SELECTING THE RIGHT CONSTANT-VOLTAGE TRANSFORMER

By B. C. BIEGA / Director of Engineering, Sola Electric Div. (Sola Basic Industries)

Factors to consider include type of waveform required, capacity, range of regulation, temperature, and mechanical considerations.

MOST electronic and electrical devices, such as instruments, system controllers, amplifiers, and data-processing equipment, require a certain narrow range of input voltage to operate properly. But, since line voltage varies widely both above and below normal, some type of internal voltage regulation is almost always required.

One of the more widely used regulators is the constant-voltage transformer (CVT). But these ferroresonant devices must be applied correctly to produce maximum benefit. *(For a description of their operating principles, refer to the article "Voltage-Regulating Transformers" by John Frye on page 62 of our July 1965 issue.—Editor)*

CTV's vs Standard Transformers

Since virtually every application requires a transformer—usually a step-down type—designers should consider combining the voltage transformation operation with line-voltage correction. Although the cost of a CVT that does this would normally run about twice the price of a conventional transformer, this extra cost can be offset by a reduction in the number of components required if a CVT is used.

For example, let us assume a given solid-state device must maintain an output of 0.01 percent and the line-voltage swing is ±15% for a total swing of 30%. If a CVT is used as a pre-regulator, with an output of only ±1%, the solid-state regulating components need only handle that swing, not the total 30% variation. In this case, the saving in electronic components alone would be enough to pay for the extra cost of a CVT. Also, far less heat-sink capacity is required because solid-state regulators operate more efficiently with reduced voltage variation, thus dissipating less heat.

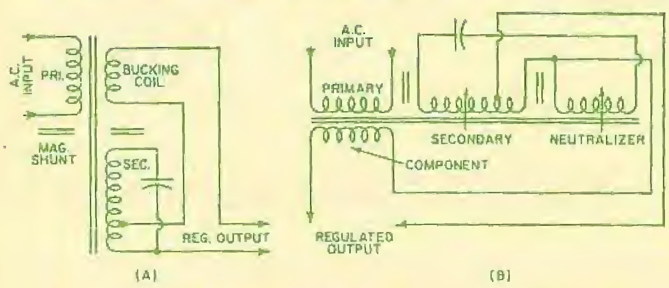


Fig. 1. (A) Normal CVT produces a non-sinusoidal output. (B) For sine-wave output more complex design is required as shown.

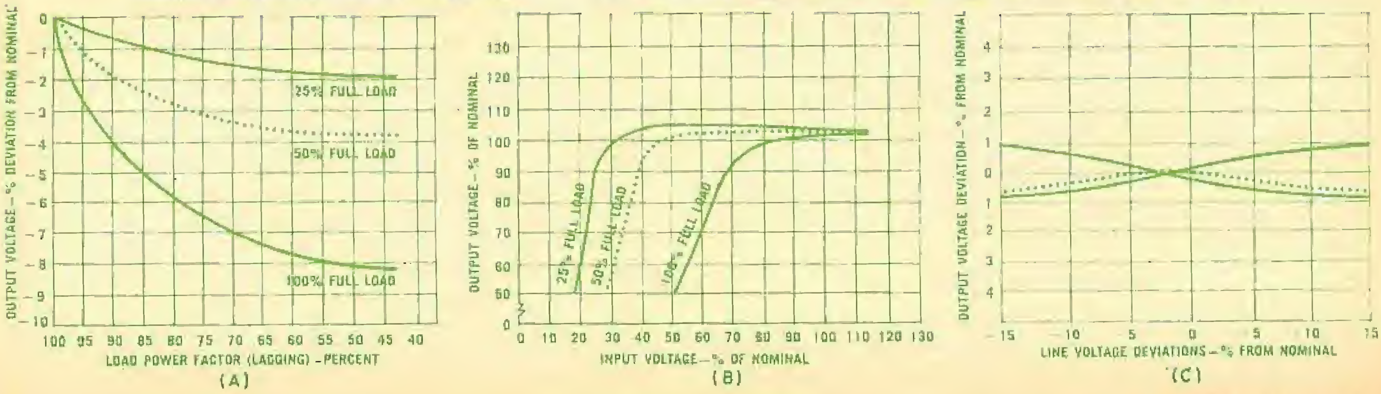
Specifying a constant-voltage transformer in the design also reduces the number of active circuit components required. One precision instrument manufacturer reports that use of a CVT provides the same degree of regulation accuracy with far fewer components than electronic regulation and at a lower cost. And fewer components in the instrument mean fewer chances of subsequent failure.

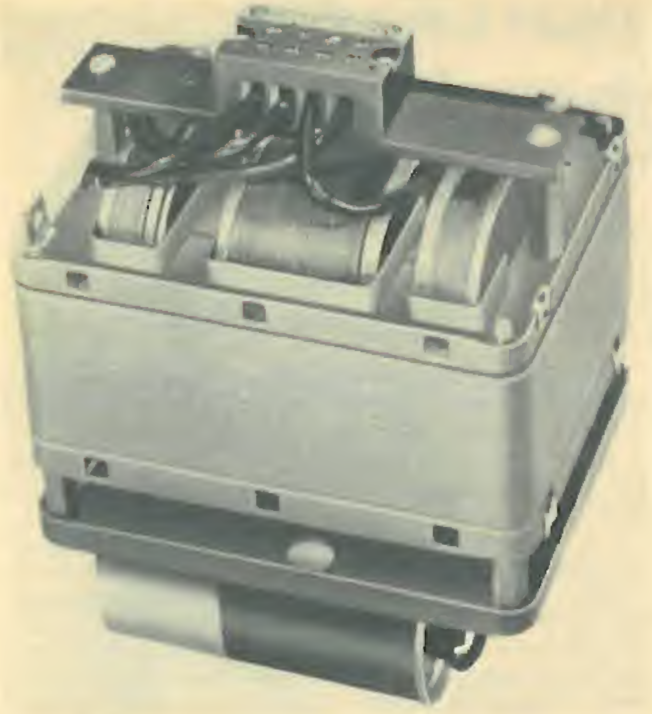
Sine-Wave Output or Not?

The designer's first choice rests between a standard CVT with a non-sine-wave output (Fig. 1A) and special CVT's with sinusoidal outputs (Fig. 1B). For a wide range of applications, the distorted sine wave of the standard CVT is no problem. In fact, if the application calls for rectifying the CVT output, the non-sinusoidal waveform is advantageous. Since the distorted waveform resembles a square wave, the amplitude of ripple in the rectified output is lower than when a pure sine wave is rectified. Consequently, less filtering is required.

However, in order that the right d.c. output may be provided, designers should take into account the lower d.c. output provided by the near square wave in comparison with a sine wave of the same r.m.s. voltage. Most CVT's have name-plate ratings in r.m.s. Therefore, for a rectification application, a standard CVT should be chosen with a slightly higher output voltage than normally required.

Fig. 2. (A) Changes in medium voltage level with changes in load and load power factor. (B) Extension of constant-voltage transformer regulation action at light loads. (C) Typical residual voltage variations within guarantee limits of ±1%.





A pair of typical constant-voltage transformers are shown.

←Interior photo of coils and core assembly of constant-voltage transformer before end-bell housings are bolted in place.

If a particular application requires almost pure sine-wave output to operate properly, a CVT that provides this type of waveform must be chosen. CVT's with sine-wave outputs generally cost about 10% more than standard CVT's.

Capacity Requirements Next

After selecting the right type of CVT, capacity of the unit should be the next consideration. Capacity should be at least equal to the total power requirement and, in some cases, higher. Thus, if the circuits draw a high momentary pulse current, the CVT must be rated high enough to allow for it. This is so because voltage output of a CVT falls off rapidly as load is increased beyond 150% of name-plate rating.

In many applications the current-limiting characteristic of the CVT is desirable and eliminates the need for special overload-sensing circuitry.

With low power factor loads, this sharp drop in output voltage occurs at smaller overload and even at less than name-plate rating (Fig. 2A). Increasing the CVT capacity to allow for pulse currents also reduces the effect of low power factor, thus eliminating the need for power factor correction capacitors or at least reducing their size. Another advantage of using a CVT larger than required for normal load current is that better line-voltage regulation and better load-voltage regulation are achieved (Fig. 2B).

Input Frequency & Regulation

Where the CVT and the device it is a part of are for use with normal utility-supplied power, there is no need to be concerned with frequency variation. The power grid system in the United States requires that frequency be controlled very accurately for correct operation. But, since a standard CVT is not insensitive to frequency changes, a special constant-voltage device should be specified for equipment to be used overseas and in areas where power sources are not reliable. Typically, the output voltage of the CVT will vary 1.6% for every 1% of frequency change.

The degree of output-voltage regulation should be considered carefully. Unnecessary reduction of the width of the regulation band can be very costly. Most standard constant-voltage transformers economically deliver an over-all output voltage regulation of ±1% for relatively fixed loads from nominal input lines (±10 to 15% line variation and less than ± 0.5 Hz frequency variation). Detailed performance of the CVT within these limits is an area of accuracy rather than a line or curve (Fig. 2C). Typical performances shown in this graph indicate most residual changes take place near the extremes of the input range. It is thus possible to obtain substantially better than 1% regulation if a.c. line variations remain within a tighter range from 105 to 125 V, for example.

If the application requires output voltage regulation of ±0.5%, special CVT's can be designed and built, but obviously at far higher cost than a standard unit.

Another way of obtaining tighter output regulation is to operate two units in cascade, with the output of one CVT feeding the input of another. Regulation of ±0.25% is possible with such a system. The first, or "driver", unit should be a sinusoidal output type of the VA rating next larger than the second, which is rated for load requirements.

Combined Specs an Advantage

Probably the most efficient way of specifying a constant-voltage transformer is to lump all applicable design parameters into a single minimum/maximum worst-case combination. Specifying individual parameters and their individual tolerances may result in the CVT vendor being forced to design a unit more sophisticated and costly than actually required. The usual parameters that could be grouped in this maximum/minimum envelope include: input frequency, line regulation, load regulation, and load variation.

Here is a typical case: a nominal a.c. voltage of 120 V at 8 A is required. Input line voltage varies from 100 V to 130 V; frequency is 60 ±0.5 Hz; load varies from 1 to 8 A with short-time overloads up to 12 A for not more than 5 minutes. Under the overload condition, output voltage may be permitted to drop to 115 V. Maximum output voltage permissible at no load is 125 V. Harmonic distortion up to 5% can be tolerated.

The CVT specification should be written as follows: input, 100 to 130 V at 60 ±0.5 Hz; load, 1 A to 8 A at 0.8 power factor lagging with loads up to 12 A not more than 5 minutes duration; output, 120 V ±5 V for any input voltage, frequency, or load; ambient temperature, 15°C to 40°C; harmonic distortion, 5% maximum.

If the specification had been written as directed by a manufacturer's standard catalogue, it would have appeared as follows: Output: 120 V ±1% at nominal line, ±1% output variation for line variation (*Continued on page* 69)

THE INSTRUMENTATION TAPE RECORDER PART 2.

By RAY A. SHIVER/AiResearch Mfg. Co.

Three basic systems for analog recording are covered, along with electronics used. Included are direct-record, FM, and PDM methods and their applications.

LAST month's article offered a brief history of the development of the magnetic tape machine and provided a detailed description of the construction of the modern tape transport and its mechanical and electrical features. This article will describe the three basic systems for analog recording and the electronics used. An analog system is any method whereby the output signal is a reproduction of the input system, that is, it is not converted to another form such as a coded format used in digital recording.

The Direct-Record System

As the name implies, direct recording is a method whereby the signal appearing at the record head is essentially the same as the input signal and does not undergo conversion. Fig. 1 shows the operational sequence as it occurs at each stage of the recording and reproduction process. The preamplifier section of the record amplifier is a straightforward *RC*-coupled circuit that produces enough voltage gain to drive the output stage. The output amplifier is a constant-impedance current amplifier with a low output impedance designed to work into the record head. This permits a fixed driving impedance over a wide frequency range. The bias oscillator signal is also inserted at this point. The two signals are mixed and applied to the record head as shown in the diagram.

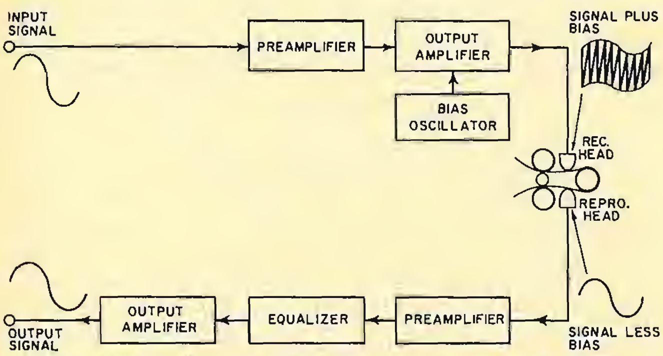
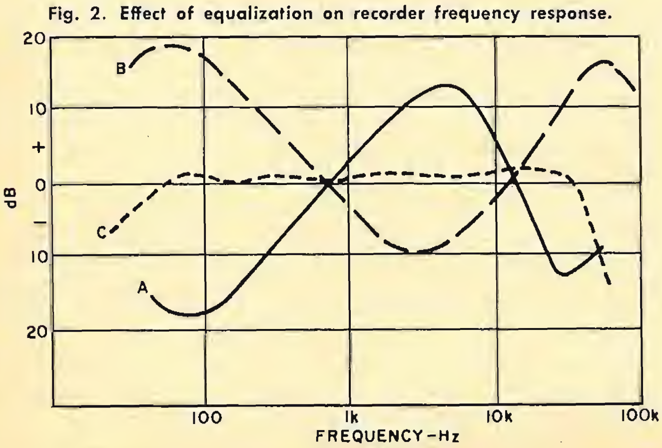


Fig. 1. Block diagram of the direct-record system described.

Fig. 2. Effect of equalization on recorder frequency response.



The reproduce signal at the playback head is shown minus the bias oscillator signal. Most of this is lost due to the spacing of the reproduce head gap. It is not sufficiently small so as to reproduce the high-frequency bias signal. The remainder of the bias signal is usually removed by a simple *RC* filter.

From this point the signal is amplified through the preamplifier stage and applied to the equalizer network. This is shown in the diagram of Fig. 2. The frequency response curve as it would appear at the output of the record head is shown as Curve A. Since the driving source impedance remains constant at the record head, the output response curve is mainly a product of frequency *vs* the inductive reactance of the head assemblies. In order to produce a flat output response curve it is necessary to provide an equalizing network that produces a response as shown in Curve B. It will be recognized that this is a mirror image of Curve A and would, in effect, produce an output response like that of Curve C. This is a typical curve for a direct-record system and most instrumentation recorders will provide a response of ±3 dB for the full recording range. In most portable-type recorders, the equalizers are plug-in units and must be changed for each tape speed. In the more sophisticated types of machines the equalizers are switched automatically each time that the tape speed is changed.

Applications for Direct Recording

Since it has been pointed out that the direct-record system has a response of ±3 dB for full-range recording, this system does not lend itself to data that requires precise amplitude accuracies. For this reason, direct recording in instrumentation is generally limited to applications where frequency data rather than exact amplitude is important. In this respect, direct recording is as good as any system since frequency or timing accuracy is dependent on the stability of the tape transport.

One of the earliest and still most important uses for the direct-record system is the recording of telemetry signals from aircraft and missiles. The wide frequency response of the direct system lends itself to this application. A simplified diagram of such a system is shown in Fig. 3.

The output voltage from one of the transducers is used to modulate the subcarrier oscillator (s.c.o.). The s.c.o. is a voltage-controlled oscillator in which a change in the level of the input voltage will change the frequency of the oscillator proportionally. The resultant FM signal is mixed with the outputs of the other s.c.o. units and the composite signal is used to phase-modulate a crystal-controlled transmitter.

At the ground receiving station the signal is received on the FM receiver, demodulated, and applied to the instrumentation tape recorder. In this manner the individual s.c.o. frequencies are recorded on tape. To reproduce the original analog signals, the tape is played back into a bank of FM discriminators, each of which is tuned to its corresponding unit in the aircraft or missile. Such a system is called an FM/PM multiplex system after the modulation used.

A system of multiplexed subcarrier frequencies necessarily limits the frequency range of each data channel. For example, on telemetry channel 18, the FM center frequency is 70 kHz and the nominal frequency response is 1050 Hz. This value may be doubled if the adjacent channels are omitted, with a corresponding decrease in the capacity of the system. The frequency response decreases as the channel number and channel 1 has a center frequency of 400 Hz with a range of only 6 Hz.

With this restricted frequency range it is important that transducers be assigned to channels that will adequately cover their frequency range. Referring to Fig. 3, it will be noted that the vibration transducer is assigned to channel 18 since a range of about 1 kHz is appropriate for this type of transducer. The magnetic flowmeter is a low-to-medium frequency device and channel 14 would be appropriate. Since the output of a thermocouple is a d.c. voltage with a slow rate of change (except for special high-response types), it is suitably covered by the limited response of channel 3.

From the above example, it can be seen that it is possible to record a large number of transducer outputs on one direct-record channel by using the appropriate telemetry equipment.

The FM System

The FM system of recording was developed primarily as a means of recording d.c. and extremely low frequencies. A great many of the transducers used in instrumentation provide output voltage of this type. A block diagram of a tvpical FM recording system is shown in Fig. 4.

The d.c. preamplifier will accept input signals from d.c. to 20 kHz. The signal is then applied to the v.c.o. which supplies an output signal whose frequency is proportional to the level and rate of change of the input. At this point the signal is FM and further d.c.-coupled stages are not needed. The output amplifier drives the record head to the point where the tape is near saturation at all times. This explains the excellent signal-to-noise ratio obtained with this system. There are no amplitude variations and the signal remains at a consistently high level which virtually eliminates tape noise. Also, since the amplitude is limited in FM recording, the effects of head inductance are of no consequence and the frequency response curve can be made quite flat, ±0.5 dB for the full recording range being quite common.

The signal is recovered at the playback or reproduce head as shown in the diagram. Several stages of limiting are generally used in the input stages of the playback amplifier before the signal is applied to the discriminator. The discriminator is usually a phantastron or similar circuit which produces a linear output pulse each time the input is triggered. The pulse train is used to drive a charging circuit which produces an output voltage analogous to the input signal. A low-pass filter is included in the output circuit to remove the center carrier frequency.

Since the accuracy of FM recording is determined primarily by the stability of the tape transport system, it is important that a precision drive system be used if the benefits of this type of recording are to be realized.

Applications for FM Recording

Any transducer that produces a d.c. output voltage which is analogous to some function to be measured can be recorded by the FM method. This would include such devices as thermocouples, strain gages, pressure transducers, and potentiometers. Transducers of this type generally produce a slowly changing (quasi-static) d.c. output voltage which permits one of the slower tape speeds to be used with a corresponding saving in tape. Since the recording range for FM is very linear right down to d.c., many low-frequency transducers can be measured with this system. This would include flow meters, vibration pickups, and tachometers.

Also FM recording offers the most accurate means of reproducing data in the medium-to-high frequency range (up to 20 kHz at 60 in/s). Some transducers that operate in this particular range include accelerometers, speed pickups, dynamic strain gages, and capacitance probes.

Pulse Duration Modulation

PDM is a method whereby 30 or more channels of data can be recorded on one tape track. This is possible with rotating commutators used as a means of sampling many separate channels of data rapidly. A diagram of such a system is shown in Fig. 5. The commutators are essentially rotating switches with 60 or more segments driven by synchronous motors. The keyer unit converts the data samples into pulses of equal height but of varying duration, as shown in the diagram. The pulse duration (*Continued on page* 63)

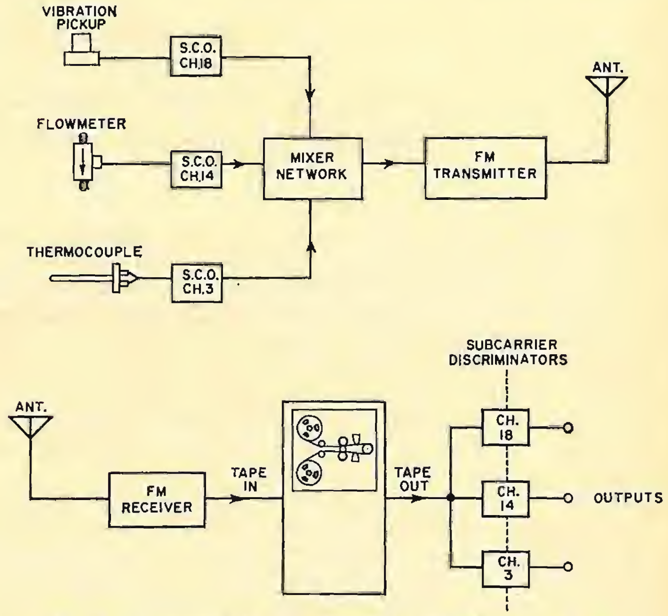


Fig. 3. A number of transducers may be multiplexed on signal.

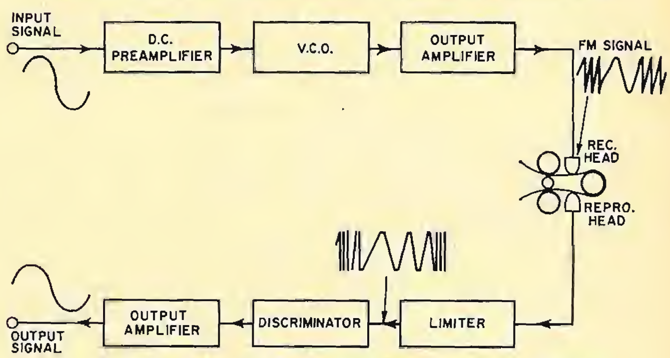
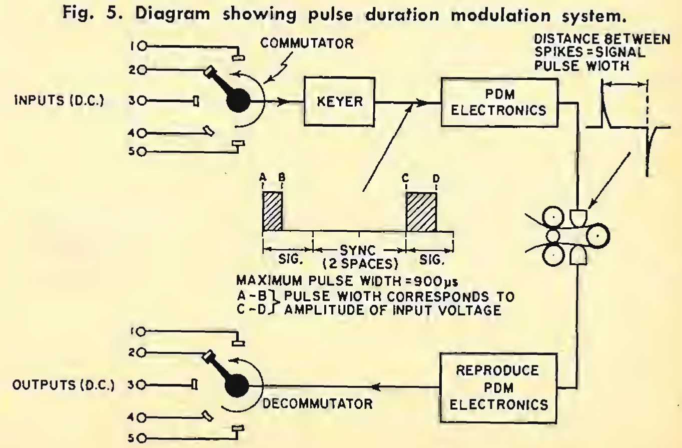


Fig. 4. Block diagram of FM system of recording described.

Fig. 5. Diagram showing pulse duration modulation system.



Designs For LOG-PERIODIC FM & TV ANTENNAS

By HAROLD D. PRUETT

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An FM-only and FM-TV antenna are described with gains of 10-12 dB, beamwidths of about 50°, and front-to-back ratios greater than 20 dB.

THE importance of a good antenna for satisfactory reception of FM-stereo or color-TV cannot be overemphasized. Unsatisfactory reception is often blamed on the receiver but, in many cases, the difficulty is that the antenna is not providing a large enough signal or is picking up signals from undesired directions. Low signal levels result in a high background noise level in the case of FM-stereo or "snow" in the case of a TV picture. Signals from undesired directions produce multipath distortion or "ghosts" for the same two systems, respectively.

