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Broadcast Engineering

the technical journal of the broadcast-communication's industry

A HOWARD W. SAMS PUBLICATION

Planning the processor Installation page 24

Equalizing phone lines

Noise in cable systems

South Carolina ETV

October, 1969 • Volume 11, No. 10

Broadcast Engineering

The technical journal of the broadcast-communications industry

in this issue...

ABOUT THE COVER

Installing a color film processor is no easy task. But more than anything else, it calls for in-depth planning on the part of the technical staff. The article on page 24 describes some of what KID-TV learned in solving their installation problems.

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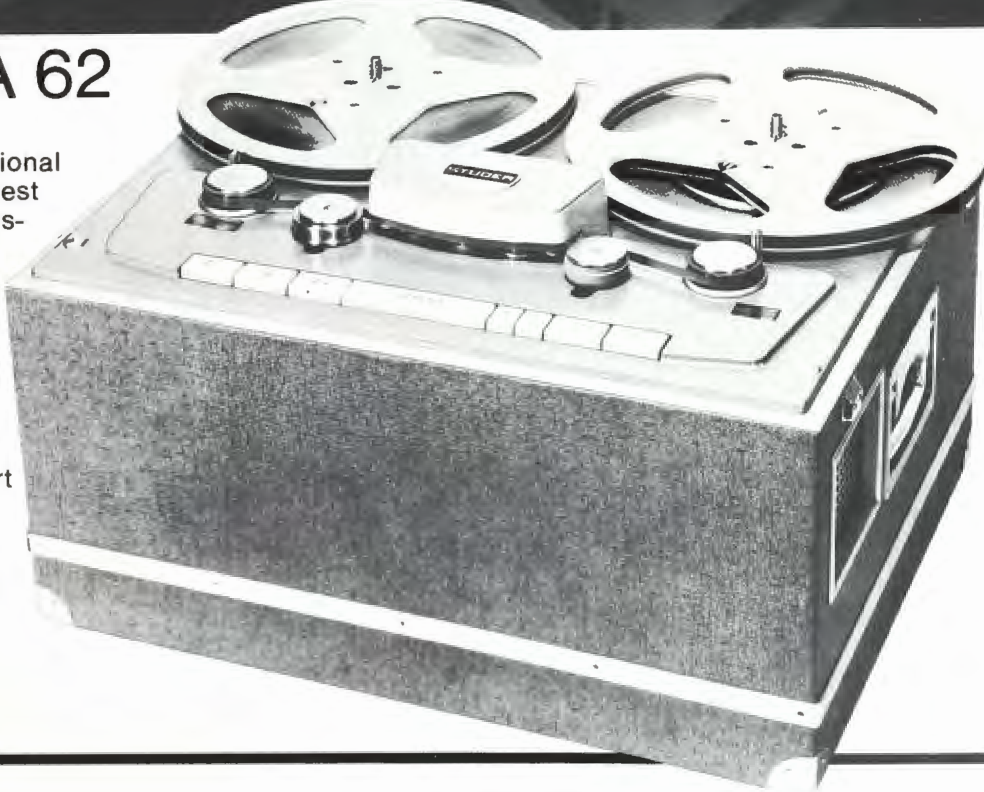
STUDER A 62



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DIRECT CURRENT FROM D.C.

October, 1969

By Howard T. Head

Land Mobile Pot Boiling

The Standard Research Institute has completed its studies under an FCC research contract and has reported its findings concerning frequency congestion and possible relief for the land mobile radio services. Land mobile radio users complain of increasing congestion and have asked that the Commission reallocate television frequency bands.

SRI conducted actual off-the-air monitoring in New York, Detroit and Los Angeles. This monitoring indicated that although some land mobile channels were heavily used and undoubtedly congested, many others were very lightly used. The conclusion from these findings is that any primary relief should come from a better utilization of land mobile channels already available rather than allocation of additional frequencies.

There will shortly be forwarded to the Commission the work of an Industry-Government Committee set up to establish the feasibility of sharing VHF television channels with the land mobile radio services. Field tests conducted by this Committee found interference to adjacent channel VHF television stations to be generally as predicted. Co-channel interference; however, for reasons not satisfactorily explained, was considerably less than expected.

In the meantime, the Commission has expanded land mobile use of the 72-76 MHz guard band between channels 4 and 5. Grants have been made in several cities for the use of one-way signaling for fire and highway call boxes in this frequency band without regard to interference to television reception and the Commission has proposed to authorize future such grants on a regular basis.

Additional Pre-Sunrise Authorizations a Step Closer

As reported in last month's Direct Current, action by the Mexican Legislature in the near future is expected to clear the way for pre-sunrise operation by some 200 daytime-only stations in the U.S. operating on Mexican clear channels. Pending ratification of the new treaty by the Mexican Legislature, however, the Commission is not yet accepting applications for pre-sunrise service authority.

When such applications are accepted they will be required to conform with the requirements of the treaty, which require protection of the Mexican Class I-A clear channel stations. A little-noticed provision of the treaty, however, eases these protection requirements in many instances where the Mexican station's skywave service area (0.5 mv/m 50% skywave)

(Continued on page 6)

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(Continued from page 4)

extends into the U.S. or into water areas. In those cases, the U.S. daytime-only station will be permitted sufficient power to lay down a 10% skywave of 50 uv/m at the Mexican border compared with the usual requirement of only 25 uv/m.

In a case involving a Canadian clear channel, the Commission has declined to authorize pre-sunrise operation, pointing out that our pre-sunrise agreement with Canada specifically prohibits any pre-sunrise operation on the Canadian Class I-A clear channels.

CATV Retransmission Consent Test Authorized

The Commission has authorized a CATV system in Owensboro, Kentucky, to test the feasibility of the Commission's new Rules which would require the consent of "distant" television stations for the carriage of their programs on CATV systems. Although the Commission recognized that Owensboro is not an ideal market in which to conduct such tests, the Commission hopes to obtain some insight into the problems presented.

Even in its original proposal, the CATV system ran into substantial difficulties. One television station involved indicated that 16 separate syndicators would have to give their own consent to the carriage of their programs and in the case of another television station, 17 syndicators were involved. Other than these syndicated programs, the stations had right to only a few local programs.

Short Circuits

The Commission is reported to be ready to adopt Technical Standards for Pay-TV . . . An educational FM station in Michigan is experimenting with the transmission of still pictures on a multiplex subcarrier (whatever happened to facsimile?) . . . The Commission has cancelled seven long-dormant UHF television construction permits . . . Regular authorization for the remote control of VHF television transmitters is expected shortly . . . Comments generally supported the Commissions proposal to require the type approval of AM phase monitors; most persons commenting generally favored relaxed phase and current ratio tolerances on directional antennas . . . The Commission has authorized a new common carrier microwave system between Chicago and St. Louis to compete with the Bell System and other common carriers over this route . . . The Commission has proposed to permit CB licensees to communicate with broadcast stations in order to report highway conditions; on-air rebroadcasting of these transmissions is still forbidden by the rules, however.

Howard T. Head

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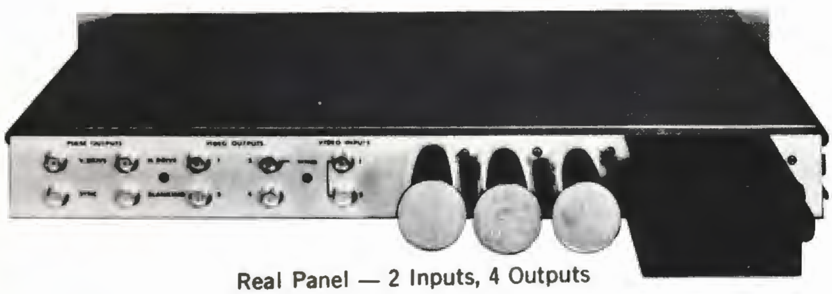

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LETTERS TO THE EDITOR

Selecting Emergency Power Generators

Dear Editor,

Please allow me to comment on Loren Mages' interesting article, "Selecting Standby Generators" in your August, 1969 issue.

Based on our experience with various gasoline and diesel generator sets up to 250 KW, we find the modern diesel will start consistently quicker than gasoline-fueled engines. One reason is that the diesel engine, if installed correctly, will have fuel in its fuel system at all times. Fuel is immediately injected to the combustion chambers as the engine is cranked.

The gasoline-fueled engine is normally equipped with a float-type carburetor. Gasoline in the float chamber evaporates when the engine is not in use. Unless some means is provided to keep this float chamber filled during periods of non-use, the first few seconds of cranking will elapse while the carburetor is being filled with fuel.

A good electric fuel pump can insure quicker starts on a gasoline engine. The electric fuel pump can be timed to operate for one minute each day to keep the float chamber topped off.

Gasoline engines designed for "regular" grade gasoline will operate better on 80/87 aviation gasoline. This will result in less spark plug deposits and no varnish buildup in the fuel system. The fuel mixture control should be readjusted with a load on the engine if the change is made to aviation fuel.

Standby generator engines should be kept warm (90° to 100° F) to insure fast starts and to minimize wear.

When the generator is to be used for television, careful attention must be paid to the frequency. There are available, excellent hydraulic-type governors. The governor should be equipped with a remote vernier control, or better yet, automatic means should be provided to keep the frequency in step with the vertical sync.

Here at the KVOS transmitter plant, where we have come to expect power outages, the standby diesel delivers power to the load five to six seconds after a power failure has occurred.

We enjoy your magazine.

Erling Manley
Transmitter Supervisor
KVOS-TV
Eastsound, Wash.

Dear Editor,

Please accept the thanks of my colleagues and I in the broadcast engineering field for the many excellent articles you print. In your August '69 issue, you have a very good example in "Selecting Standby Generators" by Loren Mages.

Mr. Mages states in the article that most radio engineers have a tendency to go overboard when it comes to voltage and frequency regulation and also states that most commercial units have a regulation of 5% or better and three Hz or better from no load to full load.

While the above may be adequate for a radio station, I do not believe it is adequate for television, especially a maximum power, high band, VHF transmitter which may vary its load as much as 40 KW from a white to a black picture or fadeout. Also, frequency requirements must be very stringent, otherwise hum bars will be very noticeable. Generator frequency in this case is usually either auto or manual controlled to match vertical sync.

I realize that this article is more slanted towards a small radio station, but basically the same general principles apply to the 200 KVA, 480 volt units necessary to run a high power television transmitter.

Robert E. L'Roy
Transmitter Supervisor
KLRN-TV

Editor's Note: Robert L'Roy has a good point when he underscores the author's comment that engineers go overboard when it comes to voltage

(Continued on page 10)

Stereo on location: Only 24 lbs. 11 oz.

Lightweight. A full 7-inch reel capacity studio professional tape deck. Pick it up and take it anywhere or use it in your studio. Operates on a self-enclosed rechargeable nickel-cadmium battery pack—or plugged into AC.

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(Continued from page 8)

and frequency regulation. Hum bars can appear. The frequency must be aligned with vertical sync. And he also is correct in that 5% load regulation leaves something to be desired when the generator is in a high power station. In a television transmitter room, the panel meters may look like those of an MCW transmitter. Obviously, the picture would suffer.

Selecting a standby generator can have more than economic implications. You must consider what is available and superimpose this on individual needs. One station in the path of hurricane Camille used an underground gas storage tank. Inundated by water, the tank took on water and pumped it into the cylinder where the mixture cracked a piston.

What's available during a disaster? Natural gas? Could be, unless the underground pipes break. High octane gasoline? For extended periods of operation this could be a problem because disaster areas report that gasoline becomes hard to find. Then too, local ordinances may prohibit above and underground storage.

Chroma Keyer Parts List

The following is a parts list for Robert Blauvelt's chroma keyer that appeared in the August issue of BE. Also, note that the PC board layout, R37 is connected between ground and pin 10 of IC #2. On the same IC, R39 is connected to pin 5 and goes to a +6 volt line. In IC #5, R 28 is connected across pins 7 and 10. For further information on alignment, contact Bob direct at KKTV, Colorado Springs, Colo.

All capacitors are 100 uf/15 Volt electrolytics unless otherwise marked.

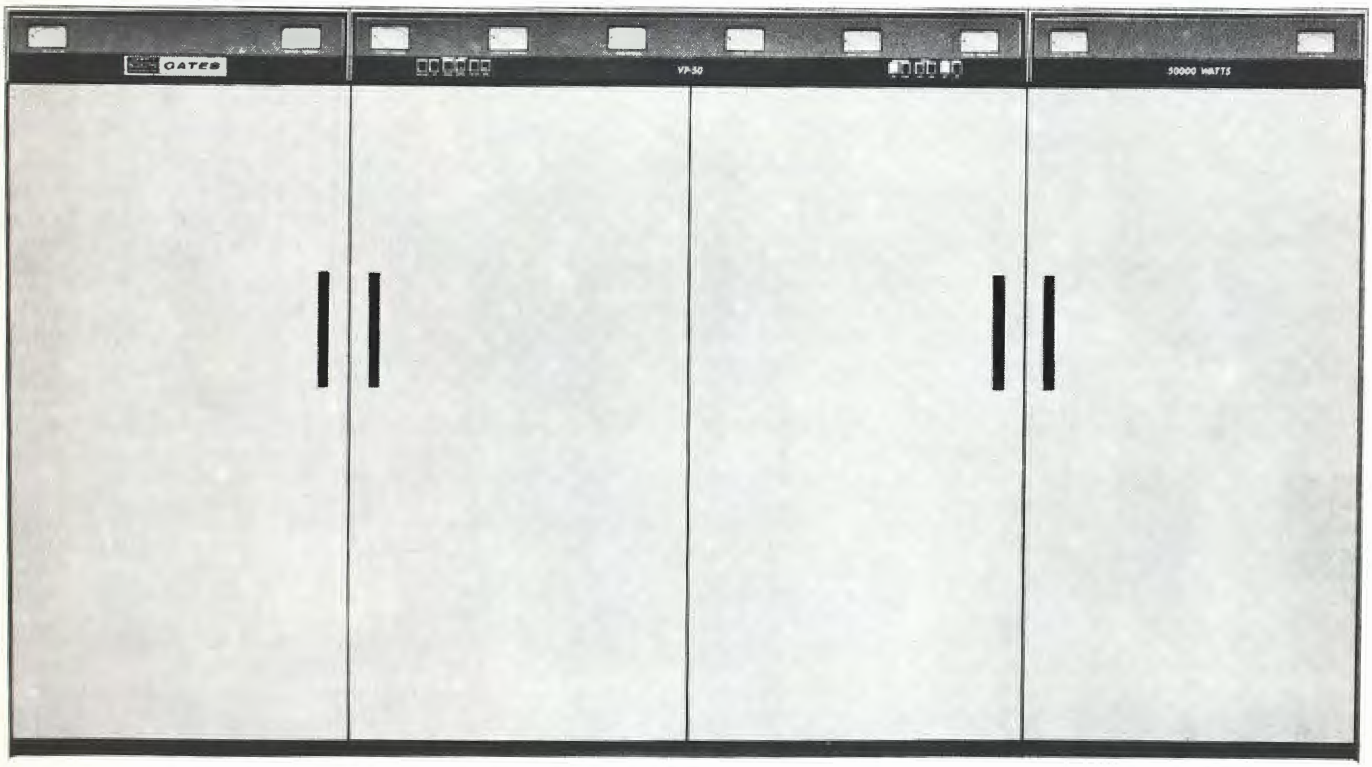
I.C. 1 & I.C. 2—RCA CA 3036
I.C. 3—RCA CA 3005
I.C. 4 & I.C. 6—RCA CA 3018
I.C. 5—RCA CA 3001

Resistors—All are 5%, ¼ watt unless otherwise specified.

*R-1	2.7 K
R-2	2.7 K
R-3	39 Ohms
R-4	3.3 K
R-5	3.3 K
R-6	1 K
R-7	1 K
R-8	250 Ohms
R-9	680 Ohms
R-10	250 Ohms
R-11	680 Ohms
R-12	5 K POT, 2W- AB type
R-13	2.7 K
R-14	680 Ohms
R-15	680 Ohms
R-16	680 Ohms
R-17	500 Ohm POT, 2W- AB type
R-18	680 Ohms
R-19	4.7 K
R-20	5 K POT, 2W- AB type
R-21	120 K
R-22	120 K
R-23	10 K
R-24	39 Ohms
R-25	30 Ohms
R-26	2.2 K
R-27	4.7 K
R-28	1 K
R-29	680 Ohms
*R-30	2.5 K Miniature POT
R-31	75 Ohms
R-32	75 Ohms
*R-33	2.5 K Miniature POT
R-34	2.8 K
R-35	1 K
R-36	3 K

(Continued on page 71)

First in its class... a vapor-cooled, high-efficiency 50,000-watt AM transmitter by Gates



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A Special Report On Hurricane Camille

Broadcasters across the nation shudder at the sight of inundated station facilities and twisted transmitting towers dotting the gulf port area after hurricane Camille died.

