warranties and provide parts for its products. The division represented only about 5 percent of the company's corporate sales last year. About 200 people were with the division; their jobs will be gradually phased out or they will be offered other positions with the company.

Tape Cassette Sales Expected to Rise 18 Percent in 1972

Cassette sales will rise 18 percent to about $330 million in 1972 according to a prediction by Edward Smulders, manager of Norelco Cassette Dept. The increase will be aided by increased distribution through supermarkets and drug stores. More than 142 million blank and prerecorded cassettes will be sold next year, Mr. Smulders said, compared to an anticipated total for 1971 of 120 million units valued at $280 million. It is said that there are more than 16 million cassette recorders in the U.S.—one for every four households.

Sperry Rand Takes Over RCA's Computer Customers

Sperry Rand and RCA have signed a final agreement under which Sperry will acquire RCA's customer base in general purpose computers. Under the terms of the agreement, Sperry Rand's Univac Div. will, starting January 1, provide software and hardware maintenance and systems support to RCA's former computer customers in U.S., Canada, and Mexico. These include more than 500 users with more than 1000 computers installed.

Tandy to Sell 36 Allied Radio Stores

The Tandy Corp. has agreed to sell 36 Allied Radio stores it acquired last year when it took over the Allied Radio Corp. A civil antitrust suit was brought against the company last year, and this agreement was contained in a proposed consent judgment filed in the U.S. District Court in Chicago to settle the suit. If approved by the court, the proposal would become effective within 30 days. Tandy would then sell 36 Allied Radio stores in Illinois, Indiana, Michigan, Minnesota, Missouri, Wisconsin, and Texas. The government had charged that the takeover eliminates competition among electronic parts dealers engaged in retail over-the-counter and mail-order sales to hobbyists.

Electro-Voice and Scheiber Announce Four-Channel Patent

A U.S. patent has been issued to Peter Scheiber of Audiodata Co. covering encoding and decoding matrix techniques for four-channel recording and broadcasting. Scheiber and Electro-Voice had previously agreed to pool their efforts in the protection of patents, licensing, and manufacture of equipment using developments from both firms. E-V's technical director, Howard Durbin, stated that it is the company's belief that the patent is basic and will cover all current or announced matrixing systems. The company is continuing development of their Stereo-4 system (in conjunction with Leonard Feldman and Jon Fixler) which they describe as the first production matrix technique on the market.

Consumer Electronics to Exceed $5 Billion in 1971

According to preliminary Electronic Industries Association statistics, consumer electronics sales in 1971 will exceed $5 billion at the manufacturing level including imports, or $8 billion at retail. This total market includes the sales of television, radio, phonograph, and tape equipment as well as such items as electronic musical instruments, transceivers, hearing aids, and home intercoms. Television, the industry's major product category, will have a record year in both units and dollar volume. Domestic manufacturer sales and foreign imports will exceed 14 million units—7 million in color and 7 million in black and white—for a total estimated sales volume of over $3 billion. In addition to the 14 million TV sales, radios will reach 45 million units, phonographs 6 million, and tape equipment 15 million units.

Students to Participate in Skylab

Skylab, our manned earth orbital space laboratory to be launched in 1973, will carry some experiments designed by high school students. More than 15,000 applications for participation have been requested of the National Science Teachers Association, which is managing the activity for NASA. Entries consist of proposals by students for experiments, demonstrations, or activities to be performed by the astronauts. Deadline for the proposals to be submitted to the chairmen of one of 12 regions was Feb. 4, 1972. Regional winners will be judged by a national committee and 25 national selectees will be forwarded to NASA. Final selection will be made from the national selectees on the basis of compatibility with Skylab requirements.

Engineering Degrees Show Leveling Off

The number of engineering degrees conferred by the 277 U.S. engineering schools during the year that ended in June 1971 was only slightly more than for the previous year, according to a report released by the Engineering Manpower Commission of the Engineers Joint Council. There were 43,167 bachelor's degrees, only 201 more than last year. At the master's level, where the increase over 1970 was largest, 16,383 degrees were awarded this year compared to 15,548 for the previous 12-month period. Doctor's degrees in engineering, at 3640, barely exceeded last year's 3620. At both advanced degree levels this year's totals were the largest ever recorded. The major field of study, amounting to about a quarter of the total figures, was electrical engineering.

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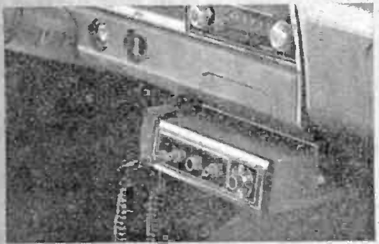

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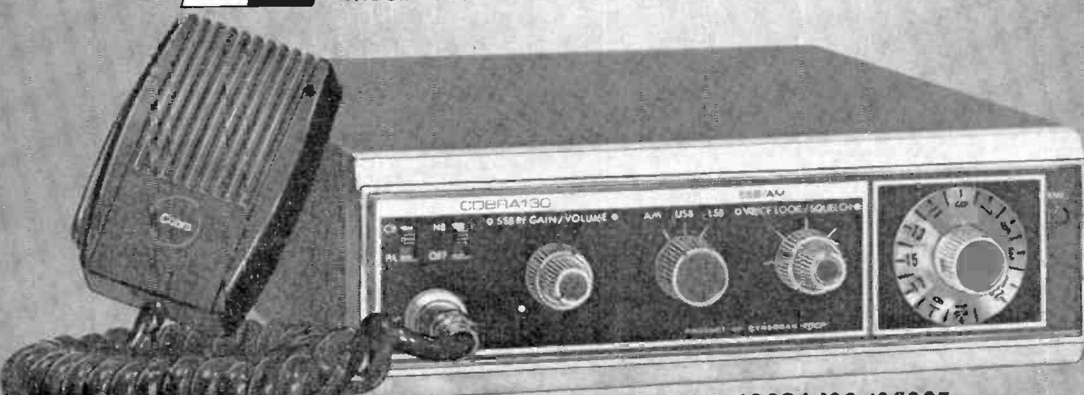

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Performance Tests of Cassette Tapes

COMPARATIVE RATINGS OF 20 RAW CASSETTE TAPES WHEN USED ON RECORDERS WITH OPTIMIZED BIAS

BY JULIAN D. HIRSCH
Hirsch-Houck Laboratories

IF YOU want to obtain the best performance from magnetic tapes with respect to frequency response, distortion, and noise, you must have a careful balance among recording bias, recording and playback equalization, and recording level. Although the design of the tape recorder's heads and electronic systems are also vital factors, for any given recorder and tape formulation, the key parameters are the bias and equalization characteristics.

The frequency response of any magnetic tape is far from "flat", and considerable equalization is required at both high and low frequencies to meet audio recording standards. The equalization is divided between the recording and playback amplifiers, but playback frequency response is standardized to permit tapes made on one machine to be played on another. This still leaves the recorder designer considerable latitude in setting bias levels and recording equalization for best results with his heads and available tapes.

The bias is an ultrasonic ac signal (often as high as 100 kHz) superimposed on the audio signal being recorded. It is used to minimize the distortion caused by the inherent nonlinearity of the magnetic tape coating. Bias also affects the recorded level and the frequency response, particularly at high frequencies. The bias, recording equalization, and tape properties are inextricably linked, and in every case require some compromise among level, frequency response, and distortion.

Except in the higher price brackets, most home tape recorders have no adjustment accessible to the user for optimizing performance with any particular tape. They are generally designed to operate satisfactorily with a variety of tapes, although the manufacturer's specifications may be realized only with a certain recommended tape formulation.

Cassette recorders, which must extract the last bit of performance from the tape in order to meet reasonable high-fidelity standards at their 1⅞-ips operating speed, are especially critical in their adjustment for the specific tape used. In particular, the bias level is extremely important if a reasonably uniform response in the 8000-Hz to 16,000-Hz octave is to be obtained. Although the user normally has no means of optimizing bias for his tape, the recorder manufacturer often recommends specific tape brands and types which will enable his specifications to be met, and qualified service technicians can adjust almost any machine for use with any tape.

We recently made an extensive study of cassette tapes—some 40 different types—to determine the range of performance one might expect from them with a single recorder whose operating conditions were held constant throughout. Our data suggested that optimizing the machine for each tape could greatly extend the performance. Therefore, we have now evaluated a smaller group of cassette tapes, adjusting the recording bias for flattest overall frequency response with each tape.

The same type of cassette recorder was used in this test (an *Advent* 201), since it is not only representative of the current state of the art in cassette recorders, but is also the only one we know of which provides external access to the recording bias adjustments. We made frequency response measurements with each tape type, adjusting the bias until the flattest response was obtained over the full frequency range of the machine. A calibrated scale allowed us to return to any bias setting at will, and to compare the optimum bias levels for the various tapes. All bias level indications were arbitrary and relative, since any absolute readings would have no significance for any other type of recorder. Whenever possible, a C-60 cassette was evaluated; exceptions are noted in our tabulated data.

Test Procedures. All frequency response measurements were made at a recorded level of -30 db, relative to the "0 dB" reading of the recorder's meter. This was necessary to avoid tape saturation at high frequencies, which could give erroneous frequency response indications if a higher level were used.

Recordings were made over the full frequency range with each tape. If the playback response in the 10,000-Hz to 15,000-Hz range deviated more than about 2 dB from the mid-range level, the bias was adjusted slightly and the measurement was repeated. Increasing the bias reduced the high frequency response, while less-than-optimum bias resulted in a peaked, or accentuated, high frequency response.

Using the optimum bias setting, we made 1000-Hz recordings at several levels around the 0-dB point, observing the playback distortion for signs of overload. We determined the level (relative to 0 dB) which resulted in 3% distortion (predominantly third harmonic) in playback. The 1000-Hz output from this "3% distortion" level was considered to be the maximum usable output of the recorder with each tape.

We operated the recorder in RECORD mode, with no input signal, and during playback measured the noise level (so-called "bias noise"). This is expressed in decibels below the maximum recording level. The noise measurement was unweighted, but was limited to a 22-kHz bandwidth to eliminate undue influence from inaudible wideband noise.

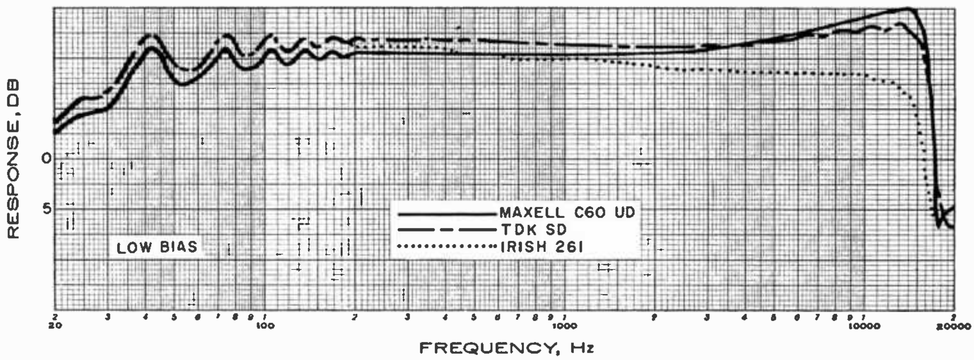
One of the major weaknesses of cassette tapes is the output fluctuation due to tape coating inhomogeneity ("dropouts") and erratic tape-head contact. The latter is a function of the mechanical design and assembly of the cassette. Unevenness of tape hub friction and tape winding can cause an irregular output amplitude similar to that resulting from actual tape coating defects.

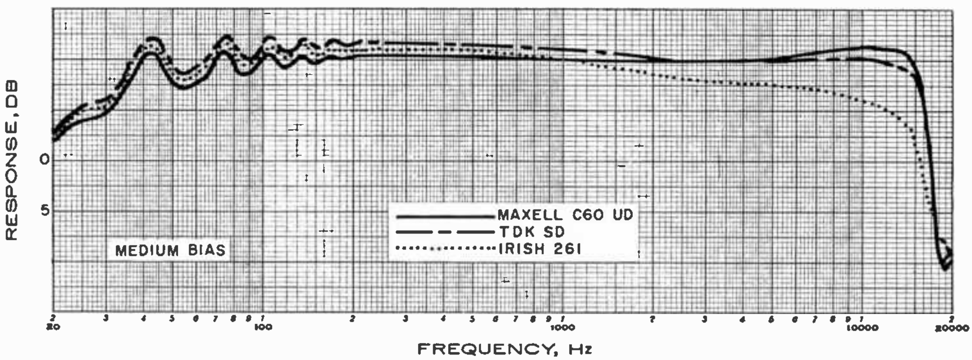
We evaluated each cassette for output uniformity by recording a 10,000-Hz tone for 3 minutes, using the middle of the tape, where best performance can be expected. Many cassettes are somewhat erratic near the ends of the tape. We then recorded the playback output on our graphic level recorder for the full 3 minutes. The degree to which the trace departed from a narrow straight line was an indication of the tape output nonuniformity. Mechanical problems within the cassette could be distinguished from tape dropouts by their periodic occurrence.

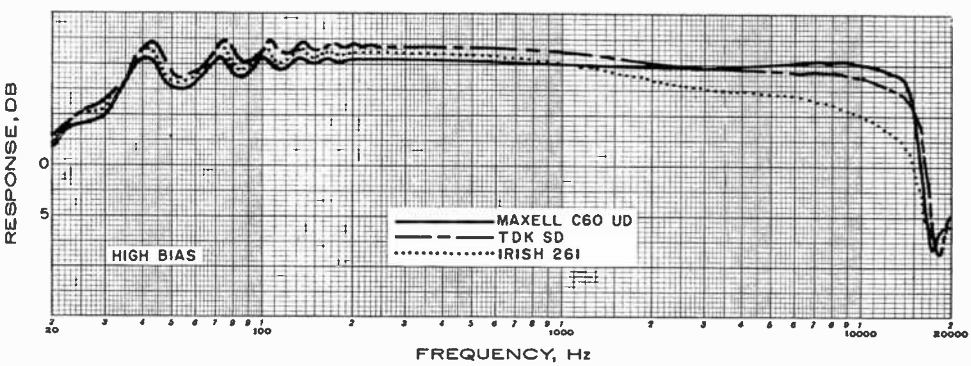
Finally, the method of cassette assembly was noted. Some cassettes use screw-assembled (S) cases. If the tape breaks, it is usually possible to open the cassette and retrieve both ends for splicing. On the other hand, the welded (W) case used on most cassettes cannot be opened non-destructively, so that a tape breakage means the loss of the cassette.

Two of the cassettes employed unique mechanical features, not found in any of the others. The *BASF* C-120 "Chromdioxid" was packaged in the new *BASF* "SM" design. This refers to an internal construction which places the tape windings under controlled tension to prevent uneven winding. Also an additional pair of slots is included in the back of the cassette, adjacent to the tabs which can be removed to prevent recording over a previously recorded program. These slots will allow automatic se-

Frequency responses of three representative tapes in the low-, medium-, and high-bias categories with recorder supplying (top to bottom) low, medium, and high bias.







CHARACTERISTICS OF TAPES BY BIAS CATEGORY

Tape Type †	Case Type (S or W)	% THD at −3 dB	% THD at 0 dB	% THD at +3 dB	Recording Level for 3% THD (dB)	Bias Noise	Output Uniformity	Relative Output (re 3% THD)	Price
Low Bias									
Capitol	W	2.2	3.3	6.3	−0.5	−50 dB	B	+0.5 dB	$1.19
Irish 261	W	–	3.0	–	0	−49.5	B	+1.0	1.85
Memorex	W	2.3	2.9	5.8	0	−51	C	+1.7	2.75
TDK LN	S	1.8	2.1	4.0	+2.5	−52	B	+2.0	1.29
Low/Medium Bias									
Soundcraft	W	2.0	2.5	4.3	+1.5	−51.5	B	+3.2	2.65
3 M "High-Energy"	W	2.7	4.0	7.2	−2.0	−51	B	+2.0	3.70
Medium Bias									
Ampex 362	W	1.9	2.7	4.4	+1.0	−51.5	B	+1.0	2.95
Audiopak (Audiotape)	W	2.1	2.8	4.3	+1.5	−50.5	B	+3.2	2.65
Auricord "PRO"	S*	1.9	2.5	4.2	+2.0	−50	B	+2.5	3.95
BASF C60LH	S	1.6	1.9	2.6	+4.0	−54.5	B	+4.0	2.65
Irish 262	W	1.9	2.7	4.2	+1.0	−50	C	+1.0	2.55
TDK SD	S	1.6	1.9	2.4	+4.0	−55	B	+5.3	1.99
Medium/High Bias									
Sony C-90	S	1.7	2.2	3.0	+3.0	−53.5	A	+3.7	1.69
Sony UHF	S	1.6	2.0	3.0	+3.0	−54	B+	+4.5	2.29
High Bias									
Hitachi UDC-90	S	1.9	2.0	3.0	+3.0	−53.5	A	+2.5	4.50
Maxell UD	S	2.0	2.0	3.0	+3.0	−53.5	B+	+3.2	3.75
Chromium-Dioxide									
Ampex 363	W	2.1	2.2	2.7	+3.5	−54	B	+2.0	3.95
BASF C-120	S	1.8	2.3	3.2	+2.5	−52.5	B	+0.9	8.29
Irish 363	W	2.1	2.3	2.9	+3.5	−54.5	B	+1.0	3.75

*Metal cassette. †C-60 cassette except as noted.

lection of special bias and equalization for CrO_2 tape in future recorder designs, although none of these are yet available. The *Auricord* "PRO" cassettes are made of cast metal, instead of the usual plastic. This is claimed to provide superior dimensional stability with temperature variations, and to eliminate problems from build-up of static charges during operation.

Test Limitations and Qualifications. As we have stated, several interrelated operating parameters determine the ultimate performance of any cassette tape. By appropriate adjustment of bias and recording equalization it is possible to optimize any cassette in any recorder. However, recording equalization is rarely user-adjustable. and recorder manufacturers are reluctant to encourage any tampering with the internal factory settings.

The only firm conclusions one can draw from our tests relate to the degree of optimized performance obtainable on an *Advent* 201 recorder, with bias as the variable parameter. In a broad sense, our findings should apply to most other cassette recorders. It is always possible, however, that with a different recording equalization characteristic, a different bias level would be required and one might obtain a different signal-to-noise or distortion measurement on any given tape.

We have also found some variation between cassettes of the same make and type, in respect to optimum bias and output uniformity. Since our tests, in most cases, were limited to a single sample, no guarantee can be offered that all samples of the same type will be identical. Doubtless some manufacturers produce a more uniform product than others, but a meaningful evaluation of this factor is beyond our capabilities.

Test Results. We tested 20 different cassettes, from 13 manufacturers. The overall frequency response was largely a function of the recorder design, and differences between tapes were insignificant once the bias had been optimized. The major differences were in the 14,000-Hz to 16,000-Hz range. The output of some tapes fell off rapidly above 14,000 Hz, while others showed a useful output between 15,000 and 16,000 Hz. In practical, audible terms, these distinctions are of little importance.

From the standpoint of optimum bias,

most of the cassettes fell into two categories, which we called "low-bias" and "medium-bias" tapes (purely arbitrary classifications, of course). Within each category, all the tapes gave their best frequency response with the same bias. The so-called "standard" tapes require a "low" bias, and most "extended range" tapes fall into the "medium-bias" category. The only "high-bias" tapes in the group were the *Hitachi* and *Maxell* Ultra-Dynamic cassettes. The *Sony* tapes required a bias intermediate between the "medium" and "high" settings, while the *Soundcraft* and *3M* High Energy tape operated between the "low" and "medium" bias ranges.

The three chromium dioxide tapes were tested with the special bias and equalization settings provided by the CrO_2 switch on the *Advent* 201. No attempt was made to change the CrO_2 bias, which was already optimum for these tapes.

The effect of bias on output and frequency response, for three representative tapes in the "low," "medium," and "high" bias categories, is shown in the graphs. Note that a bias setting giving flat response with a "low-bias" tape results in a rising high end with "high" and "medium-bias" tapes. On the other hand, a recorder biased for a "high-bias" tape will suffer a loss of highs with "medium" or "low-bias" tapes.

The other data is presented in tabular form. Most of the column headings are self-explanatory. The Relative Output referred to 3% THD is the algebraic sum of the recording level giving 3% distortion and the relative playback levels from a 0 dB recording level. Since a tape delivering a very high output from a 0-dB input might distort at a lower level, compared to some tape with less output but the ability to be recorded at a higher level without distortion, this column indicates the actual useful relative outputs of the various tapes, as operated in the *Advent* 201 recorder.

The output uniformity was graded as A, B, or C. The fluctuation in the A and B outputs is periodic, indicating a slightly uneven hub friction or mechanical tape-to-head contact. In the C examples, the trace shows a little more random variations.

Summary and Comments. As the data shows, unless one uses the type of tape for which the recorder is biased, there is little chance of realizing the potentially wide range, low noise, and low distortion designed into the recorder and the tape. At present, *Advent* is the only manufacturer we know of offering this bias adjustment capability for the technically competent consumer, but qualified service agencies should be able to do the same for most other machines.

Most tapes are very similar in their noise characteristics, with a signal-to-noise ratio of 49 dB to 52 dB in this machine. The premium tapes (*BASF* LH, *TDK* SD, *Sony*, *Hitachi* UD, and *Maxell* UD) average 3 to 5 dB better, as do the chromium dioxide tapes. The chief measurable advantage of the latter is their flatter response at the extreme high frequency end, with generally 3 to 5 dB more output at 15,000 Hz than the best ferric oxide tapes. On the other hand, although they were slightly "flatter" above 10,000 Hz, there was no significant difference between them and the ferric oxide tapes below 13,000 or 14,000 Hz.

Many of the tape brands we tested are also available in C-90 and C-120 cassettes, providing longer playing time. One cannot assume that the performance of a longer playing cassette will equal that of a C-60 of the same brand. The longer playing versions use thinner tapes and have thinner magnetic coatings, as well as potentially greater mechanical problems. However, judging from the few C-90 and C-120 cassettes included in this test, a good brand of tape can deliver excellent performance in any length.

The majority of the tapes had good output uniformity characteristics. We listened carefully to music recordings to judge the audibility of each grade of performance in our uniformity classification. With a B or C tape, an occasional roughness could be heard, but its offensiveness depended strongly on the nature of the program, as well as the sensibilities of the listener. Pop music is relatively tolerant of minor fluctuations, while most classical music is not. The B+ and A tapes were essentially free of audible roughness, and certainly came very close to open reel tape in this respect.

It is noteworthy that one manufacturer's "standard" tape may be better than another's "low noise" tape, and sometimes there is little difference between the "premium" and standard tapes (often called "low noise") of the same manufacturer. A greater difference might be apparent under different test conditions. ◈

Earth Station for Satellite Experiments

GLOBAL TV BECOMING A REALITY

TRUE global television coverage from almost anywhere on the earth may soon be a reality with the development of an air-transportable earth terminal for the ATS (Applications Technology Satellite). Recently demonstrated by the Hughes Aircraft Co., the station is to be used for satellite-relayed TV and voice communications with receive-only ground stations, and for voice and data transmissions to aircraft in flight. These experiments will be started when the new ATS series F and G satellites are orbited in 1973 and 1975.