In this article the role of the antenna as well as some details on the log-periodic antenna will be discussed. Plans are included for constructing two such antennas, one for FM only and the other for both TV and FM. These antennas will provide both an adequate signal level and enough discrimination against signals from undesired directions for most reception areas. Cost of materials for constructing either of the two antennas is less than $5.00, materials are readily available, and no special skills or tools are needed.

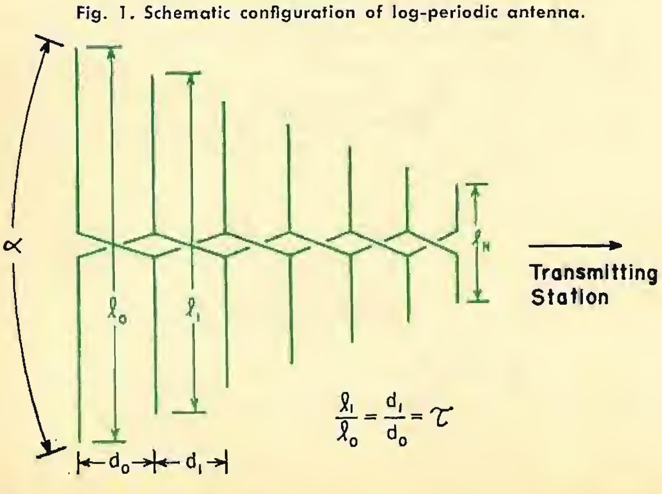
Role of the Antenna

A brief discussion of the role of an antenna in a receiving system seems appropriate before proceeding to consideration of the log-periodic antenna. In all imaginable situations where information is transmitted, achieving an acceptable signal-to-noise ratio is a primary consideration. A non-directional antenna can pick up and transfer signals to a receiver, but while it is picking up a desired signal from one direction, it is picking up undesired noise from all directions. In contrast, a directional antenna achieves gain in one direction at the expense of gain in all other directions. Since only noise signals would be received from the other directions anyway, you "get something for nothing". Therefore, a directional antenna improves the signal-to-noise ratio in two ways: the signal level is increased and the noise level is reduced by directional discrimination.

A measure of the directive gain of a receiving antenna is twice the angular beamwidth, in degrees, at which the power received falls to one-half the maximum value that is obtained when the antenna is aimed directly at the transmitter. The smaller the half-power beamwidth, the higher the gain of the antenna and the more immune it is to reception of noise from directions outside the half-power beamwidth.

The similarity between the gain-beamwidth product of an antenna and the gain-bandwidth product of a feedback amplifier should be noted. However, an antenna is a completely passive device in that it cannot amplify a signal. An antenna with directive gain is an array of more elementary antennas, usually half-wave dipoles, phased in such a way that their individual gains *add* in essentially one direction and *cancel* in all other directions.

Fig. 1. Schematic configuration of log-periodic antenna.



Geometric Relations in Log-periodic Antenna

Many readers may wonder why log-periodic dipole array (LPDA) antennas are being widely used in home installations. The primary reason is that an LPDA antenna will cover a wide range of frequencies with nearly constant directive gain and impedance. In addition, its directive gain for a given antenna length is greater than that of many other types of directional antennas. These factors, along with the ease and low cost of constructing LPDA antennas, should indicate the basis for their ever-increasing popularity.

The geometric configuration of an LPDA antenna is shown in Fig. 1. The antenna is an array of half-wave dipoles, each of which is formed by two quarter-wave dipoles that are connected alternately to the feeder line. When the length, l_n, of a dipole element is related to the frequency received by the equation $f = 5905/l_n$, the element will be a half-wave resonant dipole. In this equation, l_n must be expressed in inches and f in MHz. For example, a 59-inch half-wave dipole is resonant at 100 MHz, neglecting the relatively unimportant length-to-diameter and end effects. *(These effects may combine to reduce the resonant length by about 2-5% or to a value of about 57 inches.—Editor)*

Frequency-independent operation of the LPDA antenna is achieved by imposing a condition on the ratio of successive dipole lengths and the spacing between them. As shown in Fig. 1, the ratio condition is $l_1/l_0 = d_1/d_0 = \tau$, where τ is a constant called the *scale factor*. The same condition is imposed on all other adjacent dipole lengths and spacings. If l_n is the length of an arbitrary dipole, its length is given by $l_n = l_0 \tau^n$. Similarly, $d_n = d_0 \tau^n$. If the above condition is met, and if the shortest element of the array is resonant at a frequency somewhat higher than the highest frequency to be received, the gain of the antenna will be constant and independent of frequency. This auxiliary condition is imposed to avoid another kind of end effect, the details of which need not concern us here.

As indicated earlier, an antenna with relatively high directive gain is usually an array of properly phased elementary dipoles. In the case of an LPDA antenna, which fits the above description, proper phasing is achieved by alternately connecting the quarter-wave dipoles to the feeder line as shown in Fig. 1, and by controlling the spacing d_n between adjacent dipoles is the manner described previously. Half-power beamwidths are approximately 50° for the antennas to be described, and front-to-back ratios are over 20 dB.

Frequency Considerations

The frequency band from 88 to 108 MHz is allotted to FM. On either side of this are the two v.h.f.-TV bands, one extending from 54 to 88 MHz and the other from 174 to 216 MHz. The u.h.f.-TV band, which is not yet as widely used, extends from 470 to 890 MHz. Television antennas designed prior to the discovery of the log-periodic principle were often made up of two sections, one to cover the lower frequency v.h.f. band and the other the higher frequency u.h.f. band. This is continued with LPDA antennas, but for entirely different reasons. An LPDA antenna could be designed to cover the entire range from 54 to 890 MHz, but the dipoles which resonate in the TV-frequency gaps from 88 to 174 and from 216 to 470 MHz would serve no useful function as far as TV reception is concerned. These dipoles can be omitted in an LPDA design without disturbing the response of the antenna in the frequency ranges of interest and, if this is done, a shorter, less expensive antenna can be manufactured.

If the dipoles which resonate in the FM band are omitted, the antenna will not be very satisfactory for FM reception. Anyone contemplating purchase, rather than construction, of an LPDA antenna for both TV and FM reception should examine the unit to see if these dipoles have been omitted. If so, *any* antenna designed for FM-only reception is likely to perform better than the so-called dual-purpose TV-FM unit. To illustrate this point, the author found one commercial LPDA antenna that was proclaimed by the manufacturer to be excellent for both TV and FM-stereo, but which had less gain on the FM band than a folded dipole!

Construction Details

There are several antenna configurations in which the dipole elements are located in accordance with the basic log-periodic principle. One such alternate configuration, which lends itself to simple construction, is the zig-zag antenna shown in Fig. 2. In this design, each linear quarter-wave dipole element shown in Fig. 1 is replaced by a "vee"-shaped element such that the perpendicular distance from the centerline of the antenna out to the point of the vee is equal to the quarter-wave length of the linear dipole it replaces.

Plans for the home-constructed zig-zag TV-FM antenna were first offered by George Monser in his article "Design for an All-Purpose TV-FM Antenna" in the November 1962 issue of this magazine. Although the antenna described in his article is far from obsolete, the antennas to be described have several advantages over this earlier one. First, the new TV-FM antenna has slightly higher and more uniform gain over the entire v.h.f. TV band, while the FM-only antenna has approximately twice as much gain on the FM band as the original antenna had. Next, the frame for the planar zig-zag configuration used in the present design is easier to construct than the frame used in the original design. The planar zig-zag also requires less

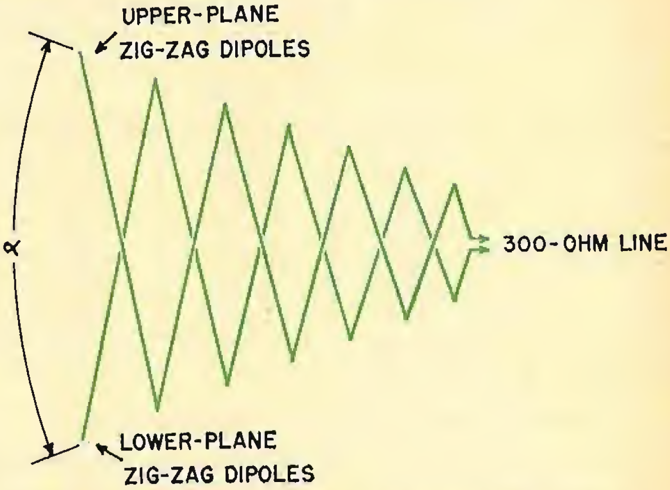


Fig. 2. Arrangement employed in the zig-zag LPDA antenna.

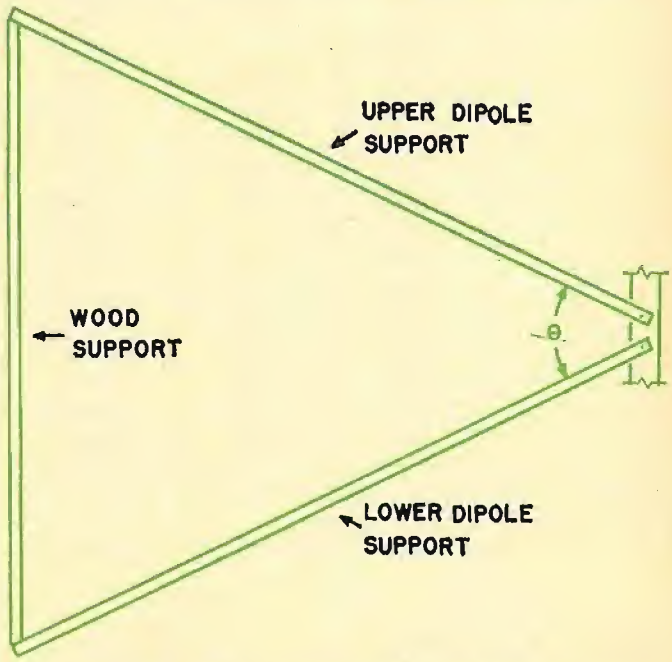
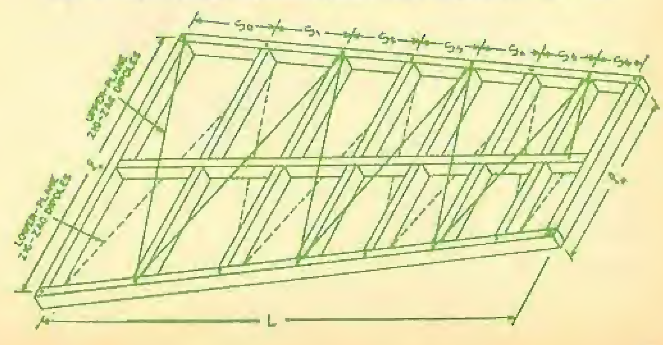


Fig. 3. Side view of the pyramidal log-periodic design shows how upper and lower dipole supports are oriented. The shortest dipole element is near apex which points to transmitter.

Fig. 4. Wood frame used to support wire zig-zag FM antenna.



vertical space for installation and can be used in an attic with an inexpensive rotor to provide multi-direction reception. Finally, the solder connections to the center feeder line used in the original design have been eliminated, resulting not only in less work, but also in a better impedance match to standard 300-ohm line.

The configuration used by Monser is called a pyramidal log-periodic design. When viewed from the side, the supports for the dipole elements are inclined at an angle θ as shown in Fig. 3. If the angle θ is reduced to zero so that the supports are parallel, but spaced a few inches apart, the antenna is called a *planar log-periodic* antenna. For either the pyramidal or planar configuration, the resonant elements may be linear dipoles, as in Fig. 1, or zig-zag elements as in Fig. 2. The only essential requirement for proper performance is that the inclination angle, θ, should not be larger than the angle α shown in Fig. 1.

n Element No.	τ^n	S_n Spacing (in inches)	ΣS_n (in inches)
0	1.0	21⅜	21⅜
1	.9255	19¾	41⅛
2	.857	18⅜	59½
3	.793	17	76½
4	.734	15¾	92¼
5	.680	14½	106¾
6	.629	13¼	120

l_0=67 inches; L=118.5 inches; l_x=39 inches; d_0=21.375 inches; τ=0.9255; α=13°.

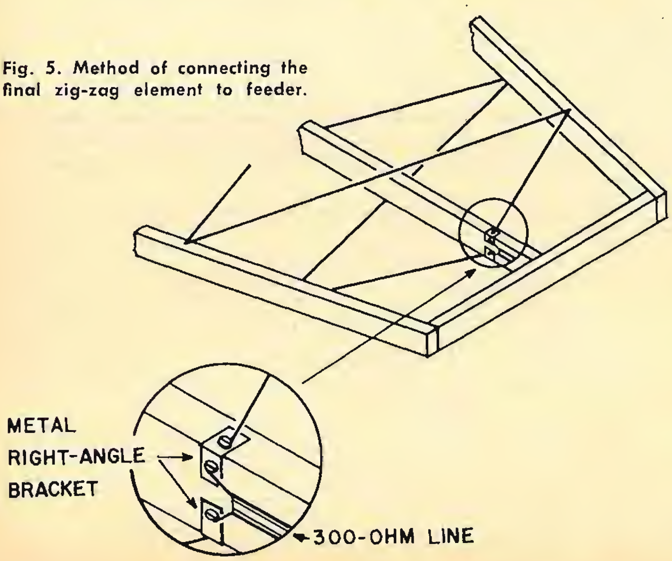
Table 1. Dimensions to be used for the FM-only antenna.

n Element No.	τ^n	S_n Spacing (in inches)	ΣS_n (in inches)
0	1.000	16⅛	16⅛
1	.900	14½	30⅝
2	.810	13	43⅝
3	.729	11¾	54⅜
4	.656	10½	65⅞
5	.590	9½	75⅜
6	.531	8⅝	84
7	.478	7⅝	91⅝
8	.430	7	98⅝
9	.387	6¼	104⅞
10	.349	5½	110⅜
11	.314	5⅛	115½
12	.282	4½	120
13	.254	4⅛	124⅛
14	.229	3⅝	127¾
15	.206	3⅜	131⅛

l_0=111⅜ inches; L=123⅛ inches; l_x=21 inches; d_0=15.1 inches; τ=0.90; α=41°.

Table 2. Dimensions to be used for v.h.f. TV-FM antenna.

Fig. 5. Method of connecting the final zig-zag element to feeder.



Although used by Monser in his design, a zig-zag antenna does not require a conducting wire along the centerline when it is connected to a balanced transmission line such as 300-ohm twin-lead. By omitting the centerline wire, distributed capacitance is decreased and the antenna impedance is increased. For example, in a planar zig-zag where the planes of the upper and lower dipole elements are one inch apart, removal of the center wire will increase the impedance from less than 100 ohms to approximately 230 ohms. The 1¾-inch spacing used in the present design results in an impedance slightly higher than that of a 1-inch spacing and an even closer impedance match to standard 300-ohm line.

The antennas to be described are intended primarily for mounting in the attic, although mast mounting is possible if the builder is willing to expend a little extra effort in constructing an all-metal version. Except in extreme-fringe reception areas, attic mounting is preferable for both aesthetic and practical reasons. It is doubtful that any rooftop antenna adds to the appearance of a house and, in addition, there are weather problems. Mast-mounted antennas are subject to wind damage and the useful lifetime of standard 300-ohm line is shorter when used outdoors rather than when sheltered by a roof.

A wooden frame, constructed from 1 x 2 inch firring strips (actual dimensions are ¾″ x 1¾″) is used to form and support the dipole elements for both the FM-only and the v.h.f. TV-FM antennas. The shape of the frame shown in Fig. 4 is that of the FM-only antenna; the shape of the TV-FM antenna is similar. Both frames should be constructed with the 2-inch sides of the firring strips oriented vertically. The spacing between the planes of the upper and lower dipole elements would then be 1¾ inches actual. Centerline-to-centerline dimensions indicated symbolically in Fig. 4 are given in tabular form in Tables 1 and 2. The column headed ΣS_n is the total distance from the large end to the nth element. The total length of the *outside* member of the frame is the last entry in the ΣS_n column. Details concerning the antenna frame supports are left to the discretion of the builder since their only purpose is to give structural rigidity.

It is best to cut and completely assemble the antenna framework in an open area to make sure that all the pieces fit together. Most attics are cramped for space and only final assembly should be undertaken there. When construction of the frame is complete, mark the positions of the dots shown in Fig. 4 by using the dimensions given in either Table 1 or 2, depending on which antenna is being built. There will be eight end-point positions for the FM-only antenna and seventeen for the TV-FM antenna. Standing at the rear (large end) of the antenna facing forward, drive nails in the first, third, fifth, etc. positions on the left side of the frame and leave about ¼″ of the nail protruding. On the right side, drive nails in the second, fourth, sixth, etc. positions. Turn the antenna frame over and then repeat the process.

After the frame has been reassembled in the attic, wire to form the dipole elements is strung between the nails. The author used aluminum clothesline wire because it is readily available, but any reasonable sized wire or tubing is satisfactory. Since a center feeder line is not required, the wire can even be covered with insulation except where it is connected to the 300-ohm line. To string the wire, connect one end to the left-rear nail on the top of the antenna, then run the wire over to and around the second nail on the right side, around the third (*Continued on page* 76)

ADVANCES IN *Magnetic Materials*

By JOHN R. COLLINS

Grain-oriented materials, new magnetic alloys, ceramic and ferrite magnets, and superconducting cryogenic magnets are just some of the new developments advancing magnetic technology.

ALTHOUGH much progress in magnetic materials can be ascribed to gradual refinements, the more important advances have come from technological breakthroughs—quantum jumps to new levels of capability. In the case of soft magnetic materials, the discovery of grain orientation was perhaps the greatest accomplishment, contributing both to economical power distribution and to important savings in size and weight for airborne apparatus. For permanent magnets, a significant milestone was the introduction of Alnico alloys which permitted, among other things, the manufacture of practical PM speakers to replace the cumbersome electro-magnetic speakers previously used. Ceramics, or ferrites, have vastly influenced both hard and soft magnetic materials. Their unusually high coercive force permits the design of relatively thin permanent magnets as compared with competitive materials; their nonconductive properties, coupled with high permeability, have revolutionized magnetics at radio and microwave frequencies. In addition, they are comparatively easy to form in irregular shapes and do not utilize critical materials.

Designing superconducting magnets for practical use has unquestionably been the greatest accomplishment in recent years. Such magnets support magnetic fields far stronger and more concentrated than any previously obtainable. They have added new dimensions to old techniques and hold the promise of solutions to problems that could not be tackled before because available magnetic fields were inadequate.

Grain-Oriented Steels

By far the greatest volume of magnetic material is used in the electric power industry for the generation and distribution of electricity. To minimize I^2R losses, voltage is stepped up for transmission of power over distances and stepped down to conventional levels before distribution to households. Large transformers are most efficient for such purposes. Doubling transformer dimensions will increase volume, weight, and losses by a factor of eight, but will increase power capacity by a factor of about sixteen. Therefore, 250,000-kilowatt transformers weighing more than ½ million pounds are not unusual.

Transformer power loss is measured in watts per pound. Although this loss may be only a fraction of a watt per pound, the enormous amount of electrical power consumed in the world today makes even minor improvements in efficiency important. For many years transformers were made from hot-rolled iron sheet containing about 4 percent silicon to increase resistivity and thus reduce eddy currents. Typical good grade material of this kind exhibits losses of about 0.5 watt per pound at 10 kilogauss and 60 Hz. Cold rolling makes a slight improvement in the material.

Grain-oriented steels first came into production after World War II. As shown in Fig. 1A, crystals of silicon steel are magnetized most readily along their edges. It follows that losses would be less if the crystals were aligned so that their edges were oriented in the direction of magnetization. This is accomplished by means of hot and cold rolling steps followed by recrystallization annealing. Individual grains of the alloy are aligned by this procedure so that magnetization is easy in the direction of rolling and losses are small, amounting to less than 0.3 watt per pound at 10 kilogauss and 60 Hz. Coercive force may be as low as 0.1 oersted, compared to 0.5 for ordinary silicon steel.

A further improvement in the past several years has produced magnetic steel oriented in such a manner that it has two directions of easy magnetization—in the direction of rolling and perpendicular to it. These steels make it possible to operate a transformer at 15 kilogauss instead of 10. Although losses rise to about 0.5 watt per pound at the higher flux density, the accompanying reduction in the amount of material needed more than compensates for the difference.

A parallel improvement has been an increase in maximum permeability—through refining the steel, removing impurities, and relieving strains—from about 5000 in early transformers to about 35,000 today. This represents an important increase in efficiency, since it permits transformers to be built with less material, and losses are proportional to

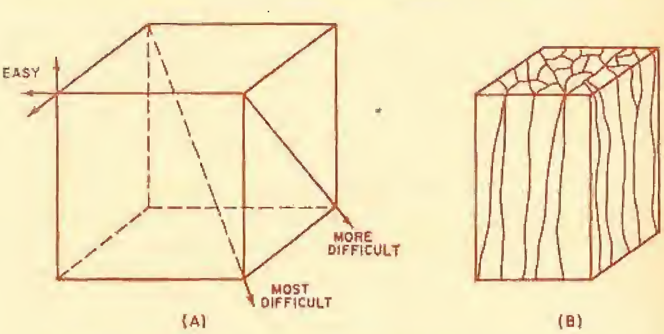
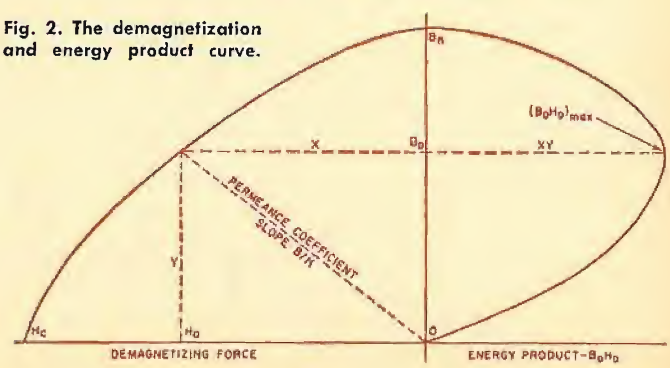


Fig. 1. (A) A crystal of silicon steel, showing relative difficulty of magnetizing along its various axes. (B) Grain structure of oriented Alnico magnetic material is shown here.

Fig. 2. The demagnetization and energy product curve.



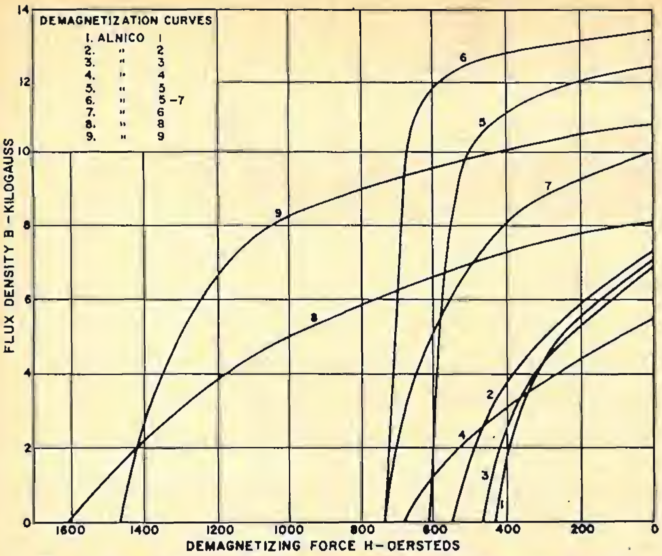


Fig. 3. Comparative demagnetization curves for various Alnicos.

weight. Far greater permeability can be achieved through further refinement, but the material is too delicate for use.

