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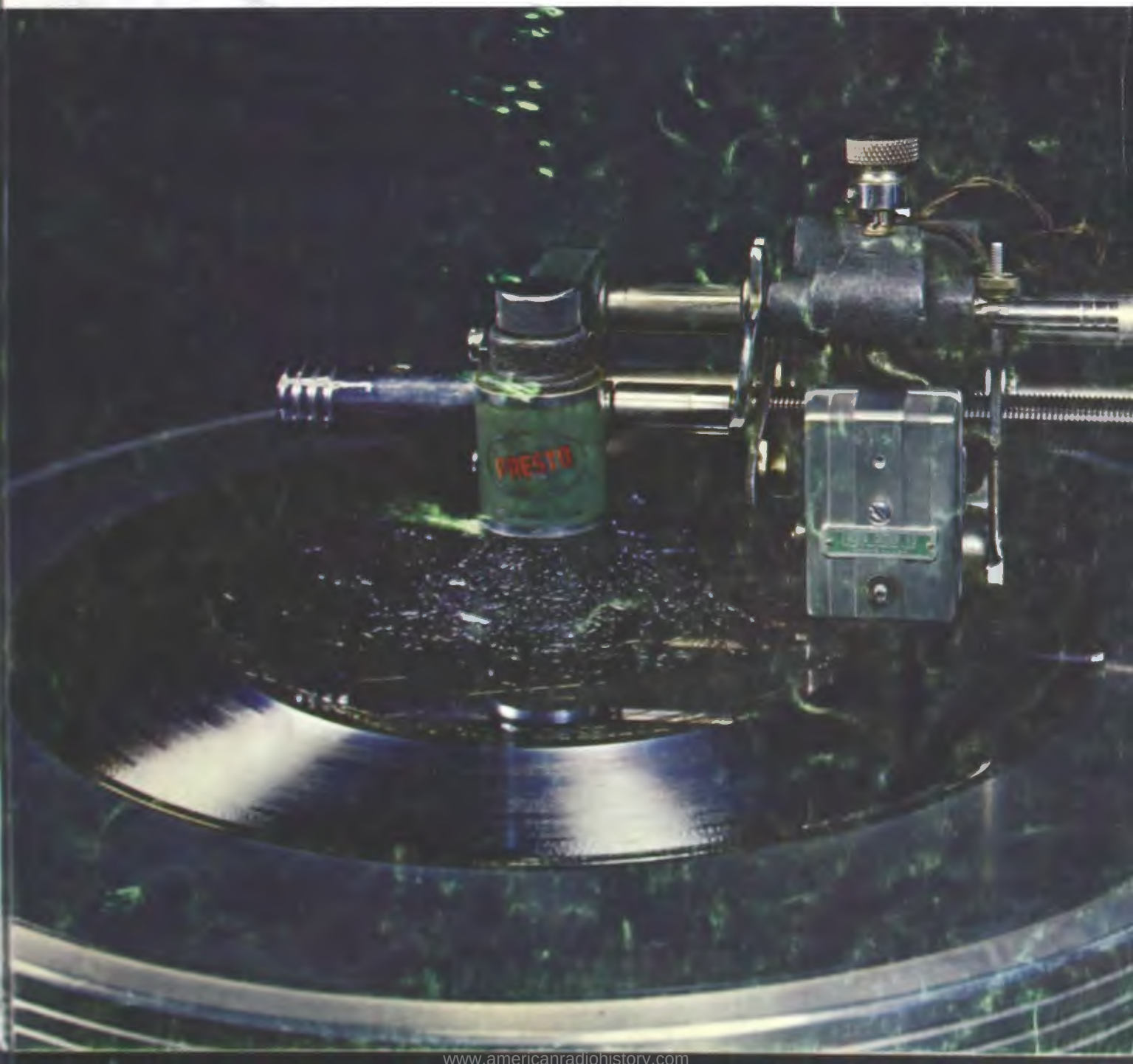

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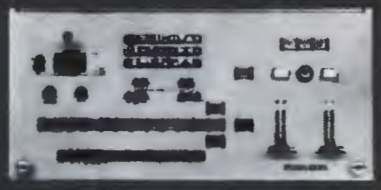

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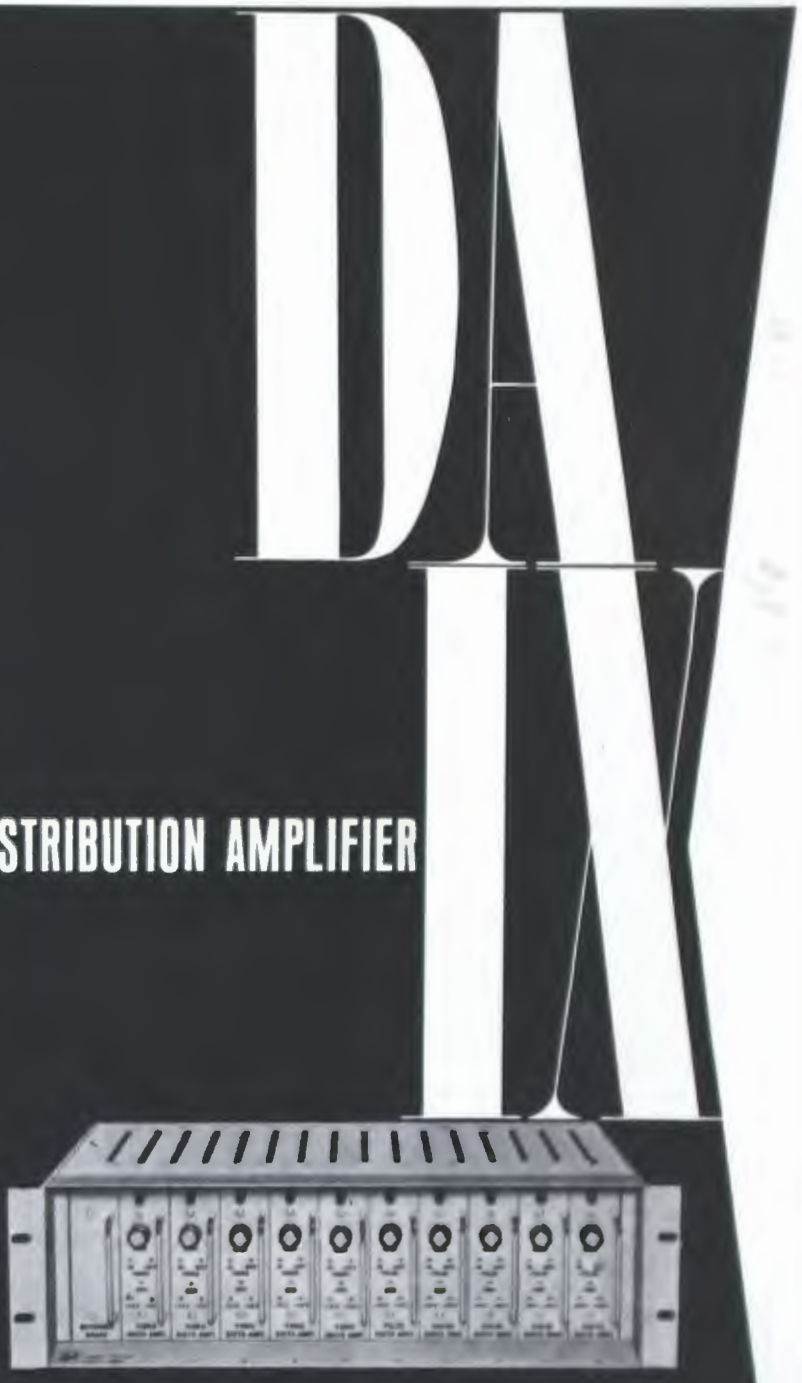

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the technical journal of the broadcast-communications industry

•Broadcast Engineering

Volume 9, No. 5 May, 1967

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This disc recorder is used by Jan Eden Recording and Sound, Inc., Indianapolis, to cut LP discs. To see how older machines can be used for this purpose, read "Rejuvenating Disc Recorders" on page 13 of this issue.

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*__75C__ . . . Transistorized FM system operating in the 7125 to 8400 MHz Government band. System uses TWT output amplifiers and IF repeaters, handling up to 1200 v-f channels or one video and program channel.

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STANTON

Circle Item 8 on Tech Data Card

LETTERS to the editor

DEAR EDITOR:

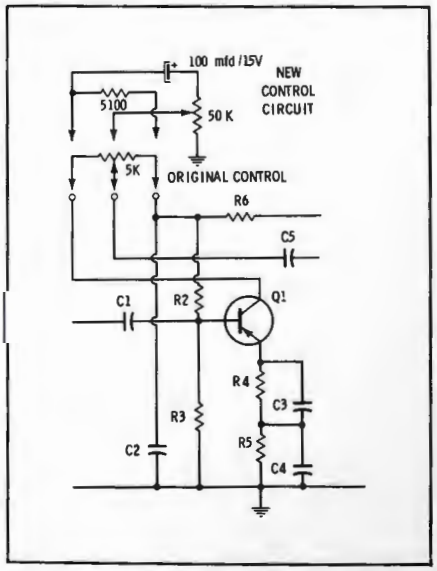
I have received many requests for information concerning the type of amplifier used in my redundant remote amplifier (February 1967 BROADCAST ENGINEERING, page 28). The redundant arrangement can be used with almost any type of amplifier, and the amplifiers do not have to be identical. The article was written on the assumption that the builder would use whatever units were available to him.

I am using Round Hill Associates' Model AA-200. In this amplifier, the volume control is also the collector load resistor, and changing the setting will cause a gain bounce. Therefore, I made the modification shown in the accompanying diagram. These units have a 50-ohm balanced input and a 500-ohm balanced output. The power source is a 9-volt battery. A word of caution is necessary: *This amplifier must be terminated at all times.* The supplier suggests that a 1000-ohm resistor be placed across the output (500-ohm) terminals. I would suggest that the line pad be used. The amplifier will "run away" and burn out the output transistors if not terminated.

Since the amplifier can draw as much as 100 ma at 9 volts, I suggest that a large battery be used. I am using two 4.5-volt batteries.

This amplifier is available with or without metal case from Round Hill Associates, 434 Avenue of the Americas, New York, N. Y. 10011.

CHARLES D. SEARS
New Whiteland, Indiana



REJUVENATING DISC RECORDERS

*by Larry J. Gardner**—
You can put this neglected piece of equipment back to work.

Somewhere in the back room of many a radio station lurks a disc recorder. It may date back to the infancy of radio, or it may be a more recent type, but almost always it is considered to be a useless antique, rendered obsolete by the advent of magnetic tape. Although present-day radio and television stations don't use the products of these machines very often, there is a waiting market for disc recordings, and making discs can be a profitable sideline. If your station happens to have one of these machines, restoring it to operation and updating it to cut microgroove discs may be well worth your while.

The Mechanism

Pull the old machine out of the closet and blow away the dust. It may need a lot of cleaning, and soap and water won't hurt it if used carefully. Clean the turntable, lathe, drive system, and cabinet. Then, following the instruction book, if you can locate it, be sure all the rotating and sliding parts are properly lubricated. Only a few drops of oil are necessary in most cases. When the machine appears to be ready to run again, turn it on and use a strobe disc to check the turntable speed. These machines were seldom used for a great many hours, as compared to a playback turntable, and the motors are usually in good condition. Most drive troubles can be traced to improper lubrication or incorrect adjustment. Usually only 78- and 33⅓-rpm speeds are available, but you probably will be making only 33⅓-rpm recordings.

*President, Gardner Electronics Corp., and BE Consulting Author.

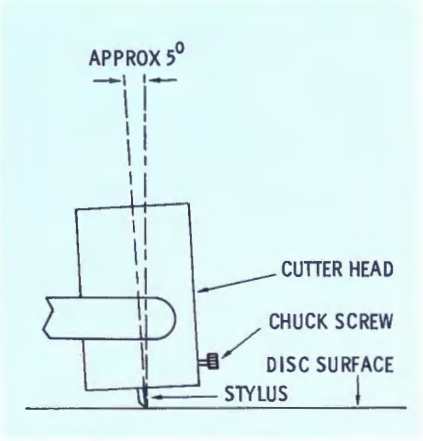


Fig. 1. Correct angle for cutting stylus is essential for good disc recording.

When you are satisfied that the turntable is running properly, check the cutting lathe. Be sure there is no stylus in the cutting head, and then put the carriage in its operating position and check the cutter feed. You should be able to hand crank the cutter across the disc, or let it feed by itself. In most cases, the cutter is driven by a blade which rides on the leadscrew, and the condition of the blade determines how evenly spaced the grooves will be. The blade should be clean and sharp, and it should mate properly with the groove. It can be sharpened with a small, round file, but you must be careful not to get it too short.

The cutting angle should now be adjusted. Position the cutting head so that the stylus is approximately 5° from vertical as shown in Fig. 1.[1] Use a microgroove sapphire stylus, short or long shank as recommended by the manufacturer. Steel or *Stellite* styli are satisfactory for standard-groove work, but the sapphires will save money in the long run, especially for microgroove cutting.

[1] Editor's Note: Some authorities recommend that the stylus make an angle of 90° ±2 or 3° with the record surface. In the final analysis, the angle used will be the one that gives the best results with the machine being used.

You are now ready to make a test cut. Use a new blank disc (any old ones left over from the "good old days" will be too hard to be cut, a microgroove stylus, and any leadscrew you happen to have. With the turntable running, and the cutting head disconnected (so that you don't record amplifier noise), gently lower the cutter and watch the cut groove. It should be very smooth and shiny, and no sound should come from the cutter. A hissing sound indicates either that you are cutting too deeply, the recording stylus is bad, or the cutting angle is incorrect. After cutting a few grooves, stop the turntable and examine the chip (thread) cut from the grooves. It should be slightly smaller than a human hair, almost straight, and shiny. A course, kinky chip indicates too deep a cut or a dry disc, and a very fine chip which looks dull indicates too shallow a cut (this, also, could be caused by a dry disc). When a pitch of 120 lines per inch is used, the ratio of groove width to the width of the "land" between the grooves should be about 60/40. For a finer pitch (over 120 lines per inch) the ratio of groove to land should never exceed 70/30, which can be easily checked with a microscope. (Standard microscopes for this purpose are available.) A 60-40 ratio at 120 lines corresponds to a groove depth of about .002 inch. The depth of cut is usually adjusted by means of a tension spring attached to the cutter. Increasing the tension of this

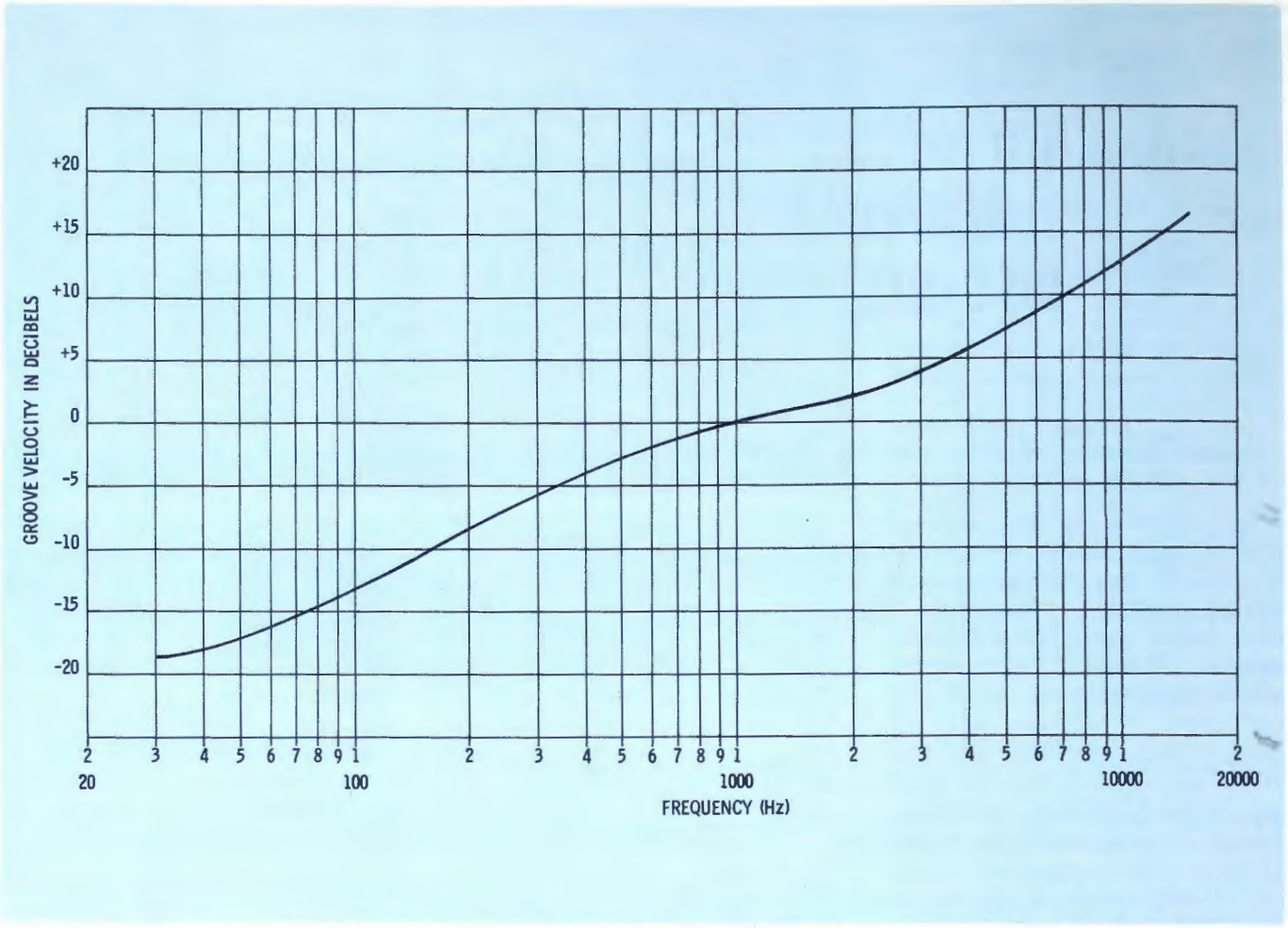


Fig. 2. Standard recording characteristic shows roll-off of low-frequency signals and boost of high-frequency signals.

spring reduces the depth of cut, and vice versa.

Many older lathes, designed for 78-rpm operation, do not have leadscrews for pitches finer than 120 lines per inch. Although excellent recordings can be made at this pitch (which is used on many 45 rpm commercial records), the recording time is somewhat limited; only about ten minutes can be obtained per side on a 12-inch disc at 33⅓ rpm. Leadscrews for 136, 148, 160, 190, 210, or more lines per inch are available from most manufacturers, and the finer pitches will give a proportional increase in recording time. Older lathes, however, are designed for coarser pitches and sometimes do not feed well at pitches over about 210 lines per inch. Using the 120-line screw for 45-rpm work and the 210-line screw for 33⅓-rpm work should give satisfactory results with most lathes, however.

If you can't get leadscrews from the manufacturer, any good precision machine shop should be able to make one for you. Be sure they understand the purpose of the screw and the shape of the threads. If you take one of your screws in as a sample, they should be able to make a screw for just about any pitch.

You may want to cut 45-rpm discs on a 33⅓-78-rpm lathe and need a means of driving the turntable at 45 rpm. How this can be done depends to a large degree on the construction of the turntable. Check first with the manufacturer and see if he has a conversion. On rim-drive turntables, this conversion is simply a sleeve which slips over the 33⅓-rpm drive surface of the motor shaft. On gear-driven turntables, it is necessary either to replace the 78-rpm gears with new ones of a suitable ratio, or to drive the turntable at 45 rpm with a separate rim or belt drive. If you want to do the conversion yourself, have a machine shop make the parts. On a rim-drive turntable, you sometimes can have the 78-rpm drive surface ground down to size for 45 rpm, which corresponds to 45/78 times the original diameter (this, of course, eliminates the 78-rpm speed). Alternatively, you can add a belt drive around the circumference of the turntable, using a pulley on a separate drive motor. If you grind down the existing rim-drive shaft, be sure there is sufficient metal left after machining to hold the set screw or screws firmly. If not, you can make a separate drive shaft for 45 rpm. This approach does have a big disadvantage: it requires a shaft change every time you change speeds.

If changing speeds is a really big problem, a good playback turntable can be pressed into service as a cutting table, provided the motor has sufficient torque to overcome the drag of the recording stylus. You will have to add a driving pin for the recording blank, and the center pin will have to match the driving disc of the feed mechanism.

Amplifiers

To make good recordings, you will need an amplifier with a minimum of about 30 watts output and

good performance specifications. Many ordinary monitor amplifiers or hi-fi types are acceptable. Choose an amplifier with an output impedance that matches the cutter you plan to use, and avoid using a matching transformer between the amplifier and the head. Losses in such a transformer degrade the damping factor of the amplifier, and good damping is especially important in disc recording. Some of the newer transistor amplifiers with very high damping factors are excellent for this purpose, and are at their best with a low-impedance recording head.

The amplifiers originally used with older disc recorders are capable of excellent performance, but usually are not equalized to the current NAB or RIAA curve, and should only be used in the "flat" response position of the equalizer.

Equalization

Equalization is used in disc recording to permit a higher recording level by attenuating the low frequencies and to lower objectionable surface noise by accentuating the high frequencies. Currently, the accepted standard curve is the NAB (or RIAA) curve, shown in Fig. 2. This curve may be most easily matched by using two networks, one in series wth the cutter head itself for frequencies below 1000 Hz, and another in the amplifier input circuit for frequencies above 1000 Hz. The low-frequency network is a simple series resistor for a low-impedance head (8-16 ohms) and a parallel RC network for a 500-ohm cutter, as shown in Fig. 3. For a low-impedance cutter, a series resistance of from one to ten ohms is required. Because of the inductive nature of the cutter, the portion of the output voltage across the resistor is greater at low frequencies than at high frequencies, and by adjusting the resistor the low-frequency roll-off may be adjusted. For any low-impedance cutter, a ten-ohm, 30-watt resistor with a slider should be suitable for close matching to the curve. Increasing the resistance decreases response below 1000 Hz.

For a 500-ohm cutter, the low-frequency network consists of a 4-mfd paper or oil-filled capacitor in parallel with a 400-ohm, 30-watt resistor, and it is adjusted in the same manner as the low-impedance network. Remember that the series resistance of the amplifier output is also part of the circuit, so you may find that only a few ohms of the external resistor is used, depending on the power capabilities of the output transformer. If it is not possible to get correct low-frequency response because of this, use a lower-impedance tap on the output transformer.

After wiring the low-frequency network, you should check the low-frequency response. Connect an audio generator, set to 1000 Hz, to the amplifier input and adjust the gain for about 2 volts across the amplifier output for a low-impedance cutter, or 15 volts for a 500-ohm cutter. Be careful not to apply excessive power to the cutter at any time, especially if you are using a high-power amplifier. Many recording amplifiers can deliver in excess of 100 watts, which could easily damage the cutter. Keeping the amplifier input level constant, record a few seconds of tones from 1000 Hz down to 50 Hz. Then, check one of your turntables against a test record such as the 1965 NAB disc. If your playback is properly equalized, the disc you have just recorded should produce response flat within about 2 dB from 50 Hz to 1000 Hz. If not, adjust the series resistor on the cutter and try again.

The high-frequency equalization network should be inserted in a 600-ohm line feeding a 600-ohm balanced input on the recording amplifier. The circuit for a suitable network is shown in Fig. 4. If the amplifier does not have a 600-ohm balanced input, a matching transformer (600 ohms to grid) should be used. The 250-ohm potentiometer is used to adjust the high-frequency boost for the cutter and speed used, although a compromise should be made between a cut made near the edge of a 12-inch disc and one near the center. The construction of the equalizer is not critical, but the 10-mhy coil should be a toroid if you can get one.

To adjust the high-frequency

• *Please turn to page 58*

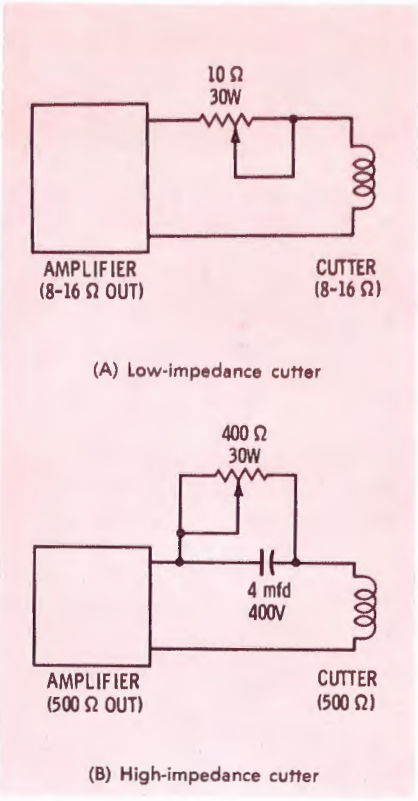


Fig. 3. Low-frequency equalization is provided by simple output networks.

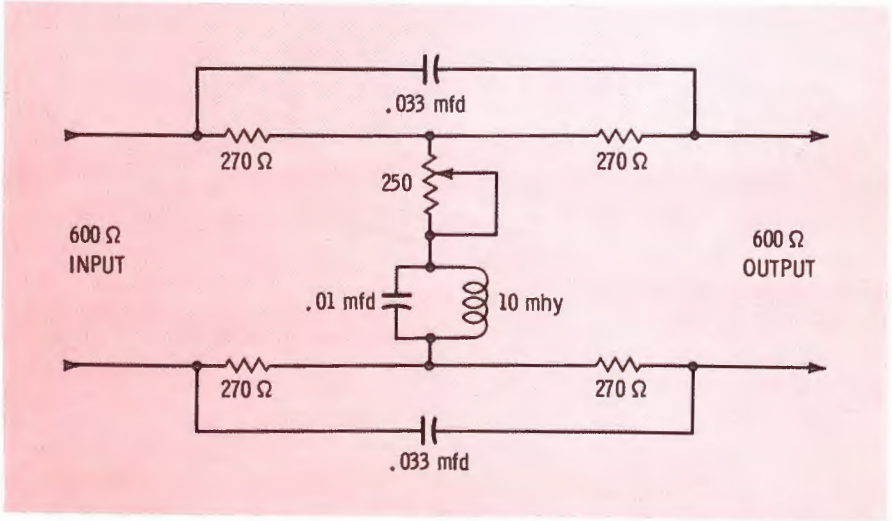


Fig. 4. Equalizing network for highs is placed ahead of recording amplifier.

PLANNING AND BUILDING THE NEW CKAC STUDIOS

*by Len Spencer**—

New studio facilities and some of the considerations that went into their design.

Although the structural design of radio studios would seem to fall in the province of the architect, the actual layout must be made by the station chief engineer or consultant. The controlling factor in studio design is, of course, programming, both present and future. Therefore the full cooperation of the management, program, and engineering departments of the station is essential. A logical decision, however, is not easily reached when one has to foresee the future of radio programming. For example, at *x* dollars per square foot, is it sound business engineering to provide a studio suitable for a 16-piece orchestra just in case it might be required in the future? Is there a trend toward more telephone call-in programs? What about complete automation? Will there be more or fewer remote broadcasts, on-the-spot news pickups, or sports programs? How about forum-type programs, and will they be with or without audience? Is intercity and international news to predominate? These and many other questions must be considered in the light of present and expected rental, construction, and equipment costs. It is the purpose of this article to describe the design and layout of a four-studio complex suitable for the present-day operation of an independent 50-kw station in a major market.