The mobile station, an outgrowth of small-earth-terminal technology developed at Hughes can be rapidly airlifted anywhere in the world and can be assembled and made ready for use in two hours by a three-man crew.

Among the features of the new terminal are a polar antenna mount that permits rapid and easy alignment of the antenna on a synchronous-orbit satellite 22,300 miles above the earth at the equator and a simplified antenna feed system that eliminates interference with terrestrial communications systems.

Each station is equipped with two parabolic antennas—one a dish 21 feet in diameter for operation in the uhf (835 to 885 MHz) and C band (5925 to 6425 MHz) and a companion 15-foot dish for the S (2050 to 2100 MHz) and L (1500 to 1580 MHz) bands. Both transmission and reception will be available on the C, S, and L bands, while reception only is provided for uhf. Two 30-foot trailer vans provide housing for the station electronics, personnel quarters, and storage for spare parts. The vans are air conditioned for use in tropical areas.

Each dish antenna is formed from fiberglass panels which can be easily handled by one man. The 21-foot dish consists of six segments about an 8-foot center, while the 15-foot dish has four segments around a similar center section.

The new transportable earth terminal for satellites consists of a 21-foot dish (foreground) and a 15-foot dish with companion electronics in vans.

A similar station equipped with a 30′ dish was flown to the West Indies during the Barbados Oceanographic and Meteorological experiment in 1969 for a national scientific study of weather conditions over an area of 90,000 square miles in the Atlantic Ocean. In a previous test, a terminal using a 16-foot dish was flown to South America in 1968 to relay throughout the world live color-TV transmissions of the historic visit of Pope Paul to the Eucharistic Congress in Bogota, Colombia. ◈

BY DAVID L. HEISERMAN

COMMUNICATIONS ON A LIGHT BEAM

HOW INVISIBLE LASER BEAMS CAN CARRY TRILLIONS OF BITS OF INFORMATION EVERY SECOND

THE idea of using a light beam to send messages from one place to another is far from new. In fact, it is probably as old as civilization itself. Since its inception, the basic method of communicating by this medium has been to interrupt the light beam according to a prearranged code system. The principle has not changed much since the first man realized that a light beam could be used to communicate over distances too long for his voice to carry.

Beginning in the 19th century and coming right up to the late 1950's, sporadic attempts were made to perfect light-beam communication equipment that would carry voice messages or high-speed codes over moderately long distances. But, even after pouring all their efforts into the project, scientists failed to perfect light-beam communication. Their designs in this century, when compared with existing radio communication systems, suffered from severely limited operating ranges, low information handling capacities, poor fidelity, and interference from bright ambient light. Little wonder, then, that some of the sincerest of scientific efforts at designing a practical light-beam communicator ended up as toys, construction projects in magazines, science fair projects, and just plain curiosities.

One popular white-light communicator which resulted from scientific efforts employed a microphone or telegraph key to operate a small loudspeaker fitted with a silvered diaphragm. Electrical signals fed through the amplifier made the diaphragm vibrate. A beam of white light focused on the diaphragm reflected out of the transmitter, carrying along the vibration as changes in light intensity. In another simple arrangement, the key merely turned on and off a light bulb, or the output of a microphone amplifier controlled the brightness of the light.

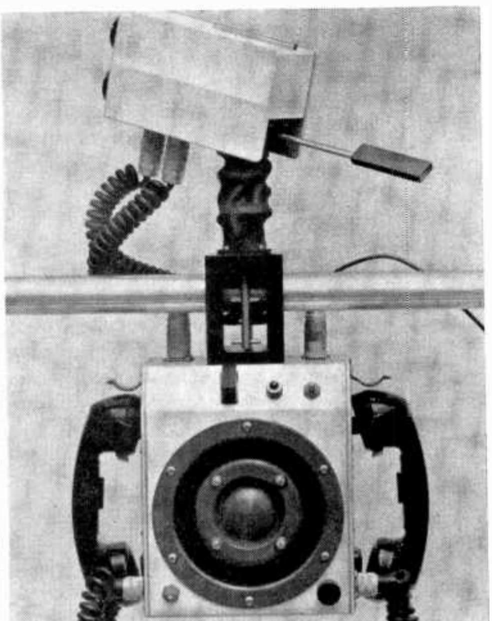
At the receiver end of the communication link, a sensitive photodetector picked up the light beam and translated the light intensity fluctuations into voltage changes. The voltage from the photodetector then drove an amplifier/speaker (or earphone) arrangement, reproducing the vibrations introduced at the transmitter by the sender of the message.

Short operating ranges and poor fidelity notwithstanding, these simple light-beam communicators gave experimenters their first inexpensive walkie-talkies. However, when the Citizens Band came into vogue, light-beam communication was driven into a limbo which lasted until 1969—the year light-emitting diodes finally became available at low cost.

LED Communicators. Light-emitting diodes, or LED's, are semiconductor diodes which emit relatively pure infrared light when a current is passed through them. Light from an ordinary incandescent lamp contains just about every color in the spectrum. Light energy from an LED, on the other hand, is concentrated in a very narrow band of the light spectrum, making it possible to select a photodetector that responds only to that band. With the photodetector carefully matched to the LED emissions, ambient light has very little effect upon the communication link. Without interference from other light sources, it becomes possible to attain communication ranges of several miles even in broad daylight.

Since the amount of light from an LED varies with the amount of current through the diode, electrical signals from a microphone amplifier or other type of input device can directly modulate the intensity of the beam. Hence, the transmitter is simpler, more reliable, and has better fidelity than is possible with white-light communication systems. (Light-emitting diodes can respond to frequencies in the megahertz range where no microphone can compete.)

A laser diode (in the upper unit) voice communicator developed by Holobeam, Inc. for ship-to-ship speech.



The new LED comunication schemes are working out so well that several companies now produce them for industrial and commercial use.

Laser Diode Communicators. While LED's generate a narrow spectrum of infrared light, compared to high-quality laser light, their light is highly contaminated with a number of different phases and wavelengths. Because the intensity of an LED light beam falls off with the square of the distance it travels, telescopic attachments can compensate for some of the losses. But there is a point where the scheme becomes impractical. So, future application of LED communicators will probably be restricted to low-cost portable voice communicators and short-range links.

The real future of light-beam communication rests with laser light which is so bright initially that it retains much of its original intensity over longer transmission distances. Just as relatively pure LED light gives light-emitting diode communicators greater range than comparable white-light systems, the coherent nature of laser light multiplies the operating range beyond that feasible with LED's.

Optical communication researchers are now working with three different kinds of laser sources: laser diodes, solid-state lasers, and gas lasers. Of the laser communication systems presently under development, those using laser diodes show the greatest promise for immediate applications.

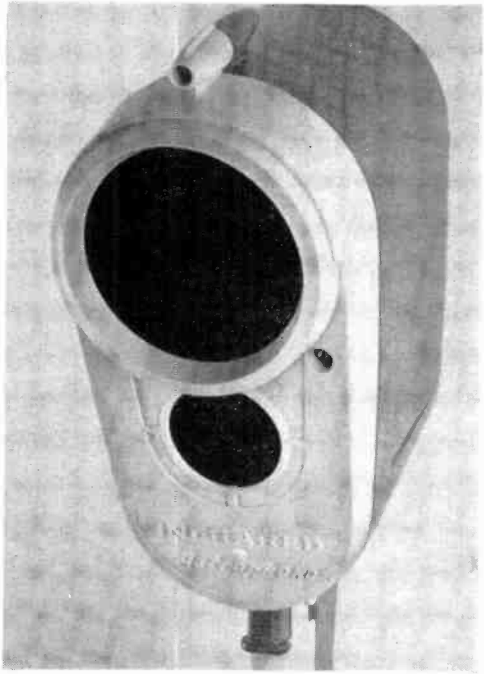
Laser diodes, properly called injection lasers, operate on the same general principle as LED's. The former, however, are capable of producing much greater output power in addition to generating true coherent laser light. Unfortunately, the tendency for laser diode devices to overheat has still to be overcome. Typically, 10 amperes of current must be pumped through the laser diode to generate one or more useful watts of laser light. Commercially available laser diodes are incapable of withstanding such high currents over long periods of time without overheating. Hence, most laser diode communicators presently in use are operated in pulse mode.

Using trigger circuits similar to those used in strobe lighting systems, a laser diode transmitter fires its diode with large doses of current for about 0.1 μs at a time.

By permitting the diode to cool for about 100 μs between firings, a pulse operating frequency of about 10,000 Hz can be achieved.

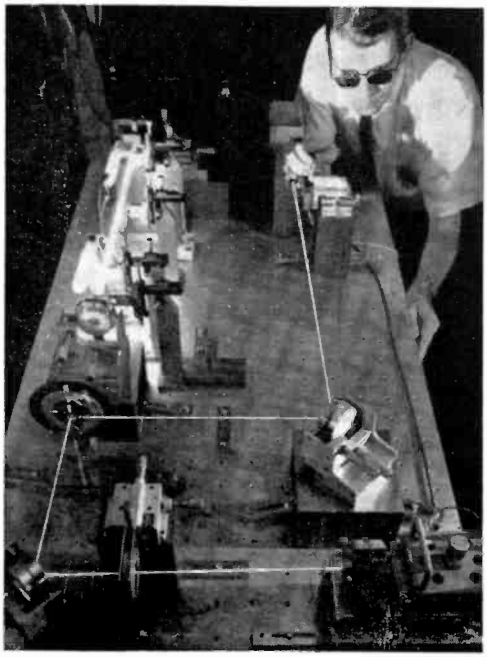
Hughes Aircraft's Santa Barbara Research Center is marketing a portable laser diode voice communicator that uses pulse triggering. It produces 2 watts of peak power, sufficient to establish a communication link over a distance of 6 miles in good weather. This basic equipment range can be considerably extended by adding elaborate telescopic attachments. The trigger pulses for the laser diode are frequency modulated. With a carrier frequency of 6000 Hz, the system can carry a single channel of voice information with frequencies up to 2300 Hz. Although current pulses through the laser diode may reach 40 amperes, the transmitter circuit drains only about 10 mA average current from a 12-volt battery pack.

Another portable laser diode communicator, built by Holobeam for the Navy, also uses short-pulse firing. The carrier is pulse-position modulated; so, voice information fed into the transmitter varies the position of each pulse with respect to some standard "no-signal" position. Conservative military specifications list the maximum operating range at 1.5 miles, but the transmitter's 8-watt peak output power could easily multiply this figure.



Simple light-beam communicator such as this one made by Infrared Industries, Inc. used infrared filters over white light source to make the beam invisible and reduce stray light.

A helium-neon gas laser (upper left) provides beam for experimental optical communications setup at Bell Labs.



Several major companies, among them Bell Laboratories and Texas Instruments, have under development more efficient laser diodes which are not restricted to the pulse mode. Such diodes promise to combine the high-frequency and continuous-wave characteristics of LED's with the high power and coherent light of modern laser diodes.

YAG Communicators. Bell Labs is working on a portable laser communicator which uses an yttrium-aluminum-garnet (YAG) solid-state laser source. Closely related to the artificial ruby, the YAG laser has served laser technology almost from the beginning.

Unlike laser diodes, YAG lasers are light amplifiers which convert a flash of light energy into a more powerful beam of laser light. The problem is to find a way to fire the light that excites the YAG crystal.

Researchers at Bell Labs believe that laser diodes make a suitable source of stimulation for a YAG laser. By firing the

YAG crystal with a laser diode flash, they hope to produce a medium-power YAG communicator as portable as laser diode communicators. The YAG devices will operate in a fast pulse mode as do laser diodes, but the former will generate much more high-quality laser light.

Gas Laser Communication Links. All the light-beam communication work using LED's, laser diodes, and YAG lasers is aimed at providing portable short-range communicators capable of carrying only a few channels of information at a time. But the time is coming when the laser links will have to take over where the already overcrowded radio, TV, and telephone channels leave off. A single laser beam will then have to carry millions of bits of information every second from point to point. Most researchers developing long-range, high-capacity laser links agree that gas lasers are the most suitable sources of light for their purposes.

Gas lasers use a mixture of at least two gases. In a helium-neon (He-Ne) laser, for example, passing a current through the tube makes the neon produce ultraviolet radiation which stimulates laser emission from the helium. As long as current flows, the gases continue to do their work.

It is possible to impress information onto a gas laser beam by varying the amount of current through the tube. A far more effective modulation technique uses special external filters which change their planes of polarization in only one direction. Rotating a polarized filter in the beam path changes the amount of light (intensity) passing through. The special voltage-sensitive filters, made of a crystal such as lithium tantalate, rotate the plane of polarization according to an applied signal voltage.

A continuous laser beam can be modulated at frequencies in the GHz range—of which no known electronic circuits can take full advantage. The best electronics technology can do today to take advantage of the bandwidth is to use a number of circuits to drive an equal number of polarization filters. By passing a single light beam through all the filters, all the electronic inputs become impressed on it. It is believed that it is possible to construct such a communication link to carry 200,000,000,000,000 bits of information. Such a system could be capable of handling all voice, TV, facsimile, computer, and commercial radio information entering and leaving a city as large as New York.

Laser beams travel in straight lines; so, future long-distance communication systems will have to use a series of mirrors or repeaters to make the beam follow the earth's curvature. Another scheme calls for using mirrors on orbiting satellites to reflect the beam from one point to another thousands of miles apart on the earth's surface.

An entirely different transmission technique will employ fiber optics to get the beam around. A modified version of this will use evacuated pipes, outfitted with reflectors, to carry the beam. These two methods have the special advantages of being immune to atmospheric disturbances.

Gas laser communications is progressing at a rather slow rate compared to the progress being made in LED and laser diode schemes. The reason is that there is presently no real need for communication links which have such staggering information handling capacities. When the time is right, high-performance laser communication systems now operating in experimental labs will be ready to open new communication channels which have virtually no limit with reference to operating range and information-handling capacity. ◈

Laser diode chip from Bell Labs (on a penny) can operate continuously at room temperature and is for possible use in small, low-cost communicators.

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BUILD

3.6-VOLT IC POWER SUPPLY REGULATOR

SIMPLE ADAPTER CONVERTS 6-VOLT LANTERN BATTERY INTO RTL IC POWER SUPPLY

BY JAMES A. FRED

UNLESS most of your experimenting is done with integrated circuits, investing in a regulated 3.6-volt (only) dc power supply is unrealistic. Yet, on those occasions when you do work with IC's, you can't do without such a power supply. While you could try to find ways of working around the need for IC's or invest in a seldom-used power supply, you would be far better off with a home-built adapter that will provide a stable 3.6-volt dc output when used with a common 6-volt lantern battery.

There are several advantages to building the 3.6-volt power supply regulator described here. First, of course, is economy; aside from the cost of the battery, total cost for parts should not run you more than $5. Then, since the regulator is line-independent, you are not restricted to using it on your workbench only. Being compact (about 1" thick and roughly the same area as that of the top of the battery), it can be stored almost anywhere—even atop the battery.

Theory of Circuit Design. As shown in Fig. 1, the adapter employs a conventional zener-diode regulator circuit. Light-emitting diode *D1* and its current-limiting resistor *R1* are optional, providing a low-current-drain power indicator feature. (With the 150-ohm value specified for *R1*, *D1* will glow at full brilliance, and the network will draw only 30 mA. If reduced brilliance is desired, *R1*'s value can be increased, and current drain will decrease proportionately.)

Zener diode *D2* is the regulator device in the circuit. It limits the current delivered to the load via *BP1* and *BP2* to 100 mA. The value of *R2* was determined with this limitation in mind. If you plan to use the adapter for one specific application, you can tailor *R2*'s value as required.

For example, if your load circuit draws a maximum of 40 mA, this would leave 60 mA to be dissipated by *D2*. The voltage to be dropped is the difference between the unregulated 6 volts from the battery and the regulated 3.6-volt level, or 2.4 volts. Now, divide 2.4 volts by 0.1 ampere, and the result is 24 ohms. If the load is to be constant, assume a required current of 110 percent of the load current. By Ohm's Law, it can be shown that a 56-ohm value is needed for *R2*. Note, too, the savings in current—only

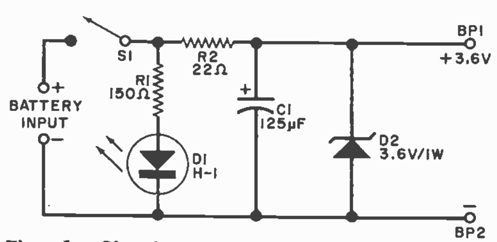


Fig. 1. Simple regulator circuit has D1/R1 for optional power indication.

PARTS LIST

BP1,BP2—Five-way binding post (one red, one black)
C1—125-μF, 6-volt electrolytic capacitor
D1—Light-emitting diode (Monsanto type H-1 or similar)
D2—3.6-volt, 1-watt zener diode (Motorola HEP-102 or similar)
R1—150-ohm, ½-watt resistor
R2—22-ohm, ½-watt resistor
S1—Spst slide switch (Stackpole type SS-26-1 or similar)
Misc.: Printed circuit board, solder, etc.
Note: The following items are available from J&M Electronics, R 1, Box 28, Cutler, IN 46920: etched circuit board with only pilot holes drilled (No. JM-PC1) for $1.00; same board with rounded corners and all holes drilled full size for $2.00. Indiana residents add 2% sales tax.

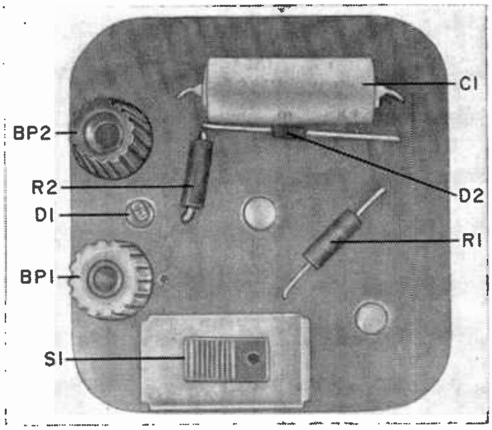


Fig. 2. At the right is actual size printed circuit board etching guide. Component location is in photo above.

44 mA as opposed to 100 mA. The battery would, under these conditions, last 2½ times longer.

When using a zener diode to regulate a voltage, remember that the diode and load are in parallel with each other. The current not used by the load flows through the zener diode to ground; thus, it is advantageous to make *R2*'s value as large as possible.

Capacitor *C1* is in the circuit to maintain a constant voltage across *D2*, even under changing load conditions.

Construction. Building the regulator adapter requires only conventional printed circuit techniques, but a few hints will make the job easier. As with any PC board (see Fig. 2 for actual size etching and drilling guide and components placement photo), avoid overheating when soldering. Also, practice the usual care when soldering *D1* and *D2* into the circuit. Remember, these two components are solid-state devices and are sensitive to heat.

Before soldering the leads of *D1* to the foil pattern, be sure that its tab is toward *BP1*. If it is not properly oriented and the light-emitting diode's leads should be reversed, *D1* will not glow. If *D1*'s glass "lens" is not a press fit in its mechanical mounting hole, dab a bit of fast-drying model cement where the two meet. Note also that *D1*'s leads are routed along the bottom side of the board.

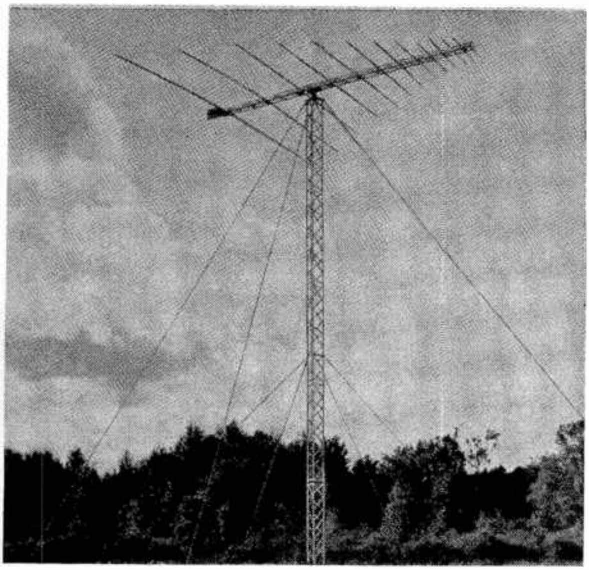
When mounting the binding posts, use lockwashers between the nuts and foil pattern. Fasten the nuts down tightly. Then carefully cut off the screw ends flush with the nuts. Finish the job by soldering the screw ends to the nuts and the nuts to the foil pattern.

When mounting *S1*, it is first necessary to cut away the eyelet ends of the solder lugs, leaving the narrow "necks" that fit nicely into the mounting holes in the board. Carefully bend *S1*'s lugs to mate with the board holes, mount the switch, and solder its lugs to the foil pattern.

A final note on assembly: to assure good electrical contact between battery posts and circuit board, it is a good idea to "tin" the copper foil around the board mounting holes with solder.

Using the Adapter. To use the adapter with any Mallory Type M915 (or similar) battery, first remove the battery's screw lugs from the terminal posts. Position the circuit board over the battery, seating it on the terminal posts. Then fasten the board down by replacing the screw lugs. Switch *S1* to the on position; *D1* should glow and, if you have a meter available, a 3.6-volt potential should be present between *BP1* and *BP2*. If all is well, you are ready to put the battery/regulator into service on your workbench.

You should recheck the output voltage from the regulator periodically since there will inevitably come the day when the battery voltage will be too low for the regulator to operate properly. When the battery becomes depleted, simply unscrew the lugs, remove the adapter, and mount the regulator on a fresh battery to get back into business. ◈



Canada's New Voice on Shortwave

OUR NORTHERN NEIGHBOR IS TAKING ITS PLACE AMONG THE MAJOR SHORTWAVE BROADCAST POWERS

BY RICHARD E. WOOD

THE Canadian Broadcasting Corporation (CBC) is a powerful voice in putting Canada on the world map. Most readers will by now have heard of the new transmitters of CBC's worldwide voice, Radio Canada International (RCI), at Sackville, New Brunswick. Some may even have obtained QSL verification cards when the first of the new 250-kW transmitters went on the air in July 1971, or on the official inauguration day, July 31, at which time programs were beamed only to Europe.

The CBC Sackville project entered a second phase on November 7, 1971, when regular transmissions began over the new transmitters on 9625 kHz to the United States. The U.S. beam is obtained by electrically reversing the array used earlier in the day by RCI European Service, which ends at 2234 GMT. The 250-kW signal pours into the target zone, overwhelming the competition on 9625 kHz.

The popular English-language transmission beamed to the U.S. is at 2300 GMT—not a convenient listening time for many SWL's, especially west of the Eastern Standard Time belt. However, a solution is in sight.