Permeability is also greatly enhanced through the use of nickel alloys. Permalloys, embodying 78 percent nickel and 22 percent iron have been quite successful, and alloys that include small quantities of chromium and molybdenum have been especially efficient, since those elements increase resistivity. A notable example is Supermalloy, which contains 70 percent nickel, 5 percent molybdenum, 15 percent iron, and 0.5 percent manganese, all of extremely high purity. When properly heat-treated, Supermalloy has maximum permeability of about 1,000,000 together with coercive force as low as 0.002 oersted. Alloys of this kind are useful for small transformers for communications equipment and specialized applications, but are far too expensive for large power types.

The Growing Alnico Family

A permanent magnet should have high residual induction to provide a strong magnetic field and high coercive force to resist demagnetization. These properties may be determined by plotting residual magnetism against the strength of the demagnetizing force, as at the left in Fig. 2. The figure of merit of a permanent magnet is its maximum energy product, measured in gauss-oersteds. This value may be determined by multiplying x and y coordinates of each point on the demagnetization curve and plotting the products as shown at the right of Fig. 2.

Early permanent magnets were made of hardened steel, usually with tungsten, chromium, or cobalt added. All had maximum energy products of less than 1 million gauss-oersteds. Carbon steel, for example, has a maximum energy product of 0.18; tungsten steel, of 0.32; 3½ percent chromium steel, of 0.29. By far the best material formerly available was 36 percent cobalt steel, with a maximum energy product of 0.94.

Because of the relatively low magnetic fields that could be obtained with permanent magnets, solenoid magnets were used almost exclusively for speakers in radio receivers and amplifiers. With the discovery of the first aluminum-nickel-cobalt alloy in 1938, however, the situation changed rapidly and permanent magnets have found increasing uses not only in speakers but in a multitude of other devices.

At the present time, there are nine such Alnico alloys in general use. The first five have been in existence for a number of years, but the latter four are relatively recent additions. There may be several variations of a single Alnico type, depending on the method of construction. Alnico 5, for example, may have a maximum energy product of 3.5, 5.5, or 6.25 million gauss-oersteds, depending on whether it is formed by sintering, casting, or a special directional grain process.

In general, Alnicos are formed by conventional casting or powder metallurgical techniques and a special heat treating procedure. The heat treatment consists of heating the alloy to about 1300°C and holding it at that temperature until a homogeneous structure is achieved. This is followed by controlled cooling, then a period of aging in which the alloy is heated to about 600°C to increase coercive force and energy product. Variations in the composition of the alloy or the time and temperature of the heat treatment result in a variety of different magnetic properties. The goal, of course, is to maximize the desired properties.

Alnicos 1 through 4 are isotropic, which means that they have the same magnetic properties regardless of the direction of magnetization. Although they were considered quite advanced when first discovered, they have only limited application today. Anisotropic or directional magnets are made by applying a strong magnetic field to the magnet during cooling. The field must also be in the same direction during aging. Magnets having markedly superior properties are produced in this way.

More recently, Alnicos have been developed in which the crystal structure is oriented in the direction of magnetic orientation. This is accomplished by casting the molten metal against steel plates which chills the magnet and causes rapid cooling and growth of long grains in the preferred direction. With careful regulation of casting and heat treating, almost complete directional grain growth is achieved. (Fig. 1B). Alnico 5-7, a premium material for applications requiring superior performance, is a product of this kind. Typical applications include airborne and space instrumentation, where high magnetic fields are attained with magnets of reduced length and small cross-section. The possible configurations of such magnets are limited, since the direction of grain growth must correspond to the direction of the magnetic field, and this can be done only in pieces magnetized in straight paths.

Alnico 8 is remarkable for its unusually high coercive force. This property makes it especially valuable for circuits having large air gaps or involving large demagnetizing influences. The most recent addition to the family is Alnico 9, whose energy product is typically 8.5 but may be as high as 9.5 million gauss-oersteds in selected specimens, and a coercive force of 1450 oersteds. It is a hard, brittle alloy that cannot be machined easily except by grinding. Because orientation and magnetization must be straight, the most common magnet shapes are cylinders and rectangles. Like Alnico 5-7, it is used in critical applications where a reduced size and weight without sacrifice of energy is required. Comparative curves of these materials are shown in Fig. 3.

Magnetic Particles

A limitation of Alnico magnets is the fact that the high-temperature heat-treating processes that are involved make it difficult to hold close tolerances in physical dimensions. The magnetic materials thus produced are hard and brittle, making grinding difficult and expensive. This problem has been overcome in a family of magnets developed by *General Electric* under the tradename Lodex. Lodex magnets grew out of the knowledge that most permanent magnetic materials derive their magnetic properties from extremely small and discrete particles dispersed in a non-magnetic medium.

In Alnicos and most other magnetic materials, the fine particles are precipitated from the matrix as a result of high-temperature processing. In the manufacture of Lodex, however, the magnetic elements are prepared by the electro-deposition of iron-cobalt and are thermally treated to develop elongated shapes having superior magnetic properties. These single-domain particles are then physically dispersed in a non-magnetic matrix composed of lead and become the magnetic domains of this synthetic system. In practice, the fine particle magnets and the lead binder are mixed in powder form and then pressed into final shape. Properties can be regulated by maintaining uniform proportions of magnetic particles to non-magnetic matrix, and close tolerances can be obtained in the finished parts, since pressing of powders is the final operation.

Lodex magnets are less powerful than the best Alnico magnets, but they are available with energy product as high as 3.4 million gauss-oersteds and coercive force of 1250 oersteds. The ease with which they can be handled permits wide latitude in design and economies in manufacturing.

Rare Earth and Hard Ceramic Magnets

Although still in the research stage, there are indications that compounds of cobalt and rare earth elements, such as yttrium, cerium, praseodymium, and samarium, may eventually yield permanent magnets with characteristics vastly superior to Alnico alloys. Already experimental magnets have been produced of these materials which exhibit energy product exceeding 5 million gauss-oersteds, and coercive force in excess of 7000 oersteds. This is still a long way from the calculated theoretical energy products, which range as high as 31 million gauss-oersteds, so there is much room for development.

Rare earth mixtures are becoming commercially available at prices that compare favorably with other premium magnetic materials. There is reason to believe that fabrication will be easier than it now is with Alnico alloys.

Magnetic ceramics, or ferrites, are classified as "hard" if they exhibit high energy product and high coercive force, and "soft" if they combine high permeability with low loss in an a.c. field. The principal hard ceramic material is barium ferrite $BaO \cdot 6Fe_2O_3$. Crystals of the material have a hexagonal structure. The ferrite has a high degree of anisotropy and, therefore, a preferred direction of magnetization.

The basic ingredients are barium carbonate and iron oxide, both readily available, which are processed to obtain the desired characteristics. The resulting powder is formed under high pressure in the required shape in a die. This fragile compact is then sintered in a furnace at a high temperature. The magnet thus obtained can be finished by grinding if necessary but is extremely difficult to drill or machine.

Barrium ferrites, some of which are produced by *Indiana General Corporation* under the tradename Indox, have the highest coercive force of any commercially available magnetic material, being exceeded only by platinum-cobalt (see Table 1) which is too costly for ordinary use. This characteristic makes it practical to use much shorter magnet lengths than is possible with other materials. Like other ceramics, barium ferrites have high electrical resistivity and are classed as non-conductors. This permits them to be used in places where other magnetic materials would create an undesired path for current or a short circuit. In addition, eddy current losses and associated heating effects are extremely low when barium ferrites are exposed to high-frequency alternating fields.

Because of their unusually high coercive force, barium ferrite magnets cannot be demagnetized with ordinary demagnetizing coils, since these are not sufficiently strong to overcome their field. For this reason, demagnetization is accomplished when necessary by heating the ferrite above its Curie temperature (about 450°C) and cooling it slowly to avoid damage from thermal shock.

The first barium ferrites were nonoriented types, consisting of aggregates of hexagonal crystals randomly arranged. Indox I is an example. It has a reasonably high energy product and coercive force that compares favorably with Alnicos. It is relatively inexpensive and thus finds extensive use.

MATERIAL[1]	PEAK ENERGY PRODUCT ($\times 10^6$)	RESIDUAL INDUCTANCE (KILOGAUSS)	COERCIVE FORCE (OERSTEDS)
Cast Alnico 1	1.4	7.0	440
Cast Alnico 2	1.6	7.2	560
Sintered Alnico 2	1.45	6.9	520
Cast Alnico 3	1.35	6.9	470
Cast Alnico 4	1.3	5.5	700
Sintered Alnico 4	1.2	5.2	700
Cast Alnico 5	5.25	12.5	600
Sintered Alnico 5	3.5	10.5	600
Oriented Alnico 5	6.25	12.6	670
Cast Alnico 5-7	7.5	13.4	730
Cast Alnico 6	3.5	10.1	750
Cast Alnico 8	5.0	8.0	1600
Cast Alnico 9	8.5	10.5	1450
Indox I (ceramic)	1.0	2.2	1825
Indox V (ceramic)	3.5	3.84	2200
Indox VI-A (ceramic)	2.6	3.3	3000
Lodex 30	1.68	4.0	1250
Lodex 31	3.4	6.25	1140
36% Cobalt Steel	0.94	9.6	228
5% Tungsten Steel	0.32	10.3	70
Platinum-Cobalt	7.5	6.0	4200

[1]Slight differences may occur in products of various manufacturers.

Table 1. Characteristics of permanent magnet materials.

The characteristics can be remarkably improved, however, through partial orientation (as in the case of Indox II) or complete orientation (as in the case of Indox V and Indox VI-A). Orientation is accomplished by subjecting the magnet to a very strong magnetic field during the pressing operation and prior to final sintering.

Barium ferrite magnets are found in many common articles, such as cabinet latches, can openers, and door closers. Because of their extremely high coercive force they are especially useful in providing magnetic fields for motors and generators. In hand tools, such as electric drills, they permit smaller and lighter devices than is possible with conventional field coils. Their resistance to high-frequency field makes them excellent choices for focusing applications, such as the periodic focusing of traveling-wave tubes. They are also finding wide use in PM speakers, especially for unusually flat speaker designs which have been made possible through the use of relatively short magnets.

Soft Ceramic Materials

Because of the high conductivity of metallic cores, losses mount rapidly with frequency. For this reason, silicon steel is rarely used much above 400 Hz. Instead, soft ceramic materials which have relatively high resistance are used as cores in such devices as horizontal output transformers and deflection yokes for TV that operate at about 16 kHz. They are also used for recording heads where, in addition to their ability to handle high frequencies without significant loss, their mechanical hardness provides superior resistance to wear.

The most common soft ferrites are composed of oxides of nickel and zinc. High permeability material is made by sintering the oxides at high temperature until a dense formation is obtained. For the higher frequencies, losses may be reduced at the expense of permeability by increasing the ratio of nickel oxide to zinc oxide.

A superior soft material may be made from manganese oxide and zinc oxide, having generally higher flux density, lower loss, and higher Curie temperature than the nickel zinc types. The valence of manganese tends to vary, making manganese oxide ferrites more difficult to produce. However, modern furnaces permit careful control of firing conditions, so the problem is no longer as troublesome.

In recent years, ferrites have become important as cores for filter inductors, i.f. transformers, antenna coils, and wideband transformers where frequencies from several hundred kHz to several hundred MHz may be encountered. The loss

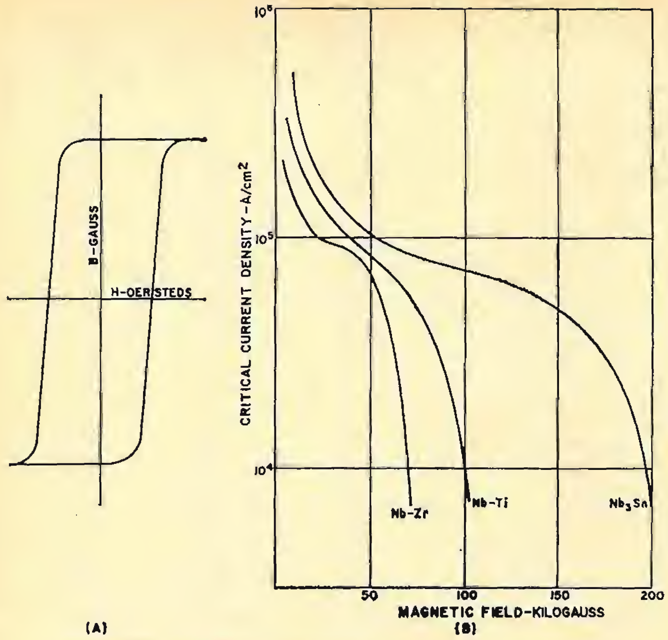


Fig. 4. (A) Rectangular hysteresis loop characteristic of materials used for magnetic amplifiers and memory cores. (B) Critical current density vs field for superconductors.

factor of ferrites, discussed above, is too high for these applications and so a special series of materials has been developed. These are characterized by unusually high resistance and high "*Q*". "*Q*" refers to the efficiency of the material for converting from electrical to magnetic energy and back again.

High-"*Q*" materials may be made from either oxides or nickel and zinc or oxides of manganese and zinc. The manufacturing process is quite similar to that described above except that the proportions of the compounds are not the same. In addition, high-"*Q*" materials are somewhat underfired, leaving them slightly porous. As a result, their permeability is substantially less than ferrites' intended high-frequency use, but this factor is more than compensated by the reduction in losses at radio frequency.

A class of ferrites known as garnets has been developed for use at microwave frequencies. They have the general formula $3R_2O_3 \cdot 5Fe_2O_3$, where *R* is any rare earth element. Yttrium iron garnet is an example of the type. They have extremely high resistance and low loss. Typical applications include isolators, phase shifters, and rotation devices. Placed within a cavity, such a ferrite causes the plane of polarization of the microwave radiation to be rotated, thus permitting nonreciprocal or one-way electrical networks to be constructed.

Square-loop ferrites are usually made by combining oxides of magnesium and manganese. Other materials, such as nickel, copper, or calcium may be added to modify the properties. These materials have high remanence, approximately equal to saturation flux density, which gives the flatness at the top and bottom of their hysteresis loop (Fig. 4A). Initial permeability is characteristically low, as is coercive force. Square-loop ferrites are used for information storage and switching applications. One of their primary uses is for core memories in computers. Switching speed is a very important consideration, and this parameter has been reduced to a fraction of a microsecond in some types.

Superconducting Magnets

Although superconductivity was discovered more than half a century ago, it has been only in the past few years that the production of practical superconducting magnets has become possible. The phenomenon was first noted in relation to mercury, which was found to lose any measurable resistance at about 4°K. Early experimentation demonstrated that tin and lead exhibit the same characteristic. As a result of concentrated research the list has continued to grow. There are now 26 known superconducting elements along with more than 1000 superconducting alloys and compounds.

The idea of winding magnet coils from superconducting materials is attractive for obvious reasons. Since superconductors have no resistance they consume no power. After a field has been established in such a coil, the terminals can be short-circuited and the current will continue to flow indefinitely. In the absence of resistance no heat is generated, and a much stronger field can be established in a small area than is possible with conventional equipment. It is thus feasible, in theory, to achieve extremely concentrated magnetic fields with lightweight apparatus.

Putting theory into practice was not easy. It was soon discovered that superconducting elements lose all trace of superconductivity when the magnetic field exceeds a certain critical value. This is attributed to the fact that the field is totally excluded from the interior of the conductor at the lower flux levels, and that loss of superconductivity occurs when the field penetrates the surface. Superconductors of this kind are called "soft". They are unsuited for sustaining magnetic fields exceeding about 1000 gauss.

So-called "hard" superconductors are alloys and compounds that will continue in the superconducting state despite partial penetration by the magnetic field. Although they also lose superconductivity when field penetration is complete, many of them are capable of sustaining quite concentrated fields before that transition occurs. Theoretical calculations indicate that fields as high as 300 kilogauss may be possible with hard superconductors, but this level has not yet been reached.

Superconducting alloys are usually quite ductile and easy to fabricate. The two most promising at the present time are *Nb-Zr*, containing approximately 75% niobium and 25% zirconium, and *Nb-Ti*, containing approximately 50% niobium and 50% titanium. Both alloys are made from fine powders that are sintered to form wires. *Nb-Zr* has a critical magnetic field of about 60 kilogauss; *Nb-Ti* of about 80 to 100 kilogauss (Fig. 4B).

Like most other superconducting compounds, niobium tin (Nb_3Sn) is extremely brittle and difficult to handle. However, it offers the greatest hope today of obtaining superconducting magnets with fields in the vicinity of 200 kilogauss. Several methods of forming niobium tin magnet coils have been devised. In one method, the tin is deposited on niobium wire. After the coil is wound it is heat treated, causing the tin to diffuse into the wire and react chemically to form niobium tin. A related process involves placing powdered tin and niobium into a niobium tube which is heated in order to form a compound after it has been coiled.

It is possible to wind a coil after the compound has been formed by coating a thin metallic ribbon with a very thin layer of niobium tin. With proper care, a ribbon of this kind can be wound into a coil no more than an inch in diameter without damaging the superconducting layer.

The highest magnetic field yet achieved with a superconducting magnet is about 140 kilogauss. This is still far short of the 250 kilogauss field that has been obtained with a conventional magnet. However, conventional magnets in that range required about 16 million watts to operate and huge quantities of water to dissipate heat, whereas the superconducting magnets are relatively compact and require virtually no power except the amount needed to refrigerate the superconducting coils.

A number of important uses are visualized for superconducting magnets. These include such projects as improved bubble chambers for atomic research, deflection systems for particle accelerators, plasma (*Continued on page* 88)

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JOHN FRYE

Electronics can play a vital role in understanding the effects of a stroke and in rehabilitating the victim.

ELECTRONICS AND APHASIA

WINTER, a little slow in coming, was definitely on the way; and Barney appreciated the cosy warmth of the service shop as he stepped inside out of the near-freezing rain that had been falling all morning. He found Mac, his employer, reading a blue paperbound book bearing the title *Care of the Patient with a Stroke.*

"How *is* your mother, Mac?" Barney asked.

"That's tougher to answer than you might suppose," Mac replied, putting the book aside. "She still can't move her right arm or leg, but the really rough thing is she still can't talk, even though it is now three months since she had her 'cerebral vascular accident,' as the doctors like to call a stroke. All she can do is nod or shake her head in answer to questions, and you can't put too much dependence on these responses because she sometimes becomes confused and nods her head when she actually means 'No'. With such sketchy, imperfect communication, it's very difficult to tell how she feels, what she wants, or if she is improving.

"It's especially frustrating to me," he went on sadly, "a communications expert of sorts who works constantly with communications media that easily span hundreds of miles with the speed of light, not to be able to communicate with my own mother when I am sitting right by her bed holding her hand. Above all else, I want to get her talking, for I know it must be doubly frustrating to her. That's why I've hired a trained speech therapist to work with us one day a week and why I'm studying the chapter on teaching stroke victims to talk in this excellent book written by Genevieve W. Smith and published by the *Springer Publishing Company* of New York City.

"The author is a registered nurse whose own husband suffered a stroke. Thus she is able to draw, not only on her contacts with the medical profession, but also on a wealth of both general and highly personalized experience in preparing this book designed for use both by the patient's family and the nurse. By explaining what you can expect in the way of patient behavior—and the reasons for that behavior—it saves tremendous wear and tear on the nervous system of the family; and, much more important, it enables you to give intelligent, meaningful help to the patient.

"The chapter I was reading is a good illustration. This business of a stroke victim's not being able to talk is a lot more complicated than most people believe. It is called *aphasia* and is defined as 'The loss or impairment of the ability to use words as symbols of ideas as the result of a brain lesion'.

"I'm sure you know the brain is divided into equal halves, or hemispheres, and that the left half controls the right side of the body and *vice versa.* As both sides of the brain are alike, there are actually two speech centers; but since speech is a single operation in which both sides participate, it's necessary that one center or the other be the leader. The dominant center is normally the one in the left side of the brain.

"As an electronics technician, I find it easy to think of the speech center as a computer that has a memory stored with all the words a person knows. Some of these words are lightly linked to others. For example, the word 'ham' may be lightly linked to 'eggs' or to 'actor.' 'Tall' is often linked with 'dark' and 'handsome'.

"Information inputs to this speech center include data from the eyes, the ears, and the sense of touch. A pin-up is likely to evoke a 'Wow!' response from a male. 'Hi' produces a return greeting. Burning yourself on the soldering iron may well cause you to exclaim 'Ouch'—or something worse! The important point is that input information combines with material from the memory bank in the speech center and produces an output in the form of nerve messages sent to the lips, tongue, vocal cords, or fingers that result in the speaking or writing of word symbols for the ideas formed in the brain. And feedback circuits from the ears and eyes compare the sound or sight of the word thus formed with the memory of that word in the brain to insure it is spoken or written correctly.

"All the areas of the brain controlling sight, hearing, feeling, speech, etc., have nerve pathways connecting them with each other as well as pathways going to the organs performing particular functions. The brain hemorrhage blocks one or more of these paths either by cell destruction or pressure on the nerves. Which paths are blocked determine the nature of the aphasia. If the path from the hearing center to the speech center is blocked, the victim can hear but he cannot make sense out of the words heard. It is as though he were listening to an unknown language. This is called *auditory aphasia.*

"Perhaps another incoming path, that from the sight center, is impaired. In this case the patient cannot read and is said to suffer from *visual aphasia,* or *alexia.* All writing and print may appear like mysterious hieroglyphics so that he cannot read a word, or he may be able to decipher single words separately but still be unable to string them together so they make sense."

"How about the paths leading out from the speech center? What if they are injured?"

"If the ones going to the speech organs are injured, as is the case with my mother, the patient cannot utter the word symbols for the ideas formed in the mind. This is called *vocal aphasia,* or *aphemia.* And if the ones controlling precise movements of the fingers and arms are injured, the patient may be unable to write and so be said to suffer from *agraphia.* A stroke victim may have any combination of these four basic types of aphasia, depending on just where the hemorrhage occurs and how extensive it is."

"What can you do about correcting the damage?"

"Nature does her best to help. The blood clot that formed to plug the rupture in the blood vessel is gradually absorbed, and this may remove pressure that has been causing a temporary disruption of the signal path. Or, if the path is permanently destroyed, other nerve paths may be bridged around the break by constant repetition. It's like the way a sudden voltage surge will sometimes restore the broken connection inside an open coupling capacitor and allow it to carry the signal again. Finally, if the paralyzed person is not too old, there is one other possibility: the other speech center, the one in the right half of the brain, may be taught to take over the communication leadership from the damaged left-side center.

"As might be suspected, the first signals to travel over these restored or substitute paths are likely to be erratic and unreliable. That's why the first words spoken by stroke victims are often swear words or obscenities, even though the victim previously never used such words. This is probably because these words in the memory bank may be weighted by emotions surrounding them and are easily triggered by a random stimulus."

