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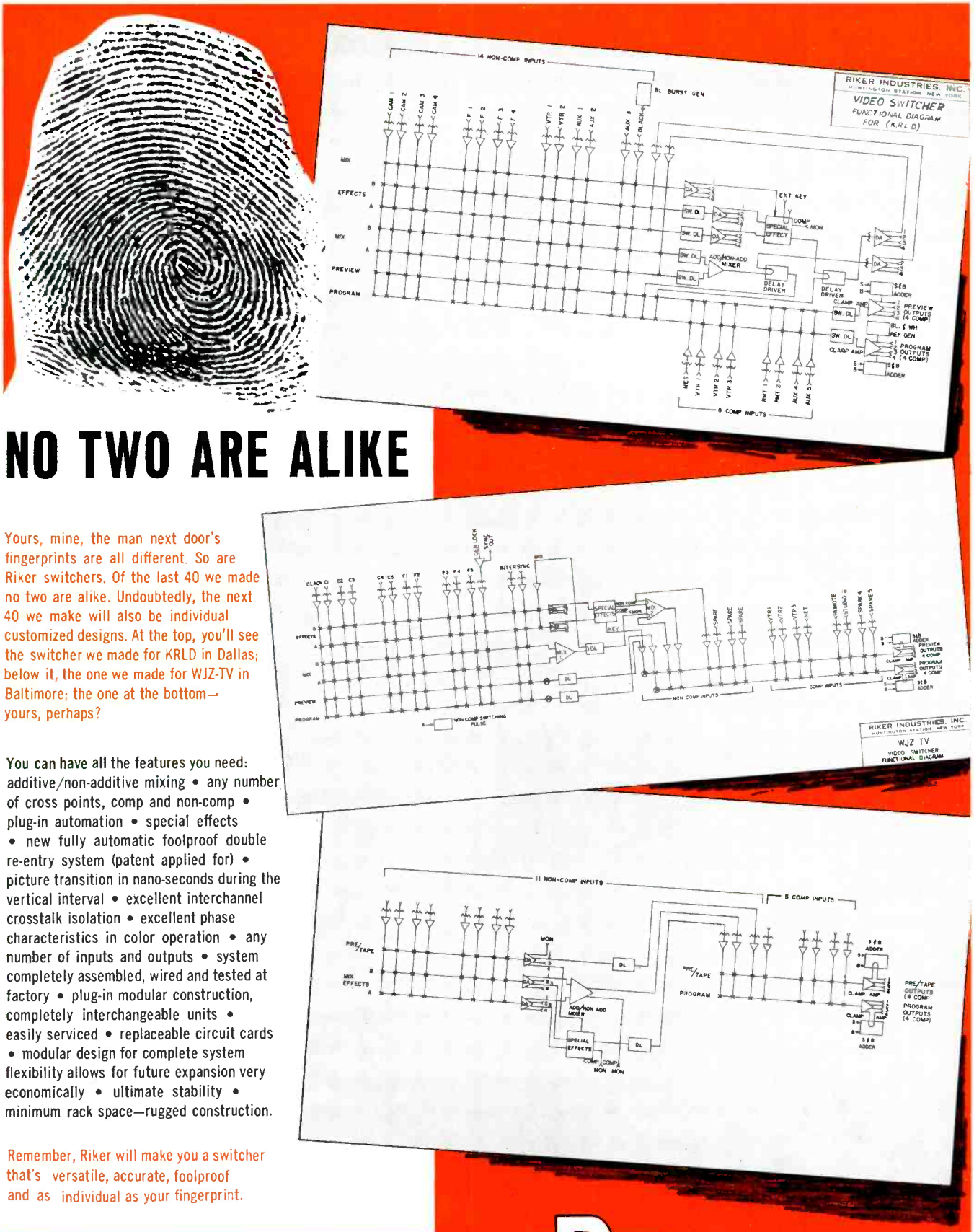
the technical journal of the broadcast-communications industry



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the technical journal of the broadcast-communications industry

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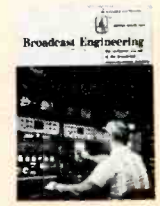
ETV has achieved an important place in broadcasting, and its influence will be felt even more in coming years. For a thumbnail sketch of ETV in Milwaukee, turn to page 32.



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*The E-V Professional Microphone Guarantee: All E-V professional microphones are guaranteed UNCONDITIONALLY against malfunction for two years from date of purchase. Within this period, Electro-Voice will repair or replace, at no charge, any microphone exhibiting any malfunction, regardless of cause, including accidental abuse. In addition, all E-V microphones are GUARANTEED FOR LIFE against defects in the original workmanship and materials.

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LETTERS to the editor

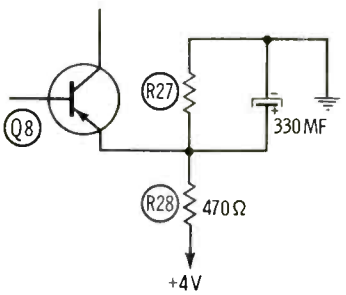
DEAR EDITOR:

Since publication of my article on the solid-state chopper in the June 1964 issue of BROADCAST ENGINEERING, I have received inquiries from more than 30 stations and follow-up correspondence from a number of them indicating satisfactory performance of the unit. Below is the parts list which was omitted in the printing of the article and a modification which may be used in the event that the 2N404 used for Q8 has an excessively high saturation voltage.

Apparently some 2N404's have a higher saturation resistance than the ones I used. When one of these is used for Q8, the higher saturation voltage shows up as a greater zero error than the .02 volt specified in the article. If this should occur, the circuit modification shown below will provide correction. R27 is about 4.7 ohms; the exact value may be selected to set the reference pulse precisely to zero.

Stations that have constructed the chopper are generally enthusiastic about its performance and indicate very few problems. However, one point could use additional emphasis: The chopper must be connected directly to the output of the monitor diode with no amplifier or coupling capacitor in between. If this is not done, the reference pulse produced will be at the average video level rather than at the desired zero-voltage point. Any D.A.'s or amplifiers used must follow the chopper in the circuit.

The original has been in service here at WKOW-TV for a year and a half with no problems and has proven to be a very convenient modulation reference.



Parts List

Q1-Q8	2N404
D1-D8	1N191
D4, D5	1N3255
D6	1N748A
D7	1N9578
T1	Triad F-13X or equiv., 6.3V, .6 amp

All Resistors ½-watt

ROBERT L. ZUELSDORF
Engineering Supervisor
WKOW AM-TV, Madison, Wisconsin

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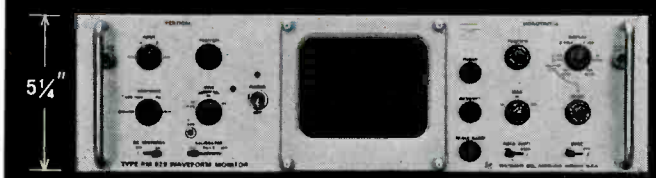
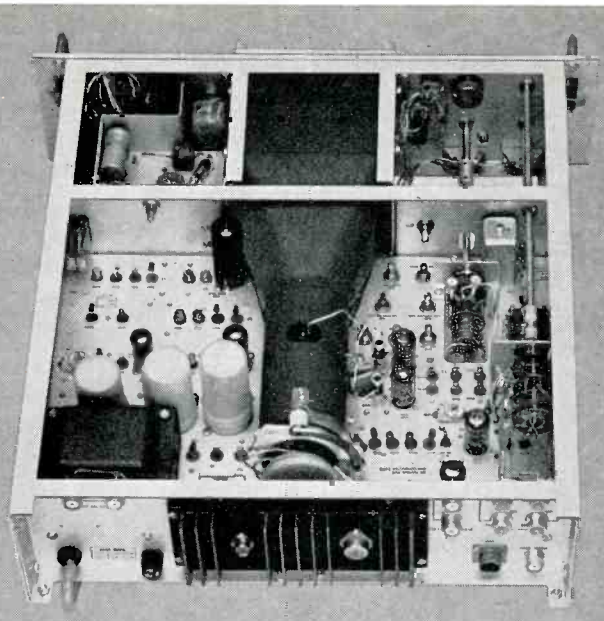
new Tektronix transistorized video-waveform monitor

with capability for analyzing VIT signals





You're looking at the back and top of a new video-waveform monitor, Type RM529. There are 45 transistors, 7 tubes, and 2 high-voltage rectifiers. All but 2 tubes and 2 transistors are socketed for easy servicing. There's no fan—it is not needed with the low power consumption of 80 watts to assure clean, quiet, long-life operation. Extremely compact, the Type RM529 uses an extremely bright crt with a full 6-centimeter by 10-centimeter viewing area—yet the instrument occupies only 5¼ inches of standard rack height.

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dc restorer—A feedback-type restorer acts during the backporch time. Not affected by presence of color burst. Does not distort the burst. Front-panel switch can disable the restorer—when other than video waveforms are viewed.

Type RM529 Video-Waveform Monitor $1100
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Circle Item 8 on Tech Data Card

ADDING FM TO CATV SYSTEMS

by Lon Cantor — How an important extra service can be added to many cable systems.

CATV is rapidly making the transition from the small community to the big town. At present, the world's largest CATV system serves some 26,000 homes in Vancouver, Canada, and a new system is now being installed in Harrisburg, Pa., that will exceed the Vancouver system in size. City councils in Los Angeles; Cleveland; Detroit; Washington, D. C.; Philadelphia; and New York City have already been asked to approve CATV ordinances. As CATV moves to larger towns, the percentage of sophisticated subscribers increases. Therefore, in order to attract subscribers, the CATV operator must offer extra program variety as an incentive to hook up.

One of the most important extras a CATV system can offer is FM programming. FM service is usually readily available to the CATV operator, and it costs relatively little, provided the system can accommodate the additional signals. Further, the advent of FM stereo has increased the popularity of FM while making it more difficult to receive by conventional methods. According to the FCC, a typical home-type antenna can receive good monaural FM signals from about twice the distance it can receive stereo FM signals.

Methods

There are three basic methods that can be used to add FM to a CATV system: The direct method incorporates a broadband FM preamplifier and amplifier to send the FM signals through the system for detection by the subscriber's set; or, an FM tuner and an FM modulator can be used for each station, to send signals through the system at convenient FM frequencies; or, a converter can be employed to send the FM signal through the system on an unused TV channel. The first method is the simplest. Fig. 1 shows a typical system using a broadband FM antenna feeding into an FM preamplifier which drives an FM amplifier. The output of the amplifier is mixed with that of the TV-channel amplifiers before being sent into the trunkline.

There are two basic problems with this method. First, not all the FM channels are received at the same signal strength, and signal balance is vital to a CATV-system trunkline because too strong a signal will cause overload and too weak a signal will result in a poor signal-to-noise ratio. You can attempt to equalize the FM stations using selective filters and traps. Separate antennas for each station will probably help, but it is virtually impossible to do a really effective job of equalization.

Another drawback is the lack of any AGC. There is no way to compensate for signal fluctuation caused by atmospheric conditions. Thus, even if you succeeded in balancing the signals at any given moment, there is no way to assure that they will stay in balance.

The second method (see Fig. 2) is preferred by most modern CATV systems. Obviously, it is considerably more complex, but it is also considerably more stable and predictable.

A separate drift-free FM tuner is used for each channel to be carried. In some systems, the FM signal is detected to audio and then sent to a crystal-controlled modulator. However, this method is unacceptable for FM stereo programs. In most systems, the incoming FM signal is simply converted by the tuner to the FM intermediate frequency of 10.7 mc. The IF signal contains both the FM monaural and stereo-subcarrier frequency channels.

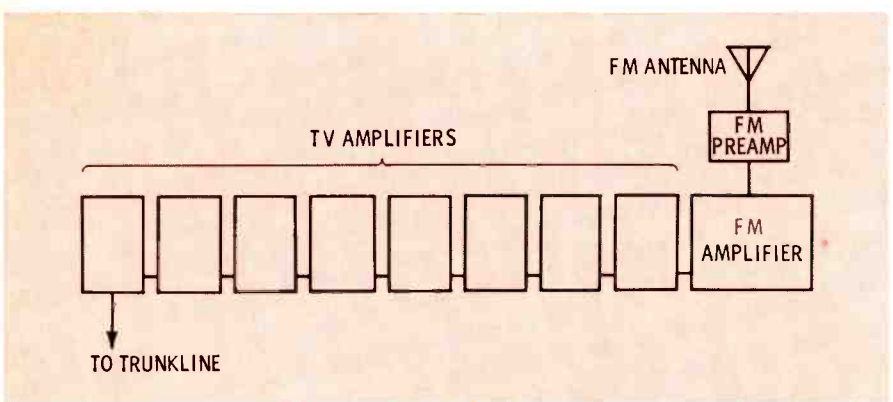


Fig. 1. Broadband amplifier and preamplifier provide the simplest FM system.

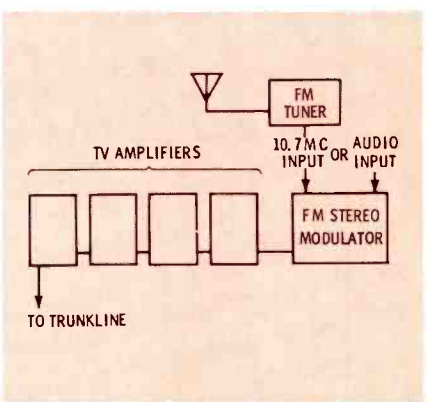


Fig. 2. Tuner and amplifier FM setup.

Fig. 3 shows a typical FM stereo modulator. Using a crystal-controlled RF oscillator, the modulator converts the IF signal to any desired RF frequency in the FM band. Normally, frequencies are chosen to space the converted signals 500 kc apart. Therefore, in the 20-mc-wide FM band (88-108 mc) there is theoretical maximum of 40 FM channels a system can carry by this method.

A high-quality FM stereo modulator will include automatic frequency control, modulation-level control, regulated power supply, and a meter for monitoring audio level and RF output.

The third method is rather ingenious and offers the advantage to the subscriber that he can listen to an FM program without using an FM tuner. The subscriber simply tunes his TV receiver to the appropriate (unused) channel and receives the FM signal through the TV audio section, while on the screen he sees a blank raster. The same type of FM tuner is used in this method as was used for method 2, but the signal is detected to audio. (There is no point being concerned with FM stereo; the TV receiver can reproduce only a single sound channel.) The audio signal is then fed into an audio modulator (Fig. 4). The FM program unit shown actually generates two distinct carriers spaced 4.5 mc apart which correspond in frequency to the sound and picture carrier frequencies of the TV channel. The audio signal is used to modulate the sound carrier.

No modulation is used on the picture carrier, but both carriers are needed to provide the difference frequency (4.5 mc), which is detected to supply the audio.

There are two drawbacks to the audio-modulator method. For one thing, each FM station requires an unused TV channel; also, it is impossible to carry FM stereo, which is rapidly gaining in popularity.

Now that many CATV systems are converting from low-band to all-band systems or including 12-channel capability, however, many systems have room available for FM on TV channels. This program concept is an inexpensive way of giving subscribers a little something extra, at least until additional TV sources become available. A variation of this third method is to provide background music for a local time-weather-music channel. Using a vidicon camera as a video source, weather devices (which indicate temperature, wind velocity, and air pressure) are scanned periodically.

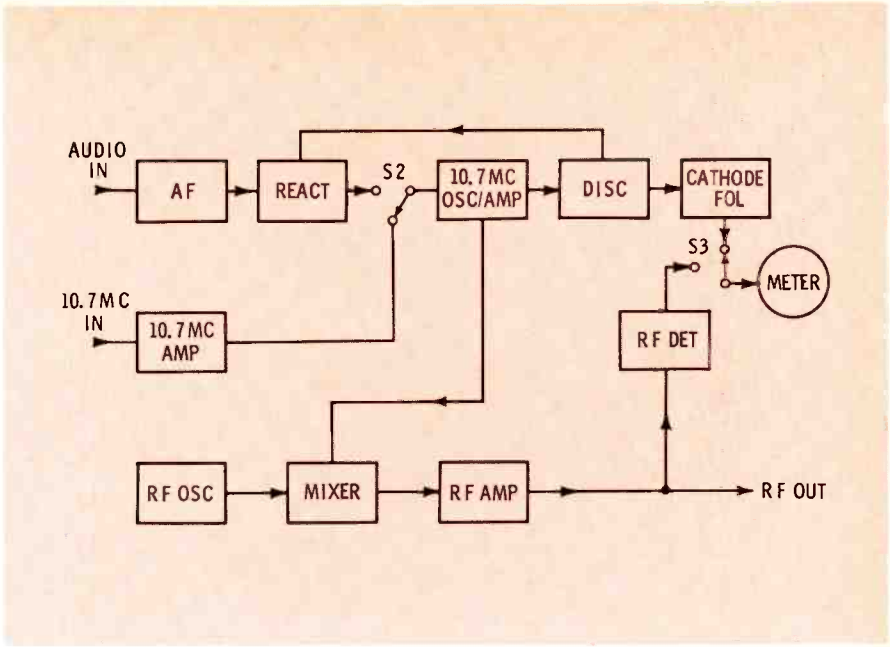


Fig. 3. Block diagram shows how typical modulator provides mono or stereo.

The audio from an FM tuner is used to modulate the sound channel, while the video output of the vidicon camera modulates the picture carrier.

Trunklines

There is one thorn in this otherwise rosy picture, however. Before thinking about adding FM to a CATV system, make sure that the trunkline can handle these frequencies. Low-band-only systems generally cut off at channel 6. Even many all-band trunkline amplifiers deliberately cut out the FM spectrum.

It doesn't pay to revamp a trunkline just to include FM. In most cases, the appeal of FM is not worth the cost of changing trunkline amplifiers. You can, of course, use the audio modulator method to add an FM channel or two, in the unlikely event that unused channels are available.

If your system can handle it, however, FM can be one of those important "extras" you offer your customers. ▲

Fig. 4. FM can be inserted on a vacant TV channel using a unit similar to this.

SMALL MONITOR AMPLIFIER

by James L. Tonne, Engineer, KBIM AM-FM, Roswell, New Mexico — An inexpensive unit to bridge the gap between a cue amplifier and a "fire breather."

We at KBIM-FM had a need for a monitor amplifier which would give us an idea of what our automation was turning out without necessarily having too-good (and too-expensive) characteristics. For making a qualitative check, we wanted a flat response at normal listening levels and a good power capability of 5 watts or better at reasonably low distortion. The input was to be bridged across the output of either our automation or our background music system. Output was to go to a single loudspeaker. Size had to be small, maintenance minimal.

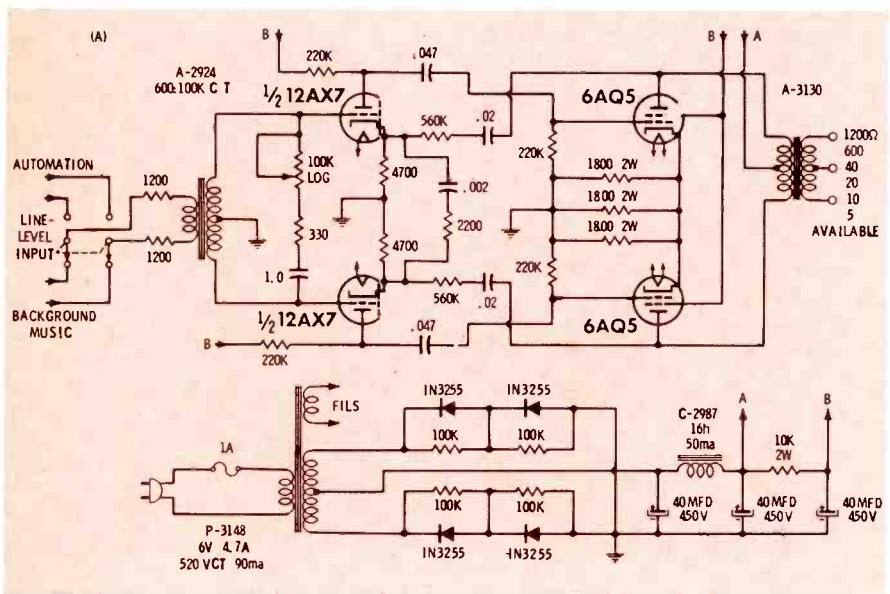
The accompanying photographs show the result, and the schematic gives technical details. The bridging input is switched as needed. The input transformer is mounted on the front panel to minimize hum pickup from the power transformer. There is some low-end droop at maximum gain due to the fact that the input transformer is operating from a higher source impedance than the one for which it was designed. It does, however, approximately complement the overload characteristics of the loudspeaker used. Since the gain control is generally set at 10 to 15 db less than maximum gain, the frequency response is normally quite flat. The high-end response also droops because of the same mismatch and is corrected within the amplifier. The gain control is connected to give a small amount of low-end boost at low levels.

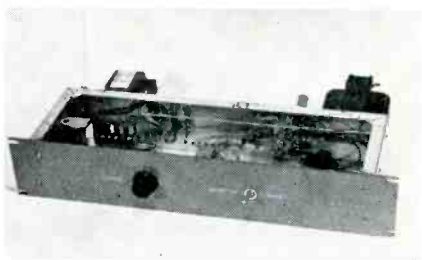
Following the gain control is a two-stage push-pull amplifier. Overall feedback from the output plates to input cathodes is used. This reliable feedback system includes both stages and is useable even if the output transformer is changed. Depending on output-stage loading, from 10 to 20 db of feedback is used with the parts values shown. The output stage is slightly overbiased; cathode current will kick up slightly with high-level audio. Output-transformer requirements are not critical. We used the unit shown because it was on hand. Plate-to-plate load impedance presented the 6AQ5's should be 12K to 14K.

Note that since the screen current will increase considerably with audio, particularly on loud passages, the voltage at point B will drop under sustained-signal conditions. This will in turn drop the continuous power output down to about 6 watts. Brief transients will generate about 10 watts output. Due to the large output transformer, this 6 watts is available across the frequency spectrum. Distortion is somewhat a function of output loading. If the unit is loaded for high power output, odd harmonic distortion will increase. If the unit is unloaded, feedback increases and distortion drops. This is true of all pentode output stages with voltage feedback.

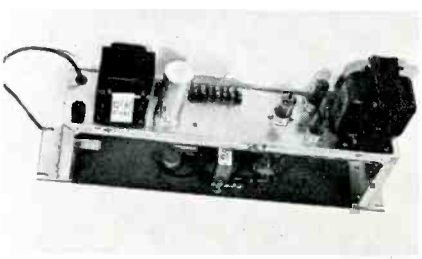
The power supply is conventional except for a large amount of filtering. The power-transformer resistance itself serves as the surge protection. Additionally, note that the rectifier legs are grounded and the output is taken from the transformer secondary centertap. Here in the Southwest we have an unusual dust problem, and this scheme places the diodes closer to ground, reducing dust collection. No on-off switch or pilot light is used.

It may pay to keep this configuration in mind when the need arises for a small monitor amplifier of intermediate capabilities. ▲





Front view of small monitor amplifier.



Rear view, major components mounted.

SURVEYING CENTRAL-AMERICAN RADIO AND TV ACTIVITY

by Martin Taylor, Editor, RADIO TELEVISION — A review of broadcast attitudes and techniques practiced by our Latin-American neighbors.

Central America, located just 700 miles from the southern tip of Texas, is composed of six small republics, has a combined population of approximately 13,000,000, embraces some of the U. S.'s friendliest neighbors, and supports over 300 AM radio stations, more than any single state in the United States. Even more startling is the fact that each of the six capital cities has at least twice as many radio stations as has New York City. This, in view of the fact that all the capitals have populations of less than 500,000, is rather hard to justify by our well-established economic standards. However, judging others using our own standard as a reference is a common fault of many of us "gringos."