Since July 1971, the CBC has been beaming to the central and western states a relay of the Deutsche Welle in German from Cologne. Presently on 9745 and 11,856 kHz, the transmissions are during the more reasonable period between 0155 and 0415 GMT. And now the CBC is actively considering their own English transmission, following the German relay, to begin at about 0415 GMT. Plans are not final, but it may go on the air some time this spring. (If you support the idea, write to Radio Canada, Box 6000, Montreal). Then, western and midwestern listeners looking for the CBC during their local evening hours won't have to try tuning in the hard-to-receive Northern Service beamed to the Arctic.

Going beyond North America, CBC's world-wide coverage plans included a series of tests in Japanese, English, and French beamed over the North Pole to Japan in 1971. The tests weren't successful because of interference on the crowded bands and the attenuation and flutter typical of polar circuits. A west coast transmitter station could solve the problem, but CBC is putting its development money into expansion of the Sackville installation.

There's a brighter outlook for the Middle East and Africa. A Voice of Germany relay station is going up on strategically located Malta in the Mediterranean. Just as CBC relays Deutsche Welle for North America, the DW base will pick up and boost Canadian programs in the target areas of the Mid-East and Africa. There is even some talk of an Arab-language service for Radio Canada International when the relay base is completed.

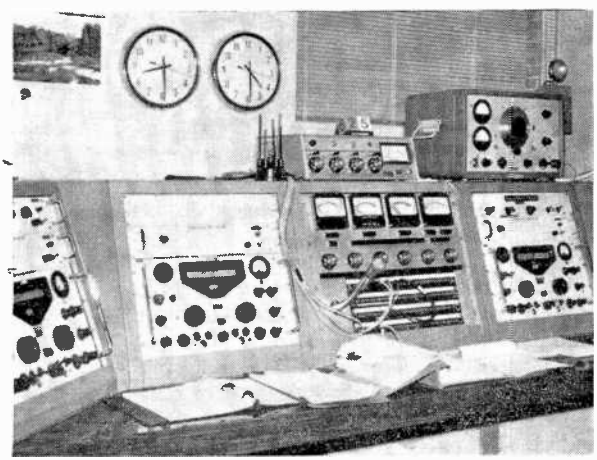
Thanks to an arrangement with the Voice of Germany, Eastern Europe and the Soviet Union are receiving a powerful Canadian Voice. The Russian-language transmissions of the CBC are relayed over Radio Trans-Europe from Sines, Portugal, which is mainly but not exclusively a Deutsche Welle relay base. Likewise, the BBC in London carries CBC relays to Europe and Africa. And there is a local FM relay in Berlin.

The plan for Sackville calls for no less than five 250-kW transmitters in addition to the existing three rated at 50 kW which are going strong after 20 years. The antennas are modestly claimed to be of "conventional" design, but the new transmitters are *un*conventional, representing the state-of-the-art in design at Collins Radio Company. The Collins 821A-2 transmitter system is computer-controlled to provide a high degree of flexibility in prescheduling as many as 100 different programming conditions for a period of 24 hours before the actual time required for them to go on the air.

All of the operations are fed into the computer on punched paper tape. As each instruction is performed, it is erased from the computer's memory, but the punched tape can be saved for a repeat performance at another time.

The transmitters can be automatically retuned in 12 seconds or less to any desired frequency in the 3.95-26.5-MHz continuous range by direct digital control of a frequency synthesizer. The computer also provides continuous control and monitoring of more than 70 analog and 80 digital parameters on each transmitter. Only out-of-tolerance readings are automatically printed out on a teletypewriter; but other readings are available to the operator via teletypewriter request.

Monitoring equipment at the CBC's receiving station near Ottawa, Canada.



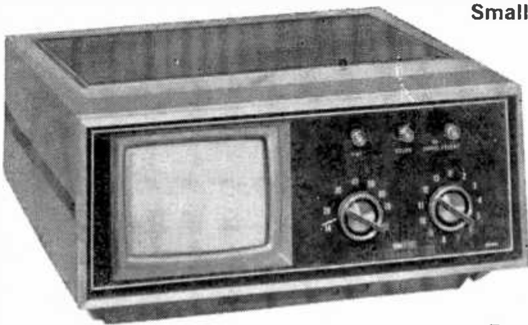
Fault reporting is followed by automatic recycling to restore the transmitter to operational status. Should the transmitter fail to operate still, a diagnostic routine is originated by the computer to isolate the cause of the trouble and print out the location of the fault. The direct digital control equipment is also self-monitoring. (Faulty equipment is quickly replaced by plug-in modules, 35 of which—in 16 types—make up each transmitter.)

Upon completion of the Sackville project in the Spring of 1974, there will be four curtain antenna arrays, beamed independently to Europe, the Middle East, Africa, and South America. Each will provide 20 dB of gain, will have reflector curtains, and will be electrically reversible and slewable. RCI shares the Sackville facility with the CBC Northern Service, but the requirements for the Northern Canadian antenna system are different—only 14 dB of gain and a broader beam angle to cover the entire North West Territories and islands of the Canadian Arctic from the Yukon in the west to Labrador in the east.

For the remaining SW stations in Canada, wattage is either elephant power like Sackville's 250 kW or flea power. The CBC's English-language domestic network is relayed on SW by CBC Vancouver on the west coast with 400 watts and CBC St. John's, Newfoundland, with only 300 watts. Identification is complicated by the fact that both stations operate on the same frequency of 6160 kHz in the 49-meter band where all Canadian mini-powered SW stations are confined. Positive identification is therefore necessary. CKZN St. John's has its major newscasts on the half-hour as opposed to the on-the-hour newscasts from CKZU Vancouver, which is one way to tell the stations apart.

Not all Canadian shortwave broadcasting is operated by CBC. Six lively commercial stations, with low-powered (ranging from 1 kW to a tiny 10 W) SW relays on 49 meters, give overseas SWL's a glimpse of North American domestic commercial radio. Best heard in the U.S. is CFRX on 6070 kHz out of Toronto, relaying CFCF.

In the West, CFVP Calgary on 6030 kHz relays CFCN on 1060 kHz. These and three others—also widely heard in spite of their low power—round out the scene in Canada where shortwave broadcasting is still very much alive. Have you heard them yet? ◈



Smallest set seen is Panasonic's 4½-inch model.

WHAT'S DIFFERENT ABOUT JAPANESE COLOR TV?

Some imported sets have features not found in domestic models

BY FOREST H. BELT

THE WORD is around that Japan faces a problem: inadequate research and development. If the rumor is true, it has yet to show much effect on color TV sets from that country. Some incorporate features not found in U.S. receivers.

An outstanding example is Sony's Trinitron picture tube. U.S. companies fiddled for several years with a color tube that would be simpler to use than the three-color triad-dot shadow-mask CRT. None of the early one-gun tubes ever reached feasibility. General Electric did build, and still uses, a small color tube with phosphor dots in rows instead of in triangles.

Then came Sony with the Trinitron. First models had 9- and 12-inch screens. Sony recently introduced a 17-inch size, and a larger version is imminent.

The Trinitron differs from a conventional color tube. Both are tricolor, but the electron guns that drive the colors are situated differently in the glass neck. Guns in a conventional color CRT are in a triangle, with blue on top. Trinitron guns are side by side.

The phosphor screens on the faces of the tubes bear no resemblance except for colors. The Trinitron phosphor is deposited in stripes instead of dots. The insides of each kind of tube are structured to take advantage of the gun and phosphor arrangements.

The Trinitron requires less complicated circuitry. Beam convergence on the screen is simpler, less critical, and needs adjustment less often. So far, no U.S. company has acquired the rights to use the Trinitron.

Television in Miniature. Imported color receivers outdo many American brands in portability and small screen sizes. One company claims a 2-inch (sizes are in viewable diagonal inches) color set, but hasn't displayed it.

The smallest we've seen working is Panasonic's 4½-inch shown at left. This model takes a prize for portability too. It weighs only 18 lb. A low-power picture tube reduces power drain to a mere 15 watts, whether from the internal battery, a car or boat electrical system, or household ac.

The Hitachi CWU-210 operates from batteries. It is the only color set we know of that does (and that you can buy). This 12-inch portable draws considerable current, but a boat or car battery can run it several hours without recharge.

Small size is distinctive of Japanese color TV. A 7-inch model was built but never got here. Sales today consist mainly of 9-, 11-, 12-, 14-, and 15-inch portables. Larger sizes (16, 17, 18, and 19 inches) usually are in table and console cabinets. Newest of these are the 17-inch and the 19-inch, both square cornered (S), and a 17-inch Trinitron. By brand, here are CRT screen sizes:

Hitachi	12, 14, 16, 18
JVC	17(S), 18, 19(S)
Micotron	12, 15, 18, 19(S)
MGA	12, 14, 16, 19(S)
Panasonic	9, 12, 16, 18
Sanyo	12, 15, 18, 19(S)
Sharp	12, 15, 16, 18, 19(S)
Sony	9, 12, 17 (all Trinitrons)
Toshiba	11, 15, 18, 19

Notice the lack of a large-screen import. One company, the MGA division of Mitsubishi, sells a 25-inch receiver with plug-in modules. But the chassis is not imported. That makes MGA the only foreign-brand color set built in the U.S. so far. (It's common to find the opposite—domestic brand labels on imported sets.) Sony won't tell the size of the larger-screen Trinitron promised for next year.

Solid Technology. American manufacturers are strong on transistors, integrated circuits, and other solid-state components. Imports have them too, although surprisingly few IC's show up in Japanese brands.

The irony is that a foreign brand almost won the race to all-transistor color. Sony's first Trinitron receiver was solid-state. The company demonstrated it in 1966. But before it was available, Motorola came out with the first "Quasar"—and this you could buy.

Color imports today continue the total-transistor trend. All Hitachi models are solid-state. One JVC chassis uses only transistors and IC's. In some models of MGA, Panasonic, and Sanyo, the CRT is the only tube. Sony has kept the Trinitron chassis solid state.

You find transistors, and even integrated circuits, in other import brands and models, but in limited numbers. More tubes than transistors fill their sockets, just as with most U.S. brands.

Easy Fixing. Few American set-makers took seriously the matter of building a TV set easy to service; that is, until recently. Naturally, neither did their offshore counterparts, the Japanese manufacturers—also until recently.

Some U.S. sets have been redesigned to make servicing less difficult. The concession to repairs began here about four years ago. Now, finally, similar attempts appear in a few Japanese sets.

JVC helps with plug-in interconnections between PC boards and chassis. MGA, in its all-solid-state 19-inch, exposes all circuitry by slide-out, fold-out boards (Fig. 1). Both sides are accessible for testing or parts replacement. Most interconnections terminate in plugs.

Circuit boards in the newest Hitachi chassis snap loose and some have plug interconnects. The boards are also interchangeable from model to model. Printed boards in these and many other brands now have connection and parts markings on both sides to ease circuit tracing.

Tuner "Equality." Beginning this July 1, 40% of the TV sets sold in this country by any manufacturer must have a uhf tuner that is as simple as a vhf tuner. Already, 10% of a manufacturer's line must reflect this tuner equality. Detented uhf positions fulfill this requirement, although not ideally. Anyway, that accounts for the 8-position uhf tuner in top models of several 1972 Japanese lines.

More consequential, perhaps, is the 25-position detent uhf tuner Mitsubishi put into its all-transistor receiver.

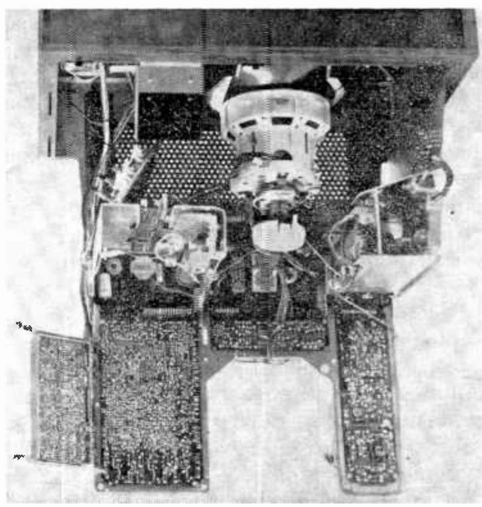
The tuner itself is tiny. The 25 positions derive from a mechanical contrivance that drives the tuning capacitors inside the little tuner. Each mechanical position allows a spread of three uhf channels. The owner pushes in and turns the center knob to fine-tune the active channel. Mechanical accuracy and stability don't suffice at uhf, so aft (and a variable capacitance diode in the tuner) takes over and holds the station solid.

Automatic? Well—Maybe. Color television brought a host of customer problems for dealers and technicians. Owners had trouble with tuning, so manufacturers added automatic fine tuning or aft. Color is stronger in some telecasts than in others; so—automatic color control or acc.

A serious shortcoming has been tint or hue. Faces come on green or purple when programs change. To alleviate that, some color sets now include automatic tint control of one kind or another. The most common atc system alters the color demodulator, making it less sensitive to variations in the signals that form flesh colors.

The temptation to use that word "auto-

Fig. 1. Only recently have Japanese sets become easy to service. MGA set has sliding chassis, fold-out boards.



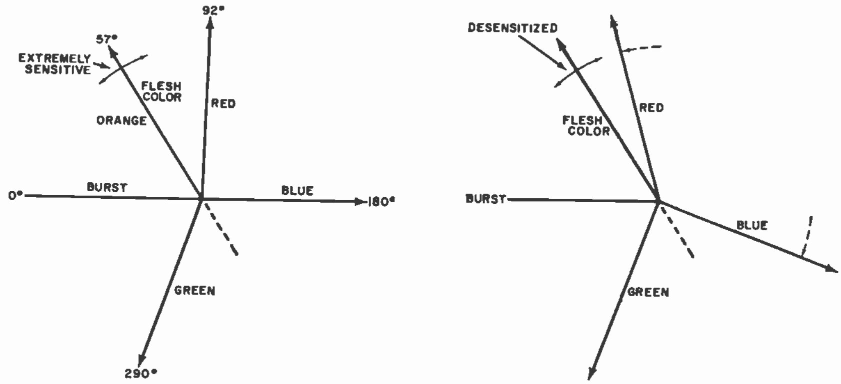


Fig. 2. Changing the demodulation angle makes demodulator less sensitive to phase errors transmitted with programs, keeps faces from turning odd colors.

matic" is great. You'll find several imported color sets advertised as having automatic tint, color, brightness, and contrast. Most of those chassis actually contain only an extra set of potentiometers. A technician pre-sets them to suit the viewer's favorite programs. A switch connects these internal controls and disables the front-panel equivalents. When color, hue, and video values in a program don't suit the pre-set pots, pushing the switch "off" reverts operation to the manual control knobs or sliders.

However, at least two Japanese brands have atc like that in American sets. Sanyo calls the circuit "Automatic Tint/Sensor." Toshiba atc is part of its abc system, which stands for "Automatic Balanced Color."

A typical atc, whether imported or domestic, depends to some extent on eye colorimetry. You see variances in red and yellow-orange shades easier than in blue or near-green shades. Widening certain angles at which a color demodulator works renders it less sensitive to flesh-tone variations. Fig. 2 shows the effect graphically. Reducing sensitivity to flesh-color alterations aggravates any changes in shade between blue and green. But the eye doesn't notice those changes as readily.

Selling Alphabetically. If calling a circuit "automatic" helps sales, so do catch-names and official-sounding acronyms. Another page from the book of U.S. set-sellers? Perhaps. Whatever the reason, the sales pitch for Japanese color sets has become alphabet-filled.

The old familiar agc, acc, afc, aft, and so on have been joined by a multitude of look-alikes. Try these new ones for meaning: aps, act, psc, abc, another abc, ats, arc. You'll find them all among imports.

Aps stands for Hitachi's *automatic picture setting*, another name for pre-set brightness, contrast, tint, and color pots. Act is Sharp's *automatic color tint*, which is just a pre-set hue control. Psc is a step toward accurate labeling: *pre-set color* (meaning hue), in sets sold by JVC America.

The two abc's bear little likeness. One stands for *automatic brightness control*, but not the kind that years ago kept TV screens adjusted for room light. This one is—you probably guessed—a pre-set brightness control activated by a pushbutton.

The other abc is *automatic balanced color*, a multi-function system in some Toshiba chassis. The abc switch activates a real atc (yes . . . automatic tint). It also connects up "Unicolor," a contrast circuit that doesn't upset color proportions. And finally, just so nothing is omitted, the abc switch puts pre-set color and tint controls into operation.

Ats, for *automatic tuning system*, is a Sanyo idea. It combines ordinary aft with a pre-set tint control. And arc is Sanyo's too. It means *automatic resolution control*, and is another name for brightness limiting—keeping the raster lines from blooming at bright whites.

Color sets from abroad have plenty you don't find in American sets. Some features are real, some just for sales promotion. But then, that characteristic fits U.S. sets too. ◈

LASER HOLOGRAMS SPEED COMPUTER PARTS ANALYSIS

ENGINEERS and scientists have used 3-dimensional photography to significantly speed up testing and analyzing computer parts at the IBM General Systems Division development laboratory in Rochester, Minnesota. The laboratory technique, an accepted standard of industrial testing using laser photography (otherwise known as holography), was successfully used to test several parts for experimental machines.

Quick and accurate parts analysis is the most important aspect of this technique. A recent analysis involved a part for a new card reader. Within two hours, the shortcomings of the part and how to prevent similar problems were known. As Dr. LeRoy D. Dickson of the Opto-Electric area of IBM points out: "Without holography, it could have taken us as long as two weeks to analyze this part."

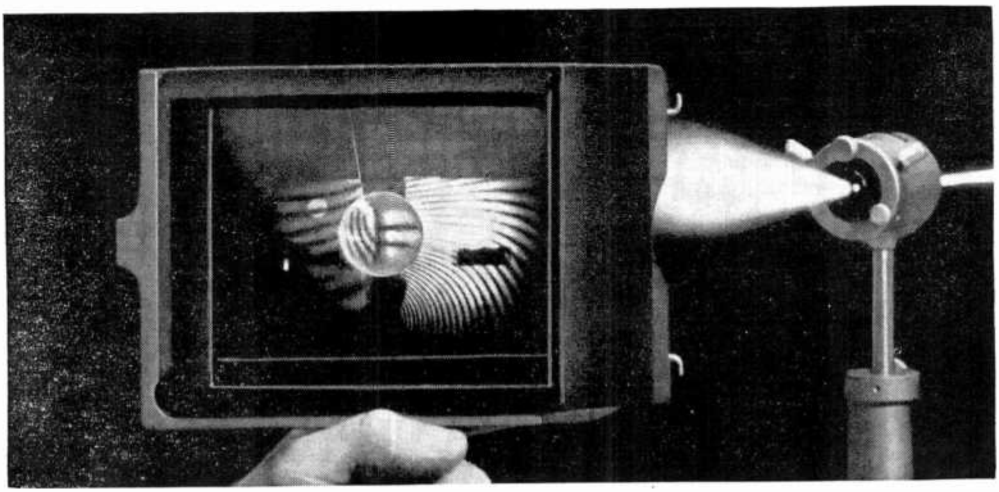
The optical facility used interferometric equipment, including a small laser, various mirrors and lenses, a variety of part holders, a photographic plate holder, and a stable table as basic equipment for the test setup. To make the holograms, the intense coherent light from the laser is enlarged and split into two beams through a series of lenses and mirrors. One beam is directed at the test part; the other at the glass photographic plate. Light reflected from the test part combines with the light in the second beam to produce the holographic exposure on the photographic plate.

The hologram is completed by making a second exposure of the part on top of the first exposure. Before making the second exposure, however, a load equal to that which the part would receive in normal use is applied to the test part. Following the second exposure, the plate is developed. After this is done, it is necessary to remount the plate in its holder and focus onto it the laser beam, to make the image visible for viewing.

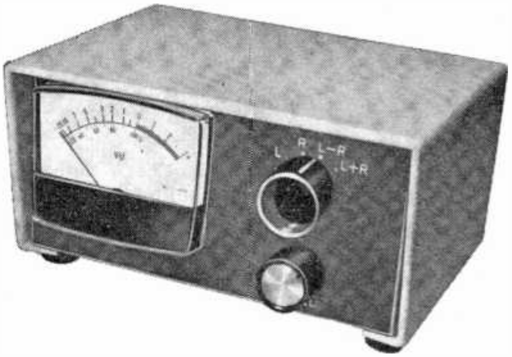
Through the double-exposure technique, part deformation between the two exposures shows up as fingerprint-like patterns of lines over the image (see photo). A visual study of the line pattern shape and spacing yields a great deal of information concerning the forces on the test part.

"Although this technique is one of many that are vital laboratory analytical tools, its speed and non-destructive elements made it particularly valuable to us," concludes Dr. Dickson. ◈

The large fingerprint-like patterns on double-exposed hologram images show the precise areas of stress during actual operation of the parts.



BUILD A SIGNAL DIFFERENCE STEREO BALANCE METER



EXACTLY BALANCES OUTPUTS OF BOTH CHANNELS FOR PERFECT STEREO SOUND REPRODUCTION

BY J. R. LAUGHLIN

MOST audiophiles invest considerable effort and money into building their home stereo systems. Often, however, they are so concerned with wide frequency response, minimum distortion, and good channel separation, that proper amplitude balance of stereo channels is overlooked.

The "Signal Difference Stereo Balance Meter" described here, when connected to the stereo system's amplifier ontputs, provides a means of quickly and accurately balancing stereo channels and gives a continuous readout of the various functions of the stereo signal. The Balance Meter is passive and requires no power supply.

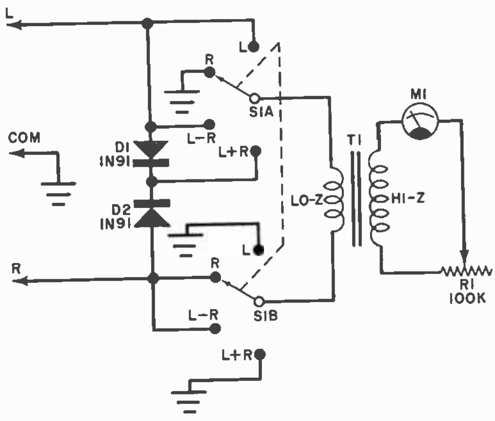
The meter used here is a standard type commonly found in the broadcasting and recording industries. The face of the meter has two scales: one reading VU (volume units) from —20 to +3; other showing voltage percentages from 0 to 100, with 100% voltage coinciding with the 0 point on the VU scale. (An internal rectifier drives the dc meter movement.) The normal level for volume units is at 0 VU.

Volume units are numerically equal to the number of decibels above the reference level of 1 mW of power into a 600-ohm load. The use of an uncalibrated level control and the omission of special circuits to compensate for loads other than 600 ohms greatly simplifies the hardware requirements of the Balance Meter. Of course, absolute power measurements are impossible without the aid of special calibration procedures; but, for any setting of the level control, accurate relative variations in audio amplitude will be displayed in dB on the meter scale.

Theory of Circuit Design. As shown in Fig. 1, *T1* is a stepup transformer that boosts the input from the amplifier to provide a driving signal for *M1*. This gives the Balance Meter great sensitivity, even at low volume levels, without the need for active amplifiers. Level control *R1*, in series with *M1*, permits on-scale readings over a wide range of volume levels.