*Chief Engineer, CKAC, Montreal, Quebec, and BE Consulting Author.

Preliminary Requirements

The CKAC studio project had to be completed within a building already in existence, so it was not possible to build from the ground up. Fortunately, the building did have a clear ceiling height of 10 feet.

It had been decided, during the preliminary discussions, that the production department should be on one floor. Available space, however, did not permit inclusion of the record library in the production area; it is situated on the floor below, along with the workshop and engineering department.

Fig. 1 shows the top-floor layout as finally developed. Included are four studios, master control, recording, remote-equipment storage, the news department, and the remote-broadcast department. The top floor was chosen to get as far as possible from street noises and vibration and to preclude the necessity of soundproofing the ceiling to keep out noise from above. The building had one wall without openings, and this wall was used as a base line from which to begin the preliminary layout. From past experience, the location of the master control room was chosen so that the operators could see into as many studios as possible.

Acoustical Considerations

An important characteristic of a studio is its reverberation time. Studio A measures 24′ x 16′ 3″ x 10′. The reverberation time of this studio can be calculated from the formula[1]

$$T = .05 \frac{V}{Aa}$$

where,

- T = reverberation time in seconds
- V = volume of the studio in cubic feet
- A = surface area of the studio in square feet
- a = coefficient of absorption

Since the studio is composed of several materials having different absorption coefficients, product Aa is determined as shown in Table 1. The reverberation time is then calculated to be

$$T = .05 \frac{3900}{360}$$

$$= .54 \text{ sec}$$

Table 1. Determination of Absorption

Material	Absorption Coefficient	Area (Sq. Ft.)	Absorption Units
Plaster on wooden studs	.039	800	31.2
Linoleum	.03	390	11.7
Perforated pressed fiber board	.76	390	296.4
Small grand piano	.6		.6
Plate glass	.025	48	1.2
Person	4.7	(4)	18.8
			359.9

Table 2. Studio A Reverberation Times

Hz	125	250	500	1000	2000	4000
Sec	1.2	.9	.7	.7	.75	.8

Table 3. Studio B Reverberation Times

Hz	125	250	500	1000	4000
Sec	0.6	0.5	0.5	0.5	0.5

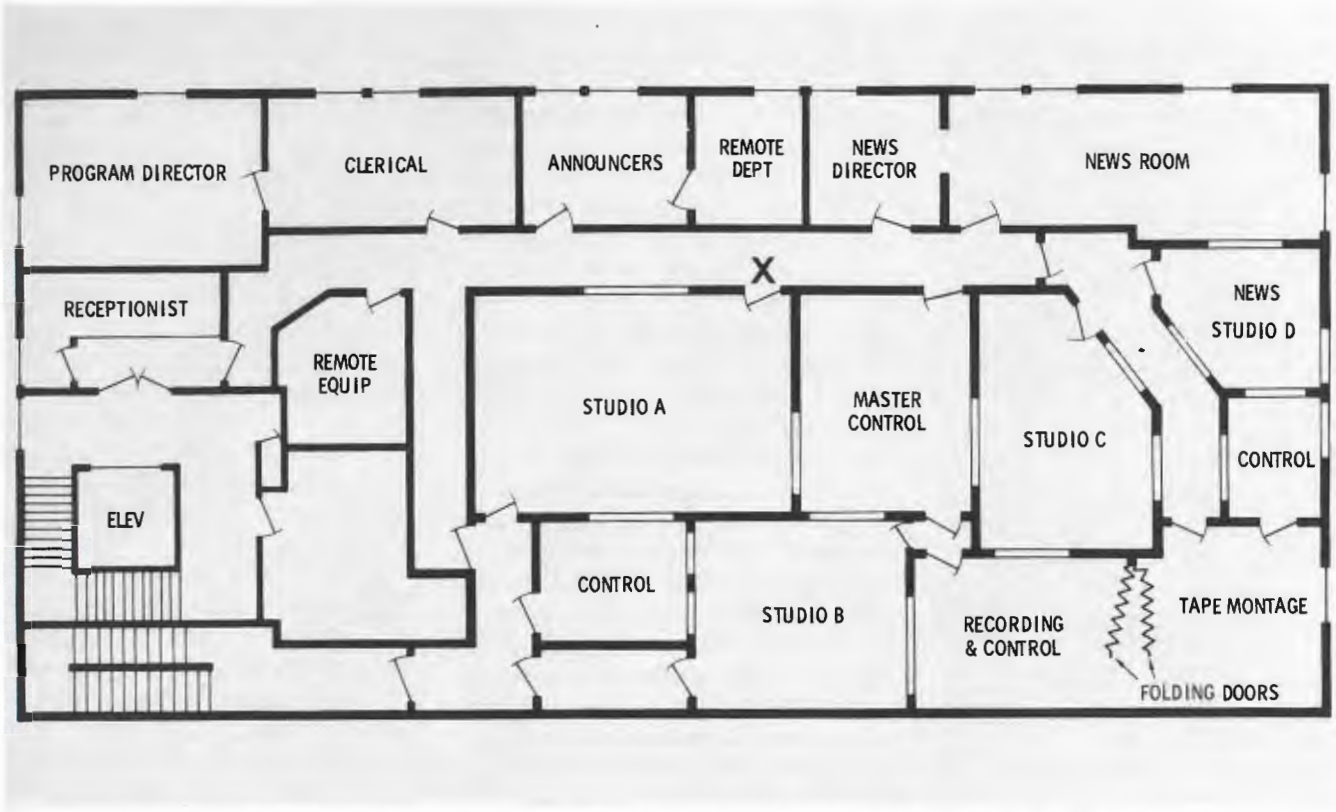


Fig. 1. Floor plan of the CKAC production area. Note sound locks and use of offices and hall for sound isolation.

This value is acceptable for a studio intended primarily for speech use. If necessary, the reverberation time could be increased easily by the addition of reflective material to the studio surfaces.

The actual readings taken in studio A are shown in Table 2. The optimum reverberation time for a small broadcast studio (4000 cubic feet) is considered to be about .72 sec at 512 Hz.[2] The optimum time increases with decreasing freqency; at 125 Hz it is about 1.02 sec.

But there is another criterion in acoustical design that is very important. Consider the reverberation times measured in studio B (Table 3). This would seem to indicate an acceptable response time for a speech studio, but in actual fact broadcasts from this studio sounded terrible, and we had to resort to all sorts of tricks to make it usable until a correction could be applied.

The trouble was caused by a phenomenon well known to radio engineers. standing waves, or reflections that were in phase with the original sound at certain frequencies. From Fig. 1, it can be seen that studio B has one solid back wall with observation windows on the three other sides. Where glass is installed in opposite sides of a studio, it has been found judicious to install the panes at an angle of 12° (Fig. 2); this precludes reflections at the higher frequencies by directing the sound toward the ceiling. But in studio B, despite the 12° angle of the windows, reflections came from the rear wall. Had it been possible to slant one wall to avoid the "square box" effect, it might have been possible to eliminate the reflections. However, in this case the cure was to install highly sound-absorbent material opposite the reflecting surface, but not enough material to change the overall reverberation time drastically.

At first glance, it would seem that 252 square feet of glass in studio C would have created both reverberation and reflection problems, but the wisdom of building walls that are offset, whenever it is possible, is shown by the actual measurements in Table 4. Because of the 12° slant of the panes, the juxtaposition of four observation windows resulted in no reflection problems. The measured reverberation times were for the studio with only

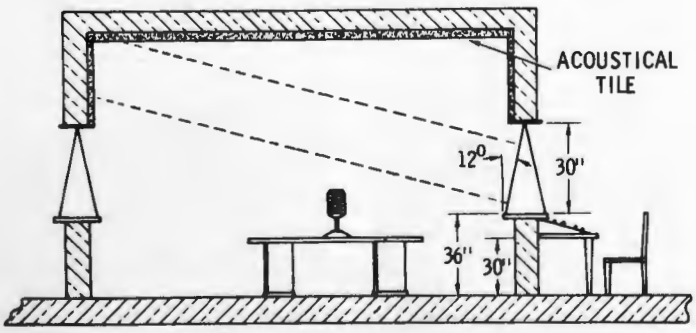


Fig. 2. Basic window dimensions. Angle of glass reduces reflection problems.

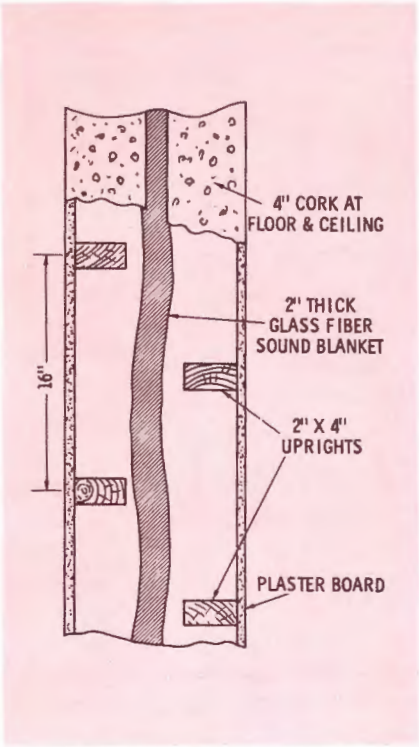


Fig. 3. Cross-sectional view of top of wall shows soundproofing method.

the control table in place. When cartridge racks, a second desk, and a coat rack were added, the reverberation time was reduced to about 0.5 sec; this was proved satisfactory by the final criterion: "Air" listening.

Contruction Details

Fig. 2 also shows the preferred control-room dimensions. The observation window has a 12° slope for sound reflections and to reduce glare. The panes are ¼-inch thick, set in medium soft rubber; this thickness of plate glass at 5½-inch bottom separation gives good sound insulation for the type of programs contemplated.

The equipment room and all studios are built with double "balloon" type soundproof (−60 dB) walls. It should be understood that the isolation obtained is only good enough for locations not subject to heavy vibrations or high sound levels such as might be found on a street with heavy truck traffic, or close to a railroad or airport. In Fig. 1, notice that except for studio D, which has a special window treatment on the outside wall, the control rooms and studios are protected from outside noises by office space and walls plus the 14-foot width of the passageway.

The rather complicated entrances to the recording department and studio D serve a double purpose. First, a sound lock is provided between the news room and the studio, and second, access is permitted to the studio without the necessity of going through the news room. The door across the passageway acts as a sound lock for studio C and the recording department.

A double folding wall allows the recording room to act as a control room for both studio C and studio B if the need should arise. At speech levels, which is all studios B and C are designed for, experienced operators could operate recording equipment without appreciable sound interference.

Control room A-B can function as designated, and studios A and B are protected by their individual sound locks. The master control room has visual control of all studios in the station.

For operation under the above conditions, the wall construction shown in Fig. 3 has proved quite satisfactory. The uprights are erected on 4-inch cork strips that are 6 inches wide to allow the plaster board to butt against them at ceiling and floor. A two- or three-inch-

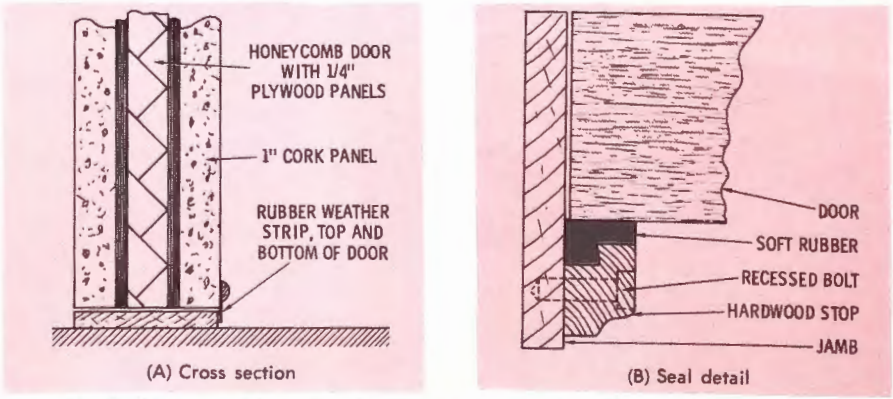


Fig. 4. Doors combine absorbent materials with seals for soundproofing.

Table 4. Studio C Reverberation Times

Hz	62	125	250	500	1000	2000	4000	8000
Sec	0.9	0.8	0.8	0.8	0.7	0.7	0.8	0.8

thick glass-fiber blanket is suspended from the ceiling so that there is no contact with the walls. The blanket is hung from 1″ x 2″ furring strips; it is of sufficient length to hang loosely and be attached to the floor. The furring strips do not touch the 2″ x 4″ uprights. A false floor was built on 2″ x 3″ runners, which were mounted on rubber pads placed six inches apart.

If there is need of acoustical treatment, perforated acoustical paneling can be mounted on 1″ x 3″ furring strips, and glass-fiber batts may be installed behind the panels. If the studios are larger and the sound problems more severe, the services of a sound specialist will be required; for the smaller station where programs are mostly at voice levels, a "cut-and-try" method may prove satisfactory. Panels without the acoustical batts are installed opposite those that are backed with 2″ fiber batts to balance out reflection areas against absorption areas.

Soundproof doors are a special problem; visits to six different stations provided six different solutions. Some studios were provided with lead-lined 4-inch-thick doors equipped with pressure edges that lock into the door jamb. These doors are nearly airtight and are quite effective when newly installed, but their weight may cause them to sag after a few months of heavy use. Another solution is a double door frame using two padded doors. This allows a six-inch separation between the doors, and if they close against soft rubber they can be quite efficient. Another type of soundproof door (for use with a sound lock) consists of a 1-inch-thick honeycomb core with a ¼-inch plywood skin on which are glued 4″ cork panels (Fig. 4). Provision must be made for a narrow pane (double) of glass in each door so that collisions can be avoided. Also, we provide a continuously illuminated 60-watt light in every

sound lock. With rubber stripping applied to the door and door frame, and with a rubber draft stopper, these sound locks are quite satisfactory.

Most engineers prefer some sort of sound lock, which basically means that enough room must be provided for one door to close before the second one opens. This costs floor-space rental, and it is preferable to use existing and necessary passageways for this purpose. Notice in Fig. 1 that the door marked "X" is for the use of the master-control operator under emergency conditions and therefore is normally in the closed position. The entrances to studios A and B make use of existing passageways, as does the entrance to the recording room and studio D. The only "waste" space is between the master control room and the control room for studios B and C.

Other Sound Problems

It is of course most important that the master and other control rooms have good acoustical properties and that the monitor amplifiers and speakers have good response curves. In some stations, it is found that mediocre reproduction systems are used in control rooms in a mistaken attempt to economize. This only results in poor on-the-air monitoring and bad microphone placements.

Air conditioning ducts are a special problem as a source of unwanted sound transmission — not only noise from the air-conditioning machine itself, but also leaks between studios and control rooms. Adaquate reduction of this noise generally results from the use of ½-inch-thick glass-fiber linings in all supply ducts, specially designed 4-inch-thick noise-suppressor pads at the output from the machine, and baffles at each outlet. For this work it is wise to rely on qualified sound engineers for the installation.

In cases where there is transmission of high audio frequencies, such as noise from electric motors or fans supplying the air, the use of glass-fiber batts applied to the cork linings for a few feet from the outlets has proved helpful in some cases.

"Air rush," when the pressure or movement of the air itself is too great, has been reduced by the use of curved baffles mounted a few inches from the outlets, but in many cases only the reduction of air flow was completely satisfactory. This trouble is most often found in small studios where the microphone is quite close to the air supply. An empirical approach to these and related problems is the only solution, and the "on-air" result is the final criterion.

In cases where there are heavy smokers on the announcing staff, a fan-type exhaust is very often necessary to clear the air before visitors or nonsmokers enter the room. This is generally needed in buildings not constructed especially for radio. The smoke exhaust is, of course, in addition to the regular air supply.

Provision must be made for wiring ducts between the several studios and the control and recording rooms. Where there is a danger of sound leakage, conduits are preferable, and when larger conduits are installed for future expansion they can be blocked at each end with oakum.

Conclusion

In an ideal case where it is possible to design a studio complex from the ground up, or where there is sufficient space available in an existing building, studios can be built to textbook specifications. For those engineers who have to work on small budgets using what they have at hand, it is hoped that these notes will be useful. ▲

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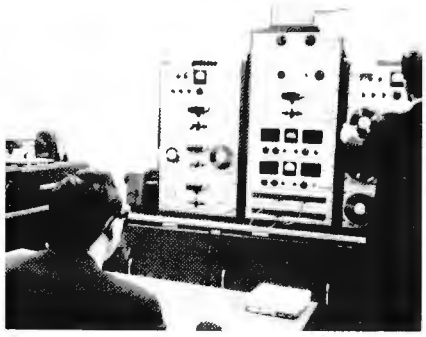
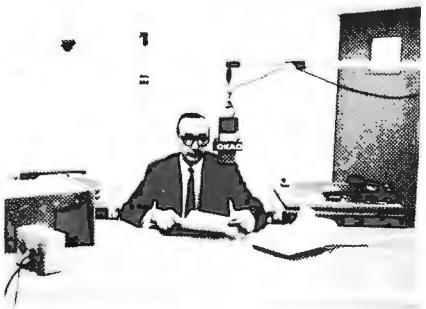
Control area for studios A and B.

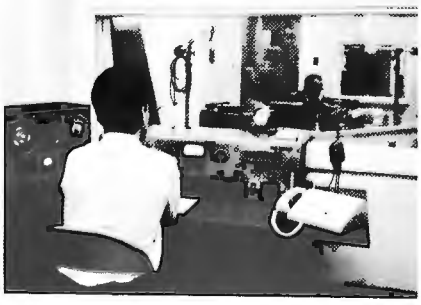
Announcer at studio C control unit.



View of CKAC recording facilities.



Studio B; note large rear wall area.



Studio B from Recording and Control.

A FREQUENCY-MEASUREMENT SYSTEM

*by Robert L. Zuelsdorf**

The design and construction of equipment for measuring TV carrier frequencies is described.

Part 1 of two parts.

Television frequency-measurement requirements have changed. For many years it was sufficient to have only frequency monitors on the station premises, and calibration checks usually were made by having a frequency-measurement service pay semiannual visits. But with the coming of the requirement for once-a-day checks and once-a-month calibration, these methods are no longer adequate. The daily requirement may still be met with the station frequency monitor, but it is now a near necessity to possess a system capable of performing the monthly calibration check. This article deals with the philosophy of design of such a system and describes a set of equipment and its operation. Sufficient information is presented to enable the broadcast engineer to duplicate these units or to modify the design to suit his own tastes.

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Method of Measurement

Nearly all frequency-measurement systems compare, either directly or indirectly, the frequency in question with the output frequency of a stable reference oscillator. The method to be described starts with a 1-MHz oscillator, and dividers and multipliers provide harmonics and subharmonics for the actual frequency comparison.

From the block diagram in Fig. 1, it can be seen that the three triplers in the frequency standard produce an output at 27 MHz. A diode multiplier generates harmonics in the UHF range which are mixed with the carrier frequency. At WKOW-TV, operation is on Channel 27 with a −10-kHz offset. The 20th harmonic of 27 MHz is 540 MHz. If this is mixed with the 549.24-MHz visual carrier, a 9.24-MHz difference frequency results. This difference signal is picked up on a

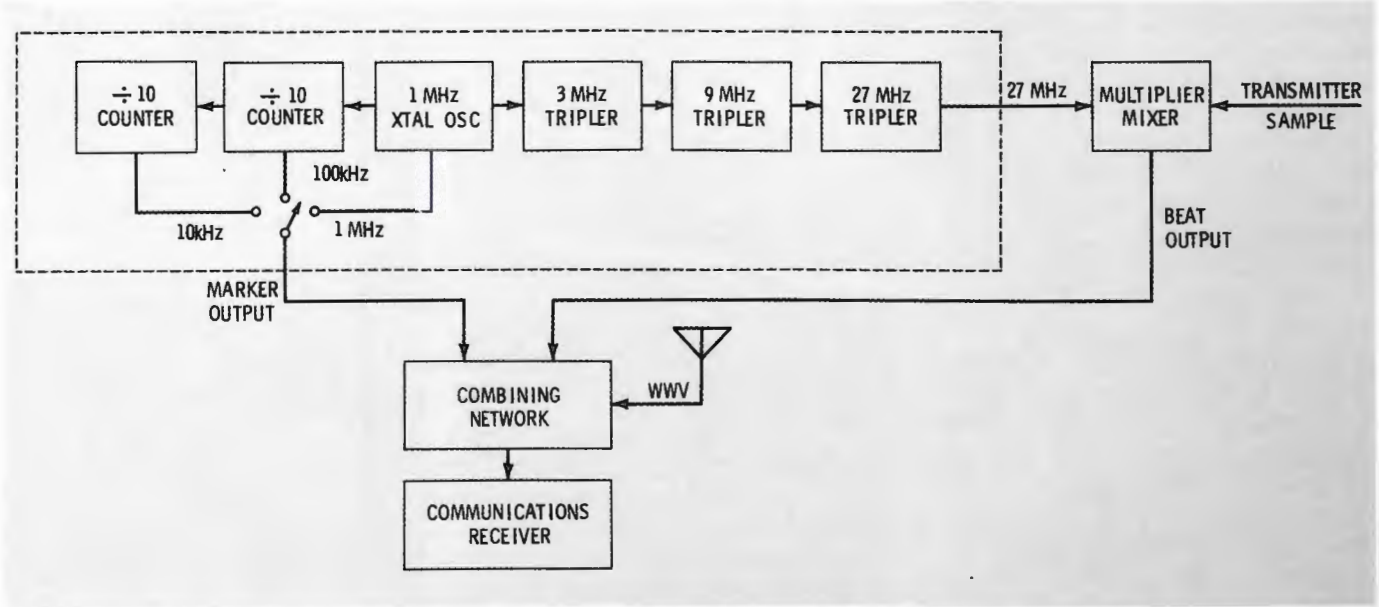


Fig. 1. System block diagram shows how multipliers and dividers produce the desired reference and marker signals.

communications receiver tuned to 9.24 MHz. There will also be a harmonic of the 10-kHz frequency-standard output at 9.24 MHz; if these two signals produce a zero beat, the visual transmitter is exactly on frequency. An aural frequency check is made in the same manner, except that the receiver is tuned to 13.74 MHz, the difference between the 553.74-MHz aural carrier and the 540-MHz harmonic.

Master Oscillator

A frequency standard can be no better than its master oscillator. Quite naturally then, stability is the prime concern in the design of this unit. There are a number of parameters which affect frequency stability of a crystal oscillator. Among the more important of these are the transistor terminal impedances, operating level, and variations of supply voltage and temperature.

For analytical purposes, an oscillator may be broken down into an amplifier and a feedback network. If amplification exceeds losses and the phase shift around the loop is zero at a given frequency, oscillation will result at that frequency. Any phase instability occurring in the circuit will cause a shift in the frequency at which zero phase shift around the loop exists. The problem, then, is to minimize causes of phase instability.

Consider a transistor amplifier coupled to a feedback network, or resonator. An impedance, Z, could be measured across one of the couplings. With a change of voltage, a change of capacitance, ΔC, would occur because of variation of the base-collector depletion region. A change of temperature would produce a change of transistor beta, giving rise to a similar capacitance variation. For small angles, the phase change due to ΔC is [1]:

$$\Delta \phi = -\Delta C \omega Z$$

This indicates that a low-impedance coupling is desirable to reduce the effects of ΔC and thus keep $\Delta \phi$ as small as possible. Or putting it another way, the values of swamping capacitance should be as large as possible to minimize the effects of intrinsic capacitance changes. This is particularly true of the relatively large and unstable base-emitter capacitance.

The amplitude of the waveform in the collector circuit will also have an effect on stability. A shift of beta, such as might be caused by a temperature variation, will vary the amplitude of the collector current. If the circuit is entirely linear, no change of phase shift will occur. However, a transistor driven beyond the linear range will not have a sinusoidal output, and exact analysis now becomes complex. It is evident, though, that a change of waveshape such as that caused by a shift of the clipping level can produce an effective change of phase around the loop. Keeping the output nearly sinusoidal will tend to minimize this problem.

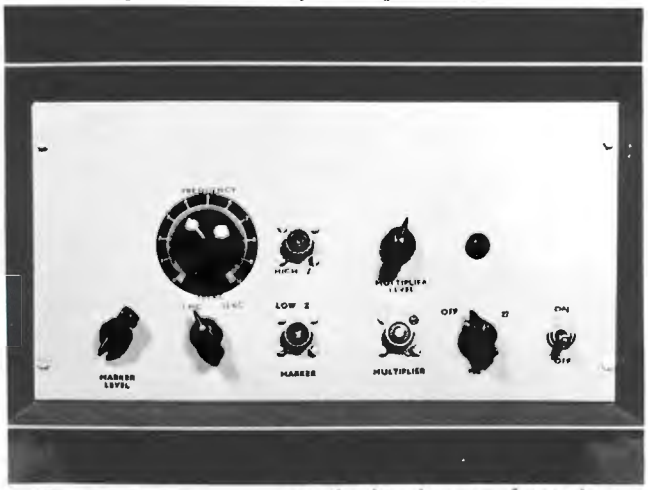
A Colpitts oscillator circuit was chosen because it readily permits a high-stability design. Large values of collector and base swamping capacitance make up the feedback network (Fig. 2). The precise values chosen are a compromise between swamping, feedback amplitude, and output frequency. The values shown allow the oscillator to be set to exactly 1 MHz. Feedback amplitude is sufficient for reliable starting, but low enough to avoid severe clipping. Substitution of another type of crystal would probably require some adjustment of the capacitance values.

The frequency adjustment system is unique in that a combination of fixed and trimmer capacitance is employed in conjunction with a voltage-variable capacitance diode. The 4-25 pf capacitor (C5) is a screwdriver adjustment used to set the oscillator to 1 MHz, while front-panel control of the voltage across the diode permits a $\pm$10-Hz adjustment of frequency. High impedances are used to isolate the diode from ground to minimize degradation of crystal Q.

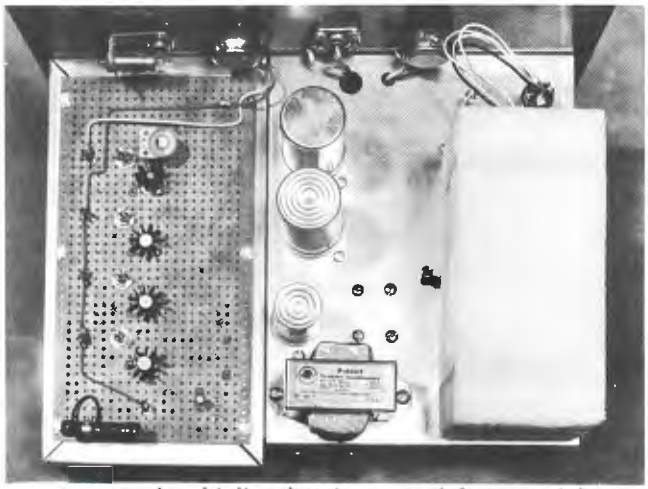
The high value of base-emitter swamping capacitance contributes to stability for the reasons mentioned previously. Output is taken from the base and fed to the class-A buffer through R3. This isolation resistor is large compared to any variation in buffer input impedance, and thus oscillator loading remains constant despite possible fluctuations of buffer parameters.