Storms of this nature are nothing new to the area, but there was something special about Camille. It pointed out once and for all that operating at ground level increases the potential for a broadcast station disaster.

The following information on Camille and its effects on radio and television in the disaster area was sent to Broadcast Engineering by Sam Schmid, chief engineer at WSHO in New Orleans, La.

"Camille, a killer hurricane, slashing first at the Southeastern edge of Louisiana, shrieked into the Mississippi Gulf Coast the night of August 17. What was able to survive the 200 mile per hour winds was enveloped by the 20 foot tidal wave which followed.

Fig. 1 Shown here is the WGCM tower after it toppled into one of the station buildings. BE will continue its coverage of emergency broadcasting in the November issue.

"At Biloxi the WLOX radio and TV studio was one of the wave's casualties. The station was able to get back on the air with a mobile van sent over by WWL-TV in New Orleans. Between Gulfport and Biloxi, WVMI suffered the loss of all utilities at its Edgewater Gulf Hotel studios. WVMI general manager George Egeditch mobilized his staff to get back on the air.

"Through the cooperation of the Broadwater Beach Hotel and its manager W. T. Dorsett, the station was able to set up an emergency broadcast studio. WVMI was able to get back on the air from the Broadwater Beach with a remote pickup unit sending the program to its main transmitter. At the transmitter site, all but 80 feet of the 340-foot tower was clipped away by the fury of Camille. The station operated on emergency power for five days. WVMI transmitted the first live radio broadcasts out of the disaster area to WSHO in New Orleans.

"Here in New Orleans our advance preparations included natural-gas and gasoline generators, studio to transmitter radio link, battery operated studio equipment, two VHF equipped mobile units and radio monitors for weather bureau, police, amateur radio and CB. Our Civil Defense staffed a complete communications center with radio links to police, amateur, CB and all utilities.

"In the early morning hours following Camille, Civil Defense and police began assessment of damages. From the eastern edge of New Orleans to Biloxi, Mississippi the picture was the same: Thousands of homes destroyed, tens of thousands damaged, power and telephone lines down, roadways washed out or clogged with debris and the additional hazard of ruptured gas and water lines.

"As daylight approached the grim task of counting the dead would begin. The first weak radio signals from the disaster area started to come in from those dedicated amateur radio operators who risked their lives with their life-saving radios. Many amateurs and Gulf Coast broadcasters lost all possessions to the storm: homes, furnishings, clothing and cars. Those we spoke to were thankful for their lives and those of their loved ones. WVMI's Ron Manning was especially thankful—his Mother flew him in a new pair of shoes(Ron and his family survived the storm with only the clothing on their backs).

"Our first communications out of the isolated areas advised of the urgent needs; doctors, nurses and technicians, medical supplies, drinking water, canned foods, generators and fuel. First supplies to the disaster area moved with New Orleans police and firemen. With the firemen went a WSHO generator to the Bay St. Louis Hospital. Listener response to our broadcast appeals was immediate.

"Through the cooperation of Pontchartrain Beach Amusement Park we were able to use their facilities as a collection point for food. Five truckloads of food departed for the stricken areas in one afternoon. A few days later the amusement park's manager, Harry Batt Jr., turned over a day's receipts to the Hurricane Disaster Fund. New Orleans mayor Victor H. Schiro organized an airlift to Biloxi and dispatched the police communications van to Gulfport.

The broadcasters, amateur radio and Citizens Band operators met the challenge of a major disaster. Every broadcaster is a potential victim of a natural or man-made disaster, Schmid concluded. Are you ready to meet the challenge?"

Little can be done to save the transmitting towers, even if the stations use remote transmitter sites. Nevertheless, something can be done about emergency power generating plants and studio facilities. And what can be done to save a station from a hurricane might also help save inland stations from tornados, heavy storms and other natural disasters. "It can't happen here" is a dangerous assumption.

Generator Location

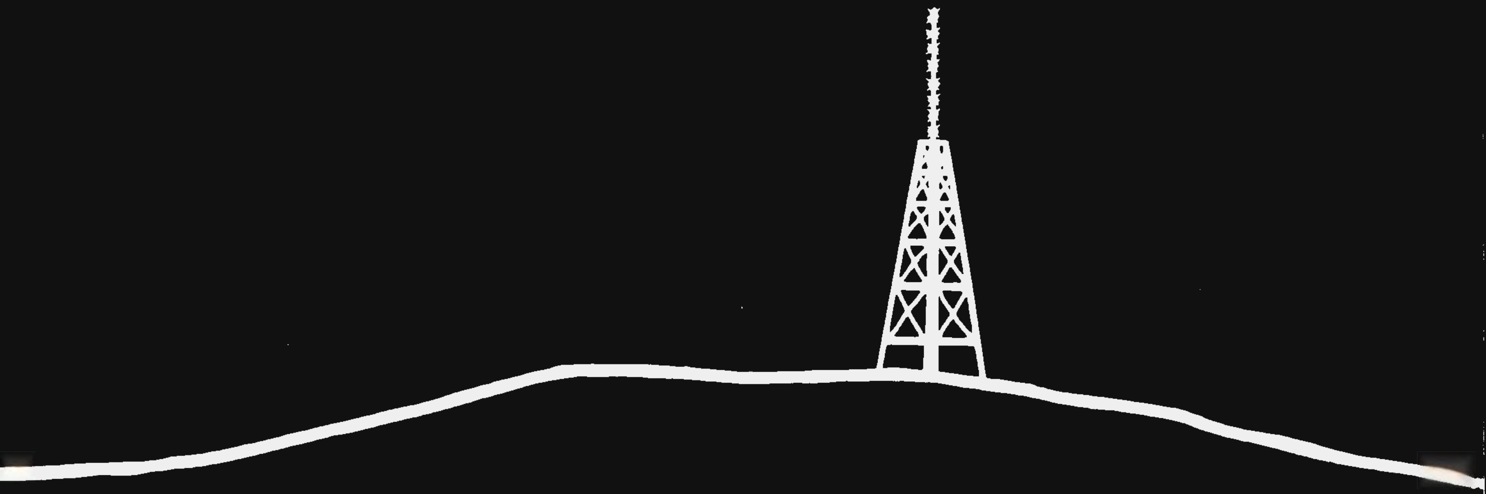
The best generator money can buy won't provide one minute of public service if it is so located that it can be covered by water along with groundfloor studios. Even if the generator is placed on a slab of concrete a few feet above the ground, the margin of emergency operation is still slight.

Generators located in basements are of dubious value, even if sump pumps are carefully deployed. Second floor generator locations, if they are in buildings of adequate construction, do offer a distinct advantage. This is especially true if the generator is mounted on a raised platform.

Obviously, many stations may not be able to find buildings where they could install a generator on the second floor . . . for many stations use a one-floor facility at ground level. This should be a consideration for those planning a new station building program and for those contemplating a move to improved facilities.

Location of the generator fuel supply is just as important. One station was back on the air shortly after the hurricane hit, but not for long. An underground fuel storage system had been installed. When the high water came, water seeped into the storage tank. When the diluted gas was pumped into the generator engine, the mixture cracked a piston. Moments later they were off the air.

There are no easy ways out. Lo-



Varian klystrons hold back the cost of doing business.

You might say that UHF TV klystrons from Varian cost about a buck an hour. Although Varian warrants its UHF TV klystrons for 5,000 hours video, their average operating life is 8 - 9,000 hours . . . at an average cost of about $9,000 per tube. If that's not a bargain, think of the UHF stations that get 20,000 hours per tube, or the one in Texas that's logged over 30,000 operating hours on one tube.

It's a fact that since the first commercial UHF TV station went on the air back in the '50's, Varian has more than doubled the operating life of UHF TV klystrons. And the price hasn't changed much since then. No wonder over 90% of the stations use Varian tubes.

You can get all the figures on Varian klystrons from any one of the more than 30 Electron Tube and Device Group Sales Offices around the world. Or write the Palo Alto Tube Division, 611 Hansen Way, Palo Alto, California 94303.

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Fig. 2 Storms usually prevail from one direction. Locate the fuel tank on the opposite side of the building to provide protection.

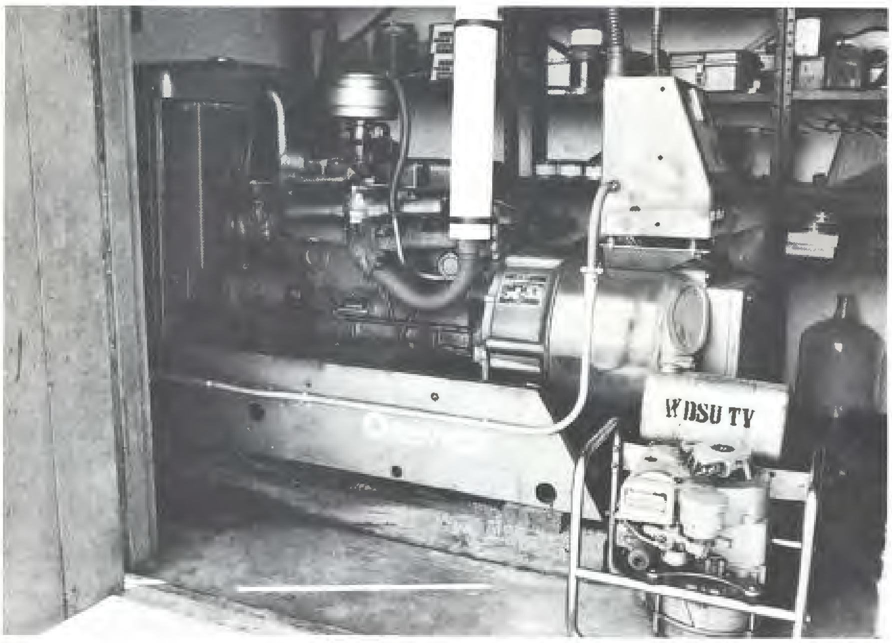

Fig. 3 When all power lines are down, the addition of a portable generator can be especially important.

cal ordinances may restrict the storage tank location to ground level slab mounted tanks. Or the tanks may rest on raised platforms. The best hope might be an inside raised tank; but, again, some ordinance may prohibit such an installation on any floor of a building. Waivers or special permits may be able to overcome ordinances if the station presents its public service during emergencies argument to local government officials.

Outside Communications

When power and telephone lines go down, as they all did during Camille, how do you communicate with the public to inform them and with the local and federal agencies to relay information?

Without some remote transmitting equipment at their disposal, all the reporters and other station personnel pressed into field service will be of little use to a station that does manage to stay on the air or to make it back on the air after putting up a long wire antenna.

During a disaster, the public service function of a broadcast station becomes paramount. With the entertainment aspect deleted, the station should function as a central information communications media. For although amateur radio, CB, and agency communications have served meritoriously during disasters, they do not operate on frequencies available to the general public. A standard broadcast station off the air during a disaster represents a missing link in the vital local emergency broadcast plan.

This magazine does not propose to answer all the questions that work their way to the top during a disaster. However, it does seem fair to call for a plan of action that possibly will help circumvent a communications blackout.

The city plan for coordinated station operations will be covered in the following issue, with the hope that the IEEE, NAB, NAFMB, NAEB and state associations will in the near future place on their programs at meetings and conventions the two basic problems washed up by Camille: (1) the need for a coordinated total communications plan for metropolitan and smaller city areas and; (2) a review of station emergency gear combined with generator installations designed to withstand natural disasters.

SCANNING THE CATV SCOPE

By Harry Etkin

NCTA Asks FCC To Curb Telco System Practices

The NCTA has urged the FCC to develop measures for effectively curbing Telco practices. It recommended that any telephone company refusing to grant pole attachments be barred from CATV operations. This would include most general system companies and practically all United System companies.

NCTA further suggested that this policy be made retroactive; systems constructed prior to the Commission's warning issued during its Section 214 proceedings should be divested and systems built after the warning should be torn down and sold for scrap unless a competing independent CATV operator is willing to purchase the system.

Telco's CATV systems were built, leased or operated without obtaining a CATV permit or franchise from the local municipal authorities. Many independent telephone companies have a policy of refusing to grant pole-line attachments and therefore, CATV systems have to reach their subscribers through lease-back arrangements. The Telcos buy the cable, string it, and lease it to the CATV operator. After about ten years the cable operator has paid for the cost of the wire system but he keeps right on paying the lease-back fees. The telephone company usually gets a free wire system paid for by the CATV operator.

CATV operators have complained to the FCC that Telco CATV systems have presented unfair competition, violated the antitrust laws and bypassed the local franchising authorities. The FCC specifies that since telephone companies are listed as common carriers they are not required to obtain FCC authority to construct CATV systems.

Section 214 of the Communications Act has been interpreted by the FCC in such a way that telephone companies shall not undertake the construction of, lease, own or operate CATV systems unless and until there shall first have been obtained from the Commission a Certificate of Public Convenience and Necessity.

The basic question before the FCC is whether or not it should prohibit telephone companies from engaging in CATV activity and if it should adopt a policy prohibiting 214 certificates to be granted in any case where the customer is a wholly-owned subsidiary or Telco-related company.

CATV System Assists Neil Armstrong Family

Shardoco Cablevision of Wapakoneta, Ohio, assisted the NBC-TV production crew which was originating coverage from the home of Apollo 11 Commander, Neil Armstrong's parents. NBC had arranged to originate live from the Armstrong family home and established a microwave setup at the residence. Since the Armstrong's were not cable subscribers, NBC technicians were unable to get quality signals off the air from the area NBC affiliates to properly monitor the origination pickup.

By an emergency request the Shardoco Cablevision, on the eve of the Apollo 11 blast-off, wired the home for cable and supplied the network crew and the Armstrong family with quality picture reception.

Electronic Mail Service Through Cable TV?

A new service which may emerge in the near future and benefit the post office department is the electronic mail service used in conjunction with cable television. With the many services which CATV now provides the subscriber, and additional future application to record or message communications would be an outstanding achievement.

RCA has already developed an inexpensive printer. When installed, it decodes information transmitted during the vertical synchronizing period of a TV signal and then prints such information as news, advertisements and stock market reports. When CATV is used to bring the TV signal into the home, the multiplexed system is not required since a separate frequency can be used for the additional data service. Instead of the printer, an inexpensive facsimile unit offered by Xerox could be used to print text and pictures.

These communication features combined into a future system could make possible the mailing of a letter into the subscriber's home. The application of this innovation could mark the end of the present method of human mail sorting, mail carrier and mail delivery which has not changed in 30 years.

Cablecasting Meet Set For November 6-8

NCTA's next Cablecasting Seminar will be held on November 6-8, at Pennsylvania State University, University Park, Pennsylvania. Because of the success of last April's seminar in Salt Lake City, Utah, NCTA plans to have two such events a year. One in the West, the other in the East.

CATV Allocation

The National Education Association's Department of AudioVisual Instruction has cited the educational potentials of cable television in a resolution recently sent to the FCC. It recommends that CATV systems allocate a percentage of total available channels to serve community educational needs.

Testing Cable Drops Requires Newer Sets

Has the small screen b-w television receiver become the final judge of cable TV quality? In far too many cases, yes.

Such a test will show that the signal is not too weak, will give some idea of b-w picture quality, but is nearly useless in estimating color quality. Is the color moved to the right of b-w? Is the color smeared or the fine tuning too critical to even obtain color?

Only a color TV receiver will help answer these questions. But even a color set has limitations when used as a cable test instrument. Suppose the colorcast quality on some channels is questionable. Is the picture problem due to a poor video tape recording? Is it a result of something else malfunctioning at the broadcast station? Or could the cable system be the source of the problem?

A quick check is to put a color test slide on an unused channel and use an 18-inch color set wi automatic fine tuning (AFT) at t home installation. If the AFT tun in all channels as well as (or bett than) manual fine tuning, it's a cin the CATV system is perfect in eve stage. However, if the AFT wor normally on some channels but n on others, there could be a defe in the cable system. Of course, t color set must be checked on oth antennas before it is used in t field. Incorrect antenna and R alignment in the tuner will cau poor AFT action. The use of a te channel does offer some hope f color reference, but should not the sole test for color on cab drops.

Solve Another CATV Problem Noise In Cable System See Page 52

the end of the pregnant pause

The Rapid-Q cartridge tape unit: It has done away with the corpulent chunk of time that lays there between the end of one recorded message and the beginning of the next.