Function switch *S1* connects the primary of *T1* to the input circuit in the appropriate manner to provide four signal configurations for driving the meter movement. In the L and the R positions, the primary is simply connected to the input selected, while grounding the unwanted input.

The L—R is obtained by connecting the primary of *T1* to both "hot" lead outputs from the amplifier, without completing the circuit to ground. If the channels contain identical signals, there is no indication on *M1*. On the other hand, with a stereo



PARTS LIST

D1,D2—1N91 diode (do not substitute)
M1—VU meter movement (Calectro No. D1-930 or similar)
R1—100,000-ohm, audio-taper potentiometer
S1—Double-pole, 4-position, nonshorting rotary switch
T1—Interstage transistor transformer with 5:1 impedance ratio (Triad T24X, Stancor TA35, or similar)
Misc.—Chassis box (LMB No. 453N or similar): three-conductor cable; control knobs (2); spade lugs (3); rubber feet; rubber grommet; panel and cabinet finishing materials; hook-up wire; solder; etc.

Fig. 1. Circuit of the Balance Meter is basically a step-up system which drives meter. Diodes provide isolation.

signal, current will flow through *T1* in proportion to the *difference* signal.

The L + R function is derived by connecting the primary of *T1* to the "hot" outputs of both amplifier channels and completing a circuit to ground through *D1* and *D2*. Thus, the meter reads a *sum* signal.

Construction. Since the circuit (Fig. 1) of the Balance Meter is very simple, a circuit board and complicated wiring techniques are not needed.

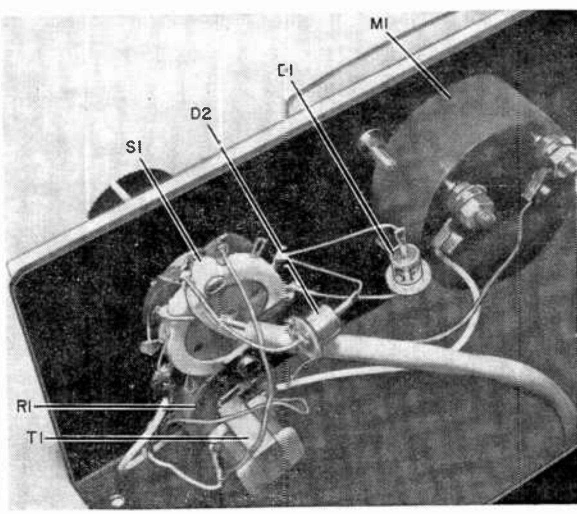
Begin construction by machining the front panel of the cabinet to be used so that it will accommodate the meter movement, function switch, and level control. Then carefully finish the panel with a coat of paint or with adhesive-backed vinyl to complement your present system. This done, use a dry-transfer lettering kit to apply the legends for *S1* and *R1;* use black letters on light backgrounds and white letters on dark backgrounds. Then, to protect the lettering during use, spray a *thin* coat of clear Krylon over the entire front panel; allow to dry. Follow up with another coat or two of the Krylon. Note: Do *not* apply one heavy coat of the Krylon and let it go at that. A heavy coat will simply dissolve the lettering.

Now mount the meter movement, switch, and potentiometer in their respective cutouts on the front panel. Referring to both Fig. 1 and Fig. 2, wire together all components and cables. When wiring *T1* into place, remember that the high-impedance side goes to the meter circuit. The polarities of *D1* and *D2* are not important as long as they are connected together either in an anode-to-anode or a cathode-to-cathode configuration. Wiring up *S1* can be a bit tricky; so, be careful when working on the switch.

After passing the input cable through a rubber-grommet-lined hole in the rear panel of the chassis and connecting it at one end to the appropriate lugs on *S1*, connect and solder spade lugs to the free ends. The spade lugs facilitate easy and dependable connections to the amplifier.

As with the front panel, pains should also be taken to make the cover of the Balance Meter blend with the rest of your equipment. You can use contact cement to apply a cloth-backed vinyl upholstery material to the cover. Then finish up by assembling the cabinet and attaching rubber feet to the bottom of the chassis.

Fig. 2. Components are mounted on lugs of switch, potentiometer and meter.



Setup and Use. Preliminary checkout is best accomplished with the aid of an audio generator. But if a generator is not available, you can use one channel of your stereo system for the tests.

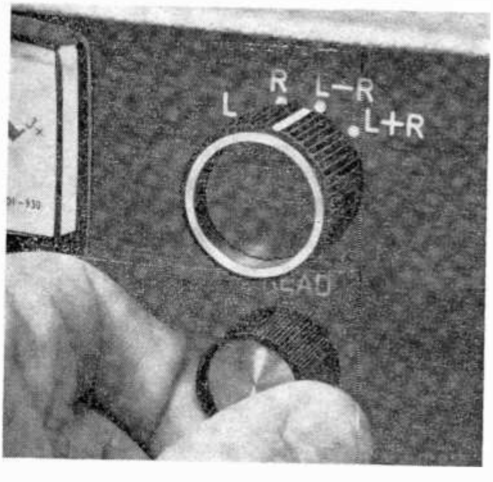
First, place *S1* in the L position and connect the L and COM input leads to the generator's hot and ground outputs, respectively. With the generator turned on, the VU meter's pointer should deflect, and the deflection should change as you change the setting of the level control.

With *R1* fully clockwise, the most sensitive position, the signal level required for full-scale deflection of the meter pointer should be less than 0.4 volts rms. This signal should also be read on the VU meter with *S1* set to L + R. (It may be slightly less due to the drop across *D1*.)

Repeat the above procedure with the Balance Meter's R and COM inputs connected to the generator's hot and ground outputs and *S1* set to R. Check also to see that the signal is read in the L + R position of *S1*. Here, again, a slight reduction may be noticed as a result of the voltage drop across *D2*.

To check out the L — R function, place *S1* in the L — R position and ground the R input lead to COM. A reading should be obtained with the generator connected between the L and COM input leads. Likewise, the same reading should be obtained with the L input lead grounded to COM and the generator connected between the R and COM input leads. Now, tie the L and R input leads together, connect them to the

Mark S1 positions to agree with circuit wiring. Finish front panel to coordinate with other system components.



hot output of the generator, and connect the ground of the generator to the COM lead. If a zero reading is obtained on *M1* with this test and all previous checks are correct, the Balance Meter is ready to use.

Locate the Balance Meter close to the amplifier with which it is to be used and in a position where it can easily be observed. Then connect the input cable to the appropriate output terminals on the amplifier. (Note: In some amplifiers, especially those which provide speaker phase switching for one of the channels, use of the Balance Meter is not recommended. To determine whether or not it is safe to use the Balance Meter with your amplifier, study the amplifier's schematic diagram; if the outputs share a common reference line —and *only* if they do—it is safe to use this instrument.)

With the Balance Meter properly installed, readings should be obtained on *M1* with the function switch in the L, R, and L + R positions. A stereo signal will provide readings in the L — R position. To exactly balance the amplifier, switch to the mono mode so that identical program material is fed into each channel. Rotate the balance control on the amplifier to a position where the VU meter nulls to the left index of the scale.

Now, adjust *R1* fully clockwise to obtain maximum sensitivity. At maximum sensitivity, it might be difficult to obtain a perfect null, especially if the volume level is fairly high. Differences in bass or treble response in each channel will cause small deflections of *M1*. Some amplifiers incorporate separate clutched controls for bass and treble adjustments. In these amplifiers, adjust the controls to obtain the best possible null. If your amplifier has a switch to take the controls out of the system to provide a flat response, put the switch in the flat position.

When using a tape playback deck or record player with the amplifier, precise balance of the entire system can be obtained by use of a full-track prerecorded test tape or a test record that produces equal output amplitude on each channel. As the tape or record is being played, first switch the amplifier to mono and balance it as outlined above. Then switch to the stereo mode and adjust the tape recorder balance control for best possible null. This will balance the system from the tape heads or pickup cartridge forward. ◈

BUILD A

175-MHz PRESCALER

BY DANIEL MEYER

EXTEND YOUR 20-MHz DIGITAL FREQUENCY COUNTER TO WORK AT 175 MHz

DIGITAL readout frequency meters capable of indicating to about 20 MHz are now becoming widely available at reasonable prices. There are a few that can reach 50 MHz, but if you have to go higher than that, the price really starts to climb.

However, by taking advantage of the latest developments in IC's, it is very easy to build a new divide-by-ten front end for less than $35. This will permit the use of limited-range counters at frequencies up to 175 MHz.

The new type of IC uses what is called emitter-coupled logic (ECL), which operates considerably faster than the TTL types now used in most counters. The high operating speed is obtained by never letting the internal transistors be driven into saturation. This eliminates the storage time delays that slow down TTL and DTL types. There are flip-flops available that can be used for counting speeds over 500 MHz. Although the Fairchild ECL-9528 dual flip-flop used here is specified for 160 MHz, in testing the Prescaler circuit, no samples were found that would not operate to 175 MHz.

Theory of Circuit Design. A schematic of the Prescaler circuit is shown in Fig. 1. The input high-frequency signal is suitably attenuated in *R1* and applied to the first IC through *C1* and *R2*, which provide dc isolation and overload protection for the IC. Resistors *R3*, *R4*, and *R5* are used to bias the input gate to the mid-point of its switching levels and to provide an input impedance approximating 50 ohms—the optimum value.

Diodes *D6* and *D7* clip any signal that goes positive or exceeds the supply voltage in amplitude. The first flip-flop (half of *IC1*) simply divides by two and passes the signal to the next three flip-flops (second half of *IC1* and both halves of *IC2*) which are connected to form a synchronous divide-by-five circuit. The output signal is amplified by *Q1* to provide sufficient drive for almost any type of counter.

Construction. It is best to assemble the Prescaler on a printed circuit board having the foil pattern shown in Fig. 2. Be sure to observe the terminal markings on the semiconductors and use a low-power soldering iron and fine solder to avoid thermal damage. The input and output connectors, transformer *T1* and filter capacitor *C4* are mounted on the metal chassis as shown in the photographs. The circuit board is mounted on four spacers.

Testing, Adjustment, and Use. Apply a signal with frequency over 20 MHz and a level between 0.5 and 2 volts rms to the in-

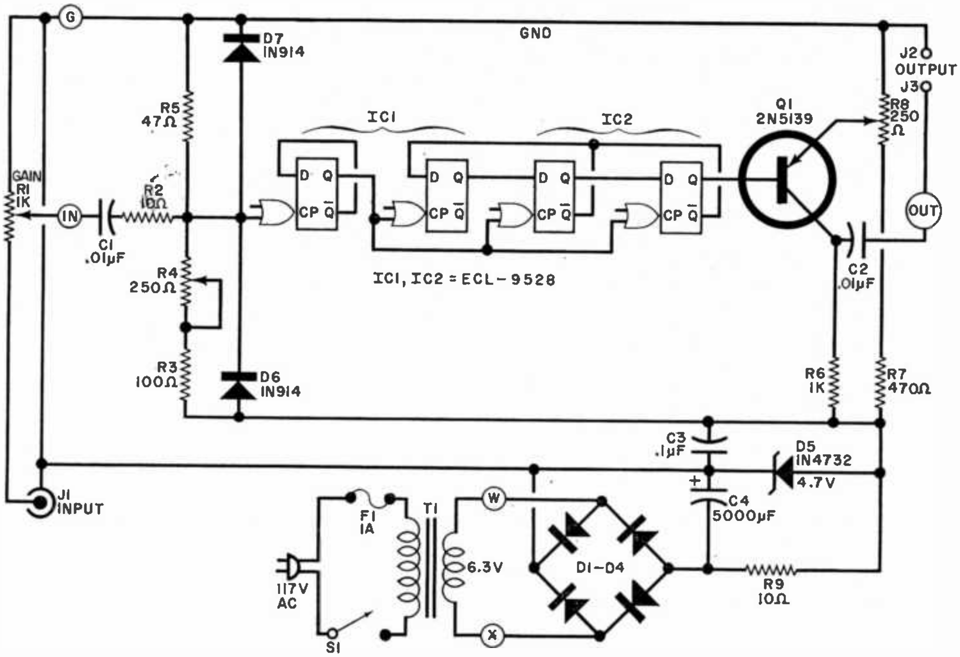
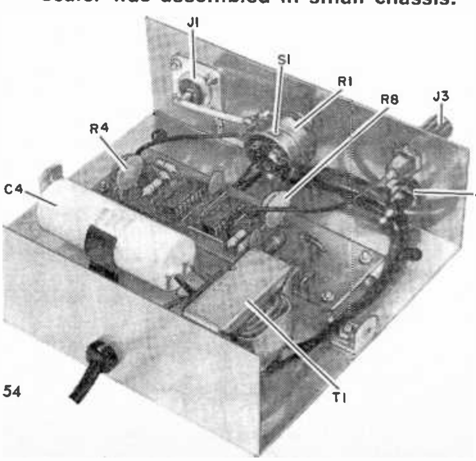


Fig. 1. The Prescaler is essentially a high-frequency divide-by-ten circuit that enables a 17.5-MHz frequency counter to indicate to 175 MHz.

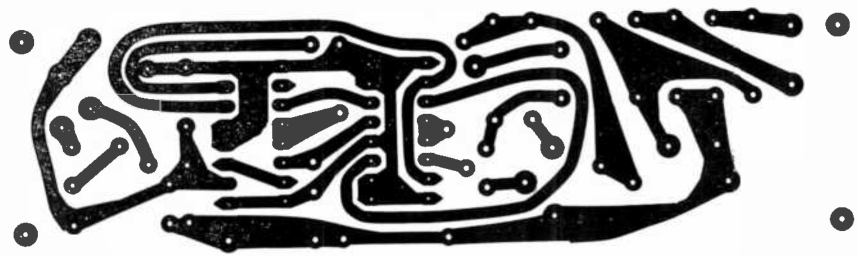
PARTS LIST

C1,C2—0.01-µF disc ceramic capacitor
C3—0.1-µF disc ceramic capacitor
C4—5000-µF, 10-volt electrolytic capacitor
D1-D4—1A silicon rectifier diode
D5—4.7-volt zener diode (1N4732 or similar)
D6,D7—1N914 diode
F1—1A fuse and holder
IC1,IC2—Dual flip-flop (Fairchild ECL-9528)
J1—BNC connector
J2,J3—Five-way binding post (one red, one black)
Q1—2N5139 transistor
R1—1000-ohm potentiometer with S1 attached
R2—10-ohm, ½-watt resistor
R3—100-ohm, ½-watt resistor
R4,R8—250-ohm PC potentiometer
R5—47-ohm, ½-watt resistor
R6—1000-ohm, ½-watt resistor
R7—470-ohm, ½-watt resistor
R9—10-ohm, 1-watt resistor
S1—Spst switch on R1
T1—Transformer; secondary: 6.3V, 600mA
Misc.—Suitable two-piece chassis, line cord, grommet, knob, board spacers, mounting hardware, capacitor clamp, etc.
Note—The following are available from Southwest Technical Products Corp., Box 32040, San Antonio, TX 78216: drilled and etched PC board #177 at $2.37, postpaid; complete kit of all parts including punched chassis at $33.75, plus postage and insurance for 2 lb.

This photo shows how prototype Prescaler was assembled in small chassis.



put. Connect the output to an oscilloscope. Turn on the Prescaler (via *S1* on *R1*) and adjust *R1* until a pulse waveform is displayed on the scope. If it is not possible to do this, leave *R1* at maximum and adjust *R4* and *R8* to obtain the desired display. Then adjust *R1* to reduce the input level and set the two controls on the board to produce an output with as low an input signal as possible. It is best to adjust these controls with an input signal of about 100 MHz since the adjustments are slightly frequency dependent. The adjustments may be broad at low frequencies, becoming more critical as the frequency is increased.



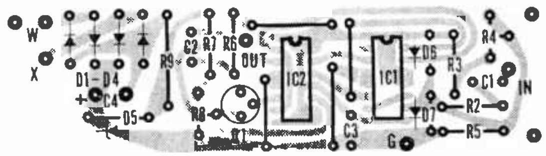


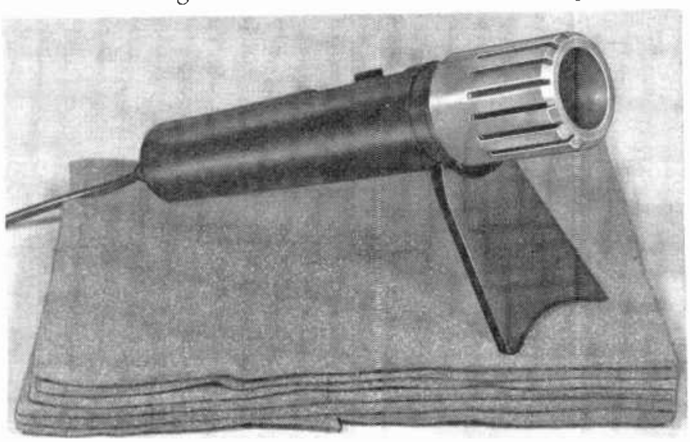
Fig. 2. Above is actual size foil pattern for the Prescaler circuit board. Component layout is shown at the left. Use low-power soldering iron and fine solder in the assembly.

In using the Prescaler and connecting an external signal to the input, always set *R1* for the minimum useful signal. Even with the protective diodes, a very large voltage level at the input could destroy the IC's.

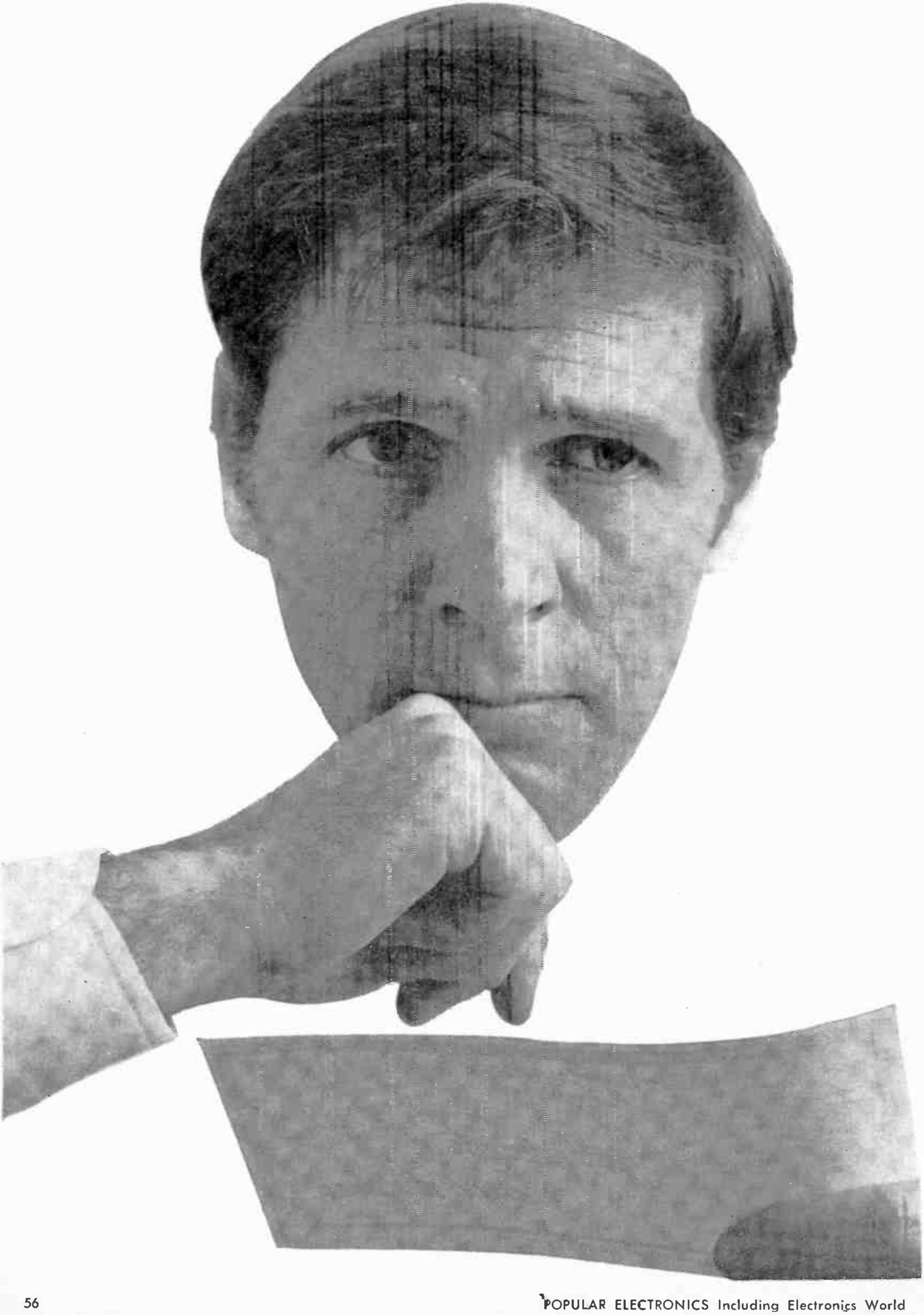
When connecting the Prescaler output to a counter, note that *J2* is the ground connector. Set the frequency counter to the kHz position and remember that, with the Prescaler added, all values will indicate one digit to the right. That is, with an input of 15 MHz, a conventional five-digit counter will indicate 15000 kHz. With the Prescaler added, the indication will be 01500 kHz. An input frequency of 175 MHz will show up as 17500 on the kHz range. If your frequency counter has a MHz range, it may be used, but you must still keep track of the decimal point mentally. ◈

SIMPLE THUMP AND RUMBLE FILTER

IF YOU do a lot of home or on-location tape recording using a microphone, you know how annoying and amateurish your tapes can be when the sound played back is loaded with "thumps" and rumbling noises. Even one thump or short rumble roll can be a downright nuisance. However, there is a simple method of practically eliminating any of these noises. All you need is a square of soft foam plastic (not the rigid kind used for arranging floral decorations or the type used in many kitchen sponges that turn rock hard when dry). Cut the foam plastic to about 6" x 6". For best results, the foam plastic should be ¼" to ⅜" thick. Just set the plastic foam pad on a solid surface, and place the recording microphone on the pad. You're ready for your next taping session. You'll be pleasantly surprised at how little background noise the mike picks up.



—*Frank H. Tooker*



Meter Accuracy Specifications

By John T. Frye, W9EGV, KHD4167

BARNEY, a little late for work this sunny April morning, had his hands cupped tightly together as he shouldered his way through the front door of the service shop.

"Guess!" he commanded Matilda, the office girl, as he stopped in front of her desk.

"Knowing you," she retorted, shrinking back in her chair, "it's probably a mouse."

Gently Barney took away one hand and held out the other, with a beautiful gold-flecked purple crocus nestling in the palm.

"Barney, how gorgeous!" she exclaimed. "Let me get a glass of water."

"Thought you might like it," Barney said gruffly as he tenderly deposited the little flower on the surface of the water. "Where's the boss?"