"I certainly see how a technical electronics background makes it easier to understand the brain damage," Barney said. "We can really put cybernetics to work for us. But it sounds to me as though teaching an aphasia victim to talk or write would take an awful lot of patience."

"It does," Mac answered. "For one thing, the patient normally has a very short span of interest, and you *must* have his undivided attention while you are teaching. To batter your way through the blocked nerve paths, you try to make as strong a presentation as possible, appealing to every possible sense. For example, if you are trying to get him to say, "drink", you may show him a glass of water, point to the written word, guide his hand in the motion of taking a drink, and say the word aloud with exaggerated lip and tongue movements that he can watch and imitate in a mirror. And you do this over and over and over until he finally utters the word in recognizable fashion. Then you praise him warmly, for if ever he needed the encouragement of achievement and progress it is now.

"However, keep in mind the speech therapy must be fitted into the routine of his very essential and extensive nursing care and physiotherapy. Remember, too, it must compete for his attention against the aches and pains that accompany his condition and the spells of frustrated depression that are bound to plague him. If the person trying to teach him to talk is in constant attendance with the patient while he is awake, that person can take advantage of the most favorable times for giving instruction; but this is seldom the case. That's why I've been thinking what is needed is a highly specialized teaching machine specifically designed for aphasia victims. With such a tireless, ever-ready machine sitting by his bed, the nurses could urge him to use it during his most alert periods; and, even without their urging, he would be tempted to use it to relieve boredom."

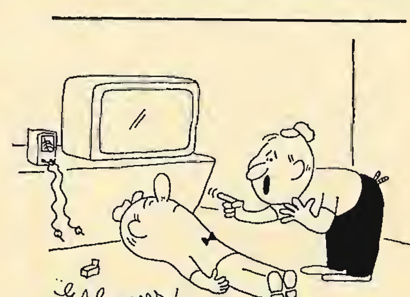
"What sort of machine do you have in mind?"

"I've been thinking basically of a video tape recorder that would play back through any TV receiver. In the home the patient could use his own set or a rented portable. In the hospital, a set designed for patient use could be employed. The video tapes would be prepared by a speech therapist for the particular use of each patient. On the tape would be the words to be learned, with close-ups showing the position of the tongue and lips in articulating the words. The words could be shown in print or script at the same time. Concrete objects could be shown to illustrate nouns; actions, to illustrate verbs.

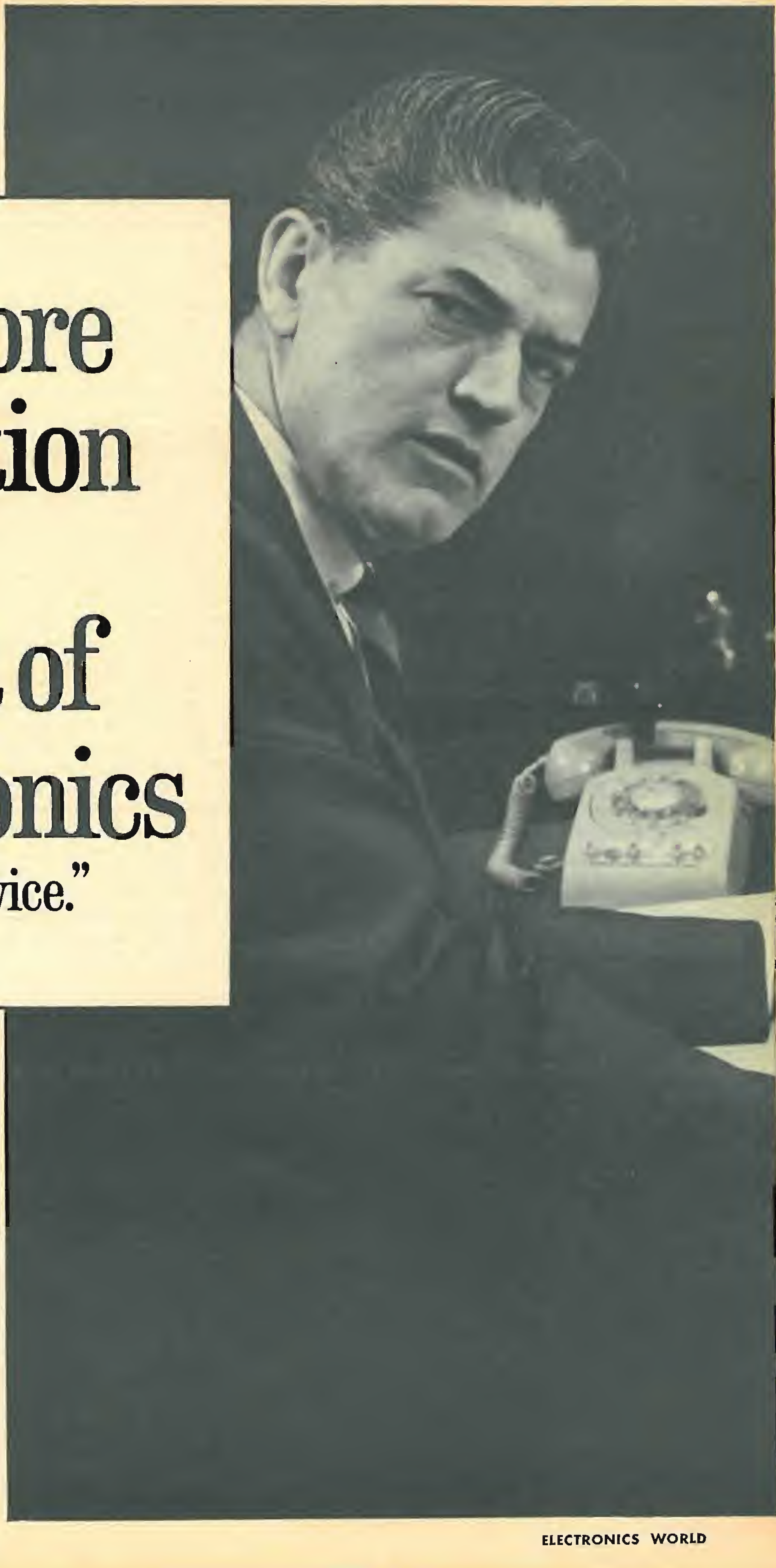
"After the patient was told to say the word, a pause would occur while he tried. This would be recorded on a separate sound track, possibly an endless loop of tape, so the patient could hear his own pronunciation. Quite possibly an attachment similar to the word-recognition devices being developed by several different laboratories could compare the word spoken by the therapist with that uttered by the patient and flash an approval signal when they were near enough alike. At any time the patient could 'back-space' the tape for a repeat of the word the therapist wanted him to say.

"Naturally I can't be too specific about the final form of the machine, but I am sure doctors, speech therapists, and electronic engineers, working closely together, could come up with something that would be of major help to victims of apoplexy. I *know* there is a need for such a device. Strokes bow only to heart disease and cancer as being a major cause of death in this country; and I am sure the number of stroke victims occupying beds in hospitals and nursing homes at any given time in this country must be staggering. Anything that speeds up their rehabilitation would go far toward relieving the shortage of doctors and nurses and hospital beds, not to mention the alleviation of anguish on the part of the victims and their families."

"You've got me sold," Barney said. "After all, electronics has shown what it can do time and again in the field of communication, and this *is* a communication problem in the final analysis."▲



Come on, now. Let's not faint at the thought of troubleshooting your first 62-transistor color set!"

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Incentive Licensing

(*Continued from page* 34)

cide between ham radio and CB will be faced with the hard fact that he'll need much more than a Novice ticket to enjoy phone operation *via* the amateur route. Opponents of the new program point out that without "young blood", *any* group or organization can only fade off into oblivion. They ask how the pro-incentive people propose to draw newcomers (especially teenagers) into the hobby. One New Jersey amateur, upon being told the news, wanted to know "if ARRL is planning a program of mass-brainwashing so as to prevent an enthusiast from ever hearing that CB exists?"

Along these same lines, opponents see amateur radio in the U.S. slowly fading away. Many feel that the number of hams will drop from 200,000 to just over 100,000 after the rules go into effect. They think the Commission will never be able to get the majority of General ticketholders to FCC examination offices for Advanced tests. The equipment industry, however, seems somewhat cheered by the over-all prospects, although they foresee dark days ahead for several months. There is some feeling that the Advanced exam may prove a major stumbling block and be primarily responsible for the almost-predestined disappearance of ham radio in this country.

If the number of licensees begins to dwindle, what will happen to the ham bands? The contention here is simply that if they are not utilized, they will be lost forever to other nations. And to many, this seems an ultimate certainty.

Finally, the quite-vocal opponents have come up with one constructive idea: lifting the antiquated eligibility requirements for the Novice Class license. As it now stands, no one can go for this test if he has *ever* before held radio amateur status in this country. Similarly, holders of 1st Class Commercial Radiotelephone licenses are now ineligible for this beginner's ticket. How about retired people who want to get back into amateur radio but who held licenses when in their late teens? Obviously, any one who's been away from electronics for any length of time cannot be expected to become an overnight expert in sophisticated communications technology. Many feel certain that if this restriction were lifted, it might offset some of the unattractive stumbling blocks Washington is putting in the way of the hobby, by replacing the youngsters with returnees.

The Advantages

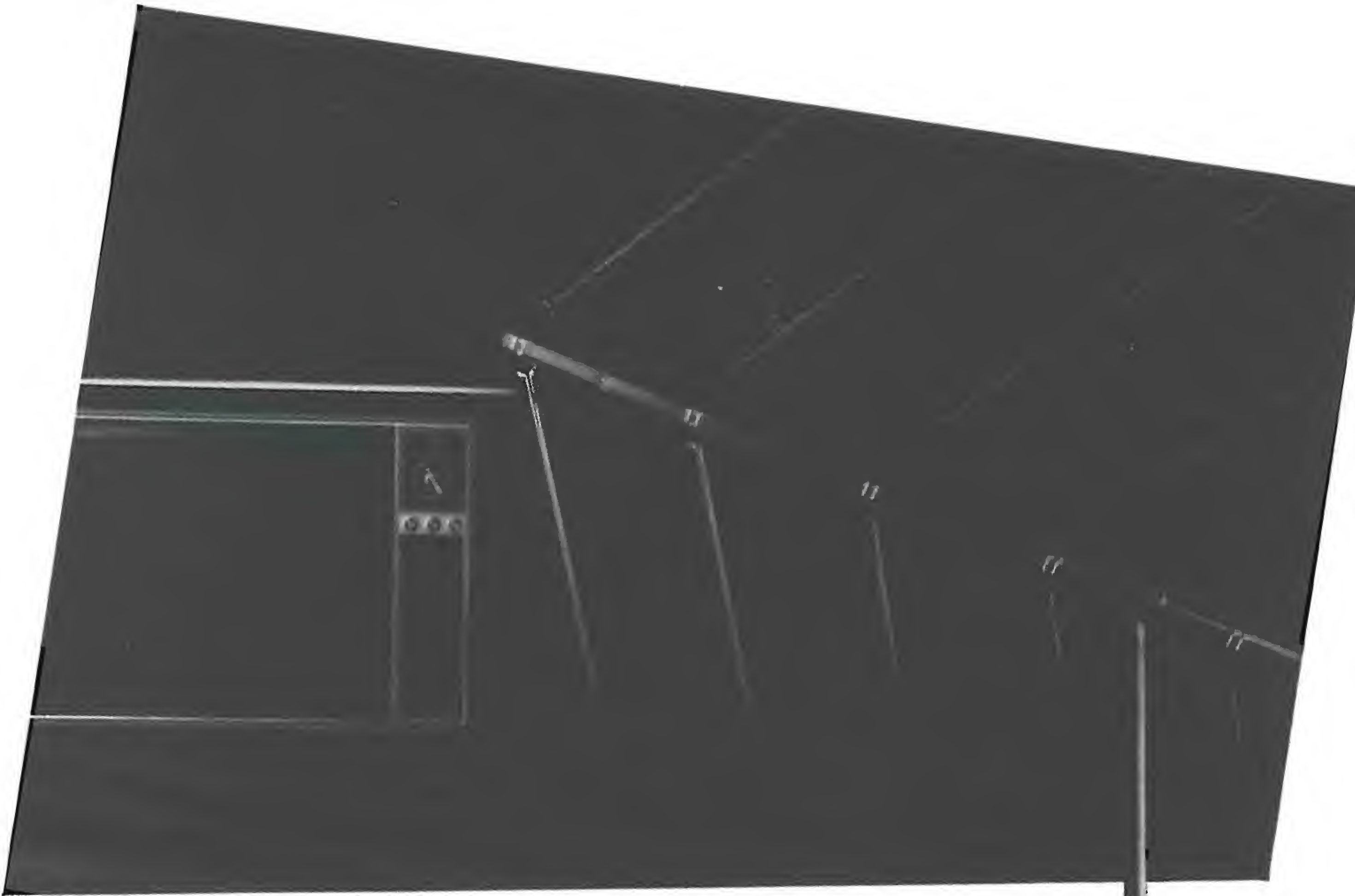
The proponents of pro-incentive licensing are concerned over the low level of technical competence and the rise in the number of "push-button" operators". By developing the knowledge and skills of the hams, it is said that America *might* be able to reach the degree of sophistication and ingenuity being demonstrated by the hams in Australia, Great Britain, and USSR.

Any honest observer must agree that ham radio has slipped badly in recent years due, in part, to the wide acceptance of CB communications and the great technological strides being made by the industry. In an age of solid-state computers, IC's, FET's, and microminiaturization, the average ham tinkers in his basement with vacuum tubes and World War II devices. Once largely responsible for major developments in communications, radio amateurs are commonly viewed as non-contributing hangers-on. With CB-ers capturing most newspaper publicity and outnumbering the hams 5 to 1, even the service aspect of ham radio has been largely forgotten by the general public. Prior to adoption of the new regulations, word was out that ARRL was looking for a NYC-based advertising PR agency to promote the hobby.

If the incentive program does what it is designed to do, it is possible that once again American industry will be relying on hams for fresh ideas and an amateur license will recapture its prestige among electronics buffs. Even if the ultimate goals are never fully realized, at least the FCC can show that it is attempting to improve conditions—something that may weigh quite heavily at the next Geneva conference.

From an international point of view, U.S. hams have come to be known as the "ugly Americans" on the air. They outnumber all other nations' hams combined. They saturate the airwaves with high-powered transmitters at levels far in excess of what is permitted in most of the other countries. And they spend more time *on the air* than their more technically inclined overseas counterparts. The result is that amateurs in other countries not desiring to contact Americans have no choice but to vacate the international frequencies in search of a band the U.S. hams can't congest. Many foreign observers feel that the incentive program was long overdue and can only improve the state of the art. In one respect, they are looking forward (hopefully) to seeing an end to American domination of the airwaves; on the other hand, they are also awaiting the time when the average U.S. ham will play an active role in complex semiconductor equipment design—a field now largely in the hands of the British, the Germans, and the Russians.

Finally, it is felt both internally and internationally, that this new move will remove the mail-order stigma that has characterized the U.S. ham since 1951.



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With few exceptions, this has been the easiest country in the world to obtain an amateur license—and its recipients receive the most privileges and the least supervision. For instance, in Australia if any of their 6000 amateurs attempted to construct a tube-type converter or transmitter he would have a lot of official (and unofficial) explaining to do. In the U.S. it is commonplace and accepted without comment.

Will It Work?

Even the FCC isn't sure. While it has been decided that the concept of using "reserved frequency blocks" will be the incentive for ham upgrading, the Commission seems to be hedging a bit on what's going to happen. The following comment summarizes the feeling in Washington: "If it is determined that there is *insufficient occupancy of any part* of the reserved frequency segments, then the effective date of the implementation schedule will necessarily *be stayed* in whole or in part." (italics ours)

Corroborating this, the FCC has stated that "it intends to make a careful review" of the ham frequencies as the new incentive program becomes effective. It is particularly interested in how many new signals will pop up on the "exclusive" Advanced and Extra Class DX-band segments—and when. ▲

CURE FOR COLOR BLINDNESS?

An electronic device that corrects color blindness in 3 to 6 months by wearing a pair of earphone-like stimulators for 20 minutes a day has been developed by Hayakawa Electric of Japan.

The unique apparatus, called "Sunvister", is based on the theory that visual sensitivity to color can be stimulated by electric current. Frequencies of 77 and 42.5 Hz were found to be the most effective for stimulating human sensitivity to red, green, and blue.

The Sunvister consists of two components: a compact, transistorized control and power supply measuring approximately 8" x 5½" x 2", and the stimulator headset, which plugs into the control and is worn over the temples. The unit is powered by a set of 9-volt batteries.

Work on the color-blindness corrector was done by Dr. Susumu Imamura of Kansai University and clinical test results were reported by Dr. Makoto Seki of Tokyo Medical University. ▲

Instrumentation Tape Recorder

(*Continued from page* 45)

is directly proportional to the amplitude of the data sample. The synchronization interval occupies two data spaces and is used to synchronize the commutator in the reproduce unit. The signal is differentiated by the PDM record electronics and appears at the record head as positive and negative spikes which correspond to the duration of the data sample. The playback signal is recovered as shown, converted once again to a pulse train analogous to the input signal, and finally demodulated and fed to the decommutator.

Since the commutator speed is usually 30 r/s, it would appear that 58 samples of data could be sampled 30 times a second (two segments are used for synchronization). However, in practice, alternate segments are generally used for calibration or zero-reference signals and ordinarily 30 is the maximum number of data channels per system. Accuracies for this method of recording are one percent of full-scale which makes it one of the better systems for the recording of quasi-static data.

Pulse duration modulation is widely used in the aircraft and missile industry where a large number of data channels must be recorded simultaneously. It can be combined with FM/PM telemetry to produce a very large number of data channels, 400 or more being possible with a 14-track instrumentation recorder. PDM is generally used when it is desired to record a large number of transducer outputs of one type on a test vehicle. This procedure is called surveying (or mapping) the test specimen and is commonly done for the measurement of such factors as temperature, stress, and vibration.

Once the signal has been reproduced on the tape recorder, some means must be provided for read-out. This requires an electronic or electro-mechanical system to provide a visual display or a written record of the events that have been previously recorded.

The oscilloscope is useful as a "quick-look" approach since it can be used for any type of data. Very often the scope is sufficiently accurate for data reduction and photographs of the display can be taken with an oscilloscope camera.

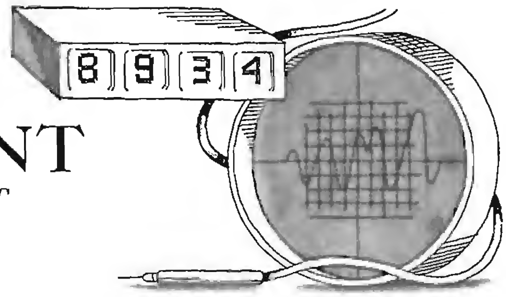
Several methods are available for reducing d.c. or quasi-static type data. The photographic oscillograph is useful since 50 or more channels of data can be handled at one time and, with sufficiently sensitive galvanometers, the signals can be recorded directly from the tape outputs without further amplification. Direct-writing recorders have the advantage that the written record is available for immediate inspection although this type usually has a maximum of eight data channels.

Digital voltmeters can be used for d.c. type data. This can take the form of a visual display or, if a printer is also used, a written record can be obtained.

The first two methods just described are also suitable for reducing data in the mid-frequency range. Galvanometers with a good response up to 5 kHz are available for the photographic oscillograph. Direct-writing recorders are useful up to about 200 Hz. Some types of signals found in this recording range are quite complex and a frequency analyzer must be employed for best results. These instruments generally have an output jack for a recorder and the necessary electronic circuitry for signal conditioning.

The oscilloscope is about the only instrument capable of handling signals in the range of 5 kHz to 20 kHz directly without a conversion process. The variable time base of the instrumentation tape recorder is really a valuable feature in this case. The playback speed of the tape recorder can be reduced until the output frequency range is compatible with the data reduction equipment. For example, if a 10-kHz signal is recorded at 30 in/s and reproduced at 7½ in/s, the results will appear as a 2.5 kHz signal. ▲

TEST EQUIPMENT
PRODUCT REPORT



Heath Model IM-25 Solid-State V.O.M.

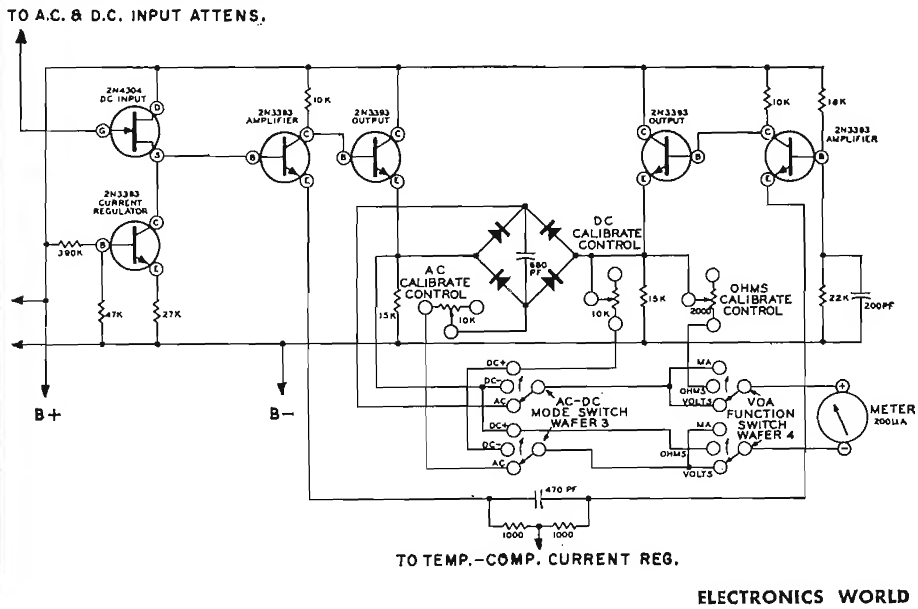
For copy of manufacturer's brochure, circle No. 34 on Reader Service Card.

THIS is no simple v.o.m. to which an FET has been added to give a high input impedance, but rather a full-fledged solid-state instrument using 2 FET's, 13 bipolar transistors, and 7 zener and other diodes. Six of the transistors are used as overload-protecting and temperature-compensating diodes. The specs are not too dissimilar from those of a conventional v.t.v.m. (11-megohm input impedance, 3% d.c. accuracy, etc.), but this unit has much more to offer. It has low-voltage a.c. and d.c. ranges (150 and 500 mV), high input impedance on a.c. (10 megohms), plus full facilities for measuring d.c. and a.c. currents in 11 ranges from 15 μA to 1.5 A. Other ranges include 9 d.c. and a.c. voltage scales and 7 ohmmeter ranges. Accuracy is 3% on d.c. and 5% on a.c.

The front-panel layout of the IM-25 is quite functional. The main operating switch, marked "Volts", "Ohms", and "MA", points to three separate range switches for each of these three measurements. The instrument has a low-profile appearance with recessed carrying handles at both sides, and the color is a handsome beige and black combination. The size and appearance match other new *Heath* solid-state instruments now being introduced.