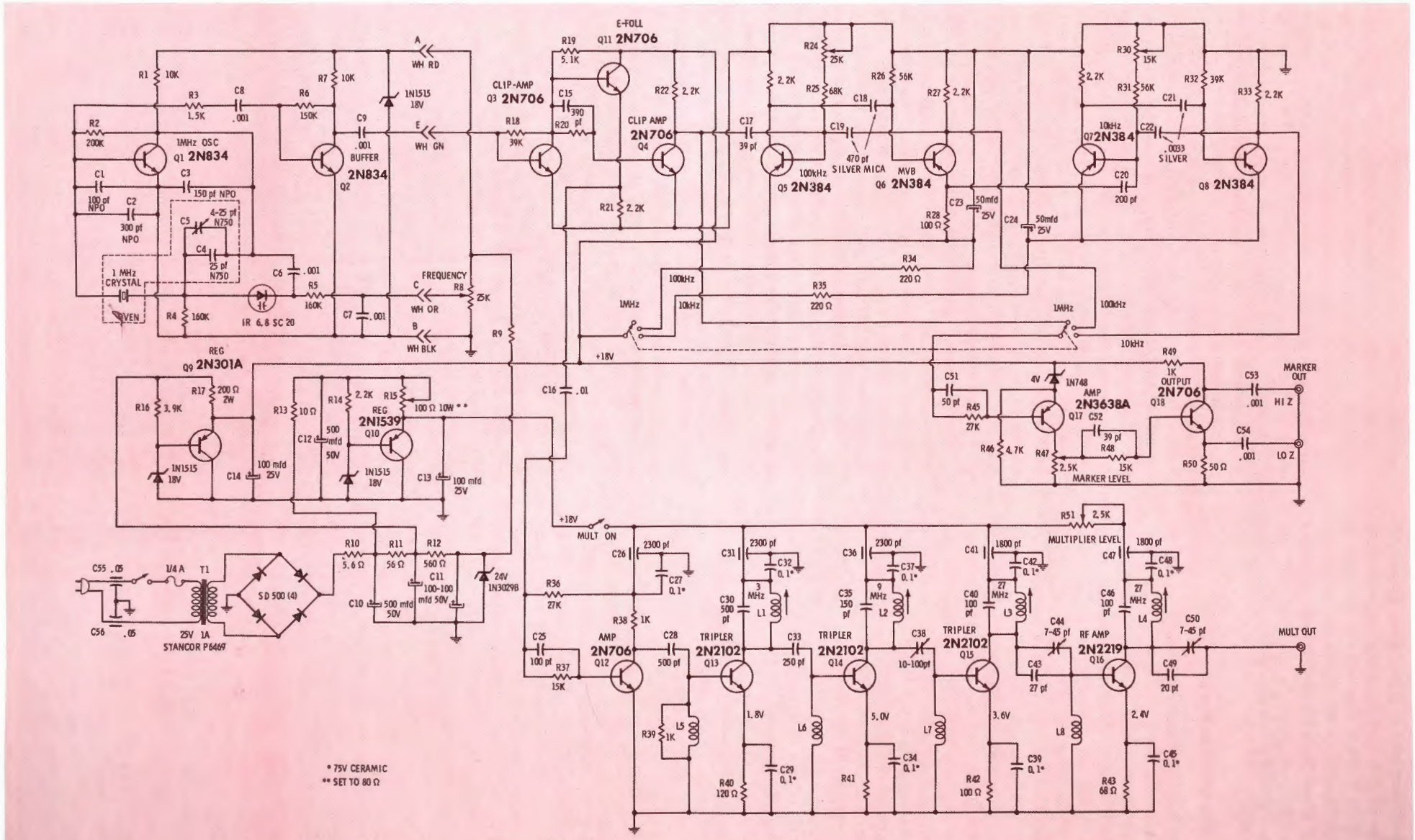
The simple biasing method used is suitable because of the low I_{co} of the silicon transistors. The values of R2 and R6 were selected to give DC voltages of 8 to 12 volts on the collectors of Q1 and Q2. R3 allows enough drive to reach the base of Q2 to develop 6 volts peak-to-peak of 1-MHz signal at the collector of that stage.

The objective of this frequency standard is short-term stability of a high order. The crystal and frequency-adjustment capacitor C5 are located in an unheated



The finished frequency standard is shown in front view.


Bottom of multiplier chassis: output left, input right.



L1—28 turns No. 28 on 3/8" slug-tuned form (Miller 4400)
L2—8 turns No. 28 on 3/8" slug-tuned form (Miller 4400)
L3—4 turns No. 20 on 3/8" slug-tuned form (Miller 4400)
L4—4 turns No. 20 on 3/8" slug-tuned form (Miller 4400)
L5—62 μh Miller 4630
L6—100 μh Miller 6112
L7—20 μh Miller 6152
L8—20 μh Miller 6152

Chassis board—Vector 42F22C2
Heat sinks—Wakefield NF207
Crystal—International Crystal F605

Fig. 2. Complete schematic diagram of the solid-state frequency-measurement system shows oscillator, multipliers, dividers, output stages, and regulated power supply.

oven atop the counter chassis. A 2¼" × 2¼" × 5" box encloses the rest of the oscillator and buffer circuitry. The oven is a piece of plastic foam material cut in half and hollowed to accept the components. It is located at the edge of the chassis away from sources of heat and provides excellent thermal isolation. The unheated oven is ideal in terms of short warmup time; if long-term stability were the goal, or if the unit were to run continuously, a heated oven would be chosen.

Of course the crystal itself should not be overlooked. A low-temperature-coefficient type is essential for stability; the one selected is a low-drift AT-cut crystal. Also, some transistor types are more suitable than others.[2] The 2N834 used here is an epitaxial mesa type, which has the low intrinsic impedances desirable for oscillator usage. Typical drift figures are 0.25 Hz in 1 hour from a cold start, and 0.6 Hz at the end of an 8-hour period.

Multiplier Chain

The multiplier chain is used to provide output of the proper frequency and amplitude to drive the multiplier diode. It is desirable to be able to develop at least 5 ma of diode current; this level is necessary to produce higher-order harmonics of sufficient amplitude. These harmonics, when mixed with the transmitter signal, must generate beat products strong enough to be picked up clearly on the receiver. The amplitude should be adjustable to enable the operator to optimize for maximum beat output. The following paragraphs indicate how these things are accomplished and go on to describe the multiplier circuit in detail.

Most broadcast engineers are aware of the advantages of conservative design. When active and passive components are but moderately stressed, increased reliability and longer life can be expected, and additional drive is available to offset the effects of component aging. The multiplier chain was designed with these considerations in mind. Gain stability, always an important factor in solid-state circuits, was provided for in the circuitry. Dissipations are kept to a conservative level, while output is more than adequate.

Output Stage

The multiplier chain consists of a 1-MHz pulse amplifier, three triplers, and a 27-MHz output amplifier. The output stage bears first consideration. An output of 250 mw will provide more than enough drive for the multiplier diode. A 2N2219 was chosen for the output transistor, since it has adequate capabilities at the frequency in question. If ideal class-B operation is assumed, the collector current and voltage waveforms will be as shown in Fig. 3. The collector voltage is:

$$e_c = \frac{E_{max} - E_{min}}{2}(-\sin\theta) + E_{cc}$$

$$= E_{cc} + \tfrac{1}{2} E_{min} \sin\theta - \tfrac{1}{2} E_{max} \sin\theta$$

and

$$i_c = I_p \sin\theta$$

describes the collector current during the conduction intervals.

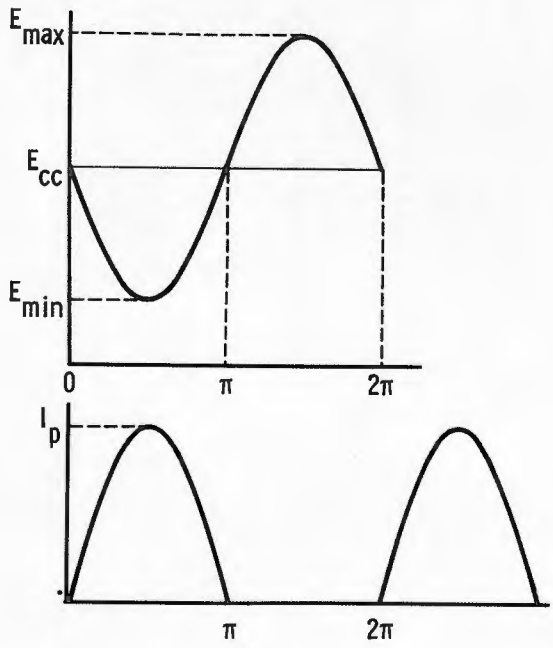


Fig. 3. Collector waveforms for a Class-B output stage.

Transistor power dissipation is given by

$$P_D = \frac{1}{T}\int_{t=0}^{t=T} i_c\, e_c\, dt$$

In this case, time is expressed in terms of electrical angle θ. Since a full cycle must be considered in determining P_D, the factor $1/T$ becomes $1/2\pi$, but since conduction takes place only during the first half cycle ($I_p = 0$ for the second half cycle), the limits of integration are $\theta = 0$ and $\theta = \pi$.
Therefore:

$$P_D = \frac{1}{2\pi}\int_0^{\pi} (I_p E_{cc} \sin\theta + \tfrac{1}{2} I_p E_{min} \sin^2\theta - \tfrac{1}{2} I_p E_{max} \sin^2\theta)\, d\theta$$

$$= \frac{1}{2\pi}\Big[I_p E_{cc} (-\cos\theta) + \tfrac{1}{2} I_p E_{min} (\tfrac{1}{2}\theta - \tfrac{1}{4}\sin 2\theta) - \tfrac{1}{2} I_p E_{max} (\tfrac{1}{2}\theta - \tfrac{1}{4}\sin 2\theta)\Big]_0^{\pi}$$

$$= \frac{I_p E_{cc}}{\pi} + \frac{I_p E_{min}}{8} - \frac{I_p E_{max}}{8}$$

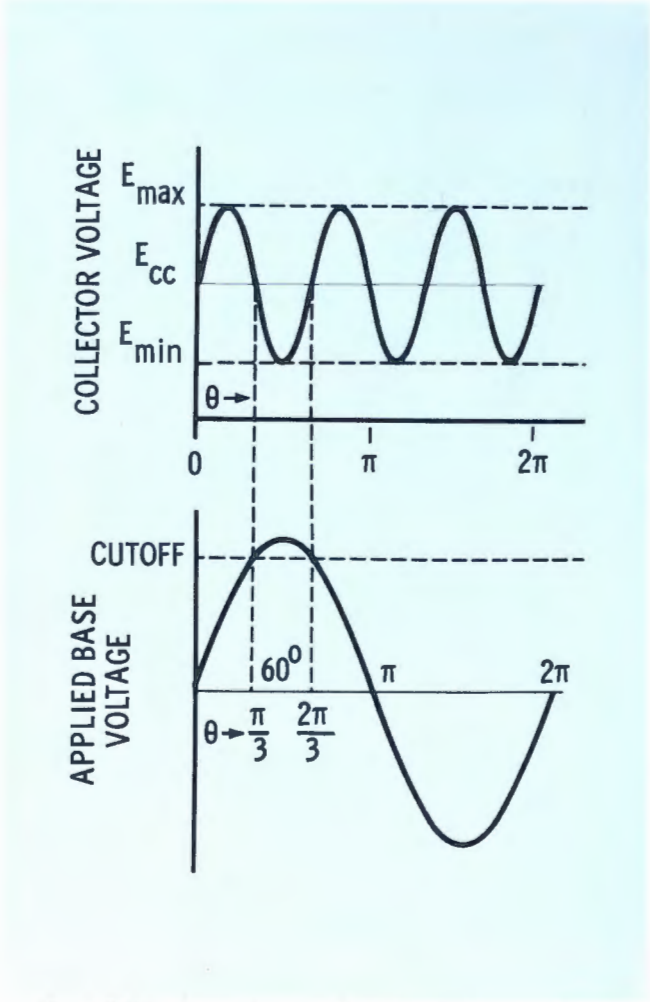


Fig. 4. Tripler-stage base, collector voltage waveforms.

$$P_D = .318\, I_p\, E_{cc} - .125\, I_p\, (E_{max} - E_{min})$$

For an average collector current (I_c) of 35 ma, I_p = 110 ma. If E_{cc} = 16 volts, 4 volts is a realistic value for E_{min}.

$$P_{IN} = I_c\, E_{cc} = (.035)16 = 560\text{mw}$$

$$P_D = (.318)(.11)(16) - (.125)(.11)(28-4) = 230\text{mw}$$

$$P_o = P_{IN} - P_D = 560-230 = 330\text{mw}$$

This gives an efficiency of 59% and an output well above the target value of 250 mw.

Tripler

In general, the tripler may be handled in the same manner, but owing to the more complex waveforms the analysis also is more complex. The base and collector voltage waveforms are shown in Fig. 4. It is noted that a 60° conduction angle is required for ideal tripler action. Considering the collector voltage waveform,

$$e_c = E_{cc} - \tfrac{1}{2}\, E_{min} \sin 3\theta + \tfrac{1}{2}\, E_{max} \sin 3\theta$$

Fig. 5 shows the collector current waveform. It is no longer a complete sine function, but rather the clipped top of a sine wave. In general, within the conduction interval

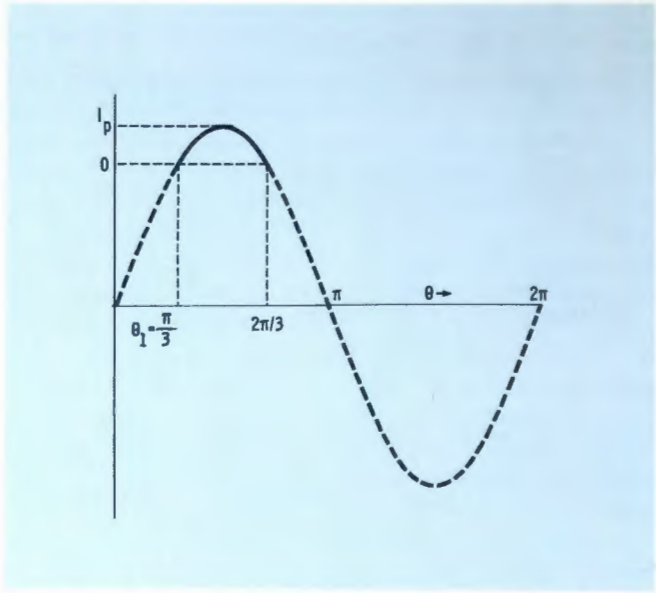


Fig. 5. Collector current waveform is clipped sine wave.

$$i_c = I_p \frac{\sin\theta - \sin\theta_1}{1 - \sin\theta_1}$$

where θ_1 is the angle at which conduction begins. For a conduction angle of 60°

$$i_c = I_p \frac{\sin\theta - .866}{1 - .866}$$

$$i_c = 7.47\, I_p \sin\theta - 6.47\, I_p,$$

from $\frac{\pi}{3}$ to $\frac{2\pi}{3}$

The power dissipation is found as before; the limits of integration are the times that conduction begins and ends.

$$P_D = \frac{1}{2\pi} \int_{\pi/3}^{2\pi/3} (7.47\, I_p\, E_{cc} \sin\theta - 6.47\, I_p\, E_{cc}$$

$$+ 3.74\, I_p\, E_{max} \sin\theta \sin 3\theta - 3.24\, I_p\, E_{max} \sin 3\theta$$

$$- 3.74\, I_p\, E_{min} \sin\theta \sin 3\theta + 3.24\, I_p\, E_{min} \sin 3\theta)\, d\theta$$

$$= \frac{1}{2\pi} \Big[- 7.47\, I_p\, E_{cc} \cos\theta - 6.47\, I_p\, E_{cc}\, \theta$$

$$+ 3.74\, I_p\, E_{max} \left(\frac{\sin 2\theta}{4} - \frac{\sin 4\theta}{8} \right)$$

$$+ 3.24\, I_p\, E_{max}\, (\tfrac{1}{3}) \cos 3\theta$$

$$- 3.74\, I_p\, E_{min} \left(\frac{\sin 2\theta}{4} - \frac{\sin 4\theta}{8} \right)$$

$$- 3.24\, I_p\, E_{min}\, (\tfrac{1}{3}) \cos 3\theta \Big]_{\pi/3}^{2\pi/3}$$

$$P_D = .115\, I_p\, E_{cc} - .042\, I_p\, (E_{max} - E_{min})$$

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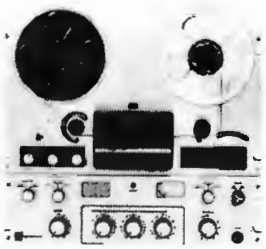

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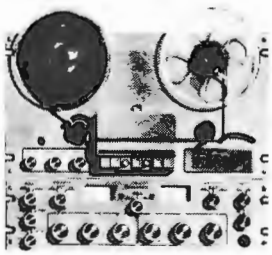
Fully transistorized professional tape recorder / reproducer for monaural operation. For use in main or production control room.



MAGNECORD MODEL 1022
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MAGNECORD MODEL 1028
Professional quality 2 channel (stereo) tape recorder / reproducer for recording master tapes. (10½" reel capacity) Available in ½- or ¼-track.

MAGNECORD MODEL 1048
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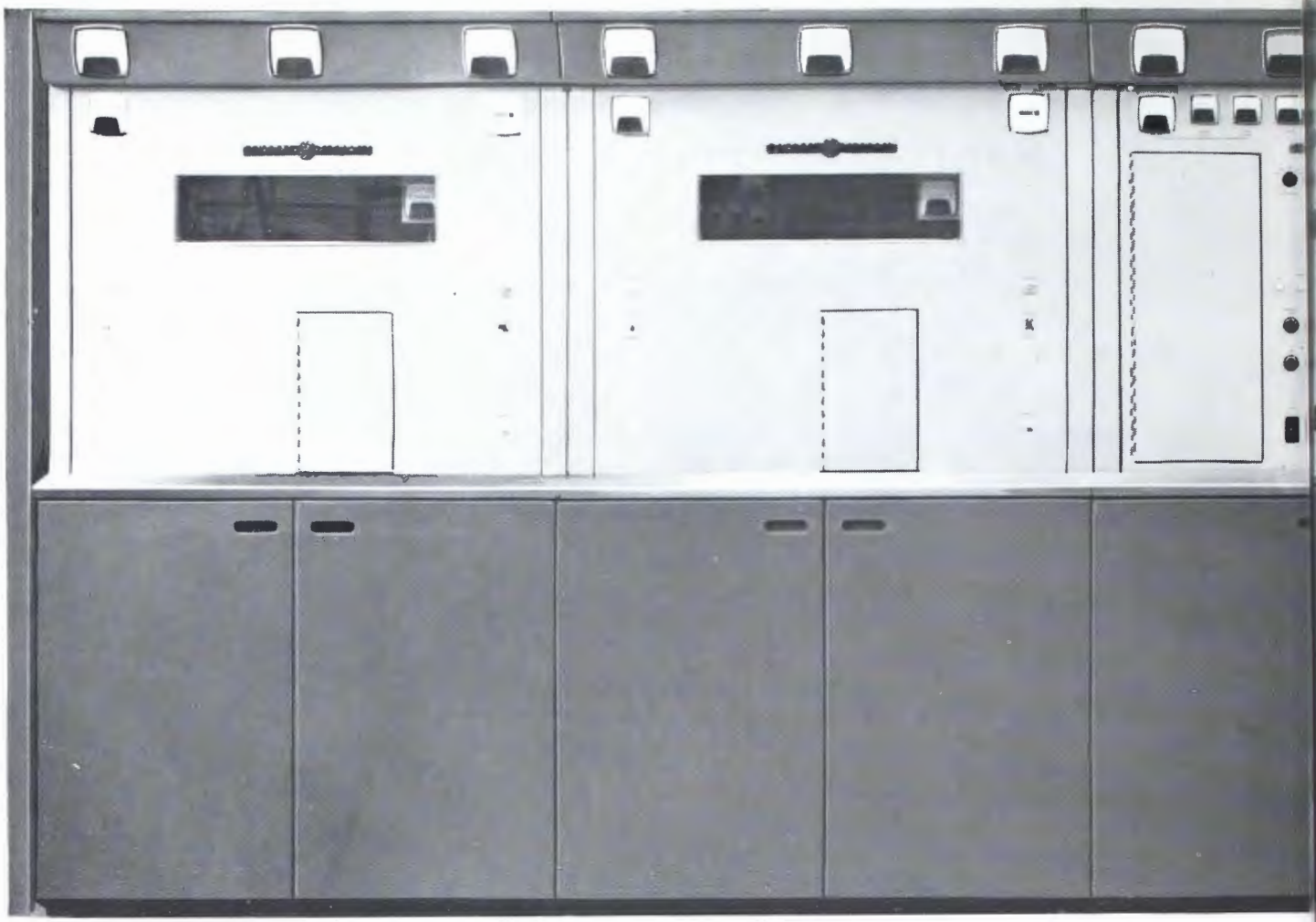

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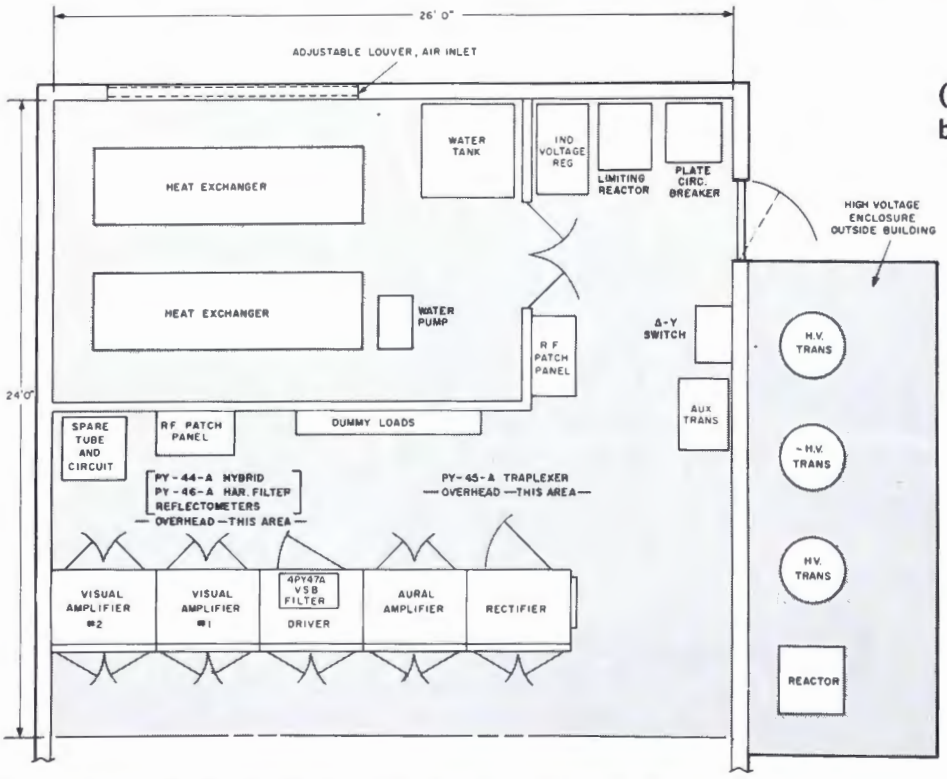

Minimum suggested station floor plan layout, GE Type TT-62-A, 100 KW UHF transmitter.

(Inquire how 5 megawatt ERP can be provided with this transmitter.)

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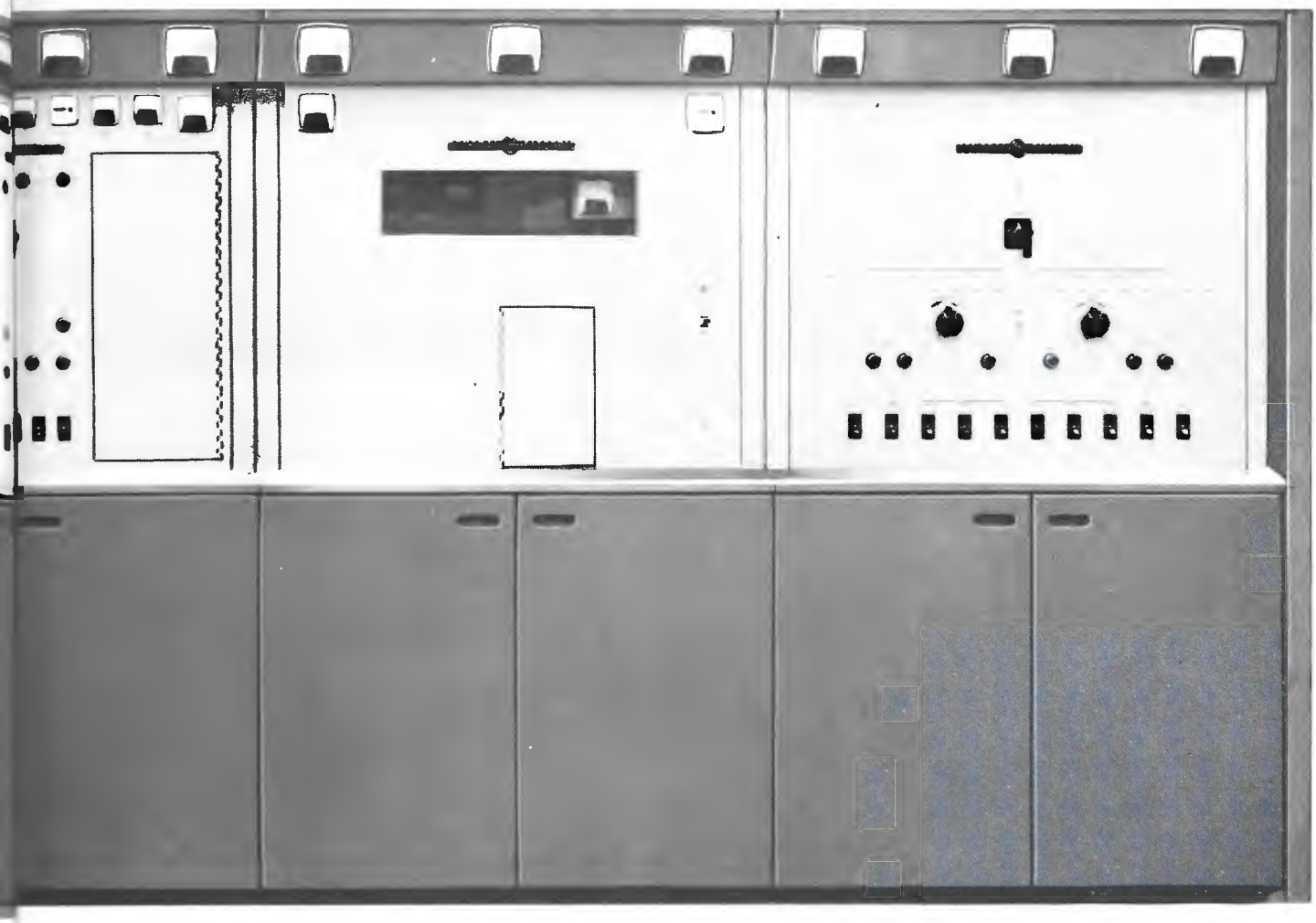
15 KW, Type TT-56-A
30 KW, Type TT-57-A
50 KW, Type TT-59-A
60 KW, Type TT-61-A
100 KW, Type TT-62-A



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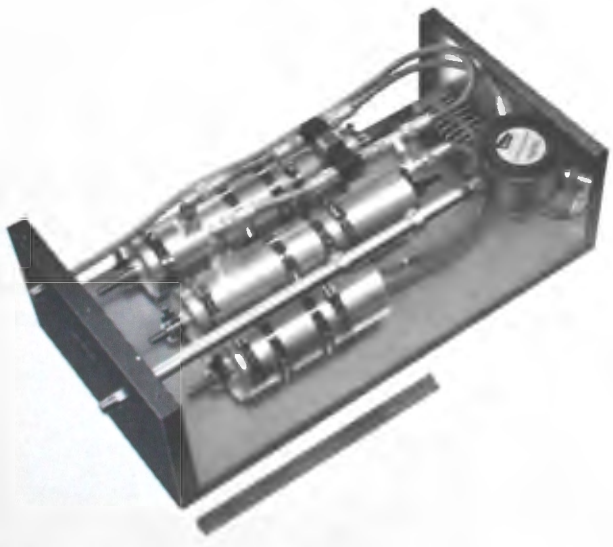

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GE-44

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GENERAL ELECTRIC

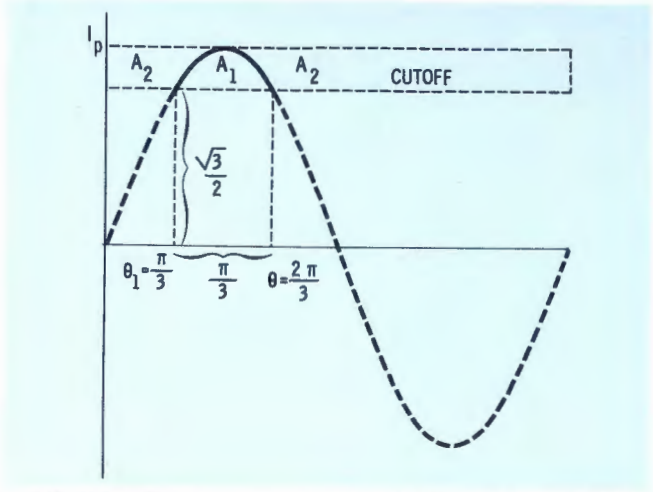


Fig. 6. Peak-to-average current ratio can be determined.