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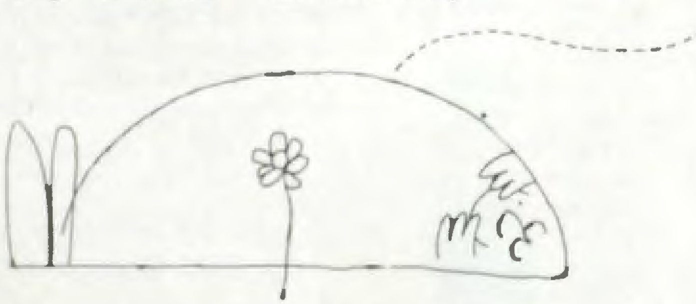

EDUCATIONAL BROADCASTING

Looking Inside Non-commercial Brodcasting

By Mike Smith

NERD Directors Propose Establishment Of National Public Radio, Tape Library

A recommendation that the Corporation for Public Broadcasting establish National Public Radio, an independent radio program and production center to be located in Washington, D.C., has been made by the board of directors of the National Educational Radio Division of the National Association of Educational Broadcasters.

Richard Estell, NER board chairman, said that NPR will be governed by a 12-member board made up of nine public radio station managers and three members representing the public at large. The nine broadcasters will be elected at the regional level by public radio station managers in each region. The nine broadcasters will elect the public board members. Estell added that the NER board has urged that NPR, which will handle interconnection for public radio stations, be formed as soon as possible and no later than January, 1970.

The NER board also proposed that the National Educational Radio Network become a taped library service and a depository for audio taped program materials to be distributed to instructional, educational and public radio stations. This new service, which will retain its NER-NAEB identity, will maintain a close relationship with NPR, Estell said. NER board members agreed that criteria should be established to identify a public radio station so that a proper funding procedure can be established at CPB. The criteria, he said, will include such information as station power, minimum operational schedule, staff composition and program schedule allowing adequate hours for public radio broadcasts.

In other actions, the NER board endorsed a proposed plan for the long-range financing of CPB; approved further discussions on a satellite experiment that would provide a relay system for public radio stations; re-affirmed its support for all-channel radio receiver legislation, and urged the FCC to complete action on Docket #14185 relating to a table of allocations for non-commercial radio stations.

FCC Acts On ITFS

The Board of Education of Long Beach, California, licensee of ITFS station KZH-31 at Long Beach has been authorized to accompany the visual transmissions of slides, films and other visual images with aural transmissions of music during scheduled breaks in its in-school programming schedule. The grant is for one year, and the operation is not to exceed ten hours per channel in any one week.

The Commission waived Section 74.931(a) of the Rules governing ITFS, which it considered to be the proper rule requiring waiver in this instance to permit the authorization.

South Carolina ETV Center Article On Page 39 In This Issue

Free ETV Via CATV For New York System

Inter-County TV, a CATV subsidiary of Sterling Communications Inc., will provide unlimited use of one CATV channel for use by the schools and libraries of Islip and Babylon, New York. Included in the agreement are free equipment and facilities for playback of prerecorded ITV materials; free installation and maintenance of one receiving installation in each school and library in the county; free conversion of signals from an ITFS system to VHF for cable distribution and additional channels in future years. This service will be extended to more than 340 schools in Suffolk County, and will mean a savings of several thousand dollars to the schools.

Educational FM

An educational FM radio plan which contains a request for channel approval for 53 non-commercial FM radio stations has been filed with the FCC by the Pennsylvania Department of Public Instruction. This is the first detailed state-wide engineering plan presented to the Commission, according to Ocko Associates, consulting engineers, Bryn Mawr, Pa.

Cow Scratching Rubs Out ETV

A cow scratched her back the other day and educational television was without service from the mountains to the coast in North Carolina. Channels WUNC in Chapel Hill, WUND in Columbia, WUNE in Linville, WUNF in Asheville and WUNG in Concord had only intermittent service between 11 a.m. and 1 p.m. that day.

Power for all stations reaches its origination site on Terrell Mountain from Chapel Hill some eight miles away. A secondary power line was brought in contact with ETV main line when the cow scratched her back on a guy wire in the pasture. The power company searched for more than two hours before pinpointing the cause of transmission interference.

The power line was rerouted. The cows weren't disturbed.

NAEB Accepting Technical Papers For Convention

Technical papers to be presented at the 1969 NAEB convention, November 9-15, should be submitted to William C. Lewis, Delaware ETV Network, P.O. Box 898, Dover, Delaware, 19901. If it is not practical to submit a completed paper, simply submit the topic, the expected length, and a list of the needed audio-visual equipment.

Many of you have solved problems around the shop which are common to a number of shops around the country. Such experiences should be shared through a technical paper. Experiences with a new kind of gear or a new concept in use of common gears make interesting and informative papers.

Papers should run about 30 minutes in length, and can be illustrated with 35mm slides, motion picture film or video tape. Since the convention is so near at hand, haste is in order so that preparations can be made, and the proper scheduling can be done.

Central Info Source

The National Association of Educational Broadcasters has formed Management and Membership Information Systems. When it becomes operational, the information system will provide current data projections, statistics, technical advice and other information about all aspects of educational broadcasting to government, industry, professional and instructional groups.

Stereo Telecast

WLVT-TV, Allentown-Bethlehem, Pa., and a local stereo FM station joined forces to present a three audio channel stereo telecast. A performance of the Creation by the Mahlenberg and Cedarcrest Colleges, local high school students and a 45 piece orchestra was recorded by the two stations, with the FM station taping right and left channels and WLVT taping the center channel and the video. The program was then played back simultaneously on each station for a 3 channel effect.

Installation considerations for color film processors Part 1

By D. Khalil Jones*

There are many small, color film processors on the market today that are well suited for small volume installations. A growing number of TV stations are taking advantage of this situation by installing their own processors. But the processor is only part of the required equipment. The support equipment required for such an installation and some of the problems involved in the actual installation will be covered in this article.

KID-TV recently installed a color film processor for 16mm and Super 8 Ektachrome film. After the processor arrived, we found the installation was going to be a larger job than anticipated. This was due to the space considerations, hot water availability and the heating and ventilation needed to make the processor operational.

Processor Selection

The first consideration is the size and type of film to be processed. Like most stations, we use 16mm film. The processor we chose can handle 16mm or Super 8 by changing leader and film magazines. Selection of a film type is not simple. The two common brands of film used in small processors are Kodak Ektachrome and Anscochrome. The process is different for each, and once you set up for one type you cannot change to the other easily. There are also factors of economics and quality which enter into the choice of film type. We chose Kodak Ektachrome.

Processing Speed

The time involved in processing is approximately the same regardless of the foot/min. rating of the processor. To put one foot of dry exposed film into the processor, process it, and receive the same one foot of dry processed film, will require approximately the same time regardless of the foot-per-minute rating of the processor.

The difference is noticed once the film starts coming out of the processor. A 15 foot/min. processor will deliver processed film at a rate of 15 fpm where a 45 foot-per-minute machine will deliver at 45 fpm. The faster machine has larger tanks which will hold more film for a shorter time thus maintaining the same film immersion time in each chemical regardless of the foot/min. rating.

Because of the larger tank size in the faster machine, it will require more chemicals, hot water and power to run and therefore, the operating costs go up. There is one adage in film processing—the smaller and slower the processor, the better, as long as it will deliver the quantity of film you need, when you need it. Of course, you should keep an eye to future demand in making this decision.

The materials used in construction of the processor are also important. Nearly all processors are constructed of stainless steel. The bleach tank should be of a suitable alloy or red brass due to the reaction between the bleach and stainless steel and the plumbing should be of PVC pipe or other non-corrosive materials. Chemical tanks should have accurate temperature control, preferably electric heaters with individual thermostats. Nearly all color processors on the market are of this design, but the buyer should keep these things in mind when shopping. The more covers and cabinet parts that are stainless steel, the easier the processor will be to keep clean and less maintenance will lower operating costs.

Site Selection

After you have chosen a processor, determine the dimensions of the cabinet with all covers open and the height with the film carriage rods fully raised. If you are unable to find these demensions, take the cabinet size and add four feet to the length, four feet to the width and double the height. This will allow sufficient room around the machine to open any covers and work comfortably and provide enough head room to remove the film carriage rods. These dimensions should be used as the minimum space required.

Our problems began when we found the ceiling-to-floor space in the darkroom too small to accommodate removal of the lower film rollers due to the depth of the processor tanks. Then, because our hot water supply was inadequate for sustained processing, installation of another electric water heater was necessary. This required running a heavier electric service to the darkroom.

The processor's chemical holding tanks required more space than we had anticipated, so a room had to be built for them. Then the room had to be vented and heated due to the toxic nature and high freezing point of some of the chemicals. The list of small problems goes on, but all of them could have been prevented by our being aware of all the requirements of the color processor we had chosen and by using more advanced planning.

The processing room must have drainage facilities and a water supply capable of providing water at the temperature and flow rate required for the processor you choose. Requirements will vary with the foot/min. processing rate. In our case we needed 100°F water at one gallon per minute. To supply this for long processing runs, we installed two 50 gallon electric water

*Engineer, KID-TV, Idaho Falls, Idaho.

heaters in series. In this way we have 100 gallons of hot water. As it is used, the first water heater prewarms the water feeding the second heater, which increases the temperature so that we can always maintain 100°F water through our mixing valves.

The processor should be installed where the chemical replenishment tanks can be located above it. In our installation we put the processor in the basement and the replenishment tanks on the main floor directly overhead, thus providing the necessary gravity flow.

Facilities are also required for mixing chemicals. Mixing can be done in the chemical storage room, if 100°F water and suitable drainage facilities are available, or the chemicals may be mixed in the processor room. This may present a problem because a means of getting the mixed chemicals back up to the storage room is then necessary.

The mixer is generally of the recirculating type with a pump used to pump the fluid through a jet which causes turbulance in the tank thus mixing the solution. Once the chemical is mixed an output valve on the pump selects either the mixing tank jet or a discharge line for emptying the tank. This pump normally has sufficient pressure to pump to an overhead storage room if the chemicals are mixed in the processor room.

Several methods can be used to get the proper chemical into the proper holding tank. One would be to employ valves and couplers in the replenishing lines and pump the new chemical back up the same lines. This method has several drawbacks. First, the non-corrosive valves and quick couplings needed on each line are expensive and secondly the chemicals may be spilled as the lines are disconnected after each refilling. Another method would be to run separate lines up to each tank for filling. This method has the same disadvantages as the first plus the expense of an extra line for each tank.

Due to the expense and mess involved in each of the methods, we decided to run one line from the mixer to the storage room and connect a hose to the line so it could reach each storage tank for filling. We also provided drainage facilities on this line for cleaning the line between the different chemical mixes. Then by adding remote control of the mixer power from the storage room, we gained the advantage of mixing from the processor room and filling from the storage room. This has worked very well for us and was inexpensive to install.

Ventilation and Temperature

Due to the toxic nature of some of the chemicals, it is necessary to provide for forced ventilation of the mixing and storage areas during the mixing and refilling of the storage tanks. Normally the storage tanks are sealed so ventilating would not be required except for refilling op-

Fig. 1 KID-TV color processor installation with operator preparing to mix chemicals. Note cutout in ceiling to accommodate film transport rods. Replenishing lines and exhaust duct also run through the cutout.

erations. Both room locations should be selected so that forced ventilation can be installed at minimum expense with minimum exhaust ducting. The exhaust discharge should be located in such a place that the building ventilating and air conditioning equipment cannot pick up the fumes and circulate them through the building.

In addition to ventilation in the chemical mixing and storage area, the processor will require ventilation whenever it is operating. This system should be separate from the mixing and storage system to avoid the chance of contaminating the chemicals in the processor with residue from all the different chemicals handled in the mixing ventilation system. The same considerations should apply to the processor-vent system as in the mixing system. Although both systems would normally follow the same ducting route, the processor-vent system would normally be much smaller than the mixing system, as all the processor would require is approximately 50 to 100 cubic foot-per-minute air flow.

Fig. 2 KID-TV's Paul Jenkins shows method used to fill the storage tanks. The trays are made of fiberglass wood. Each tray must be capable of supporting at least 800 lbs. The ceiling mounted blower is for chemical miser and storage room ventilation.

The temperature of the processor and chemical storage rooms should be kept at least 75°F because in the Kodak ME4 process, the pre-hardener crystalizes at 68°F and becomes unusable. Because of the high temperature, humidity in these rooms becomes a problem. This is especially true in the processor room due to the agitation of the chemicals. Therefore, some means of controlling humidity is needed, especially if the processor room is very small.

A humidity problem can be avoided in several ways. The simpliest way, if you mix chemicals in the processor room, is to run your mixer ventilating system while processing, providing you can draw dry air into the processing room from an outside source. A better way would be to install a dehumidifier.

Power Source

An adequate AC power source should be available to operate water heaters and the processor. The processor will require a large amount of power to operate tank heaters and the film dryer. Our processing equipment requires 110 amps for efficient operation: the processor pulls 35 amps and the water heaters require 40 amps; electric room heaters to maintain the ambient temperature pull 15 amps and 20 amps are used for ventilating blowers, chemical mixing and lights.

Another consideration in locating the processor is noise. Due to the air compressors employed for agitation of some chemicals, there is a high noise level around the processor which could be a problem if it is installed next to a recording studio or any other place where a live mike is used.

Part II of this series will deal with the actual installation of the color processor at KID-TV for processing Kodak Ektachrome film using Kodak's ME4 process.

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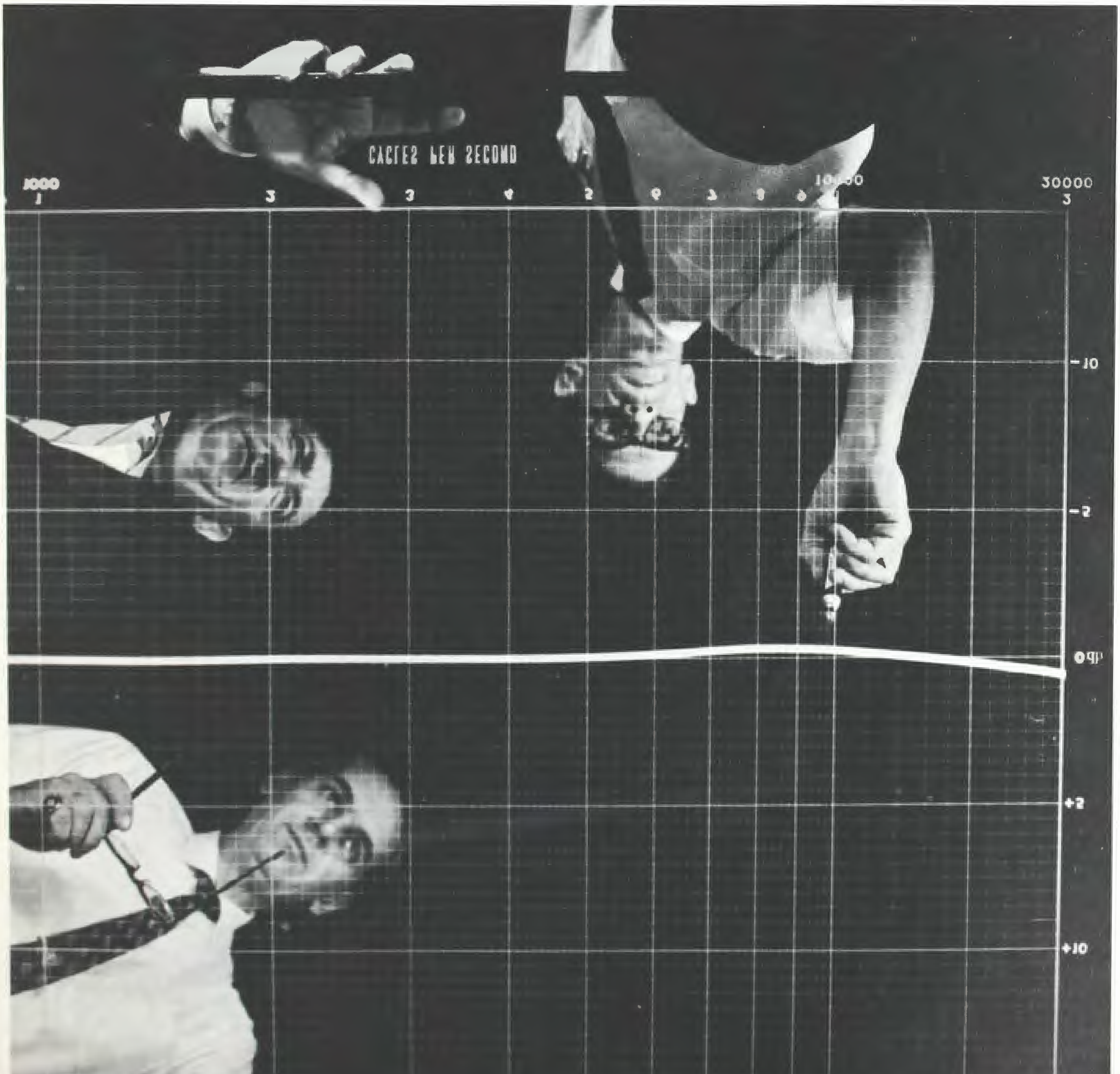

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A Survey of application ideas for IC's

Part 2 of a 3-part series

By Walter Jung*

Going further into television applications of IC differential amplifiers, this article will deal with oscillators, waveform generators and waveform shapers. Several different varieties of oscillator circuits will be illustrated and their applications discussed. Considerations involved in driving ramp and triangle waveform generators will be described and examples of TV camera and monitor usage will be given for circuits.