The use of the solid-state components should result in long life, reliable operation, and stable adjustments. The meter is powered either from the a.c. line or by means of a built-in power supply consisting of 12 "C" cells. Two other "C" cells and a mercury cell provide voltage for the ohmmeter function.

The diagram of the metering circuit shown here indicates how some of the transistors are used. The d.c. input stage is an FET for high input impedance. Output from the source electrode is ap-



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3	33	63	93	123	153	183	213	243	273	303	333	363	393	423	453	483	513	543	573	603	633	663	693	723	753	783	813	843	873	903
4	34	64	94	124	154	184	214	244	274	304	334	364	394	424	454	484	514	544	574	604	634	664	694	724	754	784	814	844	874	904
5	35	65	95	125	155	185	215	245	275	305	335	365	395	425	455	485	515	545	575	605	635	665	695	725	755	785	815	845	875	905
6	36	66	96	126	156	186	216	246	276	306	336	366	396	426	456	486	516	546	576	606	636	666	696	726	756	786	816	846	876	906 Sept.
7	37	67	97	127	157	187	217	247	277	307	337	367	397	427	457	487	517	547	577	607	637	667	697	727	757	787	817	847	877	907 Sept.
8	38	68	98	128	158	188	218	248	278	308	338	367	398	428	458	488	518	548	576	608	638	668	698	728	758	788	818	848	878	908 Sept.
9	39	69	99	129	159	189	219	249	279	309	339	369	399	429	459	489	519	549	579	609	639	669	699	729	759	789	819	849	879	909 Sept.
10	40	70	100	130	160	190	220	250	280	310	340	370	400	430	460	490	520	550	580	610	640	670	700	730	760	790	820	850	880	910 Sept.
11	41	71	101	131	161	191	221	251	281	311	341	371	401	431	461	491	521	551	581	611	641	671	701	731	761	791	821	851	881	911 Sept.
12	42	72	102	132	162	192	222	252	282	312	342	372	402	432	462	492	522	552	582	612	642	672	702	732	762	792	822	852	882	912 Oct.
13	43	73	103	133	163	193	223	253	283	313	343	373	403	433	463	493	523	553	583	613	643	673	703	733	763	793	823	853	883	913 Oct.
14	44	74	104	134	164	194	224	254	284	314	344	374	404	434	464	494	524	554	584	614	644	674	704	734	764	794	824	854	884	914 Oct.
15	45	75	105	135	165	195	225	255	285	315	345	375	405	435	465	495	525	555	585	615	645	675	705	735	765	795	825	855	885	915 Oct.
16	46	76	106	136	166	196	226	256	286	316	346	376	406	436	466	496	526	556	586	616	646	676	706	736	766	796	826	856	886	916 Oct.
17	47	77	107	137	167	197	227	257	287	317	347	377	407	437	467	497	527	557	587	617	647	677	707	737	767	797	827	857	887	917 Oct.
18	48	78	108	138	168	198	228	258	288	318	348	378	408	438	468	498	528	558	588	618	648	678	708	738	768	798	828	858	888	918 Nov.
19	49	79	109	139	169	199	229	259	289	319	349	379	409	439	469	499	529	559	589	619	649	679	709	739	769	799	829	859	889	919 Nov.
20	50	80	110	140	170	200	230	260	290	320	350	380	410	440	470	500	530	560	590	620	650	680	710	740	770	800	830	860	890	920 Nov.
21	51	81	111	141	171	201	231	261	291	321	351	381	411	441	471	501	531	561	591	621	651	681	711	741	771	801	831	861	891	921 Nov.
22	52	82	112	142	172	202	232	262	292	322	352	382	412	442	472	502	532	562	592	622	652	682	712	742	772	802	832	862	892	922 Nov.
23	53	83	113	143	173	203	233	263	293	323	353	383	413	443	473	503	533	563	593	623	653	683	713	743	773	803	833	863	893	923 Nov.
24	54	84	114	144	174	204	234	264	294	324	354	384	414	444	474	504	534	564	594	624	654	684	714	744	774	804	834	864	894	924 Dec.
25	55	85	115	145	175	205	235	265	295	325	355	385	415	445	475	505	535	565	595	625	655	685	715	745	775	805	835	865	895	925 Dec.
26	56	86	116	146	176	206	236	266	296	326	356	386	416	446	476	506	536	566	596	626	656	686	716	746	776	806	836	866	896	926 Dec.
27	57	87	117	147	177	207	237	267	297	327	357	387	417	447	477	507	537	567	597	627	657	687	717	747	777	807	837	867	897	927 Dec.
28	58	88	118	148	178	208	238	268	298	328	358	388	418	448	478	508	538	568	598	628	658	688	718	748	778	808	838	868	898	928 Dec.
29	59	89	119	149	179	209	239	269	299	329	359	389	419	449	479	509	539	569	599	629	659	689	719	749	779	809	839	869	899	929 Dec.
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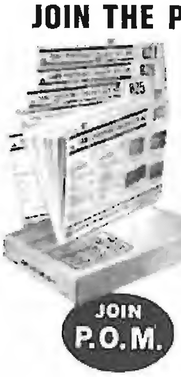

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plied directly to a transistor amplifier and emitter follower. The opposite side of the circuit uses a matching amplifier and emitter follower. Output from the two emitter followers is then applied to the 200-μA meter directly or through a full-wave bridge for a.c. measurements. Preceding the d.c. input FET are the d.c. and a.c. attenuator circuits as well as the ohmmeter and current-measuring circuitry.

Construction of the solid-state meter is simplified by the use of a single large printed-circuit board. In addition, the rotary selector switches employed are printed-circuit types in which the last wafer has right-angle pins that push directly into the PC board. Without rushing, we were able to construct the kit version of the IM-25 in about 11½ hours. After construction, we found that the instrument calibrated and performed beautifully.

Price of the IM-25 is $80 in kit form or $115 for a factory-assembled unit. R.f. and high-voltage d.c. probes are available separately. ▲

Jackson Model 806 V.T.V.M.

For copy of manufacturer's brochure, circle No. 35 on Reader Service Card.

ALTHOUGH solid-state instruments are beginning to appear on dealers' shelves and on technicians' workbenches, many users still swear by the extremely simple, tried-and-true 6AL5-12AU7 circuitry of the conventional v.t.v.m.

One new such instrument is the *Jackson* Model 806. Practically the entire front of this device is occupied by the 7-inch meter which reads a.c. and d.c. volts as well as resistance. A 0.5-volt d.c. range has been added to make the meter useful in checking the low voltages found in solid-state equipment. The twin-diode peak-to-peak rectifier provides direct readings of true peak-to-peak voltages of any complex waveform including TV sync and deflection voltages, video pulses, a.g.c., and color-gating pulses.

The meter has 7 a.c. r.m.s. and p-p ranges from 1.5 to 1500 volts (4 to 4200 volts, p-p), 8 d.c. ranges from 0.5 to 1500 volts, and 7 resistance ranges. Accuracy is 3% of full scale. Input impedance is 11 megohms on d.c. and 0.83 megohm on a.c.

The instrument is powered directly from the a.c. line, requiring only 10 watts to operate. A single "D" cell is used in the ohmmeter circuit. The 200-μA meter movement is protected against burnout as in the conventional v.t.v.m. by the self-limiting nature of the vacuum-tube bridge circuit that is employed.

Price of the Model 806 voltmeter is $84.95. ▲

Lectrotech TT-250 Transistor Tester

For copy of manufacturer's brochure, circle No. 36 on Reader Service Card.

A NEW transistor analyzer that can be used to check transistors either in or out of the circuit is available as the Model TT-250 from *Lectrotech*. When checking a transistor in its circuit, the leads of the instrument are simply clipped to the transistor, the bias adjustment is made, and the "good-bad" scale is read. The in-circuit test will work where the collector-emitter shunting impedances are as low as 10 ohms and where the base impedances are as low as 50 ohms. Since power transistors are frequently used in circuits with such low or even lower impedances, these transistors should be unplugged for testing purposes.

The instrument also performs out-of-circuit testing of signal and power transistors. A rough test may be made using the "good-bad" scale, or the actual *beta* of such transistors may be read directly on the scale of the 6-inch meter. In addition, the collector-to-base leakage current (I_{CBO}) may be read directly on the meter in microamperes.

The tester can also be used to measure reverse leakage and forward conduction of diodes and rectifiers to determine front-to-back ratio. Low-voltage electrolytic capacitors can also be checked for leakage.

The Model TT-250 measures 10½ x 7 x 4 inches and comes in an all-steel case. It sells for $87.50. ▲

NEW FINCO®

COLOR SPECTRUM™ ANTENNAS

are "signal customized" for better color reception...

"the ANTENNA that captures the RAINBOW"

FINCO has developed the Color Spectrum Series of antennas — "Signal Customized" — to exactly fit the requirements of any given area.

There is a model scientfically designed and engineered for your area.

Check this chart for the FINCO "Signal Customized" Antenna best suited for your area.

STRENGTH OF UHF SIGNAL AT RECEIVING ANTENNA LOCATION	Strength of VHF Signal at Receiving Antenna Location: NO VHF	VHF SIGNAL STRONG	VHF SIGNAL MODERATE	VHF SIGNAL WEAK	VHF SIGNAL VERY WEAK
NO UHF		CS-V3 $10.95	CS-V5 $17.50 / CS-V7 $24.95	CS-V10 $35.95	CS-V15 $48.50 / CS-V18 $56.50
UHF SIGNAL STRONG	CS-U1 $9.95	CS-A1 $18.95	CS-B1 $29.95	CS-C1 $43.95	CS-C1 $43.95
UHF SIGNAL WEAK	CS-U2 $14.95	CS-A2 $22.95	CS-B3 $49.95	CS-C3 $59.95	CS-D3 $69.95
UHF SIGNAL VERY WEAK	CS-U3 $21.95	CS-A3 $30.95	CS-B3 $49.95	CS-C3 $59.95	CS-D3 $69.95

NOTE: In addition to the regular 300 ohm models (above), each model is available in a 75 ohm coaxial cable downlead where this type of installation is preferable. These models, designated "XCS", each come complete with a compact behind-the-set 75 ohm to 300 ohm balun-splitter to match the antenna system to the proper set terminals.

THE FINNEY COMPANY

34 West Interstate Street • Dept. 410 • Bedford, Ohio 44146

CIRCLE NO. 114 ON READER SERVICE CARD

New COLOR-TV Tuning Indicator

By WALTER H. BUCHSBAUM/Contributing Editor

Westinghouse receiver uses on-screen tuning bar that moves with the fine-tuning control to indicate the proper setting.

MANY of the new *Westinghouse* color-TV receivers have a feature which is intended to help the user fine-tune his set more effectively. When the "Tuning Bar" push switch is depressed, two black vertical lines appear on the screen, superimposed on the picture. If the fine tuning is correct, the two lines will coincide at the center of the screen, as shown in the center of Fig. 1. As the fine-tuning control is adjusted, one line remains stationary at the center while the other line moves either to the left or the right. As indicated in Fig. 1, moving the fine-tuning control clockwise or counterclockwise brings the movable line to the center until the two coincide. At that point correct fine tuning is achieved, the tuning-bar control is depressed again and the display disappears. The circuitry for this feature is mounted on a separate printed-circuit board and consists of 9 transistors and 7 diodes. There are three service adjustments.

Circuit Functions

The block diagram of Fig. 2 illustrates the functions performed by the various circuits to generate the fine-tuning display. The actual selection of the correct fine-tuning point is accomplished by a slope detector. A resonant circuit receives a portion of the i.f. signal so that the 45.75-MHz video i.f. carrier frequency falls halfway on the slope of the i.f. response curve. When the fine-tuning control is set correctly, the 45.75-MHz signal falls at exactly the right spot and the slope detector, a simple diode video detector, produces a negative-going video signal of approximately 3 volts peak-to-peak. This signal will depend on the received signal strength and, to compensate for this variation, a portion of the video signal from the first video amplifier is peak-detected and the resulting d.c. is added in opposite polarity to the output of the slope detector.

If the received signal is very strong, the video signal will be correspondingly strong and the d.c. output of the peak detector will act as bias for the buffer amplifier and second peak detector. The slope detector output is a video signal added to the d.c. level established by the first video peak detector. This is fed into a buffer amplifier and into another peak detector, which rectifies the video and produces the final d.c. control signal. It is this d.c. control signal, which now depends primarily on the fine tuning (the position of the 45.75-MHz carrier on the response curve slope) that determines the position of the movable vertical line on the picture-tube screen. The stationary line is positioned by an adjustable reference voltage.

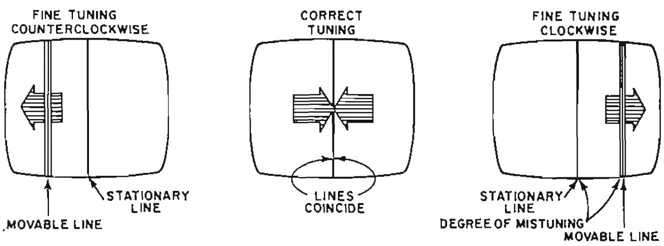
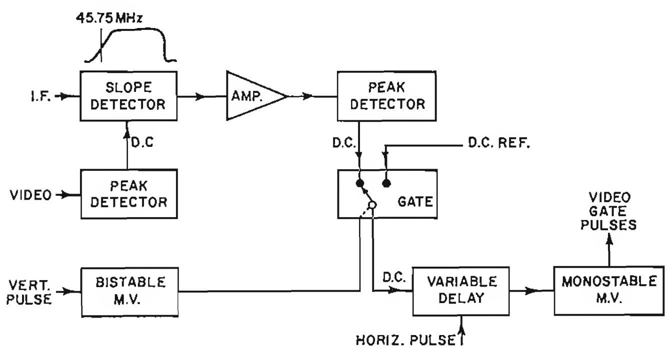


Fig. 1. Operating the fine-tuning control moves vertical line.

Fig. 2. Block diagram of circuit that provides the tuning bar.



The display on the picture tube is made possible by allowing the signals generating each vertical line to reach the last video amplifier on alternate vertical scans. To accomplish this, the vertical pulse (at 60 Hz) is fed into a bistable multivibrator which then controls a diode gate section, shown as a switch in Fig. 2. Operation is such as to connect either the d.c. from the peak detector or the d.c. from the reference source on alternate fields, at a 30-Hz rate.

To provide a vertical line on the picture tube, it is necessary to generate identical pulses during successive horizontal lines so that all pulses occur with the identical delay after the sync. This is accomplished by passing horizontal pulses through a variable delay, which is a circuit that compares the sawtooth component due to the horizontal pulse with a d.c. voltage, and then triggers a monostable multivibrator. By varying the d.c. voltage, the time delay between the horizontal pulse which corresponds to the start of a scanning line and the instant of triggering can be controlled. Depending upon the d.c. control voltage fed into the variable delay circuit, the monostable multivibrator will generate a pulse each time a horizontal pulse occurs but at a fixed time delay.

During one field of vertical scanning the d.c. reference voltage is connected to the variable delay and the monostable multivibrator will fire so that the resultant pulse appears in the center of the picture. A potentiometer in the delay circuit is used to set the d.c. reference voltage so that the stationary line appears in the center. During alternate vertical fields, when the output of the slope detector section is connected to the variable delay circuit, the position of the vertical line or the pulses generated by the monostable multivibrator depend on the d.c. voltage. When both d.c. voltages are identical the two lines will coincide.

Service Adjustments

From this description it is apparent that a number of adjustments must be made by the service technician to set up the system correctly. These adjustments are in addition to the customary r.f. and i.f. alignment procedures. The first adjustment concerns the tuning coil in the slope detector which must be adjusted so that the 45.75-MHz video i.f. carrier is centered on the slope of the response curve. Next, the reference voltage is adjusted so that the best fine tuning makes the lines coincide. Finally, there is a potentiometer adjustment in the variable delay circuit to center both lines on the screen.

The video gate output pulses from the monostable multivibrator are applied through a diode to the control grid of the second video amplifier. This means that the pulses will appear as a positive-going spike on the three cathodes of

Constant-Voltage Xformers

(*Continued from page* 43)

from 100 V to 130 V, must be able to withstand 150% overload, continuous rating of 8 A, maximum harmonic 3%, load regulation to full load of 2%.

This specification would no doubt result in the ordering of a larger and more costly CVT than necessary.

Other Considerations

Ambient temperature and temperature variations, if any, should be considered. Normal maximum temperature rise of a constant-voltage transformer may fall anywhere in the range of 45° C to 115°C depending on type and rating. In any case, the maximum operating temperature at a 40°C ambient is always within safe operating limits for the class of insulating material used. Nominal design and ambient range is between —10°C and 40°C.

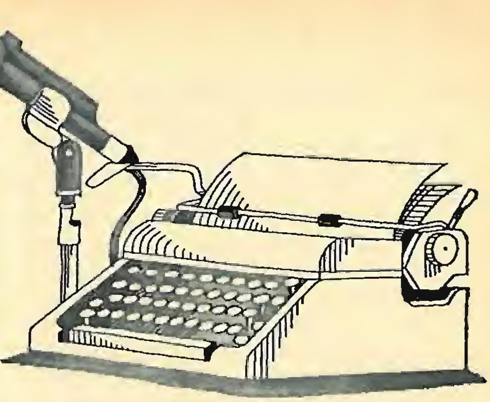
Many CVT's are built on magnetic cores specially proportioned to minimize external stray-field effects. With these designs, in the great majority of applications, stray-field effect from the CVT may be disregarded but, for critical applications, care should be taken in orienting the core with respect to critical circuits in the device to minimize field effect. Special units can be designed and built with shielding to further reduce stray-field effect.

The following basic mechanical requirements should also be specified: package size, type and location of mounting surfaces, input power termination and general location, output power termination and location. ▲

In today's electronics boom, the demand for men with technical education is far greater than the supply of graduate engineers. Thousands of real engineering jobs are being filled by men without engineering degrees—provided they are thoroughly trained in basic electronic theory and modern application. The pay is good, the future is bright...and the training can now be acquired at home—on your own time.

How to become a "Non-Degree Engineer"

RADIO & TV NEWS



LEANING heavily on all the old clichés, "sauce for the goose . . .", "all's fair in love and war", etc., the British are fighting back with a "Brain Gain" office in New York for the recruitment of top level management personnel and technical specialists.

Hoping to counteract the outflow of United Kingdom "brains" to the lusher fields of American industry, new offices have been set up at Suite 301, 465 Park Ave., manned by personnel from *Management Selection International Inc.*, a subsidiary of a British recruitment and selection consultant firm.

MSL will also publish a regular newsletter highlighting current developments within British industry and technology and send it to North American talent.

Ideographic Composing Machine

The U.S. Army has taken delivery on a new electronic typesetting machine which is capable of composing Chinese, Japanese, and Korean written language directly from a keyboard.

Developed by *RCA*, the new Ideographic Composing Machine employs a technique that is the first practical departure from hand-set type in the 3000-year history of these written languages.

By combining the latest in computer, television, and optical techniques, the machine can set 60 to 100 characters a minute, each character representing a word, phrase, or a complete sentence from any of the three languages—from a storage bank of some 10,000 characters. The machine can be operated manually or automatically by means of paper tape punched in advance.

Tiny "Teacup" Computer

What is claimed to be the world's smallest operational data processing system, (4" x 4" x 9") *Control Data's* 449 computer has been demonstrated to those attending the 1967 Air Force Association Aerospace Development Briefings and Displays in Washington.

The "teacup" computer, itself, occupies only a four-inch cube within the outer case yet it contains all of the elements and computing power of a standard-size general-purpose computer system, including a 4096-word (24-bit) memory. Weighing less than four pounds, the computer consumes just 4 watts of power. It has been specifically designed for aerospace applications, but who knows where this handy "pocket-sized" unit might pop up next!

Field-Testing Data

Miniature FM transmitters which were originally developed by NASA for broadcasting biomedical data from space capsules are finding down-to-earth application in broadcasting load data from industrial equipment under actual operating conditions.

Rex Chainbelt is using the units to gather information on the loads and stresses its machinery is subjected to in the field and are thus able to predict more accurately the service life of its products and help customers select those products which will provide the requisite service life.

The company is building its own units for this particular application, to its rather specialized specs.

Spectrochemical Analysis by Laser

The National Bureau of Standards has conducted a series of tests on the uses of lasers for spectrochemical analysis. In this application, a high-energy laser beam is focused on a specimen, vaporizing a small sample. By further exciting the vapor with a spark discharge, emission spectra may be obtained.

The wide range of laser-probe analytical applications includes analysis of microsamples, thin films, small wire, and particles embedded in specimens.

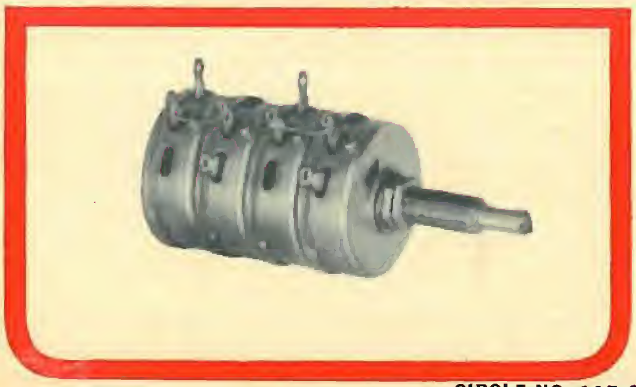
The apparatus used in the NBS study has as its main components a control console, a Q-switched ruby laser, a microscope, and an electrode system with separate spark power supply.

Master Antennas for S.A.

Siemens, the German firm, has installed master antennas in San Felipe, Peru's largest and most modern housing project, to bring radio and TV programs to some 1600 dwelling units. Since American TV standards prevail in Peru, seven TV programs can be transmitted. The subscriber network, totaling 26, is equipped with antenna socket outlets employing a directional coupler. ▲

MALLORY Tips for Technicians

Remember to ask—"What else needs fixing?"



That's the question to ask to add extra profit to every service call. It makes sense. Just about every customer who calls you for TV repair owns other electronic products that are excellent prospects for service. You've already invested your time getting to his home. So why not see what further service you can render?

Does it work? You bet! On a test program sponsored by Electronic Industries Association, in which Mallory is an active member, service men got 6% more profit from business they added just by asking that simple question.

Here are some tips that you can use to cash in on this idea.

Portable radios, for instance. Most homes have at least one. Ask 'em, "How about fresh batteries?" And then sell Mallory Duracell® batteries . . . best buy in long life and fade-free power. And don't forget cameras, flashlights and toys. They need batteries, too, and there's a Duracell type for every job.

Ask to check table radios . . . then listen for hum as the set warms up. Many people put up with hum because they've forgotten how well the radio sounded when new. But hum may be a sign that a filter capacitor is near the end of its life. Replace with a Mallory FP, WP, TC or MTA. Your Mallory Distributor can supply the exact size and rating you need.

How about hi-fi and stereo? Ask to turn them on, and see if you detect anything that calls for service. You can suggest adding remote speakers for a porch or family room. Be sure to include a Mallory balance control and remote volume controls, to make the installation complete. Record changers and electronic organs are good service opportunities, too.

Try this profit-building "What else needs fixing?" idea on the next calls you make. And for the quality components that make every job sure, see your Mallory Distributor. Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.