Central-American Attitudes

Since television in Central America is still in its infancy with only 13 stations operating at the present time, there is plenty of room for growth. The rapidly developing Central-American common market and the completion of facilities which soon will link television stations in all six republics will certainly help to stimulate expansion of broadcast services. At the present time, however, the industry is experiencing real growing pains. First of all, as each station operates independently, finding enough good material to fill a full day's schedule is a major task, and the problem is aggravated in all cases by budget limitations and by a shortage of equipment and technical resources. In addition, small audiences throughout the area necessitate moderate tariffs.

Although the number of radio stations in operation throughout Central America is quite high, very few of them have what North Americans would consider to be adequate facilities. Inadequate government supervision over the assignment of frequencies and lack of "know-how" are probably the most significant factors contributing to substandard operations. Nearly anyone who applies for a commercial broadcasting permit receives one, and little consideration is given to the financial responsibility of the applicant or to the needs of the community. Of course, it is not to be denied that the more desirable frequencies are significant political plums throughout much of Latin America.

With very few exceptions, broadcasting in Central America could be made much more profitable than it now is, as management seems generally unaware of modern programming techniques and effective methods of selling time. With so many stations on the air in an area of limited commercial activity, competition is fierce; however, much of the time this merely consists of on-the-air innuendo directed to competing stations. The lack of Spanish-language literature on broadcasting in general has had a very negative effect on the industry. The notion, held by many North Americans, that most everybody in Central America who has any education at all can understand English is simply not true. Few Latin broadcasters understand English, and only few of these men can afford the time to wade through the technical literature that is available.

In a recent survey of Central-American radio and television stations, broadcasters were asked how U. S. manufacturers could be of more assistance. The answer most frequently given was in the form of a request for more information published in Spanish; second was a request for occasional visits from factory representatives; third was a request for instruction booklets, etc., published in Spanish. In the same survey, broadcasters were asked to specify if they preferred

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One of two control rooms at Radio YSU in San Salvador, El Salvador shows decided similarity to those found in most stations in the U.S. The announcer has separate booth.

REMOTE-INDICATING ANTENNA-CURRENT METERS

by ***Robert A. Jones,*** Midwestern Regional Editor, LaGrange, Ill.—A review of pertinent FCC Rules, of circuits, equipment, and installation techniques.

All of us know that the FCC Rules require the use of antenna-current meters in standard broadcast antenna systems. Most of us also are aware that the majority of stations also employ a remote antenna-current meter. The purpose of this article is to clarify and explain just what the FCC Rules say in this regard and to point out the common methods used to comply with them.

Reviewing the Rules

Section 73.39(d) of the Rules contains the legal requirements for remote meters and describes seven ways in which remote antenna readings may be accomplished: First a second thermocouple can be installed directly in series with the main antenna-current meter at the tower, with remote wires to the indicating instrument. This is probably one of the most common ways of achieving remote indication. Fig. 1 shows the tower-located thermocouple unit and the meter which is located at the transmitter; the other parts shown are the RF filters and the calibrating control. Method two is to use inductive coupling from the antenna lead to a thermocouple or other device to provide a DC voltage to the remote-indicating meter. Normally, this other device is a tube or semiconductor unit. Fig. 2 shows one of these units. The inductive loop is shown mounted on an insulated board which in turn is clamped to the antenna lead. The unit pictured is a new type. Whereas most of us are more familiar with the older tube-type detectors employing 6H6's and requiring AC power, the unit shown has the advantage that it uses a semiconductor diode and needs no outside power source. The third method is to use capacitive coupling to the thermocouple or other device. This method is very similar to the previously described method, except that capacitive instead of inductive coupling is employed.

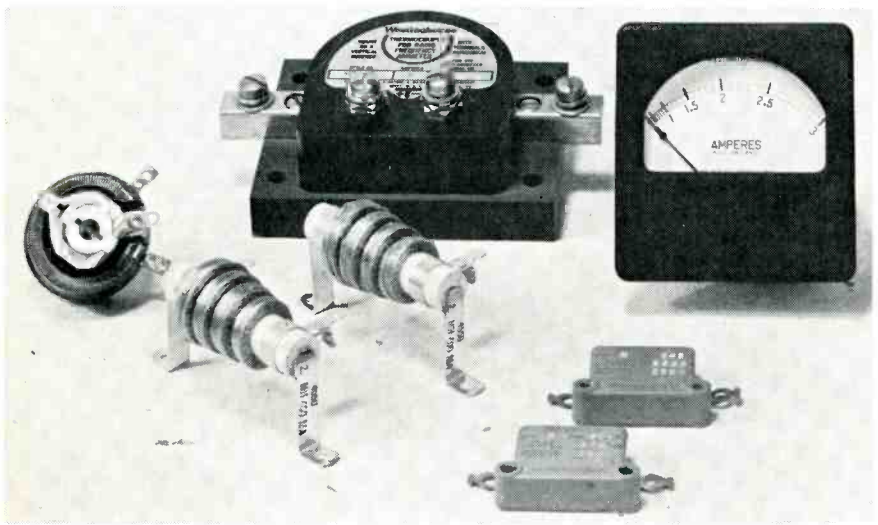

Fig. 1. Group of components used for one type of remote-indicating meter system.

The fourth method described in the Rules is to use a current transformer. The sketch in Fig. 3 shows how these units are constructed. Current transformers are also widely used in phase-sampling circuits and, in fact, are preferred by some engineers over the large tower loops. A fifth approach is to use the transmission-line current meter at the transmitter as a remote-reading ammeter. It should be pointed out that this method can be used, according to the FCC Rules, only where shunt-fed towers having no shunt-tuning elements to ground are employed. The next method, the sixth, is to use a phase monitor for determining antenna base currents, or their ratio in the case of directional antenna systems. It should be pointed out that no matter which of the above methods is used, the base-current readings must be logged in accordance with the individual station license. For most stations this is once per day for each pattern or mode of operation. In addition, the remote-current meters in the phase monitor must be connected directly to the current-sampling loops on the tower or to the current transformers, if employed. They shall have no ground-shunt paths of any nature. The meters in the phase monitor can utilize arbitrary scales with a calibration

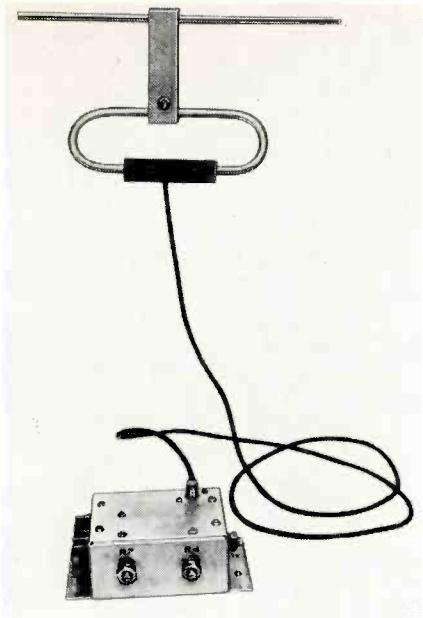

Fig. 2. A modern inductive-loop pick-up system using a semiconductor diode.

curve showing the relationship between the actual base-meter scale and the arbitrary scale, which must be posted at the transmitter. Some stations find it easier to use a fixed ratio instead of a calibration curve. For example if the base-current meter has a range of 0 to 5 amps and the phase-monitor meter has a 0-to-100 amp scale, the ratio or factor would be 20. This means that an actual base-current reading of 4 amps would be read and logged as 80. A notation on the log would serve to indicate the factor.

Method number seven, the last one acceptable to the FCC, is to use remote-control equipment, provided that the indicating instruments are connected directly into the antenna circuit at the same point as the antenna ammeter. Just how to go about connecting these remote-control systems and their respective metering problems will be discussed in a later article.

The FCC Rules further require [Sec. 73.39(d)(2)] that the remote meter be connected into the antenna circuit at the same point as, but below, the antenna base-current meter (see Fig. 4). By "below" the Commission means the transmitter side, not the tower side of the base meter. The remote meter must further be calibrated within 2% of the regular meter over the entire range above one-third of full scale.

Further Interpretation

It is important to understand why the Commission requires the remote-meter device to be "below" the antenna ammeter. This is so that any coupling from the remote meter to ground will not read on the antenna ammeter; the antenna ammeter must read only true antenna current.

In addition to the above FCC requirements, the Rules also stipulate that remote base meters shall meet the same requirements as the regular meters, with respect to scale accuracy. Further, the calibration shall be checked against the regular base-current meter at least once per week. These calibration checks, as we all know, should then be logged in the maintenance log. Further criteria are that all remote meters be provided with shielding or filters as necessary to prevent any feedback of RF energy from the antenna to the transmitter and the function of each instrument should be clearly and permanently shown on the meter itself or should be shown immediately adjacent to the meter. In most cases, the meter name plate is mounted directly above or below the meter.

Where the remote-reading device uses vacuum-tube rectifiers or semiconductor diodes, these devices are acceptable if they meet the following three conditions: that they comply with all the requirements mentioned above with regard to scales and to scale linearity; that they have an overall accuracy of 2% of the full-scale reading; and that they be installed, checked, and calibrated in accordance with the above rules.

Section 73.3(d)(9) specifically points out that the burden of proof for satisfactory performance of any

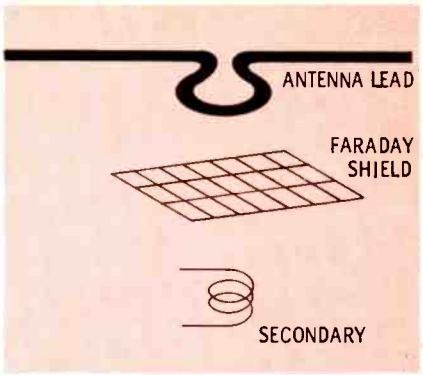

Fig. 3. A typical indirect system using loop in antenna lead for primary.

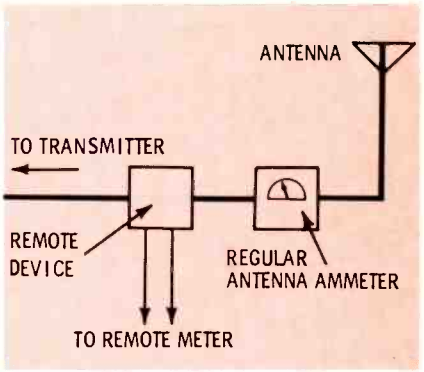

Fig. 4. Placement of remote device is always on transmitter side of base meter.

type or kind of remote-ammeter device used shall rest upon the FCC licensee and upon the manufacturer of the equipment.

Fig. 5 shows a typical circuit of a semiconductor device used for remote indication of antenna currents. You will note that L1 is a coil used for inductive pickup of the antenna current as described in Section 73.39(d)(1). It is not necessary in this case to break the antenna lead to insert the remote device. With the thermocouple type, you do have to break the line. In the unit shown, the pickup loop is connected to the rectifier unit by means of coaxial

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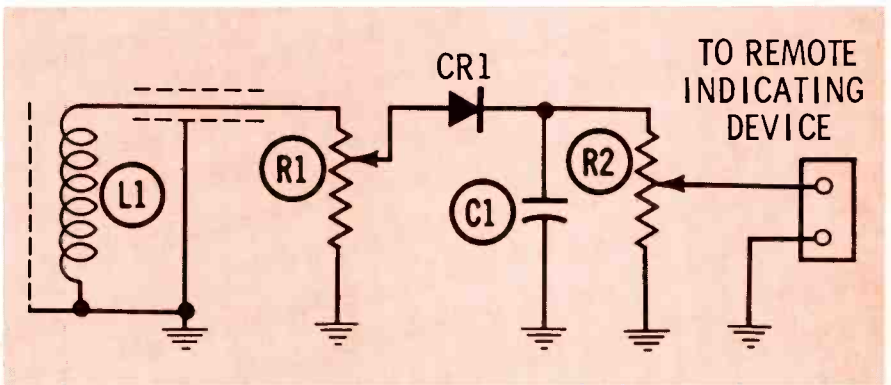

Fig. 5. Schematic diagram of typical remote unit using inductive pickup loop.

REMOTE CONTROL FOR HIGH POWER

by Len Spencer, Consulting Author, Technical Director, CKAC, Montreal, Quebec—Some general thoughts regarding those factors pertinent to unattended operation of 50-kw facilities.

Although many radio stations operating at powers below 50 kw have employed remote operation for ten years or more, the decision to risk remote control for stations of top power is not to be taken lightly. The search for reduced operating costs in the face of declining revenues provides managerial motivation, but there are many factors that must be taken into account by the engineer before he commits management to a substantial capital expense. Although the following article is predicated upon Canadian radio laws, the conclusions reached are equally valid for U. S. stations.

One of the first studies of 50-kw remote-control operation was made by O. L. Prestholdt of the Columbia Broadcasting System engineering department and delivered before the 1961 NAB Engineering Conference. This scholarly paper pointed the way to an appraisal method that was the basis for CKAC's inquiry into the experiences of other stations, their methods, and their suggestions for improvement. Not all comments, we might add, were enthusiastic.

Requirements

To establish the ground rules under which we are to operate, here is the essence of the "Broadcast Specification No. 8 for the Unattended Operation of Broadcast Transmitters" as promulgated by the Department of Transport (DOT), the Canadian regulatory body.

"The transmission equipment including transmitter, antenna system, auxiliary equipment, and accommodation shall be approved by the Telecommunications Division of the Department of Transport (DOT) as complying with the requirements governing such matters. This submission shall cover in full detail, as herein set forth, the construction and operation of the proposed control and supervisory system.

a) Block diagram of the system.
b) Complete description of all operating sequences.
c) List of all operations performed.
d) List of information returned to the control point.
e) Complete wiring diagram of control equipment.
f) Diagrams showing changes to be made in the actual transmitter.

Each installation will be considered on the basis of its separate submission. Blanket approval of a system cannot be granted since the details of installation and adjustment, on which operation of the system depend, will vary considerably. However, a system approved for one installation generally will be satisfactory for other similar requirements.

a) Transmitter on and Transmitter off controls are required together with suitable controls for different modes of operation, such as reduced power for night.
b) Means are required to shut down the transmitter immediately upon failure of the control circuits and to indicate this condition at the control point.
c) Additional control functions, such as changeover to stand-by equipment, are optional.
d) In all cases, RF power, modulation, and frequency must be monitored at the control point.
e) A telemetering system may be used with the indicating instruments accessible to personnel who will be on duty and responsible for the entire period of the transmission, or:
f) An alarm system may be employed using marginal relays with a locked-in signal system and signalling devices accessible to personnel who will be on duty and responsible during the entire period of the transmitter operation, or:
g) Any other acceptable means.

Where a directional antenna is involved, provision must be made for monitoring some parameters (such as the tower current) in accordance with e, f, or g herein. The selection of the parameter(s) to be monitored will be left to the consultant. However, an explanation of the reasons for the selection of the particular parameter shall be included in the technical submission.

A satisfactory schedule of maintenance must be declared and carried out during the period through which the transmitter is operated unattended. Such schedule of maintenance must provide for a general inspection of the transmitting equipment at least once a week and a general overall test at least once a month. The extent of the inspection and test must be satisfactory to the Telecommunications Division. An accurate and complete log of all maintenance shall be kept for the information of a duly authorized representative of the Telecommunications Division."

Limits of Feasibility

Now, at first glance, this looks as if a very rudimentary system would suffice and that the official requirements are fairly simple; but, a study of the practical application soon dashes management's hope for a large cost reduction through a small capital outlay. In nearly all cases,

the high-power station will have been in operation for a number of years, probably growing from a modest 1 kw to a 5 or 10 kw facility and finally progressing to 50 kw using a complicated directional pattern with three to five towers. It probably also has a standby power plant to drive an auxiliary 10-kw transmitter during the time the main transmitter is shut down, or when the power fails. These factors imply a complicated physical plant requiring serious study for Rules compliance.

One factor which appeared early in the feasibility study conducted by CKAC engineers was that of protecting an unmanned facility. Vandalism seems prevalent wherever buildings or equipment are remotely operated. Among those cases that came to the attention of CKAC were those of a 250-watt station in Quebec which was completely dismantled and carted away by truck and of an Ontario station whose river-located ground radials were fished out and sold as scrap! Other similar circumstances suggest that the building should be securely locked and fenced. Barring the windows often seems a good idea as well.

A second factor that might not occur immediately to many who study the remote-control problem is whether or not to maintain an on-premises engineer to cope with failures that might be very costly in terms of lost commercial announcements. In large metropolitan areas, for example, a breakdown occurring during prime time periods (which generally fall, coincidentally, during peak traffic times) might find the duty engineer tied up for an hour or more in a freeway traffic jam while enroute to the transmitter site.

Perhaps a few more items will become apparent in examining an idealized remote-control system for a hypothetical station where price is no object.

An obvious weakness lies in the vulnerability of the lines carrying the program and the proposed control circuits, which are subject to caprices of man and nature. A reliable studio-to-transmitter link (STL) with solid-state receiver and control equipment all fed from a floating battery system provides an effective answer. Even if the transmitter building has been enclosed it would be advisable also to fence the property immediately surrounding it. Since this seems to invite or challenge vandals, one could use an RF or high-frequency audio field to detect the presence of moving bodies.

Table I

Control-Line Failure

When a failure occurs anywhere along the control loop, a visual indication occurs at the studio, an alarm sounds, and the transmitter is automatically shut down.

Action: Advise Telco.

Program Failure

When program is not received from the program line for a predetermined time, the program-failure alarm is actuated.

Action: Check program source, then advise line company.

Primary Power Failure

When power to the transmitter remote-control panel fails, the transmitter shuts down. A trickle-charged battery and relay can be used to activate the remote-alarm system.

Action: Advise transmitter personnel.

High-Voltage Phase Failure

Two relays will indicate a failure in any of the three high-voltage power-supply phases.

Action: Call the power company.

Blower-Motor Phase Failure

Two relays will indicate failure at any phase supplying power to the blower motor that supplies air for tube cooling and will shut down the transmitter.

Action: Call transmitter engineer.

Tower-Light Failure

A current sensitive detector will detect a 10% current change. Failure of any side light or air-beacon lamp will activate the alarm.

Action: Call Air Traffic Control (FAA).

Pattern Monitor

Detector units at the phase-monitor end of the RF sampling lines will indicate any change in base current for either tower and operate an alarm.

Action: Advise RI and transmitter engineer.

RF Failure

An RF-pickup coil will feed a low-limit monitor which will indicate a loss in normal RF output and operate a studio alarm.

Action: Advise transmitter engineer.

Frequency Deviation

A limit-switch meter will indicate change in frequency and actuate an alarm.

Action: Advise RI and transmitter engineer.

Overmodulation

The modulation meter limit-switch contacts, connected to a tone generator which will shift frequency when overmodulation occurs, operates a relay that flashes an overmodulation indicator.

Action: Reduce line output levels.

Fire Alarm

A bimetal heat device actuates the studio alarm.

Action: Call fire department and transmitter engineer.

Burglar Alarm

Either a photocell system or a moving-field type actuates an alarm.

Action: Call police and transmitter engineer.

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INSIDE CLASS-C AMPLIFIERS

by Alan Andrews — Be sure you understand the operation of this circuit that you work with every day.

By definition a class-C amplifier is one in which the plate current flows for less than 180° of the input signal cycle. This condition is obtained by biasing the stage about 1½ to 2 times the cutoff voltage, or even more in some cases. Limiting the time during which plate current flows distorts the signal, because even with a sine-wave input signal the tube conducts in short spurts or pulses.

In some applications this distortion is not objectionable because the sine wave can be reshaped by a plate tank circuit. Use of class-C stages is limited primarily to amplification at a single radio frequency or when bandwidth requirements are not great, for example as RF amplifiers in radio transmitters. Class-C amplifiers are often associated with power amplification, but they cannot be used in audio circuits or in any wideband application. And even in AM transmitters they cannot be used to amplify the modulated RF carrier.

The distortion and other problems associated with class-C amplifiers are greatly outweighed by the excellent efficiencies that can be obtained. Efficiencies can exceed 80% in some cases, and the high efficiency is a special advantage in large transmitters where so much power is involved. The design, operation, circuit refinements, and operational problems of class C are probably more complex than with any other amplifier type. A complete volume could be written to provide adequate coverage. This article presents the basics of the subject as an introduction or a review. Interested readers can then progress to more thorough coverages in some of the existing amplifier literature.

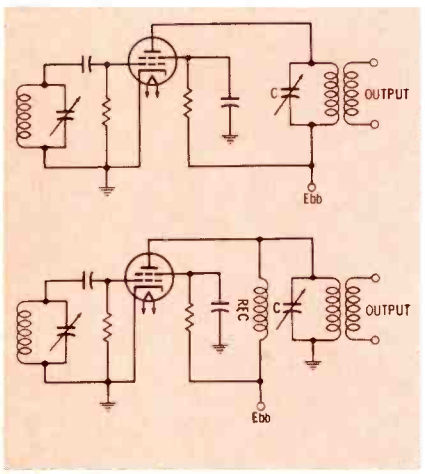

Fig. 1. Schematic diagrams of two basic class-C amplifier circuit arrangements.

Applications and Circuits

As previously stated, the main use of class-C amplifiers is in transmitters in which the relatively small output of the master oscillator must be increased in level to that required for radiation. In a transmitter the amplifiers may have different names, but their usages are similar. For example, the buffer stage is the amplifier that follows the oscillator. Many years ago this stage isolated the following stages from affecting the oscillator frequency. But with the improved equipment available today, the buffer is no different from any other RF amplifier except for its location in the lineup of stages. Intermediate power amplifier (IPA) is the term applied to RF amplifiers between the oscillator and the final stage; it can include the buffer and the driver. The driver stage is the amplifier that precedes the final and furnishes the driving signal for it. The final power amplifier (FPA) is the last stage in the system, and its output must be sufficient to apply to the antenna system for radiation.

Fig. 1 shows two general types of class-C circuits. These are basic circuits and do not include circuit refinements such as RF chokes, additional filtering, voltage and current meters. Fig. 1A is a series-fed arrangement in which the DC plate current flows through the tank circuit. Fig. 1B is a shunt-fed arrangement in which the DC plate current flows through the RF choke (RFC). The choke offers high reactance to the signal frequency and prevents shorting the signal through the power supply. There is no DC voltage or current in the shunt tank circuit; this feature provides safety for the operator in making circuit adjustments. In general, higher-power amplifiers may use shunt feed; lower-power stages use series feed. However, both circuits are similar in operation.

Class-C amplification is much like that of other classes in that the stage converts DC input power (Eb times Ib) to AC output power. But for class C the tube acts as a synchronous switch, connecting the load to the source for only a small portion of each input cycle. The stages are usually driven with a sinusoidal signal, and the grid tank is tuned to the frequency of the input signal. As plate current flows on the positive peak of each input cycle, the plate tank is furnished with sufficient energy to keep it oscillating and reshaping the input sine-wave signal into one having larger amplitude.

Class-C stages often draw grid current and may then be called class-C2 stages. C1 indicates that there is no grid current, but the number designations may not always be listed. These stages need

more drive than class A or B stages because the input signal must have sufficient amplitude to bring the stage out of cutoff on each cycle. The stage can be driven with an even larger signal (driving the grid positive and causing grid current), thus further increasing the output amplitude.

Voltage, Current, and Power

The voltage and current relationships are more complex for class C than for other classes of operation. Differences are due primarily to the time limitation of the plate current pulse and by the fact that the grid is driven positive. These relationships are shown in Fig. 2. The grid signal (eg) is a sine wave and causes the instantaneous grid voltage to vary above and below the DC bias level (Ecc). Plate current exists only when the instantaneous grid signal goes above the cutoff level; grid current exists only when the grid voltage goes positive. Thus the grid-current pulse has less time duration than the plate-current pulse. Once the plate tank circuit has started oscillating, the AC plate signal (eb) is 180° out of phase with the grid signal. The changing plate voltage causes the cutoff level of the tube also to vary at a sinusoidal rate.