Oscillators

The function of an oscillator is quite basic to both television cameras and monitors (or receivers). Stable, repetitive frequencies must be generated at both horizontal and vertical rates in the monitor. In the camera, the situation can take many forms depending upon the camera's complexity. Usually the sweeps are triggered by external interlaced horizontal and vertical rate drive signals. But in many industrial grade cameras the signals are internally generated and may or may not be interlaced.

*Senior Engineer, MTI, a division of KMS Industries.

The first oscillator (Figure 1) is an LC type, connected in Colpitts fashion. Due to the inherently good stability of the Colpitts configuration, which in this case is augmented by a symetrically arranged amplifier circuit, this oscillator can be highly suitable as a free-running time base at either H or 2H rate.

In the circuit, the positive feedback necessary for oscillation is taken from Q2 and fed back to Q1 via the capacitive tap of C1-C2. Although the LC tank generates a sine wave due to its natural flywheel action, both a sine and a square wave are available from this circuit due to the limiting action of the Q1-Q2 differential pair. Since the total current available to Q1-Q2 is held constant by Q3—and Q2's base held at ground potential, the sine wave at Q1's base will switch the current alternately back and forth between Q1-Q2 and thus the two collector loads, RL1 and RL2. The inherently high voltage sensitivity of the differential pair (6) results in this current being essentially a square pulse, and consequently, it is developed into a square wave at pin 10. The shunt effect of C1-C2 at pin 8 produces a pseudo sine wave at this point and of course, a clean sine wave is available at pin 1. It should be noted that the loading effect on pin 10 influences oscillator stability very little, because the collector of Q1 is not part of the feedback path.

The features of good stability and square wave output are natural requirements for a time base oscillator. The sharp wavefront of the square wave allows easy triggering of subsequent stages without additional buffering. This can either be a binary countdown chain (in the case of interlaced systems) or a horizontal sweep stage. A block diagram (Figure 2) shows that a voltage controlled oscillator (VCO) is required as a master clock if the syster is to be referenced to the 60 hertz line (a common requirement of industrial cameras).

A modification of the LC oscillator of Figure 1 enables frequency control with external voltage. This second oscillator, shown in Figure 3a, is the oscillator of Figure 1 (ICI) shunted by a reactance—control circuit (IC2).

The reactance control portion of this circuit uses an adjustable react-

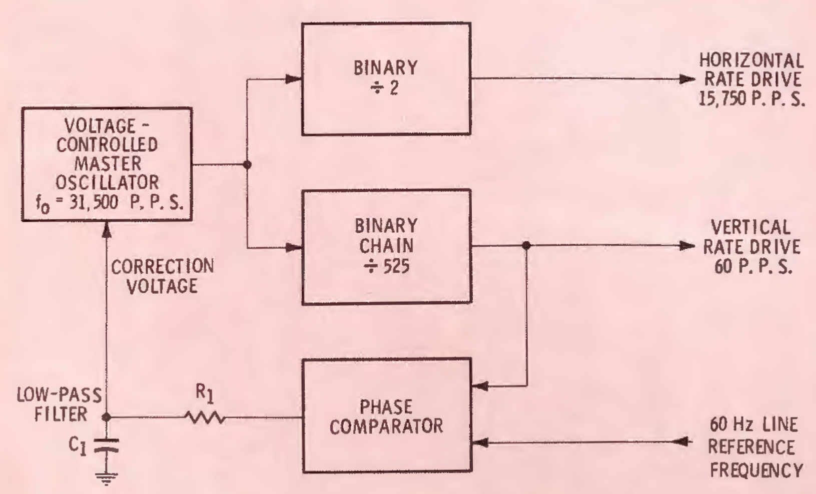

Fig. 2 Block diagram of interlaced industrial sync system.

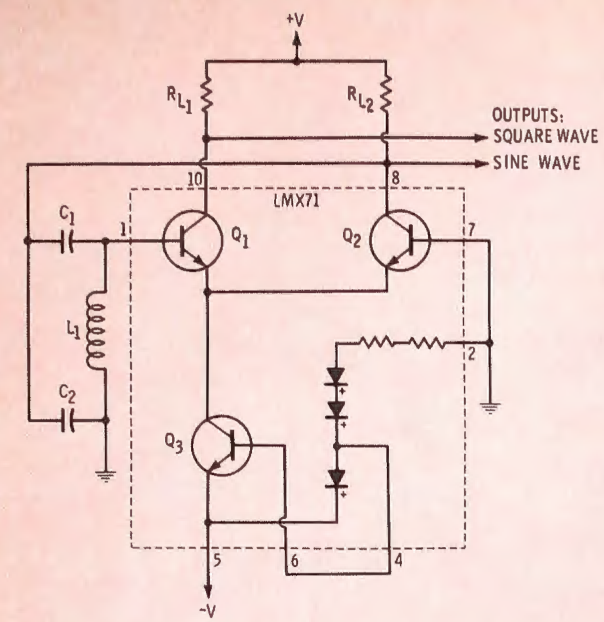

Fig. 1 LC Oscillator using an LMX 71 IC.

ance effect to vary the effect capacity shunted across the LC tank via Cc. This is accomplished by combination of a gain controlled amplifier and a feedback capacitor as elements of control. In a circuit of this type, the effective shunt capacity is a function of both the reactance feedback capacitor, Cf and the amplifier transconductance.

The amplifier configuration of IC2 consists of Q3, Q1 and RL1, Q3 being the inverting amplifier, Q1 a grounded base stage, and RL1 the load resistance. Since the total current of Q3 can be shunted to either Q1 or Q2, Q1's share of the current in this circuit can be varied by a control voltage (3) (4) (5) (6) (7) (10) (14). Thus the gain of the amplifier and the effective reactance can be made a function of control voltage, which in turn controls the oscillation frequency of IC1.

When considered as a system component, this oscillator is advantageous because the control voltage necessary to fully control frequency is very low; it is in fact the transition width of the differential pair of IC2. The voltage necessary to transfer current from Q1 to Q2, at room temperature is approximately 114 mv. It is naturally centered at zero volts DC (or small offset voltage) by the matching of Q1 and Q2. The frequency limits (min and max)

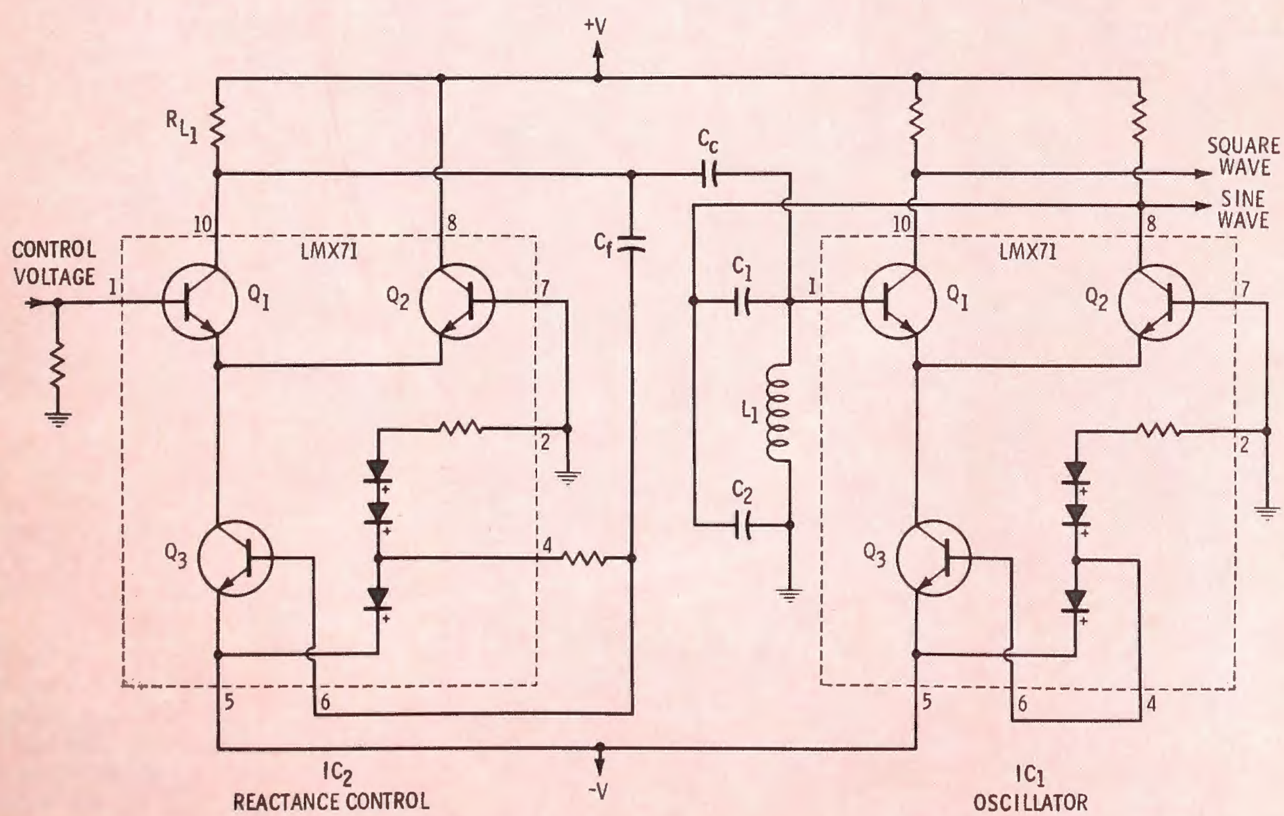

Fig. 3 Voltage controlled oscillator.

are also readily predicatble since the reactance control can only slew between 2 discrete limits of capacity corresponding to minimum and maximum gain. Increase of control voltage beyond the transition width cannot further effect the frequency, as the emitter current of Q1 can only have 2 limits; full on or full off.

This oscillator then possesses a peculiar combination of features; very high sensitivity in the region of control due to its millivolt sensitivity, but with 2 discrete frequency limits beyond which no amount of control voltage will allow it to pass. In a phase locked application such as a line-locked clock oscillator or receiver horizontal oscillator this is very important, as it means a high degree of control—but an inability to range too far from the center frequency. Because the mean center frequency is determined by an LC tank, there is good, basic stability. As in the simple LC oscillater of Figure 1, both sine and square wave outputs are available from IC1. The control characteristic of this oscillator can be easily plotted.

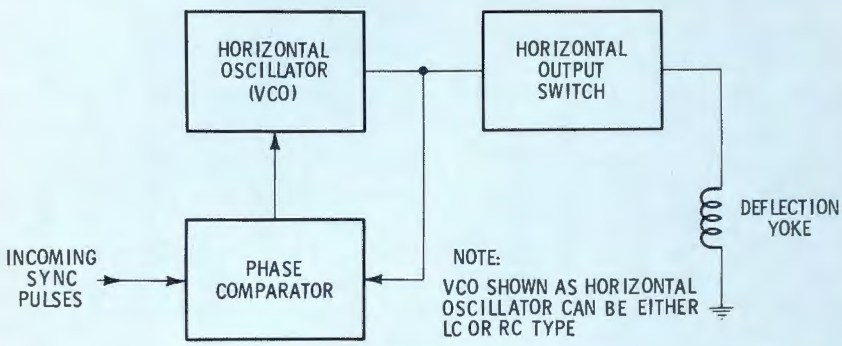

Fig. 4 Block diagram of receiver horizontal deflection system.

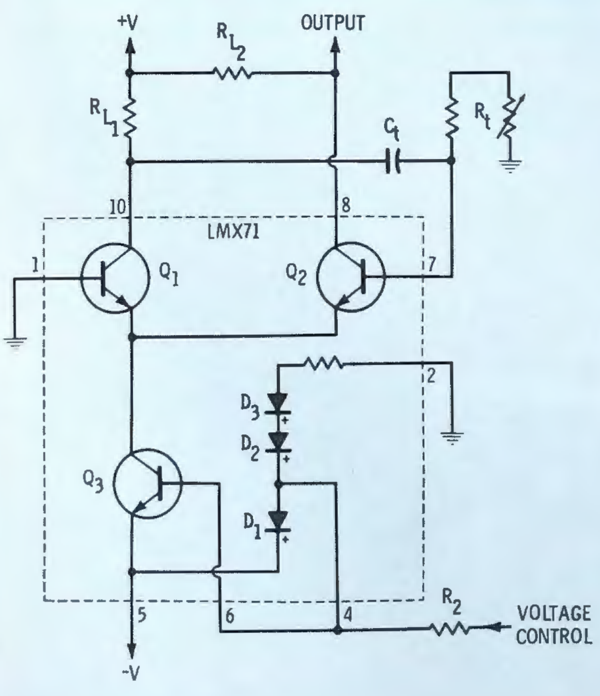

Fig. 5 RC coupled voltage-controlled oscillator.

Monitors or Receivers

Monitor or receiver sweep oscillators require two differing rates (60 and 15,750 Hz) with two different locking capabilities (vertical rate triggered, horizontal phase locked). Although these two requirements are somewhat diversified, the differential amplifier can perform both functions adequately.

Although the previously described LC voltage controlled oscillator was a camera master oscillator, its use as a receiver line scan oscillator is quite apt (Figure 4). The use of LC stabilized oscillators for this function is prevalent in almost all commercial receivers manufactured today, although predominantly the vacuum tube variety. The microcircuit version offers the stability and frequency control characteristics necessary for a TV horizontal sweep oscillator in a miniaturized package with its minimized power dissipation. The square wave output of this oscillator, with suitable adjustment of the duty cycle, can drive a horizontal output switching transistor.

The requirements of this horizontal oscillator (Figure 4) can also be fulfilled by a RC coupled version with a reduction in component count. In fact, many different varieties of RC oscillators are possible. The first, a voltage controlled emitter coupled astable oscillator (Figure 5) is unique because its frequency can be controlled in two ways, it provides an isolated rectangular wave output and it is exceedingly fast in operation.

Examining the circuit, Q1 and Q2 are the emitter-coupled pair with Q3 providing a constant DC emitter current (in conventional form, Q3 would be a simple resistor). The timing components Ct and Rt serve as the predominant frequency determining components. Direct manual control of frequency is achieved by making the charging time of Ct variable with a potentiometer from pin 7 to ground (Rt).

To control the operating frequency with an external voltage, use is made of the emitter current source transistor, Q3. The voltage drop across RL1 with Q1 on is directly proportional to the emitter current of Q3. If the current supplied by Q3 is made variable, the charging time of Ct will be variable


FAIRCHILD

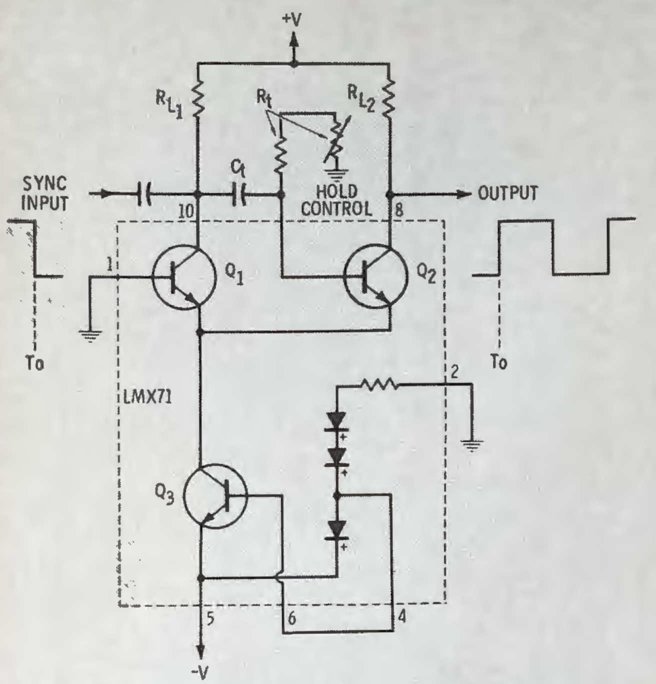

Fig. 6a RC coupled synchronized astable oscillator.