CIRCLE NO. 107 ON READER SERVICE CARD

Log-Periodic Antennas

(*Continued from page 48*)

nail on the left side, etc., in zig-zag fashion. The bottom wire is strung in a similar manner, starting with the first nail on the right-hand side. If small wire is used, it should be taut enough so that it doesn't sag, but not so taut that it bends the frame. *Note that the connection to the 300-ohm line is made at the point where the top and bottom wires would otherwise cross the center line for the last time.* A method for connecting the final zig-zag element to 300-ohm twin-lead is shown in Fig. 5.

As mentioned previously, the only difference between a pyramidal and planar log-periodic antenna is that in the former the dipole supports are inclined at an angle. Both of the antennas whose dimensions are given in Tables 1 and 2 can be constructed in pyramidal form. To do so, two identical frames must be built, one to support the upper dipole elements and the other to support the lower dipole elements. If sufficient attic space is available, the angular separation, θ, should be made equal to α for maximum gain. Approximately 2 dB additional gain can be obtained from the TV-FM antenna with $\theta = 41°$ rather than zero. Additional gain can also be obtained from the FM-only antenna by making $\theta = 13°$.

An all-metal antenna suitable for mast mounting can be constructed with a little additional work. In a sample model constructed to prove the feasibility of the idea, the author used 10-foot lengths of ½-inch diameter galvanized electrical conduit to serve both as the feeder line and as the structural support for the dipole elements. The wooden frame described earlier is recommended as a jig for locating and forming the dipole elements. Such a jig was used by the author to determine the lengths of the sides of the vees which constitute the dipole elements. Vees were formed from aluminum clothesline wire and the sides were cut about 2 inches longer than required to reach the centerline. Holes were drilled in the conduit where the vees were to be attached. The ends of the vees were inserted through the proper holes and the excess length was bent parallel to the length of the conduit. An eyelet was then formed with the excess length and a metal screw was placed through the eyelet and into a hole drilled in the conduit for anchoring.

Ordinary aluminum clothesline wire was used in the feasibility model because it can be easily bent to form the dipole vees. However, rigid aluminum rod is desirable for a mast-mounted antenna that is subject to wind forces. Also, aluminum tubing rather than galvanized conduit is preferable for use as the feeder line because of its lighter weight. As before, either a pyramidal or planar version of the two basic antennas can be constructed. The wooden support shown in Fig. 3, which is used to maintain the angle in a pyramidal version, can actually be metal, since either a short or open-circuit termination is satisfactory.

The directive gains of the planar TV-FM and FM-only antennas are 10 and 12 dB above isotropic.

Under favorable atmospheric conditions, the author is able to satisfactorily receive two FM stations 130 miles away using a 2.7-microvolt sensitivity (IHF standards) FM tuner and the FM-only antenna. One of the two stations has a radiated power output of only 23.5 kilowatts. FM-stereo stations 70 miles away which have radiated power outputs greater than 10 kilowatts are received satisfactorily all of the time. The FM-only antenna also provides snow-free reception of TV channels 4 through 9 even though the broadcast stations are 70 miles away and the antenna was not designed to cover TV-broadcast frequencies (except channel 6 which is received at 87.5 MHz).

As expected, TV reception with the TV-FM antenna is excellent. FM reception with this antenna is not quite as good as with the FM-only antenna, but is satisfactory. ▲

New Stereo Receivers

(*Continued from page* 29)

As a rule, each manufacturer specifies the *reference distortion* level for his amplifier. We used a 2% distortion level for all units to permit comparisons among models on the same basis.

The power output of an amplifier is not too meaningful in itself. It must be considered in relation to the size of the room, the speaker efficiency, and one's listening habits. For most speakers used in average-sized living rooms, an output of 15 watts (continuous) per channel is adequate. Low-efficiency speakers require at least 30 watts per channel. In a very large room, this figure should be doubled.

Power output does not relate to how loud an amplifier can play in normal use. Average power levels, even with low-efficiency speakers, are rarely more than a watt or two. However, peaks of ten times the average power, or more, are often encountered in music. If the amplifier cannot deliver that power without distortion, it sounds fuzzy and strained when played at even moderate levels. A barely noticeable 3-dB increase in listening level calls for double the power from the amplifier, so it can be seen that the 20- to 40-watt capabilities of most receivers are not at all excessive.

Dynamic power output is a measure of the regulation of the amplifier's power supply. With a perfectly regulated power supply, the dynamic and continuous output ratings would be essentially the same. It is difficult to compare amplifiers by their dynamic power ratings, which may not relate too closely to their true output capabilities.

Power Bandwidth is measured by operating the amplifier at reference (rated) output and measuring harmonic distortion *versus* frequency between 20 and 20,000 Hz. Where the distortion is either much less than, or much more than 2% at the manufacturer's rated output, we establish a reference power level as close as possible to that which results in 2% distortion at 1000 Hz.

Similar measurements are made at —3 dB (half reference power) and —10 dB (one-tenth reference power). We do not normally express Power Bandwidth numerically, but it can be read from the published curves of distortion *versus* frequency. The frequencies at which the —3 dB curve intersects the reference distortion level (*e.g.*, 2%) define the Power Bandwidth.

Power bandwidth is a measure of how much power an amplifier can deliver over the full audio frequency range. If two amplifiers can each deliver 30 watts at 1000 Hz, but at 30 Hz one can develop only 10 watts while the other produces 25 watts, it is obvious which is the better unit. Where the power bandwidth is limited, one can easily encounter distortion at moderate levels, due to overload of the amplifier at one or both of the frequency extremes. An amplifier is no better than its performance at the limits of the audible spectrum, regardless of what it can do at the middle frequencies.

Sensitivity is the 1000-Hz input voltage which will develop reference output from an amplifier, at maximum volume control setting. We modified this test slightly to use 10 watts as a reference level for all amplifiers, regardless of their power ratings. This simplifies comparison among amplifiers, indicating how much signal is required for a given listening volume, assuming the use of the same speakers in each case. We measure sensitivity at the high-level (auxiliary) and magnetic phono inputs.

Amplifier sensitivity is relatively unimportant. We know of no combinations of receiver and phono cartridge which would be incompatible from the standpoint of signal levels.

Hum and Noise are measured at the amplifier outputs in the absence of an input signal. According to IHF Standards, hum is measured at maximum gain settings, with inputs both open and shorted. The hum and noise output is expressed in decibels below reference output.

Amplifiers differ greatly in their sensitivities and sometimes have unrealistically high hum levels when operated at maximum gain. Our practice is to set the volume control so that 1 volt at the "Aux" input, or 10 mV at the phono input, will develop 10 watts output. The input being measured is terminated with 2.2 kohms, to simulate a driving source, not necessarily an open or short-circuited condition which is unlikely to be found in a real situation. Hum and noise are expressed in decibels below 10

The Lafayette Model LR-1000T solid-state stereophonic receiver.

watts output, providing a measure of the audible effect with any given speaker system when comparing different amplifiers.

Hum and noise are normally significant only on the low-level inputs, for phono cartridge and tape heads. A noise level of −50 dB on a phono input is normally inaudible (related to 10 watts, which we have used as a reference level). On high-level inputs, —60 dB is a satisfactory figure. Most such inputs will be used with tape recorders or TV sound programs which have poorer signal-to-noise ratios than 60 dB.

The other IHF ratings are of lesser importance and are not required for the minimum published specification. *Frequency Response* is normally so nearly flat that measurement is pointless. In the case of the phono input, we do measure the response and compare it to the ideal RIAA equalization characteristic. According to the RIAA, it should fall within 2 dB of the standard curve from 50 to 15,000 Hz. Most amplifiers meet this requirement, but sometimes larger errors occur, particularly at frequencies below 100 Hz.

The *Maximum Input Signal* test reveals any tendency for early stages of an amplifier to overload if a large signal is applied with the volume turned down. Practically, this is only significant in the phono preamplifier stages where high output cartridges may overdrive the amplifier on loud passages. Almost all modern stereo cartridges have average outputs of less than 5 or 6 millivolts, making overload unlikely. We do not normally make this test.

Stability is a measure of an amplifier's ability to drive loads of high or low impedance or loads which contain large amounts of inductance or capacitance without spurious oscillations. We perform a limited form of this test, shunting capacitance across the 8-ohm load while observing the effect on a square-wave test signal. This test is particularly important when driving an electrostatic speaker. Most transistor amplifier manufacturers specifically caution against using full electrostatic speakers with their products, since the high current drawn by the speaker at high frequencies may damage the output transistors. In view of this situation, we feel that this test is academic for most transistor amplifiers.

Input Impedance is no longer the problem that it was in the early days of solid-state amplifiers. The lower input impedance of some of these units, compared to tube amplifiers, caused difficulties when they were driven from tube preamplifiers having a high output impedance. It is of no significance in receivers where the necessary interface problems are fully under the designer's control.

Damping Factor is a much over-rated performance parameter. It is a measure of the internal impedance, or regulation, of an amplifier. As long as this impedance is less than the speaker impedance by a factor of 5 to 10, no improvement in speaker damping results from a further reduction of driving impedance. Although the IHF Standard calls for Damping Factor to be measured from 20 to 20,000 Hz, and at various power levels, we do not make this measurement.

The *Difference of Frequency Response* (between channels) is solely a matter of component tolerances and, in practice, is negligible. We frequently measure both channels of a stereo amplifier and have yet to find a significant difference in their frequency response characteristics.

Volume control *Tracking Error* was a serious problem in the early days of stereo. Unequal attenuation in the two ganged volume-control sections caused the stereo balance to shift from side to side as the volume was varied. Control manufacturers have made great improvements in recent years and a tracking error of more than 2 dB is unusual. We still make this measurement, but rarely find anything out of the ordinary.

Separation and Crosstalk are not a real factor in most stereo amplifiers. It is unusual to find crosstalk between channels as great as —30 dB, which is better than most signal sources including records and FM-stereo. Since a 15-dB separation is sufficient for good stereo effect, this factor can be ignored.

Receiver Survey

In this comparative survey of stereo receivers, we performed the same basic measurements on all models tested. The tabular listing of test results allows the reader to make his own judgments.

We make no attempt to "rate" these receivers in any way. All of them are

The University Studio Pro 120 solid-state stereophonic receiver.

good—capable of excellent high-fidelity performance in home music systems. As we stated earlier, some are more sensitive or more powerful than others—and more expensive as well. Since the measurements were made under *our* standard conditions, although within the framework and spirit of the applicable IHF Standards, the actual numbers may differ in some cases from a manufacturer's published ratings.

In some cases, the harmonic distortion at low power levels was masked by noise or hum. The measured figures in each case were so low that the distortion was obviously negligible. Also, the hum and noise measurements show that these were not excessive when the receiver was operated at reference gain settings.

All power and distortion measurements were made with 8-ohm loads. A rough determination was made of the power available with 4-ohm and 16-ohm loads. These powers are expressed as percentages of the power into 8 ohms and were measured at the point of visual clipping of the output waveform. Sometimes the measurement could not be made at 4 ohms without blowing a speaker fuse or tripping an automatic protective circuit in the amplifier. This does not mean that a 4-ohm speaker cannot be used with the receiver but merely that it cannot operate at full power for a prolonged period into a low impedance.

It is quite common for receiver manufacturers to rate their products in terms of total (both channels) dynamic power output at 4-ohm output impedance. This practice accounts for the ratings of "90 watts", "120 watts", or "140 watts" which one sees in many receiver specifications. Our continuous power output measurements, made at 8 ohms, result in much less impressive figures, due to the measurement technique employed. Most receivers cannot deliver more than 80 to 90 watts total on a continuous basis, which should be ample for any home installation.

Electrical performance is not the only consideration in choosing a receiver. Obviously, price and size are factors to be considered as well. Even within a given price bracket, there are numerous details of styling and control features which make one receiver more appealing than another to a particular individual.

Specific circuit features, such as the use of integrated circuits (IC's) in i.f. amplifiers, usually have little to do with the final performance of the receiver. The end product is what matters and that is the cumulative result of many factors, rarely attributable to any single feature. One of the more meaningful recent innovations in FM tuners is the use of field-effect transistors (FET's) in the front-ends. ▲

Reference Power Supplies

(Continued from page 41)

10 minutes. Do not change the output voltage setting of the reference supply, and make sure the temperature of the V_1 supply hasn't varied much.

Note which direction the change in reference-supply voltage takes, if it changes, to determine which way you should adjust $R4$. If the output voltage *increased* in value, indicated by an upscale reading on $M1$, then you have a *positive* temperature coefficient which may be corrected by *decreasing* the bias current. This is done by turning $R4$ counterclockwise.

The procedure is repeated until you obtain the desired K_T. The adjustment isn't critical unless you want the ultimate in temperature stability. In fact, you would probably get an K_T of less than 0.003%/°C by just setting $R4$ to center position or replacing $R2$, $R3$, and $R4$ by a single 1000-ohm wirewound resistor.

Precise voltage calibration requires an external voltmeter of adequate accuracy. If one is not available, you can obtain fairly good results by using three 1.345-volt mercury cells in series for V_1. Set the reference-supply dial to 4.035 volts and adjust the calibration potentiometer for a zero reading on $M1$.

A typical application of this type of supply is to permit monitoring a small fluctuation in voltage. The arrangement used is the same as shown in Fig. 9A. Initially, the reference-supply output is adjusted to give a zero reading on $M1$. Now any variation in the $M1$ reading indicates a change in voltage, V_1. The value of the change will be indicated on $M1$ directly. With my v.o.m. used for $M1$, I can see a change of less than 2 mV out of 10 volts; that's a 0.02% change!

With the voltage output calibrated, the arrangement may be used as a differential voltmeter to measure any unknown source under practically no-load conditions. Again the configuration of Fig. 9A is used. The output of the reference supply is adjusted until $M1$ reads zero. The value of the unknown voltage is read from the dial of the reference supply.

Calibrating voltmeters, recorders, or d.c. oscilloscopes is a snap when the output voltage of the reference supply is accurately known. You can add the simple chopper circuit shown in Fig. 9B to your supply. It permits calibrating a.c. voltmeters or scopes with a peak-to-peak square-wave voltage whose value is equal to the output of the reference supply. If you include this feature in your packaged unit, provide a switch to remove the chopper when you use the supply as a d.c. reference. ▲

14 KIT-GIVING IDEAS FROM HEATH . . .

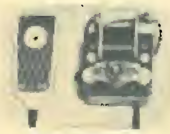
For The Whole Family . . .
New Deluxe "227" Color TV

Exclusive Heathkit Self-Servicing Features. Like the famous Heathkit "295" and "180" color TV's, the new Heathkit "227" features a built-in dot generator plus full color photos and simple instructions so *you* can set-up, converge and maintain the best color pictures at all times. Add to this the detailed trouble-shooting charts in the manual, and you put an end to costly TV service calls for periodic picture convergence and minor repairs. No other brand of color TV has this money-saving self-servicing feature.

Advanced Features. Boasts new RCA Perma-Chrome picture tube for 38% brighter pictures . . . 227 sq. in. rectangular viewing area . . . 24,000 v. regulated picture power . . . improved phosphors for brilliant, livelier colors . . . new improved low voltage power supply with boosted B+ for best operation . . . automatic degaussing . . . exclusive Heath Magna-Shield to protect against stray magnetic fields and maintain color purity . . . ACC and AGC to reduce color fade and insure steady, flutter-free pictures under all conditions . . . preassembled & aligned IF with 3 stages instead of the usual 2 . . . preassembled & aligned 2-speed transistor UHF tuner . . . deluxe VHF turret tuner with "memory" fine tuning . . . 300 & 75 ohm VHF antenna inputs . . . two hi-fi sound outputs . . . 4" x 6" 8 ohm speaker . . . choice of installation — wall, custom or optional Heath factory assembled cabinets. Build in 25 hours.

Kit GR-227, (everything except cabinet) . . . $42 dn., as low as $25 mo. . . 114 lbs. **$419.95**
GRA-227-1, Walnut cabinet . . . no money dn., $6 mo. **$59.95**
GRA-227-2, Mediterranean Oak cabinet (shown above) . . . no money dn., $10 mo. **$94.50**

Kit GR-227
$419.95 (less cabinet) $25 mo.



Kit GRA-27
$19.95

New Remote Control For Heathkit Color TV

Now change channels and turn your Heathkit color TV off and on from the comfort of your armchair with this new remote control kit. Use with Heathkit GR-227, GR-295 and GR-180 color TV's. Includes 20' cable.

Kit GR-295
$479.95
(less cabinet)
$42 mo.

Kit GR-180
$349.95
(less cabinet & cart)
$30 mo.

Deluxe Heathkit "295" Color TV

Color TV's largest picture . . . 295 sq. in. viewing area. Same features and built-in servicing facilities as new GR-227. Universal main control panel for versatile in-wall installation. 6" x 9" speaker.

Kit GR-295, (everything except cabinet), 131 lbs. . . . $48 dn., $42 mo. **$479.95**
GRA-295-1, Walnut cabinet (shown above), 35 lbs. . . . no money dn., $7 mo. **$62.95**
Other cabinets from $94.50

Deluxe Heathkit "180" Color TV

Same high performance features and exclusive self-servicing facilities as new GR-227 (above) except for 180 sq. in. viewing area.

Kit GR-180, (everything except cabinet), 102 lbs. . . $35 dn., $30 mo. **$349.95**
GRS-180-5, table model cabinet & mobile cart (shown above), 57 lbs. . . . no money dn., $5 mo. **$39.95**
Other cabinets from $24.95

FREE . . . 40-Lesson Record Course With Either Heathkit/Thomas Organ! A $50 Value! Includes four 33⅓ rpm records, music book & leatherette album.

Kit TO-67
$995
(including bench)
$200 dn.,
as low as $29 mo.

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Save Up To $500! Build in 80-100 hours. All Thomas factory-made parts . . . 15 manual, 4 pedal voices; instant-play Color-Glo; all-transistor circuit; 200 watts peak power; 2-speed rotating Leslie plus main speaker system with two 12" speakers; 44-note keyboards; horseshoe console with stop tablets; 28-note chimes; 13-note bass pedals; repeat & attack percussion; reverb; headset outlet; assembled walnut finish hardwood cabinet & bench; and more. 265 lbs. 7", 33⅓ rpm demonstration record 50c.

America's Lowest Cost Solid-State Organ

Kit GD-325B
$394.90
$40 dn., $34 mo.

Save Up To $205! Instant-play Color-Glo; 10 voices; 13-note bass pedals; repeat percussion; 37-note keyboards; 75-watt peak power; vibrato; assembled walnut cabinet & bench. 172 lbs. 7", 33⅓ rpm demonstration record 50c.

Exclusive Band Box Percussion

Automatically or manually adds 10 percussion voices to any Heathkit/Thomas organ. Build & install in 12 hours.
Kit TOA-67-1, no money dn., $14 mo. **$145.00**

Exclusive Playmate Rhythm Maker

Adds 15 fascinating rhythms to any Heathkit/Thomas Organ. Requires Band Box percussion (above) for operation.
Kit TOA-67-5, no money dn., $18 mo. **$189.90**

USE COUPON BELOW TO ORDER NOW

NEW! VOX "Jaguar" Transistor Combo Organ By Heathkit

Kit TO-68
$349.95
$35 dn., $30 mo.

Save Up To $150 on the world's most popular combo organ with this new Heathkit version. Features the most distinctive sound of any combo organ. Has a special bass output that gives a brilliant stereo bass effect when played through a separate or multi-channel amplifier, 4 complete octaves, vibrato, percussive effects and reversible bass keys. Includes hand crafted orange and black cabinet, fully plated heavy-duty stand, expression pedal and waterproof carrying cover and case for stand. Requires a bass or combo amplifier like Heathkit TA-17 (opposite page).

Kit TO-68, 80 lbs.... $35 dn., $30 mo. **$349.95**

NEW! Deluxe Solid-State Combo Amplifier & Speaker System ... Choose Kit Or Factory Assembled

Amplifier Kit TA-17
$175
$17 mo.
(Assembled TAW-17 $275)

Speaker System Kit TA-17-1
$120
$11 mo.
(Assembled TAW-17-1 $150)

Special Combination Offer
Amplifier & Two Speaker Systems Save $20
Kit TAS-17-2
$395
$40 dn.
$34 mo.
(Assembled TAW-17-2 $545)

All the "big sound" features every combo wants . . . tremolo, built-in "fuzz", brightness, reverb, separate bass and treble boost and more. Delivers a shattering 120 watts EIA music power (240 watts peak power) through two TA-17-1 speakers . . . or 90 watts through one TA-17-1 speaker. Features 3 independent input channels, each with two inputs. Handles lead or bass guitars, combo organ, accordion, singer's mike, or even a record changer. All front panel controls keep you in full command of all the action.

Speaker system features two 12" woofers, special horn driver and matching black vinyl-covered wood cabinet with casters & handles for easy mobility.

NEW! Lowest Cost Solid-State Stereo Receiver

Kit AR-17
$72.95
(less cabinet)
$8 mo.

Features wide 18-60,000 Hz response @ ±1 db at full 5 watts RMS power per channel . . . 14 watts music power . . . inputs for phono and auxiliary . . . automatic stereo indicator . . . outputs for 4 thru 16 ohm speakers . . . adjustable phase for best stereo . . . flywheel tuning . . . and compact 9¾" D. x 2⅞" H. x 11¾" W. size. 12 lbs. Optional factory assembled cabinets (walnut $7.95, beige metal $3.50).

Kit AR-17, (less cab.) 12 lbs. . . . no money dn., $8 mo. . . **$72.95**
Kit AR-27, 7-Watt FM Mono Only Receiver (less cab.) 9 lbs. . . . no money dn., $5 mo. **$49.95**

Kit AR-15
$329.95
(less cabinet)
$28 mo.

Assembled
ARW-15 $499.50
(less cabinet) $43 mo.

World's Most Advanced Stereo Receiver

Acclaimed by owners & experts for features like integrated circuits & crystal filters in IF amplifier; FET FM tuner; 150 watts music power; AM/FM and FM stereo; positive circuit protection; all-silicion transistors; "black magic" panel lighting; and more. Wrap-around walnut cabinet $19.95

Kit AR-15 (less cab.), 34 lbs. . . . $33 dn., $28 mo. **$329.95**
Assembled ARW-15, (less cab.), 34 lbs. . . . $50 dn., $43 mo. **$499.50**

Professional 10-Band Shortwave Receiver

Kit SB-310
$249
$23 mo.

Covers 49, 41, 31, 25, 19 & 16 meter shortwave . . . 80, 40 & 20 meter ham . . . 11 mete· CB Includes 5 kHz crystal filter for AM, SSB and CW listening. Features selectivity that slices stations down to last kHz; 11-tube circuit; crystal-controlled front-end and more. 20 lbs. SB-600 8 ohm 6" x 9" speaker in matching cabinet $18.95.

NEW! Solid-State Portable Volt-Ohm-Meter

So Handy, So Low Cost we call it "every man's" meter. Just right for homeowners, hobbyists, boatowners, CBer's, hams . . . it's even sophisticated enough for radio & TV servicing! Features 12 ranges . . . 4 AC & 4 DC volt ranges, 4 ohm ranges; 11 megohm input on DC, 1 megohm input on AC; 4½" 200 uA meter; battery power; rugged polypropylene case and more. Easy 3 or 4 hour kit assembly. Ideal gift for any man! 4 lbs.

Kit IM-17
$19.95

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CIRCLE NO. 89 ON READER SERVICE CARD

NEW PRODUCTS & LITERATURE

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, fill in coupon on the Reader Service Card.