Note that the instantaneous plate voltage (eb) is lowest at the time of tube conduction; this coupled with the short conduction time accounts for the low power input and, hence, high efficiency. Power is applied only during the conducting portion of the input cycle, and during this time enough energy must be supplied to the tank circuit for the power output and the power losses. On each burst of current the plate side of the tank-circuit capacitor (C in Fig. 1) swings to its minimum voltage. After the pulse, the field built up around the coil collapses in an attempt to keep current flowing in the same direction. Then the capacitor charges to opposite polarity (maximum positive). When C is fully charged, no more energy is available from the inductor field, so discharge begins. Circulating tank current is then in the opposite direction, and a field of opposing force builds up around the coil. Then the negative (actually minimum positive) charge begins to form on the plate side of the capacitor, and tube conduction again takes place.

The main power loss is in the tube, and this loss can be reduced somewhat by decreasing the angle of conduction. This means increasing the bias, but a larger input signal is then required. When the grid goes positive, power is consumed in the grid circuit, and this power must be supplied by the preceding stage. Thus the smaller the operating angle is, the greater are the driving voltage and power required to develop full output signal. The best compromise of driving power, plate efficiency, and power output usually results when minimum plate voltage (at peak of driving signal) is just equal to the peak positive grid voltage. If the minimum plate voltage falls below maximum positive grid voltage, grid current increases rapidly because electrons are attracted to the grid rather than to the plate—in fact the plate current pulse would be flattened on its peak if this occurred. And if the plate current decreased, so would the power output. Grid driving power then would need to be increased, and as a result grid dissipation would also increase.

With a given peak plate current, the number of electrical degrees of conduction determines the efficiency and the power input and output. As the number of degrees is increased, the power input and output are also increased, but the additional plate dissipation causes a decrease of efficiency. However, smaller drive voltage and power are needed to produce a given output in the load circuit. With minimum plate current flow there is less power input; hence the power output is limited. A compromise of all the factors involved sets the angle of plate current flow at 120° to 150° for most stages. In all cases, however, the operating conditions must be kept within the ratings for the tube being used.

The tuned plate circuit acts resistive at its resonant frequency and offers maximum load impedance. This high impedance does not drop the plate voltage very much, as would be the case when a resistive plate load is used. In addition, the tuned circuit acts as a filter, offering high impedance at the operating frequency but much lower impedance at all other frequencies. Generally the tank impedance equals L/CR; when the stage is loaded, the effective resistance coupled back into the tank lowers its resonant

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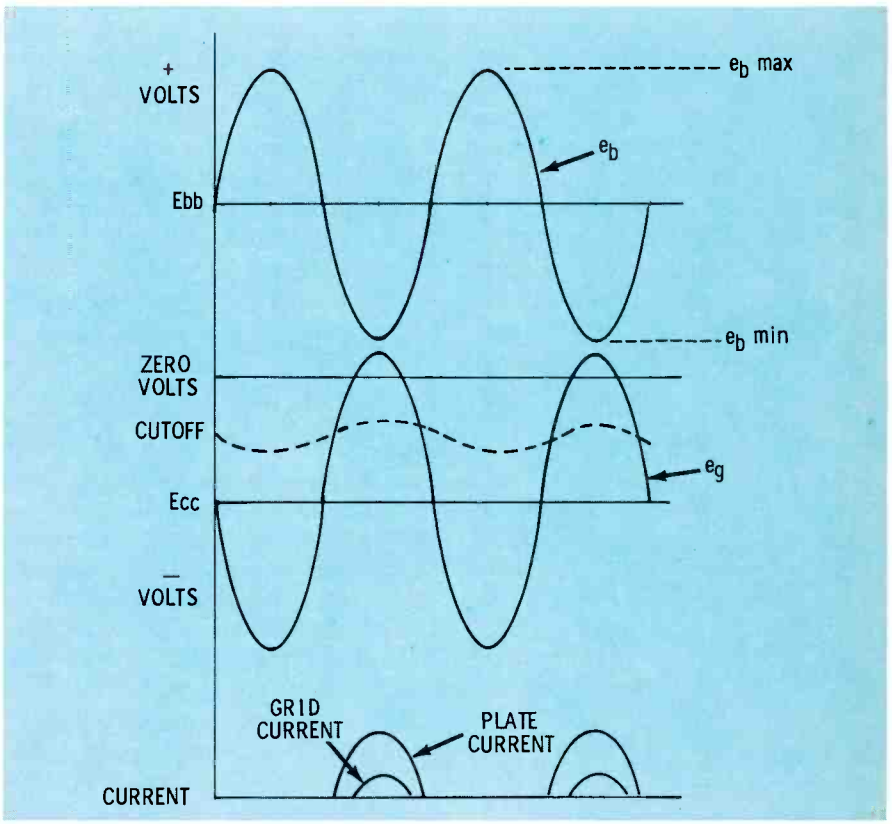

Fig. 2. Relationships of the voltages and currents in a class-C amplifier.

A NEW LOOK AT NEGATIVE RESISTANCE

by **C. G. Cunningham,** Professional Engineer, Taos, New Mexico—Part 2: Continuing the examination of the semiconductor family exhibiting the negative-resistance phenomenon, with a description of simple circuits and applications.

Last month we examined the basic phenomenon of negative resistance and suggested some of the applications which might be found using modern semiconductor methods. Mention also was made of the unijunction transistor and the tunnel diode. Prior to looking at these devices (and others) in more detail, a few words about volt-ampere curves may be in order. So far, these curves have been drawn with the voltage along the horizontal (X) axis and current along the vertical (Y) axis; this was done to emphasize the differences between voltage-stable and current-stable negative resistance. It is more conventional and convenient, however, to draw these curves with the independent variable (the factor that is controlled) along the X axis and the dependent variable (the factor that changes as a result) along the Y axis. Unfortunately, this makes the curves for both types of negative resistance look the same. Nonetheless, the curves that follow will be drawn according to convention, so, close attention must be given to which unit, voltage, or current is along which axis. Current-stable curves have current along the X axis; voltage-stable curves have voltage along the X axis.

One of the handiest of the negative-resistance devices is the unijunction transistor. In the strict sense of the word, it is not a transistor, but a double-based diode. It is constructed using a bar of semiconductor material with ohmic contacts at each end and a rectifying contact in the middle. The equivalent circuit for the unit is shown in Fig. 1. When a voltage is impressed across B1 and B2, the semiconductor bar acts as a voltage divider, so that a portion of the voltage across the base appears at the emitter connection. When the emitter voltage is less than the fraction of the inter-base voltage appearing at the junction, the junction appears to be a reverse-biased diode with a normal high input resistance. If the voltage at the emitter is raised to the forward conduction point, carriers are injected into the semiconductor, and the resistance between the emitter and base 1 drops to a low value.

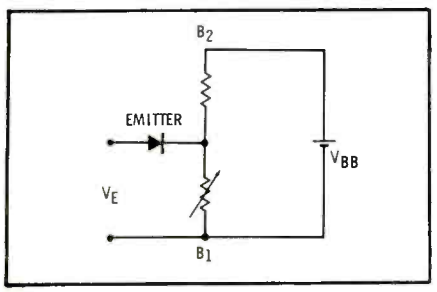

Fig. 1. Unijunction equivalent circuit.

Fig. 2 shows the characteristics of emitter voltage and current for different values of voltage across the bases of the unijunction transistor; these characteristics make it a member of the current-stable negative-resistance class. The voltage decreases with increasing current, the net resistance decreases, and its action is controlled by the emitter voltage. In short, it acts like a neon bulb. But, there is a vast difference! The firing voltage can be varied over wider ranges and to lower values than were possible with gas discharge devices. Also, reliability, control of the firing voltage, and uniformity of the value of negative resistance are better from unit to unit.

Unijunction transistors make an ideal and flexible element in relaxation oscillators as shown in Fig. 3. The wave shapes shown are obtained through the slow charging of capacitor C through R3, until the firing voltage is reached; then, C discharges rapidly through the lowered resistance between the emitter and B1, until the voltage falls below the minimum point and the diode becomes reverse biased again. The rapid discharge current causes a pulse of voltage across R1 as shown. Numerous variations are possible. For instance, by clamping the voltage across the bases and varying the voltage applied across R3 and C, the frequency of oscillation becomes proportional to the variable voltage. Without the RC circuit, this arrangement becomes a voltage-sensing circuit. The voltage across R1 increases as soon as the emitter voltage exceeds the firing voltage.

Unijunctions make simple multivibrators when arranged as shown in Fig. 4. Off time T1 is determined by the charge time of the capacitor through R2 and the diode up to the firing voltage; on time T2 is determined by the discharge of the capacitor through R1 and the unijunction transistor. Many other timing circuits, triggered and free running, are possible with this negative-resistance circuit element.

Another current-stable negative-resistance device of exceptional utility is the silicon-controlled rectifier. In fact, this family of semiconductor devices holds the promise of becoming one of the most important of the recent electronic inventions. As a two-terminal element, cathode to anode, it exhibits the characteristics of all the four-layer-junction semiconductors. This is the curve represented by Fig. 4 (Part 1); but, in the case of the silicon controlled rectifier (SCR), the negative-resistance region is extremely sharp as shown in Fig. 5.

The unique advantage of the SCR is its capability of switching into the negative-resistance region by means

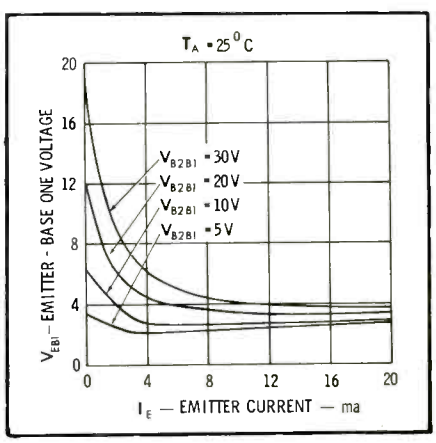

Fig. 2. Unijunction emitter operation.

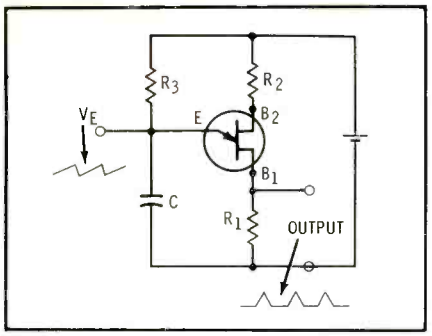

Fig. 3. Simple relaxation oscillator.

of a low-current pulse to the cathode gate junction. The SCR remains blocked until the gate signal is supplied or the breakover voltage is reached; in other words, no biasing power is required. Since the SCR is capable of controlling large amounts of power with small gate signals, it is an extremely high gain device.

The SCR is the solid-state equivalent of a thyratron; however, its small size, low power requirements, and flexibility make it much more useful. It can be used as a solid state—therefore sparkless—switch or relay, in inverter circuits, as a regulating element, and in countless other power control applications.

Voltage-stable negative resistance is less familiar than the current-stable variety; the tetrode vacuum tube when properly biased was the most important component that displayed this characteristic prior to the semiconductors. In this type of negative resistance, the net resistance across the terminals increases after some terminal voltage is passed; in other words, current decreases with increasing voltage. Logically, the timing function in this type of circuit is controlled by inductance, while in a current-stable negative-resistance circuit it is controlled by capacitance.

The sensational new component that displays voltage-stable negative resistance is the tunnel diode. It operates by tunneling, a different principle from that used in most other semiconductors. The significant characteristic of the tunneling effect is that there is no delay of the current carriers (holes or electrons) in reaching the other side of the junction. Tunneling is a special type of ordinary conduction similar to that in a copper wire. The current impulses through the junction travel at the speed of light. The result is that tunnel diodes are capable of operation at extremely high frequencies and display negative-resistance characteristics from DC to the gigacycle region. Thus, the tunnel diode is useful as an extremely fast switch, high-frequency multivibrator, microwave amplifier, or oscillator.

Fig. 6 shows the equivalent circuit of many tunnel-diode applications. By juggling the values of the three possible variables, R, L, and E, the tunnel diode becomes a free-running multivibrator, a one-shot multivibrator, a flip-flop, an oscillator, or an amplifier.

The general objective in most of these circuits is to allow current to build up through the inductor and tunnel diode; then, the diode is switched to its high-resistance state. Since the current can't change rapidly through the inductor, it must discharge through the load. Fig. 7 shows an idealized representation of the volt-ampere characteristics of a tunnel diode. The three solid lines indicate the three possible types of load lines we can construct. For a one-shot multivibrator, E and R are selected to obtain load line 1. A pulse is applied to the input to increase the current past point G on the curve. As the current tries to rise past point G, the tunnel diode starts to increase its resistance. Since there is inductance in the circuit, the current can't decrease as rapidly as the tunnel diode is increasing resistance, so the operating point switches to point H. Then, current

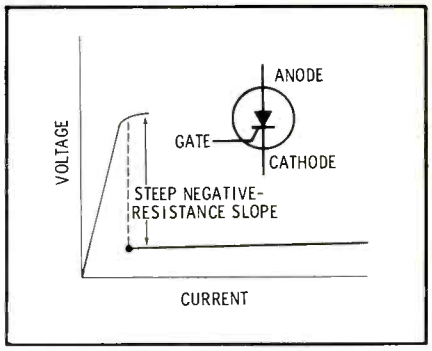

Fig. 5. SCR Negative-resistance curve.

through the inductor starts to decrease along the lines H to J. At J, the diode switches to point K, and current starts to increase until the stable point E is encountered. The duration of the pulse is determined by circuit inductance and the diode and circuit resistances.

When load line 2 of Fig. 7 is used and the inductance in the circuit of Fig. 6 is made zero, flip-flop operation is obtained. A positive pulse is required to exceed point G, and the diode switches to some point above C and settles back to point C when the current pulse is removed. A negative pulse is required to reset it.

Load line 3 is used for free-running multivibrator operation. When power is applied, current starts rising toward the load line until it exceeds point G. Then the operating point shifts to H, and the inductor starts to discharge until J is reached; switching again occurs, and the process starts over.

Load line 3 is also used for tunnel-diode amplification. As can be seen from the oscillation of the free-running multivibrator, the inductance must be zero for amplification. Since the negative-resistance characteristic of the tunnel diode extends to extremely high frequencies, it is very difficult to get the inductance low enough to prevent oscil-

• Please turn to page 36

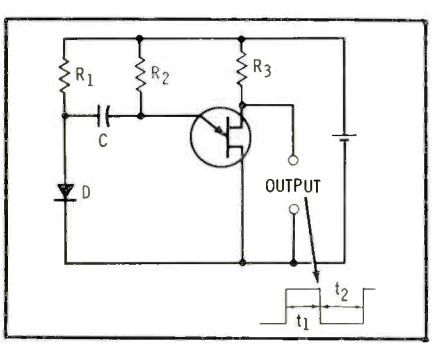

Fig. 4. Simple multivibator circuit.

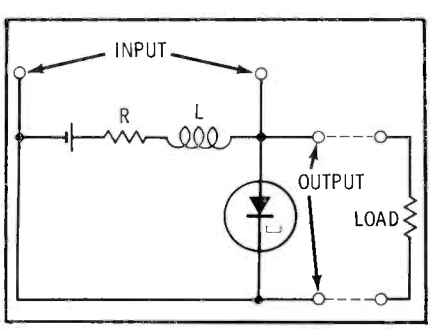

Fig. 6. Simple tunnel-diode circuit.

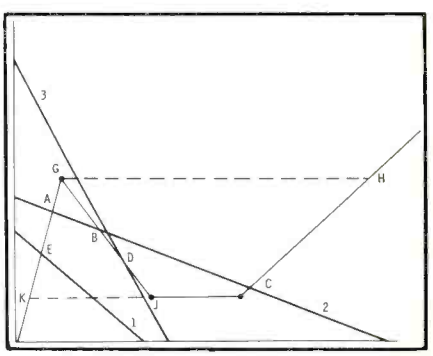

Fig. 7. Three tunnel-diode load lines.

20-CPS TONE GENERATOR

by James L. Tonne, Engineer, KBIM AM-FM, Roswell, New Mexico — An inexpensive unit which will generate and key a clean 20-cps tone for use in cueing tapes used in tone-operated automation equipment.

Stations thinking of going to an automation system which uses 20- or 25-cps tones for control or channel transfer might do well to keep in mind the following circuit for the tone generator shown in Figs. 1 and 2. It is certainly economical to build and, by virtue of its simplicity, should give trouble-free service.

A study of two commercial generators showed that their tone oscillators were remarkably similar to the National Bureau of Standard bridged-T type. We decided to use the basic RC-tuned oscillator which would be followed by a photoconductive switch. The circuit was designed to use a minimum number of parts, and the key word was to be dependability.

A look at the circuit will show the oscillator to be an all-triode version of the NBS bridged-T. This approach minimizes the number of parts required. Positive feedback is applied around the 12AX7, through both the 6AQ5 (connected as a cathode follower) and the 6-watt, 117-volt light bulb. Negative feedback is also applied around this circuit, through the bridged-T RC network. The negative feedback is at a minimum at one frequency—in our case 20 cps. Positive feedback is set, to the point which sustains oscillations, by adjusting the 2000-ohm pot in the cathode circuit of the 12AX7. If oscillations are a bit on the strong side, resistance of the light bulb increases, reducing the positive feedback. If oscillations are weak, the bulb resistance decreases, increasing the positive feedback. As a result, the amplitude tends to be stable.

Output is taken from the junction of the electrolytic blocking capacitor and the light bulb. The signal here is about 30 volts peak to peak, and it may be fed to any circuit having a load impedance as low as about 10K ohms. (These figures are mentioned in case the reader might have other uses for a good, stable oscillator circuit. There is no reason the circuit can't be used as high in frequency as the upper end of the audio spectrum. Above this range, the input capacitance of the triode throws a monkey wrench into things by reducing the feedback signal, thus altering the relationship between frequency and network capacitance.)

Timing and Keying

Before we go into details on timing and keying, it should be pointed out that if tone length can be controlled manually by a pushbutton only, then about $25 can be shaved off the construction price. We have found in practice, since unskilled personnel use this thing, that the relays for timing are worth every penny of their cost.

It would be possible simply to use the relay contacts (or a pushbutton) to key the output, but this will result in an annoying click each time the signal is keyed. A balanced modulator or filter could be used to reduce the undesirable effect, but we wanted a simple non-frequency selective keying system; so we chose the photo-conductor route.

By arranging a cadmium-sulphide photocell (type 8347) in series with the output transformer as shown and taking the output across the

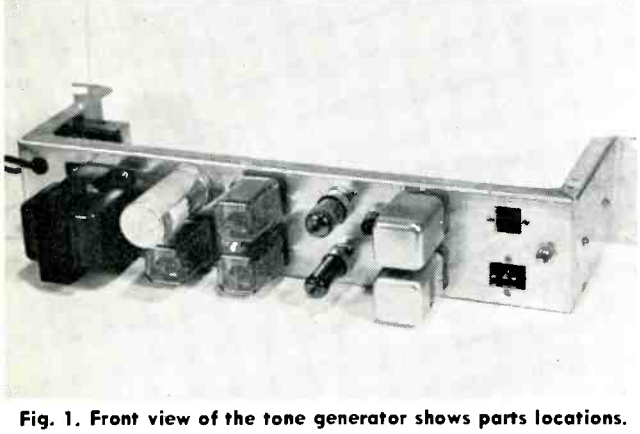

Fig. 1. Front view of the tone generator shows parts locations.

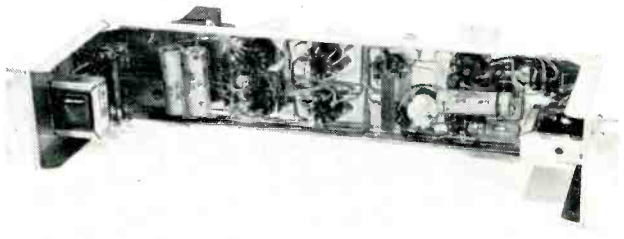

Fig. 2. Under-the-chassis view of the 20-cps tone generator.

transformer secondary, output will appear only when the cell is illuminated (in our case by a No. 47 pilot light) and conducting.

Since the output tone-burst length generally must be timed to some degree of accuracy, a timing circuit was devised. We have a pair of buttons, one for timed tone length and another for untimed but minimum length tone.

Pressing the TIMED button (see Fig. 3) operates K1 directly from the high-voltage supply. This discharges 20-mfd capacitor C6 into K2, which pulls in briefly and does the actual keying. Another set of contacts (pins 1 and 3) on K2 parallels the TIMED button, so that if the button is released before the tone is stopped, K2 will, in effect, keep the button closed. K2 will fall out when C6 is discharged, thus ending the tone.

Pressing the UNTIMED button operates K2 from the high-voltage supply. K2 contacts 1 and 3 pull in K1, connecting C6 across K2. C6 again keeps K2 pulled in for the minimum chosen time. C6, then, controls tone-burst length.

Whenever K2 pulls in to key the tone, C7 is connected to the high-voltage supply through R17. When the tone ends, C7 pulls in K3 for about one second. This added circuitry is most handy when cutting reel-to-reel tapes: K3 can operate a "caution" light to warn the announcer to keep audio off the bus during the time following the tone. It is during this interval that the playback decks cue up or restart. Wowing audio can thus be avoided. C7 controls the time the caution light is on.

The working contacts on K2 (pins 9 and 11) operate the No. 47 pilot light (see schematic shown in Fig. 4) which is mounted adjacent to the photocell. When the light shines on the cell, the cell conducts and allows the oscillator to drive the output transformer. By controlling the rate of rise and fall of the lighting, the rise and fall times of the output-signal envelope can be controlled. The type 47 pilot light, with its series 47-ohm resistor, has a relatively slow rise and fall of illumination intensity. Consequently, tone-output amplitude rises to 90% of final level in about 3 cycles and falls to 10% in about 8 cycles. When the "switch" is off, the tone is suppressed over 60 db. The cell must be shielded from extraneous light, however. Ours is assembled with the pilot light and its 47-ohm resistor mounted in a closed plug-in assembly. Keying the output has little effect on the oscillator; amplitude bounce is about .3 db and frequency shift is difficult to verify. Internal impedance of the tone-generator output does not vary objectionably with keying.

If the 12AX7 burns out or is removed for testing (seldom) then the 6AQ5 will be driven to saturation. When this occurs, the only factor limiting the 6AQ5 cathode current will be the 10K cathode resistor and the 6AQ5 operating characteristics. Such a worst-case failure will result in the 10K cathode-resistor dissipation rising from 4 watts to about 7 watts. The 6AQ5 plate dissipation will drop from its usual 3 watts to 2 watts.