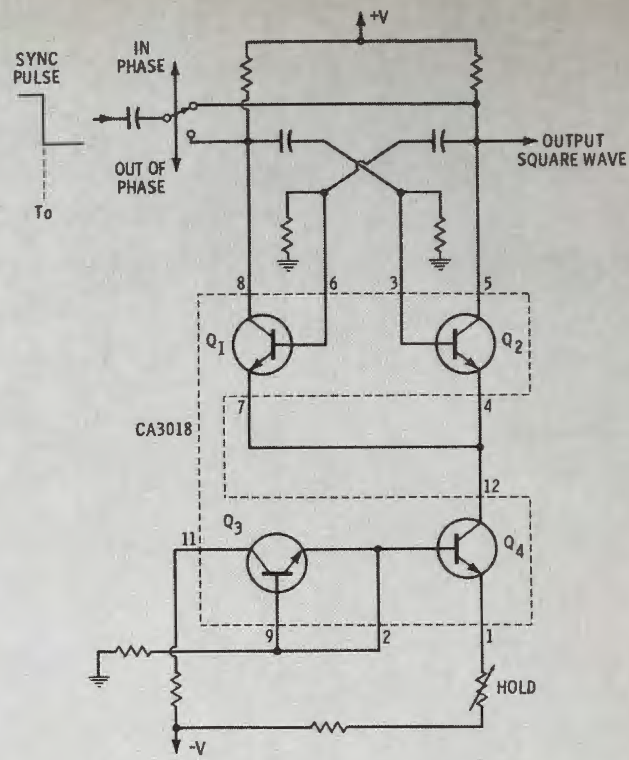

Fig. 6b RC coupled synchronized symetrical astable oscillator.

also, since Ct must charge towards Q2's firing potential from the drop developed across RL2. Therefore, control of the drop across RL1 can also control frequency. The current provided by Q3 can be varied by the frequency control input, R2 which modulates the static bias of the D1-D3 bias chain. Other methods of frequency control are possible and in general, any method which controls the drop across RL1 with Q1 "on" will alter the charging time of Ct and the frequency.

Since the collector of Q2 is not part of the positive feedback loop, it can be considered an isolated output and will deliver a voltage proportional to the value of RL2 (if IQ3 is fixed).

By deleting the frequency modulation input to this circuit and providing a suitable synchronizing point, this same oscillator can be used as a vertical rate oscillator to drive a sawtooth generator (Figure 6a). In this configuration, operation is very similar to the circuit in Figure 5. The timing control serves as a vertical hold control. Negative sync pulses are applied at the collector of Q1, which force Q2 off and Q1 on, synching the oscillator with the incoming pulses.

Another variation of this oscillator is Figure 6b, a symmetrical (50% duty cycle) astable. With a balanced output waveform, triggering of the oscillator at the alternate collectors will force the output wave to either be in phase or 180° out. This causes the display of the vertical interval information in the center of the screen during the 180° out-of-phase position. This is a rather simple solution to the vertical portion of a pulse-cross display for professional monitoring applications.

Although this differential configuration is equivalent to an LMX71 type in that it uses a matched monolithic pair (18) (22) and a constant current source, the use of the CA-3018 array in this biasing condition is for another reason. Normal component tolerances and timing ranges for a vertical rate oscillator require a rather wide range of emitter current from the current source element when using this current to control frequency. Although this is possible in an LMX71, the CA3018 connected as shown allows a temperature compensated current source. It also allows a slightly higher package dissipation.

Waveform Generators

Having produced a synchronized waveform, it remains now to trigger a sweep generator to generate a voltage ramp (sawtooth) to use for deflection. The first circuit is Figure 7a, a positive ramp generator. This circuit operates by alternately charging and discharging the timing capacitor Ct by transferring the constant current of Q3 alternately between the differential pair Q1-Q2. During the charging period of Ct (positive output slope), Q2 is held off and Q1 on, via the .6V bias provided by D1-R1. Retrace or discharge of Ct occurs when a negative step is applied to Q1 through C1. When Q1 is pulsed off, the emitter current is transferred over to Q2, which discharges Ct.

Since the discharge current of Ct is constant due to the constant-current action of Q2, the slope of the discharge will be very linear. Positive slope linearity (Q2 off) is dependent on Rt-Ct time constant, charging potential and output loading. Linearity can be optimized by charging Ct towards a very high voltage (100-200 volts) or alternatively, charging through a transistor constant current generator operating from +V (see note 2 of figure). In any of these options, it is necessary to buffer the high impedance charging node across Ct with an emitter follower. This can be done by a high gain Darlington pair or a voltage follower configuration as mentioned in Part I. An example of the Darlinton pair using a monolithic array is shown in the figure.

The circuit of Figure 7b appears to be similar to 7a, but a few subtle changes have transformed it into a negative slope ramp generator. This circuit also works by alternately charging and discharging Ct, but the sequence of events is different in this case. When a positive trigger pulse arrives at Q1, this side of the differential pair switches on, which in turn drives Q4 on, charging Ct to +V. After the trigger pulse ends the negative bias of D1—R1 hold Q1 off (during the trace period) while Q2 discharges Ct linearily back towards ground potential, forming the negative ramp. As in the previous circuit, an output buffer is used to isolate loading affects from the timing network.

In the triangle generator, Figure 8, the emitter current of Q1-Q2 again is alternately switched back and forth, but on a 50-50 basis resulting in equal positive and negative slopes—a linear triangle waveform. To accomplish this, a square wave is applied to Q1 which switches it between equal periods of conduction and non-conduction. When Q1 is on, it in turn gates on Q4, a constant current generator which charges Ct positive. When Q1 switches off, Q2 comes on and discharges Ct forming the negative slope. Once again the output is buffered as in the two previous cases of waveform generators.

Waveform Shaper

The final circuit is a waveform shaper (or clipper). This is a circuit useful for processing a linear sawtooth into a pre-distorted or "S" corrected waveform to compensate for deflection yoke distortion.

Referring to schematic diagram, Figure 9a, the circuit utilizes two monolithic transistor arrays connected in a dual polarity, fully variable clipping arrangement. In both sections of the circuit, full advantage is taken of the inherent matching characteristics of monolithic transistors—as a result the clipping levels are very stable and temperature independent.

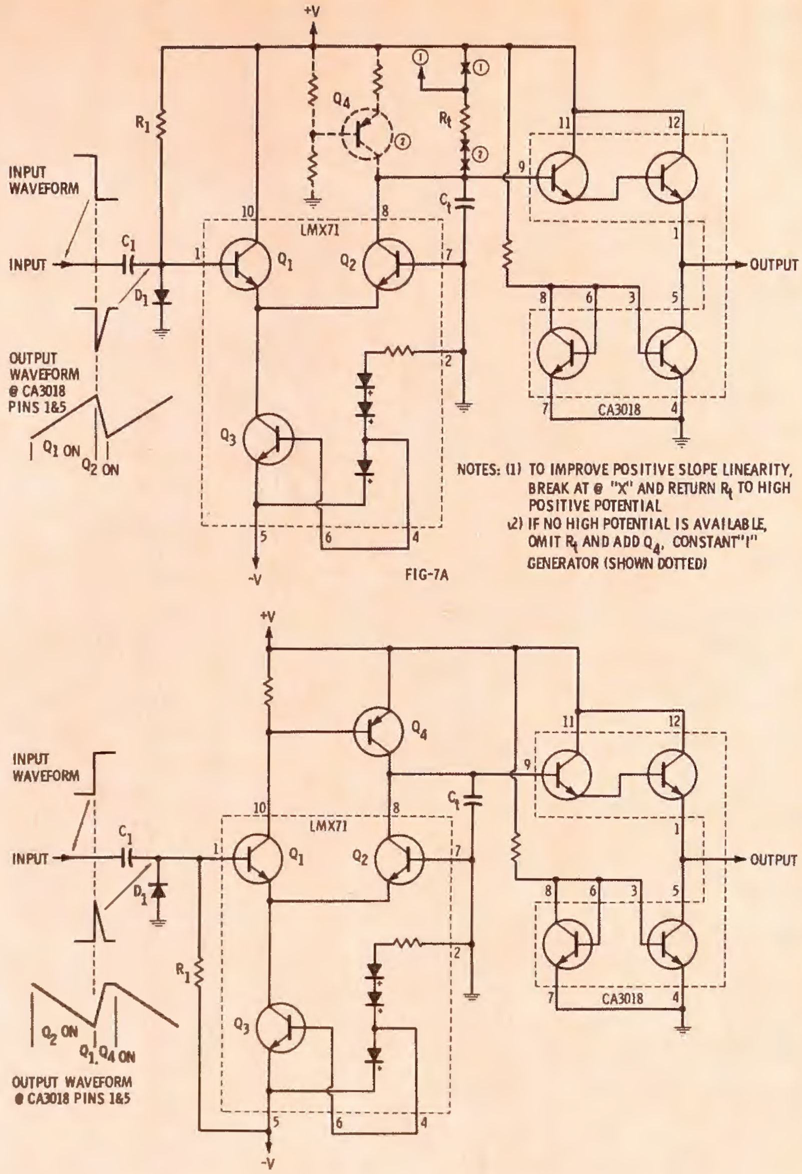

Fig. 7a Positive sweep generator. **Fig. 7b** Negative sweep generator.

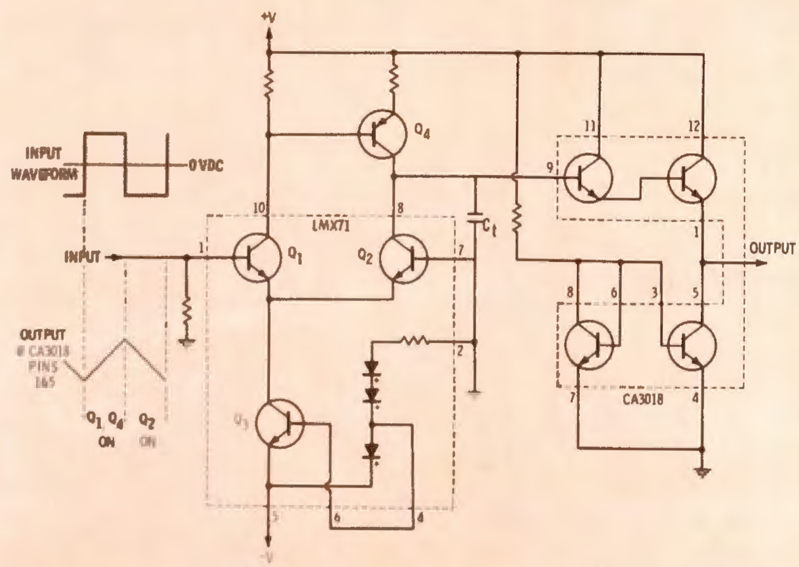

Fig. 8 Triangle generator.

To analyze operation of the circuit refer to the simplified diagram of Figure 9b. In essence, both sections of the clipper are biased diodes such as D1 and D2 of Figure 9b. If the potentials applied to the diodes via R1 and R2 are such that D1 and D2 are back biased, they are effectively out of the circuit and do not effect the signal applied via Rin. When signal amplitude becomes great enough to forward bias D1 and D2 on signal peaks, these diodes clip further increases in amplitude and the signal becomes "limited".

Several factors influence the quality of a limiter such as this. The temperature dependence of a normal silicon diode (–2mv/oc) can become a problem if the signal amplitude is small and the total drift is a relatively high percentage. This indicates the desirability of some form of temperature compensation. Also, the impedance of the potentiometer can be troublesome if a high degree of attenuation is desired, as the abruptness of the clipping is a direct function of the "stiffness" of this voltage source. This indicates a low impedance, emitter follower type voltage source to bias the clipping diodes.

With these considerations in mind, Figure 9a will show how they have been accomplished. In the positive limiter, diode—connected Q2 is the clipping diode and its bias is furnished by Q4, an emitter follower. The respective Vbe's of these two transistors cancel, and the circuit clips at the same potential as Q4's base due to the monolithic matching. The remaining two transistors of the array, Q3 and Q1, act as additional emitter follower (Q3-Q4 form a Darlington pair) and an offset canceling diode. Since all of the Vbe potentials within the circuit cancel, the voltage introduced at R1 will be the voltage at which clipping takes place. Introduction of the series resistance, Rp, allows the degree of clipping to be varied by softening the clipping action.

The negative clipper is very similar in concept, but arranged slightly different. Q4 is the clipper diode and is biased by Q3 an emitter follower. The two Vbe's of Q3-Q4 are cancelled by Q1-Q2, connected as diodes. Again, the voltage introduced by the level pot R2 is the same as the clipping potential, due to the Vbe cancellation. A similar series resistance, Rn, allows adjustment of negative clipping slope.

Operationally, this circuit allows independent adjustment of four parameters; positive and negative clip level and positive and negative clip slope. With this degree of manipulation, a wide variety of functions can be synthesized even with this simple single clipping level circuit. These basic techniques can be expanded into a wide variety of specialized video processing functions, with similar considerations towards the optimization of control. ▲

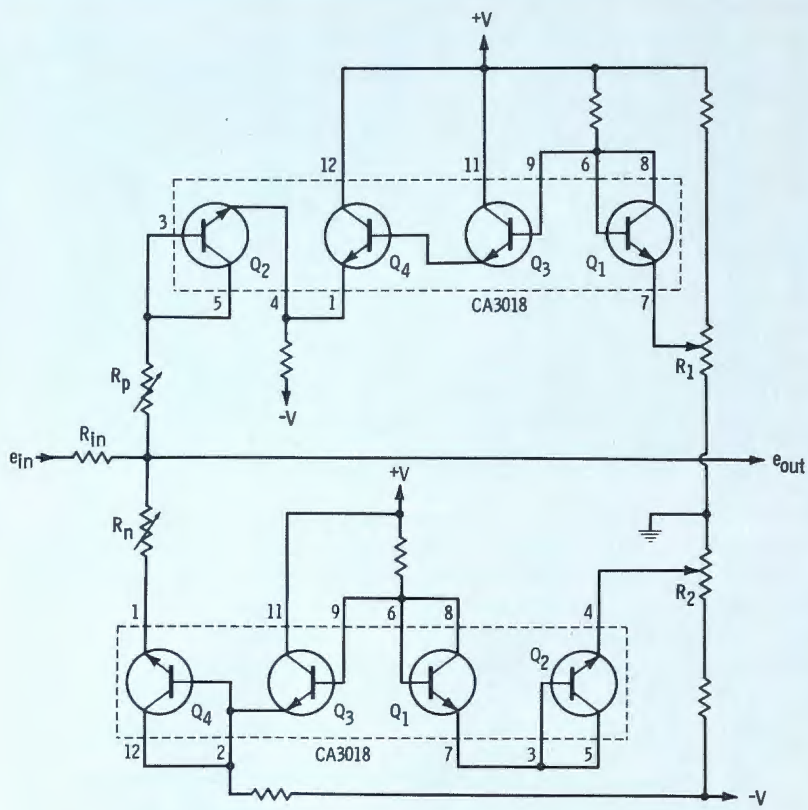

Fig. 9a Bi-directional clipper with independent clip levels and slopes.

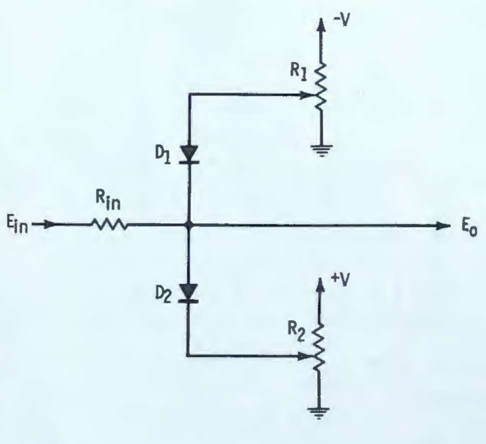

Fig. 9b Simplified clipper.

Fig. 1 Barely visible at the main console over the operator's left shoulder is a cartridge tape machine for emergency announcements. Note that five programs were being shown when the picture was taken.

Automating complex programming for educational television

By Lloyd W. Brown*

From its beginning, the South Carolina Educational Television Network was primarily designed to provide instructional television for elementary and high schools in South Carolina. That was twelve years ago.

The system used only closed-circuit distribution until 1963, when federal matching funds became available for the construction of broadcast stations. ETV has evolved into a network combination of open- and closed-circuit transmission paths which reach almost every school in the state.

Over this network, the ETV Center in Columbia, South Carolina, transmits instructional porgrams to schools; programs of continuing professional education for doctors, lawyers, nurses and others; law enforcement training programs; supervisory training for industries; adult education information and programs of general and cultural interest. This diverse programming has placed unusual demands on the ETV Center.

After years of study and analysis of present and future needs, the ETV engineering staff developed the concept of a completely automatic, computer-operated switching system, which would eliminate human errors in switching and timing to the greatest extent possible.