"Back in the service department," Matilda answered absently, still spellbound by the sight of the velvety petals floating in the glass.

Mac was sitting crosslegged on the service bench reading several stapled-together mimeographed sheets.

"Hi, my ten-o'clock-scholar," he said, glancing up. "Have a hard night?"

"Nope, just spring fever," Barney answered and then went on rapidly, "but let's not talk about me; let's talk about you. What are you reading?"

"A paper sent me by a young friend attending the British Columbia Vocational School in Burnaby, B.C. It's a study prepared by H.F.R. Adams, the Chief Electronics Instructor for the school, and it's entitled *The Meaning of Accuracy Descriptions of Measuring Instruments*. My young friend says the instructor's lectures remind him of me, which I consider very flattering, considering the impressive credentials possessed by this man."

"Anything in there I should know?"

Pointer-Type Meters. "Yes, so let's review it. Mr. Adams points out that pointer-type meter accuracies quoted by manufacturers reflect several sources of error inherent in the instrument as part of its manufacturing and calibration process: the balance, alignment, and resistance of the moving coil; friction in bearings or taut-band suspension; shunt and multiplier resistance values; magnetic strength, shunting, and shielding; and the effect of temperature on all of these. In addition, the technician often introduces additional errors because of parallax, pointer width, scale misreading, and improper interpolation of sub-divisions of the scale.

"Manufacturers have different ways of describing the accuracy of their products. One may advertise '±1% of Full Scale' while another may claim '±1% of Reading.' Suppose we compare these descriptions for a voltmeter with a full-scale reading of 100 volts. Obviously the permissible error of the meter with a claimed accuracy of ±1% of full scale will be 1 volt over the entire scale. At the top of the scale, the percentage of error will be 1/100 or 1%. At the 50-volt mid-scale point, this changes to 1⁄50 or 2% of the reading. At 33⅓ volts it becomes 1/33.3 or 3% of the reading, and at the bottom of the scale, at 1 volt, the possible error can be 1/1 or 100% of the reading."

"A guy would be wise to stay away from the bottom end of the scale on that meter when accuracy is important," Barney observed.

"Right. If the reading falls in the upper two-thirds of the scale on such a meter, you can depend on the reading to be off no more than 3% of the true value. That's why a multimeter with many scales affords better accuracy than does one with only a few scales. With the former, you can always select a scale so the reading will fall in the upper two-thirds of the scale."

"How about meters in which the accuracy is rated as ±1% of the reading?"

"Here the maximum percentage of reading error is constant clear across the scale, but the permissible voltage error increases with the reading to reach a maximum at full scale. In our example, this would be 1 volt at 100 volts. It would only by 0.5 volt at 50 volts and 0.1 volt at 10 volts. This might mislead you into thinking the meter was more accurate at lower readings, but of course the permissible error, 'percentagewise,' is exactly the same at 1 volt or 100 volts. But note the maximum percentage of reading error can never exceed 1% and the maximum voltage error, in our example, can never be more than 1 volt. At full scale, the anticipated accuracy of both meters would be the same; but the reliability of the readings on the meter rated at ±1% of full scale would decrease as the pointer moved downscale, while the percentage-of-reading accuracy of the other would stay the same."

"Some manufacturers have done their best to decrease 'cockpit trouble,' or operator error," Barney pointed out. "A mirror beneath the pointer lets the operator avoid parallax errors by moving his head until the pointer is directly over its reflection before taking a reading. Some multimeters shift a different appropriate scale into position with each setting of the range knob, or they illuminate the proper scale. But how about the new digital voltmeters? Does Mr. Adams say anything about those?"

Digital Voltmeters. "Yes, and I have a few thoughts of my own to add. He points out that DVM's eliminate reading errors. Viewing angle does not affect accuracy of readings; and, in most models, placement of the decimal (selection of the most sensitive range) and indication of the proper polarity are all automatic. However, DVM's do have other internal sources of error. Noise riding on the voltage being measured must be filtered out to avoid errors with high speed DVM's. Amplifier zero drift and offset voltages arising from switch positions can contribute to error according to Mr. Adams. Finally, a DVM has a built-in ambiguity error of ±1 digit.

"To understand why, you must realize

that, in a DVM, the measured voltage is balanced by an internal voltage in a bridge circuit. The internal voltage is applied lightning-fast in counted and displayed identical increments until the bridge is balanced as nearly as possible. By that I mean we reach a point where the bridge is almost nulled on the low side; yet the addition of one more increment of voltage makes it just slightly unbalanced on the high side. The displayed count can stop on either side of the true null, with the unbalance not being sufficient to cause the addition and subtraction of another unit of voltage and consequent change in the right-hand, least significant digit of the displayed voltage.

"DVM's usually specify accuracy as a percent of reading plus a percent of full scale. Sometimes the latter half is given as a number of digits. A 5-digit DVM accuracy may be specified as either ±(0.005% of reading plus 0.001% F. S.) or ±(0.005% of reading plus 1 digit.) Both are the same. As in the case of the pointer type meter, the *percent of reading* error is fixed, but as the reading increases, the number of digits error increases. On the other hand, the *percent of full scale* determines the greater portion of the permissible error on the lower portion of the scale. This can be an important factor in selecting a DVM for a particular purpose. For example, a DVM with a specified accuracy of ±(0.01% of reading plus 1 digit) will be more accurate over the lower 80% of the range than will one with a claimed accuracy of ±(0.005% of reading plus 0.005% F. S.)"

"I guess the accuracy of a DVM depends on the number of digits displayed. Is that right?"

"Probably it's better to say the 'resolution' of a DVM depends on the number of digits. Resolution is the amount of change in the voltage being read required to produce a 1-digit change in the reading. As the number of digits in the display goes up, the value of this voltage goes down. You might lump all these factors together and say that, in general, if you need 0.01% accuracy over most of the range, it's advisable to buy a 5-digit DVM; if 0.1% accuracy is sufficient, a 4-digit instrument will do; but only if 1% accuracy over most of the range is good enough should you buy a 3-digit DVM. However, if your needs are centered around a particular voltage, computing the accuracy at or near that voltage, according to published specs, is the best way to select an instrument. If this voltage falls near the full scale reading of any range, you can expect 0.1% accuracy and resolution from a 3-digit DVM, 0.01% accuracy and resolution from a 4-digit, and 0.003% accuracy and 0.001% resolution from a 5-digit instrument."

"DVM's have better accuracy and sensitivity than pointer-type meters, don't they?"

"Yes, because they lack the mechanical friction and inertia of moving coil meters, they can respond more quickly and to much smaller changes in voltage than can pointer-type meters. While DVM's are not designed to perform as laboratory standards or to replace laboratory potentiometers, they have brought near-laboratory accuracy into the field and into the production line."

"Do you think radio and TV service technicians should use DVM's in their work?"

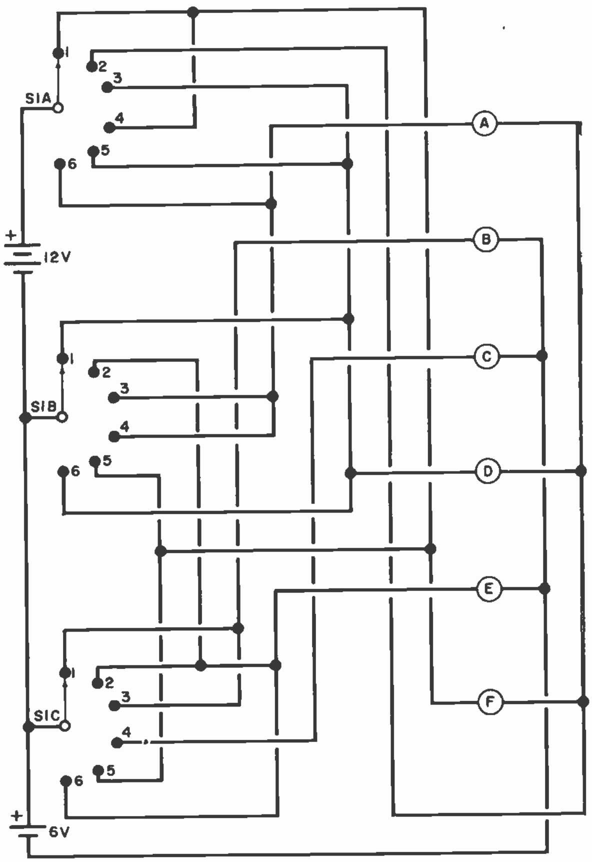
"If you mean do I think we should replace our pointer-type meters with DVM's the answer is no. We do not need anywhere near the accuracy of even a 3-digit DVM. Remember most resistors in radio and TV sets have a 10% tolerance and most voltages listed on schematics are within ±20%. Using a DVM to perform routine voltage checks in our work would be about as logical as mounting a high-powered telescope sight on a shotgun. However, I'm thinking of buying at least a 4-digit DVM for use as a reference in checking and calibrating our other meters and for use in those few cases where critical voltage measurement is necessary. I have a hunch the quick response of the DVM might also be useful in some intermittent cases."

"I guess no matter what instrument a fellow uses, he ought to know what to expect from it," Barney observed.

"That's right. When you are using any tool, you cannot use it to the fullest extent and with confidence unless you know two things: what it is capable of doing, and what its limitations are. The latter is just as important as the former, for it avoids trying to do something of which the tool is incapable. When you know the accuracy limitations of a meter, you keep these in mind when taking a reading; furthermore, when the accuracy is not uniform across the scale, you are in a position to take advantage of this fact in selecting the range that provides maximum accuracy." ◈

Ganged Switching Quiz

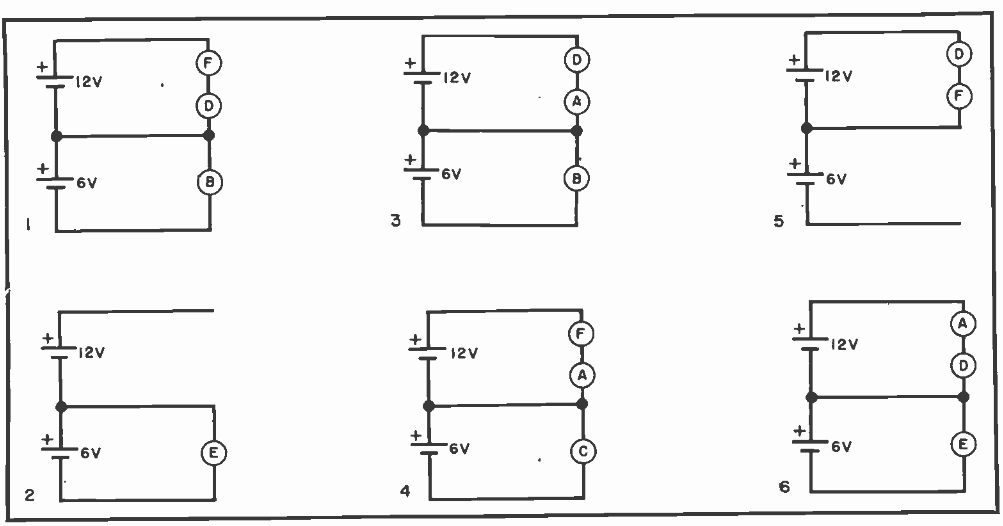
BY ROBERT P. BALIN



ELECTRONICS hobbyists, especially troubleshooters, can always use some practice in tracing out circuits that include ganged switches. Unless you are careful and systematic, it is easy to get confused, lose your way or overlook a component. Here's a chance to practice this important skill.

The schematic at left contains a 6-position, 3-pole switch, six 6-volt lamps and 6- and 12-volt batteries. As the switch is rotated, determine what combinations of lamps will light—each to full brightness. The answers are below so cover them up while you work out the circuit.

Note that although the switching function which this circuit performs can be done by a much simpler circuit (a single 6-volt battery can do the job) such a circuit would be too simple to be challenging and only unnecessary schematic zig-zagging could make it look more complicated. Since this quiz is intended to be a training problem, practical considerations have been ignored.



Product Test Reports

AMPEX MODEL AX-300 TAPE RECORDER DECK
(A Hirsch-Houck Lab Report)

The Ampex Corporation's Model AX-300 differs, both in appearance and function, from previous tape decks in the company's line. The deluxe three-motor, six-head machine which can record and play back in both directions with off-the-tape monitoring is manufactured in Japan to Ampex specifications. Its transport mechanism is solenoid-controlled through light pressure on "piano-key" levers. All transport controls are duplicated in an optional remote control unit which is fitted with a 15-foot cable.

The AX-300 has a foolproof tape-handling system which defied our attempts to outwit it. No matter how rapidly the controls are operated, or in what sequence, the recorder mechanism comes to a complete stop and pauses for a second or two before going from a fast speed to a normal speed. Its electromechanical brakes are failsafe, halting the tape without spillage in the event of a power interruption.

This is a three-speed tape deck, providing operation at 1⅞ ips, 3¾ ips. and 7½ ips with a single control to change both speed and equalization. Recording levels are set by four slider controls. A line source can be mixed with microphone inputs or with another high-level source to provide a variety of operating modes. Playback levels are fixed. And the two large VU meters can be used to monitor either source or tape playback levels.

Special effects are possible with a Function Programmer switch; no external patching is required. Programs can be recorded in stereo or quarter-track mono formats, transferred from one track to another with added material for sound-on-sound, rerecorded with a time delay for an echo effect, or recorded on one channel while listening with the other for sound-with-sound.

The tape direction can be reversed at any time by operating a control lever or automatically by a 20-Hz tone recorded on the tape. Commercially recorded tapes produced by Ampex already have this tone on them. However, by pressing a lever on the AX-300, the user can add the tone to his own home-recorded tapes.

The PAUSE control stops and starts tape motion instantly. Each of the six tape heads has a cueing/editing mark for simplified pinpointing of any specific instant of time on the tape.

The microphone inputs and headphone output jack are located on the front panel; all other inputs and outputs are located on the rear apron of the recorder. A recess on the left side of the deck contains four separate bias adjustment controls for the two channels in both directions of tape movement so that the recorder can be optimized for any tape formulation. As shipped from the factory, the AX-300 is set up for BASF LP-35-LH tape, the same type we used in our tests.

A novel feature of this new tape deck is the continuously variable 12-dB/octave low-pass filter in the playback outputs. The cut-off frequency can be set for less than 3000 Hz to beyond 16,000 Hz. The Ampex philosophy in supplying this filter is that limiting the bandwidth to that needed for the program provides optimum signal-to-noise ratios.

Laboratory Measurements. In our laboratory measurements, the record/playback frequency response in both tape motion directions within a ±2 dB range was 33-18,500 Hz at 7½ ips, 40-11,500 at 3¾ ips, and 38-6000 at 1⅞ ips. Playback response, with Ampex full-track tapes, was ±1 dB from 150 Hz to 15,000 Hz at 7½ ips, rising to +5.5 dB at 50 Hz. The low-frequency rise was partially due to "fringing" effects which occur when playing a full-track tape with quarter-track heads. But with a quarter-track test tape, the output at 50 Hz was still up 4 dB. At 3¾ ips, the full-track response was flat out to 7500 Hz and up 3 dB at 50 Hz.

The filter had ideal 12-dB/octave slopes with a sharp "knee." At its minimum setting, cut-off was at 2000 Hz. The calibration markings at 3, 6, 10, and 16 kHz were accurate. The response in the OFF position on the control was the same as in the 16-kHz position.

A line input of 98 millivolts or a microphone input of 0.82 millivolts produced a 0-VU recording level. The corresponding playback level was 0.83 volt. Distortion was a low 1.0 percent at 0-VU, reaching the standard 3.0 percent level at +6 VU, far off-scale. The signal-to-noise ratio measured out at 55 dB referred to 0 VU, or 61 dB referred to the 3.0-percent distortion level, which makes the AX-300 one of the quietest recorders we have ever tested.

Wow was unmeasurably low, reading the residual level of our Ampex test tapes (0.01-0.02 percent). Flutter was 0.08 percent at 7½ ips, 0.09 percent at 3¾ ips, and 0.175 percent at 1⅞ ips. Tape speeds were exact, and the fast speeds moved 1800 feet of tape, end to end, in about 70 seconds.

User Comments. The mechanical operation of the AX-300 was outstandingly smooth and faultless. The control levers required only about 1/16" travel with a feather-light touch to activate. This contrasts sharply with recorders using purely mechanical control linkages.

When we recorded FM broadcasts, we were not able to distinguish any difference in the playback at 7½ ips, only rarely at 3¾ ips. Using wide-range phonograph records for source material, we occasionally detected minute changes in the highest frequencies associated with bells and wire brushes. However, speakers with exceptional high-frequency response were needed to reveal these effects.

The frequency response at 1⅞ ips limits that speed to background music and voice recordings. The audio filter worked well, but in view of the recorder's low noise and distortion, the AX-300 could have done just as well without it.

The Ampex AX-300 is housed in a walnut base which measures 16½" x 15½" x 8". The combined weight of the deck and base is 45 pounds. It should be mentioned that the AX-300 is designed to be used horizontally or vertically.

The suggested retail price of the AX-300 tape recording deck is $649.95. The optional remote control, Model RC-204, sells for $39.95.

Editor's Note: We understand that Ampex is discontinuing their line of tape recorders for the consumer. At this time we do not know what the disposition of the line will be. However, since the recorders and decks may still be available, we have presented the above report.

UTAH STUDIO 4 FOUR-CHANNEL ADAPTER
(A Hirsch-Houck Lab Report)

The Utah Electronics "Studio 4" Ambience Regenerator is a passive device designed for extracting "ambience" or reverberant sound from 2-channel stereo recordings and broadcasts, reproducing four channels of sound with an additional pair of speaker systems located at the rear of the listening room. In some ways, the Studio 4 resembles other matrix devices for "decoding" specially processed 4-channel material. However, it is not offered as a 4-channel decorder or synthesizer. Rather, it is advertised as a means for enhancing listening pleasure by reproducing some of the sounds not normally heard through a 2-channel stereo system.

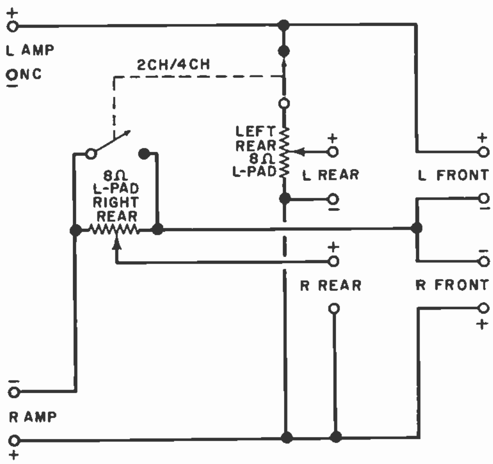
The simplified schematic of the Studio 4 shows how this is accomplished. The Ambience Regenerator is connected to the amplifier's left and right speaker outputs, and cables go from it to four speaker systems, two of which are in the traditional front left and right locations and one each in the rear left and rear right. The only special requirement for the amplifier is that its speaker output grounds be internally tied together, which is no real problem since most amplifiers are so constructed.

The common, or ground, lead from the two front speakers returns to the amplifier's common connection through an 8-ohm L-pad, shown in the schematic diagram as

a simple potentiometer. This potentiometer, identified on the front panel of the Studio 4 as RIGHT REAR, controls the level of a *sum* signal (L + R) used to drive the right rear speaker. The left rear speaker, with its level controlled by the LEFT REAR L-pad, is connected across two "hot" amplifier outputs and, thus, receives a *difference* signal (L−R).

Off hand, it is not easy to imagine the spatial distribution produced by the Studio 4. The left rear difference signal can be expected to supply ambience sounds, as it does with other matrix systems (including the original system proposed by Dynaco some time ago). But the purpose of the sum signal in the right rear is not quite as clearly understood.

Listening Tests. It was a pleasant surprise to find that the Utah Studio 4 produced a very listenable and pleasant pseudo-4-channel effect with most stereo program material. At most points in the listening room, one senses a distinctly different sound character from each of the four corners of the room. As an Ambience Regenerator, it must be considered a success, quite comparable in its subjective qualities to the other matrix decoders we have used on ordinary 2-channel stereo programs.



Simplified diagram of Utah Ambience Regenerator shows speaker hookup.

One could hardly expect the Studio 4 to decode records cut for a specific matrix parameter (such as those used by Dyna, Electro-Voice, Sansui and the like) with any faithfulness to the original intent. We played a number of these records through the Studio 4, and although there was at times a vague sense of directionality, it was random and difficult to define. Certainly, it was not equivalent to the results one obtains with the appropriate decoder. However, the records sounded fine, exhibiting a strong sense of spaciousness, even if directionality was lacking.

One mildly annoying side effect of the Studio 4 was the difference in noise level from the two rear speakers. A large percentage of hiss, hum, rumble, and other unwanted sounds on records and on FM broadcasts seems to be out-of-phase information. It appears to emit from the left rear speaker, often at audible levels. On the other hand, little or no noise comes from the right rear speaker system. Fortunately, the rear speaker systems are normally operated at rather low levels, preventing this effect from becoming a serious problem.

The Studio 4, besides its rear speaker level controls, has two rocker switches on its front panel. One switch converts the adapter to conventional straight-through stereo operation, a very effective way to convince the user that the Studio 4 is really doing its job. As Utah states, one is unlikely to use this switch much after the initial period of use.

The second switch reconnects the speakers to produce a sound null when the amplifier output levels are perfectly balanced. This output level balancing is a necessity for proper operation of the system (a similar function is part of the Dynaco "Quadaptor" and other units).

Utah's Studio 4 Ambience Regenerator is housed in a 9⅞" x 4⅝" x 4" attractive walnut-finished wood cabinet. Its retail price is listed at $39.95.

Circle No. 76 on Reader Service Card

TRAM TITAN III AM/SSB CB TRANSCEIVER

The Tram Corporation's Titan III is a solid-state Citizens Band transceiver capable of operating on all 23 channels in both AM and SSB, the latter on either the upper or the lower sideband. Designed for base-station use—requiring a 117-volt ac power source—this transceiver is an impressive looking piece of equipment. It is housed in a large cabinet with a woodgrain finished bottom and side panels and a scuff-proof vinyl-clad top. A host of controls make the Titan III a "dial twiddler's" delight.

The size of the transceiver is 18⅞" x 11¾" x 8⅛". Weight is 22¾ pounds. It is a high-quality product made in the U.S. and is available for $598 with an Electro-Voice Model 719 microphone or for $614 with an Astatic Model D104 microphone.

Operating Controls. There are two channel selector switches, one for transmit and the other for receive. In contrast to gear with a single selector, this permits convenient split-channel operation.

An r-f gain control, not usually found on CB units, is provided to allow the user to minimize overload and distortion on strong nearby signals. The power switch and a-f gain are combined on one control. There is also a squelch control which can be adjusted for threshold sensitivities between 0.2 and 10,000 μV on either AM or SSB.

Another control switches an automatic noise limiter in and out to allow the user to set the degree of limiting action. This optimizes the effectiveness with minimum distortion. A fine-tune control varies the receiver over a range of $\pm$1000 Hz; this is a must for SSB operation.