The power supply is on the conservative side, using silicon diodes for rectification and an LC filter. The 400-ohm "surge" resistor was used to hold the power-supply voltage down. It's not needed for surge

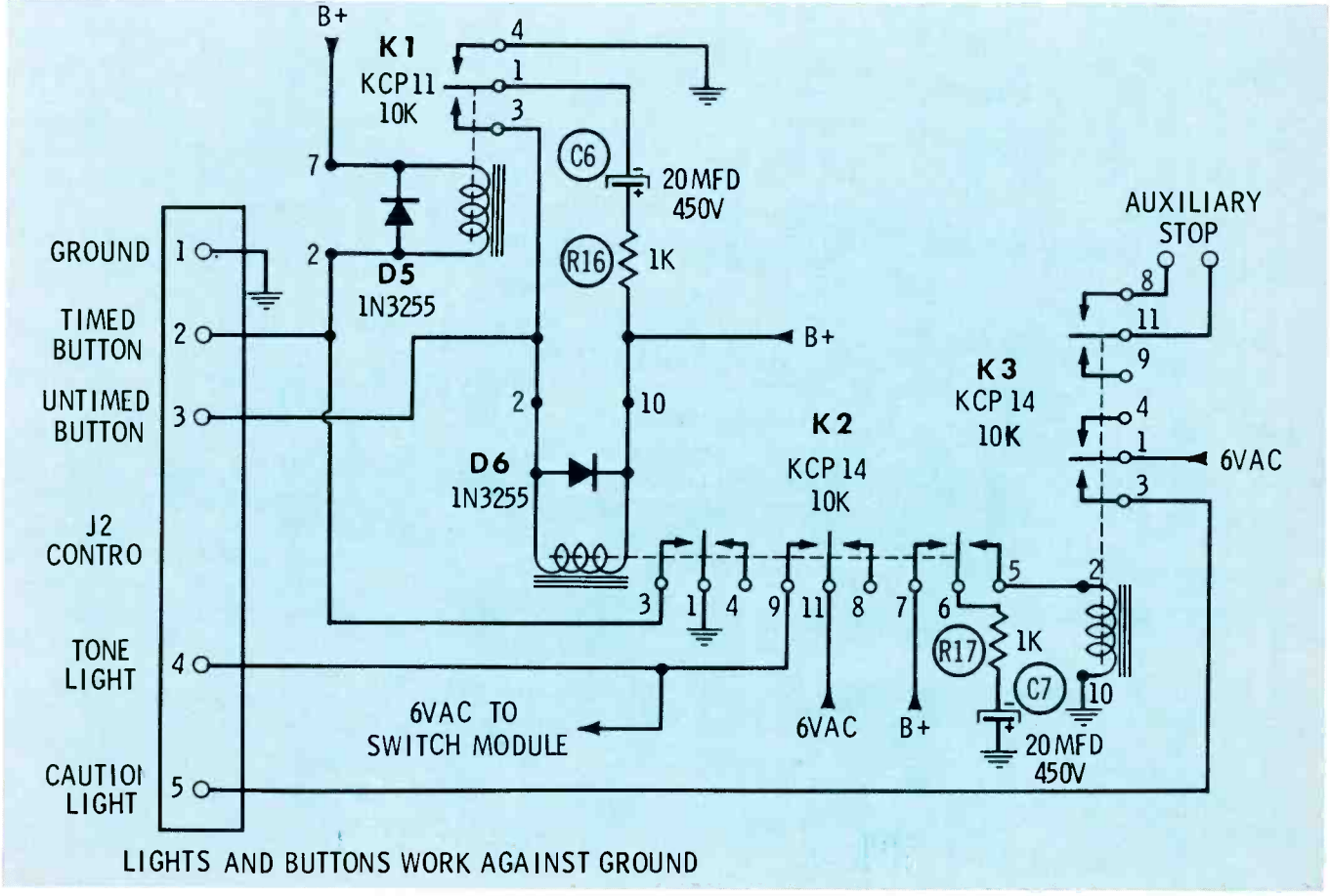

Fig. 3. Schematic diagram of the keying circuitry and timing circuitry of the unit shows how these two sections operate.

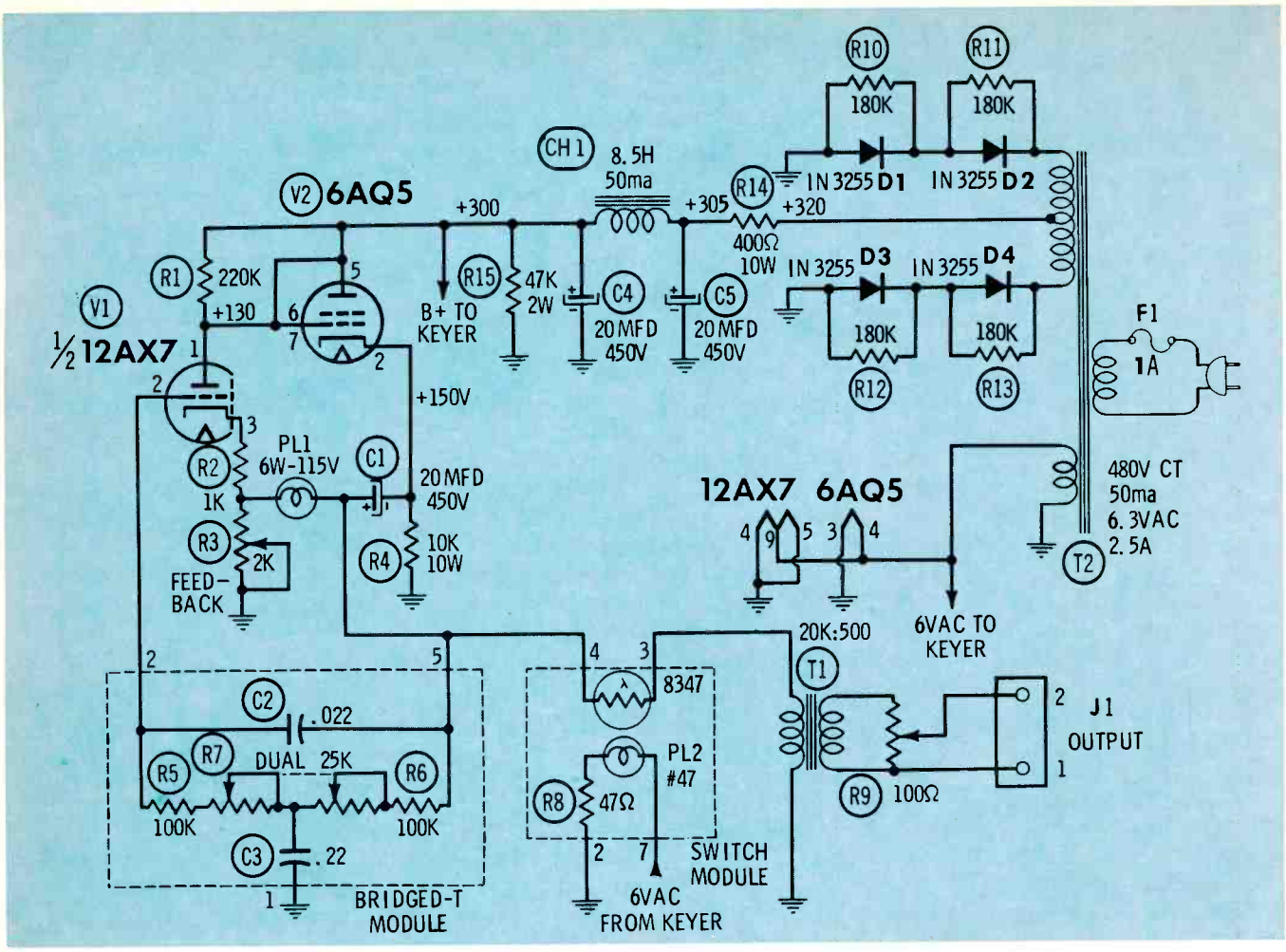

Fig. 4. Schematic diagram of the bridged-T oscillator, the photoconductor keying switch, and the solid-state power supply.

protection, since the power transformer has a 200-ohm secondary resistance. High voltage is taken from the transformer centertap to keep the diodes electrically closer to ground, minimizing dust pickup.

Adjustment

The feedback control is best set with the aid of a scope connected to the output of the unit. Adjust the control for maximum output without distortion. The bridged-T network may have to be trimmed to the proper frequency. Small frequency changes are best made by adjusting the values of the 100K resistors. Our network has a dual 25K linear pot as shown. Fixed resistors will work. Increasing either the resistor values (keep them about equal to one another) or capacitor values (keep them to about a 10:1 ratio) will lower the frequency. In our case, we compare the oscillator frequency with that of the power line using the ever-present scope and Lissajous patterns.

The output level is set at whatever value is desired. Here at KBIM we simply insert the tone-generator output in **series** with the output of the recording limiter (see Fig. 5). We record the tone right up to the 100% mark on the record-amplifier meter. The recording level must not be so high that intermodulation occurs if the tone is printed when audio is also being recorded. It might be of interest here to point out that the frequency response of the record-amplifier VU meter must be checked to make sure that its response at 20 cps is reasonable. We found that we had to increase the value of a coupling capacitor to bring up the meter low-end response.

It is important to keep the recording heads demagnetized. If they become magnetized, a kind of modulated noise will appear when the low-frequency tone is printed. And, perhaps needless to say, the recording system should have a high-pass filter in it (after the limiter) to prevent spurious low-frequency signals from being recorded unintentionally, as they will eventually arrive at the tone sensor on playback and trip it.

Output of this unit is rather low, about .8 volts rms, and may require the recording-limiter output to be padded down somewhat. It is, however, entirely sufficient for recording purposes. ▲

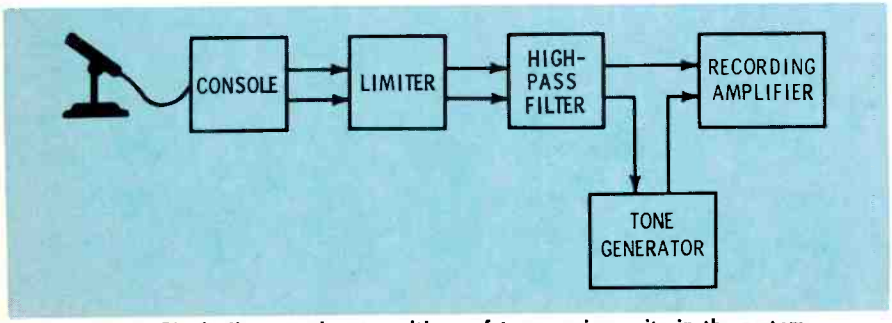

Fig. 5. Block diagram shows positions of tone-cueing units in the system.

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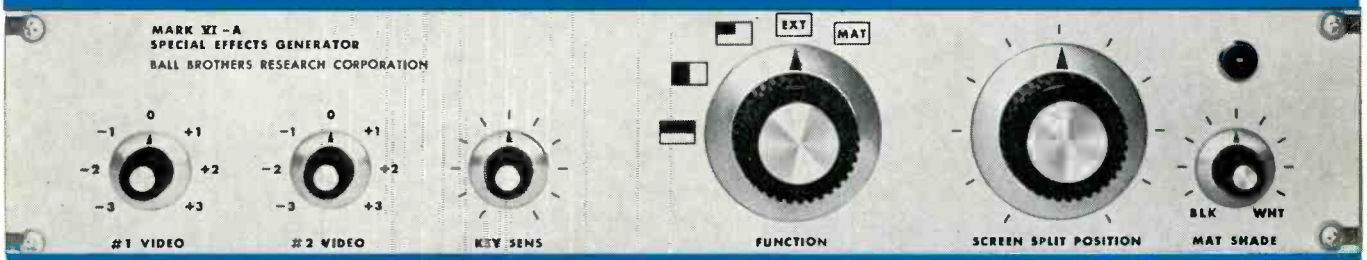

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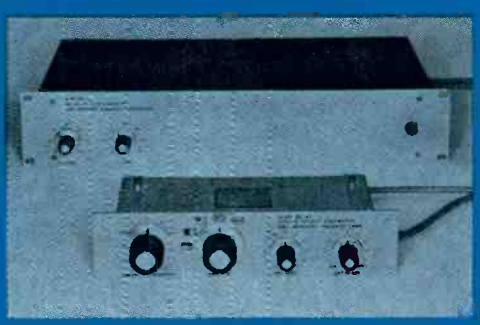

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Central-American

(Continued from page 13)

In the studios of Telesiete, Channel 7, in Guatemala, Sr. Carlos Jara discusses the day's programming with Rodrigo Sánchez.

European, Japanese, or U. S. equipment. The majority preferred U. S. equipment; however, the question many times provoked a series of comments. Central-American broadcasters feel that U. S. manufacturers do not, in general, give the technical assistance needed for efficient installation and adequate maintenance. European manufacturers seem to follow their sales more closely and supply information, printed in Spanish, concerning the equipment. A factory-trained technician often is sent to the area to help during the installation or to clear up problems that might occur in the maintenance of the equipment. Broadcasters complain that U. S. manufacturers often seem interested only in the original sale and do not follow through. Both Japanese and European manufacturers are deeply interested in capturing the growing Central-American market, and, to this end, the isthmus recently has been the object of attention from trade delegations representing broadcast-equipment manufacturers located in many European countries and in Japan.

Programming Concepts

The concept of programming in Central America is quite different from what is familiar in the U. S. Networks as we know them in the U. S. do not exist in Central America. There are a few radio-station chains, but these merely consist of a central station, usually located in the capital city, with repeaters scattered throughout the rest of the country. Radio programming consists mostly of recorded music, with an average of three or four "soap-operas" and three or four newscasts each day. The embassies of the United States, Great Britain, and France provide cultural programs at no cost, and a good clue to a station's financial success often may be estimated by counting the number of these cultural programs on a station's log. Stations with limited facilities or with large blocks of unsponsored time will use them to help fill out the schedule.

As news services are expensive and not generally available throughout all of Central America, the preparation of a daily newscast presents a real problem. Most newscasts are prepared by recording information from international shortwave stations such as the Voice of America, the British Broadcasting Corp., Radio Canada, and others. These recordings are then played back and painstakingly copied on a typewriter. Radio newscasts are very important in Central America, as there are only a few newspapers; even these are not circulated widely in the interior. Radio news, therefore, replaces the daily newspaper in many areas of Central America.

Remote broadcasts of ball games, other sports events, political rallys, and similar events are not at all uncommon. If the program is to originate in the same city, the only requirements are a telephone wire, a small amplifier, one microphone, and an announcer who is usually in charge of the entire set-up. As telephone facilities are not available between the Central - American countries, except via radio telephone, some stations are equipped with small single-sideband transmitters of the type used by amateurs here in the U. S. These transmitters also prove useful for relaying programs originating in the interior where telephone communications are generally unsatisfactory or unavailable. Television programs originating outside of the studios present a somewhat more difficult problem. Because of the terrain and other factors, microwave relays have not proved satisfactory in Central America; therefore, several TV

Six-bay turnstile antenna of Channel 7 in San Jose, Costa Rica, is on a 240' tower on a mountain 10,000' above sea level.

stations are now using small UHF transmitters as links between the studio and the remote equipment. With the exception of two stations in Nicaragua, all television stations in Central America are now equipped with small broadcast-quality video-tape recorders, providing a means for delayed remote programming.

Radio in all six of the Central-American countries is commercial, just as it is here in the U. S.; however, the national government of each country maintains, usually in the capital city, a government radio station which is cultural and noncommercial. In most cases, the government stations have very low ratings. Presently, all television outlets are commerical, but a few years ago the government of Guatemala operated a cultural, noncommerical channel in Guatemala City. Present plans are to resume operations as soon as possible, but at this time little progress has been made to that end.

Stations in Operation

The radio and television industry in these six small republics is representative, in many ways, of the industry throughout Latin America. It may be stretching a point to compare these relatively undeveloped areas of broadcasting with the sophistication and progressive development found in Mexico where there are more than 500 radio stations and 40 TV stations, or with Argentina where in 1964 alone 18

new TV stations went on the air. Nevertheless, Central-American problems are very similar to those found in the rest of Latin America, even if magnified and complicated by the dearth of modern equipment and of trained technicians.

Guatemala

Guatemala has 52 radio stations and two television stations. At the present time, the primary television outlet is TGBOL-TV—Channel 3. TGAB-TV, known as Telesiete, operates on Channel 7. A construction permit also has been granted for a new station on Channel 11, and that station plans to begin regular operation before the end of 1965.

After a bad fire several years ago, TGBOL-TV reconstructed its studios, in downtown Guatemala City, which they used until recently when they moved to their new transmitter/studio site on the outskirts of the city. Studio and transmitter of Channel 7 both are located in a residential area of Guatemala City. This station began transmitting during January of this year.

One of the most modern radio-broadcasting facilities in all Central America is also located in Guatemala City. Radio Fabulosa, TGRT, has been on the air for about one year and already has a very high rating directly attributable to energetic management and modern programming. The success of this enterprise is indicative of the possibilities for radio in Central America.

Nicaragua

Nicaragua, the largest of all Central-American countries, has 62 radio stations and one television station. The television station transmits simultaneously on Channels 6 and 8. The station has very limited studio space and the barest minimum of equipment necessary to get on the air. A new studio is being constructed in Managua, and it probably will be occupied and in service sometime during 1965. The family of ex-dictator Somoza owns and operates several radio stations and has an interest in the television station.

El Salvador

El Salvador, the smallest mainland country in the Western Hemisphere—only slightly larger than the state of Massachusetts—is also the most densely populated country in the Western Hemisphere. The country has 36 radio stations and three television stations. The television stations operate on Channels 4, 6, and 8. Channel 4 is licensed to Radio Television YSU and has been leased to Television Salvadoreña. Channel 6 and Channel 8 are both licensed and operated by Television Salvadoreña. All three channels operate from the same building. The present installations at Telecentro are very modern and complete. The most up-to-date broadcast facility in the country is Radio YSU, which also operates out of Telecentro.

Honduras

Honduras is, without a question, the poorest of all Central-American republics. HRTG-TV, Channel 5, operates in the capital city. A repeater station in San Pedro Sula, the second city of Honduras, operates on Channel 9. A construction permit has been granted for a second channel in the capital, but at the present no work has begun on its construction. There are 35 radio stations and two television stations operating in the republic. Radio plays a very important role in Honduran life, as rugged mountain terrain and bad roads make it very nearly the only communication means available to people located in the interior of the republic.

Costa Rica

The Republic of Costa Rica, the most economically stable of all Central-American countries, is growing rapidly. There are 41 radio stations and three television stations. Recently, a construction permit was granted for a new television station in Alajuela, the second largest city in the country. Panamanian television interests have also been investigating the possibility of a fifth radio station to be located in the capital of Costa Rica. Televisora de Costa Rica Ltda. operates on Channel 7. This was the first television station in the country. Channel 9, TIC-TAC-TV, is the larger of the two stations operating in San Jose. Channel 7 has a repeater station in

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the interior. Television seems to be growing faster in Costa Rica than in any of the other Central American countries.

One of the most important chains of radio stations in Costa Rica is Sistema Atenea. This chain operates three stations, one in San Jose and two in the interior. They celebrated their 30th anniversary this year. Another important radio station in San Jose is Radio Monumental. To date, Radio Monumental is the only station in Central America using tape-cartridge equipment.

Panama

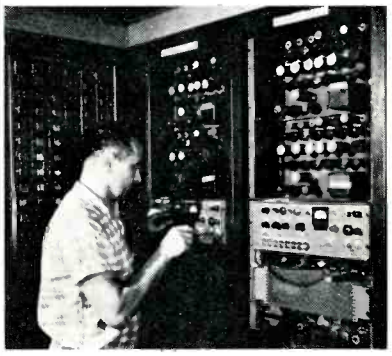
Not including U. S. operations in the Canal Zone, Panama has 65 radio stations and two television stations; Channel 2 is owned and operated by the family of ex-President Chiari, and Channel 4 is operated by the Corporation Panemeña de Radiodifusion owned by the Eleta family. Construction permits have been issued for new television stations both in Panama City and in the interior of the country. The commercial AM band is almost as crowded in Panama as it is in Guatemala with 34 AM commercial stations. This does not include 7 short-wave stations and 20 FM stations. As is the case throughout most of Central America, most of the FM stations are used as studio-to-transmitter links; however, they are operated in the commercial band. The largest network of radio stations in Panama is Circuito RPC.

Conclusion

While broadcasting in general throughout Central America suffers from equipment and personnel shortages, it is a thriving industry which has become an important part of the lives of many Latin Americans. Dependence upon radio for news and entertainment is as strong or perhaps even stronger than in the U. S. Increased support from North American manufacturers will undoubtedly reap mutual benefits, allowing equipment to be improved technically as funds become available. The importance of broadcasting has been established, and its growth seems assured. ▲

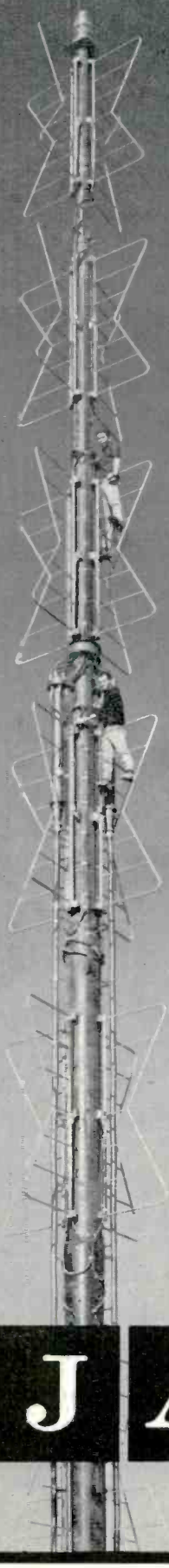
ETV in Milwaukee

The scene on our cover this month shows part of the control facilities of Milwaukee educational TV stations WMVS (channel 10) and WMVT (channel 36). WMVS, which covers ten southeast Wisconsin counties with its 316-kw signal, has been on the air since 1957. By 1963 the demands for television time for education had become so great that a single channel was not adequate. To solve this problem, WMVT was placed in operation. Both stations operate within the television division of the Milwaukee Vocational and Adult Schools. Both antennas are mounted on the tower of commercial station WITI-TV.



Last January, WMVS began programing a limited number of color film programs. Obsolete color-film scanning equipment donated by WISN-TV and WITI-TV was modified by WMVS engineers for this purpose.

From the foregoing and the pictures shown here and on the cover, it can be seen that ETV in Milwaukee is no small operation. ▲



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Remote Control

(Continued from page 17)

Of course, it does no good to know that the building is under attack unless the alarm is given to the nearest police station by an additional wireless link. To protect the approaches to the RF feedlines, our imaginary installation could use photoelectric cells by day and floodlights by night. Loss of power or of any phase might be signalled both to the studio and directly to the power company. Add a fire-alarm system and with day-and-night helicopter service and reliable remote-control equipment and all should be okay.

This slightly facetious specification is given only to illustrate to what extremes one could go if money were no object; the other extreme would be a simple ON and OFF switch and remote frequency and modulation meters located at the studio. There is, of course, a happy medium between these two extremes which can now be examined in the context of CKAC, where most of these procedures were adopted.

A Practical Approach

Initially, let us eliminate those things which are too costly or which can not be changed. In general the antennas and their supply lines cannot be protected or duplicated. In some cases there are available two sources of power from the same power company using alternate routes, but this case is so rare one can assume that the power supply is fed from only one source. Failure of any of these essential elements could not be prevented by an on-premises transmitter engineer; neither could a telephone-cable break occurring either in the city or in the run between studio and the transmitter. Physical protection for the transmitter can be achieved by bricking up all windows and by installing adequate fencing.

Since the most significant hours, from the standpoint of economics, fall between 6:00 AM to 6:00 PM, retaining an on-duty engineer at the transmitter during this period offers a means to obtain the best elements of manned and unmanned systems. For the remaining hours of the schedule, an on-call engineer can provide adequate backup for a reliable remote-control installation.

CKAC has a 10-kw emergency transmitter and an auxiliary power plant capable of operating the transmitter, its associated audio equipment, and the tower lights. This standby setup can be started by dropout relays which detect loss of voltage to the main power supply or by pressing a remote-start button at the studio. Generator voltage output level is controlled by a small motor-driven rheostat operated remotely from the studio.