The next step is finding the ratio of peak to average collector current. It is found by comparing the area inside the conduction curve (A_1 in Fig. 6) with the total area ($A_1 + A_2$) between sin θ_1 and I_p from 0 to 2π. Referring to Fig. 6 and considering the peak sine-wave amplitude as unity,

$$A_1 = \int_{\pi/3}^{2\pi/3} \sin\theta \, d\theta - \frac{\pi}{3}\,\frac{\sqrt{3}}{2}$$

$$= \left[-\cos\theta\right]_{\pi/3}^{2\pi/3} - \frac{\pi\sqrt{3}}{6} = .092$$

$$A_1 + A_2 = 2\pi\,(1 - \sqrt{3/2}) = .842$$

$.842/.092 = 9.15$, the ratio of I_p to I_c for a 60° conduction angle.

Consider a tripler operating as follows:

E_{cc} = 15 volts I_c = 35ma

E_{min} = 5 volts I_p = 320ma

Conduction angle = 60°

$P_{IN} = (.035)(15) = 525\text{mw}$

$P_D = (.115)(.32)\,15 - (.042)(.32)(25 - 5)$

$= 280\text{mw}$

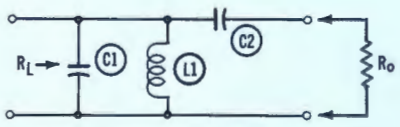


Fig. 7. "L" coupling network is used between multipliers.

$P_o = 525 - 280 = 245\text{mw}$

$$\eta = \frac{.245}{.525} \times 100 = 47\%$$

An efficiency of 47% seems surprisingly high for a tripler. The prime reason is the 60° conduction angle chosen to give ideal tripler action. In practice a 60° angle is difficult to achieve because of the high drive level required; 90° is a more realistic conduction angle. Recomputing for a 90° angle gives

$$P_D = .169\, I_p\, E_{cc} - .045\, I_p\,(E_{max} - E_{min})$$

$$I_p = 6.05\, I_c$$

For the 90° conduction angle:

$$P_D = (.169)(.212)15 - (.045)(.212)20$$

$$= 348\text{mw}$$

$$P_o = 525 - 348 = 177\text{mw}$$

The efficiency is 34%, still a high-sounding figure for a tripler. In the idealized tripler, the collector voltage and current pulses were of the same width, giving high third-harmonic output with a resonant tank circuit. With a 90° conduction angle, a portion of the current goes into generation of second and other harmonics. A Fourier analysis of the collector waveform, with a tank-circuit Q of 5, indicates that 8% of the output will consist of unwanted harmonics, thus lowering the collector efficiency to about 30%. Coupling-circuit and miscellaneous losses amount to another 3 to 5%, giving the stage an overall efficiency of 25 to 27%.

Coupling

The pi network is perhaps the most widely used device for interstage and output matching. Being basically a low-pass filter, it provides excellent suppression of higher-order harmonics but poor rejection of subharmonics. Thus it is not the most suitable coupling network for use with frequency multipliers. Adequate suppression of the fundamental and second harmonic would be difficult to attain. For better performance, a type of "L" network, as shown in Fig. 7, was chosen as a coupling device. Because this network has a high-pass characteristic, it gives improved rejection of the lower frequencies.

To find tank-circuit and coupling values, the formulas given below are applied.[3] The 2N2219 output circuit is worked out as an example.

$$R_L = \frac{E_p^2}{2P_o} = \frac{(E_{cc} - E_{min})^2}{2P_o}$$

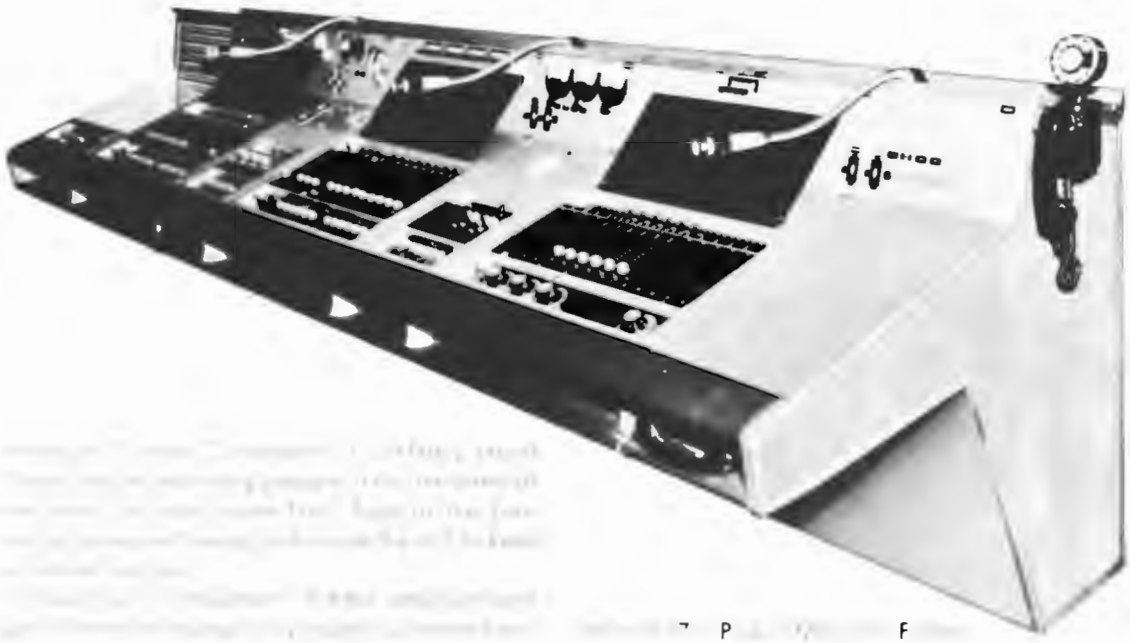
$$= \frac{12^2}{2\,(.35)} = 206 \text{ ohms}$$

Select a loaded Q of 5;

$$L_1 = \frac{R_L}{\omega_o Q_L} = \frac{206}{2\pi\,(2.7 \times 10^7)\,5} = 0.24\,\mu\text{h}$$

Three months of competitive 'in use' tests is the reason Paramount chose Altec Audio Controls for their new solid-state console.

Good Reason.



ALTEC

$$C_2 = \frac{1}{\omega_0 R_0 \left(\frac{R_L}{R_0} - 1\right)^{1/2}}$$

$$= \frac{1}{2\pi\,(2.7 \times 10^7)\,50\left(\frac{206}{50} - 1\right)^{1/2}} = 67 \text{ pf}$$

$$C_1 = \frac{Q_L}{\omega_0 R_L} - C_2\left(1 - \frac{R_0}{R_L}\right)$$

$$= \frac{5}{2\pi\,(2.7 \times 10^7)(2.06 \times 10^2)}$$

$$- (6.7 \times 11^{-11})\left(1 - \frac{50}{206}\right) = 92 \text{ pf}$$

A Q of 5 is adequate for the output stage, since the rejection of harmonics of 27 MHz is not important. For the multipliers, a Q of 10 to 15 is used to improve further fundamental and second-harmonic rejection.

The interstage coupling networks may be handled in the same manner. However, an unknown quantity must be dealt with first. This is the input impedance. If plots of y_{ie} vs collector current are available for the frequency in question, the solution is simple. In many cases, however, the only input information available is h_{ie} vs collector current. This is not sufficient for an exact determination of input impedance, but fortunately a precise result is not necessary. For an approximation, it is found that

$$R_{IN} \approx \frac{h_{ie}}{\left(\frac{f_o\, h_{fe}}{F_T}\right)^{2/3}}, \quad \frac{F_T}{f_o} \leq h_{fe}$$

where,

F_T = gain-bandwidth product at I_p and E_{min}
h_{ie} = input resistance at I_p
f_o = input frequency
h_{fe} = low-frequency beta

This approximation is sufficiently accurate up to about $f_o = \frac{1}{3} F_T$.

As previously mentioned, the frequency-multiplier chain consists of five stages. There are a 1-MHz pulse amplifier, Q12; three triplers, Q13, Q14, and Q15; and a 27-MHz output amplifier, Q16. Pulse amplifier Q12 is forward biased by R36 and R37, and the stage is driven to cutoff by the 1-MHz input pulse. Its output is coupled to the first tripler through 500-pf capacitor C28, which is resonant with L5 near 1 MHz. The rest of the coupling circuits are of the type previously discussed.

Decoupling

Waveforms observed on the supply side of the 2300-pf feedthrough bypass capacitors indicated they were inadequate by themselves. Addition of the 0.1-mfd capacitors in parallel greatly reduced RF on the B+ line. Lead lengths are kept short, and components are positioned to minimize interaction of ground currents. The copper-clad chassis board helps simplify grounding and shielding. Adequate bypassing is essential if stability of cascaded stages is to be achieved.

Thermal Considerations

The entire chain uses 135 ma at 18 volts DC, for a total input of 2.5 watts. The last three stages dissipate 80% of this power. Thermal considerations require that junction temperatures be kept below the rated maximums and that measures be taken to insure gain stability. Emitter bias is used for stabilization. Although it would not be satisfactory for a single-sideband amplifier, this method works nicely for cw. It is a means of narrowing the conduction angle, and emitter bias also provides a convenient means for checking the emitter current and thus determining stage input.

Emitter current indicates the 3-to-9 MHz tripler is operating at an input of 540 mw. For conservative design, the input power is considered as dissipation when making heat-sink calculations. The 2N2102 has a maximum operational junction temperature of 200°C and a thermal resistance of 35°C/watt. Wakefield NF207 heat sinks were selected for cooling. With natural convection, these units allow a temperature rise of 49°C/watt. The maximum allowable ambient temperature

$$T_{max} = 200 - (49 + 35)\,(.540) = 155°C$$

This is far above the anticipated maximum ambient temperature.

Adjustment

To tune up the multiplier chain, it is best to use a selective absorption wavemeter coupled to the collector tank coils. An RF probe or a high-frequency scope may also be useful, but unless a selective device is used to identify proper frequencies, it is easy to arrive at maximum output on 21 or 24 MHz instead of 27 MHz. Each stage should be peaked with the wavemeter, starting with L1 and proceeding to L4. Trimmers C38 and C44 permit touching up the drive to the proper levels, while C50 allows output-stage matching adjustments.

A calibrated RF probe may be used to measure output from the multiplier chain. Transistor Q16 produces an output of 320 mw with an input of 535 mw, for an efficiency of 60%. This compares with a calculated efficiency of 59%. Factors reducing efficiency which were not included in the calculations include tank and coupling-circuit loss, harmonic loss, and collector-body resistance loss. On the other hand, the conduction angle has been reduced somewhat, from class B into class C, which tends to increase the efficiency. Neutralization was not necessary, but it could be incorporated by adding two turns to the cold end of L4 and a 1-10 pf piston trimmer back to the base.

The concluding portion of this article will appear in next month's issue.

References

1. "Oscillators," Sec. 5-1, *Selected Semiconductor Circuits*, Navships 93484, Dept. of the Navy.
2. Pullen, "L-C Oscillators" Sec. 10-0, *Handbook of Transistor Circuit Design*.
3. Texas Instruments, Inc. Engineering Staff, *Transistor Circuit Design*, New York: McGraw-Hill Book Co., 1963, p. 351.

FRONT VIEW
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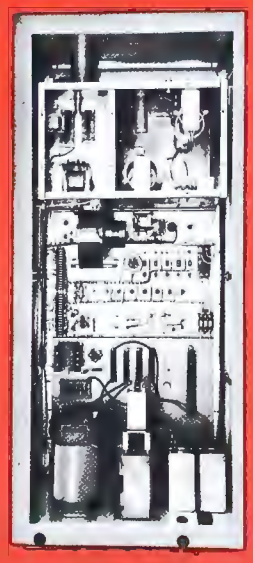

REAR VIEW
1 KW AM

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1967 NAB Convention Report

Part 1—Highlights of the Equipment Exhibits

As always, there was much to see and hear in the exhibit area. Perhaps this was not a year for electrifying new breakthroughs, but if the Convention-goer took more than a quick glance, he saw many interesting and significant developments.

Through sheer force of size and showmanship, the television exhibits commanded first attention. Each major manufacturer of color cameras conducted live demonstrations, engineered (and in several cases choreographed) to emphasize the performance of his particular camera design. The debate over color camera systems seemed not to have subsided in the slightest.

There was other TV equipment on display, too. A new color/monochrome film scanner was shown, and interest was high in video recording equipment. A lightweight, backpack VTR and companion camera were on display. Also of interest was the presence of transmitters and antennas for producing the maximum power on UHF channels.

A definite trend, in radio as well as TV, was exemplified by a demonstration in one booth: TV antenna patterns were being plotted (over teletype lines) by a computer. Another manufacturer presented a synchronizing generator incorporating computer-type circuitry for improved stability.

There were new items in other areas as well. Several manufacturers introduced circularly polarized antennas for FM. There was a demonstration of an automatic loudness-control device. Interesting, too, was the apparent increase in the use of slider-type audio attenuators.

New and established models of equipment were shown in almost every area familiar to the broadcast engineer: automation and automatic logging, audio and video equipment, recording and reproducing equipment, transmitters, towers, antennas, microphones, wire and cable, test and measuring equipment—far too many to catalog completely. Even the armed services were represented with some nonbroadcast hardware possibly not so familiar to the broadcast engineer who is not also a recent veteran. And, while CATV is anathema to some broadcasters, it is a second business to others; this fact was evidenced by the size and number of CATV exhibits.

A person could have spent much more than the time available in examining the literally thousands of items on display. However, to provide an overall picture of this year's exhibits we offer the following summary of highlights.

Addressograph Multigraph Corp.

Equipment for duplicating promotional material, logs, or other printed matter made up this exhibit.

Advance Industries

Information about a line of towers, microwave reflectors, and prefabricated buildings was featured.

Albion Optical Co., Inc.

Featured were Rank Taylor Hobson Varotal zoom lenses, with ranges up to 16:1. Also occupying a prominent position in the booth was the Pantilt 520 servo controlled pan and tilt unit.

Alford Manufacturing Co.

Antennas and related products for VHF TV, UHF TV, and FM were on display.

Altec Lansing

Prominent in the display was the Model 9200 audio console, which makes use of modular amplifiers, attenuators, etc., and blank panels to permit custom design for a given application. Also shown were microphones, speakers, and other audio equipment.

Ameco, Inc.

Featured by this manufacturer of CATV equipment were the "Channeleer" heterodyne headend unit, "Pacer" line extender, "Pacesetter" series of amplifiers, "Courier" multichannel closed-circuit TV systems, "Amecoax" aluminum-sheathed cable, and a line of Delta Electronics MATV equipment.

American Electronic Laboratories, Inc.

AEL placed emphasis on its AM-50KA 50-kw AM transmitter, AM-5KA 5-kw transmitter, Model 2203 solid-state stereo generator, and Model 2202 solid-state direct FM multiplex exciter. Also in this booth were two Belar Electronics Lab. FM monitors, the Model FMM-1 baseband monitor and the Model FMS-1 stereo unit.

American Pamcor, Inc.

Representative of this company's

product line were multiple-circuit and coaxial connectors and a video switcher.

Ampex Corp.

One of the highlights of the Ampex exhibit was the Model VR-3000 battery-powered portable video tape recorder, which together with its companion camera weighs 50 pounds; both are designed to be carried by a single operator. Other new products included: Model 7500-C color video tape recorder for closed-circuit use; the HS-100 high-band color recording system which uses metal discs for instant replays in slow motion and stop action; the Multilock system for synchronizing separately recorded sound with the picture output of a video tape recorder; a head-alignment accessory for adjusting video head compensation in VR-2000 machines without external test equipment; solid-state video and pulse distribution amplifiers for closed-circuit and broadcast use; and the Mark II Editec system for timing control of electronic tape editing and cueing with VR-1200 and VR-2000 recorders. A full complement of tape, audio recorders, and amplifiers was shown.

Also in the Ampex area was the Marconi television studio set, where the company's Mark VII color camera was demonstrated.

Andrew Corp.

Included in this exhibit were coaxial transmission line, elliptical waveguide, coaxial switching equipment, and coaxial fittings.

Arriflex Corp. of America

An array of professional film cameras, projectors, magazines, and accessories made up the display.

Audio Devices, Inc.

For those involved with audio recording, *Audiotape* and the *Audiopak* tape cartridge were shown.

Ball Brothers Research Corp.

Included in the company's line of special-effects generators, AGC amplifiers, and other video equipment was a new waveform oscilloscope, the Mark 21. This unit is designed primarily for the educator.

Bauer Electronics Corp.

A new FM transmitter, available in two models, was introduced; Model 603 has 3000 watts output, and Model 603-5 delivers 5000 watts. Other items included audio consoles, *Log Alarm* automatic transmitter logging equipment, and vidicon camera chains.

Beckman & Whitley

The Model CM 16 professional 16-mm motion-picture camera and its accessories formed the heart of the exhibit.

Borg-Warner/Ingersoll Products

An assortment of *Emcor* equipment racks and cabinets for broadcast control-room applications was presented in this booth.

Boston Insulated Wire and Cable Co.

Cables and connectors to mate with all major European and American broadcast television cameras were featured. Included was the TV-85C 85-pin connector, designed for positive alignment and protection of mating parts.

Broadcast Electronics, Inc.

On view were models from the complete line of cartridge recording and playback machines, cartridge winders, remote amplifiers, and audio distribution amplifiers.

CBS Laboratories, Div. of CBS, Inc.

A sound, color film showed mobile color TV units, which can be built on order for any customer. Demonstrations were given of image enhancement equipment, and the *Audimax* III automatic level control, *Volumax* and *FM Volumax* automatic peak controller, and Model 600 wide-range program monitor were highlighted. Of special interest were demonstrations of the new loudness monitor and automatic control, and a new digital display system for presenting vote totals, scores, etc., for on-camera pickup in a TV studio.

CCA Electronics Corp.

Transmitters included power levels of 1 kw, 3 kw, and 10 kw for FM and 1 kw and 5 kw for AM. Other highlights of the display included a "Dual Reliable" combiner, circularly polarized FM antenna, stereo and SCA generators, and AM monitoring equipment.

Central Dynamics Corp.

Among the featured products were the Type 67NAD switcher, including Type 2071 nonadditive/additive mixing amplifier; processing amplifiers, Types 2085, 2081, and 2080; and the D-6500 International Standard Daylight photometer.

Century Lighting, Inc.

A line of studio lighting equipment and lighting control devices made up this exhibit.

Chrono-Log Corp.

Shown in the Riker Video Industries booth was the Step system for TV station-break automation.

Cleveland Electronics, Inc.

Deflection components for vidicons and image orthicons in both black-and-white and color applications were featured.

Cohu Electronics, Inc.

In the Cohu booth were a color encoder, a color film chain, a synchronizing generator, and video distribution systems.

Collins Radio Co.

In the Collins exhibit were the following: Model 831D-1 2-kw FM transmitter with stereo generator; Model 830F-1A 10-kw FM transmitter; Model 820D-1 1-kw AM transmitter; Model 820E-1 5-kw AM transmitter with remote control; Model 900C-2 FM modulation monitor, including stereo and SCA functions; Model 54N-1 FM frequency monitor; Model 54Z-1 AM frequency monitor; three audio consoles, Model 212T-1 (television), Model 212S-1 (stereo), and Model 212M-1 (mono), all employing photoconductive switching; and Model 37CP circularly polarized FM antenna.

ColorTran Industries, Inc.

A large selection of items from the ColorTran catalog of lighting equipment and accessories was available for inspection.

Conrac Div., Giannini Controls Corp.

Black-and-white monitors in a range of sizes, and color monitors with rectangular and round CRT's were offered. Among these were the Model RVB 17/C (17″) and RVB 23/C (23″) transistorized monitors.

Continental Electronics Mfg. Co.

In addition to Prolog automatic programming and logging systems, this manufacturer showed the Type 315C/316C 5/10-kw AM transmitter and the Type 317C 50-kw AM transmitter.

Cooke Engineering Co.

Model 22B *Cojax*, Model 22T *Coterm*, Models 2-2 and 2-2A *Copatch*, and Models 105-23 and 105-24 coaxial jacks were in this display of coaxial switching devices.

Cummins Engine Co., Inc.

A full-size cutaway model of a diesel-powered generator set was the central feature of this exhibit, the theme of which was standby or auxiliary power sources for broadcast applications.

Davis & Sanford Co., Inc.

Camera-supporting devices were the featured products in this manufacturer's exhibit.

Delta Electronics, Inc.

Measuring equipment included the Model OIB-1 and Model OIB-2 operating-impedance bridges, the Model CPB-1 common-point impedance bridge, and the RG-1 receiver/generator. Also shown was the Series RVI high-current rotary variable inductor.

Dresser Crane, Hoist, and Tower Div.

Photographs and other descriptive means were used to present the company's towers for television and radio.

Dynair Electronics, Inc.

Video and audio/video switchers, video and pulse distribution amplifiers, audio/video modulators, the Model TS 100B sideband analyzer, the MINI-Series of CCTV equipment, and Equa-Dyn video cable transmission equipment were among the numerous items for CCTV, CATV, and other applications that were shown.

Eastman Kodak Co.

Film for professional use was featured by this manufacturer of photographic supplies and equipment.

Effective Communication Systems, Inc.

Several items of television equipment were shown, but emphasis was placed on a new Telemation color synchonizing generator. Making use of computer technology in its design, this unit combines a high-frequency "clock" with fast-rise logic circuitry to provide improved time-base and subcarrier phase stability.

Electronics, Missiles & Communications, Inc.

Equipment for the Instructional Television Fixed Service, and UHF and VHF translators were featured. The exhibit was titled "The Profit Improvement Clinic," and emphasis was placed on the use of translators to improve coverage by television stations.

Entron, Inc.

A comprehensive display of equipment for CATV systems was shown.

Fairchild Recording Equipment Corp.

The *Conax* for preventing high-frequency overmodulation by FM stations, reverberation systems, and audio consoles were among the audio products offered to broadcasters.

Filmline Corp.

In keeping with the swing to color film for local newscasts, Filmline was showing its professional 16-mm color film processor.

Fort Worth Tower Co., Inc.

Visual representations of towers for radio, TV, CATV, etc., and tropo scatter antenna systems were included in the display.

Gates Radio Co.

New consoles included the Model M-6546 portable television audio console with 12 mixing channels and three master or submaster channels, the Dualax II for the AM/FM stereo/SCA broadcaster, the Gatesway II, and the Stereo Statesman. A line of FM transmitters, with outputs from 250 to 20,000 watts, is based on the model TE-1 solid-state exciter, in which modulation occurs at the carrier frequency. Also introduced was the Dual-Cycloid circularly polarized FM antenna.

Three automatic programming systems by the Automatic Tape Control Division of Gates were shown. These were the "Automate 244," which accommodates 24 events from four sources; the "Automate 484" which accommodates 48 events; and the

"Automate 1007," which handles 1000 events from seven sources.

General Electric Co.

A stage for live performances formed the heart of demonstrations of the PE-250 live camera and other GE color equipment. The demonstrations included various lighting effects (including a luminous backdrop bathed in black light), color moving against color, and chroma keying. Also in this large exhibit was the TT-62-A 100-kw UHF transmitter, which can be used with six sections of the TY-95-C antenna to develop 5 megawatts erp. The Model BC-31T is a large, new audio console for television applications. Transmitter logging facilities and numerous other equipment items for both broadcast and closed-circuit TV were included in the exhibit.

In one corner of the area was a demonstration in which TV-antenna parameters were fed, by teletype, into a distant computer center. The pattern was computed and printed out as points for a polar plot by the teletype printer.

A front projection system for color TV, a product of Front Projection Corp., was demonstrated in the GE exhibit.

Gotham Audio Corp.

This booth was filled with audio equipment and devices. Among them were: turntables, earphones, attenuators, Neumann condenser microphones employing FET circuitry, the EMT 140st reverberation unit, EMT Vid-E-Dit electronic video tape editor and splicer, the EMT 159 FM stereo fault alarm, EMT-160 microphone polarity tester, Eltro Mark II information rate changer, and Gotham ME-101/102 solid-state wow and flutter meters.

The Grass Valley Group, Inc.

Among the items on display were a video insert keyer, color-lock equipment, and video processing equipment.

The Harwald Co.

Film-splicing equipment and supplies were shown, including the Mark X film editor with facilities for cleaning, inspecting, and editing 16-mm motion-picture film.

Hewlett-Packard Co.

Test equipment included voltmeters, a square-wave generator, test oscillators, an oscilloscope, a multimeter, a waveform monitor, a time-domain reflectometer, an automatic distortion analyzer, and a video monitor.

Houston Fearless Corp.

In this exhibit were the Colormaster film processor, and the PD-8 (studio) and PD-16 (field) pedestals for television cameras.

International Good Music

Automation systems for radio broadcast stations were presented. In the group were the Models 362 and 363 program loggers, Model 50-3 random-select memory, and the Series 500 and Series 600 control systems.

International Nuclear Corp.

Model TMA2 video mixer, Model TSC2 sync comparator, Model TDA7 video distribution amplifier, Model TVM2 video modulator, and other video processing and switching equipment shared the spotlight with the Model TS2 weather satellite processor.

Jampro Antenna Co.

Antennas for television (including zig-zag and bat-wing types), FM, and instructional television service were represented in the Jampro booth.

Jerrold Corp.

An extensive selection of CATV headend and distribution equipment was shown by Jerrold, which stressed the concept of "Total Turnkey Responsibility."

Johnson Electronics, Inc.

Johnson-Aire solid-state equipment for the receiving function in multiplex SCA systems was displayed.

Kaiser-Cox Corp.

Another of the major manufacturers in the CATV field, Kaiser-Cox had an extensive display of equipment for cable-TV applications.

Kliegl Bros. Lighting

In addition to a line of quartz-iodine luminaires, a new preset plate for control of studio lighting was a featured item.