A three-position selector permits selection of SSB on the lower sideband (LSB), SSB on the upper sideband (USB), or AM operation. A large meter is coupled with another rotary switch and a potentiometer control. The meter can be switched to indicate receiver S units, *actual* r-f output power, SWR calibration (in conjunction with the pot control located just above the selector switch), or SWR. A fifth position of the switch transfers the transmitter's output from the antenna to an internal 50-ohm dummy load at which time the meter also indicates the r-f power. This position facilitates transmitter tests and adjustments without putting a signal on the air and, thus, eliminates unnecessary interference.

Technical Details. Dual conversion is employed on receive with a first i-f of 4.4 MHz and a second i-f of 455 kHz. Selectivity is obtained using a mechanical filter which has a rated bandpass of 6 kHz at 6 dB and 20 kHz at 75 dB. An adjacent-channel rejection of 70 dB is obtained on AM, and for SSB, unwanted sideband suppression at 1 kHz is 25 dB.

An excellent sensitivity of 0.1 μV with 10 dB S+N/N on SSB and 0.35 μV on AM, plus good signal-handling capabilities, are made possible with two FET's in a cascoded r-f stage, followed by FET's at the two conversion mixers. A better-than-usual image rejection of 80 dB and an i-f signal rejection of 75 dB are realized.

A crystal-controlled oscillator is used for heterodyning at the first mixer, while a self-excited tunable oscillator is engaged at the second mixer. This oscillator functions in the 4.3-MHz range where excellent frequency stability can be obtained, thus eliminating the need for crystal control on receive. Individual detectors are switched in for AM and SSB. Optimized noise suppression for each mode is realized with individual series-gate type noise limiters.

The a-f system ends with four transistors in a push-pull Darlington amplifier to produce a 1-watt, 2-percent distortion or a 2-watt, 2.5-percent distortion power output at 1000 Hz. The speaker is front-facing. There is also a jack for an external speaker. An amplified agc system holds the a-f output change to within 10 dB, with 100 dB (1-100,000 μV) signal input change.

For transmitting, an initial carrier is generated in the 6.2-MHz region with an SSB signal obtained from a four-diode balanced modulator and a 6.255-MHz crystal-lattice filter where an unwanted sideband suppression of 50 dB at 1000 Hz is realized. A carrier suppression of 35 dB is obtained at the balanced modulator. For AM, the modulator is unbalanced and the initial carrier is slightly shifted to produce a carrier through the filter.

The SSB signal or the AM carrier is then heterodyned with a crystal-controlled signal of a frequency which produces an output on the desired 27-MHz channel. An overall frequency tolerance of 0.0015 percent is maintained. Two 27-MHz drivers precede the power amplifier where the bias is thermistor-stabilized to guard against thermal runaway.

For AM, the second driver and the power amplifier are collector-modulated by the receiver's a-f power amplifier. A pi network at the output is designed for operation into loads of 30-70 ohms.

Operation is at the maximum legal power input levels of 5 watts on AM and 15 watts PEP on SSB. Power outputs are 3 watts carrier and 8 watts PEP in the respective modes. Distortion products with a two-tone test on SSB were at least 23 dB down.

An FET, functioning as a shunt limiter

at the speech amplifier, provides compression which maintains a high modulating level with wide variations in voice intensity. The user can back off from the microphone or come close up to it without any significant level changes. This, coupled with adequate a-f filtering, introduces much less distortion than is possible with conventional clipping systems.

Operationally, it takes a bit of getting used to the two-dial method of channel selection. Selection is done in the conventional lock-in-place control for the transmitting channels. But the receive channel selector employs a continuously tunable system. The tuning control must be rotated to the channel identification numeral and then "rocked" slightly for peaking to obtain maximum signal. The correct spot falls close to the dot at the related numeral. On SSB, however, proper tuning with a fine-tuning control must be made for natural voice quality. This occurs a bit to either side of this spot, depending on which sideband is in use.

In some cases, it might not be quite clear just to which channel the receiver is tuned. But this can be easily ascertained by depressing a "frequency-spotting" button and rotating the transmitter selector until a signal from the transmitter's crystal oscillator is heard on the receiver. Reference to the channel number on the transmitter selector then identifies the channel to which the receiver is set.

Since the tuning spot is slightly different for each sideband when SSB is involved, the receiver's dial must be accordingly reset when sidebands are switched by another station. This can be an inconvenience where an instant change is desired at the receiver. It also might be noted that only the receiver frequency is varied by the fine tuning, whereas in some SSB gear the fine tuning simultaneously adjusts both the transmitter and receiver to exactly the same frequency.

All performance figures given above were essentially the same as those specifications supplied by the manufacturer.

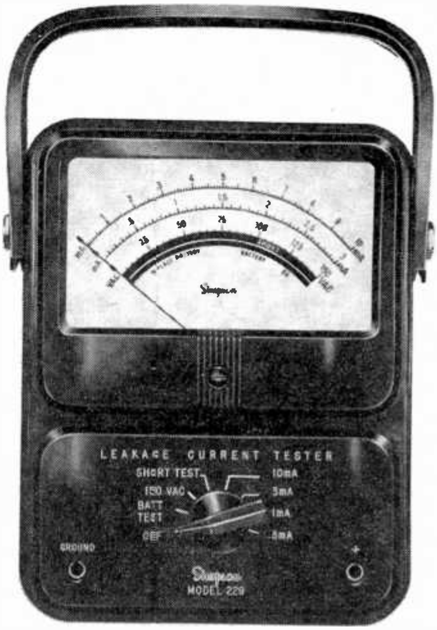
Circle No. 77 on Reader Service Card

SIMPSON MODEL 229 AC CURRENT LEAKAGE TESTER

Although many of us think nothing of fearlessly shoving a voltmeter probe into a "hot" circuit, sober thought is always given to working on an ac power-line operated appliance that has no transformer because there is always the possibility that the chassis may be hot with respect to ground.

One important question is, how hot is "hot"? Legally, it is spelled out in the U.S. Standards Committee Proposed Specification No. C101.1 for ac current leakage tests. This proposes a maximum leakage current of 0.5 mA measured through a 1500-ohm resistor shunted by a 0.15-μF capacitor. Note that this is *current* leakage NOT voltage. This is because it is current that does the damage, and the amount of current is a function of the applied voltage and the resistance of the body parts in the conducting path. (See "How Much Current Is Fatal?" on page 31, in our issue of January 1972, for more detailed information.)

A mean value of 1.067 mA at 60 Hz was determined as the threshold of perception in some recent tests having to do with ac leakage currents. Obviously, then, the lower the leakage current, the safer



the device. Above a couple of milliamperes or so, there is a dangerous threat to life.

The Simpson Electric Company's new Model 229 AC Current Leakage Tester follows the Specification to within 1 dB and can measure leakage currents as low as 5 μA. The complete full-scale ranges for this instrument are 0.3, 1, 3, and 10 mA. The 229 also has the capability of measuring ac voltages to 150 volts, which effectively doubles the instrument's usefulness.

The input impedance to the Model 229 is 1500 ohms, shunted by a shaping network on all current ranges, and 500,000 ohms on the ac voltage function and ranges. The instrument is fully protected to 150 volts ac on all ranges. Full-scale accuracy is within 2 percent.

The large, easy-to-read meter movement not only indicates the voltages and currents being measured, but it also indicates the condition of the internal battery. Another scale is used to indicate short circuits and near-short circuits.

User Tests. In use, the Simpson Model 290 is connected between the metal frame of the electrical appliance under test (washer, dryer, toaster, ac-dc radio receiver, etc.) and a good earth ground such as a cold water pipe. It is best to connect the ground lead first, then the hot probe. The range/function switch is then set to the SHORT-TEST position; if the meter pointer rises into the red area on the meter scale, the current leakage is in the danger zone and is greater than 10 mA. Conversely, if the meter pointer stays in the green area, the amount of current leakage can be measured by setting the switch to the appropriate range/function position.

We had occasion to try out the Model 229 on some typical home appliances which have been in daily use for years. It came as quite a shock to see the amount of leakage in the washer-dryer area in our basement utility room and how close the lady of the house has literally been to danger. Our readings convinced us that we should immediately remove the elderly two-wire electrical system and replace it with a three-wire system with a safety ground lead. After doing this, we removed several years accumulation of lint, oily dust, and other sundry items from around the electrical connections. The connections were then coated with a nonconducting plastic spray, after which we again used the leakage tester to see what improvements, if any, had been made. It was nice to see the leakage drop to well within the safe limits for operating home electrical appliances.

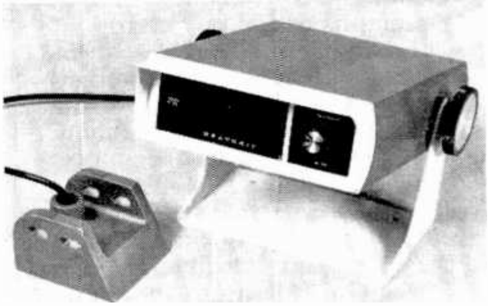
The Simpson Electric Co. Model 229 AC Current Leakage Tester sells for $90. An optional leather carrying case, No. 00805, is also available for $13 more.

Circle No. 78 on Reader Service Card

HEATHKIT MODEL MI-101 DIGITAL DEPTH SOUNDER

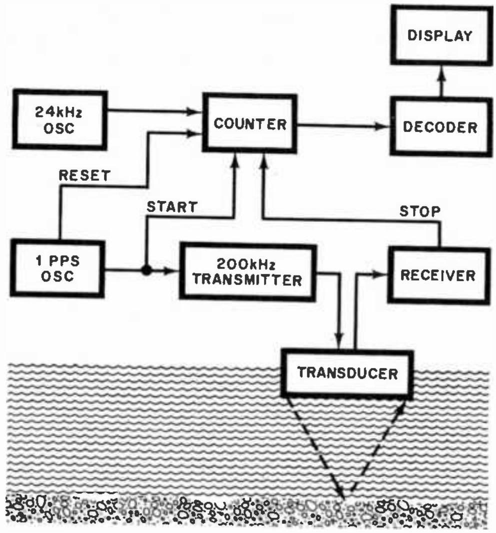
For the past couple of years, this reviewer has been dashing around the waters off the East Coast using a Heathkit Model MI-29 Depth Indicator and Fish Spotter. The primary use of the device was to keep tabs on where the bottom was with respect to the fragile hull of our staunch craft, rather than to locate fish. However, we did locate many a school of bass and blues when they were running.

During this time, we were very pleased with the performance of the fish spotter, finding it to be the equal of many more expensive spotters. Therfore, we jumped at the chance to build and try out the new Heathkit Model MI-101 Digital Depth Sounder which sells in kit form for $139.95. The MI-101 is quite a step forward in depth sounders. It displays water depth through 2½ decades of



seven-segment incandescent readouts along with a very useful "under-10-feet" indicator lamp. The complete range of the sounder is 2.5-19.9 feet, with automatic switchover to 20-199 feet. But if desired, the minimum depth indication can be modified to one foot of water.

The display is updated once a second.



Logic diagram shows how depth indicator functions like frequency counter.

The readout brightness can be controlled from a low light level for use on those dark nights when you don't want bright panel lights disturbing your night vision, to a very bright display which can be easily read in sunlight.

Operated from a conventional 12-volt automotive-type battery—the same one used to power the radio, lights, and electric starters on most boats—the MI-101 draws only 300 to 500 mA of current, depending on readout brightness.

The instrument comes in a smart-looking blue molded plastic case which measures 8¼" x 6⅝" x 2¼". The readout/electronic package is designed for use with a screw-down gimbal bracket (supplied) which permits the user to adjust the sounder for almost any convenient viewing angle of the readout display.

The MI-101 is available in two models, depending on the type of transducer mounting desired. The MI-101-1 has a through-the-hull transducer, while the MI-101-2 has a transom-mounted transducer.

Easy Assembly. Using the first-class Heathkit assembly and operating manual, assembly time for the MI-101 worked out to about eight hours.

The assembled MI-101 employs seven integrated circuits, for which sockets are provided, thus virtually eliminating the possibility of heat damage to the IC's during the soldering operations. The metal-work, plastic housing, and electronic components are all of top quality. With a little care, the kit builder will have a depth sounder to be proud of.

Operation of this new sounder is quite different from the earlier spinning-wheel type which just displayed two red blips, one at zero and the other at a position on the scale which corresponded to the depth of the water. At first glance at the logic diagram, the MI-101 appears to be just another digital frequency counter (which, in a way, it is). A one-pulse-per-second master oscillator causes the 200-kHz transmitter to emit the "main bang" into the water and simultaneously turns on a frequency counter. The counter follows either a 2400-Hz or 24-kHz pulse train, automatically selected by the water's depth, and when the receiver picks up the echo pulse from the bottom or a nice-sized fish or school of fish, the counter stops and displays its last count. A blanking circuit keeps the display on until the next cycle occurs, eliminating the blurring display common to unblanked counters. The display remains on, changing the digits only when the water depth beneath the boat changes. Also, a built-in noise suppression circuit greatly reduces interference from engine ignition noise (the assembly/operating manual which accompanies the kit details how to reduce engine noise).

User Results. We used the MI-101-2 version of the depth sounder, the one with the transom-mounted transducer. After mounting everything in place in our boat, we took off. Knowing we were in shallow water, it was reassuring to see the under-10-feet lamp signalling its warning. Once out into the deeper waters of a bay, the lamp extinguished and the digital display kept us posted on just how deep was the water.

With the earlier depth sounder, too long a time was required to read the depth as the red blips were often dimmed out by ambient light, necessitating the directing of our attention to the display instead of the water ahead of our boat. This can be a little bothersome in unfamiliar waters where shoals can materialize as if by magic. With the MI-101, however, all we needed was a fast glance at the display panel to get an instant reading.

Circle No. 79 on Reader Service Card

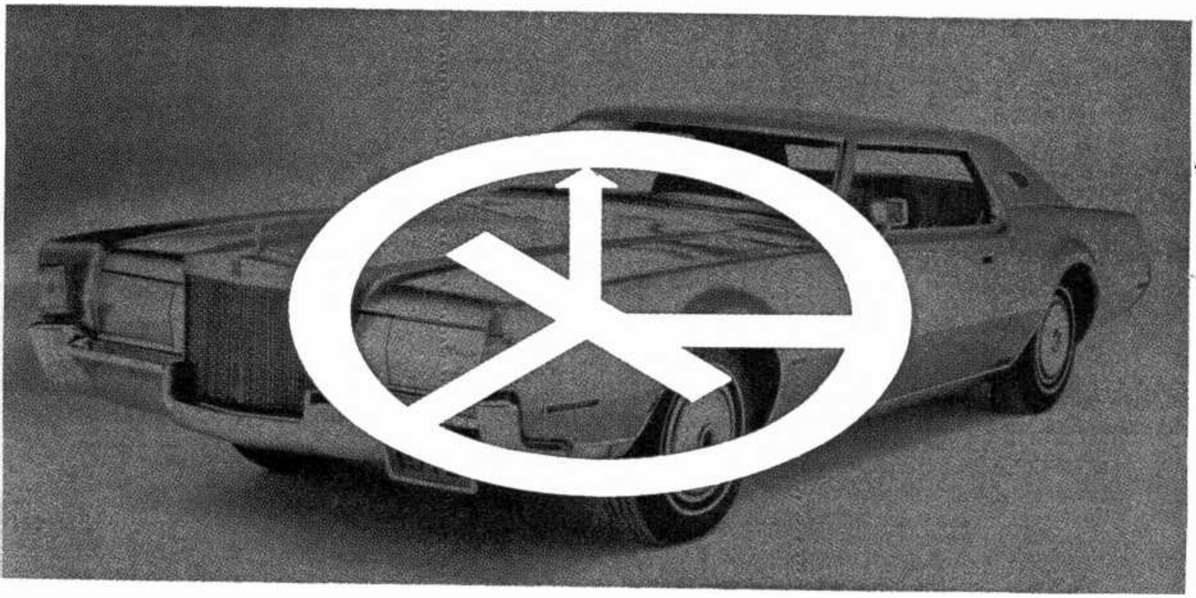
For a solid future...

NTS Home Training makes tomorrow's electronics happen–today!

Now included in two exciting NTS color TV courses, this set is the largest, most advanced color television made. Guided by the NTS "Lab-Project Method" of combining professional kits and easy-to-follow lessons, you build this color TV step by step – learning TV Servicing as you go! NTS has successfully trained thousands of men at home for rewarding careers as electronics technicians. Prepare for the great opportunity fields of TV-Radio Servicing, Computers, Communications, and Automation.

This solid-state color set contains: 45 transistors, 55 diodes, 2 silicon controlled rectifiers, and 4 advanced Integrated Circuits representing an additional 46 transistors and 21 diodes. The first solid-state color TV this large – yours to keep! It features Automatic Fine Tuning; "Instant On"; an Ultra-Rectangular Screen (25 in. diagonal measurement) that lets you see the complete transmitted image for the first time – a full 315 square inches; exclusive built-in Self Servicing features which eliminate the need to buy costly test equipment; exclusive design Solid-State VHF Tuner with an MOS Field Effect Transistor; 3-stage Solid-State IF; Automatic Chroma Control; Adjustable Noise Limiting and Gate Automatic Gain Control; High Resolution Circuitry; Matrix Picture Tube; and a specially formulated Etched Face Plate that eliminates unwanted glare, and heightens contrast. Colors are more vivid, fresh tones more natural, and the picture is sharper than ever before. By training on this unique color TV, you'll gain the most up-to-date skills possible in TV Servicing!

Other valuable equipment you build and keep includes an AM SW Radio, Solid-State Radio, FET Volt-Ohmmeter, and Electronic-Tube Tester. All included in your tuition. You learn trouble-shooting, hi-fi, multiplex systems, stereo, and color TV servicing. Step right into a technician's job at top pay or open a business of your own! For complete details on *all* NTS electronics courses, mail the coupon today for the full-color NTS Catalog. No obligation. No salesman will call.



More Solid-State Electronics for the New Cars

PART 2

WHAT FORD AND CHRYSLER ARE OFFERING IN THEIR 1972 LINES

BY JOHN D. DRUMMOND

CHANCES are that the first car you drive with an on-board minicomputer that starts the engine, optimizes ignition and air/fuel mix, sets safety mechanisms, and gets ready to shift transmission, will come from Japan or Germany. The reason such a car is not likely to come from Detroit is that foreign car firms and electronics companies are cooperating with each other to develop and deliver sophisticated system packages. The picture on the domestic front is quite different; a lack of good communications has put the auto men and electronics men at odds with each other.

There is certainly no lack of expertise or ambition in the U.S. The missing ingredients are cooperation and understanding. But with no clear, enthusiastic agreement, solid-state electronics in American-made automobiles has only inched along.

It is obvious that any little "blackbox" electronic package integrated into an automobile must be able to outfox and outlast the hostile environments created by rough roads, snow, ice, mud, extreme heat, and extreme cold. Otherwise, the highly practical automobile engineer wants no part of it, according to Charles T. Mulcahy, a Ford Motor Co. Engineer. He goes on to say, "If the engine won't start, the car won't go; if the engine starts and the car is inoperative, the car won't move."

But consider this: the little black box has guided man to the moon and back in spectacular form. Solid-state devices contain no inherent wear-out mechanisms. In fact, thanks to their proven reliability, solid-state devices and systems are perhaps the only practical and economical way to realize safety, environmental cleanliness, and the convenience required for tomorrow's automobile.

The Pressure is On. With enforcers breathing down their necks, the auto makers are necessarily devoting most of their efforts to solving the problem of reducing exhaust emissions and developing passive-restraint devices to comply with Federal regulations. So, Detroit has had to lay aside, at least for the present, development and implementation of such exotic things as a single-wire multiplexed system that replaces the maze-like electrical network wiring harness; radar-based anticollision and braking systems; central processor to control antiskid braking; electronic fuel injection; and speed and transmission controls.

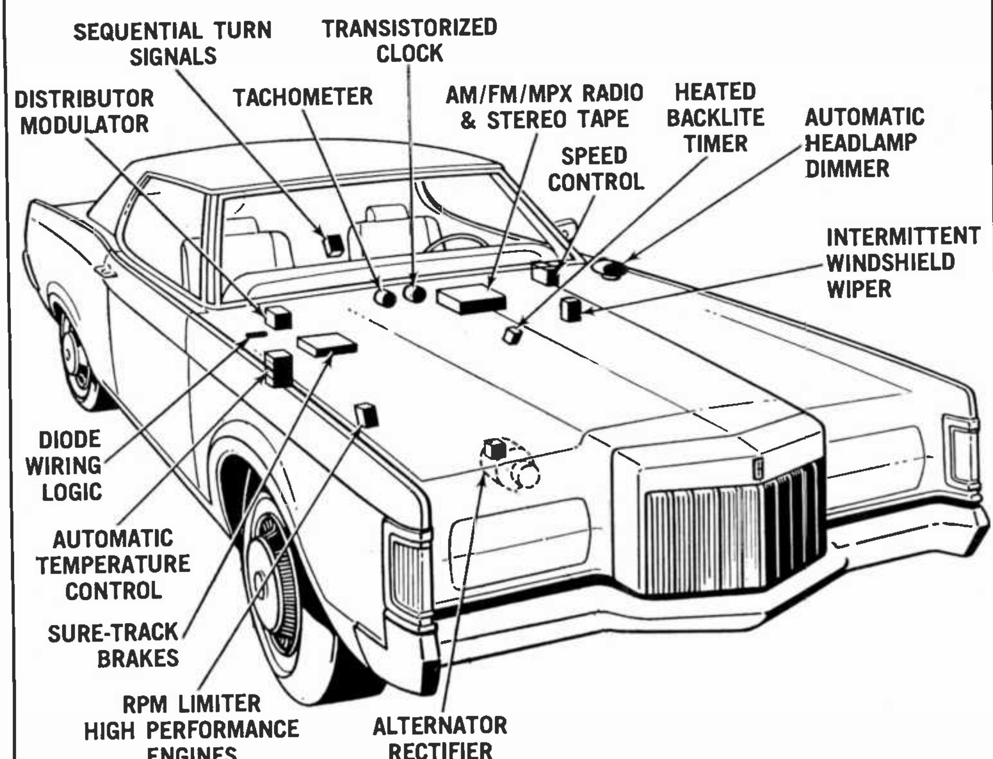
The auto men are furious over this stringent Federal legislation. Ernest S. Starkman, a General Motors vice president, explains that considerable progress has already been made toward reducing air pollution from automobiles. But pressure for further reductions is a consequence of impatience with the progress being made in the state of the air in our urban environments.

Whatever the impetus, the electronics industry has a golden opportunity to work with Detroit in meeting Federal pollution standards. The electronics men feel that solving both the pollution and passive-restraint problems are within their bailiwick. Presently, however, the auto men are more preoccupied with grappling with the pollution problem. But some electronic devices are showing up in Detroit's new cars.

Ford's Better Ideas. Typical of what is being marketed are the electronic controls in Ford's 1972 line. Not all of the items (see illustration below) are available in any one model. But they are available in various combinations on all Ford-built cars.