The complete list of control functions for a high-power station should generally incorporate the following:

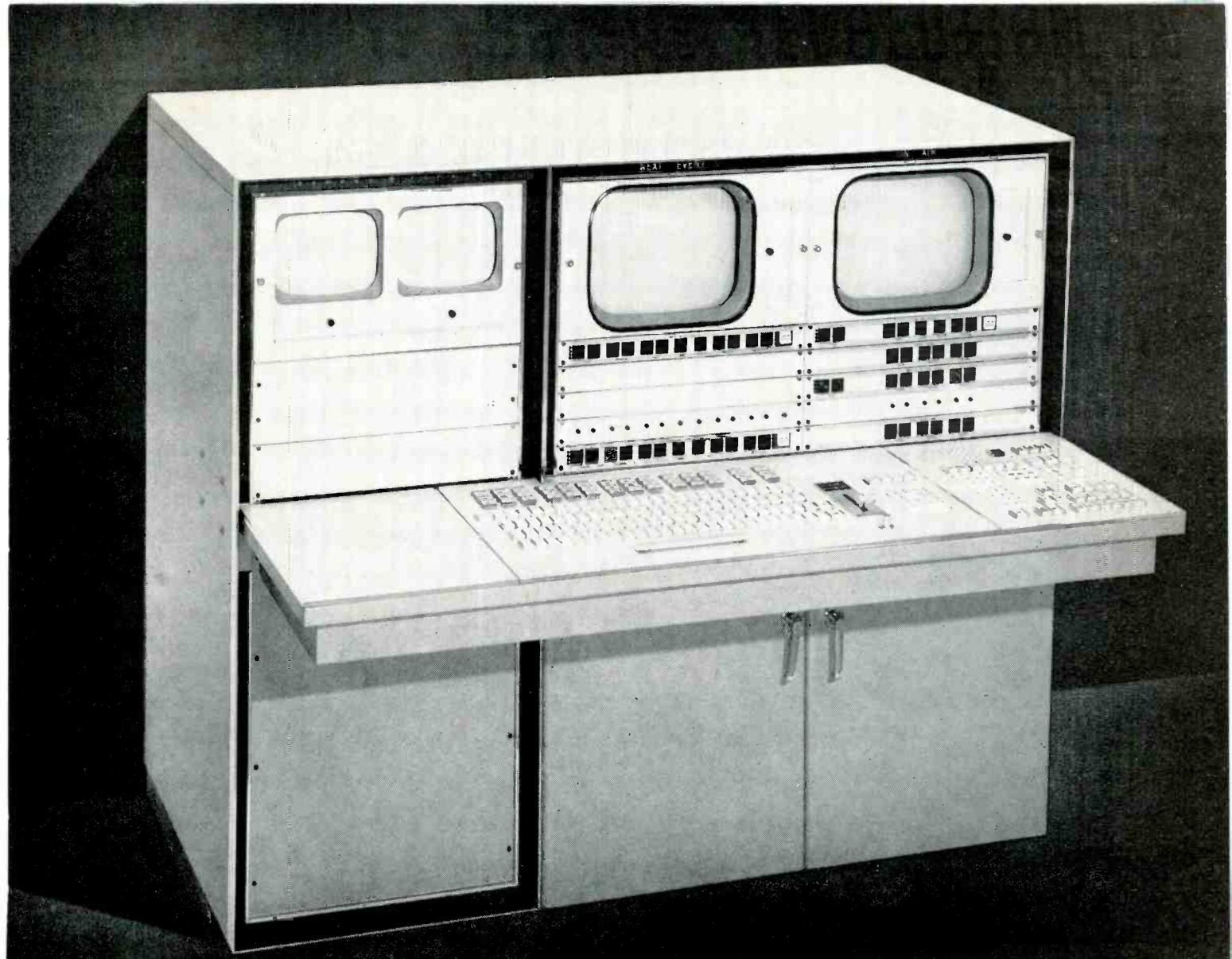
- Filaments OFF-ON
- Plates OFF-ON
- Transmitter OFF
- Raise or Lower voltage
- Emergency Power ON-OFF
- Antenna change-over from 50 kw to 10 kw (daytime pattern to nighttime pattern)
- Emergency Filaments ON-OFF
- Emergency read voltage
- Emergency Plates ON-OFF

In addition to the various control functions required for remote operation, a series of monitoring devices must indicate, through visual or aural alarms located at the control point, any deviation from normal operation. The parameters monitored vary, of course, from installation to installation, but will probably include those listed in Table 1.

Two three-frequency tone transmitters at the station and one three-frequency tone transmitter at the studio will use frequencies between 2300 and 3000 cycles. Highpass and lowpass filters at each end will separate the telephone channel from the control tones. Ringing for the telephone circuit will be achieved by using one control function from the studio and one alarm function from the transmitter.

Conclusion

Obviously, a single article cannot give detailed specifications for installing remote control at every station. It is hoped, however, that the general comments offered here will serve to help direct the thinking of those who may be planning such a move. ▲



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Tarzian's APT-1000 is the most versatile television programming system in existence. In fact, performance of the APT has been so sensational, we invite you to try to stump it. We're confidant this solid state computer can handle any programming problem you have—better, faster, and smoother than you ever thought possible. Fact is, it has never been possible . . . before.

A special purpose computer, APT-1000 was designed solely for total and flawless television programming. It can't panic, prime time or any time. Easy operation develops an operator confidence that shows up in improved efficiency and quality of programming.

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SARKES TARZIAN

BROADCAST EQUIPMENT DIVISION BLOOMINGTON, INDIANA

Circle Item 16 on Tech Data Card

Negative Resistance

(Continued from page 21)

lation. The capacitance of the junction, other stray capacitance, and lead inductance also permit other modes of oscillation. Accordingly, the use of the tunnel diode as a microwave oscillator seems very easy. Getting the tunnel diode to oscillate is not the problem; getting it to oscillate only at the desired frequency certainly is. Special techniques are required to use the tunnel diode as an oscillator or amplifier.

The condition for operation as an amplifier is shown by Fig. 8. Inductance is assumed to be zero. Voltage and resistance are selected to bias the element into the negative-resistance region as shown by the solid line. As the voltage is increased by some small amount ($\triangle e$, representing a small AC input signal), the load line shifts upward as indicated by the dashed line. This shift alters the operating point of the tunnel diode from point 1 to point 2, with a corresponding change in voltage $\triangle E$ and current $\triangle I$. The gain is, of course, $\triangle E/\triangle e$.

Recently, "packaged units" that have negative-resistance characteristics similar to the tunnel diode have been produced. Actually, these are not devices that exhibit this feature inherently; they are packaged transistor circuits using feedback to obtain the desired characteristics. Their packaging, stability, versatility, and general usefulness justify their inclusion with these other devices.

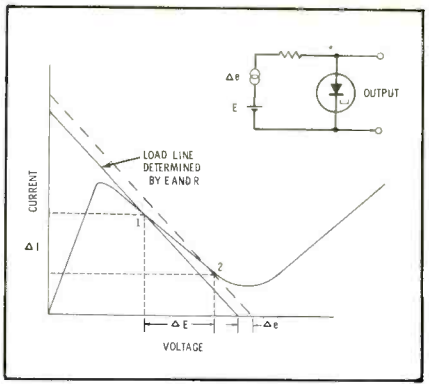
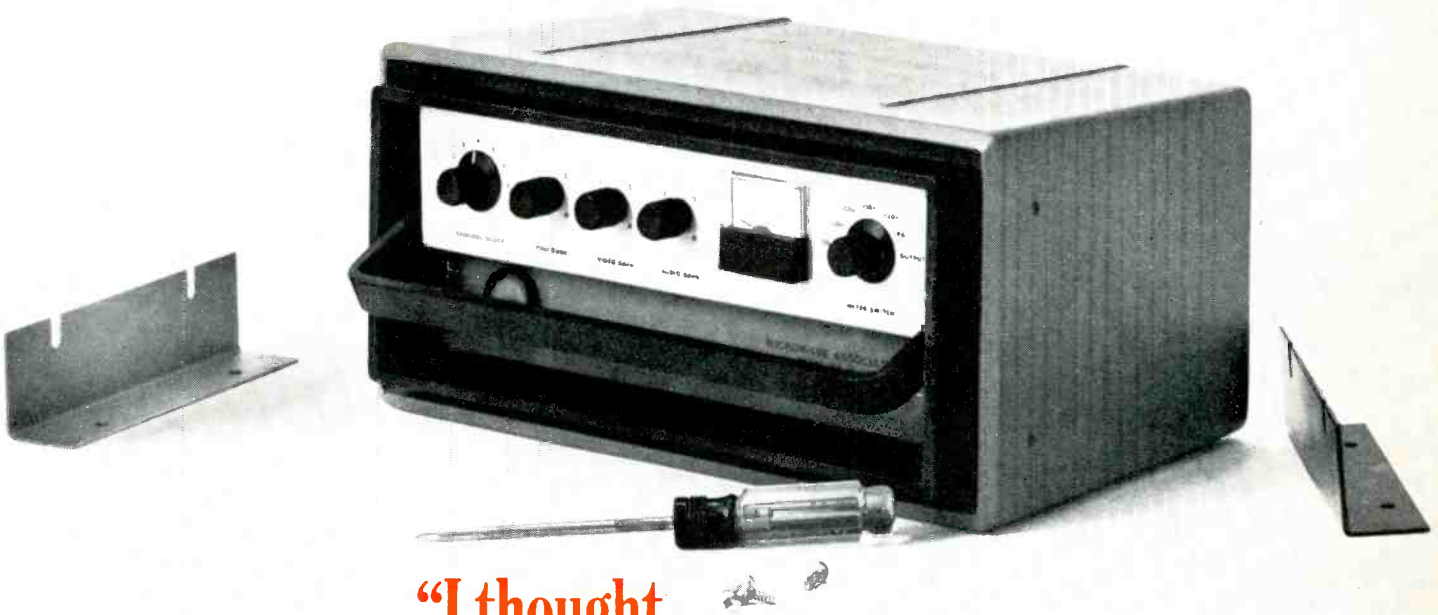


Fig. 8. Tunnel-diode amplifier curve.

The volt-ampere curve for these units is similar to that of the tunnel diode. In fact, they are similar to the idealized curve of Fig. 7. Their operation follows the same general principles as those described for tunnel diodes. There is one important difference; they are transistor circuits and therefore do not have the speed and high-frequency characteristics of a tunnel diode.

Most of the other new semiconductor negative-resistance devices operate on one or more of the same principles as those described here. The current-stable units behave like switches that close with increasing current; the voltage-stable units function as switches that open with increasing voltage. Naturally, the chief large-signal use of these circuit elements is in switching circuits. The small-signal negative-resistance characteristic can be used, in some cases, for amplifiers or tuned-circuit oscillators. As a group, they are an important new circuit element to make modern electronic circuits simpler, cheaper, and more flexible and useful. ▲



"I thought I was an STL."

Only with the brackets on.

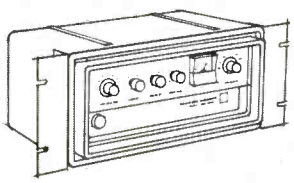
Remove the brackets and the STL becomes a high power, portable, lightweight TV pick up relay.

Put the transmitter and matched receiver on a mountain top — unattended. Give it only 60 watts total power. It becomes one hop of an intercity multi-hop relay link.

So it's an STL — an all solid state STL without klystron, meeting CCIR and FCC video and audio program requirements for color and black and white TV. In the studio, it works with 110 or 220 VAC. As an option, a low noise RF preamp gives extended range systems performance.

But it's more than an STL. In the field, it works with 12 or 24 VDC. It can run on a car battery. It has been flown in helicopters, been bounced in golf carts, newswagons, yachts and jeeps. Very wide band video circuitry assures stable top performance in widely varied environments.

Major TV networks and independents in the United States, Europe, and Latin America, as well as the U.S. military, have evaluated it, tested it, and bought it. Write for details.



Model	Band (Mc)	Nominal RF Power	Allocation
MA-2	1990-2110	2 watts	TV auxiliary broadcast, STL, remote TV pick up
MA-6	5925-6875	1 watt	Misc. common carrier, common carrier TV pick up
MA-7	6875-7125	.75 watt	TV auxiliary broadcast, STL, remote TV pick up
MA-8	7125-8400	.75 watt	Government, military, TV & wideband data

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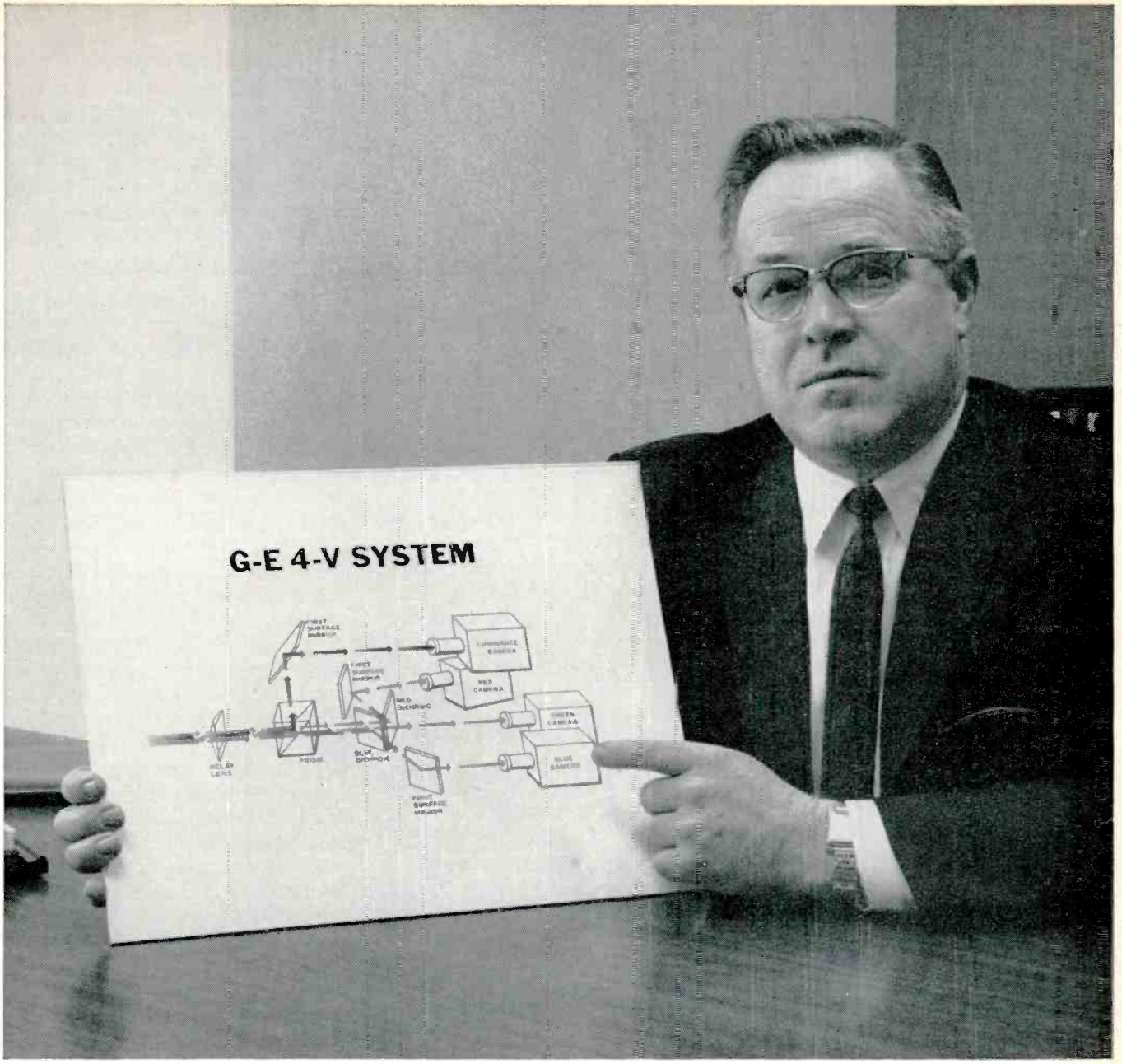
Remote Indicating

(Continued from page 15)

cable. The loop should, of course, be located below the antenna-current ammeter. The pickup loop forms the secondary of a transformer, the primary of which is the antenna lead. The induced RF voltage developed across R1 is directly proportional to the antenna current. Semiconductor diode CR1 rectifies the RF voltage and develops a DC voltage across R2, and C1 is used to filter out the RF component. Resistor R2 is made adjustable so that the amount of voltage, and hence the remote indication, can be preset to any desired calibration level.

In summary, there are three points to be sure of: First, always mount the remote-current device "below" the regular antenna ammeter; second, be certain you check the calibration at least once per week and record the fact that you did; lastly, always be certain the remote meter is working the day the local RI visits, as he will become most unhappy if it isn't! ▲



Harry Whittemore, RKO General Broadcasting, with G-E 4-V Light Path Diagram.

Now It's G-E 4-V's at RKO General

Harry Whittemore, Director of Engineering at RKO General Broadcasting, has witnessed all recent developments of color film cameras right in his job.

His experience with 3-V's came from cameras at two RKO General Stations–KHJ-TV, Los Angeles, and WOR-TV, New York.

He first worked with the 4-V type when WOR-TV put one on the air late last year.

Now it's 1965, and Mr. Whittemore is still taking advantage of color film camera progress. This summer, RKO General, under his engineering direction, will take delivery of three more 4-V's – two for WNAC-TV, Boston, and one for WHBQ-TV, Memphis, Tenn.

This time, all three are General Electric 4-V's.

This is the kind of customer acceptance that will put more than 100 G-E 4-V's on the air by autumn. No other manufacturer can even approach this record of field-proven performance and market approval. For details on television's most-accepted 4-V Color Film Camera – the G-E PE-24 – contact your G-E Broadcast Equipment Representative, or: General Electric Company, Visual Communications Products, #7-315 Electronics Park, Syracuse, N. Y. 13201 (Phone AC 315, 456-2105). GE-18

Visual Communications Products

GENERAL ELECTRIC

Electronics Park, Syracuse, New York

Circle Item 22 on Tech Data Card

Inside Class-C

(Continued from page 19)

impedance. A high-Q tank gives a higher resonant impedance, hence greater output, and in addition lowers the minimum plate voltage that occurs during tube conduction, further increasing efficiency. In addition, a high-Q tank produces a better sine wave because of its filtering out of other frequencies.

Meters in the grid and plate circuits of transmitter amplifiers read the average (DC) current values. The grid tank circuit should be adjusted for maximum grid current, corresponding to maximum drive. The plate tank circuit should be adjusted for minimum plate current, because when tuned to resonance the tank presents maximum load impedance. When the stage is loaded, the DC plate current increases because of the decrease of tank-circuit impedance. Then more energy is drawn from the tank circuit, and consequently from the power supply. An equivalent-circuit approach to class-C operation is difficult because of the pulsating nature of the plate current as opposed to continuous flow for other classes.

Bias

The grid bias determines the point of operation of any amplifier and especially in class C is the determining factor for a number of amplifier characteristics. Class-C amplifiers may use fixed, grid-leak, or cathode bias, and often a combination of these. A negative bias voltage may be applied at the lower end of the grid resistor in Fig. 1 instead of having the resistor grounded as shown. Fixed bias requires a separate power supply, or at least a separate portion of the main supply. Its advantage is that its value may be set to a desired value and made to remain constant and independent of signal variations.

The circuits in Fig. 1 use grid-leak bias. The grid is driven positive on the peak of each signal alternation, and the grid capacitor charges through the resistor and the cathode-grid circuit of the tube—mostly through the tube. For the remainder of the input cycle, the capacitor discharges through only the grid resistor; this action causes the grid to be negative. As the grid is negative for much longer during each cycle than it is positive, the average (or DC) level is negative. Advantages are eliminating the need of a special power supply and the fact that the bias is self-adjusting. If signal level were to increase, so would the bias, and vice-versa, assuring a more constant output. The primary disadvantage is that if signal excitation fails, so does the bias, and there could be excessive current through the tube. In some stages, cathode bias or a small amount of fixed bias is used with the grid-leak arrangement as protective bias, thus limiting the tube current in case of signal failure.

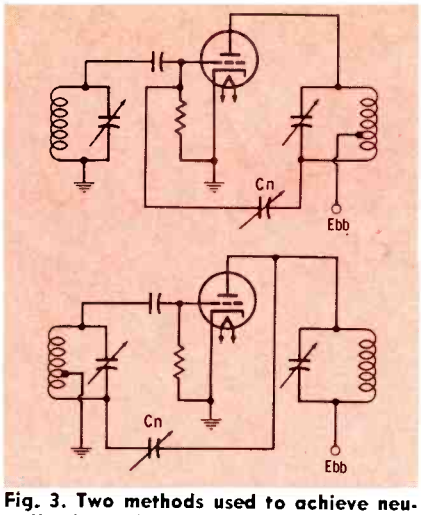


Fig. 3. Two methods used to achieve neutralization of a triode class-C stage.

Neutralization

Triodes are often used in class-C stages because of their signal-handling capabilities, but triodes operated at high frequencies may oscillate. The oscillations occur because of the phase of signal fed back through the plate-to-grid capacitance. In order to eliminate these effects, an out-of-phase signal (the neutralizing voltage) is applied to the grid or plate in the correct quantity to cancel the effects of the in-phase feedback. Tetrodes and pentodes normally do not need neutralization because the smaller plate-to-grid capacitance does not allow sufficient feedback to cause oscillations.

Fig. 3 shows methods of plate (Hazeltine) and grid (Rice) neutralization. In Fig. 3A, B+ is applied to a tap on the plate coil, causing that point to be the zero RF reference. This means that the top and bottom ends of the coil have signals that are 180° out of phase with respect to each other. By proper adjustment of Cn (the neutralizing capacitor) the voltage fed from the bottom of the coil equals that fed back to the grid from the plate end. The same principle is used in Fig. 3B except that neutralizing voltage is fed from the grid to the plate with the same net result: cancelling the feedback voltage that could cause the stage to oscillate.

Frequency Multipliers

Two factors combine in enabling a class-C amplifier to be used as a frequency multiplier, an amplifier in which the output frequency is higher than the input frequency. These two factors are: (1) The pulsing plate current causes considerable harmonic distortion of the input signal, and (2) the plate tank need not be pulsed on every cycle in order to keep it oscillating. In a multiplier, the plate tank circuit is tuned to a whole-number multiple of the input frequency to which the grid tank is tuned. (Multiples of more than four are seldom used because the power output decreases as the order of multiplication is increased.)

Operating further into cutoff increases the amplitude of the higher-order harmonics, and maximum harmonic output occurs when the plate conduction time is the same as the time of a half-cycle of the output frequency. For a frequency doubler, best results are obtained when the conduction time corresponds to 90° of the input frequency. For a frequency tripler this angle should be 60°, for a quadrupler 45°. Tetrodes and pentrodes are often used as multipliers because of their good power sensitivities. But triodes are also used and do not require neutralization in this application because the feedback and input frequencies are different. Even-order multipliers (doublers, quadruplers, etc.) cannot be push-pull because the tendency of this circuit arrangement is to minimize the production of even-order harmonics.

Conclusion

Here, then, is an introduction—or reintroduction—to the class-C amplifier. It is hoped that the foregoing information will give you a better practical insight into the workings of this important circuit in your daily encounters with it. ▲

August 1965

We interrupt this magazine to bring you...

Late Bulletin from Washington

by Howard T. Head

Commercial Loudness Policy Statement Issued

The Commission has issued its long-awaited policy statement dealing with the loudness of AM, FM, and TV commercial announcements (April and December 1964, and February 1965 Bulletins). After more than two years of deliberation, the Commission concluded that no single set of simple technical rules is sufficient to define commercial loudness; however, in the announcement, broadcasters are cautioned against various practices which in the Commission's opinion exaggerate the apparent loudness of commercial material.

Among other things, the Commission has (1) lowered the minimum permissible average modulation level below the 85% value now specified in the Rules, (2) urged a 6-db limitation on the volume compression which may be employed, and (3) recommended that changes in average level between contiguous program segments not exceed 4 db. The use of filters and reverberation units to enhance apparent loudness is also to be avoided. The broadcaster is expected to preplay all prerecorded commercials and screen out material which is offensive according to these criteria.