Lenkurt Electric Co., Inc.

The Type 76 and Type 75A microwave systems, and their uses in broadcast applications, were featured in this exhibit.

MaCarTa, Inc.

Tape-cartridge equipment, including the new Model 593 record/delay playback unit, was shown. Rotary-magazine machines for tape cartridges, and racks for cartridge storage were among other items and accessories in the booth.

Marti Electronics

Audio and special systems, remote-pickup and automatic relay equipment, and 950-MHz STL and intercity relay systems were represented. Some individual items were: M-PRE-OP (phonograph) and M-PRE-OM (microphone) preamplifiers, AC-22 power supply, M-PGM-18 program amplifier, SCG 41/67 subcarrier generator, RMC-1C remote control consolette, RMC-2A remote control system, and PA-1 150-MHz remote-pickup antenna.

McCurdy Radio Industries, Inc.

A wide range of audio equipment was shown by this Canadian manufacturer. Among the units on display were audio consoles, a single-channel

These unretouched photographs, taken directly from monitors, tell the story:

First, we took a picture off our black-and-white monitor of the contour signal alone (above). Derived from the green channel and matrixed to all three channels, the contour signal increases the contrast and emphasizes both edges of every transition in the scene. Finally, we photographed the color monitor (above right), with "contours-out-of-green." Now you have it! Lifelike sharpness, with minute detail clearly defined.

"Contours out-of-green"

One more reason why the Norelco PC-70 Plumbicon® Color Camera sees eye-to-eye with the viewer

The Norelco 3-tube Plumbicon Color Camera delivers the most lifelike picture in television today. It matches the visual discrimination of the human eye more closely than any other camera.

And now, with its unique contour enhancement, the PC-70 produces a picture of dramatic sharpness that cannot be duplicated by a 4-tube camera without contour enhancement.

"Contours-out of-green," an exclusive Philips engineering achievement, accomplishes this sharpness without any of the drawbacks that accompany 4-tube camera systems. It does not require an extra tube and the resulting complexities of setup and operation. It does not divert light from the chrominance channels.

"Contours-out-of-green" sharpens *all* edges, not just half of them, both horizontally and vertically—eliminating any possibility of bas-relief, one-sided illumination effect.
It is one more reason why the PC-70 is the one camera that sees eye to eye with the viewer.
For *all* these reasons, call or write for our new brochure, or see our representative, Visual Electronics.

® Registered trade mark for television camera tubes.

Norelco

PHILIPS BROADCAST EQUIPMENT CORP.

900 South Columbus Avenue, Mount Vernon, New York 10550

remote amplifier, and a four-channel remote amplifier.

McMartin Industries, Inc.

Frequency and modulation monitors for FM stations, and equipment for receiving SCA multiplex transmissions were well represented in this exhibit. A featured item was the Model LX-600 mixer-preamplifier.

Memorex Corp.

Type 78V tape, for use with high-band video tape recording systems, was shown by this manufacturer.

Microwave Associates, Inc.

Emphasis this year was placed on new and diverse applications, such as airborne pickups, for the company's solid-state microwave equipment. Also shown were microwave components, including a 2.5-gHz transistor amplifier and a "Sugar-Cube" Series tunnel-diode amplifier for the 1.9-13.2 gHz range.

D. B. Milliken Co.

The Model DBM-64A camera for video film recording was on display in this exhibit.

Miratel Electronics Co.

Solid-state general-purpose video monitors, solid-state professional black-and-white monitors, and color monitors were exhibited by Miratel.

3M Company

A full line of video tapes and accessories was shown. Emphasis was on No. 399 tape for high-band quadruplex video recording.

Mole-Richardson Co.

Lighting equipment and accessories of interest to television broadcasters were shown.

Moseley Associates, Inc.

Among the items on display were these: Model SCS-1 8-channel status/control system, for a single wire line or radio circuit; Model WRC-10T (for single DC control pair) and Model PBR-21 (for single AC control pair or STL) solid-state remote control systems; Model SCG-4T all silicon solid-state SCA subcarrier generator; Model PCL-303 all-solid-state aural STL; and Model ADP-101 automatic data printer for transmitter logging.

North American Philips Co., Inc.

Philips Broadcast Equipment Corp., a newly formed subsidiary and successor to the former Studio Equipment Div., maintained an extensive studio demonstration area. Hourly demonstrations of the Norelco PC-70 color television camera were centered about four dancers who performed a pantomime dance routine timed to a recorded sales presentation. The dance was designed to present in an attention-compelling manner the basic technical concepts behind the Norelco color camera; emphasis was placed, of course, on the absence of a fourth tube. Fast-action sequences and various lighting levels were included in the routine to demonstrate the performance of the cameras.

In addition to the PC-70, on display was the Model EL-8530 color camera, for applications where a viewfinder is not needed and light weight and remote-control capability are advantageous. Test equipment for both monochrome and color was also featured. In a nearby booth, CCTV equipment, microphones, and other items were shown.

Nortronics Co., Inc.

This company presented its extensive line of replacement heads and head-mounting devices for magnetic tape recorders, both cartridge and reel-to-reel types.

Optical Imports

Optical products available from the company were represented in this booth.

Perfection Music, Inc.

Automated presentation of recorded music was demonstrated.

Power Optics, Inc.

A major item of the display was the Servo-Pak, a control system designed for use with all zoom lenses.

Q-Tv Sales & Distributing Corp.

Equipment included the "Q-Prompter," "Grafic" Q-Crawl (vertical movement), and "Q-Dispatcher" (horizontal movement) moving-title machines which use tape with white-on-black lettering prepared by the Q-Typer typewriter.

Quick-Set, Inc.

A number of tripods, dollies, pedestals, and heads for use with television and motion-picture cameras were exhibited.

Radio Corp. of America

The RCA Broadcast and Communications Products Division maintained studio sets for demonstration of its live color cameras. In addition to a new version of the TK-42 studio camera, the company introduced the TK-44, a camera designed for field use. A model football stadium was especially lighted to show the performance of this camera in the presence of late afternoon shadows. In addition to the live cameras, two film islands using TK-27 cameras were in operation.

Other video equipment included the TP-77 slide projector with 120-slide capacity; two new solid-state television switchers, the TS-50 video distribution switcher and the TS-51 production switcher—they mark the first use of integrated circuits in RCA video switchers; the solid-state TA-19 video processing amplifier; and the TR-70 high-band color TV tape system. Other operating RCA TV tape equipment was converted to high-band color with field conversion kits.

The Type TTU-110A 110-kw UHF

transmitter is designed for erp's up to five megawatts (on channels 14 through 50) in combination with pylon or panel antennas.

A full line of "Professional Television" equipment for closed-circuit and broadcast ETV systems was shown.

Other items included monochrome TV cameras, FM transmitters, TV antennas, BFC circularly polarized FM antennas, and stereo cartridge systems. Audio equipment included the BN-26 battery/AC remote amplifier, the BA-43 program amplifier, BA-45 AGC unit, BA-46 limiter, and BA-47 peak clipper.

In separate booths, the Electronic Components and Devices Division exhibited microphones, solid-state devices, camera tubes, and power tubes, while the Magnetic Products Division displayed its tape line in the main exhibit.

Raytheon Co.

Dage television cameras and control equipment were shown in addition to the Raytheon line of microwave systems for STL, intercity relay, ETV, and other applications.

Reeves Soundcraft Div., Reeves Industries, Inc.

Video tapes on display were Type 303 for high-band color recording, and Type 302 for monochrome use.

Riker Video Industries, Inc.

Some of the items from this company's full line of video and test equipment were: the Model 5619 Colorizer, for adding several color effects to monochrome transmissions; an Encoded Color Keyer; a color encoder; and a Title Inserter for adding titles with white letters and black border or black letters and and white border. An audio mixer and video special-effects equipment were also shown.

Rohde & Schwarz Sales Co. (U.S.A.), Inc.

Items from this company's range of test equipment for television systems, including its new Type UPSF video noise meter, were to be seen in the booth.

Rohn Systems, Inc.

Information was available concerning towers, microwave reflectors, tower lighting equipment, and accessories for AM, FM, TV, CATV, and communications uses.

Rust Corp. of America

Highlights of this exhibit included: the Model RC-2400D (single DC pair) and Model RC-2400F (microwave/voice line) push-button remote-control systems in which control is achieved by coded-pulse-width signals; dial-operated video/audio remote switching systems; and a new strip recorder for the company's transmitter logger—24 hours of recorded readings can be seen simultaneously.

Sarkes Tarzian, Inc.

Regular demonstrations of the company's color-camera chains were given in the Tarzian display area. Live models performed in two colorful sets to show live-camera performance, and color film chains also were in operation. In addition to the cameras, this exhibit included solid-state microwave equipment and the APT 1000C computer programmer.

Schafer Electronics

Switching and program automation equipment was highlighted by a complete, operating stereo tape system.

Seeburg Music Library, Inc.

Model SABMC-2 disc automatic background music equipment, and an automatic stereo music center were shown.

Shibaden Corp. of America

The Model SV-700U video tape recorder, Model VS-100 video tape splicer, and Model FP-107 television camera were in this booth.

Shure Brothers, Inc.

A number of professional audio products were included in this display. Among them were microphones, phonograph cartridges, tone arms, and a microphone mixer.

Sony Corp. of America

Video tape recorders for broadcast and other applications were included in this display, along with color adapters and electronic editing devices for use with the company's VTR's.

Sparta Electronic Corp.

Reel-to-reel and cartridge tape equipment, audio consoles, and turntables were presented, along with Vega wireless microphones and solid-state compressor/limiters. One highlight of this booth was the introduction of the Teac Series R-310 professional tape recorder, available in mono and stereo configurations.

Standard Electronics Corp.

Highlights of the exhibit included a VHF television transmitter (output 5 kw visual, 1 kw aural) that employs several transistor stages; other items were an FM transmitter and auxiliary equipment for TV and FM.

Studio Television Products Sales Corp.

A balanced camera pedestal was presented in this company's booth.

Sylvania Electric Products, Inc.

Sylvania's array of equipment included tungsten halogen lamps; television cameras, for both live and film applications; a video control console; and a helical-scan video tape recorder.

Tape-Athon Corp.

Audio automation equipment using magnetic tape as the program source was exhibited.

Tapecaster Electronics

Solid-state tape-cartridge equipment for use by broadcast stations was featured.

Tektronix, Inc.

Oscilloscopes and related products included the Model 453 oscilloscope, Model 549 storage oscilloscope, Model 1S2 time-domain reflectometer, and television waveform monitors.

Tele-Beam Div., The Kalart Co., Inc.

The *Tele-Beam* large-screen television projector, and a Kalart/Victor 16-mm motion-picture projector were in operation in this booth.

Telecontrol Corp.

This exhibit was centered around the Unicon automatic controller for television programming. This equipment incorporates a magnetic core memory.

Telemet Co.

Among the items in this booth were test signal generators, processing amplifiers, clamper amplifiers, video and pulse distribution amplifiers, synchronizing generators, special-effects generators, color-bar generators, color standards, monitors, encoders, and subcarrier regenerators.

Telequip Corp.

Items from Telequip's line of tripods and heads for TV cameras, reels for electrical cable, and television lighting equipment were featured.

Telesync Corp.

Horizontal and vertical crawls for black-and-white and color, conversions for color slide projection, and prompter mounts for color cameras were among the products shown.

Television Zoomar Co.

Highlights here were the Newsbreaker 400 automatic color-film processor, a zoom-lens drive (providing zoom and focus controls) for the GE PE-250 camera, and the Gardner TV Color Guard.

The Telex Corp., Magnecord Div.

Magnecord tape recorders, earphones, and other acoustic products were exhibited by this manufacturer.

Tiffin Scenic Studios, Inc.

Cycloramas and related products for use in television studios were on view.

Toshiba America, Inc.

Video switching equipment and the Model IK-37 color television camera were available for examination.

Townsend Associates, Inc.

Transmitters for FM and UHF television broadcast were featured. TV equipment included Model TA-55BT 55-kw UHF transmitter, Model TA-10BT 10-kw UHF transmitter, and Model TA-1000 TLA 1-kw translator amplifier.

Tracor, Inc.

Equipment for synchronization of television signals from different sources was featured in this company's exhibit.

Trompeter Electronics, Inc.

A selection of items from the Trompeter line of connectors, patching systems, switches, and matrixes was shown.

Utility Tower Co.

Base insulators, operating tower lights, and sample sections of towers in several sizes were in evidence in the Utility booth.

Varian Associates

Eimac power tubes, Microlink 2500-MHz Instructional Television equipment, and master-antenna distribution equipment were displayed.

Viking Industries, Inc.

Turnkey systems were featured in addition to an extensive line of equipment for CATV applications.

Visual Electronics Corp.

Adjacent to the Norelco color studio was Visual's large display of equipment for television and radio.

The new Fernseh flying-spot scanner for color or monochrome moving-picture film was shown; the machine advances each frame, during the vertical blanking interval, by pneumatic action rather than with a claw mechanism. A companion slide scanner also was shown.

New production units of the Visual/Allen high-band color video tape recorder line, Models V/A 100 and V/A 50, were presented; these featured state-of-the-art electronics and a precision video head and transport mechanism. Also stressed, in the post-Convention seminar, was the Visual/Allen rebuilding program for converting existing recorders to high-band operation.

In the area of video switching, the LS-18 switching system was introduced; the system provides for ten noncomposite and eight separate composite inputs. Also introduced was an added facility for the VAT thumbwheel preselection system: event duration can now be preset into the system in addition to the video source, audio source, and transition. Another new system was the VS/AS-12, a 12 x 1 solid-state video and audio switching system.

Many other items of interest to television broadcasters were included. A line of ELCON matched color tubes came from English Electric Valve, Ltd. Solari digital clocks were represented, along with AC-operated Teleindicator digital display modules for the display of election returns, sports scores, etc. The Visual/Videograph Model 990 character generator per-

forms digital to video conversion of 64 different alphanumeric and special characters; the techniques employed in this generator are all-electronic, making use of integrated circuitry.

Radio equipment included the new Model AM-50K-A 50-kw transmitter and the Model AM-1K-A 1-kw unit. The FM line featured a new 10-watt solid-state direct FM exciter, the Model DFM-3K-A 3000-watt transmitter, and the Model DFM-20K-B 20-kw transmitter.

Vital Industries

The Model VI-1000 solid-state processing amplifier incorporates automated features, including automatic correction of a number of common faults in television video signals. Other equipment on display included a color stabilizing amplifier and video and pulse distribution amplifiers.

Vitro Electronics

Nems-Clarke equipment included the Type 112 solid-state phase monitor, Model HFM harmonic field-intensity meter (1.6 to 5 MHz), the solid-state Model FIM-135 field-intensity meter for the 540 to 1600 kHz band, and stainless-steel patching equipment for video and RF applications.

Ward Electronic Industries

A new TV switcher, Model TS-206, utilizing a solid-state double re-entry system was presented. Other equipment included a TV station-break programmer, transmitter demodulator, transmitter phase equalizer, audio consoles, audio amplifiers, and intercom systems

Wilkinson Electronics, Inc.

Transmitters included the FM 20000D 20-kw FM model and the AM3 3000/1000-watt AM unit. Other featured items included the S-1A line-surge protectors, Model 4N1 field-intensity meter, TAC-1B solid-state audio console, ARF-1A RF amplifier, AMM-1A AM modulation monitor, TAGC-1 solid-state AGC amplifier, FM-10D FM exciter, SG-1D stereo generator. and replacement silicon rectifiers.

Part 2—Highlights of the Technical Sessions

For broadcast engineers, the radio/television technical sessions are the heart of each NAB Convention. The extensive displays and demonstrations, the "hospitality" suites, and the opportunity to get together with old friends, though a part of the show, are for the most part of transistory value. The real reason we gather in a distant city and spend a dozen hours a day on our feet is, hopefully, to find concepts, techniques, or equipment that will make broadcast operations more efficient or easier to maintain.

While no technical conference could, in its entirety, provide everything each engineer needs, some part of the presentation interests almost everyone. This 21st Engineering Conference had no spectacular, industry-revolutionizing breakthroughs, but no one who attended the three days of technical sessions could have come away entirely emptyhanded.

Monday, April 3
Radio/Television Session

The first technical meeting was called to order by chairman James D. Parker, CBS-TV, New York, who introduced NAB president Vincent T. Wasilewski. The NAB President welcomed all engineers to the 45th Annual Convention and recalled the significant contributions made by the Engineering Conference to the health and wealth of the broadcasting industry. He gave particular weight to the establishment of the NAB Engineering Seminars held in 1965 and 1966 at Purdue University and announced the Third Annual Seminar, to be held during November 1967. Purdue once again will host the meeting, under the direction of NAB Vice-President and Director of Engineering George W. Bartlett.

Before the technical papers were presented, reports from two NAB Engineering Advisory Committees were given Clure Owen, ABC, New York, session coordinator, told of the FCC denial of NAB's petition requesting rule making for remote control of VHF transmitters. (Further comment on this topic is given in the report on the Wednesday technical session) He also commented on NAB reaction to FCC Docket 13598 concerning sharing of VHF channels 2 through 13 with the land mobile service The NAB Advisory Committee reviewed all exhibits presented by proponents of the measure and concluded that such sharing was not feasible. The Commission was informed of these findings. FCC tests to determine what interference might occur under such sharing will be conducted soon on channel 6 in Washington, D.C. and channel 8 in Los Angeles, Calif.

The Advisory Committee also petitioned the FCC against the 10-kw reliability requirements for remote control. FCC action followed, and a rule change was filed.

In another petition, the FCC was told of NAB opposition to the 2-hour inspection requirement for phase measurements on directional antennas. NAB recommended that such measurements be made during normal engineering procedures, and the Commission has the comment under consideration.

Plans also were announced for publication of a new Sixth Edition of the time-honored NAB Engineering Handbook.

The second committee report was from the Advisory Subcommittee on Loudness. John T. Wilner, Hearst Corp., Baltimore, Md. read the report which dealt with NAB efforts to provide means and procedures to assist broadcasters in complying with the FCC statement of policy on loudness (dated July 12, 1965). NAB guidelines are described in two tutorial papers on automatic audio-level control, and implemented with standard-loudness tapes, ET's, films, and video tapes. This material is, or soon will be, available from NAB Engineering Division offices.

Loudness Meter

In the first of the technical papers, Benjamin B. Bauer, CBS Laboratories, Stamford, Conn., described the significant work performed in developing an effective equal-loudness contour for the design of a loudness monitor. The contour of the CBS-developed curve lies between that of the established Fletcher-Munson 70-phon contour and the CBS Labs 70-phon octave-band contours for noise. Information for the design of the new loudness contour was obtained through a psychoacoustic testing program using a selected panel of listeners who made thousands of sound-level comparisons against standard volumes in a controlled environment.

Effectivness of the monitor (calibrated in Loudness Units —LU's—, rather than Volume Units—VU's) is supported

by the fact that its readings correspond within 1 dB to those determined by the subjective analysis of the psychoacoustic panelists. In other words, the loudness monitor responds objectively, within 1 dB, to the same sounds observed subjectively by a panel of listeners.

The monitor is a fairly complex instrument which splits the audio spectrum into eight separate bands through the use of filters. Each band of frequencies is processed in accordance with the newly developed CBS loudness contour for that band, and then the bands are recombined into a single waveband. A ballistic network, to compensate for the manner in which the meter needle responds to signals of differing frequency and duration, is located between the signal-processing network and the meter itself. This ballistic compensator produces an attack time of 0.1 sec and a decay time of 0.5 sec. The effect of the composite circuitry very closely approximates the overall response to loudness of the average human ear in typical listening environments.

The loudness monitor is now available for field testing, and work is progressing satisfactorily on a companion loudness controller to guard automatically against loudness variations in program material from various sources and with different kinds of "enhancement" and other signal processing applied.

Demonstration tapes played during the presentation of the paper showed excellent results, especially considering the deviation in the convention hall from recommended enviromental conditions for "average" listening.

EBS System Activities

This paper, prepared by Arthur Barriault and presented by W. Elmer Pothen of the National Industry Advisory Committee, was nontechnical. Mr. Pothen described work done by NIAC in cooperation with various governmental agencies and the military to set up and operate the system which, in time of national disaster, must go into effect automatically. He described methods of implementing requirements of the EBS and encouraged cooperation of all engineers in working out compliance with the operating rules established for the system.

VHF Radiation-Pattern Measurements by Helicopter

Kear & Kennedy, Consulting Engineers, prepared a paper on determining radiation patterns in both vertical and horizontal planes by making measurements from a helicopter. The ability of the rotary-wing aircraft to rise vertically over a check point on the ground and to fly slowly over a circular route to ensure an accurate path makes it particularly suited to this purpose. Neil M. Smith of Kear & Kennedy presented the results of several patterns measured in this manner.

For most measurements, K & K mounted a Nems-Clarke Model 107 field-intensity meter and an Esterline-Angus chart recorder in the aircraft. The equipment was powered by a storage battery mounted in the luggage section. A standard dipole was used for most measurements, and it was mounted on a mast capable of being lowered into position away from the craft during flight.

Based on considerations of transmitting antenna aperture, radius distance measurement errors, altitude measurement errors, possible radiation hazards, and ground reflections, most analyses were made using a radius of approximately 1.5 miles. Altitudes generally were the minimum required by the FAA.

To provide several sets of data for averaging out measurement errors, three to four flights were made over the circular path in each direction. The permanent record obtained on the chart recorder was analyzed to give specific field-intensity figures for each azimuth reference. This information then was averaged for all runs and plotted to obtain a final pattern chart.

Measurements made at WNDT, channel 13, Newark, N. J., WPIX, channel 11, New York, WPRO-TV, channel 12, Providence, R. I., and WCBS-TV, channel 2, New York, have provided highly satisfactory measurements of both horizontal and vertical patterns. Best results were obtained at the high-band frequencies, but even low-band channels permitted measurements better than had been obtained using conventional ground-based measurement techniques.

Similar helicopter-airborne measurement techniques also have been used to select sites for head-end equipment for CATV systems. Sites selected in this manner have proved to be quite satisfactory.

IC's for the Broadcaster

R. N. Hurst, of RCA, gave an interesting view into what broadcast engineers soon will be seeing in new equipment designs using integrated circuits. He also presented several examples of how modern solid-state technology has progressed in a very few years from simple diodes to complex multiple-component circuits in a single TO-5 transistor case.

To give an example of how solid-state electronics has affected the design of equipment for broadcasters, Mr. Hurst pointed out that a vacuum-tube version of RCA's latest video recorder would require at least 14 six-foot racks of equipment. The new tape unit, the TR-70, is roughly 3′ x 5′ x 5′. IC's most likely will result in equipment of greater capabilities and sophistication rather than in smaller equipment, according to M. Hurst.

Most of this paper was concerned with manufacturing and design features of IC's, rather than with equipment or circuit applications. For many of the engineers in this technical session, this was their first introduction to the marvelous, almost magical, world of fabricating silicon chips into functioning electronic circuits.

In making a final educated guess about what might follow IC's, the RCA engineer suggested that large-scale integration (LSI) would probably lead into molecular electronics. In this area of circuit miniaturization, *all* the electronic circuitry for an entire camera or sync generator might be contained on a single silicon chip, one not much larger than a postage stamp. Once we get over the shock of ". . . dropping a faulty sync generator into the nearest wastebasket and plugging in another one, LSI could change the industry even more radically than the transistor did," according to Mr. Hurst.

Tuesday, April 4
Radio Session

A troublesome engineering problem, several new items of equipment, and a discussion of standby power sources were the subjects of this session. William S. Duttera, NBC New York, was session coordinator, and Leslie S. Learned, MBS New York, presided.

Spurious Signals in Radio

That spurious signals can be a problem to both AM and FM broadcasters was made evident by the first two papers. First, Fred L. Zellner, of ABC New York, related experience with low-frequency signals generated by beats of the signal of WABC (770 kHz) with those of WINS (1010 kHz) and WHN (1050 kHz). The beats were found to be originating in the final stages of the WABC 10-kw and 50-kw transmitters, and the solution to the problem was to install a bandpass filter between the transmitter and the

antenna. A passband of 250 kHz centered on 770 kHz was chosen, and a three-section filter was used together with a matching network. Following adjustment, field measurements showed the spurious signals to be in the noise level when either transmitter was operated at full output.

Eldon Kanago, of KICD, Spencer, Iowa, showed that spurious signals can be even more troublesome—and difficult to eliminate—when the FM band is considered. The problem here is largely one of harmonic interference to high-channel VHF television stations and to aviation communications and navigation systems. Case histories were given to show how interference problems can arise: Preamplifiers for TV receivers clipped a strong FM signal, producing a square-wave signal rich in second-harmonic energy (solution: change the FM-station frequency); spurious outputs originated in the final-tube socket of the FM transmitter; a station's AM and FM transmitters produced a beat in the aviation band (solution: better shielding and grounding to prevent mixing in the FM exciter); other cases showed an increase of spurious outputs as the final tubes aged.

The speaker stated that the problem is serious, and it will get worse. He observed that better airborne equipment would help the aircraft situation and pointed out four major problem areas: A greater number of better engineers are needed at stations; better assignment of frequencies would avoid many problems; better shielding and grounding at the stations are needed; and, perhaps most important, better understanding and communication among the FCC, FAA, stations, and manufacturers is essential.

Fault Alarm for FM Stereo

Stephen F. Temmer, of Gotham Audio Corp., next described equipment for detecting and warning of faults in FM stereo transmissions. The equipment, known as the EMT-159, detects total loss of modulation, loss of right channel, loss of left channel, loss of difference signal, and reversal of polarity of one channel. With the aid of slides, Mr. Temmer explained the circuit operation for each function. Readout is by means of indicator lamps, and external relays may be connected in series with the lamps if desired. Prolonged or repeated failures must, of course, be verified by the operator, but the system is intended to make unnecessary continuous subjective monitoring of the stereo signal, which can be both costly and tiring.

Automation From Program Through Billing

J. L. Smith, of Collins Radio Co., discussed the use of automation in the programming, equipment operation, and accounting phases of station operation. He hastened to point out, however, that automation is not a panacea, nor does it relieve the broadcaster of his responsibilities; it is instead a tool with which to do a better job.

The operation of an "automatic" radio station was described. Sales, promotion, and community-relations functions must be done "manually," but sales information can be entered into the system data storage, for example in the form of punched cards. This information, combined with the program information, is interpreted by the automatic programmer, which puts the desired program material on the air and logs it. The punched cards are then stored for use in billing and bookkeeping.

The automatic program equipment must be capable of maintaining the station image, be familiar to the broadcaster, and be priced within his budget. Different degrees of program automation are possible. First, there is "total" automation, the so-called "background sound." This can be modified by the addition of periods of manual operation to give "fractional" automation. A type of "tailored" automation uses prerecorded intros, etc., on a "tie-in" tape correlated with the music tape. This system gives most of the advantages of full-time personalities with part-time announcers, but it involves more effort and requires care in maintaining the proper tape sequences. A fourth possibility is the use of an external source (network or program service) with local insertions controlled from the external source.

All of this leads to the heart of the paper, the automatic, self-monitoring transmitter plant. As envisioned, the monitoring system would sense the important parameters at two levels, an alarm level which would signal station personnel that an out-of-tolerance condition is approaching and remedial action is needed, and a second level at which the transmitter is automatically shut down. A three-time recycling feature would be incorporated to allow for transient out-of-tolerance conditions. Override provisions and a fault-location display would be included for maintenance and troubleshooting purposes. Alarms would be located at the transmitter and at the point where the maintenance man is located.