COMPONENTS • TOOLS • TEST EQUIPMENT • HI-FI • AUDIO • CB • HAM • COMMUNICATIONS

IC POWER SUPPLY

An integrated voltage regulator that contains the monolithic equivalent of one of the most popular and widely used discrete power-supply circuits is now being marketed in a space-saving, low-profile TO-3 case.

The new WM-110 and WM-330 units can

replace most present discrete power-supply regulators since these integrated circuits can deliver 0-2 ampere outputs at 8 to 48 volts. According to the company, they provide 2% or better regulation at 1 ampere.

The main difference between the two units is that the WM-330 has an additional lead brought out so that external discrete zener references may be used instead of an internal zener reference. This permits the WM-330 to be used for outputs of less than 8 volts.

Good regulation over the full —55 to +125 degree C military temperature range is provided by both units.

Complete details on the units and their applications will be supplied on request. Westinghouse

Circle No. 126 on Reader Service Card

PISTON TRIMMER

A new high r.f. voltage piston trimmer capacitor featuring high stability and small size is now available as the VCJ 1616D. Applicable in communications equipment and wherever a small trimmer capacitor is needed to handle large voltage peaks and high power at elevated temperature, the new unit operates over a frequency range of from 1 to 30 MHz.

The operating r.f. voltage level of this unit is 3100 volts peak at +25°C derated to 2500 volts peak at +200°C. Its capacitance is variable from 0.5 to 5 pF and its operating temperature range is from —55° to +200°C. Turning torque is 1-10 in./oz in accordance with the MIL-Spec.

The trimmer is furnished for panel mounting and is 1 3/8" long x 5/16" in diameter. JFD

Circle No. 127 on Reader Service Card

OSCILLATOR FOR IC SYSTEMS

Operating from a 5-6 volt d.c. source for compatibility with integrated circuit systems, the

Model CO-204-5 cystal oscillator provides a stability (aging rate) better than one part in 10^9 per day.

This 2" x 2" x 4" package employs an integrated circuit proportional oven control system to provide reliability and stable operation over the —20°C to +70°C temperature range with —54°C to +75°C operation optional. Despite low power drain, the CO-204-5 exhibits excellent restabilization characteristics, achieving an accuracy better than five parts in 10^9 within 30 minutes after turn-on, according to the company. Electronic tuning is provided for remote frequency control or phase locking operation.

Other units in the series range in stability from one part in 10^8 per day through three parts in 10^9 per day. They have been designed to provide a high stability reference for frequency counters, time code generators, frequency synthesizers, communications receiver/transmitters, and similar equipment. Vectron

Circle No. 128 on Reader Service Card

TOROIDAL POWER TRANSFORMERS

A new line of 400-Hz toroidal power transformers is now available from stock. These units are designed for low-voltage silicon power supplies and isolation applications for transistorized equipment requiring low height and small package size.

Toroidal construction provides an inherently low radiation magnetic field. The transformers are available in 9 to 20 VA power ratings with center-tapped secondaries of 28, 56, or 115 volts. Primary ratings are 115 V at 400 Hz. Supplied with pins for printed-circuit applications, the transformers can also be mounted for point-to-point wiring if desired. The transformers are built to meet MIL-T-27 Grade 5 class S requirements. Microtran

Circle No. 129 on Reader Service Card

ALL-DIFFUSED SCR'S

A new line of high-current, high-voltage, all-diffused SCR's has just been introduced as the NL-C180 series.

These all-diffused, shorted emitter, 235-ampere units have a guaranteed d.v./d.t. rating of 200 volts/μs. The series is offered in a voltage range from 100 volts to 1300 volts. Maximum d.i./d.t. ratings are available up to 100 A/μs. Typical peak on-voltage is 1.8 volts. I^2t rating is 49,000 A^2 and surge current rating is 3500 amperes.

Hard solder construction is used to give minimum thermal fatigue and thermal impedance. There is no peak forward voltage limitation. A data sheet on this new series will be forwarded on request. National Electronics

Circle No. 130 on Reader Service Card

NEW TV ANTENNA LINE

The "Color Spectrum" series of antennas is now available in 35 basic models and, with kit packs and special applications, a total of 45 models can be had.

The new models are the CS-B2, an 82-channel TV and FM combination 300-ohm antenna which is designed for those areas where the v.h.f. signal is of moderate strength and the u.h.f. signal is relatively weak. The Model XCS-B2 is a 75-ohm version where the same relative signal strengths are found, but interference conditions or the installation makes the use of coax preferable. The Model CS-C2 is also an all-channel TV plus FM 300-ohm design for reception areas where both the u.h.f. and v.h.f. signals are relatively weak. The XCS-C2 is the 75-ohm version of this model. Finney

Circle No. 1 on Reader Service Card

LOW-VOLTAGE SOLDERING STATION

A single heat capsule that delivers a tip temperature range of 370°F to 880°F is designed for use in prototype and production assembly of microelectronic flat and stack packs, hybrids, and discrete devices.

The complete low-voltage station consists of a specially engineered, featherlight, Princess sol-

dering pen and heat capsule with coaxial connector, "Select-A-Temp" control unit, and three of the most widely used Princess threaded soldering nibs.

A 4-pin molded connector joins the isolated slim-line pen to the control unit which, operating on line current of 120 volts a.c., delivers 12 volts to the soldering pen. A fingertip control dial permits the operator to select the correct tip temperature required for a specific assembly. A visible meter registers line voltage so that a precise power setting can be dialed to achieve the desired temperature. Ungar

Circle No. 2 on Reader Service Card

"WRAP" FILM CAPACITORS

The new "Aerofilm" Type V170 capacitor offers excellent electrical characteristics in a miniature construction for upright mounting, according to the company. It has been constructed by wrapping the film dielectric section with a synthetic film and thermally sealing the end. It uses a welded lead construction and is said to exhibit its performance characteristics even at high frequencies and microvoltages.

The V170 units, the largest of which measures 0.413" x 0.669", are available in six types with capacitances ranging from 0.01 to 0.1 μF and dissipation factor not exceeding 1% (at 25°C). Standard tolerance is ±10%, although ±5% units can be supplied for special requirements. Aerovox.

Circle No. 131 on Reader Service Card

TEMPERATURE INDICATORS

A microminiature series of temperature indicators which permits the temperatures on small parts to be seen is now available with one, three, or four different temperature indications. Sizes range from 3/16" diameter with one indication to 1/4" diameter with up to four indications.

The series may be obtained in indicated values from 100 to 500°F, or the centigrade equivalents. Accuracy factor is ±1%. When the indicator is exposed to its calibrated temperature it changes from a pastel to solid black. This change is irreversible and cannot be altered, serving as a positive record of temperature exposure. They may be used on such items as heat sinks, transistors, tube shields, and other critical components. Temp-Plate Div.

Circle No. 132 on Reader Service Card

TRANSISTORIZED INDICATING LIGHTS

New fixed neon and removable cartridge incandescent model transistorized indicating lights have been introduced. The CR103 Type G lights meet the application requirements for computers, data processing equipment, communications and

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control systems using printed or integrated circuits.

The new lights require very low input signal power to turn the indicator on or off. Input signals required to actuate the lights are: neon "on", 0-2 volts d.c., neon "off", 3.6 to 6 volts d.c.; incandescent "on", 0 volt d.c. at 1.4 mA, incandescent "off", 6 volts d.c.

Compact and easy to install, the new lights may be mounted from the rear of the panel with a single knurled nut and backwasher. Lights mount in a 3/8" diameter hole on centers as close as 19/32" and on panel thicknesses of from 1/8" to 3/16". General Electric

Circle No. 133 on Reader Service Card

MINIATURE SOLDERING IRONS

A new line of miniature irons designed for soldering of miniature electronic assemblies has been put on the market as the "Slim-Line".

Ruggedly constructed to stand up under heavy production use without bending or loosening, the new irons weigh less than 2 ounces. The short slim 5/16" case diameters offer maximum visibility of work and directional control. White room handles are of small diameter, extra cool, and well balanced. A super flexible 2- or 3-wire grounded cord provides effortless handling, according to the company.

Long-life tips are available in a wide selection of shapes and are non-scaling and non-freezing for ease of maintenance. Tip diameters from 1/16" to 3/8" and wattages ranging from 15 to 60 watts are available. Hexacon

Circle No. 134 on Reader Service Card

LIGHTWEIGHT SHIELDED CABLE

The new BC6/U is a low-loss, solid-aluminum-sheath coaxial cable designed for applications where RFI may seriously affect transmission performance.

The dielectric is "Polyfoam", a patented cellular polyethylene core, which lowers attenuation by as much as 35 percent over solid dielectric cables of similar size and drastically reduces cable weight. Nominal o.d. of the BC6/U is 0.257 inch and it weighs only 32 pounds per 1000 feet.

Shielding tests rate the new cable at 80 to 80 dB down, making it suitable for both commercial and military-communications systems. Amphenol

Circle No. 3 on Reader Service Card

R.F. LEAK DETECTOR

An r.f. shielded-enclosure leak detection system is now available as the "RF Sniffer", Model 500.

The detector is portable, solid-state, and has a very high order of sensitivity. It can be used in conjunction with MIL-Spec methods to ensure continuous integrity of an enclosure and, in many applications, can replace the laborious conventional method for making this determination.

Use of the "RF Sniffer" can improve the attenuation of a shielded enclosure by 20 to 40 dB, by detecting seam leakage, poorly mating joints, minute construction flaws, and high-resistance regions. Even the very small perforations that can cause r.f. leakage at frequencies to 10 GHz and higher are readily detected.

The system is made up of two units, an exciter and a hand-held detector-indicator. The exciter couples a test signal to the outer surface of the enclosure at two diametrically opposite points. Where leaks exist, the electromagnetic field inside the enclosure will have a component perpendicular to the enclosure wall. This component is detected by the detector-indicator.

Full specifications on this instrument are available on request. Stoddart

Circle No. 135 on Reader Service Card

GERMANIUM POWER TRANSISTOR

A new 25-ampere "p-n-p" germanium power transistor, the SDT3080 series, is now available in a TO-3 or TO-41 package. It is a low-cost, high-current device capable of 106 watts. Typical

specifications include a minimum gain of 10 at 25 amps, V_{CBO} of 40-80 volts, V_{CEX} of 40-80 volts, and V_{CEO} of 30-50 volts.

This device is a general-purpose transistor for use in military and industrial inverters, converters, switches, regulators, control circuitry, and audio amplifier applications. Solitron

Circle No. 136 on Reader Service Card

INTEGRATED-CIRCUIT COUNTERS

Three new integrated-circuit counters have been introduced: the Model 8300, a 100-MHz universal counter-timer; the Model 8200, a 12.5-MHz universal counter; and the Model 8220, a 500-MHz digital frequency meter.

The Model 8300 is a versatile 8-digit instrument with 10 ns resolution, high input impedance, a.c. or d.c. input coupling, and many more features. By adding a plug-in module, the frequency range may be extended to 500 MHz.

The Model 8200 is an externally programmed instrument using the latest design concepts to provide a wide range of measurement flexibility. The unit includes measurement functions for frequency, period, multiple period averaging, frequency ratio, time interval, and totalizing.

The Model 8220 features direct frequency measurement to 500 MHz and 7-digit resolution. It is designed to meet the needs of the communications industry as well as other industry and laboratory applications. Fairchild Instrumentation

Circle No. 137 on Reader Service Card

CONTROLLED HEAT SOLDERING

Introduction of the new "V-3000" brings to three the number of systems now available for dealing with the problems of controlling soldering tip temperatures. Choice will depend on such factors of operation as degree of miniaturization, the importance of eliminating component damage from temperature overshoot, and demands for tool economy.

The V-3000 is the most advanced of the systems. It direct-dials and continuously controls any tip temperature from 350 to 750 degrees F. The soldering iron, usable only with the system, is a 40-watt unit with 3/16" diameter tip. The sensing mechanism is an integral part of the iron, not the tip, so regular, plug-type tips of any shape may be used.

The second is the V77 variable power control for use with any regular conduction-type soldering iron up to 125 watt size. Dial control is stepless, infinitely variable. The third system is the T-6. This 12-watt system is designed for use on delicate jobs. Tip temperature is dial controlled, in approximately 50° steps from 310 to 850 degrees F. The handpiece weighs 3/4 oz and the tip element is a needlepoint. American Beauty

Circle No. 4 on Reader Service Card

SOLID TANTALUM CAPACITORS

Ratings of 1000 μF, 6 volts d.c.; 560 μF, 10 volts d.c.; 330 μF, 15 volts d.c.; and other super ratings in standard military style, A, B, C, and D cases are now available in the A-series.

This new Kemet series meets or exceeds the environmental and mechanical requirements of MIL-C-39003A and exhibits the same superior electrical characteristics normally associated with solid tantalum capacitors, according to the company. In addition, the super capacitance devices display exceptionally low impedance characteristics from −55°C to +125°C and are ideal for d.c. power supply filtering and decoupling.

The new capacitors are available in values ranging from 0.82 μF to 1000 μF and in working voltages from 6 to 60 volts. Union Carbide

Circle No. 138 on Reader Service Card

LOW-LOSS 75-OHM COAX

No. 8221 is a new low-loss 75-ohm, #22 AWG solid, foam polyethelene vinyl-jacketed coax which is being offered in standard colors of white, gray, and black.

Easily installed with standard RG 59/U connectors, the new cable has been designed to meet the multiple requirements of MATV, CATV, CCTV, and indoor/outdoor applications.

The 100% sweep-tested cable also features a flexible all-weather jacket and is available in 100, 500, and 1000 foot put-ups as standard catalogue items. Belden

Circle No. 5 on Reader Service Card

RFI ADAPTERS

Designed to provide 360° shield termination for the "new breed" of high-density microminiature circular connectors, the new adapters are easy to assemble, convenient to repair, and meet the most restrictive weight limitations while maintaining connector performance and integrity, according to the manufacturer.

Available for over-all shielded cables and harnesses and for shielded and jacketed cables alike, the new connectors come in either environmental or non-environmental versions and in a choice of cable entry sizes for each size connector.

Shield termination is accomplished by the use of the exclusive single-ferrule "Wedge-Lok" and these adapters are available for all circular connectors including such microminiatures as Amphenol Astro 348, Bendix JT-JTRE, Cannon Centi-K, Deutsch STK, Matrix Mini-Mate, Microdot Marc 53, and others. Glenair

Circle No. 139 on Reader Service Card

WIRE/CABLE HARNESS KIT

A sample kit for evaluation of wire/cable harnesses and markers has been assembled for engineers. It includes the Cradleclip, Spiroband, strapping, cable tie, and adjustable P-clip harnessing systems; three different types of markers for indestructible coding of wires and cables; and grommet-strip, the snip-n-fit grommeting material. Electrovert

Circle No. 140 on Reader Service Card

LOG-PERIODIC ANTENNAS

Four new models in the "Color Ranger" line of log-periodic antennas provide for connection to either 300- or 75-ohm coax downlead. A mating male connector is supplied for the 75-ohm coax. Patented stainless steel stripless screws are provided for connecting the 300-ohm twin-lead.

The models with this new dual-connection facility include the 15-300/75, a 15-element fringe area model; the 10-300/75 designed for metropolitan and suburban areas with severe ghosting; 7-300/75 designed for metropolitan and suburban areas where ghosting is a problem, and the 5-300/75 designed for metropolitan and strong-signal suburban areas.

All of the antennas feature the patented spaced dual-boom log-periodic design for uniform gain across the entire bandwidth. The v.h.f. units are easily convertible to 300-ohm, channel 2-83 antennas with the addition of the "U-Ranger" u.h.f.

add-on log periodics. No couplers or extra downleads are required and a single downlead carries television channels 2-83 plus FM. Blonder-Tongue

Circle No. 6 on Reader Service Card

MINIATURE CERAMIC CAPACITORS

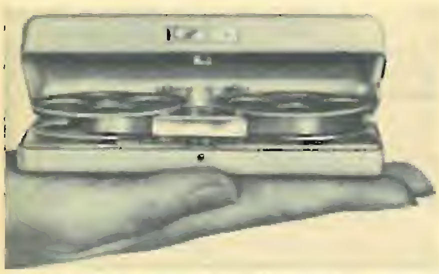
A complete line of miniature ceramic capacitors is now being offered as the "Red Cap" line. The line provides values ranging from 1 pF through 4.7 μF in fourteen temperature compensating and seven Hi-K formulations in sizes as small as 0.1" square. They meet all applicable requirements of MIL-C-20 and MIL-C-11015. They are protected by a patented encapsulant to give maximum ruggedness and superior moisture protection. Erie Technological

Circle No. 141 on Reader Service Card

HI-FI—AUDIO PRODUCTS

ULTRA-MINIATURE RECORDER

An ultra-miniature tape recorder designed as a "talking note pad" is now available in two models. The Model M-75 is a mono unit while the M-75-B is stereo. The recorder measures 5" x $2\frac{3}{4}$" x $\frac{15}{16}$". It functions automatically and completely hands-free while worn on the person. A remote switch controls start or stop. It is capable of taping voices up to a distance of 75 feet.



Both models have capstan-drive constant-speed at $1\frac{7}{8}$ in/s. The motor is governor controlled. Two inexpensive mercury batteries furnish power up to 50 hours of use. Long-play $\frac{1}{4}$" tapes can be replayed directly from the unit or most standard recorders. The recorders come complete with twin earset. ElectroData

Circle No. 7 on Reader Service Card

INTEGRATED STEREO AMP

An all-silicon integrated stereo preamplifier/control and power amplifier has just been introduced providing 60 watts r.m.s./ch at 4 ohms,

50 watts r.m.s./ch at 8 ohms, and 30 watts r.m.s./ch at 16 ohms.

Frequency response is 20-20,000 Hz ± 1 dB at indicated flat tone-control settings at full power or below. Distortion at any power output level up to and including full rated power is IM (60 & 7000 Hz, 4:1) less than 0.25%, harmonic less than 0.5% from 20-20,000 Hz. These figures include the phono preamp stages.

Switched inputs are magnetic phono, tuner, and tape playback. Signal-to-noise ratio on the phono input is 65 dB unweighted and 76 dB unweighted for the tape playback and tuner inputs. Damping factor is 8 to 20 for 4-ohm speakers, 16-40 for 8-ohm speakers, and 32-80 for 16-ohm speakers.

Controls include an input selector switch, individual bass control for each channel, individual treble control for each channel, concentric balance control and mode switch, power "on-off" and volume control. Rear panel controls include an individual phono input level control for each channel.

With the optional wood cover, the amplifier measures $15\frac{3}{4}$" w. x $4\frac{1}{2}$" h. x 10" d. Without the cover it is $15\frac{1}{8}$" w. x $4\frac{5}{16}$" h. x 10" d. Acoustic Research

Circle No. 8 on Reader Service Card

UNRECORDED CASSETTES

In response to the demand by those owning cartridge machines capable of recording as well as playing back, the company is now offering unrecorded cassettes. Irish

Circle No. 9 on Reader Service Card

AUTOMATIC TURNTABLE

The new Perpetuum-Ebner P.E. 2020 automatic turntable features an exclusive 15° tracking angle adjustment for all records, permitting perfect tracking even in the automatic play mode, according to the company.

The turntable also features an automatic anti-skating device combined with an exact adjustment dial to compensate for stylus shape and friction; a cartridge shell that accepts all cartridges with a foolproof, slide-fit mounting; a single lever command center which controls start, stop, repeat, cueing, and lift; automatic start and automatic shut-off in either single play or with a stack of

records; and automatic scanning to determine the diameter of any record and adjust the tonearm accordingly.

The new unit plays records at all four speeds and has a four-pole, four-coil induction motor. It has a revolving spindle on single play to reduce center-hole wear. Elpa Marketing

Circle No. 10 on Reader Service Card

STEREO RECEIVER

The Model Eighteen stereo receiver provides 40 watts continuous watts per channel with less than 0.2% distortion across the entire audio frequency spectrum. It is designed to be used with speakers ranging from 4-ohm acoustic suspension types to 16-ohm electrostatic units.

The solid-state FM tuner section incorporates a passive front-end, representing the first use of a non-amplifying front-end in a hi-fi component,

according to the company. The receiver incorporates an oscilloscope for tuning, thus enabling the user to observe multipath reception and re-orient his antenna to eliminate it.

The tuning knob is actually a heavy flywheel turned so that its edge protrudes through the panel for smooth, easy tuning. An accessory walnut cabinet to house the receiver is available extra as the Model B18-0. Marantz

Circle No. 11 on Reader Service Card

TAPE PLAYING ADAPTER FOR CARS

The new CA-150 car adapter is a sliding tray with simple plug-in connections for playback of prerecorded tapes through any automobile radio speaker system using the F-100 cartridge "Sound Camera."

Used with the F-100, the adapter provides a complete automobile sound system with high-fidelity music reproduction. In addition to playing music tapes while traveling, the F-100 functions as a mobile dictation machine. The automobile electrical system provides the power source, saving the F-100 batteries for portable tape recording applications.

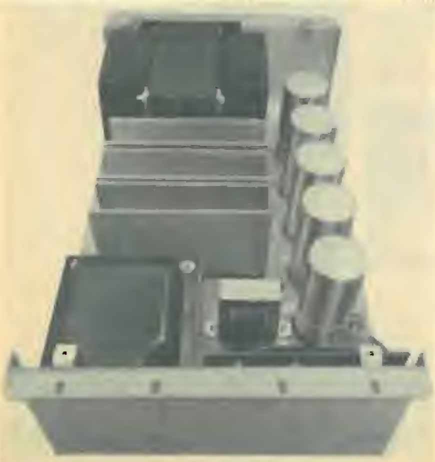
The CA-150 is bolted under the dash. Operation for tape playing is accomplished from the plug-in connections. An "on-off" switch on the adapter lets the listener select sound either from the car radio or from the tape recorder. Concord

Circle No. 12 on Reader Service Card

HIGH-POWER AMPLIFIERS

Two new high-power, all-silicon solid-state amplifiers are now available in the DX Series.

The DX250 with a 250-watt professional rating, 325-watt commercial rating and the DX125 with a 125-watt professional rating, 165-watt



commercial rating carry a five-year warranty and come with individual registered certificates of performance.

The DX250 has an output of 325 watts r.m.s. (650 watts peak), thermostatically controlled protective relay, a back-up fast-acting overload protective relay, instant operation with no-warmup time, low power consumption, and a frequency response of 30-20,000 Hz $\pm 1\frac{1}{2}$ dB. Distortion is less than 2% at rated output and noise level is 85 dB below rated output.

Complete details on either or both of these professional amplifiers will be forwarded on request. Rauland-Borg

Circle No. 13 on Reader Service Card

PUSH-BUTTON RECORD PLAYER

An automatic push-button record player, styled for the home and equipped to provide push-button selection, change, and repeat of any one of 50 record sides automatically, is now available.

The "Radionette Multiplayer" features a 15-watt transistorized amplifier with a three-way speaker system, all housed in a bookshelf cabinet. The unit, which plays 45 r/min in records only, is designed for the young adult market. Tandberg

Circle No. 14 on Reader Service Card

STEREO CASSETTE DECK

A four-track stereo cassette deck has just been introduced as the Model F-105. Designed for use with a high-fidelity system (component, compact, or stereo console), the new deck permits recording of stereo or mono sources off-the-air, from records, or from another tape source. A standard size cassette snaps into place instantly. The cassettes can be erased for new recordings if desired.