The National Association of Broadcasters unsuccessfully urged the Commission to withhold the issuance of this policy statement. In the meantime, NAB has instituted a series of tests at WSVA, Harrisonburg, Virginia, which are intended to provide more definitive information about loudness. As a result of these tests, NAB hopes eventually to develop more effective equipment for indicating actual sound volume.

EBS Alerting Device Proposed

The Transmission Standards Subgroup of the National Industry Advisory Committee (NIAC) has proposed transmitting standards for triggering AM, FM, and television sets. This triggering system will provide automatic audible means for emergency alerts where public receivers might be otherwise unattended.

In the proposed alerting system, two tones are transmitted to accomplish the triggering. Tests are planned soon in cooperation with the Office of Civil Defense by a working group of NIAC.

Translator Rules Relaxed

The Commission has made final Regulations (April 1965 Bulletin) which considerably liberalize channel assignments for translator operation. Under

the new regulations, effective August 16, both VHF and UHF translators may be authorized with transmitter power up to 100 watts on any unused VHF or UHF commercial channel. Before this, UHF translator operation has been permitted only on channels 70 to 83, and VHF translators were limited to 1 watt output. The new Regulations do not permit commercial translator operation on channels reserved for noncommercial educational stations.

Under a further liberalization of the translator Rules, new high-powered translators -- even at VHF -- may now be licensed to the licensee of a television broadcast station even in instances where the translator would serve beyond the station's Grade B contour.

New Rules Protect FM from IF Interference

The Commission has taken steps to help avoid the interference resulting from the beat between FM stations separated by approximately the standard FM receiver intermediate frequency (10.7 mc) (May 1965 Bulletin). Under new Rules, mileage separations are established between FM channels separated in frequency by either 10.6 mc or 10.8 mc (53 or 54 channels). Separations range from 5 miles between two Class A stations to 30 miles between two Class C stations. The new Rules apply alike to both commercial and noncommercial FM stations, except for low-power (10 watt) Class D educational stations. No changes will be required in existing assignments.

Commission Requests CATV Operating Data

In connection with proposals to regulate all CATV systems (June 1965 Bulletin), questionnaires have been sent by the Commission to all known CATV systems. Information is sought to assist the Commission in formulating regulations requiring CATV systems to carry local and nearby television stations. The questionnaire asks each CATV operator to inform the Commission of the channel capacity of the system, to indicate stations presently carried or proposed to be carried, and to furnish a list of all commercial and noncommercial television stations operating within 75 miles. Plans for channel expansion are requested, as well as details of any interference problems that make specific cable channels unusable.

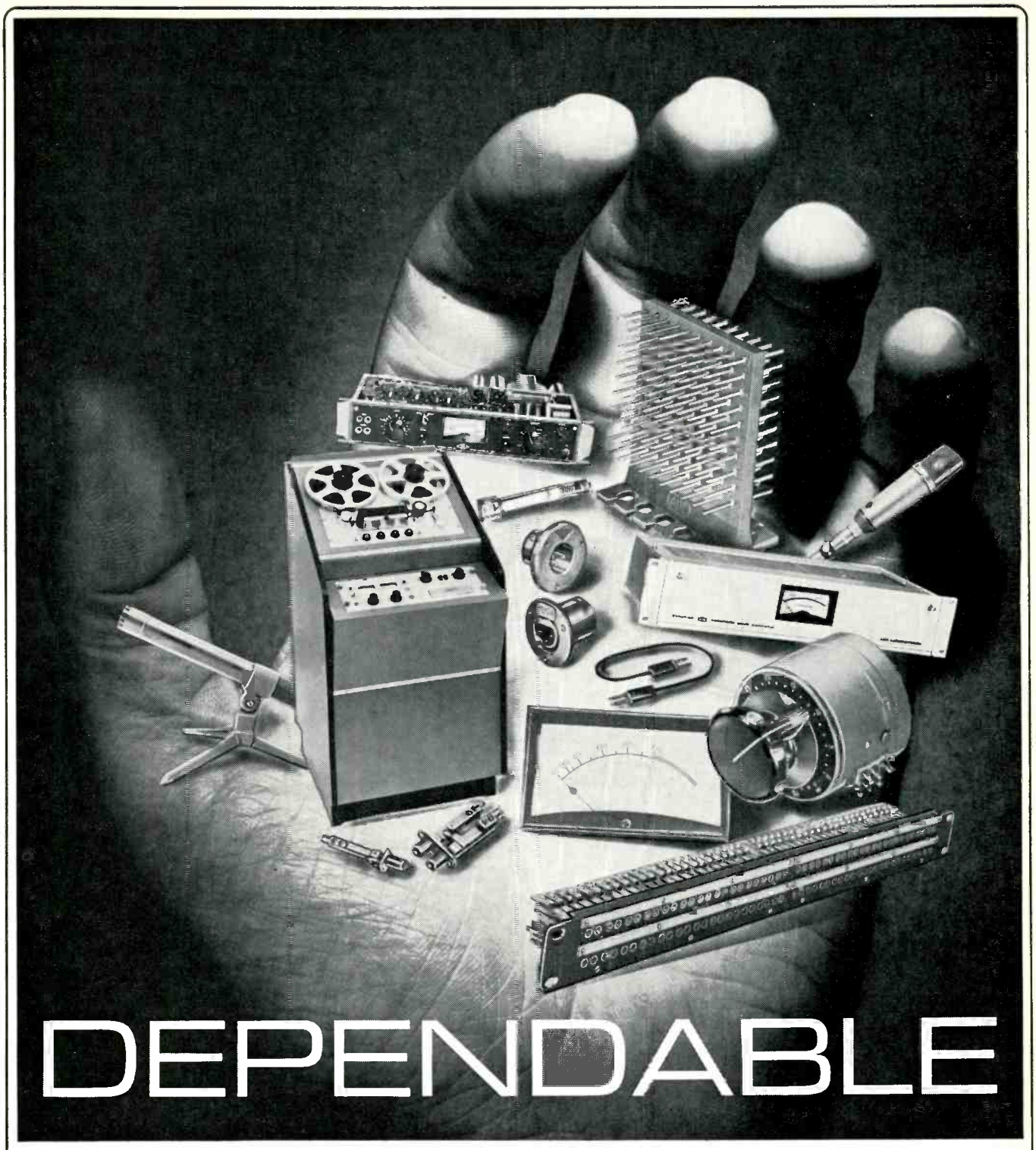
Additionally, CATV operators are requested to give details of other material carried by the system, such as FM radio transmissions, time and weather services, and local program originations.

Airborne ETV Request Turned Down

The Commission has turned down a request by Midwest Program on Airborne Television Instruction, Inc. (MPATI) for permanent assignment of channels 72, 74, 76, 78, 80, and 82 for airborne educational television instruction in the midwestern states bordering Indiana. For the past three years, MPATI has operated two transmitters on channels 72 and 76 in a DC-6B aircraft circling at 23,000 feet over Montpelier, Indiana. The height of the transmitting antenna has resulted in service being provided under favorable conditions out to a distance as far as 200 miles.

MPATI had asked the assignment of six UHF channels on a permanent basis. The Commission concluded that these assignments were not warranted; however, operation was extended on the present two channels for an additional five years to permit MPATI to amortize their existing investment. The Commission has announced that thereafter it will entertain proposals for regular airborne educational assignments in the 2500-mc band.

Howard T. Head...in Washington



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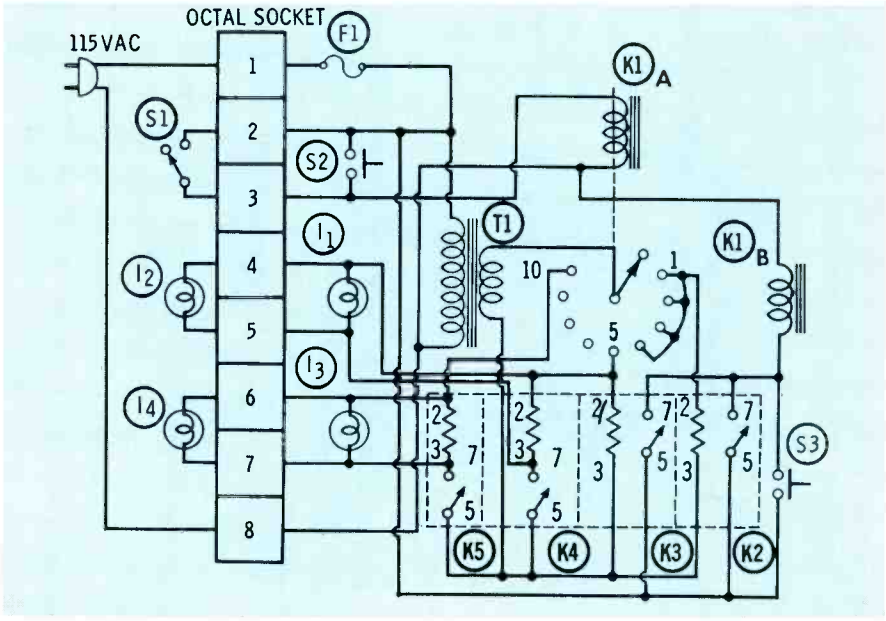
Circle Item 23 on Tech Data Card

ENGINEERS' EXCHANGE



Teletype Alerting Device

by Donald L. Coleman, Chief Engineer, WFGM & WBNE-FM, Fitchburg, Mass.

While we were revamping our news-gathering and reporting facilities, it became apparent that we would need a method of alerting the on-the-air announcer to teletype bulletins and Conelrad tests and alerts when no newsmen were present. The following circuit has been developed to perform these functions. While no originality can be claimed for the basic bell-counting method, we have never seen the overall package duplicated.

The operation is as follows. Switch S1 is provided (for a small fee) on the teletype machine by the wire service; it closes with every ring of the machine bell. This causes the stepper, K1, to advance one set for each ring of the bell. A random bell or two—caused by "trouble east of Boston" or "foners on line"—causes the heater of K2 to energize. After 5 seconds, its contacts apply voltage to reset coil K1B, and the stepper resets.

Five bells (the bulletin signal) energize the heaters of K3 and K4; the latter starts flashing the alerting light on the unit and the remote light, I2, in the control room. If the announcer goes immediately to the newsroom and checks the machine, he can push S3 and reset the stepper. If he does not, K3 will reset it after 3 minutes.

The ten-bell signal for Conelrad advances the stepper to the tenth position and activates the heater of K5, which flashes I3 on the unit and I4 in the control room. The man on duty **has** to check the machine and reset the stepper manually for this signal. If he does not, the light will flash in his eyes all night.

The unit was constructed in a metal utility box; the indicators were mounted on the front and the relays on a chassis inside. The box is mounted over the teletype in the news room.

While an octal socket was used for the external connections because it was on hand, it might be better to bring the 117VAC in separately.

S2 is a push-button switch in parallel with the teletype switch, S1. It is used for testing the stepper and delay tubes. The 6.3-volt transformer would not be necessary in all situations. However, in our installation, it was necessary to run the leads to the remote indicators from the second floor to the cellar and back up to the second floor control room through half-inch conduit which was already jammed

with other wiring. It was just asking for trouble to use 117 volts.

A final refinement was the use of rubber grommets in the stepper mounting-screw holes. This isolates the stepper mechanically and cuts down the noise materially.

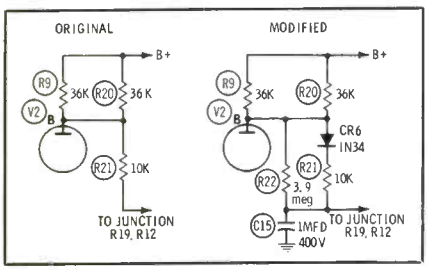
The flasher manufacturer recommends placing capacitors of approximately .05 mfd across the flasher contacts to suppress arcing. This was not a problem in our case, but it might if larger loads were flashed.

Parts List

F1	1 amp fuse
K1	Guardian MER 115 stepping relay
K2	Amperite 6N05 delay relay
K3	Amperite 6N0180 delay relay
K4	Amperite 6F60 flasher
K5	Amperite 6F60 flasher
I1, I2	1847 bulb (bulletin alert)
I3, I4	1847 bulb (Conelrad alert)
T1	117V/V6.3 transformer
S1	Teletype mounted switch
S2	Push-button switch (test)
S3	Push-button switch (manual reset)

Improved Vidicon Automatic Sensitivity Control

by Karl A. Black, Studio-Engineering Supervisor, WENH-TV, Durham, New Hampshire



Adding a fast-attack, slow-decay circuit to the RCA vidicon automatic-sensitivity control greatly improves its performance. After this modification is installed, film chains will no longer flutter in response to flickering highlight material on films, and fades to black on film will now be preserved (for 3-5 seconds) as they were recorded.

The operation of the original circuit is as follows: A DC voltage derived from peak-to-peak video level at the camera-control input is amplified by V2B. At the plate of V2B, a positive shift in voltage results from an increase in video level. The increase in voltage is applied via a floating power supply to the cathode, control grid, and focus electrodes of the vidicon, decreasing the target-to-cathode voltage; thus, vidicon sensitivity is decreased until the video is the correct level.

Addition of CR6, R22, and C15 allows the circuit to operate as before as long as the plate of V2B continues to go positive. If the plate voltage shifts in the negative direction, CR6 does not conduct. C15 must then charge to this new potential through R22, requiring 3-5 seconds to charge fully.

In operation, any increase in video level causes V2B plate to go positive. CR6 conducts and C15 charges rapidly, decreasing vidicon sensitivity. If video level decreases and V2B plate becomes more negative, CR6 is cut off and R22 charges C15, resulting in a gradual increase in sensitivity.

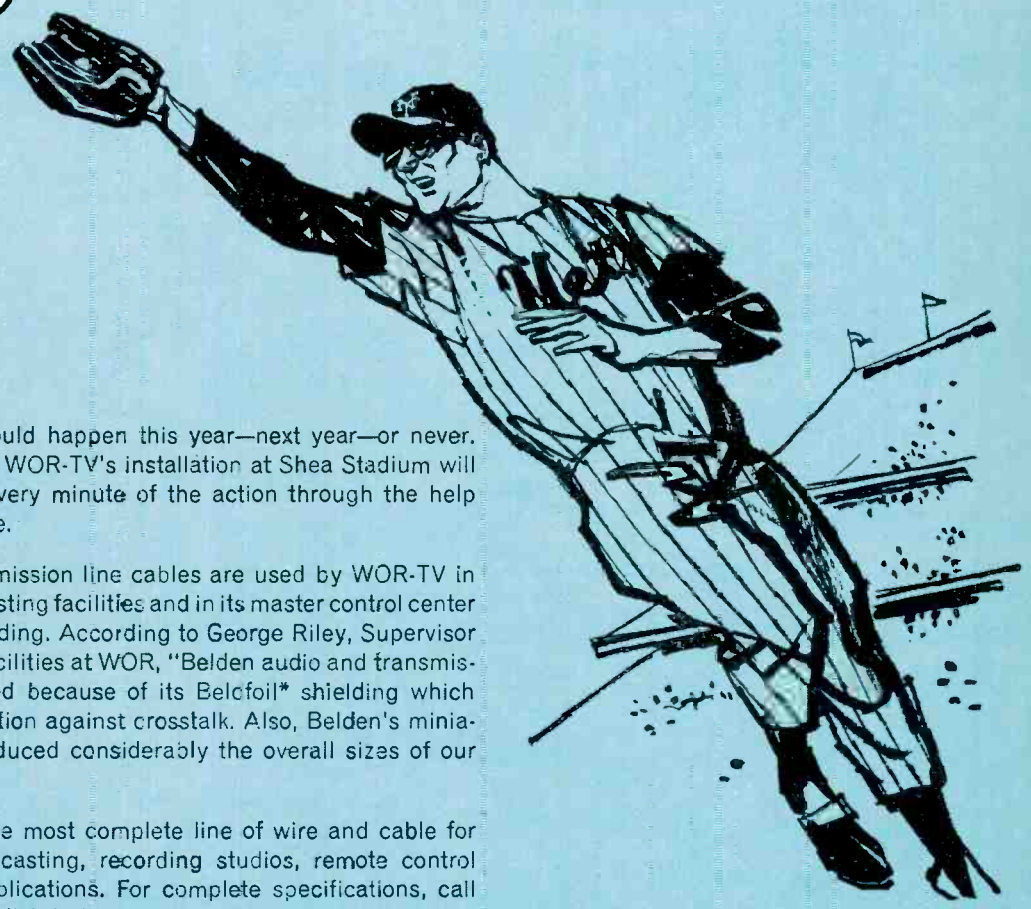
A value of 3.9 meg for R22 and 1 mfd for C15 results in a very gradual increase in gain; too slow to be noticeable to the viewer. If a different recovery rate is desired, other values could be substituted, or a potentiometer in place of R22 would permit the recovery rate to be varied at will.

Carrier-Current Repeaters

by J. W. Slate, College of William & Mary, Williamsburg, Va.

One of the problems encountered in operating a low-powered, campus-oriented FM station is the inability to reach a large percentage of the student body. This is due to the fact that most students do not own FM receivers. We considered

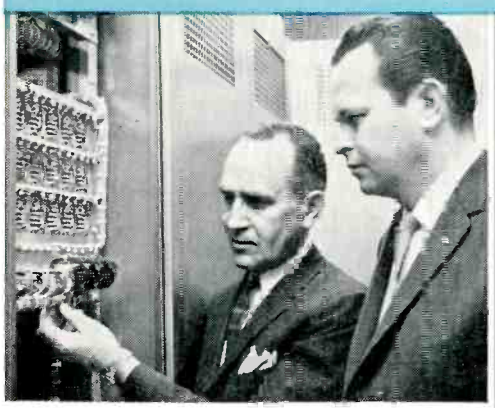
When the "Mets" capture the pennant... Belden will be there



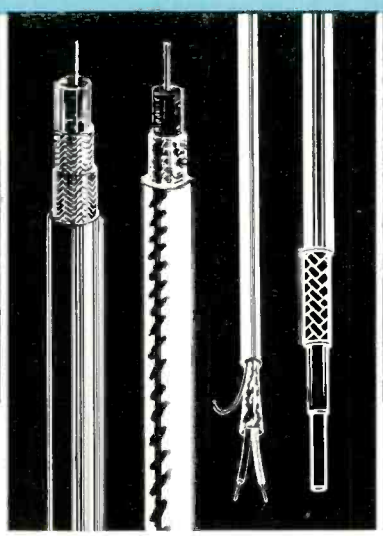
Such a phenomenon could happen this year—next year—or never. But if and when it does, WOR-TV's installation at Shea Stadium will record and broadcast every minute of the action through the help of Belden wire and cable.

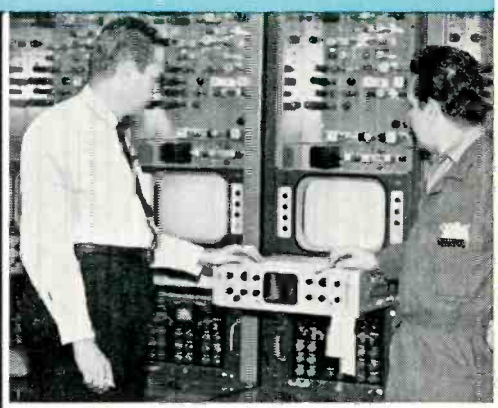
Belden audio and transmission line cables are used by WOR-TV in both its stadium broadcasting facilities and in its master control center in the Empire State Building. According to George Riley, Supervisor of TV Operations and Facilities at WOR, "Belden audio and transmission line cable was used because of its Beldfoil* shielding which provides superior insulation against crosstalk. Also, Belden's miniaturized audio cables reduced considerably the overall sizes of our panels and consoles."

Belden manufactures the most complete line of wire and cable for all TV and radio broadcasting, recording studios, remote control circuits, and similar applications. For complete specifications, call your Belden electronics distributor.



The control center of WOR-TV-AM-FM is wired with Belden 8451 and 8700 miniature broadcast and audio cables. Explaining the complexity of the installation to George Kyros is Orville J. Sather, Director of Engineering for WOR-AM-FM.





In the control room, six monitor screens help the engineers transmit the play-by-play action. Looking over part of this installation are George Kyros, Belden Territory Salesman, and Earl Neely, Maintenance Supervisor of WOR-TV. The monitors are wired with Belden 8451, 8241, and 8281.

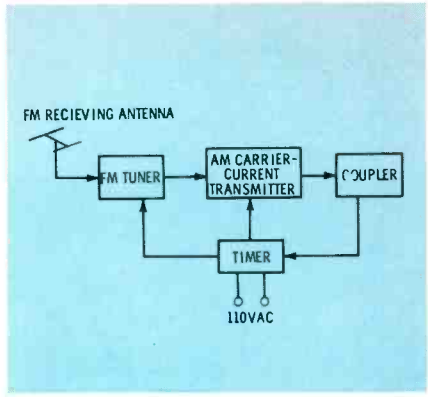
Better Built...Better Buy...

Belden
WIREMAKER FOR INDUSTRY
SINCE 1902 – CHICAGO

power supply cords • cord sets and portable cordage • electrical household cords • magnet wire • lead wire • automotive wire and cable • aircraft wires • welding cable *°Belden trademark—Reg. U.S. Pat. Off.*

8-3-4

Circle Item 28 on Tech Data Card

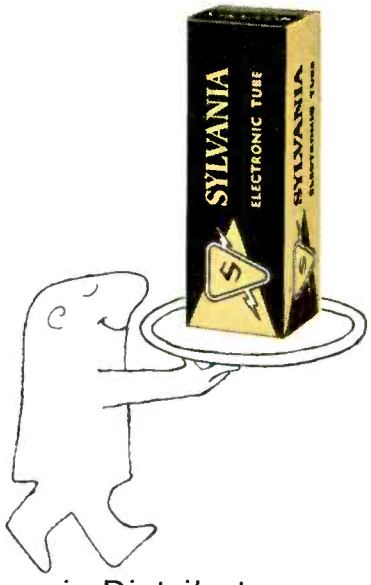


many ways of solving this problem; renting FM receivers to students, selling low cost receivers in the campus book store, wiring speakers in each room, and carrier-current transmitters were all considered.

Carrier current seemed to be the best bet. We were informed that this system had been tried in the past and had proved to be impossible to operate. After much research, we determined that our predecessors were right. Standard carrier-current methods were impractical on our campus.

We then hit upon the idea of converting the FM signal to audio with an FM tuner and then modulating a low-power carrier-current transmitter with the audio signal from the tuner. By placing one of these units in a central location of a dorm and properly matching the transmitter output to the AC power lines, we get a good AM signal carried to all rooms in an average-size dormitory.

The timer shown in the diagram is set to cut the units on about half an hour before our FM station goes on the air and then off when the station goes off.



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He's geared to supply any industrial and commercial tube in any quantity, large or small. He's a specialist in fast service, too. He likes the big orders (who doesn't!), but the small ones get the same prompt attention. Same-day delivery, wherever possible.

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Electronic Tube Division, Sylvania Electronic Components Group.

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NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

Circle Item 32 on Tech Data Card

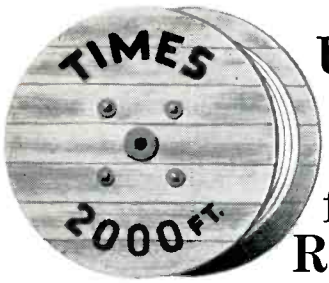
BOOK REVIEW

Acoustical Tests and Measurements: Don Davis; Howard W. Sams & Co., Inc., Indianapolis, Indiana; 192 pages, 5½" x 8½", soft-bound; $4.95. For more years than most engineers care to admit, analysis of the acoustical properties of convention halls, auditoriums, theaters, broadcasting studios, and concertoriums has been of an essentially subjective nature. An architect's observations of previously constructed halls that "sounded good" and liberal use of reflectors, absorbtion plates, and baffles served to sound condition a new hall. Undeniably, music listeners and broadcasters suffered as a natural result of the method.