A block diagram of a self-monitoring FM station was shown. A load-power monitor was added to the transmitter to control power output; control of modulation and means for detecting distortion were included. One interesting aspect of this operation would be the lack of need for an operating log; only the carrier on and off times would be logged (automatically).

Before the fully automatic radio station becomes a reality, much work remains: some types of equipment still are needed, some definitions need to be made, and FCC approval must be secured. (In the case of FM stations, Collins has applied for the latter.) Mr. Smith concluded his remarks by asking for comments from broadcasters.

Circular Polarization for FM

A paper describing one approach to the design of circularly polarized FM antennas was presented by Dr. Matti S. Siukola, of RCA. A vertical component of radiation is desirable because of the increasing use of automobile-mounted and other vertical receiving antennas.

The speaker first listed some of the drawbacks of dual-polarized antennas (as opposed to circularly polarized types). Dual types are more complex and expensive, and their use may be restricted by the physical capabilities of an existing tower. In addition, the horizontal and vertical portions have different radiating centers, so the vertical and horizontal radiation components may arrive at the receiving antenna with other than an optimum phase relationship. If the signals are in oblique phase, elliptical polarization results, and the position of the receiving antenna determines the amount of signal received. If the signals are in phase, linear polarization at 45° results; an antenna oriented at 135° theoretically would receive no signal. For a 90° phase difference, and a 1:1 "axis ratio," however, the orientation of the receiving antenna makes no difference, so long as it is perpendicular to the direction of radiation.

The derivation of RCA's circularly polarized antenna from two dipoles at right angles was shown. The result was two half-wave dipoles, formed into one-turn helices and interlaced. A one-sided delta-match is used as a feed, and no balun is required; a variable input transformer is provided for a 1.1 VSWR. The elements are welded to a backbone, and the entire assembly is pressurized. High current through the elements provides a de-icing capability.

The antennas may be stacked. Gain can be stated two ways: with respect to input power at one polarization, gains correspond to those of other antennas; with respect to total input, the gain is approximately one-half as great. Power handling capability is 10 kw per layer.

On-Carrier Direct FM

A new Gates Radio Co. FM exciter was the subject of a paper by Hardin G. Stratman. This is a solid-state unit, in which direct frequency modulation of the oscillator takes place at carrier frequency; no multiplication is used. The entire oscillator circuit is enclosed in a shock-mounted oven, and the mono or composite stereo input is applied to the bases of the oscillator transistors. Two diodes (voltage-variable capacitors) act as frequency-control elements; SCA input is applied to these diodes through an isolation network. These separate program and SCA feeds are used to reduce crosstalk.

AFC is accomplished by comparing the output signal with the third harmonic of a reference crystal oscillator. The 200-kKz beat-frequency signal is processed through a chain of circuits which produces a train of equal-width pulses for application to an AC-DC converter; the converter provides the correction voltage.

The stero generator uses a linear balanced modulator, and a crystal oscillator is the 19-kHz source. The subchannel second harmonic is fed back into the circuit 180° out of phase to reduce crosstalk. Oscillators at 941 and 967 kHz are beat with a 900-kHz oscillator to produce the SCA subcarriers. SCA muting is provided.

Modular construction is used in the exciter, and cables are provided so that modules can be operated out of the cabinet. The cabinet is supplied wired for SCA and stereo, and these modules may be added at any time.

Emergency Power System

The subject of emergency power sources has always been important to broadcasters, but interest seems to have increased in the last few years. James J. Strathmann, of Cummins Engine Co., delivered a talk on this subject.

The speaker observed that the broadcast industry has created a need for reliable continuity of information, especially in emergencies, and the industry is better prepared than most to cope with power emergencies. He said that 1965 was the year that standby power became popular (there were ten major failures that year). Some states have enacted laws regarding standby power.

In general, three types of systems are available: A fully automatic system can be in service in five to ten seconds after sensing a failure; such a system would be used, for example, at an unmanned transmitter site. A semi-automatic system is less costly; it starts automatically, but the load must be transferred manually. For many applications, however, a manual system is adequate even though starting and load transfer may require from two to ten minutes.

Cost is usually one deciding factor in selecting a generator set, but other factors relating to dependability must be considered as well. It was recommended that the buyer set up performance specifications (NEMA generator specs can be used as a minimum) and consult with several suppliers before buying. A key decision is choosing a qualified supplier; factors to consider are location, facilities, qualified mechanics, parts inventory, field service, and sales personnel (they will be your advisers).

Some comments about operating and maintaining generator sets should be of interest: Be careful of freezing of the coolant. As a starting aid, keep the coolant heated; combustion is better and lubricants flow more quickly and easily. Fuel should be replaced (through use) every six to twelve months. The system should be exercised under load —a no-load test is almost meaningless. The equipment should be inspected annually by qualified personnel.

The speaker touched on some of the differences among engines, fuels, etc. However, he stressed this advice for prospective purchasers of standby power equipment: Consult several suppliers, and then decide what equipment (and which supplier) will best meet your needs.

Television Session

This meeting covered several topics of interest to TV engineers, from million-dollar mobile studios to test films and slides. The session was coordinated by Dick F. Engh, KTNT AM-FM-TV, Tacoma, Wash., and presided over by Robert W. Flanders, WFBM Stations, Indianapolis, Ind.

Designing Mobile Units for Color

Faced with increased demands for mobile TV production in color, the three major networks have undertaken extensive design, development, and construction projects to provide comprehensive mobile capability. Costs range to $1 million or more per system and, as for the twin-unit ABC studios, weights can be as much as 60,000 pounds per unit. Typical size of these new-generation behemoths is: length, 50 ft; width, 8 ft; height, 12 ft, 6 in.

Panelists for this presentation were representatives from all three major networks and an independent station:

James R. Baker, ABC-TV, New York, N. Y.
Robert Zagoren, CBS-TV, New York, N. Y.
Allen Walsh, NBC-TV, New York, N. Y.
Charles Blair, WJZ-TV, Baltimore, Md.

John T. Wilner, Hearst Corp., Baltimore, served as moderator.

While individual differences, too numerous to evaluate in a brief report, were obvious in the course of the descriptions given by the speakers, all mobile studios were characterized by extraordinary complexity. Each of the systems, including even the independent station's unit, exceeded in many ways the comprehensive facilities of a permanent production studio.

One area of fundamental difference in concept led ABC and NBC to choose a tractor/trailer combination for each of their two-unit mobile studios, while CBS and WJZ chose self-powered van-type chassis. CBS, like its network competitors, required two units to contain the equipment and support subsystems, while WJZ, through lesser equipment requirements, managed to house necessary items in a single van. All units carry comprehensive environmental conditioning units, including air conditioning, heating, humidity control, and electrostatic dust precipitators.

All engineers presenting papers during this meeting announced their willingness to make available their observations and findings to engineers undertaking major mobile-studio construction projects for color production.

Color-Newsfilm Handling

Sigmund Bajak, NBC New York, described the experience of the NBC news department in switching to the use of color film for all hard-news coverage. He related early use of Eastman type 7255 color film, and the final choice, when it became available, of improved-type 7258 sound-striped color emulsion. With good fundamental film speed (tungsten 125, daylight 80 with Wratten No. 85 filter) and a useful forced-processing speed increase of three full stops, the single emulsion gives the desired capability for shooting almost all possible assignments.

Mr. Bajak also noted the necessity of providing supplemental 3200° Kelvin quartz-iodine lighting units in the kits carried by newsfilm cameramen. NBC also recommends that their film teams always provide the required color balance (3200° K) through the use of set-up lighting, rather than use filters to compensate for other tungsten lighting or fluorescent lighting.

Other procedures required by the switch to color film were added refrigerated storage for film, modification of

film-path rollers and guides in the Auricon cameras used for sound filming, and constant review of color-film quality to maintain the exposure values necessary for high-fidelity color newsfilm.

Color & Brightness Contrasts in TV Production

The Operations Department of CBS-TV, New York, has produced two outstanding color films for their production and creative people. These films, "Color and Brightness Contrasts" and "Color By Design," present in highly understandable terms reasons why filming in color for use in TV is different from filming for theater presentation.

The first film, on the two different types of contrast—color contrast and brightness contrast—clearly demonstrated the effects and control of these important fundamental concepts. Pure white, for example, never should be used in color sets or in costumes, or the brightness-range (20:1) capability of film and equipment will be exceeded. Maximum brightness of "TV White" should not exceed a reflectance of 60 percent. The film also demonstrates the effects of improper color use. Color disharmony, lack of color contrast, use of *too much* color, or failure to use color accents all adversely affect the end-result TV picture.

The second film showed the difference in how cameras (TV or film) see color and how people see color as they *expect* to see it—the subjective response. Necessary use of makeup, for both men and women, was demonstrated. Proper selection of fabric types (lames, brocades, silks are better than velvets and velours, as a rule) also was covered.

The two films were presented in person by the film narrator, E. Carlton Winckler, CBS-TV, New York.

SMPTE Color TV Reference Test Film

Those unable to view the excellent CBS films described above will, when production prints become available this Summer from SMPTE, be able to purchase for their own use a test film which does in a less polished, but equally effective, way what the CBS films do. John M. Waner, SMPTE, New York, showed the film soon to be supplied to TV stations as a standard color-film reference for equipment setup and production comparisons. Varied lighting situations demonstrate the brightness and color-contrast parameters of color films for TV use. Color problems in harmony and accent also are described. These films, according to Mr. Waner, should be available from SMPTE by the middle of the summer. A series of slides to assist in equipment set-up and evaluation also will be available. The full program will be described in a forthcoming issue of the SMPTE Journal.

New Developments in Color Cameras—Image Isocon

In related papers, Robert L. VanAsselt and Dr. H. N. Kozanowski, of RCA, presented information on an image-orthicon type camera tube with a greatly improved signal-to-noise figure. Although it is not a new tube in concept, recent development of new electronic optical techniques has made production of the type feasible.

In describing the image isocon, Mr. VanAsselt says, "The image isocon has the same image section as an image orthicon. The essential difference between the two tubes is in the scanning section. To discuss this difference it is necessary to recognize two kinds of electrons in the return beam. These two classes of electrons originate at the target. When an electron in the primary beam approaches the target, one of three events occurs: The electron may not quite reach the target and be specularly reflected, the electron may strike the target with finite energy and be scattered, or the electron may enter the target and neutralize a positive charge. Thus, the return beam consists of two components, the reflected electrons and the scattered electrons. In the image orthicon, the entire return beam is directed into the multiplier. In the image isocon, the return beam is split, and only scattered electrons are directed into the multiplier."

The result of this fundamental difference gives the image isocon tube the following characteristics: The signal-to-noise ratio is superior to an equivalent IO; beam setting is less critical than for an IO; there is very low noise in the blacks, permitting required gamma correction with small added noise; and resolution, sensitivity, and knee characteristic are very similar to the IO.

Following Mr. Van Asselt's description of the tube characteristics, Dr. Kozanowski described the RCA TK 44 camera, a color camera intended primarily for outdoor or remote TV pickup. The camera uses a 3-inch image isocon in the luminance channel of the four-tube circuit. The chroma tubes are vidicon types, which will be available with lead-oxide surfaces to attain improved sensitivity.

The TK 44 is said to have an exposure characteristic completely linear from black to the knee, beyond which the signal rises only very slowly with increased light.

An operator of the new camera is required only to aim and focus the lens. All other set-up adjustments which are not automatic or completely regulated and preset are made by the camera-control operator.

Color-Image Enhancement Techniques

In the final paper of this technical session, Charles E. Spicer, of Visual Electronics Corp., described a method of compensation for the image-softening horizontal- and vertical waveform rounding common to all camera tubes as a result of aperture distortion. By the use of delay lines and filters, the contours of the horizontal and vertical waveforms are reshaped to provide sharply defined waveform edges.

In a color system, to obtain control of the contour being enhanced, the contour may be taken from the green channel within the camera itself. This approach takes maximum advantage of the fact that the signal-to-noise ratio of the green channel is significantly lower than that of the red and blue channels or the matrixed signal. The green contour also can be matrixed, after enhancement, into the red and blue channels before encoding. The effect of misregistration in the red and blue channels is then reduced.

"Contour-out-of-green" enhancement, then, uses vertical and horizontal aperture corrections integrated into a three-tube color camera. It achieves reduced noise and provides increased sharpness in the color signal. There also is increased tolerance to misregistration of the three color images.

Wednesday, April 5
Radio/Television Session

The final meeting of the 21st Annual Engineering Conference was held Wednesday morning. Glenn G. Boundy, Storer Broadcasting, Miami Beach, Fla., presided; James D. Parker CBS-TV, New York, was session coordinator.

Maintaining Video-Tape Program Quality

In the first paper of this session, Charles E. Anderson, of Ampex Corp., offered a straightforward program designed to help engineers get the most from their video-tape recording and playback equipment. Referring to video-tape

• *Please turn to page 55*

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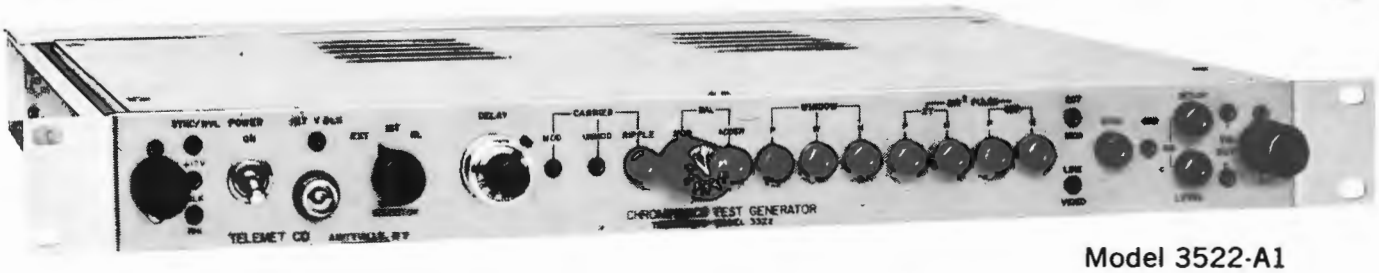

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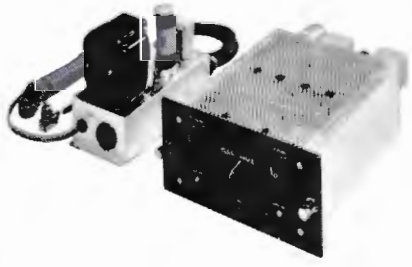


Shure stereo equalizer and preamplifiers are praised as MAJOR contributions to upgrading station quality by broadcasters.

SE-1 Stereo Transcription Preamplifier
Provides precise RIAA equalization from magnetic phono reproducers at line levels. Separate high and low frequency response trimmers. Lowest distortion, noise level, susceptibility to stray RF fields.

M66 Broadcast Stereo Equalizer
Passive equalizer compensates recorded frequency to three playback characteristics: RIAA, flat, roll-off. Provides precise equalization from magnetic pickup at microphone input level.

Circle Item 121 on Tech Data Card

BOOK REVIEW

Amplifier Handbook: Richard F. Shea, Editor-in-Chief; McGraw-Hill Book Company, New York, 1966; 1504 pages, 6″ x 9″, hard cover, $37.50

This volume may be described as a major attempt to provide an encyclopedia of amplifier theory and circuitry. Its scope ranges from tubes to lasers, and from ceramic and magnetic devices to complex integrated circuits.

The work has been divided into three principal areas, each comprised of the elements essential for thorough explanation and illustration of the analysis at hand.

Part one deals with the fundamentals of amplifier theory, including network definitions and concepts as they relate to amplifiers, necessary matrices, feedback, and noise. Treatment extends to the detailed mathematical analysis and proof which are necessary to full comprehension of the principles involved.

The second part is devoted to the description of every significant form of amplifying device. This includes tubes, transistors, tunnel diodes, other solid-state components, and magnetic, ionic, and ceramic devices. The description of each type extends to the full range of its theoretical and practical application, and includes explanation of the use and effect of the various materials employed in their construction. For example, the chapter on electron tubes covers simple diodes, the more complex multielement tubes, klystrons, and receiving and transmitting types.

Part three, and by far the largest part of the book, is given to the presentation of specific amplifier circuits by their application. Included are chapters on audio, DC, high-power, magnetic, ionic, servo, tuned, nonlinear, microwave, and induced-emission (laser and maser) amplifiers, and the special requirements and limitations of integrated circuits. Within each broad area, actual working circuits are given the attention sufficient for their full explanation and application in working devices.

This is essentially an engineer's handbook, but its thorough treatment of the subject permits its use by any advanced technician with a requirement for more than an elementary knowledge of a few basic circuits and principles. It should be especially useful to anyone who wishes to have access to knowledge of amplifier circuits not encountered in the ordinary day's work ▲

What's new

at KABC-TV, KATV, KEMO-TV, KEPR-TV, KFMB-TV, KGGM-TV, KHET-TV, KHFI-TV, KHTV, KIMA-TV, KIRO-TV, KMED-TV, KMVT, KNBC-TV, KOAP-TV, KOLO-TV, KPIC, KPRL-TV, KQED-TV, KTCA-TV, KTCI-TV, KTVB, KTVH-TV, KVIE-TV, KVOS-TV, KWGN-TV, KWTX-TV, WABC-TV, WBMD-TV, WCNY-TV, WDIQ-TV, WEDH-TV, WEIQ-TV, WERO-TV, WGEM-TV, WHDH-TV, WHDO-TV, WITA-TV, WJCT, WLOS-TV, WNBC-TV, WOR-TV, WPRO-TV, WPTZ-TV, WRAL-TV, WROW-TV, WSCO-TV, WTIC-TV, WTWO-TV, WVTV, WWTV, WCBS-TV, KGGM-TV, ABC Network, CBS Network, NBC Network **and** BELO HORIZONTE TV (Belo Horizonte, Brazil), CBC (Montreal, Can.), CFRN (Edmonton, Can.), CBC Newfoundland, BOGOTA TV (Bogota, Col.), CHSJ (St. Johns, N.B., Can.), CKLW-TV (Windsor, Ont., Can.), NRK (Norway), Radio Bandirantes (Sao Paulo, Brazil), RTB/ BRT (Belgium), Staatsbedrijf Der Posterijn (Holland), Telefis Eireann (Eire), TV-2 (Panama City, Pan.), XEIP (Mexico City, Mex.), XET-TV (Monterey, Mex.), XEW-TV (Mexico City, Mex.), YNSA-TV (Managua, Nic.).

May 1967

We interrupt this magazine to bring you...

Late Bulletin from Washington

by Howard T. Head

Radio Stations Warned on Commercial Practices

The Commission has renewed the licenses of seven Florida AM radio stations whose applications indicated commercial time of 20 minutes or more in each hour as a regular practice (see December 1966 Bulletin). In doing so, however, the Commission directed the licensees to report to the Commission at the end of an 18-month period regarding commercial practices during that period, and to inform the Commission of any public complaints or other adverse response to commercial time in excess of 18 minutes per hour.

NAB Small Market Committee Studies Problems

The National Association of Broadcasters Small Market Committee has under study the problems associated with the taking of FCC operators' license examinations. Applicants in remote parts of the U. S. are often obliged to travel several hundred miles to take the required examinations and the Committee is attempting to persuade the Commission to provide more convenient locations. A survey is also to be conducted, through state broadcaster associations, of the time and expense involved in sending personnel to present examination locations.

The Committee is also studying the effect on daytime-only radio stations of the new Federal law requiring uniform observance of Daylight Saving Time (see May 1966 Bulletin). The Commission has reminded licensees that the new law does not affect sign-on and sign-off times, or in the case of fulltime stations, the time of changing from day to night patterns; these times will continue to be governed by Standard rather than Daylight time. Minimum hours of operation for AM stations (Section 73.71(a) of the Commission's Rules) are also established in terms of Standard time, although this was not pointed out in the Notice.

Proposed Channel Sharing Tests Advance

The joint Government-Industry Committee for Testing Sharing of TV Channels By Land Mobile Services has approved plans for field testing of land mobile/television channel sharing on Channel 6 in the Washington, D. C. area (see December 1966 and March 1967 Bulletins), to start about June 1, 1967. The test locale had been shifted from Los Angeles to Washington, D.C. because of Mexican concern over possible interference to a Channel 6 station at Tijuana, B.C.

In approving the field test plans, the Committee noted the necessity for laboratory testing in addition to the field testing, both to guide the conduct of the field tests and to permit analysis of the results. Shortage of adequate laboratory data on receiver interference has been one of the principal obstacles to a Commission determination of the extent of interference to television reception from land-mobile operation.

Negotiations Incomplete on New AM Treaty With Mexico

At the conclusion of a month-long second negotiating session between the United States and Mexico, agreement still has not been reached on a new standard broadcast radio treaty between the two countries. The present treaty will now expire at the end of 1967. At stake are such issues as increased hours of operation on clear channels, and power increases for Class IV local-channel stations near the common border.

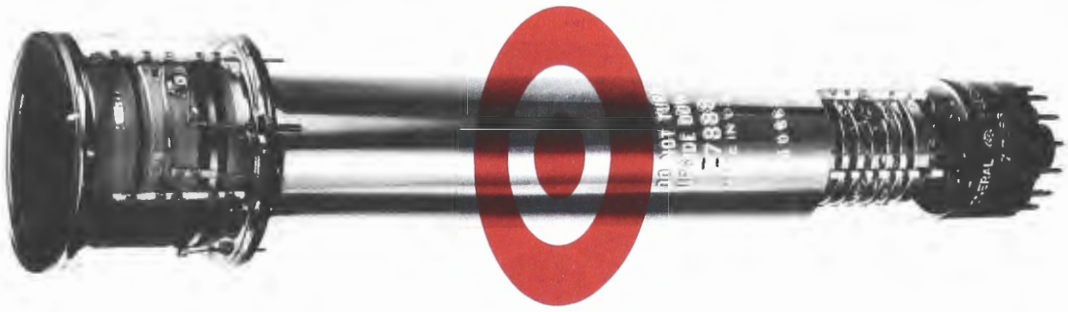
No date has yet been set for the resumption of negotiations. It appears unlikely, however, that agreement will be reached, and ratification effected, before the present treaty expires.

Short Circuits

NAB has urged the Commission to authorize the establishment of a specialized television-radio space satellite system for network relaying, with individual broadcasters to own and control their individual ground receiving stations (see September 1966 Bulletin). . . The Commission has declined to add a fifth commercial television channel to Charlotte, North Carolina (population: 230,000) on the ground of lack of need. . . A major FM-transmitter manufacturer has proposed that the Commission authorize the unattended operation of FM transmitters. . . A number of licensees have been admonished for failing to exercise proper control and supervision over foreign-language broadcasts. . . The Commission has turned down a proposal for remote-control operation of VHF television transmitters on the ground that it might lead to picture degradation and spurious radiation.

Howard T. Head . . . in Washington

Aim high



Target innovations in GE Pickup Tubes give you a better picture.

Shooting for the best possible picture? Set your sights on the new generation of Image Orthicons and Vidicons from General Electric!

New innovations in GE Pickup Tube glass target technologies now permit higher signal-to-noise ratios and improved amplitude response in existing color or monochrome TV cameras. The new Z7899 IO, for color remotes and monochrome VTR, and the Z7888 IO, for studio color video taping—give *sharper, quieter,* better pictures. At medium to high illumination levels, they give up to 3 to 5 times longer life than conventional glass targets. Stickiness, loss of sensitivity, and burn-in are virtually eliminated.

Let us prove—*with your equipment, in your own studio*—that NEW IDEAS IN ELECTRONICS from General Electric will give you a better picture! To request a demonstration contact your nearest GE Sales Engineer:

Type	Target	Field Mesh	Signal Noise @ 4.5 MC		Amplitude Response @ 400 TV Lines	Application
			Min.	Avg.		
Z7899	New Electronic Glass Target	No	65:1	72:1	65%	Color Remote & Monochrome VTR
Z7888	New Electronic Glass Target	Yes	65:1	72:1	65%	Studio Color Video Taping

OTHER GE PICKUP TUBES AVAILABLE

Image Orthicons		Vidicons			
5820A	8093A	6198A	7262A	7735B	8572
4401	8092A	7038	7263A	8484	8572V
7293A	Z7866	7038V	7697	8507	8573
7629A		7226	7735A	8541	8134V

Available From Your GE Camera Tube Distributor

Charles M. Liddic
1330 W. Peachtree St., N.W.
Atlanta, Georgia
Telephone: (404) 875-6691

Charles Shields
3800 N. Milwaukee Ave.
Chicago, Illinois
Telephone: (312) 777-1600

Harold F. Boreiko
200 Main Avenue
Clifton, New Jersey
Telephone: (201) 472-8100

Fred A. Sachs
Electronics Park, Bldg. 6
Syracuse, New York
Telephone: (315) 456-2584

GENERAL ELECTRIC

288-07

Circle Item 17 on Tech Data Card

Overly builds doors to keep this out

What noises do *you* want to hold back? Overly makes a complete line of certified acoustical doors – 1¾" to 4½" or thicker, depending upon the required sound reduction and size. Full-flushed design, glazed units, and a special louvered door. Overly units come complete: doors, frames, seals, hardware. STC loss ratings from 35db to 53db – in tandem doors 62db – certified by Riverbank Acoustical Laboratory.

For lab test reports and information on how you can hold back unwanted sound, write to: Manager of Product Development, Overly Manufacturing Company, Greensburg, Pennsylvania 15601.

Overly

Circle Item 18 on Tech Data Card

(Continued from page 45)

design and operation as "sciences, not art," Mr. Anderson suggested a five-point method for high-efficiency operation:

1. Set up a planned maintenance and adjustment schedule, then stick to it. Modify schedule only when better operation results.
2. Adhere closely to SMPTE recommended practices and standards for TV magnetic-tape recording. This assures good interchangeability.
3. Take care to ensure proper signal levels in all phases of the recording process.
4. Set burst key to yield as many cycles of burst as is legal, and position burst properly.
5. Establish a training program for operators and maintenance personnel.

The man-pack Ampex VR-3000, a portable recording instrument designed for news and remote coverage, also was described by Mr. Anderson. Slides showing the unit in operation with a two-man reporting team demonstrated a capability for making useful remote-location recordings.

New Video Noise Meter

A significant contribution to TV instrumentation was described in a paper presented by Rudolph Feldt, of Rohde & Schwarz. The complex design of the instrument precludes a detailed description of the circuitry. In brief, however, the unit processes the composite video signal to remove the sync and blanking pulses, leaving the video signal. Compensation is made for duty cycle of the remaining video bursts to obtain measurement accuracies of better than 1 dB for remaining noise pulses.

The instrument is direct reading and indicates both the weighted and unweighted signal-to-noise ratio in both rms and peak-to-peak values. A measurement range of 80 dB is available, and the gray level has no effect on the overall measurement. The gating pulses which blank the sync and blanking pulses are generated internally; external sync provision also is made. Various filters are provided to allow measurements to be made within tolerances established by CCIR.

Tower Care and Maintenance

J. Roger Hayden, of Dresser Crane, Hoist & Tower Div., gave engineers useful information on tower care. Drawing from years of experience on towers ranging from lightweights to 1000-ft-plus giants, Mr. Hayden showed photographic examples of poor practice taken on actual repair jobs. He also outlined a comprehensive list of items that should receive special attention: lights and lighting systems, feedlines, structural members, foundations, bolts, wedges, and guys.

A self-supporting structure often can be inspected on a two-year schedule, but guyed towers should have a yearly inspection, according to Mr. Hayden. A self-supported structure also should be reviewed after any extremely violent storm and following a particularly severe winter when icing has been heavy.