Among the offerings are safety braking for skid control to prevent the wheels from locking up and skidding should the driver attempt a panic stop on wet, slippery or icy roads. The system utilizes an electronic computer that goes to work only during an emergency situation that could cause the wheels to lock. The computer receives

This diagram shows various items being offered by Ford, though not all of them are available on all Ford cars. The systems shown are all-electronic.



POSSIBLE APPLICATIONS FOR SOLID STATE IN AUTOMOBILES

	Signal Devices	Power Devices	Hybrid Subassemblies	Applications for IC's	Transducers and Sensors
Safety	Speed limit warning Obstacle warning	Automatic braking Automatic headway control Air bag trigger	Automatic headlight dimmer Obstacle detection	Anti-skid braking Failure monitor Drunk driver spotter	Passive restraint sensor Tire pressure monitor Manifold pressure sensor Engine temperature sensor
Propulsion	Ignition trigger	Breakerless ignition Chopper for battery-powered cars	Voltage regulators Electronic fuel injection	Triggers for power devices	Torque measurement Ignition timing Compression measurement
Comfort and convenience	Air conditioner control Headlight time-delayed action	Remote control for radio or tape equipment Cruise control	Transistorized clock Automatic temperature control Electronic speedometer	Automatic vehicle control	Temperature control devices (thermistors)
Entertainment	Radio and tape player	Electronic tuning	Speed regulator for tape player drives	AM/FM/MPX radio Tape players	
Economy of operation		Electric propulsion	Sequential turn signals	Coolant temperature indicators Electric fuel pump	Fuel flow measurement and control Electric fuel pump
Control	Fuel and coolant gauges Temperature indication Electronic tachometer	Voltage regulator Shaft and rotor position control	Interval windshield wiper control	Voltage regulator	Liquid gauges Temperature control Braking control
Lighting	Automatic headlamp dimmer	Instrument lighting	Headlight and domelight delay	Triggers for flashers	Instrumentation
Maintenance	Brake fluid level warning Tire pressure warning	Ignition	Trouble indicators Multiplexed power distribution	Engine performance analyzer Voltage regulator	Failure sensors

speed information from a wheel sensor through a digital-to-analog (D-A) converter that translates it to a dc voltage before it is fed to a differentiator and data analyzer. The differentiator output is compared with a reference signal representing the coefficient of friction of the road surface from the data analyzer. The comparator output is fed to a logic circuit which determines the amount of braking required and simultaneously activates a power stage which controls braking.

Automatic speed control is another offering. Using an electronic memory, this system automatically maintains a constant speed in response to the driver's command. When the car reaches cruising speed, the driver presses a button. The desired speed is then "memorized" and maintained up- and downhill and on the straightaway without the driver having to touch the accelerator. When the brakes are applied, the speed control is automatically deactivated.

A number of safety features have been put into the system to meet the industry's standards. For example, a redundant brake-disable feature is available to protect against a defective or poorly adjusted brake switch. Hence, if no disabling signal is received when the brake pedal is depressed, the speed control will automatically disable when the car's speed drops to about 8 miles below the speed that was set into the computer.

A distributor modulator is a third offering. Designed primarily as an exhaust control device, the modulator precisely controls spark advance at speeds in the 25-32-mph range, assuring more complete fuel combustion.

There is also an rpm limiter available. It is used primarily in Ford cars equipped with high-performance engines and manual transmissions. This overspeed limiter keeps the engine from exceeding a safe maximum rpm limit.

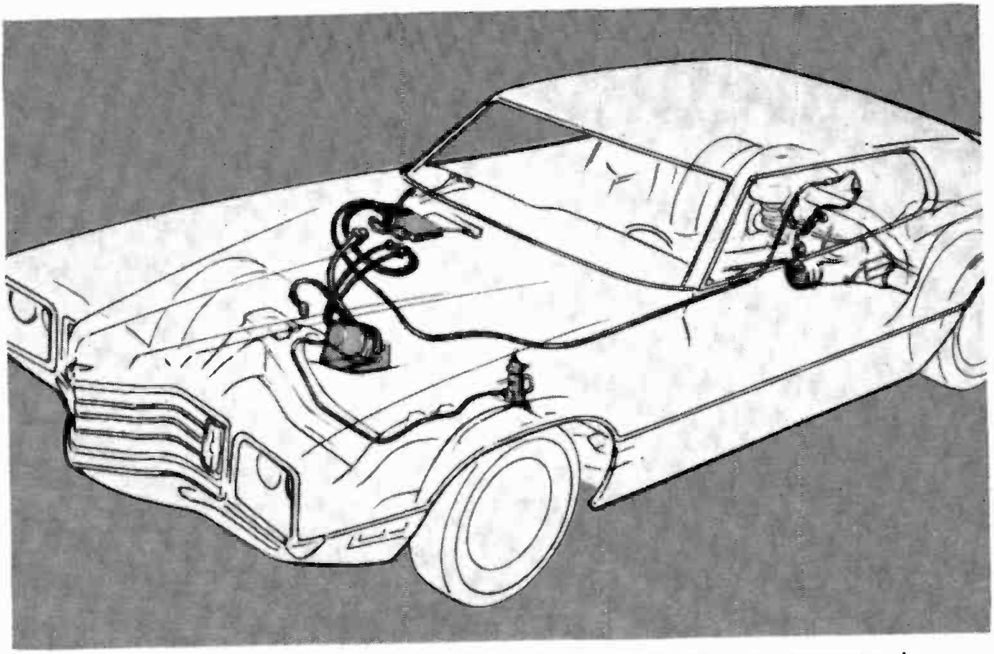


Diagram of Ford's new anti-skid braking system installation. Computer is located behind glove compartment. (Photo courtesy of Ford Motor Company.)

Chrysler's Coming Through. Keeping up with their Detroit rivals, the Chrysler people are pushing electronics in their ignition systems, a safety braking system, and automatic temperature control.

The electronic ignition, which eliminates breaker points, looks pretty much like a conventional system except for a control unit between the distributor and the ignition coil and the addition of a dual ballast resistor. The electronic circuitry is activated by a pickup coil and is used to control a switching transistor that opens and closes the primary circuit of the ignition coil.

The great advantage of the breakerless system is lower tune-up cost. A by-product of the electronic circuitry, claims Chrysler, is that ignition timing and dwell angle are more accurately controlled than would be possible with conventional breaker points. The end result is better exhaust emission control.

Like the systems employed by GM and Ford, Chrysler's safety brake relies on a logic computer to activate a pressure modulator to decrease the amount of hydraulic pressure being applied to the brake at the wheel which is about to lock up or skid. Where it differs from the competition is that the Chrysler system prevents front or rear wheel lockup for shorter straight-line stopping distances. It is claimed that the four-wheel safety braking system makes any driver better than an expert driving a standard-equipped car in straight-ahead braking applications. However, as Chrysler engineers are quick to point out, it cannot correct for skids initiated by bad driving, such as when entering a curve too fast.

The 1972 Chrysler and Imperial model autos are equipped with a second-generation automatic-temperature control which uses an all-electronic solid-state amplifier to totally control the system's performance. In prior systems, Chrysler employed a combination of vacu-electronic components to automatically adjust temperature. This marks the first time that Chrysler Corp. has used a totally solid-state system employing IC's, transistors, and diodes to control a major system.

The Coming Tide. It is obvious from the foregoing that, in spite of foot-dragging and lack of cooperation, some inroads are being made by the electronics industry in Car City. What is also obvious is that, if and when a team effort is finally made, great things are in store for the average American-made automobile. Let us hope that the animosity gap existing between the car makers and the electronics industry narrows soon and creates the friendly conditions needed to bring about cooperation. ◈

ANALOG LOGIC

IT TAKES MORE THAN FLIP-FLOPS TO MAKE A CALCULATOR

BY JAMES HANNAS

HAVE YOU ever wondered how some complex calculators can do so many operations at such high speed and accuracy? The answer is in the use of linear and nonlinear integrated circuits that are basically quite simple in theory. Most of the circuits involve an operational amplifier—a very high-gain linear amplifier that inverts the input signal.

When input and feedback resistors are connected to the op amp as shown in Fig. 1, the amplifier tries to maintain its input as close to zero as possible. The higher the gain, the lower the offset or error voltage. To do this, the amplifier must cause a current through the feedback and input so that the voltage drop across the input resistor is equal to the input voltage. The input swing is equal to the input voltage times Rf/Ri. A graphical analogy of the amplifier is shown in Fig. 2.

Using the same circuit, but with additional input resistors, the amplifier can be made into an adder. The sum of the voltages can also be multiplied by a constant by adjusting the input resistors.

Nonlinear functions, such as squaring, can be performed by the diode shunt matrix shown in Fig. 3. By adjusting the feedback resistors, any type of curve with increasing magnitude can be formed. A logarithmic, or decreasing, curve will result when the diode matrix is used as a feedback instead of a shunt matrix.

The most common squaring circuit is shown in Fig. 4. The numbers on the op amps indicate the multiplier constants. By adding one quarter of the sums of A-B and A+B, the result is the product of A and B.

Division is shown in Fig. 5. Here an op amp is supplied feedback by a multiplier circuit which is controlled by B. As B increases, the output decreases.

FIG. 1

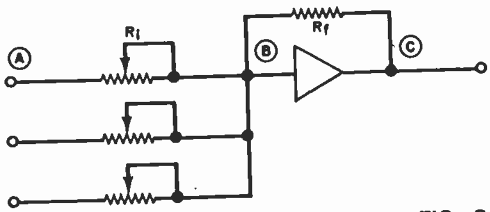


FIG. 2

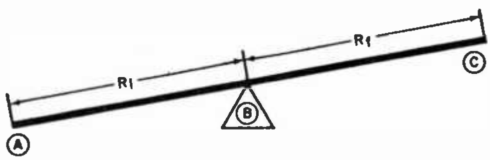


FIG. 3

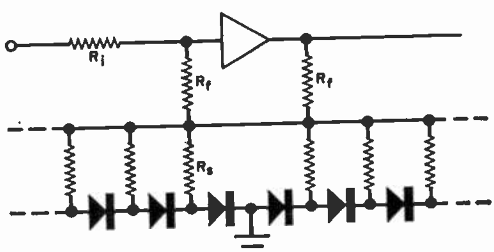


FIG. 4

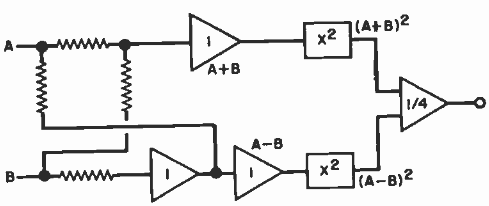
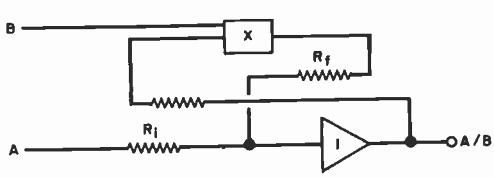
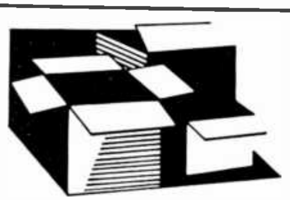


FIG. 5



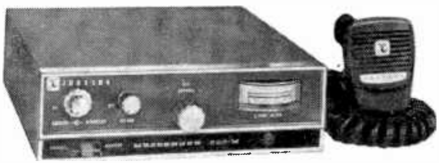
There are also operational amplifiers and multipliers which are binary-to-analog and analog-to-binary converters. These are basically resistor networks and amplifiers. By combining analog circuits with binary bit storage, switching and readouts, a compact calculator can be designed. ◈



New Products

JOHNSON MOBILE CB TRANSCEIVER

Dual Receive Capability (DRC) introduced by *E.F. Johnson Co.* recently in their Messenger 124-M base station is now available in a mobile CB transceiver, the Messenger 323-M. DRC allows the operator to use any of the 23 channels normally while simultaneously monitoring any other channel. Separate squelch controls are provided for the primary receiver and the monitoring function, permitting the user to squelch down the monitored channel so that only local callers will activate the DRC circuitry. The main channel selector covers 23 channels, and all crystals are supplied.



Circle No. 60 on Reader Service Card

SENCORE TUBE TESTER

A new solid-state "Mighty Mite VII" tube tester featuring ten pin-elimination switches that permit testing more tubes than ever before is currently being marketed by *Sencore, Inc.* The pin-elimination switches can be used to isolate from test up to ten pins simply by setting the switches for the pins to be isolated. The switches are simple slide types, grouped together for maximum user convenience. They can be set and reset individually or all at once by pressing a reset slide. The new tester retains the full-load cathode emission, 100-megohm grid leakage, and stethoscopic shorts tests of the six previous Mighty Mites.

Circle No. 61 on Reader Service Card

ONKYO LINEAR SUSPENSION SPEAKER SYSTEM

A 3-way "Linear Suspension" speaker system featuring a 14" woofer, 2" hemispheric dome midrange driver, and a 1" hemispherc dome tweeter is being marketed by *Mitsubishi International Corp.* as the Onkyo Model 25. The system has a ported cone cap woofer, linear suspension enclosure design, and a unique integrated crossover network with exclusive filter circuits to help produce smooth transitions at the 700-Hz and 7000-Hz crossover frequencies. Frequency range is 30-20,000 Hz, maximum power handling capacity is 60 watts, minimum power required is 10 watts rms, and impedance rating is 8 ohms.

Circle No. 62 on Reader Service Card

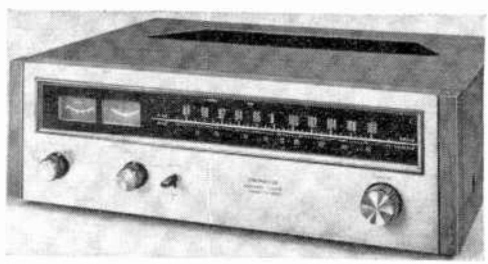
TV TUNER CLEANER/LUBRICANT FROM GE

A specially blended compound of methyl alkyl silicones and transport fluids are formulated into a new type of *General Electric Co.* silicone chemistry for polishing and lubricating tuner contacts in both color and monochrome TV receivers. Developed for the professional serviceman, GE Silicone TV Tuner Cleaner/Lubricant is safe for all plastics, driftless, nonflammable, and immune to evaporation and running. It resists temperature extremes as well. An extension spray nozzle included with the aerosol can provides an accurate means of getting at tuner contacts.

Circle No. 63 on Reader Service Card

PIONEER AM/STEREO FM TUNER

U.S. Pioneer Electronics Corp. now has a medium-priced AM/stereo FM tuner, their Model TX-600, with performance specifications and advanced engineering design that put it into the professional class. The tuner section includes a FET to increase sensitivity and safeguard against cross-modulation. The i-f section is equipped with IC's and ceramic filters for improved selectivity. Multiplex separation of the two channels of stereo FM programs is better than 40 dB at 1000 Hz, while there is more than 35 dB subcarrier rejection. Technical specifications demonstrate that the TX-600 is indeed a professional-quality tuner.



Circle No. 64 on Reader Service Card

CENTRALAB SERVICE KITS

Assortments of the most popular and widely used *Centralab* electronic components are offered in eight new service kits. The kits are designed to provide instant access to well-balanced supplies of components. Kits include: KIT-10F with Fastach II controls, KIT-20W with miniature wirewound controls, KIT-50A with axial-lead electrolytic capacitors, KIT-55P with PC-lead electrolytics, KIT-60D with general-pur-

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the tonal truth, and nothing but the truth.

Our trim, new true-fidelity cassette tape recorder. What a beautiful way to break the big-sound/small-package barrier.

With built-in uniform sound-level control, full-range dynamic speaker, new automatic shut-off that prevents electrical or mechanical damage to tape and machine . . . many other high-value features.

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The MCR-1211 joins our other two solid-state models for go-anywhere, great-everywhere cassette recording. Try 'em all. See your nearby Mallory Distributor, soon.

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Recorder and superb AM/FM radio. Total entertainment in sound. Batteries/a-c plug-in.

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Neat, easy-to-use, battery-operated recorder.

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The perfect gift. Simple, push-button operation. Batteries/a-c plug-in.

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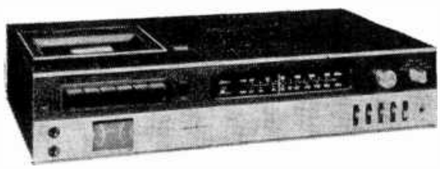
CIRCLE NO. 30 ON READER SERVICE CARD

pose capacitors, KIT-70H with high-voltage capacitors, and KIT-100P with packaged electronic circuits (P.E.C.'s). Each is housed in a steel-frame cabinet with 15 plastic drawers.

Circle No. 65 on Reader Service Card

LAFAYETTE STEREO RECEIVER/RECORDER

The Model LRK-900 is the newest combination AM/stereo FM receiver and cassette tape deck with built-in 4-channel composer and adapter available from *Lafayette Radio Electronics Corp.* The cassette deck features standard and chromium-dioxide tape bias equalization, dual record meters, sound-with-sound mixing, automatic mechanical/electrical shutoff, and jacks to suit most input needs. Output power is 20 watts total, FM sensitivity is 3.5 μV IHF, stereo



separation is 35 dB at 400 Hz, signal-to-noise ratio is 48 dB, and frequency range is 50-10,000 Hz. The built-in 4-channel composer produces 4-channel stereo from 2-channel stereo signal sources. The sensitive FM tuner utilizes "Acritane" for instant center station tuning.

Circle No. 66 on Reader Service Card

TRI-STAR CD IGNITION

A capacitive-discharge ignition system Simpli-Kit, called the "Tiger SST" CD Module by *Tri-Star Corp.*, can be built and installed in any car in less than 90 minutes. It is said to be the most reliable, powerful, and efficient ignition system on the market. The circuitry is so unique that improper construction or installation will not damage the unit or the vehicle. The Tiger SST can be added to any engine that employs a 12-volt negative ground generator/alternator ignition system. No rewiring is necessary.

Circle No. 67 on Reader Service Card

SONY/SUPERSCOPE QUADRADIAL TAPE DECK

The introduction of the lowest priced 4-channel reel-to-reel tape recorder now on the market was recently announced by *Superscope, Inc.*, as the Sony Model 277-4. The deck is designed to provide complete 4-channel record and playback, plus 4-/2-channel formats with a record selector switch which makes it possible to either record or play back 2-channel stereo or the new Quadradial tapes. Features include illuminated VU meters, independent channel level controls, record equalization selector, triple-function headphone switch, reel locks, automatic shut-off, and 7½, 3¾, and 1⅞ ips tape speeds.

Circle No. 68 on Reader Service Card

KNIGHT-KIT SPEAKER SYSTEM KITS

Do-it-yourselfers can now assemble their own hi-fi speaker systems with one of three new Knight-Kits from *Radio Shack*. The Model KG-5120 kit is an acoustic suspension system that employs an 8" dual-cone woofer and a 3½" cone tweeter with an overall range of 45-18,000 Hz and input power handling capability of 24 watts peak. Model KG-5121 is a 3-way system with a bass reflex enclosure, 10" woofer, 6" midrange driver and 3½" tweeter; response is 40-18,000 and power capacity is 40 watts peak. Top-of-the-line Model KG-5122 features acoustic suspension design with 12" woofer, 3½" x 8" compression midrange driver, and horn-loaded dome tweeter; it has midrange and tweeter level controls, 30-20,000 Hz range, and 60-watt peak power capacity.

Circle No. 69 on Reader Service Card

DATRON PICTURE TUBE RESTORER

An electronic device that restores brilliance to weak, faded monochrome and color TV picture tubes can be obtained from Electronic Specialty Division of *Datron Systems, Inc.* The patented Picture Tube Restorer is not a booster, nor will it have any favorable effect on tubes which have been on a booster for an extended period of time. What it does is test the quality of the picture tube, then provide a "cleansing" voltage that removes the cause of many picture tube failures. No special training is needed to use the Restorer. Its low-voltage output makes it safe for use even by the most untutored individuals. It is said that the Restorer can extend the life of a picture tube up to 3 years.

Circle No. 70 on Reader Service Card

SUPEREX ELECTROSTATIC STEREOPHONES

An electrostatic stereophone system from *Superex Electronics Corp.* has a virtually flat response with negligible distortion over the entire audio range. The Model PEP-77C phones

feature a dual-polarization capability for self-energization and 117-volt ac operation. With the phones comes a control console which accommodates two sets of Superex electrostatic stereophones. Frequency range is 10-22,000 Hz, and nominal impedance is 4-16 ohms. Individual separate grounds, one per channel, are provided as are individual channel volume controls.

Circle No. 71 on Reader Service Card

RUSSOUND IMPEDANCE CONVERTING AMP

The *Russound/FMP, Inc.*, Model IMP-1 "Impedaverter" is a solid-state device for impedance matching high inputs to low outputs in microphone and instrument lines. This impedance converting amplifier allows cables up to 500 ft long to be used without altering audio response or picking up hum or noise. The input and output characteristics allow bridging lines without loading and the output to be split to feed two amplifiers simultaneously. Standard phone and phono jacks are paralleled at both the input and output for maximum convenience. Gain and phase switching are provided.

Circle No. 72 on Reader Service Card

New Literature

INTERNATIONAL RECTIFIER DATA HANDBOOK

The Winter Edition of International Rectifier's "Semiconductor Cross Reference and Transistor Data Book" is now available. The 64-page book has been fully revised, including listings for more than 4000 new transistors. It has information, such as complete specifications and electrical characteristics, for diodes, zeners, capacitors, rectifiers, and SCR's. An applications-oriented table permits the user to locate the descriptions which fit his requirements in determining the proper transistors to use. Address: International Rectifier Corp., Semiconductor Div., El Segundo, CA 90245.

SEARS POWER AND HAND TOOL CATALOG

As its name implies, tools of every description for the wood and metal working shop, the automotive do-it-yourselfer, the home repairman, and the electronics enthusiast are listed and described in this 132-page illustrated catalog. All items are fully described, most accompanied by a photo or drawing, with prices. For the electronics enthusiast, there are metal and wood working tools, soldering irons and guns. Address: Sears, Roebuck & Co., 303 E. Ohio St., Chicago, IL 60611.

GC ELECTRONICS REPLACEMENT CATALOG

An updated line of exact-replacement rubber drives and belts is detailed in the new Walsco cross-reference catalog just issued by *GC Electronics*. The catalog, No. FR-135-W, contains an enlarged cross-reference section, with replacement part numbers listed for equipment made by 194 manufacturers, both domestic and foreign. Special charts are included to help in choosing the proper size belt for any unusual machine types not in the cross-reference listtings. Address: GC Electronics, 400 South Wyman St., Rockford, IL 61101.

WORKMAN REPLACEMENT COMPONENTS

A new 1972 catalog, No. 100, of replacement components for radio and TV is available from *Workman Electronic Products, Inc*. It contains an illustrated 68-page listing of resistors, fusing devices, circuit breakers, sockets, convergence controls, service accessories, electronics chemicals, audio cables, adapters for hi-fi and cassette-type recorders, battery holders, and prototype kit components. Address: Workman, Box 3828, Sarasota, FL 33578.