This volume by Mr. Davis serves notice that measurements pertaining to the manner in which various rooms respond to sound waves throughout the audible and superaudible frequency spectrum not only are possible, but also relatively simple and easily understood. In a straightforward manner, Mr. Davis sets forth four basic parameters for consideration: quietness; reverberation; loudness; and distribution. In each of these areas, the author describes an understandable frame of reference, the use of specific test instruments, gathering the data, and interpreting the results of the tests. Individual and collective results of various tests are correlated to provide a good understanding of acoustics.

The useful technique of using short-duration audio bursts to evaluate the relationship of direct and reflected sound waves and their effect on listeners in various sections of the hall deserves special notice. Another very informative section concerns practical methods used to test sound systems installed in various types of halls and auditoriums. Frequency response, distortion, and distribution patterns are covered with data-recording and analytical aspects receiving primary consideration.

In every respect, this is an excellent book for the engineer or advanced sound technician who, in the normal course of his work, is required to make objective evaluations of various rooms in which sound must be distributed to a sizable audience. ▲



Until April 16, 1965, you couldn't buy 2,000 ft. continuous seamless aluminum sheath CATV cable for love or money. Now Times is shipping it. Read why this revolutionary new cable makes every other CATV cable a compromise.

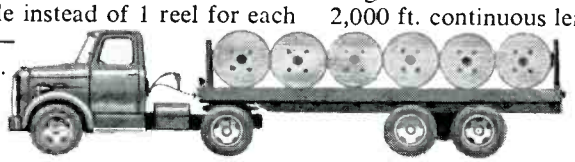
Everyone in the CATV business knew it: the longer the cable, the fewer the splices, the lower the maintenance, the better the performance ...the higher the profits.

But no one did anything about it until Times, the company the industry expects to be first*, took up the challenge of longer-length cable.

The result: Times made the breakthrough with its 2,000 ft. continuous lengths of seamless aluminum CATV cable. Even more exciting, Times is shipping this cable right now!

Here's what this new 2,000 ft. cable can do for you that no other cable can:

▪ **It easily saves you 10% on installation and shipping costs.** 2,000 ft. lengths mean fewer splices—8% saved. Only 1 reel needed for 2,000 ft. of cable instead of 1 reel for each 1,000 ft.—2% saved.



▪ **It increases profit.** The fewer the splices, the less maintenance needed. Less maintenance means less labor cost and more profit.

▪ **It improves electrical performance.** Times JT-1000 cable guarantees 26 db minimum return loss—a must for minimum ghosting. Moreover, it won't let in moisture vapor that stops your signal short of the target.

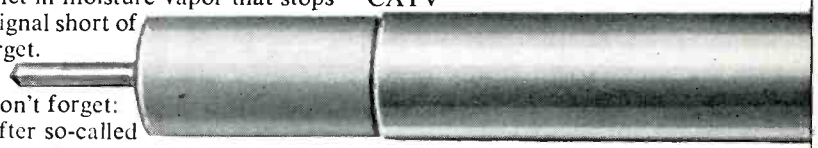
And don't forget: long after so-called economy cable has been replaced (it starts deteriorating the day you install it), Times 2,000 ft. JT-1000 cable will still be a top performer, keeping pace with your system's planned potential.

Why compromise when you no longer have to...now that Times 2,000 ft. continuous lengths of seamless aluminum CATV cable are on the shelf and ready to be shipped to you.

Times' Family of Firsts*—
The Standards of the Industry

First to design a long life cable specifically for CATV

First with foam dielectric cables for CATV



First with cable that made all-band systems economically feasible

First to make aluminum tube sheathed coaxial systems economically feasible

First to offer 26 db minimum return loss guarantee

First again with 2,000 ft. lengths of seamless aluminum sheath CATV cable

TIMES
WIRE & CABLE
DIVISION OF THE INTERNATIONAL SILVER CO.
Wallingford, Conn.

Transmission System Design and Engineering/Standard & Special Coaxial Cable/Multiconductor Cable/Complete Cable Assemblies/Teflon* Hook-Up Wire *A Du Pont Trademark

Circle Item 34 on Tech Data Card

NEWS OF THE INDUSTRY

INTERNATIONAL

European Color-Standards Committee Votes in Vienna

A report from **Dr. George H. Brown** of RCA upon his return from the recent Vienna conference of CCIR on color TV states that the most significant result of the Vienna meeting was the emergence of a clear-cut preference among most major countries in the world for the American Standard NTSC system over the French SECAM system.

Two of the three systems initially considered at the meeting—the NTSC system employed in the United States, and the PAL system proposed by West Germany—represent two variations of the same technique. They were therefore considered by the conferees as a single basic system approach under the designation QUAM (for Quadrature Amplitude Modulation). PAL is, in fact, an offshoot of the NTSC system. Consideration of the variants of a single system provides an umbrella under which either may be employed according to the preference of the country concerned.

In the balloting that concluded the CCIR meeting, it is significant that the Western nations representing the largest portion of the European television industry joined Japan, Canada, and the United States in favoring the QUAM system in its NTSC or PAL forms. The only Western votes for SECAM, in addition to that of France, were cast by Luxembourg, Monaco, and Spain.

The remaining votes for SECAM were cast by the Soviet Union and the Eastern European countries, excluding Yugoslavia, and by former French territories in Africa, nearly all of which do not have any television industries or service.

Votes for the QUAM concept were cast by Great Britain, West Germany, the Netherlands, Sweden, Denmark, Norway, Finland, Italy, Ireland, Switzerland, Austria, Iceland, Brazil, New Zealand, Japan, Canada, and the United States.

New Argentine Television Service

A new television station in Argentina will be opened toward the end of this year to provide full television coverage for the town of Santa Fé and the neighboring town of Paraná. Operated by **Televisora Santafecina S.A.**, the station will be equipped with Marconi studio and transmitting equipment.

TELEMET'S COMMERCIAL BROADCAST MODEL

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Well, there isn't any! They're exactly the same. In fact *all* Telemet Video Broadcast Equipment is identical in every respect to the units we deliver in quantity to the military.

Telemet's high reliability equipment is specially designed for those critical aerospace and communications applications where even the most minor failure can be very costly.

And our commercial video broadcast models are exactly the same—in performance characteristics—in the high standards of quality and reliability. That's why you'll get the best—from Telemet.

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The studios, located in Santa Fé, will have 4½" image-orthicon cameras for normal program work and a vidicon camera for announcements, news, and interviews. Film-chain facilities will consist of two 16-mm film projectors and a slide projector, coupled to a vidicon camera. A full range of sound equipment will also be employed, together with synchronizing and test-signal generators and control, mixing, and switching equipment.

The transmitting station will have a single 5-kw Band III visual transmitter and a 1-kw FM aural transmitter. The high-gain omnidirectional antenna system will be mounted on a 495' tower.

NATIONAL

Gear for Local Color Films

Delivery of three General Electric 4-V color film cameras to **Meredith Broadcasting Co.** stations during May and June will make Meredith one of the first groups to have local color-film capability at all its stations. The new cameras will be installed at WOW-TV, Omaha, Nebraska; KPHO-TV, Phoenix, Arizona; and KCMO-TV, Kansas City, Missouri. The other Meredith station, WHEN-TV, Syracuse, New York, already has local color-film equipment.

Compact Vidicon

A "hybrid" vidicon, recently developed by the **General Electric Company,** is intended to permit the design of smaller, more lightweight, high-resolution television cameras for military, space, industrial, and commercial use. The tube employs a method of magnetic focusing

and electrostatic deflection called Focus Projection and Scanning (FPS). The FPS design reduces the vidicon's power requirements—it requires only five watts, about one-half the power needed by a typical all-magnetic vidicon. The FPS tube measures four inches in length—excluding pins—and one inch in diameter. It has a resolution of 800 TV lines with 750 volts beam acceleration. Usable target diameter is .58" maximum. The standard vidicon target has an S-18 spectral response; however, other targets can be used. The tube's design for focusing and deflection consists of a crossed-field system, employing a transverse electrostatic field for deflection. This field is immersed within an axial magnetic field which focuses the electrons. Other hybrid vidicons employ electrostatic focusing and magnetic deflection.

Named Vice President

The appointment of Nelson D. Pagani as vice president and general manager, international operations, was announced recently by James B. Tharpe, president of **Visual Electronics Corporation.** In his new post, Mr. Pagani will be directly responsible for Visual's programmed expansion of its activities throughout the world.

A native of Montevideo, Uruguay, Mr. Pagani has an extensive international background in the electrical and electronic industries with both General Electric and RCA. He was manager of GE's Electronics Division in Brazil when the initial TV stations in Rio de Janeiro and Sao Paulo were sold to Emissoras Associadas and Emissoras Unidas. Subsequently he served as resident representative for International GE in Italy, as marketing director for RCA in their Italian Project, and as president of RCA in Brazil.

Mr. Pagani holds a degree in Electrical Engineering from the University of Detroit.

Recorder Plant

A new 85,500 square foot manufacturing plant of the **Ampex** video and instrumentation division is now in operation for the manufacture of the company's line of professional audio recorders for master recording, broadcasting, education, and industrial uses. Air-conditioned throughout, the single-story building is of steel, concrete, and sun-retardant glass-window walls. Utility services including gas, water, and electricity are distributed through walk-way tunnels beneath the building to provide ready accessibility for maintenance. High intensity lighting is provided throughout the manufacturing areas, and later a landscaped terrace will accent the front of the building. A large parking lot on the south side of the building will accommodate nearly 400 employee cars.

NARDA/CATV Negotiations

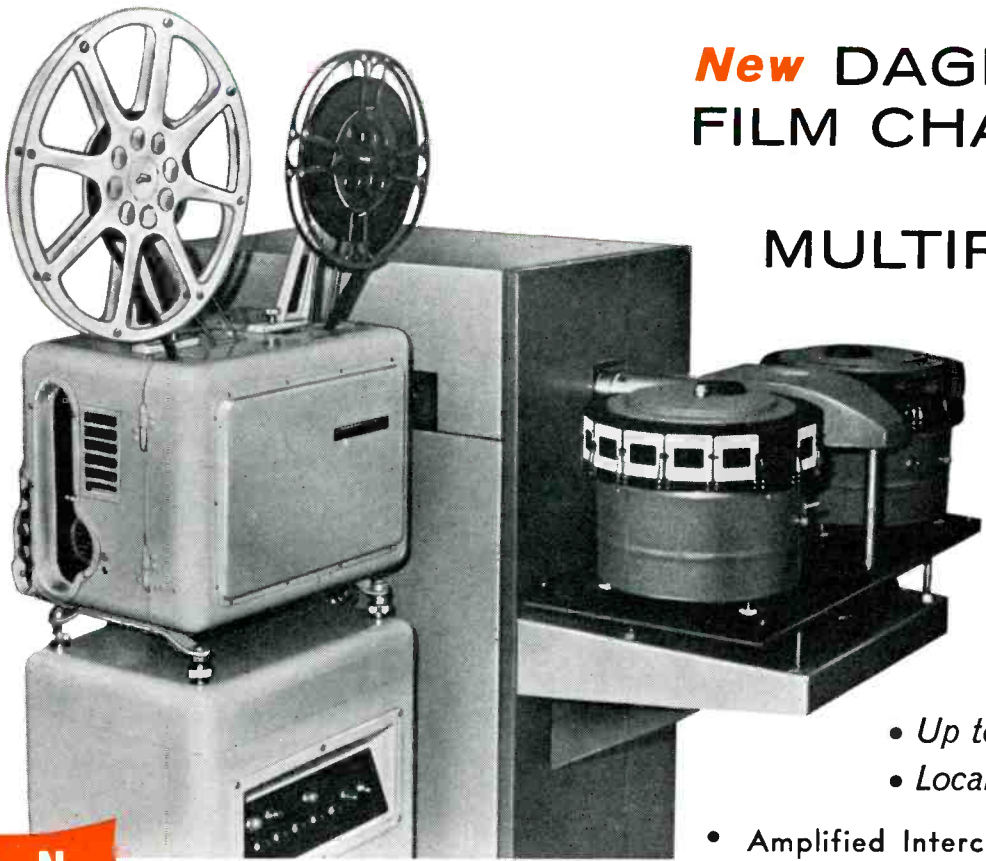
A Community Antenna Television permit application acceptable to both parties has been worked out by representatives of the **National Appliance & Radio-TV Dealers Association** with officials of **Perfect Picture TV, Inc.,** in Sacramento, California.

As a result of discussions, the original CATV application was amended to include the following provision: "Any permit or franchise granted Perfect Picture TV shall prohibit the permittee from engaging in the sale and/or service of television sets to the general public."

Sacramento dealer and NARDA Director Myles Myers urged retailers throughout the nation to establish local retailer committees to insure that the intent of the NARDA resolution—"CATV

DAGE BROADCAST AND EDUCATIONAL MODULAR TELEVISION SYSTEMS

QUALITY



New DAGE FC-11 FILM CHAIN and PRISM MULTIPLEXER

- *Up to 4 Optical Sources*
- *Local Set-up Controls*

• Amplified Intercom • No Secondary Images • Modern Functional Design • Eliminates Field Lenses • Rigid Optical Base with Simple Unit Design • Optional Video AGC • Heavy duty construction throughout with Dependable DAGE Engineering

Specifications Available From

NEW

800 Line Resolution FC-11 Film Camera

Solid State Circuitry • • Minimum Maintenance • High Picture Stability over Wide Temperature and Line Voltage Variations • Exceptional Signal-to-Noise Ratio • Excellent Detail Response

DAGE BELL

Dage Television Division
Dage-Bell Corporation

455 Sheridan Avenue Michigan City, Indiana 46360 Dept. 30-7

Circle Item 40 on Tech Data Card

companies shall provide cable service and no more"—be incorporated into locally-granted permits.

GAB Holds Convention

U. S. Senator Richard B. Russell was named Georgian of the Year for 1965 by the **Georgia Association of Broadcasters** during their recent 30th Annual Convention. Senator Russell was presented with a huge bronze plaque during the GAB's Annual Awards Banquet. In other awards, the GAB selected WAGA-TV, Atlanta, as 1965 Station of the Year, and the Broadcaster-Citizen of the Year award went to Elmo Ellis, General Manager of WSB, Atlanta. The Promotion of the Year Award was presented to WALB-TV, Albany. Special awards for excellence were won by WDEC, Americus; WBML, Macon; WSNE, Cumming; and WDAK, Columbus in the promotion of the year competition. WBMK, West Point, received an award for excellent in the Station of the Year category.

The group selected Ridley Bell, Station Manager of WRBL-TV, Columbus, as its president. Don McDougald, WWNS, Statesboro, was reelected vice-president for radio, and Esther Pruett, WTOC, Savannah, was reelected treasurer. Newly elected vice-president for television is Virgil Wolff, WRDW-TV, Augusta. Jack Williams was named to serve his fifth year as executive secretary of the GAB.

Elected to the Board of Directors for the coming year were C. James Murphy, KBMK, West Point; Allen MacMillan, WGGA, Gainesville; Paul Reehling, WFPM, Ft. Valley; H. E. Ray, WAGA-TV, Atlanta; Jim Popwell, WCEH, Hawkinsville; James Rivers, Jr., WACL, Waycross; Mark Shor, WALG, Albany; N. B. Mills, WMTM, Moultrie; "Red" Cross, WMAZ, Macon; and Bob Thorburn, WLBB, Carrollton. Outgoing president Charles Doss, WROM, Rome, automatically remains as a board member.

Broadcast Equipment Display

Engineers from radio and television stations in the greater Los Angeles area recently attended a private showing of broadcast equipment held by **Moseley Associates, Inc.** at the Hollywood Roosevelt Hotel, Hollywood, California. Area representatives of all major broadcast transmitter manufacturers were also invited.

The new equipment on display included: Model RPL-1 160 mc Broadcast Remote Pickup System, Model PBR-21 Solid-State Transmitter Remote Control System, and Types II/III STL-Radio Remote Control Systems. Other established products, such as SCA and stereo transmitting equipment, were demonstrated.

The private showing allowed broadcasters to discuss informally present and future equipment requirements.

The display was the company's first attempt at this type of meeting, and another may be held next year. Similar showings in other major metropolitan areas at various times during the year are also under consideration.

Engstrom Receives Steinmetz Centennial Medal

Dr. Elmer W. Engstrom, distinguished electrical engineer and a leader in the development of the practical commercial television system, received the Charles Proteus Steinmetz Centennial Medal of the National Academy of Engineering, in Washington, D. C., during the first annual meeting of the Academy.

The medal was the first to be awarded by the National Academy and was presented to Dr. Engstrom by Dr. Augustus B. Kinzel, President of the Academy. The medal itself was a gift from the General Electric Company.

Dr. Engstrom, who is President of RCA, gave the Charles Proteus Steinmetz Centennial Lecture in honor of Dr. Steinmetz following the presentation ceremony. Dr. Steinmetz, who died in 1923, was consulting engineer at the General Electric Company and for 30 years carried on pioneering electrical engineering research at General Electric in the fields of alternating current, high-voltage transmission, and lightning. The personal aspects of Dr. Steinmetz' life and work were reviewed by his former associate Mr. Emil J. Remscheid.

In 1931, Dr. Engstrom led the first test of a complete television system at RCA. The test was made in the Empire State Building, where a transmitter was installed on the 85th floor. A mechanical scanner provided a 120-line, 24-frame picture from live and film subjects. Extensive field tests were then made using the first cathode-ray-tube receivers. The picture left much to be desired, but the equipment worked well as a system, and the tests helped prove that a television broadcasting service was possible.

PROPERTY TRANSACTIONS

Radio station WREB, Holyoke, Massachusetts, has been sold, subject to FCC approval, by **Don Hancock Broadcasting, Inc.** to **Donald H. Kingsley and Associates** of Framingham, Massachusetts, for a total consideration of $200,000. WREB is a 500-watt daytimer on 930 kc.

Radio station KRRV, fulltime, 1-kw outlet on 910 kc at Sherman, Texas, has been sold by **Wayne Phelps** to **R. B. McAlister** and **Bill B. McAlister,** owners and operators of KSEL at Lubbock, Texas. Consideration was $220,000.

Palestine, Texas, 250-watt fulltimer KNET has been sold to **Tom** and **Tolbert Foster,** owners of KDET at Center, Texas, according to Allen Vinson, president of KNET. Consideration was $117,500.

Radio One Corporation, licensee of radio station WPEO, Peoria, Illinois, has sold the assets of the station, subject to FCC approval, to **Wister Broadcasting Company, Inc.,** for $170,000. WPEO is a 1-kw daytimer on 1020 kc.

SIMPLIFIED VIDEO-TAPE PREVIEW

Preview of motion-picture film for editing purposes has long been a reasonably comfortable process. Director, producer, and other interested parties can sit in a review room and watch both the picture and a projected footage counter. The atmosphere is generally quiet and contributes to the task at hand. Video-tape editing, however, usually involves a number of people crowded around the tape machine, trying for a look at the tape timer, and both contributing to and subjected to the noise.

In January of 1965, with several major editing projects in progress, the ITV Center at San Jose State College decided the time had come to solve the problem. Some method of remoting the tape timer had to be found so that previewing could be done in a location other than Master Control where the VTR's were located. Various methods of mechanical linkage and projection counters were considered. All were discarded because of the delicate nature of video-tape time counters. After not too much thought, it became obvious that the practical solution was television. A number of simple, random-interlaced vidicon cameras were available. Normally these were used for image magnification purposes in classrooms, but it was possible to free one for editing sessions.

The camera and a 150-w PAR lamp were mounted on the VTR bridge above the tape timer. A 3" lens mounted on a single extension tube gave a good close-up of the timer. The camera monitor was placed in the preview room and the timer image was displayed alongside the playback video monitor. To complete the system, telephone communication was provided between preview and VTR rooms.

This particular installation required frequent use of the camera for jobs other than editing, and so temporary mountings were required. With the camera mounted in the most convenient fashion, its image of the tape timer was upside down. Rather than get involved in problems of scan reversal, for which the camera was not equipped, the viewing monitor was simply turned upside down. If one were to make a permanent installation, prisms or mirrors could be used to put the camera out of sight and thus effect a cleaner finished appearance.

The camera used was a commercially available one costing about $700. With price of lens and monitor added, total retail value of equipment used was not over $950. There are approaches other than retail purchase of the equipment needed. A station with sufficient time available could probably build a satisfactory camera for about $200. For those whose backlog of construction projects is already large enough, there are surplus outlets offering completed units for from $300 to $500.

While the resolution and sensitivity of this class of camera are low, the Center's experience shows the resultant pictures to be more than satisfactory. All personnel are very happy with the system; confusion in Master Control is eliminated, and working conditions for those participating in preview sessions are greatly improved.

—Glen Pensinger
Director of Operations
Instructional Television Center
San Jose State College

ENGINEERS' TECH DATA

AUDIO & RECORDING EQUIPMENT

55. CBS LABS—Literature on the "Volumax" automatic peak controller and the "Audiomax III" solid-state automatic level control.
56. CINE SONIC—Data sheet describes rental service which supplies background music prerecorded on 7", 10½", and 14" reels of tape, or in cartridges.
57. ERCONA—Literature describes PML microminiature condenser microphones, transistorized microphone mixers, and parabolic microphone reflectors.
58. GATES—Brochures list specifications for "Cartritape II" stereo/monaural cartridge tape system, "The Producer" four-channel recording mixer, and four new portable transistorized remote amplifiers.
59. GOTHAM—Eight-page brochure describes Studer C-37 master tape recorder.
60. MILES—Sound reproducing and indexing system providing six hours recording time on continuous belt is covered by brochures.
61. 3M—*SOUND TALK* bulletin No. 40, "Tape Considerations for Continuous Loop Recording," explains characteristics and advantages of continuous-loop recording.
62. QUAM—New general catalog No. 65 lists speakers for color-TV replacement, PA systems, high-fidelity, and general replacement.
63. SENNHEISER—Data sheet describes Model MD 31 professional floor-stand microphone.
64. VIKING—Series of technical bulletins provides data on Model 38 tape-cartridge handler, Model 96 tape transport, and other tape and audio accessories.

CATV EQUIPMENT

65. BIONIC—Data available describing 12-channel DC momentary-control unit for program switching by remote control between receiving site and control office.
66. ENTRON—Facility brochure describes product line and manufacturing procedures as well as general history of company's participation in CATV.

COMPONENTS & MATERIALS

67. AMPEREX—Condensed semiconductor catalog with listings and specifications on full line of germanium and silicon transistors.
68. BRADY—Self-bonding signature plates for studio property identification and control.
69. CORNELL DUBILIER—Descriptive material on TV, FM components, rotor systems, and a cross reference guide for vibrators.
70. SWITCHCRAFT—New product bulletin No. 152 describes series H-100, H-200 "HI-D" and series DA "DATA-SWITCH" momentary-contact switches.

MICROWAVE DEVICES

71. MICRO-LINK—Planning guide for 2500-mc ITV systems, data on Model 420A portable link and Model 600 fixed link.

MOBILE RADIO & COMMUNICATIONS

72. MOSLEY—Literature describes Citizens band antennas.
73. SPRAGUE—Circular M-853 describes SK-1, SK-10, SK-20, and SK-30 "Suppressikits" for vehicles with alternators or DC generators.

POWER DEVICES

74. HEVI-DUTY—Bulletin 7-22 supplies data on line-voltage regulator using saturable-core reactor.
75. TERADO—Folder illustrates and lists specifications of Model 50-160 Trav-Electric power inverter.

REFERENCE MATERIAL & SCHOOLS

76. CLEVELAND INSTITUTE—Booklet outlines courses in electronics, including those for broadcast engineering and FCC license preparation.