While common sense suggests many obvious points for consideration, says Mr. Hayden, a specialist should always be consulted for assistance in setting up a thorough maintenance and safety program.

Advanced Manufacturing Methods for Complex Broadcast Equipment

The final formal presentation of a technical paper dealt with the advanced quality-control concept General Electric has developed to control tolerences during manufacture of color cameras, signal-processing equipment, and other com-

plex broadcast gear. An integrated policy, encompassing all phases of manufacturing from product evaluation to sales after service, the program of "Total Quality Control" includes environmental testing, shock tests, life expectancy, and ease of component interchangeability. Manufacturing processes and special training programs for assembly technicians have been designed to contribute to the construction of complex equipment. Automated test equipment gives a means for rapidly evaluating circuit boards not only for completeness, but for acceptable operation of each component.

The entire program, however, is far too detailed to review in its entirety. Engineers at the meeting did obtain an unusual insight into the extensive care taken to ensure that the equipment they use every day is dependable and easy to care for. The paper was offered by A. J. Strumar, of GE.

Industry/Government Technical Panel

To close off the three days of technical sessions, the conference committee assembled the following panel to discuss questions of interest both to broadcast engineers and to FCC engineers in attendance:

Wallace E. Johnson, FCC Broadcast Bureau, Wash., D. C.
Malcolm M. Burleson, Metromedia, Wash., D. C.
Harold G. Kelley, FCC TV Applications, Wash., D. C.
Philip Whitney, WINC/WRFL, Winchester, Va.
Paul C. Schafer, Schafer Electronics, Chatsworth, Calif.
Harold L. Kassens, FCC Broadcast Facilities, Wash., D. C.
Clyde M. Hunt, Post-Newsweek Stations, Wash., D. C., was moderator.

Verbatim transcripts of the session are not yet available, although they will be obtainable later from NAB. Topics, as might be expected in a free-form discussion, ranged widely.

Foremost, perhaps, was the comment from FCC engineers on the Commission's denial of the petition for remote operation of VHF TV transmitters. It was made clear that although the petition was not felt to be adequate, there should be another petition filed later by NAB. The wording of the denial, said Mr. Johnson, suggests the approach to be followed in any forthcoming petition to assure adequate maintenance of remotely situated transmitters.

Additional discussion touched on the need for clarifying the whole list of FCC rules and regulations to reflect the advanced state of the art of electronics. Engineers also learned that field-office Radio Inspectors operate not only from the rule book, but also from field-office operating manuals provided by the Washington office to aid in interpreting the rules—a rule book for the rule book! This situation accounts for delays in implementing new rules and indecision as to how they apply in specific cases. Other comment concerned progress being made in securing agreement from international agencies (in Canada and Mexico, particularly) to enable a new rule authorizing a uniform sign-on time for daytime-only stations.

Summarizing

The Conference contained interesting information in many particular areas of engineering operations. We have a lot to look forward to, not only in terms of new equipment and systems concepts, but also in the regulations under which we all function. Invaluable opportunity exists in technical conferences of this sort to make known to manufacturers, designers, and government engineers our needs and desires for bettering our profession. ▲

Disc Recorders

(Continued from page 15)

equalization, insert the equalizer network in the line feeding the amplifier, set the audio generator to 1000 Hz, and adjust the gain for about 0.4 volt across the amplifier output when using a low-impedance cutter, or about 3 volts for a 500-ohm cutter. This should give you a recorded level about 15 dB below NAB standard reference level. Make a recording again, this time using spot frequency checks from 1 kHz to 10 kHz, and play it back on your standard turntable. When the equalizer is correctly adjusted, response during reproduction should be essentially flat up to at least 7 kHz, or, if you're lucky, as high as 12 or 14 kHz. If you're not within about 3 dB on the first try, adjust the 250-ohm equalizer control. Changing the resistance changes both the high-frequency response and the insertion loss. It will be necessary to readjust the input level each time the setting of this control is changed. Don't try to check the high-frequency response of the cutter at a higher level than specified above or you will risk damage to the cutter, since the amplifier response rises with frequency. (Program material may be recorded at higher level because very little high-frequency energy is present in normal music or speech.)

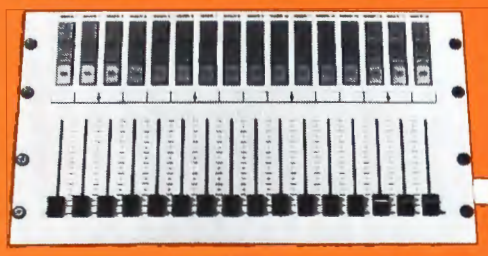
Once you get the high-frequency equalizer adjusted, you should adjust the gain control on the amplifier for standard level. To do this, play the standard-level cut on the test disc, and adjust the turntable gain for a zero indication on the VU meter. Then, make a test recording of a 1000-Hz tone with about 2 volts across the amplifier output (15 volts for a 500-ohm cutter). Play this back on the turntable without changing the gain from the playback level of the test disc. The reading of the VU meter will now be your deviation from standard level. Adjust the recording amplifier gain and recheck until you are within one or two dB of standard level. Now, with program material reading the same level as the output of your audio generator, you will be able to make recordings at NAB standard level. This is the standard normally used on 33⅓-rpm records. Many 45's will show levels several dB higher than this, but unless you have a very high-power amplifier, don't expect to match this level. With most standard cutters, you run the risk of damage if you attempt to record with the power required to match "pop" 45's.

If you wish to make a frequency-response run on your cutter, be sure you record levels no higher than about 15 dB below NAB standard reference levels, since the high frequencies are boosted some 20 dB by the equalizers. You may measure response at frequencies below 1000 Hz at standard level, however.

Conclusion

Making good disc recordings takes considerable practice, and you may go through several discs and a stylus or two before you get the swing of it. If you do a good job of rejuvenating your recorder, though, you should have a machine capable of good performance—and which can bring you in some extra money. ▲

212T-1



212T-2

In 8 out of 10 cases one of these STANDARD consoles will meet CUSTOM console requirements

Rack Assembly

Before ordering a custom installation for your control room, check your requirements against these features of Collins' standard 212T-1 and 212T-2 Audio Control Consoles:

REMOTE CAPABILITY. Rack-mounted assembly containing amplifier cards can be located in an equipment room and linked by cable to the audio control panel in the studio. Sensitive audio wiring is concentrated in a card cage away from interference. Noiseless switching and audio level control are accomplished by photoconductive cells which employ a light beam to isolate control voltages from the audio circuits.

COMPONENT ACCESSIBILITY. Plug-in etched circuit card construction ends time-wasting troubleshooting. Attenuator, input switches, amplifiers, and amplifier output switches are replaced by simply taking one card out of the rack-mounted assembly and plugging in another card.

The 212T Audio Control Consoles consist basically of three units:

CONTROL PANELS. The control panel constitutes the difference between the two systems.

The 212T-1 control panel provides 28 inputs to 14 faders, 2 program output channels, and 2 10-watt monitor speaker outputs. The overall dimensions are 15¾" high by 24" wide.

The 212T-2 control panel has 32 inputs to 16 faders. The panel is divided into two sections: The fader operating controls are mounted on a panel 10½" high by 19" wide; the VU meters and monitoring controls are mounted on a panel 5¼" high by 19" wide.

RACK-MOUNTED ASSEMBLY. The assembly contains 16 preamplifier cards. Quantity and types of cards depend upon individual requirements. The assembly includes three program amplifier cards—one for cue and two for program channels. Two amplifiers are for speaker monitors; two switching cards select monitor inputs. The rack-mounted assemblies for the 212T-1 and 212T-2 are identical.

POWER SUPPLIES. Two power supplies are housed with the rack-mounted assembly. One power supply provides variable illumination for meters and push-button controls. Another provides powering for cards, attenuators, amplifiers, switches, and photoconductive cells.

Most studio audio requirements can be met by adapting the standard 212T-1 or 212T-2 Console through strapping options and minor wiring changes. Expansion and adaptation can be accomplished easily with additional space which the units provide for two extra preamplifier cards, two additional program amplifiers, and two unwired spare card receptacles.

For a copy of a new descriptive brochure on the 212T series, contact Broadcast Marketing, Collins Radio Company, Dallas, Texas 75207. Ph. (214) AD 5-9511.

COMMUNICATION / COMPUTATION / CONTROL

COLLINS

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Circle Item 24 on Tech Data Card

NEWS OF THE INDUSTRY

To Build Earth Stations

Communications Satellite Corp. has asked for fixed price proposals for four large antennas and related earth-station equipment. The request for proposals (RFP), the largest single earth-station procurement issued by Comsat, was sent to 52 companies. Comsat filed the RFP with the Federal Communications Commission. It included four 90-to-100 foot precision-designed antennas, eight low-noise receivers (two for each station), and four sub-systems of ground communications equipment—all to be integrated into reliable systems at each station site. The new equipment would be supplied for installation at three new high-capacity stations at sites to be chosen in Puerto Rico, West Virginia, and California, as well as for augmenting the Hawaii station for increased Pacific service.

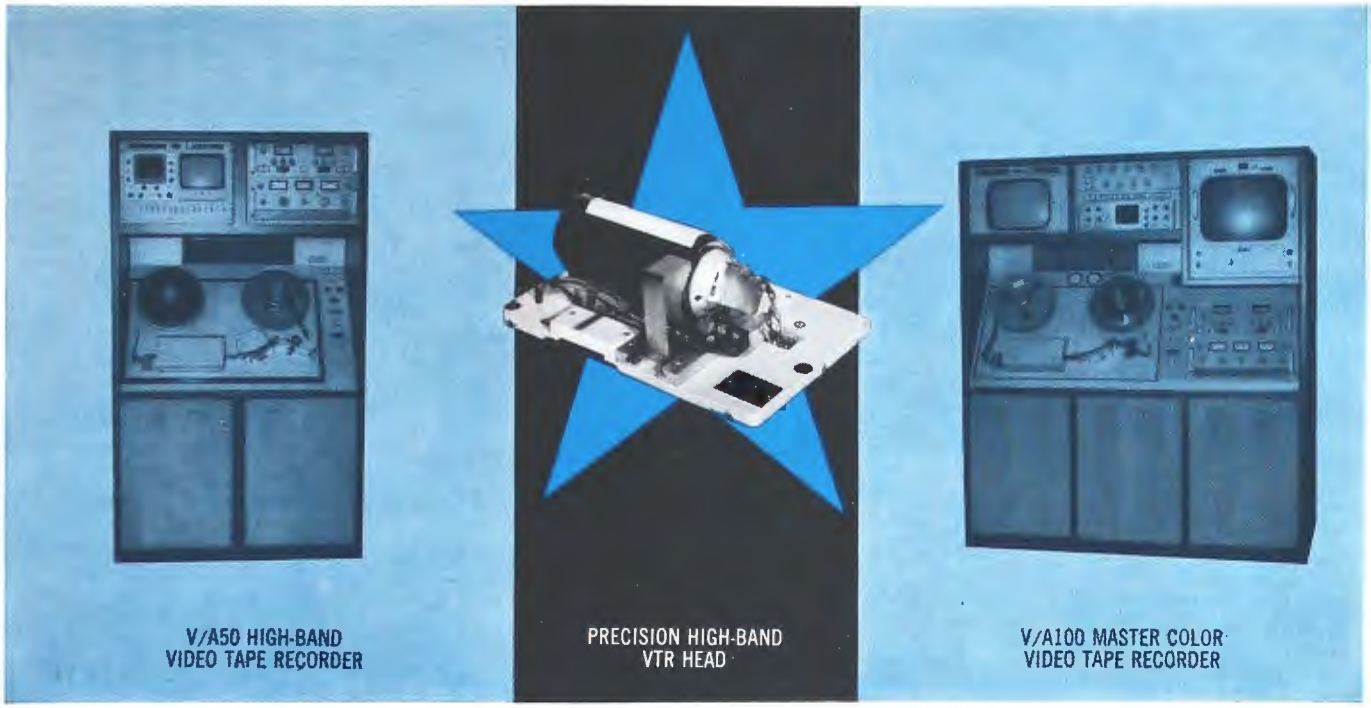
Proposals for architectural and engineering services relating to the three new station sites have been received and are being evaluated by Comsat. Construction is expected to get underway at all four locations this year and be completed in 1968. The new facilities will more than double present earth-station capacity. Comsat currently operates three earth stations, at Andover, Maine, Brewster Flat, Washington, and Paumalu, Oahu, Hawaii.

Transactions

Subject to FCC approval, the assets of Radio Station **WRCR,** Maplewood, Minnesota have been purchased by **Armand Belli** of Arlington Heights, Illinois for a total consideration of $115,000 on terms. WRCR operates on 1010 kHz with 250 watts.

Minnetech Laboratories, Inc., Minneapolis manufacturer of automation equipment and industrial measuring devices has been purchased by **Nortronics Company, Inc.**

Hans Trechsel will continue as general manager of Minnetech, which



another key to better color

THE VISUAL/ALLEN HIGH-BAND VIDEO TAPE RECORDER LINE

VTR Designed and Built from the Operator's Viewpoint

New Precision Long-Life High Band Video Head

New Operations Oriented Console Housing

New Precision Tape Transport

Full Monitoring and Playback Processing Facilities

New "State-of-the-Art" VTR Electronics Systems

Simple, Occasional Maintenance for Routine Excellent Performance

Introducing the PRECISION High-Band VTR Video Head

To fulfill a long standing industry requirement this long-life VTR video head is designed and built as a *precision instrument* to provide a revolutionary new tool for the highest quality color VTR operation.

the Blue Ribbon Line

VISUAL ELECTRONICS CORPORATION
356 west 40th street • new york, n.y. 10018 • (212) 736-5840

FIRST BY ANY STANDARD

will be operated as a wholly-owned subsidiary of Nortronics. Minnetech was founded by Mr. Trechsel in 1961.

New Plant

A new plant at Hauppauge, Long Island, New York has been occupied by **Riker Video Industries, Inc.** The custom-built 20,000 square-foot structure houses the company's manufacturing facilities, executive offices, and New York sales headquarters.

Expanded Plant Facilities

American Electronic Laboratories, Inc., has acquired new plant space at Montgomeryville, Pa. The new facilities, to be leased by AEL affiliate **Electromagnetic Technology Corp.,** will provide an area of approximately 43,000 square feet. Current plans call for doubling this space in the near future.

Cable Facilities Doubled

Shipments have started from the new **Viking Industries, Inc.,** cable facility at Freehold, New Jersey. The 130,000 square-foot plant doubles the firm's capacity for producing cable, and will be devoted primarily to serving the needs of the CATV industry. The plant is managed by Harold Roveda. ▲

ALWAYS ON TARGET WITH SOLID STATE EQUIPMENT

Years of technical experience in television broadcasting stand back of the many new advances developed by Richmond Hill Laboratories in this highly specialized field. Designed, engineered and manufactured in Canada, the wide range of RHL solid state equipment includes:
Studio Switching Equipment • Synchronizing Pulse Generators
Video Test Signal Generators • Special Effects Generators
Colour Bar Generators • Video Distribution Amplifiers
Pulse Distribution Amplifiers • Clamping Amplifiers
Digital Cue Generators • Digit Generators
Clock System Driver • Routing Switching Equipment (Audio Video)
All RHL products carry a 5-year warranty, backed by skilled craftsmanship, quality components and rigid control . . . important factors in building a fine record of service to the television broadcast industry.

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Circle Item 31 on Tech Data Card

NEW PRODUCTS

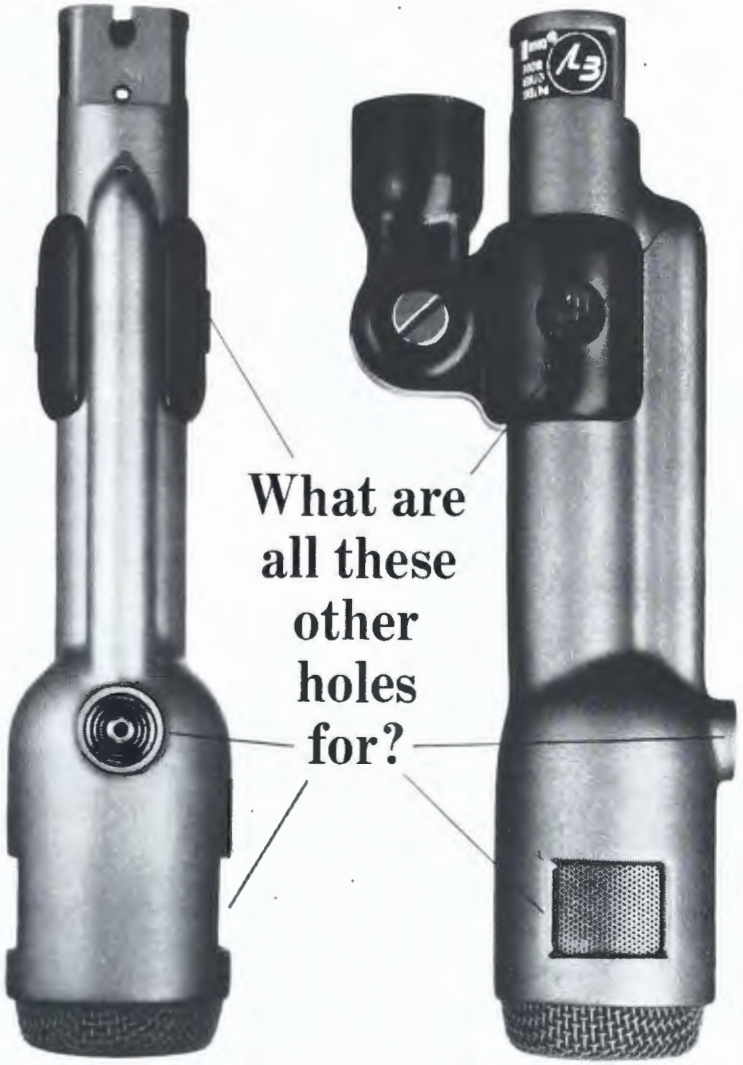
For further information about any item, circle the associated number on the Tech Data Card.

Video Waveform Monitor
(110)

A flat-face, rectangular, 5-inch CRT with an edge-lighted IEEE-type graticule is one feature of this video waveform monitor for professional and broadcast television systems.

The **Ball Brothers Research Corp.** Mark 21 monitor uses semi-conductors throughout the electronic circuitry including the integrated circuitry. Since power consumption is low, con-

If the Electro-Voice Model 666 picks up sound here...



What are all these other holes for?

The holes in the top, sides and rear of the Electro-Voice Model 666 make it the finest dynamic cardioid microphone you can buy. These holes reduce sound pickup at the sides, and practically cancel sound arriving from the rear. Only an Electro-Voice Variable-D* microphone has them.

Behind the slots on each side is a tiny acoustic "window" that leads directly to the back of the 666 Acoustalloy* diaphragm. The route is short, small, and designed to let only highs get through. The path is so arranged that when highs from the back of the 666 arrive, they are cut in loudness by almost 20 db. Highs arriving from the front aren't affected. Why two "windows"? So that sound rejection is uniform and symmetrical regardless of microphone placement.

The hole on top is for the mid-range. It works the same, but with a longer path and added filters to affect only the mid-frequencies. And near the rear is another hole for the lows, with an even longer path and more filtering that delays only the bass sounds, again providing almost 20 db of cancellation of sounds arriving from the rear. This "three-way" system of ports insures that the cancellation of sound from the back is just as uniform as the pickup of sound from the front—without any loss of sensitivity. The result is uniform cardioid effectiveness at every frequency for outstanding noise and feedback control.

Most other cardioid-type microphones have a single cancellation port for all frequencies. At best, this is a compromise, and indeed, many of these "single-hole" cardioids are actually omnidirectional at one frequency or another!

In addition to high sensitivity to shock and wind noises, single-port cardioid microphones also suffer from proximity effect. As you get ultra-close, bass response rises. There's nothing you can do about this varying bass response — except use a Variable-D microphone with multi-port design* that eliminates this problem completely.

Because it works better, the E-V 666 Dynamic Cardioid is one of the most popular directional microphones on the market. Internal taps offer 50, 150, or 250 ohm impedance output. Frequency range is peak-free from 30 to 16,000 Hz (cps). Output is—58db.

To learn more about Variable-D microphones, write for our free booklet, "The Directional Microphone Story." Then see and try the E-V 666 at your nearby Electro-Voice professional microphone headquarters. Just $255.00 in non-reflecting gray, complete with clamp-on stand mount. Or try the similar Model 665. Response from 50 to 14,000 Hz (cps), $150.00 (list prices less normal trade discounts).

*Pat No. 3,116,807

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638 Cecil Street, Buchanan, Michigan 49107

Electro-Voice®
SETTING NEW STANDARDS IN SOUND

Circle Item 35 on Tech Data Card

vection cooling is employed; no fan is required. Electronically regulated high- and low-voltage power supplies are employed for the purpose of providing constant trace brightness and low-drift amplitude calibrations.

Three switch-selected vertical amplifier response characteristics are included: FLAT—to 5 MHz; IEEE—roll-off; and CHROMA — high-pass peaked at 3.58 MHz. An internal amplitude calibrator is provided for gain measurements. The 2H and 2V horizontal selections and expanded sweeps are switch-selected by a single control. Automatic horizontal centering on two-line, two-field, and expanded sweeps requires no adjustment when switching horizontal sweep modes.

Additional design features include DC restoration on backporch of sync, sweep triggering from video or external drives, and two high-impedance looping video inputs.

Two models are available. One is rack-mounted in 5¼ inches of vertical space; the other is available in a half-rack version. List price for either model is $995.

Something to buy or Sell?
Use the classified pages.

TOTAL QUALITY CONTROL – ANOTHER REASON WHY CDC EQUIPMENT PERFORMS FROM THE INSTANT YOU TURN IT ON.

"Total" means just that. All our people, in engineering production and administration, are trained to be quality control conscious in their day-to-day operations. To this is added a complete understanding of station operation by our systems engineers, who will visit your studio if required. The result is that when your CDC equipment is installed, it just can't help fitting naturally into your station's operational environment. CDC video terminal equipment is crafted in Canada to your specifications and serviced in the United States by our own people.

CENTRAL DYNAMICS CORPORATION

HEAD OFFICE: 903 Main Street, Cambridge, Mass. 02139

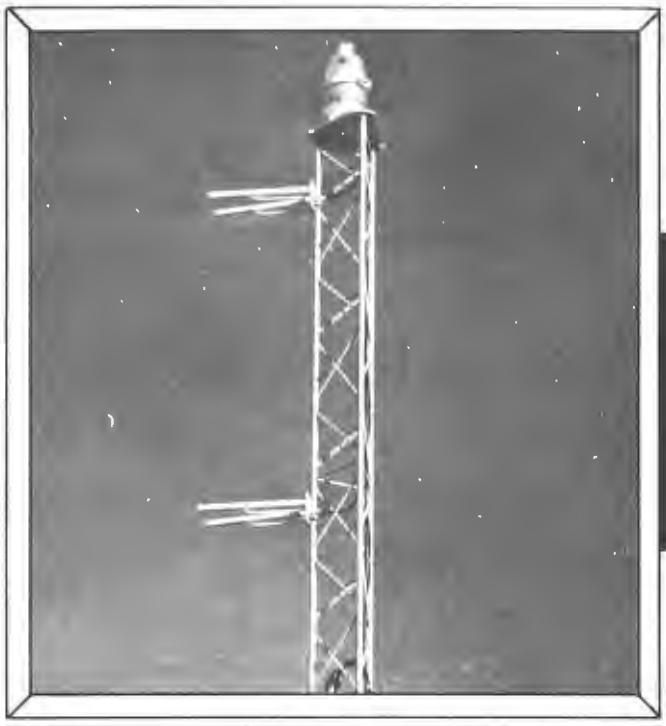
Circle Item 38 on Tech Data Card

CATV Converter

(111)

For CATV systems whose customers encounter ghosting problems between a strong local broadcast signal and the cable transmission on the same channel, **Standard-Kollsman Industries Inc.** has introduced a new converter unit. The equipment converts the incoming cable signal to 40MHz and then to channel 12 (other output channels optional).

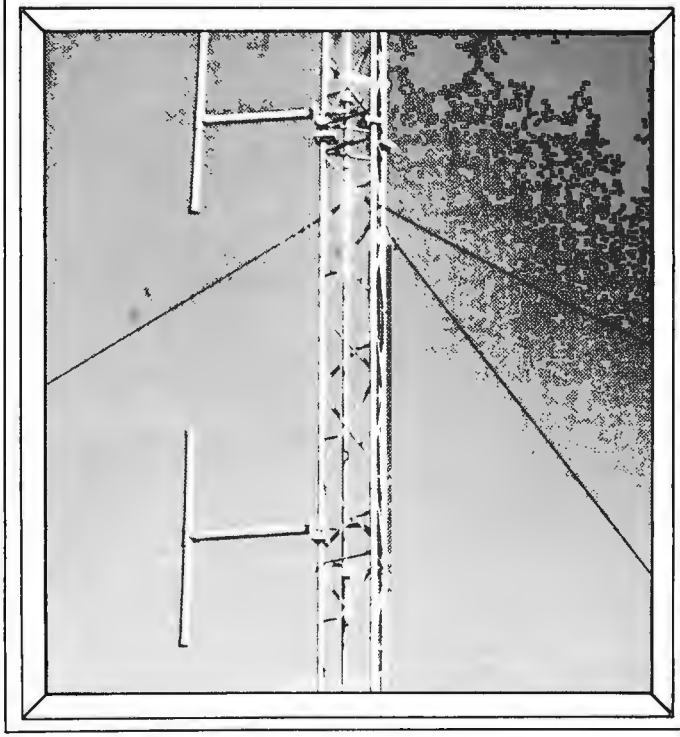
Features and specifications of the unit include: input frequencies, channels 2 through 13; gain, 15dB on channels 2-6 and 10dB on channels 7-13; bandwidth, 6.0 MHz, with adjacent-channel carriers down 10dB minimum; noise figure, 10dB maximum; input and output impedance 75 ohms; input VSWR, 2:1 maximum; output VSWR 1.5:1 maximum; cross modulation, down 55dB. A zener



ANNOUNCING A MAJOR PRICE

BREAKTHROUGH

ON DUAL POLARIZED FM ANTENNAS



Expanded production facilities and increased volume capacity at our factory mean superior JAMPRO quality antennas can now be furnished at these new low prices. Save up to 42% on your FM antenna. Call Jampro today.

PRICES EFFECTIVE FEBRUARY 1, 1967

JAMPRO TYPE	No. of H. Bays	No. of V. Bays	NEW PRICE
J2B/2V	2	2	$2,075.
J4B/4V	4	4	$4,150.
J6B/6V	6	6	$6,300.
J8B/8V	8	8	$8,900.
J10B/10V	10	10	$11,100.

Prices apply to antennas having equal division of power to all bays.

For a complete list of prices and specifications, write or call Jampro Antenna Co., today!

- ANTENNAS MAY BE MOUNTED BACK to BACK or INTERPOSED to CONSERVE TOWER HEIGHT
- VSWR is better than 1.1 to 1 for ± 200 KC from carrier when properly installed.
- Antenna input connections are all 3⅛" 50 ohms with EIA flanges.
- De-icers can be installed on **horizontal bays** at only $90 per bay. (250, 500, 1000 Watts)
- Prices are FOB Sacramento, Calif. and include suitable tower mounting hardware.