*Sr. Transmitter Engr., South Carolina Educational Television Center

Program Storage

A high percentage of the programs sent from the ETV Center are on video tape. The Center maintains a large tape vault where more than 5,000 reels are stored. Some of these reels contain two or more complete programs. There is also a library of instructional and other films, plus numerous tapes and films which are regularly shipped to and from other stations. In addition, the Center maintains two complete production studios as well as a mobile unit.

During the broadcast day, the programs may originate live or from any of the stored film or tape sources. Many programs are repeated at various times during the day, or the same program may be shown twice or more during a single week.

The educational program schedule for the entire school year is worked out with school officials from the entire state during the preceding year and incorporated into a master list for all instructional programming. Around this basic schedule are inserted the other types of programs to be shown. By the end of the summer, the master schedule for the next nine months is set. Another problem arises in the scheduling of the nighttime programs, which are of a more general nature, often timely, and impossible to schedule completely months in advance.

Computer Complement

The first step was to enter all information on tape and film pro-

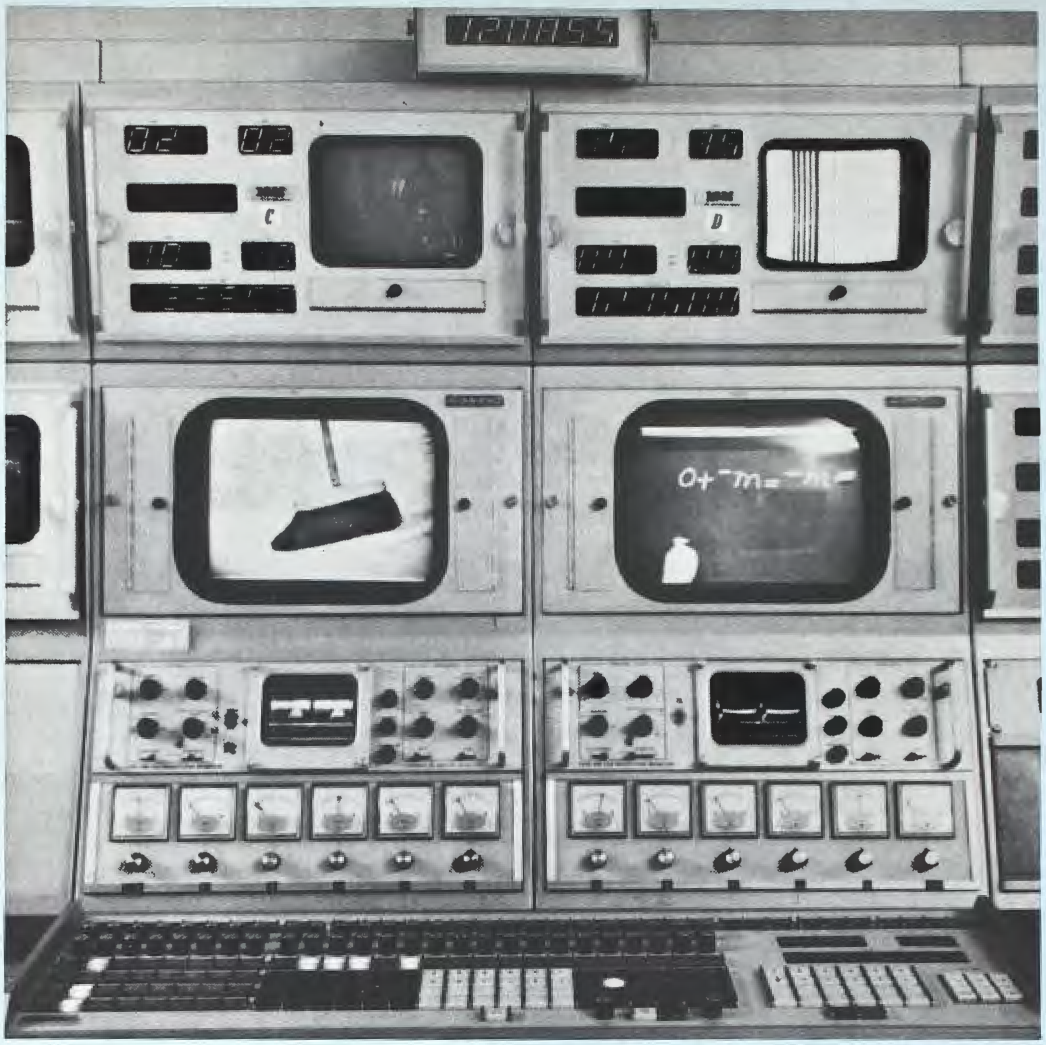

Fig. 2 The center portion of the console showing monitors, audio controls, manual switching controls and the master clock.

Fig. 3 A sample pag from the master ET schedule. Note th warning notes in th upper left corner di rected to the opera tor.

grams contained in the ETV libraries into the memory of a state-owned computer. All information about each program was entered in this manner: title; whether it was tape or film; tape speed; high or low band; color or monochrome; length and any pertinent special information. The master schedule for the upcoming school year was also entered into the computer memory, as well as a tentative schedule of all programs other than instructional. This was accomplished during the summer.

During the school year, additional information about new programs, program changes, and deletions is entered into the computer memory every two weeks.

From the basic memory and instructions written into a special program, the computer prints out bi-weekly program schedules for master control and all five open-circuit stations. These schedules are printed on forms which are also used as program logs. There is also a separate schedule of tape/film machine assignments to be used in loading the machines.

The master control schedule not only shows the program to be transmitted, but also which tape/film machine is to be used, the reel number of the program, the channel it is to be fed to and the times involved. The computer also schedules the sign-on and sign-off for each open circuit station, as well as test patterns (where there are no programs to be shown) and station identification in accordance with FCC Rules.

At the same time the computer is printing out the schedule forms, it is also punching out a deck of IBM cards, one deck for each day's operation. The cards contain the same information which is printed on the schedule.

The open-circuit schedules are then mailed to the stations involved, and the master control schedule and the decks of cards are taken to the master control/tape area.

The Master Switcher

The master control switcher has two basic parts: a control/monitoring console and five racks of associated equipment. In the racks are the card read-out, all audio/video switching devices, patch panels, distribution amplifiers, power supplies, test signal generator, monitor amplifiers and the microwave transmitter for the local broadcast station.

The Master Console

The console section contains a video and information monitor for each of the twelve outgoing channels, plus two switchable master monitors, audio VU meters and controls for the manual operation of the system when necessary.

The heart of the system is the master clock, an extremely accurate oscillator, regularly calibrated against WWV. This oscillator and

South Carolina Educational Television Network

PROGRAM LOG FOR MASTER CONTROL NUMBER 13 RESERVED

DATE 05/07/69 PAGE 02 OF

SCHEDULED TIME	CIRCUIT	PGM LOC	PROGRAM TITLE	LESS NO	REEL NO	CUT NO	PROGRAM LENGTH	TIME START/END	TYPE	PGM SORC	SSEP NO	TECHNICAL DIFFICULTIES	COMMENTS OR DISCREPANCIES
••••WARNING•••• RESERVED VTR USED ON NEXT ENTRY													
09,00.00	G	13	TRIGONOMETRY	063	2651	0	27.50	/	I	L	0222		
••••WARNING•••• NO VTR AVAILABLE FOR NEXT ENTRY, NO ASSIGNMENT MADE													
09,00.00	A	18	ELEMENTARY ALGEBRA	080	3549	0	28.50	/	I	L	0223 17.		
09,14.30	J	03	ETV NETWORK ID					/	SI				
09,14.50	J	03	WRLK-TV STATION ID					/	SI				
09,15.00	MIJEF	~~12~~ 03-1	PATT. IN ARITH VI	066				/	I	0	0224		
09,29.50	J	03	WRLK-TV STATION ID					/	SI				
09,30.00	MIJE	14	PATT IN ARITH IV	063	8005	0	13.25	/	I	0	0225		
09,30.00	BF	15	S.C. HISTORY	051	0285	0	19.22	/	I	L	0226		
09,30.00	A	16	GENERAL MATH I	069	3869	0	28.50	/	I	L	0227		
09,43.25	J	03	ETV NETWORK ID					/	SI				
09,44.50	J	03	WRLK-TV STATION ID					/	SI				
09,45.00	MIJE	09	ART AND YOU	060	4836	2	13.50	/	I	L	0228		
09,58.50	J	03	ETV NETWORK ID					/	SI				
09,59.50	J	03	WRLK-TV STATION ID					/	SI				
ALL TIMES EASTERN DAYLIGHT TIME													

associated counters provide time information to the switcher, as well as to digital readouts which may be installed at any local or remote location.

In its basic form, the system takes video and audio from any of 36 sources and switches it any of 12 outgoing channels. The innovations come in the associated circuitry.

When loaded into the card readout, the punched cards tell the switcher which program is on which machine. The switcher starts the tape ten seconds and the film three seconds before air time; then switches audio and video to the proper channel at the correct time.

The switcher also has a built-in memory circuit. There are two sets of digital readouts for each outgoing channel. The memory bank shows the source which is "on air" at that particular moment on one readout, the source which is scheduled to be used next, and the time the next source is to be switched.

There is an audio sensing circuit which flashes to notify the operator when there are sustained periods of silence from the audio source. In the event that there is no card for a program to follow the one that is on the air, the readout will flash a "memory vacant" sign to warn the operator. Should a tape or film machine fail to start when the card says it should, an audible alarm sounds in the control room.

One picture monitor and VU meter are provided for each outgoing channel. Two master monitors, consisting of an oscilloscope and picture monitor, may be switched to any channel. In addition, one monitor may be set to automatically scan the outgoing channels in rotation, stopping for a short time on each channel.

The control console also contains video level and pedestal controls for each video source, as well as audio level controls for each outgoing channel. An audio monitor speaker may be switched to any channel at the operator's discretion. In an emergency, or for special programming, the automatic features of the switcher may be by-passed and the entire operation done manually.

In theory, once the cards are loaded into the readout, all the operator has to do is watch video and audio levels and make sure the correct tapes and films are loaded on the proper machines before air time. The normal ETV complement includes one master control operator and two tape/film operators on duty during the main part of the day.

The computer-operated automatic switcher has eliminated many manual errors in the transmission of programs, thus allowing greater attention to the technical quality of the material being sent. When programming becomes as complex as the South Carolina ETV network now demands, this kind of operation becomes a must, not icing on the cake. ▲

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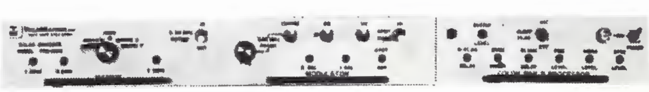

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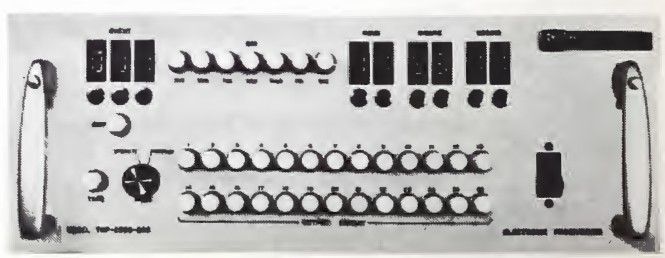

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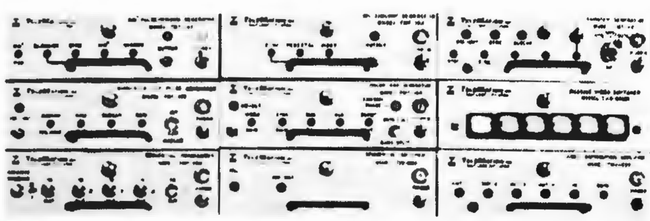

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Taking the dog out of the doghouse

By Robert A. Jones*

Take antenna tuning houses for granted and something inside will surely go wrong. Take them so much for granted that you fail to put adequate planning and materials into tuning houses and they will become real "dog houses" and something will go wrong inside.

Good, sound structures will pay for themselves because the equipment is better protected from the weather, vandalism, aging, bugs, snakes and other pesty varmints. Also, less time will be required for regular maintenance work. Greater stability and dependability of the antenna system will result. This means less frequent visits from the consulting engineer. One retuning of the antenna pattern due to inadequate protection of the antenna coupling could be more expensive than the cost of a good tuning house.

*Consulting Engineer, LaGrange, Ill.

This article contains two basic designs used to provide good, high quality shelters. One uses concrete blocks, the other wood.

Both designs start with the same foundation, a solid concrete floor. In areas where the soil may be soft or where freezing and thawing can shift the foundation, it is necessary to dig footings under the outside walls for stability. If the transmission lines, sampling lines and other cables are to be installed underground, it is a good idea to place a clay pipe or plastic tube in the foundation forms before pouring the concrete.

Before concrete is poured, the grounding system should also be considered. Several copper ground wire may be run through the foundation forms before the cement is poured in the first stage. These short lengths of wire are laid through the forms. Later, the antenna tower side of these wires is brazed to the tower pier and the opposite side to the long ground radials. The wires must be installed first because the dog house floors are usually poured at the same time as the tower piers and anchors.

Also, there is a second method of installing the grounding system. In this method, either a two or four-inch copper strap is buried six inches below the ground peripherally around the foundation. The size of this copper strap depends on the station's frequency and power. The ground wires are then brought up to the edge of each side and brazed. This second method is almost always used where an expanded copper ground screen is employed as in Figure 2. The edge of the copper mesh is brazed to the copper strap around the tower pier.

If a wooden building is constructed, it is advisable to bury some one-half inch bolts along the edge of the foundation. These are used to bolt the "plate" to the floor. The plate is the 2 x 4 which forms the bottom edge of the walls. These are not required in a concrete block wall. The grounding strap that connects the tuning panel and the tower

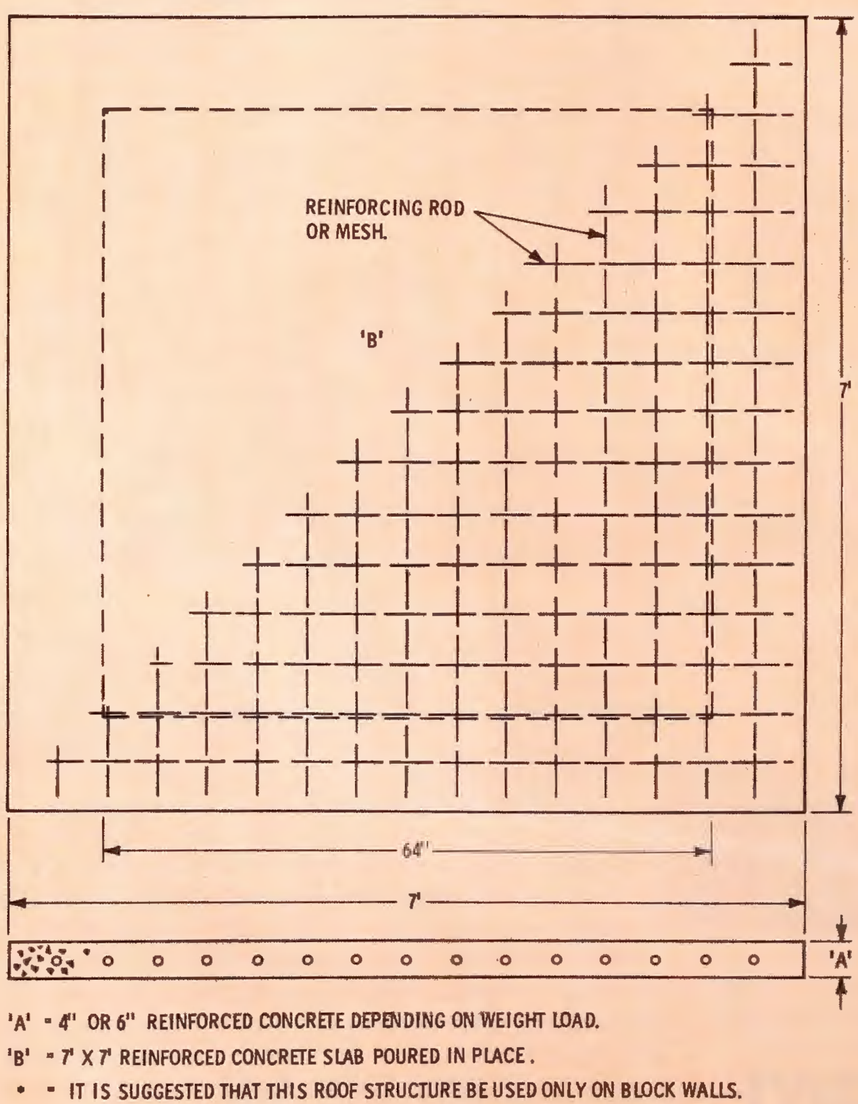


Fig. 1 All-weather roof construction is an important consideration.

pier can be brought up through the clay pipe, under the bottom row of concrete blocks or in under the 2 x 4 plate.