The tape deck contains solid-state preamplifiers, precision tape-transport mechanism, flux-field heads, capstan driver, two vu meters and recording level controls, stereo auxiliary and microphone inputs, cassette ejector button, stereo

headphone jack, and instant fast-forward and reverse control.

The deck operates horizontally and measures $9\frac{5}{8}''$ w. x $2\frac{3}{4}''$ h. x $8\frac{3}{8}''$ d. It is housed in a teak cabinet with "black screen" dust cover. Concord

Circle No. 15 on Reader Service Card

SOLID-STATE TAPE RECORDER

The Model 1040 records and plays 4-track mono and stereo at speeds of $7\frac{1}{2}$, $3\frac{3}{4}$, and $1\frac{7}{8}$ in/s while an "instant stop" feature permits "edit-as-you-go" operation. The same single control is used for rewind, stop, play, and fast forward.

The recorder incorporates a digital counter and two professional-type vu meters. The stereo amplifier (10 watts peak) is of solid-state design. Two detachable speakers may be positioned for best stereo effect or a stereo headphone may be plugged into the front-panel headphone output.

A fold-down panel conceals the recording controls, record interlock, and inputs. The recorder and speakers fold into a compact portable case measuring $13\frac{5}{8}''$ h. x $18\frac{1}{2}''$ w. x $9\frac{7}{8}''$ d. Allied

Circle No. 16 on Reader Service Card

PHOTOELECTRIC CARTRIDGE

A photoelectric cartridge for professional and audiophile use incorporates a lamp, a screen (which is attached to the cantilever that works by the tracing operation of the stylus), photoelectric diodes, and a preamplifier.

Operational theory of the cartridge is as follows: 1. the movement of the screen controls the amount of light ray passing through the screen on to the diode; 2. the movement of the stylus on the record causes the screen to vibrate; 3. the amount of light ray passing through the screen on to the diodes changes the current of the diodes to sound current. The cartridge, according to its maker, can transform the most minute vibration to electricity. Kenwood

Circle No. 17 on Reader Service Card

SOLID-STATE MIXER

An economical mixer-preamplifier which greatly extends the performance capability of p.a. systems or tape recorders has just been introduced as the MX6A-T.

The new unit is an a.c. powered, all-silicon, solid-state unit which can be used singly to add four or more microphones or other signals to an existing system. Up to three units may also be paralleled to provide 12 individual inputs, with three mixers mounted "piggy-back" if this is desired.

Measuring just $9\frac{1}{4}''$ x $6''$ x $2\frac{5}{8}''$ and weighing less than five pounds, the new mixer only requires plugging in to existing equipment to be instantly operable. It has standard phone jacks for high-impedance microphones and guitars, screw terminals for low-impedance microphones, and RCA-type phono jacks for ouput to auxiliary input of public address amplifier or tape recorders. Bogen

Circle No. 18 on Reader Service Card

AM-FM-STEREO MUSIC CENTER

The LRC-60 is a 60-watt, solid-state AM-FM-stereo music center which provides complete tuner and phono-playing facilities in compact form.

The unit incorporates a new 60-watt stereo receiver with FET front-end and four IC's, plus a BSR McDonald 500 4-speed automatic stereo turntable with Pickering V15/AC-3 "Dustamatic" stereo cartridge. All components are mounted on an oiled walnut wood cabinet.

The turntable will handle 7", 10", or 12" records at $16\frac{2}{3}$, $33\frac{1}{3}$, 45, or 78 r/min. The amplifier delivers 60 watts (IHF) power. Impedance is 8-16 ohms. Frequency response is 20-20,000 Hz ± 1 dB. Tuner sensitivity is 1.8 μV IHF and the capture ratio is 1.25 dB.

The music center includes a full set of audio controls: d'Arsonval tuning meter, automatic FM mono/stereo switching, stereo indicator light, stereo headphone jack, tape recorder jacks, and a precision vernier dial drive for accurate tuning.

The control center measures $16\frac{3}{8}''$ w. x $7''$ h. x $15\frac{7}{8}''$ d. It will operate at 117 volts, 50 or 60 Hz a.c. Lafayette

Circle No. 19 on Reader Service Card

AM-FM-STEREO RECEIVER

The Model AS-60 solid-state AM-FM-stereo tuner amplifier has facilities for up to four tape-deck inputs to provide studio tape handling versatility, and serve as a central tuner and audio control component.

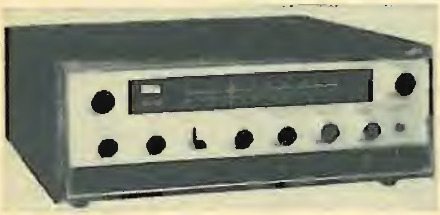
The power amplifier is rated at 100 W (IHF) dynamic power; 40 W/ch r.m.s. power at 1% harmonic distortion. Power bandwidth is 30-

60,000 Hz ±1 dB, over-all frequency response of the receiver is 20-20,000 Hz. Channel separation at 1000 Hz is 50 dB.

Controls include bass, treble, loudness, low filter, high filter. Center channel output is 4.4 V at rated output. The source selector includes AM, FM, FM automatic, phono, tape player, and aux. The mode selector provides for stereo reverse, stereo, left, right, and L+R.

The FM tuner section provides a range of 88-108 MHz or 76-90 MHz. Sensitivity is 2.5 V (IHF), and i.f. selectivity is 3 dB at 250,000 Hz. Channel separation is 40 dB at 1000 Hz and stereo left, right, and L+R.

The unit will operate from 110/115 volt a.c.,



50/60 Hz. It measures 17⅞" w. x 5½" h. x 15½" d. Teac

Circle No. 20 on Reader Service Card

CB-HAM-COMMUNICATIONS

BATTERY PACK FOR CB RIGS

A self-contained battery pack designed to make most of the firm's solid-state CB rigs completely portable has been introduced as the "Port-A Pak" Model PAP-1.

It features a rechargeable nickel-cadmium battery which provides continuous operation in the "receive" position for up to 8 hours. It can be left on trickle-charge continuously or can be recharged while in "standby" position. Reliable operation is claimed over the temperature range from −30 to +140 degrees F.

Other features include a collapsible antenna, rechargeable battery and battery meter, durable Texion case, charging connector, mounting hardware, shoulder strap, and microphone bracket. Courier

Circle No. 21 on Reader Service Card

ELECTROMECHANICAL RESONATOR

A tunable, low-cost electromechanical resonator suitable for use in a radio control for model aircraft and boats is on the market as the "Twintron". The unit can be used in audio oscillator circuits, as a narrow band reject or pass filter, and as a tone echo reflector.

The resonator is inherently immune to shock, vibration, and mounting position and is insensitive to harmonics. It is available in three types for the following frequency ranges: 100-700 Hz, 300-3000 Hz, and 700-8000 Hz. Each type is tunable to any frequency within its range. The "Q" can

be adjusted from approximately 50 to higher than 200. Thermal stability is 0.05% from −30° to +60°C.

Complete specifications and application data are available on request. HB Engineering

Circle No. 22 on Reader Service Card

LAND/MARINE MONITOR RECEIVER

The HA-153/155 is a dual-conversion v.h.f./FM monitor receiver which may be operated on up to six crystal-controlled channels in the 153-157 MHz FM land mobile and marine band. Sensitivity is 0.7 μV for 20 dB quieting. Selectivity is 60 dB down at $\pm$30 kHz. Image rejection is 60 dB and audio output is 3 watts.

The six channels permit monitoring of fire, police, special emergency, Civil Defense, industrial, and business FM communications as well as radio paging and alerting stations and the v.h.f. marine band channels.

The receiver measures 6" w. x 8" d. x 2" h. and comes complete with all mounting hardware. It operates from an external 12-volt battery, drawing less than 0.7 amp, or with optional 117-volt a.c. power supply. Unimetrics

Circle No. 23 on Reader Service Card

TRANSISTORIZED DYNAMIC MIKE

A new transistorized dynamic microphone that will directly replace most carbon mobile mikes is now available as the "+350".

The new microphone contains a transistorized preamplifier which provides improved transmission quality compared to carbon microphones, according to the company. The greater intelligibility results from reduction of distortion and background noise. Output level of the "+350" is -38 dB below 1 volt/dyne cm^2. Response is 350-4000 Hz. Turner

Circle No. 24 on Reader Service Card

MANUFACTURERS' LITERATURE

R.F. SPECTRUM ANALYSIS

A handy 30" x 40" three-color wall chart of engineering reference information for microwave and electronics engineers is now available. Covered on the wall chart are spectrum-analysis data, signal and transmission information, and receiver noise-figure data. Polarad

Circle No. 142 on Reader Service Card

NEW DIGITAL VOLTMETER

A new 4-page illustrated brochure describing the features and specifications of the new Model X-3 solid-state multipurpose digital voltmeter with v.t.v.m. capabilities has been released.

The instrument measures d.c. volts from 10 microvolts to 10,000 volts at 100 megohms input impedance; a.c. volts from 10 mV to 300 volts, 20 Hz to 500 MHz; ohms from 10 milliohms to 2000 megohms; and current from 10 picoamperes to 200 mA. Readout is a four-Nixie display with a fifth $\pm$ overload indication Nixie. Non-Linear Systems

Circle No. 25 on Reader Service Card

COLOR-TV ELECTROLYTICS

A new 6-page foldout brochure listing more than 250 replacement electrolytics for color-TV according to capacitance value is now available. Single-, dual-, triple-, and quadruple-section types are included. Cornell-Dubilier

Circle No. 26 on Reader Service Card

ELECTRONIC HARDWARE

A complete line of circuit boards, spacers, washers, leads, and cables is described in a new Summer 1967 catalogue. Intended for the specifying designer and engineer, the booklet contains technical specifications, dimensions, and prices. Technical Accessories

Circle No. 27 on Reader Service Card

SCR CATALOGUE

Condensed technical information on a complete line of silicon controlled rectifiers is contained in a new 8-page quick-reference catalogue (No. SB-57). The SCR's covered in the booklet range in current values from 16 to 235 amperes.

Featured in the catalogue is a 2-page glossary of symbols and definitions of terms. National Electronics

Circle No. 143 on Reader Service Card

TRANSISTOR SUPPLEMENT

Featured in a new 12-page supplement to the company's 1967 condensed catalogue of semiconductor products is a line of small-signal "n-p-n" and "p-n-p" transistors for military, industrial, and commercial applications. For speedy reference, each transistor listing is accompanied by a summary of primary specifications.

New small-signal devices recently introduced by the firm are also included in the booklet. Solitron

Circle No. 28 on Reader Service Card

MICROPHONE CATALOGUE

A new 14-page illustrated catalogue of microphones and public-address equipment has been issued. Included are professional broadcasting and recording microphones, general-purpose microphones, paging and two-way microphones, and accessories; sound reinforcement loudspeakers; p.a. transformers and accessories; and p.a. horns and drivers. Electro-Voice

Circle No. 29 on Reader Service Card

PRODUCTS CATALOGUE

A new 72-page illustrated catalogue of electromechanical components and equipment has been published for Fall 1967. Featured are accelerometers, counters, motors, precision potentiometers, test equipment, and timers. Special complete sections are included on relays, pressure transducers, and gyros. American Relays

Circle No. 144 on Reader Service Card

TAPE RECORDERS

A new 32-page illustrated brochure spotlighting a line of tape recorders and other audio products is now available. Included are portable tape recorders, solid-state stereo tape recorders and tape decks, portable cassette players, stereo tape players for automobiles, marine radios, and CB transceivers. Craig

Circle No. 30 on Reader Service Card

EDUCATIONAL AIDS

A new 4-page illustrated catalogue describing five training-aid kits designed to give students a basic foundation in elementary electronics and electricity is now available.

The kits utilize solderless connections and permit up to 20 different projects, including the construction of a transistor radio, microphones, amplifiers, oscillators, and intercoms. Each set contains a manual which discusses each project separately, includes some theory, and provides both the technical name and schematic symbol for each component. Marcon

Circle No. 31 on Reader Service Card.

THERMAL RELAYS

A new literature package on a complete line of industrial thermal timing relays is now available. The folder supplies specifications, dimensional drawings, and typical application information on the Red Line DT Series of octal-base time-delay relays; the Type DM instant-reset thermal timing element used in communications systems and data-processing equipment; and the JT Series of thermal timing relays designed specifically for PC-board mountings. G-V Controls

Circle No. 145 on Reader Service Card

COAXIAL CABLES

A new 8-page catalogue describing the 9800 Series of coaxial cables is now available. Included in the booklet (No. C-7) are cables specially engineered for CATV, MATV, color, black and white, CCTV, educational TV, FM, CB, and amateur use. Alpha Wire

Circle No. 32 on Reader Service Card

PHOTO CREDITS

Page	Credit
22	Eico Electronic Instrument, Inc.
35, 36, 37	McDonnell Aircraft Corp.
43	Solo Electric Div.
88	Varian Associates

Magnetic Materials

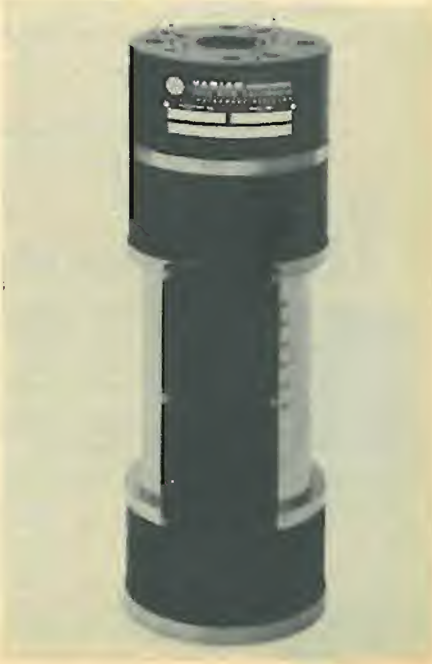
(*Continued from page* 52)

containment for thermonuclear reactions, magnetohydrodynamic propulsion, and magnetic shielding and braking systems for space vehicles.

Although most of these applications are in the future, it is important to note that superconducting magnets are no longer laboratory curiosities but are becoming standard equipment. As a case in point, consider the nuclear magnetic resonance spectrometer manufactured by *Varian Associates*. This device requires a strong magnetic field for its operation, and was traditionally supplied with a huge iron-core magnet weighing 5000 pounds and capable of producing a 23-kilogauss field. Until quite recently, such magnets represented the state of the art for NMR use: it was not feasible to exceed that figure using conventional techniques. However, *Varian* now offers superconducting magnets for use with its NMR spectrometers which weigh only 100 pounds and produce a field of 50 to 60 kilogauss (Fig. 5).

Although it is necessary to refrigerate the coil with liquid helium, the dewar holding the liquid and minimizing evaporation adds only 200 pounds to the weight, so the total is still only a fraction of the weight of the conventional magnet. Operating cost per kilogauss is less and there is better stability in the magnetic field. Most important, however, is the fact that the markedly higher field has added another dimension to NMR spectroscopy. The chemical shift of NMR spectra is proportional to field strength, so results are clearer, more easily interpreted. ▲

Fig. 5. This superconducting magnet provides a field of 60 kilogauss.



1967 INDEX

VOLUMES 77-78

As a service to our readers we are again presenting a complete listing of all feature articles which appeared in ELECTRONICS WORLD during 1967. We suggest you keep this for reference.

COMMUNICATIONS

COMPONENTS

HIGH FIDELITY & AUDIO

EW LAB TESTED

INDUSTRIAL & GENERAL

NOMOGRAMS & DESIGN CHARTS

SOLID-STATE

TELEVISION & RADIO

TEST EQUIPMENT & MEASUREMENTS

PRODUCT REPORTS

PLEASE. . . .
Save this Annual Index for future reference to all the feature material which has appeared during 1967.

EROS System

(*Continued from* 38)

aircraft. "Bogey" aircraft, planes not equipped with EROS, can also be detected and identified.

The Future of CAS

McDonnell Douglas engineers are already at work on an improved EROS. EROS II, as the new model is designated, will have increased range and range rate measurement capability. This improvement in performnce will make EROS II suitable for use aboard the U.S. Supersonic Transport (see "Electronic Challenges in the SST Program" in the July 1967 issue).

With two SST's approaching one another at 1800 miles per hour each, the closure rate is 3600 miles per hour, or 60 miles a minute. The human eye could not resolve the hazard in time for corrective action to be taken. Hence a system such as EROS II will be mandatory if we are to traverse the skies of the world in safety. The history of aviation is marked by significant achievements made possible by the art of electronics. The CAS, of which EROS is a spectacular example, is yet another chapter in that saga. Other chapters are yet to be written. ▲

ELECTRONICS
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COMMERCIAL RATE: For firms or individuals offering commercial products or services. 70¢ per word (including name and address). Minimum order $7.00. Payment must accompany copy except when ads are placed by accredited advertising agencies. Frequency discount: 5% for 6 months; 10% for 12 months paid in advance.
READER RATE: For individuals with a personal item to buy or sell. 40¢ per word (including name and address). No Minimum! Payment must accompany copy.
GENERAL INFORMATION: First word in all ads set in bold caps at no extra charge. Additional words may be set in bold caps at 10¢ extra per word. All copy subject to publisher's approval. **Closing Date:** 1st of the 2nd preceding month (for example, March issue closes January 1st). **Send order and remittance to: Hal Cymes, ELECTRONICS WORLD,** One Park Avenue, New York, New York 10016

FOR SALE

JUST starting in TV service? Write for free 32 page catalog of service order books, invoices, job tickets, phone message books, statements and file systems. Oelrich Publications, 6556 W. Higgins Rd., Chicago, Ill. 60656.

GOVERNMENT Surplus Receivers, Transmitters, Snooperscopes, Radios, Parts, Picture Catalog 25¢. Meshna, Nahant, Mass. 01908.

METERS—Surplus, new, used, panel and portable. Send for list. Hanchett, Box 5577, Riverside, Calif. 92507.

INVESTIGATORS, FREE BROCHURE, LATEST SUBMINIATURE ELECTRONIC SURVEILLANCE EQUIPMENT. ACE ELECTRONICS, 11500-J NW 7TH AVE., MIAMI, FLA. 33168.

CONVERT any television to sensitive big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans, $2.00. Relco-A22, Box 10563, Houston, Texas 77018.

MUSIC LOVERS, CONTINUOUS, UNINTERRUPTED BACKGROUND MUSIC FROM YOUR FM RADIO, USING NEW INEXPENSIVE ADAPTOR. FREE LITERATURE. ELECTRONICS, 11500-Z NW 7th AVE., MIAMI, FLORIDA 33168.

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6 tube Amplifier, New 4 lbs. ....2/$1.98
¼ Watt Resistors, asstd. 50/1.00
½ Watt Resistors, asstd. 60/1.00
2N4138 Sil. Chopper To-46 NPN 1.50
Precision Resistors, asstd. 50/1.00
Pots, 2-4 Watt, asstd. 15/1.00
2N1724 Sil. Pow. 50 W. 80 V. Stud. 1.50
2N1047B Sil. Pow. 80V. To-57 .... .60
Tantalum Capacitors, asstd. 10/1.00
2N1722 Sil. Pow. 50W. 80V. To-53 .... 1.45
2N2944 Sil. Chopper To-46 .... 1.00
50W. Zeners 10 to 19 Volts 1.00
Thermistor head, 1200 ohm. 2/1.00
2N1021, Ger. Power, 7amp, 100V., To —3.... .60
2N456A, 7A. 40V. Ger. Power To —3 .... .45
2N1718, Sil. Power, 10W., 60V., Heatsink 3/1.00
70 amp Stud. 50PIV—$2.50; 100PV....$3.50

SILICON CONTROLLED RECTIFIERS

AMPS.	300PRV.	400PRV.	500PRV.
7A.	1.50	2.05	2.75
10A.	2.15	2.65	3.25

Pots. 1W. 100K, or ½W. 500K, ...5/1.00
Surprise Kit, 10 lbs. components 2.50
Epoxy Hi-Vol diode, 200ma, 3000PIV .... .98
Computer Board, TO-3 Power, Heat Sink 1.00
I.C., TO-5, untested 5/100
I.C., Dual-inline, untested 10/1.00
2N389,85W 60 V. TO53 .... .79
2N3707-11 Asstd. Plastic Silicon Xisters 20/1.00
2N3704-3706, Asstd. Plastic Sil. Xisters 10/1.00
2N2151, Sil. Power Xister .... .65
2N1009 Ger. Min. Xister untested 30/1.00
3N35 Tetrode, NPN, untested 5/1.00
Ger. Diodes, Asstd. 15/100
2N458A, 7A. 80V. Ger. Power, TO —3 .... .55
Sil. Diodes, Switching, Signal, Asst. 15/1.00
2N118, Silicon, NPN 10/1.00
2N1149, Silicon, NPN, untested 20/1.00
2N1300, Untest. PNP & NPN, ¼" leads 25/1.00
2N1714, Silicon Power 10W, 60V. 4/1.00
Computer Boards, Parts Free, per transistor .... .05
Germanium Power, 2N457A, 7A; 60V .... .50
Silicon Power 40 W, 2N1047, TO-57 ....2/1.00
Tophats 750 ma., 200PIV-8¢, 400, 12¢ 600 PIV .18
1N34A 100/2.98
Varicaps, 27, 47, or 100 pf.... 1.25
2N1038, Germanium 20 W. 40 V 4/1.00
With any $10.00 Order any $1.00 item Free. On $25.00 order any (3) $1.00 items Free. Catalog.

Minimum order $3.00 plus postage, C.O.D.'s 25%

ELECTRONIC COMPONENTS

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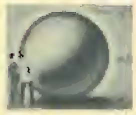

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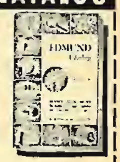

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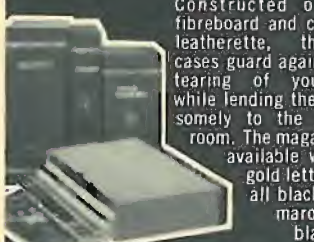

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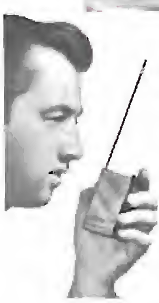

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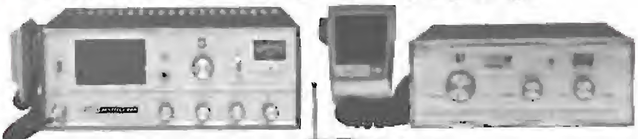

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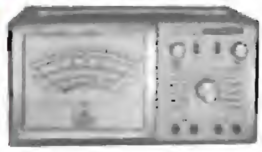

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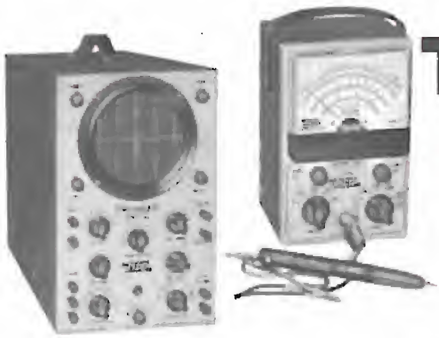

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