STUDIO & CAMERA EQUIPMENT

77. CLEVELAND ELECTRONICS — Data concerns modifications using new yoke assembly to update 3" image-orthicon camera.
78. GENERAL ELECTRIC—Brochure GEA 7859 describes new PE-26 completely transistorized portable 3" IO camera system. "First With 4-V" (brochure GEA-8050) includes photos and user reactions to the first 27 G-E color film-camera installations. Brochure GEA-7858 lists specifications and tube complements for VHF transmitter cubicle combinations. Specifications for second generation UHF klystron transmitters are listed in brochure GEA-7555B.
79. MOLE-RICHARDSON—Technical bulletins 104, 106, and 107 illustrate Softlites, Nooklites, Single Broad, Double Broad, and Cyc-Strips.
80. TV ZOOMAR—Information on Angenieux lenses for IO's and vidicons, and data on Evershed Mark II servo-controlled pan and tilt equipment.
81. VISUAL ELECTRONICS—Technical information covers new accessories for Mark 10 camera line and VAT preselect switcher.

TELEVISION EQUIPMENT

82. COLORADO VIDEO—Eight-channel solid-state "Bar/Graph" generator is described in illustrated specification sheet.
83. DAGE-BELL—Specification sheets give particulars on broadcast VTR with 2000-hour head-life warranty.
84. DENSON—Flyers and catalog describe new, used, and surplus electronic equipment.
85. VITAL—Data sheets give specifications of Model VI-500 stabilizing amplifier, Model VI-10A video distribution amplifier, and Model VI-20 pulse distribution amplifier.
86. WARD—Specification sheets describe new solid-state color phase equalizer and low-pass filter.

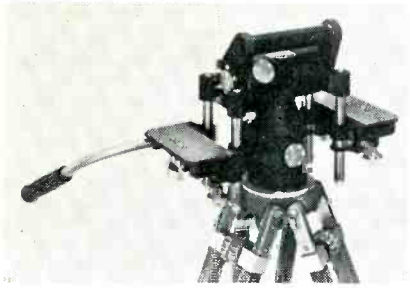
TEST EQUIPMENT & INSTRUMENTS

87. ANALAB—Eight-page brochure describes oscilloscope camera system called Rapromatic® used for trace recording. Features use of 35-mm film and has on-camera processing unit.
88. HICKOK—Brochures on industrial tube testers including new Model 580, Model 539C, and Model 752A instruments.
89. SECO—Folder illustrates 20 test instruments including color-bar generator.
90. TELEMET — Sheet supplies specifications for transistorized TELECHROME Model 3518-A1 color-bar generator.

TRANSMITTER & ANTENNA DEVICES

91. AIR SPACE DEVICES—Brochure describes "Saf-T-Climb" device used to ensure safety during tower erection or maintenance.
92. DYNAIR—Flyers give particulars on RX-4A solid-state professional TV tuner. Illustrated bulletin introduces Series 6000 solid-state modular balanced-line transmission equipment and cites advantages of balanced-line video transmission.
93. JAMPRO—Copy of engineering study titled "A Study into the Effects of Dual Polarization in FM Broadcasting" is available on request.
94. MOSELEY—Four-page folder gives details and specifications for new Type II and Type III STL radio remote-control systems.

NEW PRODUCTS



Fluid Camera Head

The Model 40 fluid-action pan and tilt camera head can tilt straight up or down and pan through a full 360°. The dual camera platforms can accommodate up to 40 lbs each and allow two cameras to be focused continually on the same subject. The camera tilts above its center of gravity, thus affording static and dynamic counterbalancing. Wide-range drag controls are provided and can be quickly adjusted with no loose parts. All adjustments can be made without tools. The mechanism is constructed of aluminum and steel alloys and is resistant to salt, air, dust, grit, and corrosive atmospheres. The manufacturer is **O'Connor Engineering Laboratories.**

Circle Item 96 on Tech Data Card

Head Repairs

Both full-track and half-track replacement pole pieces for the older Magnecord PT6 heads are now available from **Minneapolis Magnetics, Inc.** Also available are newly designed replacement caps for both the erase head and the record-reproduce heads of these recorders.

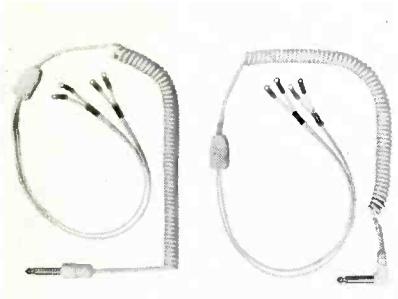
The red molded-plastic caps incorporate two adjustable stainless-steel guides that provide a positive guiding action of the tape across the heads. The pole pieces have a straight, tight, fine-line gap and are built with a greater depth of metal for extended life. These pole pieces and replacement caps make it possible to rebuild worn heads, often in less than 30 minutes.

Circle Item 98 on Tech Data Card

Switch-Model Lavalier Microphone

The Model S-58, a new dynamic lavalier microphone, was recently introduced to the broadcasting market by **The Turner Microphone Co.** Designed for any application requiring freedom and mobility, the S-58 features a slide on-off switch. Frequency response is 60-13,000 cps. Output level is —60 db. Impedance is combination hi or 150 ohms. A 25' cable and lavalier assembly are furnished. The S-58 lists at $67.00.

Circle Item 97 on Tech Data Card

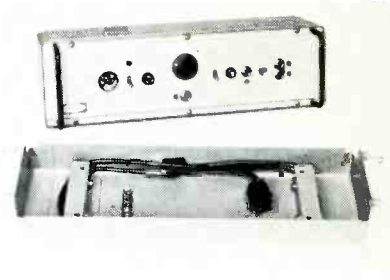


Replacement Coiled Cords

These coiled cords are designed for replacement of most monaural headphone cords and as direct replacements for cords used on Brush BA-200, BA-205, and BA-206 headphones and the RCA MI-38107B headphone. The **Switchcraft, Inc.** cords feature white neoprene jackets molded in a flexible process designed to eliminate shorts, minimize noise, and assure positive electrical contacts. The cords are available with either a straight or right-angle phone plug, with cable clamp, securely molded to one end of the cord. "Y" junctions of the cords are also molded to give strength to the "Y" termination. Four color-coded eyelet lugs terminate this end of each cord assembly.

Straight-plug models are the 05NJ88, with an extended length from "Y" junction to plug of 5′, and the 05NN88, with an extended length of 10′. Right-angle phone plug models are the 13NJ88, with extended length of 5′, and the 13NN88, with extended length of 10′.

Circle Item 99 on Tech Data Card



Video Amplifiers

Three solid-state Type-B clamper amplifiers are available from Raytheon for use in microwave radio or cable circuits handling NTSC color or monochrome television. The amplifiers are designed to provide reduced low-frequency amplitude and phase distortion, improved low-frequency signal-to-noise ratio in video transmission channels, and suppression of 60-cps interference by more than 30 db. All models offer solid-state, plug-in, printed-circuit modules; gold-plated signal connections; weight of less than 9 lbs; and power consumption of 16 watts. The units can be operated as clamper amplifiers or as wideband video amplifiers with a gain of 20 db.

Model 10255, the portable unit, has accessories—the power cord, spare fuse, and rack-mounting adapters—stored inside the top cover. The 10255A is designed for Bell System television operating center relay racks, and the 10255B is front mounted in standard 19″ EIA racks.

Applications include intercity relays, studio-to-transmitter links, remote pickups, off-the-air relays, and closed-circuit television systems.

Circle Item 100 on Tech Data Card

Studio Recorder

The AG-350, first all-transistor studio recorder offered by **Ampex Corp.**, is an advanced version of the company's 351. Features of the recorder include auto-

matic equalization switching when a change in speed is made, a wider-opening head gate for easier threading and editing, a redesigned control panel, simplified operation, locking level controls, and improved ferrite-type erase heads. A console model is available with overhead electronics and a transport that can be tilted to various operating angles for user convenience. A console with electronics mounted below is offered, and unmounted and portable versions also are available.

The recorder/reproducer ranges in price from $1750 for a full-track unmounted recorder-reproducer to $2670 for the two-speed stereo console. A playback-only version is available beginning at $1325 for a full-track unmounted model.

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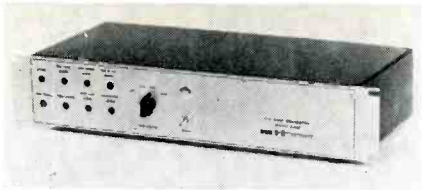
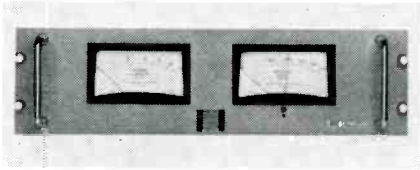


Compact Sync Generator

The S-501 sync generator, manufactured by **Maryland Telecommunications, Inc.** features solid-state plug-in circuitry and computer-type logic. It may be locked to line or an externally driven pulse, allowed to free run, or be provided with internal crystal control. Weighing 8 lbs and occupying 3½" of rack space, the generator is a complete system for providing EIA timing pulses for broadcast and closed-circuit television applications. Its price is $1995 (optional crystal lock is available at additional cost).

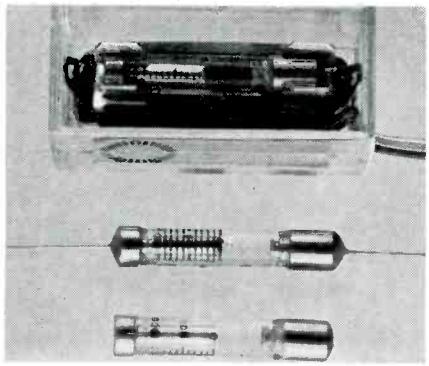
Circle Item 102 on Tech Data Card



RF Power Monitors

Continuous display of VSWR conditions and power output levels is presented by **Bird Electronics Corp.** "Wattchers" Models 3127 and 3128. The monitors provide simultaneous indication of forward and reflected power on two meters. Local and remote audible and visual alarms are activated and automatic shutdown of the transmitter occurs when a fault appears. Model 3127 is available for 1⅝", 6⅛", and 9" rigid transmission lines. Model 3128 is designed for use with flexible cable.

Circle Item 103 on Tech Data Card

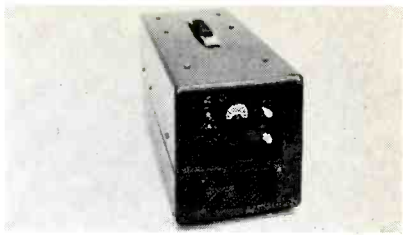


Time Meter

A subminiature time totalizer, the Minichron by **SELA Electronics Co.,** has either pigtail or standard 3AG-fuse configurations, and provides a visual indication of total equipment operating time in a wide range of time increments. Capable of use with any combination of available currents, the Minichron is designed for use in compact instruments as a "time meter."

The device is essentially a small-scale electroplating tank mounted inside a graduated glass cartridge; it indicates, by a process of ionic metal deposition, the accumulated length of time the device is operated.

Circle Item 104 on Tech Data Card



TWT Power Amplifier

A portable 20-watt traveling-wave-tube RF power amplifier, primarily designed for television relaying operations, is being produced by **Microwave Associates, Inc.** It is particularly useful in established airborne and other remote broadcasting applications where increased transmitting power is required. The Model MA-8531 power amplifier was designed to be driven by Microwave Associates' Model MA-8507 solid-state transmitter or other transmitter/exciter. Power required is a nominal 150 watts from a 28-volt DC source; the instrument can be modified on request to accept 110 volts AC. Higher power output offers extended range and improved signal to noise ratio.

The unit is weather sealed and contained in a compact portable metal case for field use. A front-panel meter provides visual checks on all important circuit voltages and RF output. All circuit elements other than the traveling-wave tube are solid state to insure maximum ruggedness. ▲

Circle Item 105 on Tech Data Card

Professional Services

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CONSULTING RADIO ENGINEERS
Applications and Field Engineering
345 Colorado Blvd.
Phone: (Area Code 303) 333-5562
DENVER, COLORADO 80206
Member AFCCE

JAMES C. McNARY
Consulting Engineer
National Press Bldg.
Washington 4, D. C.
Telephone District 7-1205
Member AFCCE

LAWRENCE BEHR ASSOCIATES, Inc.
RADIO ENGINEERING CONSULTANTS
FM Applications and Field Engineering
also
AM — Communications — CATV
LAWRENCE BEHR, PRESIDENT
2501 East Fourth Street
Greenville, North Carolina
919-PL 8-3966

OSCAR LEON CUELLAR
Consulting Radio Engineer
AM-FM-TV
411 Phoenix Title Building 623-1121
Directional Antennas Design
Applications and Field Engineering
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Cleveland, Ohio 44141
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CAMBRIDGE CRYSTALS
PRECISION FREQUENCY
MEASURING SERVICE
SPECIALISTS FOR AM-FM-TV
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Cambridge, Mass. 02138

AMPEX HEAD ASSEMBLY RECONDITIONING SERVICE for all Ampex professional model recorders. This professional service features precision relapping of all heads for maximum head life. Your assembly is thoroughly cleaned and guides are replaced as required. Price includes optical and electrical inspection and complete testing on Ampex equipment in our plant. Full track or half track assemblies . . . $35.00. One to two day service. "Loaner" assemblies available, if necessary. Audio assemblies from Ampex and RCA Video Tape Recorders also serviced. LIPPS, INC., 1630 Euclid St., Santa Monica, California 90404. (213) EX 3-0449. tf

Classified

Advertising rates in the Classified Section are ten cents per word. Minimum charge is $2.00. Blind box number is 50 cents extra. Check or money order must be enclosed with ad.

The classified columns are not open to the advertising of any broadcast equipment or supplies regularly produced by manufacturers unless the equipment is used and no longer owned by the manufacturer. Display advertising must be purchased in such cases.

EQUIPMENT FOR SALE

Will buy or trade used tape and disc recording equipment—Ampex, Concertone, Magnecord, Presto, etc. Audio equipment for sale. Boynton Studio, 295 Main St., Tuckahoe, N. Y. 1-64 tf

Ampex Head Assemblies for 300 and 400 series recorders reconditioned. Service includes lapping and polishing all three head stacks, cleaning entire assembly, readjusting and replacement of guides, and realignment of stacks as to azimuth and zenith. Full track assemblies—$60.00. Taber Manufacturing & Engineering Co., 2619 Lincoln Ave., Alameda, California. 5-64 tf

Audio Equipment bought, sold, traded. Ampex, Fairchild, Crown, McIntosh, Viking. F. T. C. Brewer Company, 2400 West Hayes Street, Pensacola, Florida. 3-64 tf

Television/Radio/communications gear of any type available. From a tower to a tube. Microwave, transmitters, cameras, studio equipment, mikes, etc. Advise your needs—offers. Electrofind Co., 440 Columbus Ave., NYC. 212-EN-25680. 8-64 tf

COMMERCIAL CRYSTALS and new or replacement crystals for RCA, Gates, W. E., Bliley, and J-K holders; regrinding, repair, etc. BC-604 crystals; also service on AM monitors and H-P 335B FM monitors. Nationwide unsolicited testimonials praise our products and fast service. Eidson Electronic Company, Box 96, Temple, Texas. 5-64 tf

AMPEX 350 SERIES reconditioned capstan idlers for $7.50 exchange. Send us your old ones, or order them for $10.00 and get $2.50 back after sending the old ones in. Ours have new bearings, the rubber softened and surface precision ground. TABER MANUFACTURING & ENGINEERING CO., 2619 Lincoln Ave., Alameda, California. 1-65 12t

AMPEX 350 SERIES reconditioned capstan drive motors (BODINE NCH-33 only) $85.00 exchange. Send us your old one, or order for $100.00 and get $15.00 back after sending old one in. Ours have new bearings and rewound stator. Package motor well. TABER MANUFACTURING & ENGINEERING CO., 2619 Lincoln Ave., Alameda California. 1-65 12t

CO-AXIAL CABLE Heliax, Styroflex, Spiroline, etc. Also rigid and RG types in stock. New material at surplus prices. Write for list. Sierra-Western Electric Co., Willow and 24th St., Oakland, Calif. Phone 415 832-3527. 5-65 tf

Conrac TV Monitors for sale, 3—27", 2—21", 1—17", 3—8". All encased and in good condition. GPL PD-150 camera and control unit. Best offer on any or all. F & B/CECO, Inc., 315 West 43rd Street, New York City, Mr. Zuch. Phone: JU 6-1420. 8-65 tf

(4) Collins Record/Playback units plus (2) Record Amplifiers. Will sell separately or as a package. Write Chief Engineer, WSPF Radio, P. O. Box 1790, Hickory, N. C. 28601, or telephone (704) 328-1338. 8-65 1t

One rack mounting Western Electric Type 124G twelve watt output Amplifier with self-contained power supply. Two brand new RCA 872-A tubes. One Seeburg Select-O-Matic 45 RPM Library Unit, Model 200 LU-1P. WGFS, P. O. Box 869, Covington, Ga. 8-65 1t

REL FM microwave links for sale. Two transmitters and associated equipment, spare parts, tubes. $1,000.00. KPEN, 1001 California Street, San Francisco, California. 8-65 1t

UHF TV EQUIPMENT: 1—RCA BWV-5 SIDEBAND ANALIZER, complete with UHF Converter, $1,500.00; 1—TK 20, IKE FILM CAMERA, with spare 1850 tube, $350.00; 1—GRAY TP3 SLIDE PROJECTOR, incl. pedestal and remote control, $250.00. Contact: Gene Miller, Chief Eng., WTAF-TV, P. O. Box 631, Marion, Indiana. 8-65 1t

469B COND capacitors rebuilt; must have old top and bottom rings, no finger stock missing. Write for prices. Sound and TV Systems, 316 Mariemont Drive, Lexington, Ky. 8-65 1t

Everything in used broadcast equipment. Write for complete listings. Broadcast Equipment and Supply Co., Box 3141, Bristol, Tennessee. 11-64 tf

New and Recondtioned Remote Pickup and 2-way radio equip., Fire and Police Receivers. All brands and models. Sales Manager, Box 238, Phone 817-594-5171, Weatherford, Texas. 5-65 12t

Audio Equipment — Ampex, Altec, Fairchild, Langevin, Neumann, etc. Trades. New and used. Get our list. Audio Distributors, Inc., 2342 S. Division, Grand Rapids, Michigan. 7-65 6t

ITA FM10B EXCITER AND POWER SUPPLY, completely rebuilt, schematics but less filament transformer, $500.00. KDFM, 1581 Botelho Drive, Walnut Creek, Calif. 7-65 1t

PERSONNEL

ENGINEERING SALES OPENING? Sales background plus nine years in broadcasting, from engineer to management level, adds up to good representative for manufacturer dealing with broadcasting field. Box 133, Broadcast Engineering. 8-65 2t

CONSULTING ENGINEER'S ASSISTANT position wanted. First Phone with Radar Endorsement. Four years in Broadcast Engineering. Two years as an Electrical Engineer's Assistant in Industrial Controls designing, Product Noise Analysis, Solid State Telemetering Systems design, and Test Equipment design. Young, single, active military duty completed. Write Broadcast Engineering, Dept. 134.

Employment

Need TV engineer, experienced in all phases of station operation, to teach college accredited communications course, plus limited assignment in major ETV station operations. Chief Engineer, WMVS, Milwaukee, Wisconsin. 7-65 2t

Business Opportunities

EXCLUSIVE FRANCHISE

Amazing new liquid plastic coating used on all types of surfaces interior or exterior. Eliminates waxing when applied on Asphalt Tile, Vinyl, Linoleum, Vinyl Asbestos, Hard Wood, and Furniture. Completely eliminates painting when applied to Wood, Metal, or Concrete surfaces. This finish is also recommended for boats and automobiles.

NO COMPETITION

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CHEM-PLASTICS & PAINT CORP.
1828 Locust, St. Louis 3, Mo.
6-65 14t

McMartin TBM-4000 FM Modulation/SCA Multiplex Monitor

Every FM station with an SCA Multiplex permit needs one.

Oh, you could get along without one, but engineers know the difficulties of measuring crosstalk and injection without a monitor like this. (Incidentally, there is no other monitor like this.) ■ The TBM-4000 provides a continuous check of sub-channel frequency and modulation and also main channel modulation . . . Type-Approved (Type No. 3-116) under the new FCC regulations. ■ McMartin is the leading producer of FM Monitors. The units are so reliable that most transmitter manufacturers use McMartin monitors as their reference standard. FM stations in all 50 states and overseas in places like Tel Aviv and Uganda use our TBM-4000. The workmanship is guaranteed *forever*. We make this bold warranty because 20% of our people are in final testing. ■ Please contact us for complete specifications and prices.

McMartin®

McMARTIN INDUSTRIES, INC.
605 North 13th Street
Omaha, Nebraska 68102

Circle Item 52 on Tech Data Card

RCA Test Equipment helps keep you on the air

EVERYTHING THE WELL-EQUIPPED STATION NEEDS

Of course there's a lot of station test equipment around. But wouldn't you rather use test instruments from the same company you depend upon for your other station equipment—RCA?

Next time you call your RCA Distributor for microphones, receiving or power tubes, image orthicons or what have you, check your test equipment requirements. RCA test instruments are available from the same convenient source.

Your RCA Distributor carries a full line of test instruments designed and engineered with you in mind... to help you keep your station on the air at minimum cost. **Here are eight, with prices:**

❶ **RCA WT-100A MICROMHOMETER** Measures tube characteristics under actual operating-voltage conditions.

Tests vacuum tubes, gas-filled tubes, semiconductor diodes.

Measures: True transconductance (both control-grid-to-plate and suppressor-grid-to-plate) to an accuracy of better than 3%; Transconductance up to 100,000 micromhos in six ranges; DC plate, screen grid, and grid-No. 1 test voltages; Electrode currents from 3μa to 300 ma; Heater-cathode leakage currents; . . . and other important electron tube parameters. **$989.00***

❷ **WV-84C ULTRA-SENSITIVE DC MICROAMMETER** Battery-operated vacuum-tube microammeter measures down to 0.0002 microampere. Especially useful in measuring "dark currents" in vidicons and phototubes as well as minute currents in image orthicons. Can also be used as a high-impedance voltmeter and as an ohmmeter to measure extremely high resistances in the order of billions of ohms. **$110.00***

❸ **WO-91B RCA 5-INCH OSCILLOSCOPE** A high-performance, wide-band 'scope—serves as a display-type VTVM. Choice of wide band (4.5 Mc—0.053-volt rms/inch sensitivity) or narrow high-sensitivity band (1.5 Mc—0.018-volt rms/inch sensitivity). New 2-stage sync separator provides solid lock-in on composite TV signals. **$249.50***

❹ **WA-44C RCA AUDIO GENERATOR** Generates sine-wave and square-wave signals over range of 20 to 200,000 cps to test audio systems. Can be used to measure intermodulation distortion, frequency response, input and output impedances, speaker resonance, transient response, and phase shifts. Less than 0.25% total harmonic distortion over range of 30 to 15,000 cps. **$98.50***

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❻ **WV-98C NEW RCA SENIOR VOLTOHMYST®** For direct reading of peak-to-peak voltages of complex waveforms, rms values of sine waves, DC voltages, and resistance. Accuracy: 3% full scale on both AC and DC, with less than 1% tracking error. Color-coded scales differentiate peak-to-peak from rms readings. New 0.5 volt full scale DC range for use in low-voltage transistor circuits. 6½" meter. **$79.50***

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❽ **RCA WV-120A POWER LINE MONITOR** Provides a constant check on incoming line voltage. Responds to voltage fluctuations. Highly accurate (± 2% at 120 volts). Gives true rms reading. 5" wide meter. **$14.95***

SEE THEM ALL AT YOUR AUTHORIZED RCA TEST EQUIPMENT DISTRIBUTOR.

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

**All prices are subject to change without notice. Prices may be higher in Alaska, Hawaii and the West.*

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