Wooden Walls

In the wooden dog house, the walls, plates and braces are constructed from 2 x 4's. Some stations try to save money by using 2 x 2's, but these will warp and curve and weaken the structure. Each corner is formed by two 2 x 4's nailed in an "L" configuration. Figure 3 is a view looking down on the spacing between the vertical wall braces or studs. Nineteen 2 x 4's, seven feet high are used for the vertical members or studs and eight 2 x 4's, 64 inches long form the bottom and top plates for the walls.

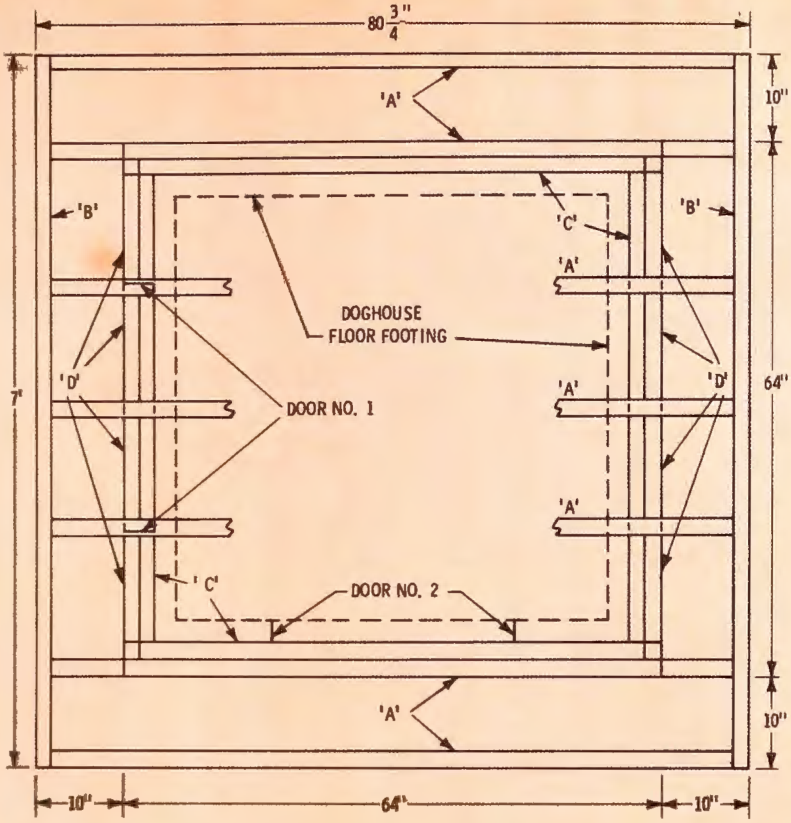
The best material to use for covering the walls is marine plywood because it will not be affected by rain or moisture as will ordinary plywood. This can be purchased in 4′ by 8′ sheets and then cut to size. Five sheets of plywood would be required to cover the walls of the dog house shown in Figure 2. The corners of the outside walls can be trimmed with 1 x 3 boards. These boards will keep the corners or edges of the plywood from chipping or becoming broken and will also enhance the appearance of the dog house. Similar trim can be used around the door opening.

Doors

The best type of door for this building is either one of solid wood or metal. Well-seasoned wood should be used for the 2 x 4 frame to give the least amount of warping or sticking. Station KWEB installed both metal frames and doors to prevent any sticking. Hollow doors are not recommended because they are prone to warp and can be kicked in.

Wooden Roofs

The roof is made of several 2 x 6's in an open box with ten-inch eves all around the tuning house as shown in Figure 4. The rafters,



'A' - 2" X 6" X 80 3/4"
'B' - 2" X 6" X 7'
'C' - 2" X 4" STUD WALL OR BLOCK WALL.
'D' - 2" X 6" BLOCKS BETWEEN JOIST.

Fig. 2 Suggested floor measurements

COPPER MESH SCREEN BRAZED TO COPPER STRAP AROUND DOG HOUSE AND TOWER PIER

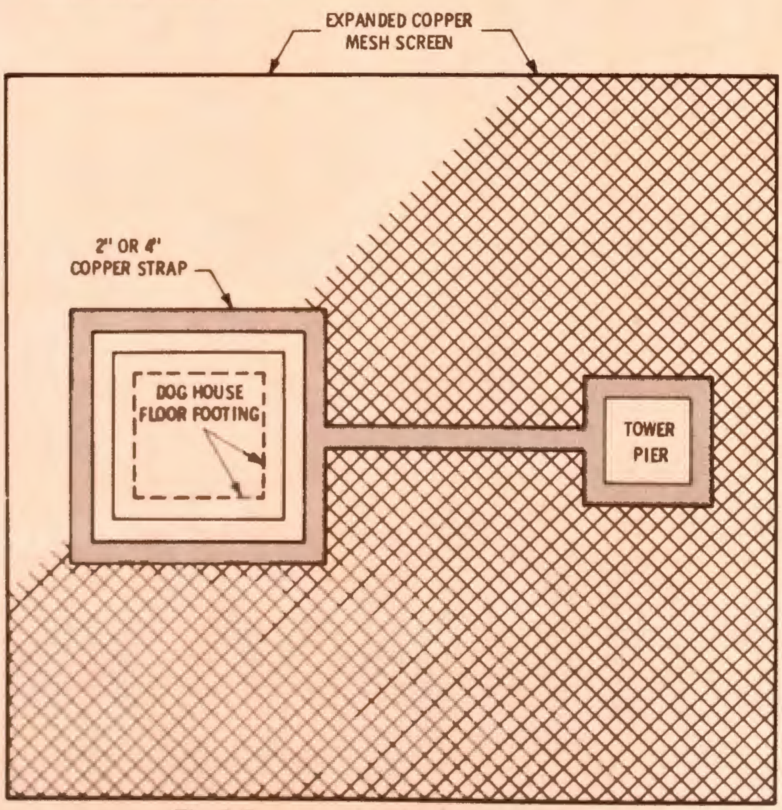


Fig. 3 Top view of tuning house, pier and surrounding copper screen.

marked "A", are notched into the 2 x 4 wall joists and help to form the top plates for the walls. The roof is then covered with two 4 x 8 foot sheets of marine plywood. The extra plywood can be used to cover the underside of the eves, completely sealing the roof against the weather and animals.

The only difference between the pitched roof and the flat roof is the angle of the pitched roof. The pitch angle need not be great, usually ten or fifteen degrees is sufficient. In areas where the snowfall on the roof may be great, the pitched roof is preferred. Metal edges may be nailed along the top edge of the outside rim of the roof. This helps protect the wooden edge of the eves from rain and moisture.

A first coat of good paint sealer should be applied to the walls, doors and eves to protect them against the weather. This is followed by two finishing coats. High quality paint is recommended for this job because if cheap paint is used, the structure will need repainting too often.

The flat roof is covered with a high grade of tar paper and spread with a thick layer of roofing cement. Some stations prefer to use a gravel mix with this cement. As this gravel mix is worn away, additional coats may be added. The tar paper may be wrapped over the eves instead of using metal flashing.

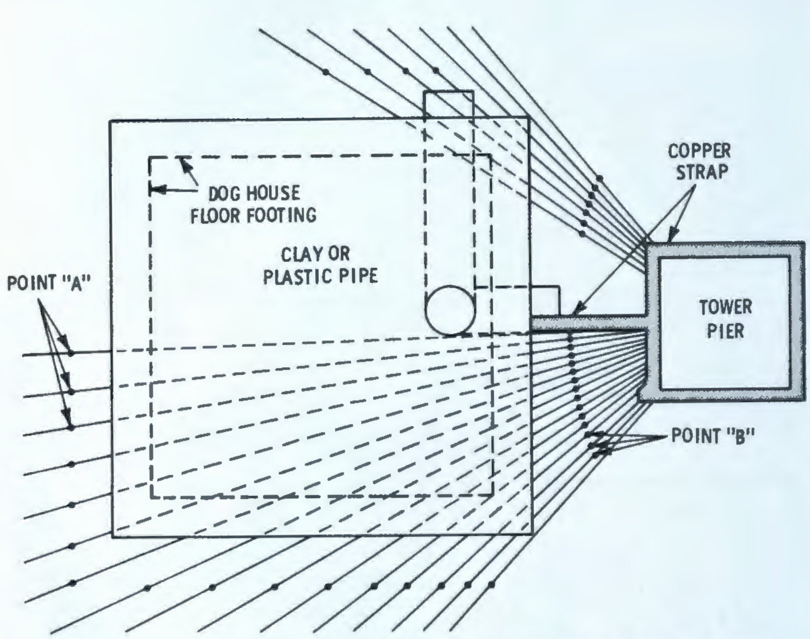


Fig. 4 Brazed connecting points are at point "A" and "B". Route wire through forms before pouring.

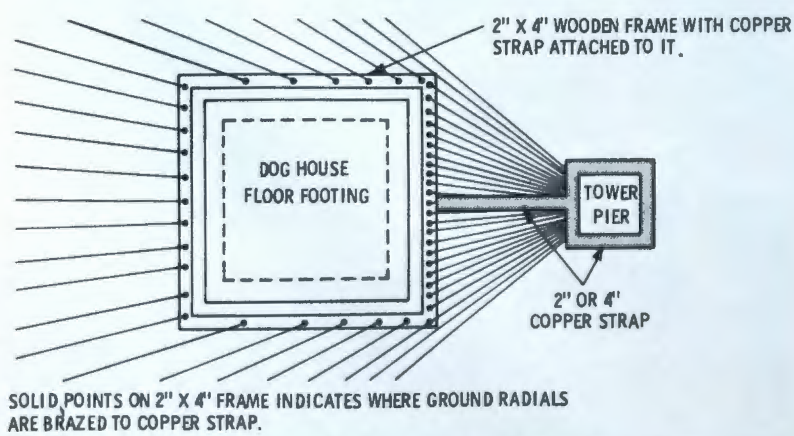


Fig. 5 Ground radial pattern and connecting points.

Concrete Block Walls

If the walls are made of concrete block, the wooden or metal door jam is set and held in place by a temporary brace. Long bolts should be installed through the door frame into the blocks at several levels to hold the frame securely. The blocks should be layed one row at a time, all the way around until there are eleven rows. Each row should be checked to make sure it is level and each corner should be checked with a plumb bob.

If the tuning house is constructed using cement blocks, there are two ways to bring the tower leads into the house. The most common way is to break out the center of one block and bolt a small, square piece of marine plywood on each side of the wall. A typical bowl insulator can then be attached to this wood.

Another method, illustrated in the photographs, requires mounting a panel of glass or plexiglass in the wall in place of one or two of the blocks. This can be done when the blocks are being laid. Holes can then be drilled in the glass to accommodate the various tower leads and cables. Glass blocks are not recommended for this because they are thicker and would require holes to be drilled on both sides. They also tend to fill up with water.

Concrete Roof

There are several types of roofs that can be used with concrete block walls. The flat, wooden roof would be the easiest to install since the walls are all even at the top. If a wooden roof is used, it is advisable to close up the eves and to use a metal flashing around the lip of the roof. Again, the use of tar paper and roofing cement is recommended.

All-cement or pre-stressed roofs can also be used. In some locations, small pre-stressed roofs can be purchased and installed. Other stations use a poured cement roof. This can be made by building wooden forms atop the completed walls then pouring the concrete into the forms. When the cement dries, the form are removed.

The dog house can be either square or slightly rectangular. The ideal house would be five blocks deep and six blocks wide. These dimensions will yield slightly less inside space than the 64 inch square wooden house mentioned previously. The normal height is eleven blocks.

Special Suggestions

It is simple, while constructing either type of tuning house, to add a second door which opens inside the tower fence. This was the method used by Charles King when he constructed the wooden tuning house at WZBN, seen in Figure 2. The cost of this extra door is about the same as that of a good gate.

No equipment should be installed on the floor. The tuning equipment and lighting equipment should be installed on the walls in such a way that the station operators can go inside to work and close the door in bad weather. Flat panels are preferable to wall and shelf units as they do not collect as much dirt or as many dead mice and bugs.

Since the tuning house is expected to last several years, only quality materials should be used for basic construction.

The labor and money put into constructing a sound antenna tuning house will be less in the long run that the expense of replacing or repairing equipment ruined because of inadequate protection. It pays to have equipment in the right kind of dog house. In fact, this approach could take the "dog" out of dog houses. ▲

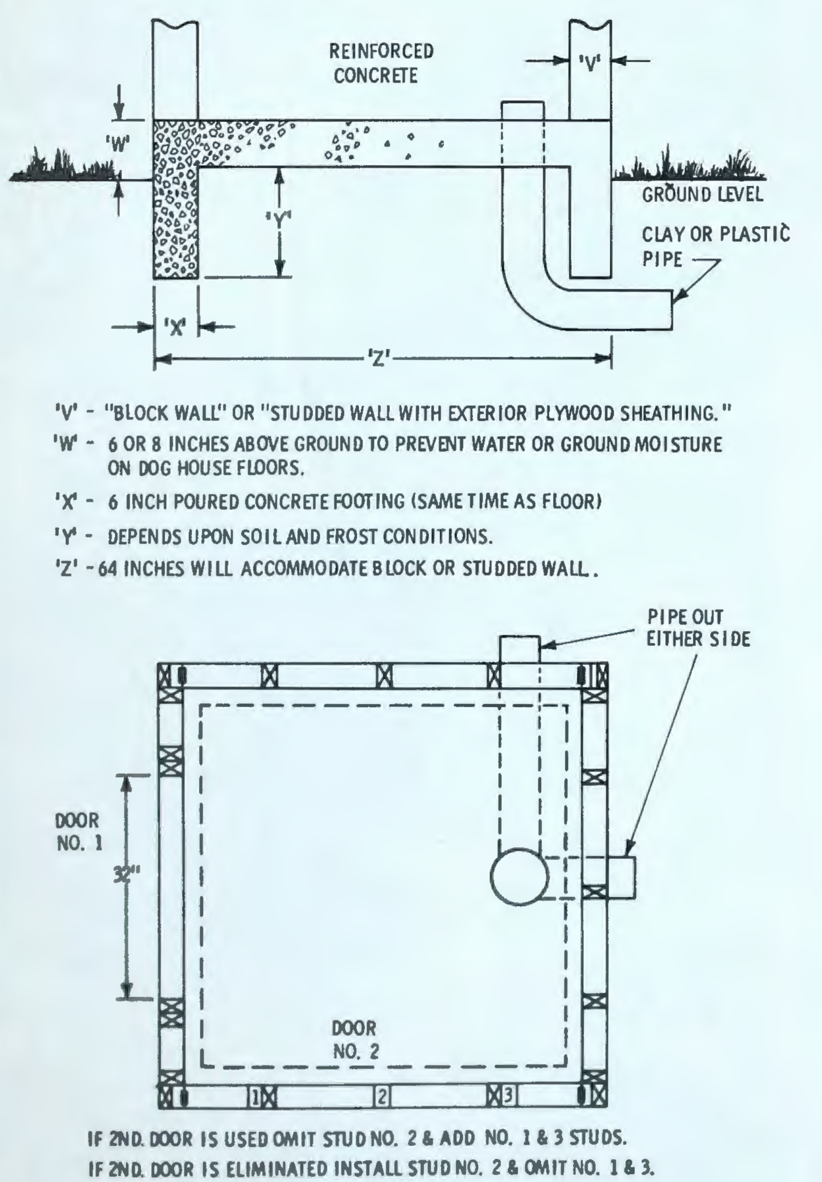
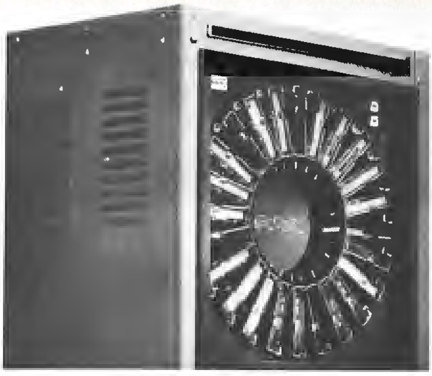


Fig. 6 Tuning house base detail.