RUSTRAK AC VOLT-AMP RECORDER BROCHURE

A data sheet, No. 27107, which describes a new low-cost ac recorder capable of measuring both voltage and current is available from Rustrak. The sheet describes the company's Model 230 recorder with its clamp-on transducer and leather carrying case. The data sheet and further information are available from: Rustrak Instrument Div., Gulton Industries Inc., Municipal Airport, Manchester, NH 03103.

KEYSTONE ELECTRONIC COMPONENTS CATALOG

Keystone's Standardized Electronic Components Catalog No. 678 and companion supplement provide listings for all sorts of items used by the prototyper. Items listed are battery holders, plug-in housings, terminal boards and solder terminals for PC work, phenolic instrument boxes, alignment tools, etc. Listed separately in the supplement are standardized power transistor sockets, mica insulators, and mounting kits. Address: Keystone Electronics Corp., 49 Bleecker St., New York, NY 10012.

JAMES MILLEN FOR AMATEUR RADIO

Things of particular interest to amateur radio operators are listed and described in James Millen's latest catalog. The listings include both discrete components and electrical/mechanical assemblies. In the first category are such items as tube and crystal sockets, plate/grid caps, air-wound transmitting inductors, transmitting r-f chokes, and tuning capacitors. The second category is composed of listings for dial assemblies, midget absorption frequency meters, worm drives, and miniature i-f transformers. James Millen Mfg. Co., Inc., 150 Exchange St., Malden, MA 02148.

FREE LITERATURE FROM SMALL BUSINESS ADMINISTRATION

The following free Government booklets will be of interest to anyone thinking of going into the electronics sales and service business:

- OPI-6 "SBA—What it is—What it Does"
- OPI-18 "SBA Business Loans"
- OPI-18A "Business Loans for Veterans"
- OPI-38 "Simplified Blanket Loan Guaranty Plan"
- SMA No. 71 "Checklist for Going into Business"
- SBB No. 57 "Selling and Servicing Household Appliances, Radio and TV"

These booklets may be obtained by visiting your nearest Small Business Administration field office or by requesting them (by catalog number and title) from the Small Business Administration, Washington, DC 20416.

Electronics Library

SO YOU WANT TO BE A HAM, Fifth Edition

by Robert Hertzberg, W2DJJ

In earlier editions, this book was directly responsible for introducing an enormous number of readers to the satisfying hobby of amateur radio. New editions, like this one, have been brought out every few years when changes in the state of the ham radio art demand detailed explanation and coverage to keep the reader abreast of the latest developments in licensing and equipment. This new edition covers the entire field of ham radio from FCC regulations and code to operating mobile units and organizing a ham radio club. This is a general information book and has nothing to do with electronics theory.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Soft cover. 189 pages. $5.25.

UNDERSTANDING DIGITAL COMPUTERS, Second Edition

by Paul Siegel

This book is a comprehensive introduction to the fundamentals of digital computer "hardware." It is about principles, not specific commercial computers. Its objective is to convey a good understanding of how digital computers are designed and built. The introduction describes the digital computer and its functions, while the three remaining sections move from a theoretical discussion of arithmetic and logic to the exposition of techniques for achieving these ideas in practice. These building blocks are then combined into larger functional units from which a complete computer may be constructed.

Published by John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. Hard cover. 462 pages. $11.95.

COMMUNICATION CIRCUITS: DESIGN AND ANALYSIS

by Clarke & Hess

A book written to assist advanced students and practicing engineers in analyzing and designing the latest solid-state circuits. While emphasis is on large-signal analog circuits and systems, digital circuits are also discussed. The text contains one of the most comprehensive treatments of FM theory available. In addition to a large number of worked illustrations, more than 200 problems are given.

Published by Addison-Wesley Co., Inc., Reading, MA 01867. Hard cover. 658 pages. $17.50.

ELECTRONIC PROJECTS FOR THE CAR AND GARAGE

by R. M. Marston

Eighteen of the 20 timely projects described in this book are intended for use in the car; two are for the garage. The circuits for the car range from those which warn of danger, such as from icing or overheating, to those which ease the driver's task and allow him to concentrate on his driving (a windshield wiper control or an automatic sidelight control, for example). The two projects for the garage are a self-regulating battery charger and a speed controller for a drill.

Published by Drake Publishers, Inc., 381 Park Ave. South, New York, NY 10016. Hard cover. 115 pages. $5.95.

1972 WORLD RADIO-TV HANDBOOK, 26th Edition

This British book is the only annually updated publication detailing every facet of shortwave, mediumwave, and TV broadcasting—from nominal information such as callsign and frequency to the name and title of the station manager. Thousands of users rely on the Handbook for schedules and programming; many others refer to it for information on broadcasting organizations, station identifications, interval signals, QSL policies, etc. This is a valuable reference that no SWL or broadcasting industry executive can afford to be without.

Imported from England by Gilfer Associates, Inc., Box 239, Park Ridge, NJ 07656. Soft cover. 384 pages. $6.95.

REGULATED POWER SUPPLIES

by Irving M. Gottleib

It is the goal of this book to demonstrate that such benefits as low distortion and stable operation under varying loads are desirable and are often attained most effectively through the use of regulated power supplies. The first chapter lists other benefits obtained, including increased efficiency, greater dynamic range, feedback stabilization, higher S/N ratios, and wider frequency response. The second chapter discusses the static characteristics of regulated power supplies—dc regulation, temperature effects, stability, and long- and short-time deviations and drift. Other chapters cover dissipation control and the uses of IC's.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Soft cover. 160 pages. $4.95.

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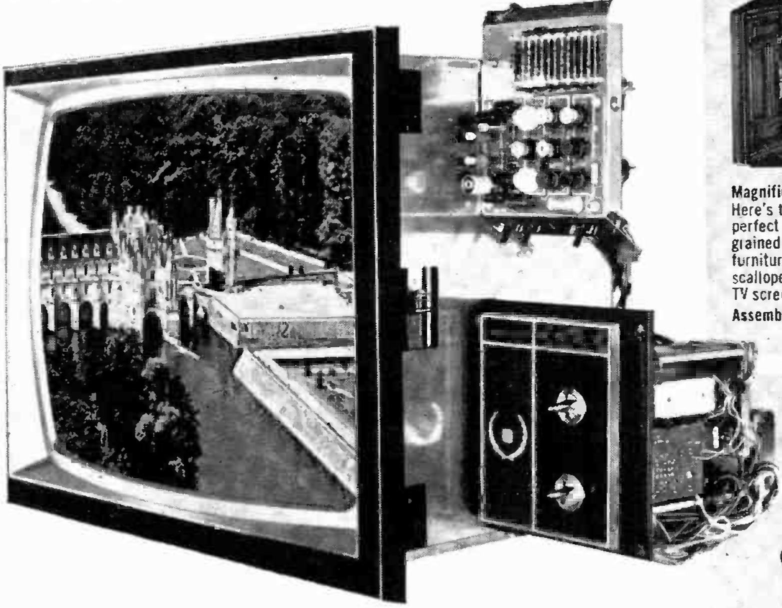
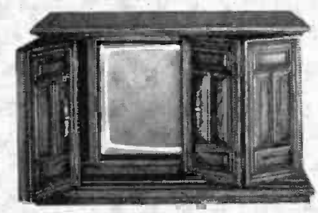
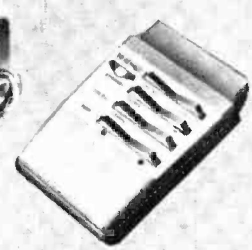
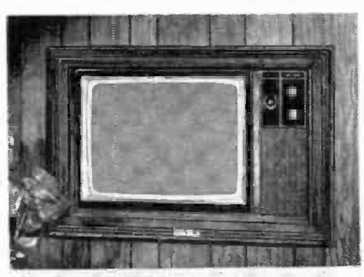




Magnificent Mediterranean Console. Here's the finest TV cabinet we offer, a perfect choice for a GR-900. Has deep-grained pecan veneers on hand-rubbed furniture grade hardwood solids. Two scalloped double-hinged doors hide the TV screen when not in use.
Assembled GRA-405-25, 100 lbs. 179.95*



Wireless Remote for your GR-900. The ultimate in armchair viewing. Gives you eight-function across-the-room control of on/off, three preset volume levels, power tuning (up or down), color, tint, UHF/VHF channel selection. Also activates Custom Wall Mount doors.
Kit GRA-900-6, 6 lbs. 79.95*



New Custom Wall Mount. Touch a button on the frame or on your Heathkit Remote Control unit and the folding tambour doors open to reveal your color TV. Kit includes everything needed to build your Heathkit GR-371MX or GR-900 into a wall.
Kit GRA-402-25, walnut finish, 50 lbs. 114.95*
Kit GRA-407-25, unfinished, 50 lbs. 109.95*

The new Heathkit GR-900 25V Color TV has UHF/VHF detent tuning & varactor UHF tuner, angular tint control — more features than any other color TV kit! Better performance than any other set.

UHF/VHF detent power tuning. Push a button and you scan the channels in either direction with detent action locking in on VHF channels 2-13 and any 12 preselected UHF stations. A pushbutton selects either UHF or VHF mode, and a lighted dial indicates tuner position. And you can have full remote-control selection too for just a few dollars more.

New voltage-controlled varactor UHF tuner and specially designed VHF tuner with MOS Field Effect Transistor contribute to better fringe-area reception, increased sensitivity.

New angular tint control. A switch now gives you either "normal" or "wide angle" color demodulation to reduce tint and flesh tone change when changing stations and when programs change. Other deluxe features include "instant on" operation with override for conventional on/off operation; automatic fine tuning; adjustable tone control, and an output for playing TV audio through your stereo hi/fi system.

Exclusive Heath MTX-5 ultra-rectangular tube. It's the largest color screen you can buy anywhere, with a full 25 inch meas. diag., 315 sq. in. viewing area. You see virtually everything the station transmits, in the corners and at the sides. The specially etched face plate cuts glare, and reflection, increases contrast without sacrificing brightness, and each dot is projected through a matrix screen to stand out crisply against a solid black background.

Modular solid-state circuitry. Plug-in circuit boards and plug-in transistors make assembly, adjustment and servicing easy. There are 46 transistors, 57 diodes and four ICs — making this one of the most reliable sets we've ever designed.

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Kit GR-900, TV less cabinet, 125 lbs. 599.95*

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The better-than-ever '72 Heathkit Catalog has the world's largest selection of fun-to-build, money-saving electronic kits...including color TV, stereo/hi-fi, organs, home appliances, engine tune-up tools, radio control, portables, shortwave, marine gear, metal locator, instruments, hundreds more. If you don't have this catalog, you've missed seeing over 50 new kits, introduced since the last edition. Send today for your free copy.

New AR-1500 stereo receiver 379.95*

Successor to the famed Heathkit AR-15, with impressive improvements in every critical area. 180 watts Dynamic Music Power, 90 watts per channel, 8 ohm load. Less than 0.2% IM and 0.25% harmonic distortion. Greater than 90 dB FM selectivity and 1.8 uV sensitivity. Vastly superior AM, too. It's the talk of the audio world. Order yours now.

Kit AR-1500, 42 lbs. (less cabinet)..379.95*
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New digital multimeter 229.95*

Now, a digital multimeter that meets lab specs at a low, low kit price! 3½ digits for 100 uV resolution on 200 mV range; 1V on 1000V; 5 DC ranges (100 uV—1000V, either polarity); 5 AC ranges (100 uV—500V); 10 current ranges (100 nA—2A AC or DC); 6 resistance ranges (0.1 ohm—20 megohms.) DC calibrator supplied for 0.2% accuracy without external equipment. Can be lab calibrated to 0.1%. Don't miss this outstanding instrument value.

Kit IM-102, 9 lbs. 229.95*

New digital frequency display for Heathkit ham gear.. 179.95*

There's nothing else like it on the ham radio market! Actually computes operating frequency. Six bright readout tubes show you exactly (to within 100 Hz) where you are as you dial across the 80-10 meter amateur bands. Designed for all Heathkit SB-Series Receivers and SB- and HW-Series Multiband Transceivers. With transceivers, the SB-650 reads and displays both received and transmitted frequencies. Manual fully describes and illustrates all interconnections for installation with the specific rig you own. Kit assembles approximately 8 hours. All solid-state circuitry — 6 transistors, 35 ICs.

Kit SB-650, 9 lbs. 179.95*

New...Heathkit solid-state 120 MHz counter...just 349.95

Another Heathkit first! The new Heathkit IB-1102 brings you a 120 MHz frequency counter with professional features, accuracy and stability rivaling counters costing far in excess of this modest kit price.

Features include eight cold-cathode display tubes, an overrange lamp, gate lamp, and two range indicator lamps for an easy-to-read display. Overall accuracy is assured by the use of temperature compensated "clock". The high-impedance (FET) input circuit presents minimum loading to the circuit under test. And an automatic triggering level offers simple "hands off" operation.

The Heathkit IB-1102 features a sensitivity of 50 mV to 100 MHz, 125 mV above 100 MHz. It will accept inputs up to 120 V rms from 1 Hz to 150 Hz, 50 V at 4 MHz, and 3 V at 120 MHz without damage to the instrument. The time base crystal is a temperature compensated TCXO offering ±1 ppm stability from +10° to +40° C and an aging rate of less than ±1 ppm/yr. Other features include the latest ECL (Emitter Coupled Logic) circuitry; 1 Hz resolution without switching time base. Plug-in ICs and circuit boards reduce assembly time to an easy 15 hours. And you can wire it for either 120/240 VAC operation. Kit includes handy detachable line cord, portable case with bail handle that converts to stand for best viewing angle.

Kit IB-1102, 12 lbs., mailable 349.95

Send for your FREE 1972 Heathkit Catalog today

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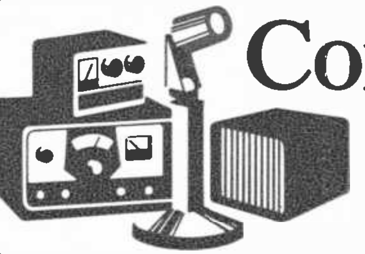

Communications Scene

By Richard Humphrey

Nicholas Johnson of the FCC

IN THE PAST, FCC Commissioner Nicholas Johnson has been accused of practically everything from inexperience and flamboyance to being "self-seeking" and politically motivated. His numerous appearances on TV talk shows, his outspoken opinions, and his opposition to vested interests—not to mention his book "How to Talk Back to your Television Set" (Little, Brown, 1970)—haven't made him the most popular kid on the block; nor, one suspects, were they meant to.

But in a recent exclusive interview with POPULAR ELECTRONICS he revealed not only a tightly wrapped legal mind and a firm grasp on a far-ranging variety of communications interests but also what sounded suspiciously like a conservative attitude on certain questions.

That we might be listening to a new Johnson was evident when he was asked to comment on the broadcast industry's occupation of over 80% of the radio spectrum thus leaving but a small portion for aeronautical, public safety, amateur and CB, marine and other two-way communications.

"Ever since I've been here," he said, "I've tried to have more attention paid to the problems of those who are using the frequencies for personal communications or business or for the kind of use the amateurs make of them; but the political and economic power of the broadcasting industry is pretty formidable because virtually all elected officials have to turn to the broadcasters to get any time to talk to their constituents."

"But what about the uhf television channels?" he was asked. "Particularly in view of the broadcasting industry's losing certain channels to other services because those channels weren't being used?"

"We *have* loosened up a bit in the uhf channels," he replied. "And I would predict that over the years to come there's going to be increasing pressure to follow that system (take uhf channels where the use it or lose it communications philosophy applies). However, when that will be done and how far it will go is hard to say."

It's interesting to note that immediately following FCC action in authorizing uhf channels 14-20 (470-512 MHz) and 70-83 (806-890 MHz) for land mobile use, the broadcasters hurriedly began "double-casting" their vhf (channels 2-13) program content on selected uhf channels in a style reminiscent of the duplicate programming in AM-FM radio before the FCC put a stop to it.

The CB Situation. Commissioner Johnson backed off when pressed for specifics on the Electronic Industries Association's petition, in February 1971, for 80 FM Citizens Band channels in the 220-222-Mhz portion of the 220-225-MHz amateur band and the rumored FCC action requiring automatic identification circuitry for practically all two-way radios. He was well within his rights in saying "no comment" since no Notice of Proposed Rule Making has been released on these two items.

When these Notices *are* released, the amateurs can certainly be expected to be vocal about the 80-channel class E CB petition although one is tempted to agree with the Electronic Industries Association's comment that the 220-225-MHz band is "seldom used". The big fuss, of course, will erupt when the Notice of Proposed Rule Making on automatic identification comes out. This reported move by the Commission was sparked mainly by the bad operating practices on the 27-MHz CB band. Talking about this situation Johnson said:

"The problem, quite frankly, is that you've got thousands of licensees and very few people at the FCC to get involved in enforcement. There's very little control, therefore, over the people operating this equipment. One way to do it," he hazarded, "would be to increase by about tenfold the number of FCC employees and send them out to track all this down."

"Is there any hope of that?"

"Well," answered Johnson, "I'm not sure that anyone wants that. There *is* another alternative and that is to get more self-regulation on the part of the Citizen Band operators." One could detect a warning note in the Commissioner's voice when he added: "Ultimately, they're going to kill this off if they keep going the way they have been. One of the proposals which comes before us from time to time," he offered as a grim afterthought, "is the suggestion that the whole thing (the 27-MHz Citizens Band) simply be closed down."

The Public Interest. We wondered aloud if automatic ID and a few other things contemplated by the FCC would be in the public interest and inadvertently trod on a Johnson toe.

"Let's not confuse the phrase 'public interest' as it is used in the Communications Act of 1934 with the expression 'something of public interest'," he said. "The legal term has a meaning of its own that's grown up over 37 years of FCC reports and thousands of decisions in the courts and the agencies. Whatever the term means to lawyers," he emphasized; "it does *not* mean 'something of interest to the public'."

"But what about television coverage of a major sporting event?" we asked.

"A problem *does* arise," said Johnson, "when a sporting event takes on the dimensions of a 'national resource' (like a World Series) and has traditionally been made available to the public and then for one reason or another is no longer made available. Once an event takes on the quality of a national institution and something in which everyone feels he has the right to participate, we begin to put limitations upon what the owner (so called) can do because it affects so many millions of people."

"Actually," Johnson continued, "this happens to any institution which gets big enough—whether it's a network, General Motors, a large state university or a government agency. When the 'owner' starts acting in a fashion that is too independent and whimsical, he's apt to find some kind of regulation coming at him one way or another from consumers or taxpayers or the government. That," he concluded, "is what's happening all across our society with Ralph Nader's movement and civil protests of all kinds."

We came out of this interchange—rightly or wrongly—with the impression that there are times when "something of interest to the public" becomes "something in the public interest." But exactly when this happens, only the Lord and the FCC know.

The 27-MHz CB question comes in for its share of Congressional attention. There's an almost daily flow of letters of complaint from the Hill to various FCC Bureaus along with requests for answers and action. One Congressman (who shall remain un-named) acidly took the FCC to task when a CB'er with a long record of intentional interference was shot on the front lawn of his midwest home by his fellow (?) Citizen Banders. The Congressman said it was the Commission's fault because they did not enforce the CB frequency rules properly!

While Commissioner Johnson will probably be glad to get along without situations such as that when his term expires in July of 1973, it was clear he didn't intend to retire from the arena. When asked if his future plans included anything of a political nature, he said:

"I *am* interested in the area of public policy, but there are so many ways today you can do that besides holding an elective office. I'm not particularly interested in having to go out and raise millions of dollars in order to run for office. Besides," he said, "I think Ralph Nader is probably more influential than most of the 535 Congressmen." ◈

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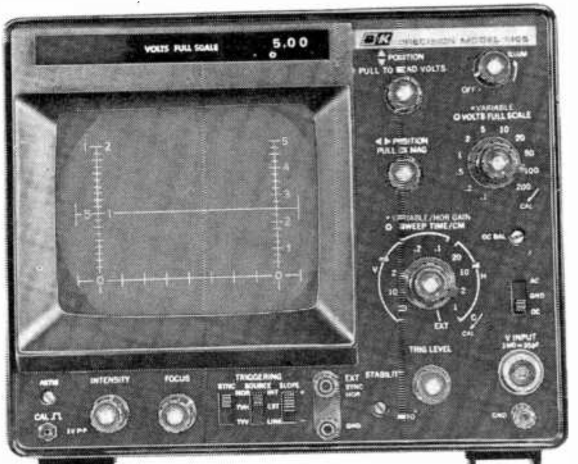

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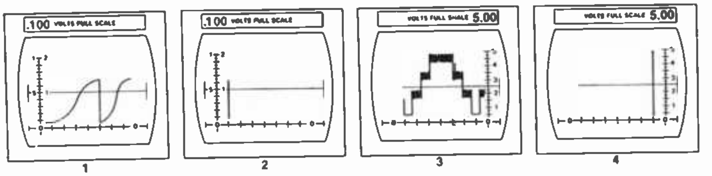

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To read peak-to-peak voltages utilizing Cali-Brain, note the full scale voltage reading in the bezel above the screen (fig. 1–.100 volts full scale) (fig. 3–5.00 volts full scale). Pull out the Cali-Brain knob and you will notice that the 1st waveform in fig. 2. reads .067 volts P-P and the second waveform in fig. 4. reads 4.95 volts P-P.

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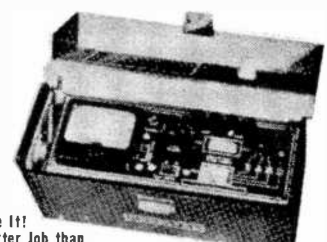

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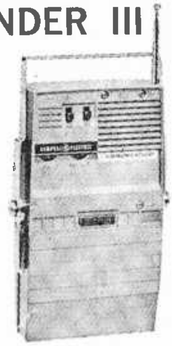

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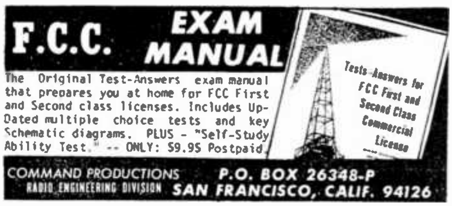

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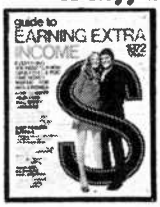

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- Sine-wave tone-bursts to test transient response of pickup.
- Intermodulation test using simultaneous 400-Hz and 4,000-Hz signals.
- Intermodulation sweep to show distortion caused by excessive resonances in tone arm and cartridge.
- 1,000-Hz reference tones to determine groove velocity.
- 3,000-Hz tone for flutter and speed tests.

Sample waveforms—illustrating both accurate and faulty responses are provided in the Instruction Manual for comparison with the patterns appearing on your own oscilloscope screen.

FREE Instruction Manual Includes Detailed Instructions, Charts, Tables and Diagrams

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