JAMPRO ANTENNA COMPANY

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Circle Item 41 on Tech Data Card

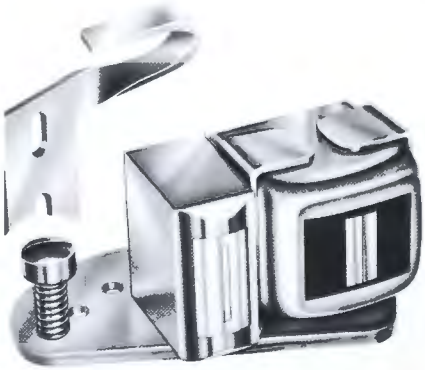
regulated power supply and fine tuning of the preset, or memory, type are used.

Overall dimensions of the unit are 11.5″ × 6″ × 3.5″. Weight is less than five pounds.

Provision has been made for the addition of a second tuner (channel selector), which may be included or added later. This combination requires a second cable, but it allows up to 24 input channels.

Indoor SCA Antenna
(112)

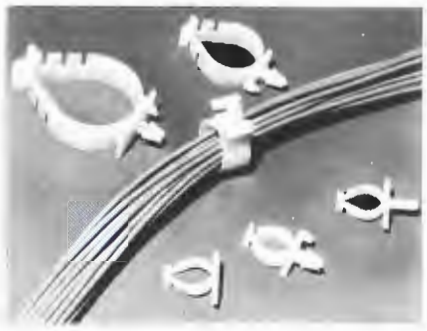
This indoor antenna, primarily for SCA operators, is available from **McMartin Industries, Inc.** The unit can also be mounted in a car. Built into the base of the A-72-PA antenna is a transistorized pre-amplifier with a 12-volt power requirement. The cylindrical antenna has a gray vinyl covering, is 22½ inches long (including the connector), and has a 1¼-inch diameter. Frequency alignment to a specified frequency (within the 88-108 MHz range) is accomplished at the factory. The antenna assembly has been designed to be mounted anywhere in a vertical, horizontal, or 45° position. The antenna has a rated gain of 8 dB. The item is shipped complete with coaxial connector and mounting bracket.



Head Conversion
(113)

A kit to convert the new monophonic Wollensak and Revere transistorized tape recorders from half-track to full-track recording is avail-

able from **Nortronics Company, Inc.** Called the WR-30, the conversion consists of a full-track erase head and a full-track record-play head mounted on a brass plate to permit full-track recording compatible with studio-type tape transports. The assembly fits the new 1500SS and 1400AV Wollensak recorders and the older T1500 models. The all-metal erase head has a double gap for complete erasure, while the record-play head has laminated cores and a fine gap for good high-frequency performance.



Routing Clamps
(114)

New clamps for temporary routing of wires or for clamping of permanent wiring have been added to

the **Thomas & Betts Co.** *Ty-Rap* line of harness fabrication products. The clamps are locked closed by means of slots which permit reopening at will without damaging the clamp. They can be locked in either of three positions to permit adjustability for varying diameters.

The clamps are fabricated of nylon and are available in four basic sizes, ½", 1", 1½", and 2" diameters. Each size has a variety of mounting configurations with or without an antirotation feature: adhesive-backed, threaded studs, push-in, push-in with antirotation feature, etc.

Crimped Solderless UHF Connectors

(115)

A line of fully crimped, solderless, UHF connectors is being marketed by **Kings Electronics Company, Inc.** Called *K-Grip Jr.*, the new units do not require hand soldering, and have been designed to increase the tensile strength of cable connections.

With these connectors, cable trimming jigs and a crimping tool are furnished. The user trims the cable jacket and dielectric, crimps the center contact, and then crimps the connector to the cable.

Engineers' TECH DATA

ANTENNAS, TOWERS, & TRANSMISSION LINES

60. ANDREW—New 128-page Catalog 25 features detailed product information and engineering data on antennas for microwave, UHF and VHF communications, and telemetry; flexible coaxial cables and elliptical waveguides; switching and pressurization equipment; and system accessories such as radomes, positioners, and telescoping mounts.
61. CCA—Literature describes the FMA-7016R circularly polarized FM antenna.
62. FT. WORTH TOWER—Material covers towers, passive reflectors, and equipment buildings.
63. GATES—Brochure is about the Dual-Cycloid FM antenna with circular polarization.

AUDIO EQUIPMENT

64. ATLAS SOUND—Catalog 566-67 lists public-address loudspeakers, microphone stands, and accessories.
65. BAUER—Model 910S eight-channel stereo console is subject of new brochure.
66. CROWN INTERNATIONAL—Sheets provide technical data and specifications for the SA30-30 60-watt rack-mounted stereo monitor-amplifier.
67. NORELCO—Brochures give description, features, and other pertinent information on professional microphones, commercial sound equipment, closed-circuit television equipment, motion-picture projectors, and color TV cameras.
68. PERMOFLUX—Subjects of brochure are monaural and bi-

Circle Item 51 on Tech Data Card

Circle Item 50 on Tech Data Card

naural headphones and dynamic microphones for headset attachment.

69. QUAM-NICHOLS—Sound sheet deals with speakers and specifications for use in public address, background music, intercom, and outdoor applications. Data on line-matching transformers is also included.
70. VEGA ELECTRONICS—Literature includes specifications and prices on all-new, high-power wireless-microphone systems and on new compressor/limiter for telephone use.

CATV EQUIPMENT

71. AEL—Technical data bulletins relate to plug-in modules developed for **Colorvue** series line amplifiers: CVT-AM automatic-gain-control module, CVT-BM bridging-amplifier module, CVT-PM DC-powering module, and CVT-TM trunk-amplifier module.
72. SIGMA INDUSTRIES—New bimonthly bulletin presents information regarding cable-plant construction using thick-wall, heat-shrinkable splice covers and other products.

COMPONENTS & MATERIALS

73. BOSTON INSULATED WIRE & CABLE—Information sheet refers to the TV-85C color television connector with 85 pins.
74. CENTRALAB—22-page catalog contains detailed information and illustrations of line of push-button switches which feature modular approach to combining elements.
75. DIALIGHT—New catalog L-204 is on the 913-Series momentary-action, push-button switches for mounting in 3/8"-clearance hole on 19/32" centers.
76. ELCO—64-page guide describes and illustrates line of printed-circuit connectors, enclosures, and installation equipment. Guide shows suggested applications, mounting data, PC-card layouts, and complete specifications.
77. STACO—Line of variable autotransformers and isolated variable transformers is pictured and described in six-page Variable Autotransformer Product Guide.
78. SWITCHCRAFT—Bulletin 166 details new series of push buttons to fit firm's Series 21000, 22000, and 15000 illuminated switches. Bulletin 169 is about a new 11/16"-square "Box Switch" (momentary-action push button) which can accommodate up to four poles of switching.
79. TROMPETER—New Catalog T6 gives information on the complete line of patching equipment, connectors, etc., in coax, twinax, and triax.
80. VITRO—Covered in four-page data sheet is the **Nems-Clarke** line of stainless-steel jacks, plugs, and jack panels.

MICROWAVE & STL EQUIPMENT

81. MICROWAVE ASSOCIATES—The MA-2A and MA-7A all-solid-state color television relay systems are illustrated and described in a new eight-page, short-form catalog.
82. MOSELEY ASSOCIATES—The Model PCL-303 5-watt, solid-state aural STL is subject of Bulletin 219.

MISCELLANEOUS

83. WALLACH—Cabinets for disc recordings, transparencies, filmstrips, and slides are covered in six-page brochure, which also includes information about the **Reelmobile** and mobile audio-visual center units mounted on wheels.

MOBILE RADIO & COMMUNICATIONS

84. MOSLEY ELECTRONICS—1967 catalog lists line of Citizens-band antennas.

RECORDING & PLAYBACK EQUIPMENT

85. AMPEX—Features, specifications, and applications are listed in brochures for the new AG-440 Series professional audio recorders, the VR-1100E and VR-1200E compact broadcast Videotape recorders, and the line of products for TV broadcast use, including Videotape recorders, cameras, and accessories.
86. AUDIO DEVICES—**Audiotape** Formula 10 all-purpose, Formula 14 low-print, Formula 15 low-noise, and Formula 17 lubricated (for cartridge use) recording tape are described in brochures.
87. AUDIO MAGNETICS—"Magnetism and the Critical Dimension" is the title of a booklet which explains magnetic tape and its manufacture.
88. DOBBS/STANFORD—The **Butoba** MT225 all-solid-state bat-

tery- or AC-powered tape recorder is detailed in spec sheet. Literature is also concerned with MB microphones and headphones.

89. MAGNASYNC/MOVIOLA CORP.—Model DR-1 solid-state displacement recorder for 16-mm, 100-mil magnetic-stripe motion-picture film is covered by data sheet.
90. VIKING/MAGNECORD—Brochures illustrate and describe the **Viking** 230 and **Magnecord** 1028-1048 audio tape recorders.

REFERENCE MATERIAL & SCHOOLS

91. CLEVELAND INSTITUTE OF ELECTRONICS—Pocket-size plastic "Electronics Data Guide" includes formulas and tables for: frequency vs. wavelength, dB, length of antennas, and color code.

TELEVISION EQUIPMENT

92. BALL BROS—Illustrations, specifications, and general description about the Mark VI-A and Mark VI-AR special effects generators are given in four-page brochure.
93. CLEVELAND ELECTRONICS—A 52-page quick-reference, step-down diecut catalog covers complete information on vidicon, **Plumbicon,** and image-orthicon deflection components. Included are photographs, specifications, technical data, and dimensional drawings.
94. COHU—3200 Series vidicon cameras, 1000 Series color television system, and Model 9830-071 color encoder are subjects of brochures.
95. COLORADO VIDEO—Data sheet tells about Model 405 scan converter which translates oscilloscope patterns to TV format with storage.
96. COLORTRAN—Kits for adding adapter and specular or diffuse intensifier to the **Cine King** or **Cine Queen** fixtures are outlined in specification sheet. Performance with boosted and non-boosted lamps is included.
97. DYNAIR—Offer is 26-page, illustrated booklet "Video Switching Techniques." Described are various methods of switching audio and vidoo signals. Numerous diagrams show typical systems.
98. INTERNATIONAL NUCLEAR—Complete line of vidoo equipment is presented in now Catalog 7A.
99. KALART—Four-page brochure "Large Screen TV Projection" and two-page information sheet show applications of **Tele-Beam** projector.
100. KAPPA NETWORKS—Essential factors which determine cost and size of delay lines, and product descriptions are featured in leaflet.
101. KLIEGL BROS.—Booklet titled "Lighting for the Plunge to Color" compares quartz iodine and incandescent lighting for color television; "Television Lighting for Quartz" and condensed catalog present lighting products.
102. TELEMATION—Brochure about the Model TSG-2000 Series television synchronizing generators includes specifications.
103. TELEVISION ZOOMAR—Literature is concerned with **Newsbreaker 400** portable color film processor for 16-mm film, **TV Colorgard** Meter designed to reduce color monitor setup time, and HTS studio equipment.
104. VITAL—Information is for Model VI-10A video distribution amplifier and Model VI-20 pulse distribution amplifier.

TEST & MEASURING EQUIPMENT

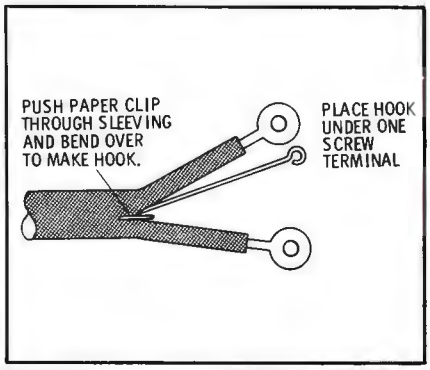
105. BARKER & WILLIAMSON—Specifications for Model 210 audio oscillator and Model 410 distortion meter are given in data sheet.
106. EICO—Firm's complete line of kits, factory wired equipment and accessories, including those for test-instrument applications is presented in new catalog. Special feature is compilation of dealers listed by state and city.
107. SECO—Offer is operating manual for new Model 107C tube tester with "constant-voltage" transformer and "eye-tube" indicator for grid-circuit test.
108. TRIPLETT—New test-equipment catalog Number 50-T is available.

Headphone-Cord Strain Relief

by R. M. Kruse, Chief Engineer
WFHR AM-FM
Wisconsin Rapids, Wis.

We were bothered by a chronic problem of headphone leads pulling open at the earphone end. Since the eye lugs used on most headphone cords are simply crimped on, any strain placed on the cord opens the connection. To solve the problem, we made a hook by straightening a paper clip. One end of the hook is placed under one of the screw terminals, and the other end is hooked through the sleeving on the cord. This arrangement absorbs the strain. If desired, the exposed end of the hook can be wrapped with tape to conceal and protect the installation.

Headphone cords now last for almost a year, compared to a week or two before this method was adopted. ▲



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

CAMBRIDGE CRYSTALS
PRECISION FREQUENCY
MEASURING SERVICE
SPECIALISTS FOR AM-FM-TV
445 Concord Ave. Phone 876-2810
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. LIPPS, INC., 1630 Euclid Street, Santa Monica, California 90404. (213) EX 3-0449. tf

CRYSTAL AND MONITOR SERVICE — Frequency change and repair service for AM monitors including G.R., RCA, Gates, W.E., and Doolittle; also H-P 335B FM. AM monitors bought and sold. What have you, what do you need? New or regrinding of AM crystals for RCA, Gates, Bliley, W.E., and J-K oven holders, repairs, etc. Fastest service, reasonable prices. Over 25 years in this business. Eidson Electronic Co., Box 96, Temple, Texas 76501, Phone 817 773-3901. 2-67-tf

VIDEO TAPE RECORDER
AUDIO HEAD ASSEMBLY SERVICE
Precision relapping of all heads and supporting posts, including cleaning and testing. Ampex head assembly with "cue" tracks, $75.00 complete. RCA units also relapped. One to two day service. LIPPS, INC., 1630 Euclid St., Santa Monica, Calif. 90404. (213) EX 3-0449. tf

Kits serviced, shipped. Professional, reasonable. Also small broadcast rack and table units, carts, tuners, limiters. Write: 109 Pinetree, Woodbridge, Va. 1-67-tf

Servicing arranged by mail on anything electronic. Flat fee. You know the cost before you ship. Work prepaid before returned precisely repaired to factory specifications $30 average, $20 handling on all callbacks. VTVM's SWL receivers, CB sets, cc License Limiters, Monitors, Stereo, meters, Test equipment. Busy? Why waste dollars on trips to "quickie shops." Can do! Ship! To: Mailtronics, 109 Pinetree Woodbridge, Va. 5-67-tf

Classified

Advertising rates in the Classified Section are fifteen cents per word. Minimum charge is $2.00. Blind box number is 50 cents extra.

EQUIPMENT FOR SALE

CO-AXIAL CABLE Heliax, Styroflex, Spiroline, etc. Also rigid and RG types in stock. New material. Write for list. Sierra-Western Electric Co., Willow and 24th Streets, Oakland, Calif. Phone 415 832-3527 5-66-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

Trimm 504 Audio Patch cords $4.00. Audio jack panels for 19" racks, 10 pair $8.95. Repeat coils 500-500 ohm flat to 20kc $4.00 —Relay racks and equipment cabinets. Write for list. Gulf Electro Sales, Inc., 7031 Burkett, Houston, Texas. 1-66-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

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

RADIO AND TELEVISION STATIONS for sale in all parts of United States. Qualified buyers may receive further details by writing to Inter-Media Communications Corporation, 246 Fifth Avenue, New York, New York 10001. 1-67-12t

G. E. Phono cartridges for broadcast use. Prompt service. Send for price list. Ridge Audio Co., 91 E. Lake Rd., Skaneateles, N.Y. 13152. 2-67-tf

New Spotmaster cartridge equipment, ORK turntables, all models available, will take in any trade regardless age or condition. Audiovox, 4310 S. W. 75 Ave., Miami, Fla. 3-67-tf

CARTRIDGE TAPE EQUIPMENT
Completely reconditioned and guaranteed. Spotmaster Model 500 Record Playbacks, $350.00. Model 505 Playbacks $250.00. 30-day money-back guarantee on all equipment.
BROADCAST PRODUCTS COMPANY
18804 Woodway Drive, Derwood, Maryland, 20855
(301) 942-1224 3-67 12t

T-shaped Broadcast Console, Collins 808-A Remote Console, 2 A.T.C. Playbacks, 1 Recording Amplifier, Meades. 10800 Dale St., Space 715, Stanton, Calif. 3-67-5t

FOR SALE: Large assortment tube type television equipment, cameras, switchers, sync generators, stab amplifiers, power supplies, monitors, etc. Cox Broadcasting Corporation, 1601 West Peachtree Street, N. E., Atlanta, Georgia. 1-67-tf

"AUDIO EQUIPMENT — Whatever your needs, check us first. New and used Ampex Altec, AKG, EV, Fairchild, Neumann, Langevin, Rek-O-Kut, Uher, Viking. Send for equipment list." Audio Distributors, Inc., 2312 S. Division Ave., Grand Rapids, Michigan 49507 6-66-tf

HAMMARLUND FM50A (141-174 MC), 35 watts, 6/12/110 transistorized power supply, 10 units, purchased less than 12 years ago at $600 each; $240. ARC VANGUARD (141-174), 50 watts, 12v, w/decode all transistorized except transmitter, 2 units, less than 1 year old. Original cost $1000 each, $495. All equipment top condition w/accessories. INTERNATIONAL DIVERSIFICATION, 1013 Glenside Place, University City, Missouri 63130 314 991-1911. 5-67-tf

Two modified RCA TK-10A Color Camera Chains in working condition. Exceptional value. Immediate delivery. Write P. O. Box 18151, Tampa, Florida, 33609, or phone area 813, 253-0447, Tampa. 5-67-2t

One KW Collins transmitter. Extra parts D. C. Stephens, Manager WPRT Radio Station, Prestonsburg, Ky. 41653. 5-67-tf

"Arcturus" Catalog
A Trusted Name in Electronics Since 1925
FREE Catalog. Electronic parts, tubes. Wholesale. Thousands of items. Unbeatable prices.
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502-22 street, Union City, N. J. 07087

EQUIPMENT WANTED

We need used 250, 500, 5K & 10K Watts AM Transmitters. No Junk. Broadcast Equipment and Supply Co. 1314 Iturbide St., Laredo, Texas 78040. 3-66-tf

EMPLOYMENT

Need general maintenance technician with first phone and some experience in broadcasting. Salary commensurate with radio and television maintenance experience. Send resume and phone number to George Wussow, KHSL-TV, P.O. Box 489, Chico, California 95926. 1-67-3t

VIDEO CIRCUIT DESIGN ENGINEER . . . Leader in audio, video, and instrumentation recording engineering seeks Video Engineer with BSEE or equivalent. Some TV station background desirable. Smog-free location in one of So. Calif.'s garden spots just 45 min. north of L.A. Send resume: Employment Mgr., Revere-Mincom Div., 3M Company, 300 So. Lewis Rd., Camarillo, Calif. 93010. 5-67-tf

MICROWAVE RELAY TECHNICIANS: Immediate and future openings at all experience levels with fastest growing Microwave Common Carrier in U.S. First or second class FCC radiotelephone license required. Prefer men with microwave and video experience but will consider other related background. Work in New York and Pennsylvania. Good pay, terrific growth opportunities. Reply to: John Murray or Alan Burgess, Eastern Microwave, Inc., WSYR-TV, 1030 James St., Syracuse, N.Y. 13203. 4-67-2t

(Help Wanted—Television—Technical) Established group-owned TV station in the Southeast has opening for video operator with first class license and potential for growing into administrative duties assisting the Chief Engineer. This is a position with an aggressive fast-growing company and has excellent possibilities. Send resume to Dept 174, Broadcast Engineering. 4-67-2t

"First Class engineers, maintenance background, no board work. Immediate openings. Excellent growth opportunity with independent group. Rush reply by letter to C. Dingmen, WCTC, 385 George St., New Brunswick, N. J." 5-67-2t

RCA

BURBANK, CALIF.

has an exceptional challenge for a

PROJECT LEADER

Color TV Camera

This is a ground floor opportunity to enhance your career by joining our select team of engineers in the development of TV systems for the Instructional Electronics field. If you have experience as a Project Leader in the development of color TV cameras and associated equipment and a MSEE or equivalent, this position offers unusual professional growth potential.

RCA in Burbank is an engineering oriented organization. Big enough so there's room to grow. Not so big that you'll get lost in the shuffle. Yet backed by all the resources of one of the nation's largest electronics companies. We offer liberal fringe benefits including relocation allowances. To inquire, send your resume to: Mr. Glen Seltzer, RCA Broadcast & Communications Products Division, 2700 W. Olive Ave., Burbank, Calif.

An Equal Opportunity Employer

The Most Trusted Name in Electronics

SYSTEMS ENGINEERS

VIDEO SWITCHING SYSTEMS

Our rapidly expanding volume of business has created openings for systems engineers familiar with vertical interval switching equipment. Responsibilities include provision of wiring information on rack and control panel equipment for custom switchers. Some station experience and familiarity with audio preferred. Please send resume of experience or call Mr. R. J. Rainey, 201-382-3700.

WARD ELECTRONIC INDUSTRIES
142 Central Ave.
Clark, N. J. 07066

5-67-1t

CATV FIELD ENGINEERS

A well-known manufacturer and designer of CATV equipment, builder of turnkey systems, and systems owner has several career openings for qualified field engineers and technicians. Please forward a resume of your background and experience, including salary requirements. All contacts will be confidential. Our employees have been informed of this advertisement. Box 175, Broadcast Engineering. 5-67-1t

Job Headquarters for all Radio and Television Engineers. Immediate openings exist in 9 western states and elsewhere for qualified engineer and technical personnel. All categories from trainees to experienced transmitter maintenance, chief, assistant chief, live color video maintenance and technical operations. Send us your complete resume now. The AMPS Agency, 3974 Wilshire Blvd., Los Angeles, California 90005. Telephone DU 8-3116.
By Broadcasters—For Broadcasters 11-66-tf

TELEVISION ENGINEERS

We are interested in contacting Station Engineers capable of design or field engineering. Excellent opportunities in TV Development Engineering and Systems Engineering with Sarkes Tarzian, Inc., Broadcast Equipment Division.

TV station engineering experience required, BSEE or equivalent desirable. Send resume of experience, or call, Mr. Biagio Presti, Broadcast Equipment Division, Sarkes Tarzian, Inc., Bloomington, Indiana, Area Code 812, 332-7251.

Symbol of Excellence in Electronics

International Assignment

International Television Organization needing qualified engineers for challenging position in Far East. Minimum of 5 years maintenance experience in such positions as Chief Transmitter, Mobile Van and Studio Engineer.

Job requires separation from dependents; however, periodic home leave included as condition of contract.

Salary and allowances commensurate with position.

BOX 176
BROADCAST ENGINEERING

PERSONNEL

College student, 21, accounting major, seeks summer employment. Available June 9. Third-endorsed ticket. Experience w/NBC owned and operated, and others. Henry Navin, 9325 Beacon Avenue, Cleveland, Ohio. 5-67-1t

Advertisers' Index

your television ation owned one our TS2 eather Satellite Signal nexpensive equipment, nore than just talk

This ingenious engineering feat makes satellite weather pictures available to any television station. The basic equipment needed is sheer simplicity (our TS2, a Yagi antenna, an FM Radio receiver, a 5" oscilloscope and a polaroid camera).

The system (we furnish diagrams and specifications free) can give your station instant pictures of weather for a 1000 mile square. It can put muscle into the ordinary flabby job of forecasting or reporting weather.

Don't just talk about the weather at your station. Do something. Write for complete information about our TS2 — another example of the results of International Nuclear's search for a better way to do a better job . . . in electronics.

Write or wire or phone collect
Ray Weiland, President
INTERNATIONAL NUCLEAR CORPORATION
608 Norris Avenue
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"Transistorizing the Television Industry"

Circle Item 57 on Tech Data Card

MAY, 1967

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148	149	150	151	152	153	154	155	156	157	158	159	160	161	162

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- ☐☐ FM Radio Station
- ☐☐ Television Station
- ☐☐ Network
- ☐☐ Consulting Engineer
- ☐☐ Manufacturer or Distributor
- ☐☐ Recording Studio
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"First Class engineers, maintenance background, no board work. Immediate openings. Excellent growth opportunity with independent group. Rush reply by letter to C. Dingmen, WCTC, 385 George St., New Brunswick, N. J." 5-67-2t

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142 Central Ave.
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5-67-1t

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NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

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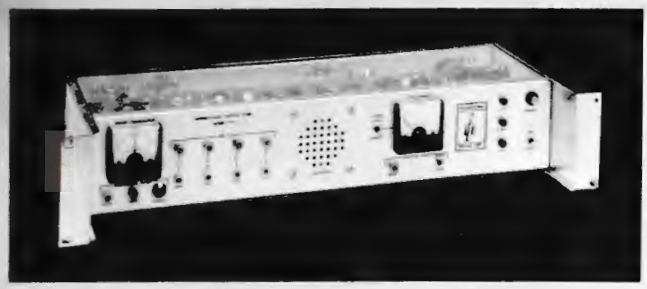
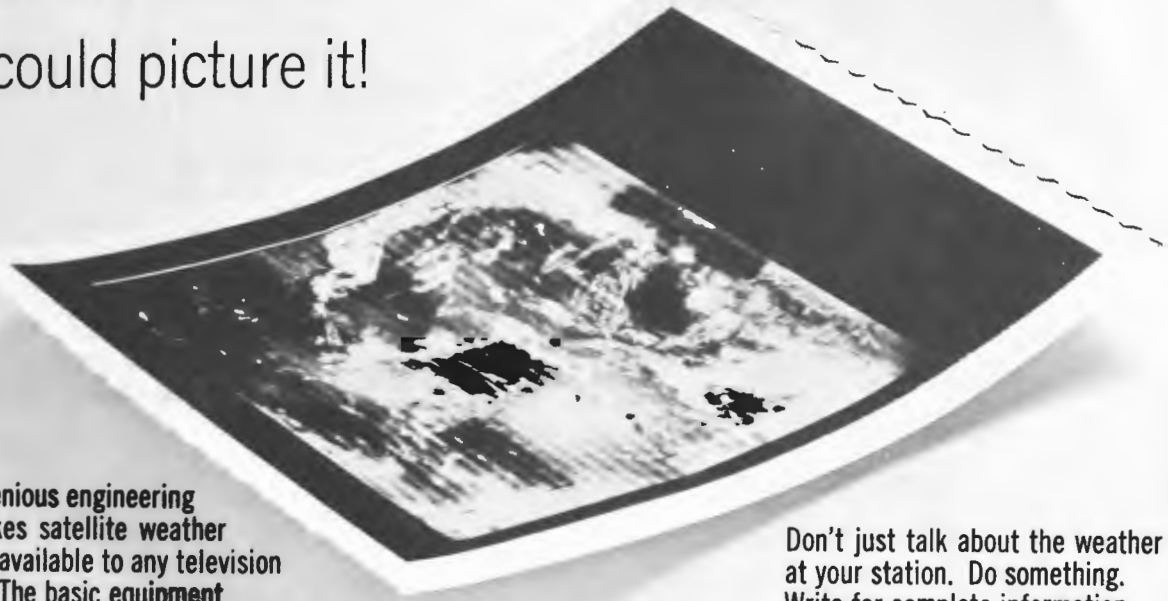
ENGINEERS' TECH DATA DEPT.



If your television station owned one of our TS2 Weather Satellite Signal Processors and some other inexpensive equipment, your weatherman could do more than just talk about the weather...

He could picture it!



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Write or wire or phone collect
Ray Weiland, President
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608 Norris Avenue
Nashville, Tennessee
615 254 3365

INTERNATIONAL
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NUCLEAR CORP.

Transistorizing the Television Industry"

Circle Item 57 on Tech Data Card