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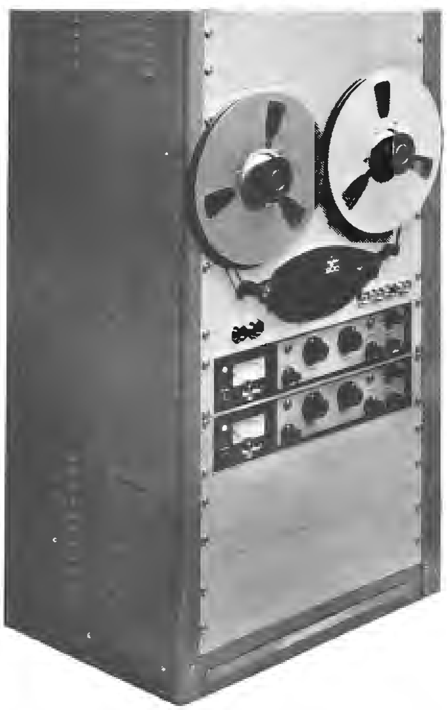

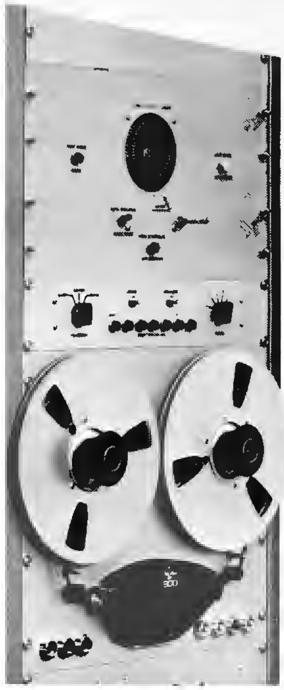

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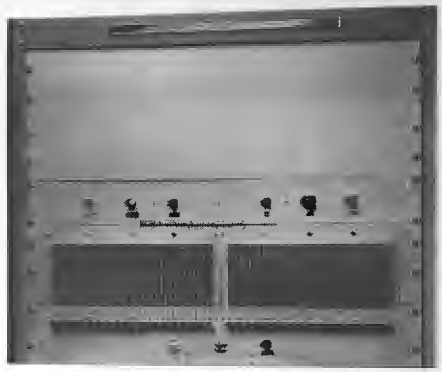

The ultimate in programming of course is provided by one or more of these switchboards which allow an infinite variety of music/announcement ratios and timing.

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Circle Number 18 on Reader Reply Card

Noise supression in cable systems

By E. Trompeter

Electrical noise has the accepted definition of being any unwanted and interfering voltage developed within or external to a system, which reduces the performance of that system. Interfering noise has been a problem in the past and was usually reduced by brute force filtering which worked on the principal of stopping the noise after it had entered the system. This method was quite expensive but reasonably effective, since signal information voltages were low in frequency while systems were few and not too large or complex.

In an atmosphere of expanded electrical and electronic equipment usage, present day communication and data systems are continually becoming larger and more numerous, using higher information rates and frequencies. The net result is ever increasing interference and noise, creating an electronic traffic jam of major proportions.

This is particularly true now that a preponderance of new systems are using low level digital pulse techniques. Filtering is practically useless or in some cases, completely unusable, since it produces excessive deterioration of the desired pulse waveforms, or inaccuracies and distortion of analog signal voltages.

Obviously, noise reduction is best accomplished by simply stopping the noise before it enters the system. The purpose of this article is to discuss how noise is primarily introduced into systems by the equipment interconnecting wiring and the improvements that can be made by installing noise rejecting type cables while applying good equipment isolation and grounding techniques.

Most electronic equipments do not produce random noise unto themselves and usually perform a singular task. When assembled and connected to other equipments to form a circuit, unwanted noise is picked up by the interconnecting wiring through the direct contact action of the ground loops and common mode returns or by inductive and capacitive pickup of nearby radiated fields. A desired signal in one circuit can be noise to another and could be produced by local circuits within the system or from equipment completely removed and external to the system.

Conversely, these same cables will radiate or cross-talk the signal they are carrying into adjacent circuits becoming themselves a generator of interference to other data systems or the cause of security compromises in classified military communications. In other words, poorly selected and installed cabling can act both as noise transmitting and receiving antenna or as undesired primary and secondary windings of coupling transformers, injecting interference.

Systems are often designed, fabricated and installed using the simplest multiwire cable or grounded coax between equipments, racks and buildings, not realizing that they will probably encounter and pick up all manner of interference. Nearby electrical equipment such as high power radar, broadcast stations, power distribution mains, flourescent lighting, arcing motors, teletype and communications circuits are but a few of the noisemakers. The lower the signal voltage level, the greater is the susceptibility to this outside interference.

A newly designed system might work fine on paper or when first assembled for checkout, but when installed at its final crowded location on ship or shore, it will not perform as anticipated. Only then is it realized that the completed system has picked up much noise and hum or is itself radiating so heavily that the equipment is unusable. Costly additional effort, parts and time must be expended to locate and attempt to eliminate the cause of the noise pickup.

Taking Noise Out

To avoid this unnecessary waste, cable to equipment interface engineering should be applied at the start of system planning and design. This applies to all systems irrespective of whether the signal is low or high frequency or used in TV, telemetry, timing, ordanance, environmental testing, computer, telephone, test instrumentation or just plain communications. Each system must be considered individually, since the signal frequency and amplitudes with the system will dictate what type of cabling and installation techniques should be used.

Cable Engineering

The following are typical examples where good cable engineering applies. Low level environmental cabling systems predominately now use "guarded" balanced and shielded lines to transmit the calibrated transducer test voltage to an isolated charge amplifier.

TV video is distributed over 124-ohm "shield twisted pair" or twinax, instead of coax, in high noise areas to obtain the low frequency magnetic field crosstalk and hum concellation provided by the "twist".

Digital engineers in the computer and instrumentation fields must begin to use good high-frequency design engineering to transmit nanosecond rise time pulses. A 10 nanosecond rise time pulse is equivalent to 100 MHz RF and must be transmitted using the best coax cable techniques to avoid pulse reflection, false noise triggering or data inaccuracy.

Low level communication circuits should be space separated and have effective shielding from adjacent parallel power circuits to avoid induced hum. Unprotected ordinance and timing circuits can be dangerous if exposed to etxernal radiated RF interferring fields.

High megawatt pulsed radar will introduce both its carrier and PRF into nearby sensitive low level unprotected cable runs that inadvertantly act as antenna. Sometimes, the transmitted pulses have amplitudes of hundreds of thousands of volts as used in atomic energy testing or linear accelerators, thereby producing large magnetic and capacitive interference fields. These in turn play havoc with local cable connected instrumentation and electronic equipment.

Long telephone lines in the near field of a nuclear explosion will pick of the accompanying tremendous electrical fields and transmit the induced high voltage pulse long distances and burn out equipment in contact with these lines.

In today's economy, the lack of money, time and qualified personnel will not permit the very complicated and expensive post-completion interference cleanup of poorly engineered systems. Expensive electronic equipment handling low level signals cannot be interconnected with the cheapest of cable and connectors and still be expected to work properly in a system.

The use of coax, twinax, triax or double shielded balanced line "quadrax" in isolated or guarded circuitry will do much to supress outgoing EMI and RFI while reducing incoming unwanted noise pickup. This protects both your system and the adjacent system from mutual interference. Obviously, careful cable-to-equipment interface planning must be exercised in the future to produce workable, compatible systems. Design engineers will not be free to treat cable installation casually as in the past.

Coax Cable

In all cases of potential interference, low or high frequency, shielded cable should be used to protect against magnetic and capacitive stray fields. Grounded coax cable installations are excellent and can be used from 20 KHz to 5 GHz for most systems. But even coax, if subjected to very strong interference, will not completely protect the desired signal. The more sophisticated cable and equipment isolation techniques must be used, dependent upon the frequency of the interferring noise and how it enters the cable system. Additional measures taken to reduce noise will conversely reduce outgoing radiation and crosstalk.

Ground Loops And Common Mode Returns

Coax cable consists of an inner and an outer conductor insulated from each other, with both conductors carrying the desired signal currents (source to load and return). Inasmuch as the outer conductor is usually grounded at the source, load, bulkheads and other intermediate points, "ground loop" or "common mode" currents caused by potential differences of external noise sources are also carried on the outer conductor. Since the desired signal and the undesired noise are both carried on the same outer conductor simultaneously, noise will be introduced into the system, greatly reducing the "signal to noise ratio."

Low frequency signals (20 KHz to 6 MHz) are particularly susceptible to both ground loop and common mode interference. In this case, coax cable is recommended with the complete coax chain having a minimum number of outer conductor ground contacts. Reducing the number of ground connections reduces the number of possible ground loops. This demands that major equipment, relays, switches, connectors, patch panels, etc. be isolated from ground with the ultimate being one ground connection at the source.

Radiated Fields

Where strong radiated noise fields exist, such as high powered radar, broadcast stations, power lines, flourescent lighting, office and industrial machinery, and multiple cable runs, the cable conductors act as receiving antennas or secondary windings of transformers and pick up the external noise sources. A particularly bad source of noise pickup is the "crosstalk" or induced currents encountered in large, multiple cable installations. To protect against these radiated noise sources, two other types of cable may be used.

Triax Cable

Triax cable is coax cable with an additional outer copper braid insulated from the signal carrying conductors that acts as a true shield and protects the enclosed coax conductors. This braid or shield is grounded and bypasses both ground loop and capacitive field noise currents away from the signal carrying coax, thereby greatly improving the "signal to noise" ratio over standard coax cable usage.

Triax cable is also used in "driven shield" applications where the inner conductor and first shield are driven in parallel at the transmitting end and work against the outer braid which is insulated above ground. At the receiving end, the inner braid is left floating, providing a "Faraday" shield between the inner conductor and outer braid. In this way, the cable distributed capacity is greatly reduced thereby reducing cable losses and loading. This application is most effective in low frequency transducer data systems where the distributed capacity in coax cable limits the data capability.

Twinax Cable

Twinax cable is a two-conductor twisted balanced wire line having a specific impedance, with a grounded shielding braid around both wires. Twisting the two balanced signal-carying wires provides cancellation of any random induced noise voltage pickup, thereby giving protection against magnetic noise field of the low frequency variety that passes through the copper braid.

This cable also provides protection against ground loops and capacitive fields as does triax cable. Twinax cable usefulness however is limited to approximately 10 MHz since it has rather high transmission losses above this frequency. Concentric twinax cable and connectors are available for low frequency and video distribution systems.

Additional common mode rejection of noise can be obtained in instrumentation systems where thermocouple and other transducer information must be remotely recorded by using twinax with only one ground contact located at the transducer.

For the ultimate in flexible cable proteced and guarded circuits, twinax cable with two separate and insulated braids (quadrax) can be used wherein the two braids are connected to "system" ground and "earth" ground respectively.

Quadrax cable can also be used to provide additional noise and EMI suppression by connecting both shielding braids to earth ground if a separate equipment ground is not available. Quadrax connectors are available for this application.

Bonding And Grounding

Bonding and grounding problems have been with us many years and much has been written to define the correct methods to accomplish both. Some suggested reading material is listed in the bibliography. However, equipment isolation, bonding and grounding still play a part in the noise pickup and EMI/-RFI problem.

From The Ground Up

"Earth" grounds require extensive grids, ground rods and chemical preparation to obtain an extremely low resistance and impedance system ground return.

Where equipments comprising a system are widely separated, equipment ground "planes" in many instances should be isolated from earth grounds to avoid "noisy" ground loops caused by power and other equipment in the immediate area.

If "system" ground and "earth" ground must be connected, it should be done at minimal locations (preferably one) using extremely low-impedance bonding paths and materials. On the other hand, RF bonding should be made quite frequently to provide the shortest RF path to ground and to prevent the ground return from acting as an additional length of antenna. To repeat, the method of equipment interconnecting and grounding is a function of the signal frequency (LF, video or RF) and no one simple answer to interference can be provided.

This article is not intended to be a complete interference manual. But awareness as to what must be done to produce noise-free systems without extensive rework and debugging is important.

Recommended reading for detailed examination:

Ground and Shielding Techniques in Instrumentation, Ralph Morrison, Wiley & Sons, New York.

Electrical Interference, R. F. Fecchi, Hayden Book Co., New York. University of California Lawrence Radiation Laboratory, Engineering Note LEN 22163, Dated 7/18/68, L. R. Allen.

Dana Labs Incorporated, Irving, California, Technical Paper No. 521, December 1965.

Brush Instruments Article in Measurements & Data, May/June 1968, D. H. Nalle.

Hum Reduction in Video Systems, Dynair Electronics, San Diego, D. A. Keller.

Shielding and Grounding for Instrumentation Systems Dynamics, Instrumentation Co., Monterey Park, California, Ralph Morrison.

Interference Coupling—Attack It Early, Richard J. Mohr, Cutler-Hammer, Inc., EDN Magazine, July 1, 1969, Vol. 14, No. 13.

Analysis of Cable-Coupled Interference, L. J. Greenstein and H. J. Tobin, IEEE Trans. Radio Frequency Interference, Vol. RFI-5, March 1963, pp. 43-55.

Crosstalk Between Coaxial Transmission Lines, S. A. Schelkunoff and T. M. Odarenko, Bell Systems Technical Journal, Vol. 26, April 1937, pp. 144-164.

Servicing Transistor Circuits

By Carl Babcoke*

Current and gain in vacuum tubes are affected very little by ambient temperature since each tube has its own private built-in furnace that is many times hotter than the surroundings. Not so with transistors. Heat is not necessary for normal operation; any generated heat is strictly a byproduct, and often a detrimental one.

Those of you who have experience only with well-designed solid state circuits may be surprised how thermally unstable some of the simpler circuits can be. In the low-level audio circuit of Fig. 1A, assume that the base resistor is the correct value to produce maximum gain. Use an audio oscillator for an input signal, monitor the output with an AC meter and the collector with a DC meter. Just cup your thumb and forefinger around the transistor case for a few seconds and watch both the output AC and collector DC voltages drop enough for a definite difference in reading. If you go one more step and also monitor the base-emitter voltage, you will discover that the base voltage decreased from this slight increase in heat. The transistor conducted **more** collector current with **less** base voltage. Or turn that statement around so it reads: for the same collector current, less forward bias is required at higher temperatures.

*BE Technical Editor

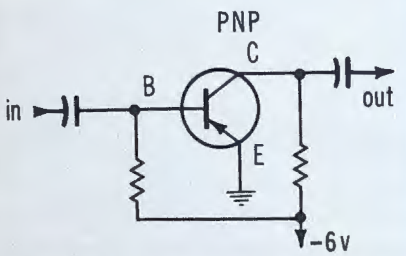


Fig. 1 (A) Simple audio amplifier without thermel stabilization.

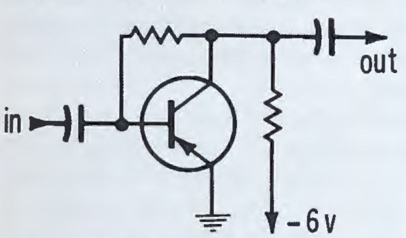


Fig. 1 (B) Effective stabilization for resistance-coupled circuits.

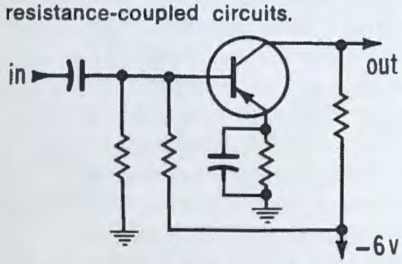


Fig. 1 (C) Base voltage stabilization by a voltage divider. The emitter resistor helps thermal stabilization the most of the two methods.

It is undoubtedly true that **more** base current caused more collector current (transistors are "current amplifiers"), but base current is very difficult to measure, while base voltage measurement is simple if you have a meter with a full-scale reading of .5 or 1.0 volt. Later we will show that collector or emitter current can be measured easily by reading a resistance, the voltage drop across it and calculating the current by Ohms Law.

Stabilization

Four basic types of temperature stabilization are commonly used. Fig. 1B shows the base voltage supply taken from the collector rather than the supply voltage. This is an effective method, if the resistance in the collector circuit is fairly high. Any increase in collector current will lower the collector voltage which in turn reduces the base supply voltage. And this lower base voltage will decrease the collector current. The opposite action takes place if the collector current goes down.

There are two limitations. Transformer output coupling is not practical since the collector DC voltage would not change enough for effective control, and the resistor between collector and base can introduce negative feedback which lowers the gain.

The two most common thermal stabilizing methods are both shown in Fig. 1C. Forward bias for the base is developed by a voltage divider to minimize voltage variations, and more important, an emitter resistor is added. For example, increased emitter current raises the emitter-to-ground voltage and any emitter voltage is subtracted from the base-to-ground voltage to give the true forward bias. The more emitter voltage, the less forward bias and this causes less gain and collector current.

Let's consider some hypothetical voltages. Assume a base-to-ground voltage of –2.15 and an emitter-to-ground voltage of –2.0; the forward bias is –.15 volt. Suppose that a higher transistor temperature increases the collector-emitter current so the readings become: base –2.15 and emitter –2.05 for a forward bias of –.10. This reduced forward bias decreases the collector-emitter current and restores the change in gain. Of course, reverse action takes place if the emitter current goes down, but we are not so concerned because this is just the opposite of "thermal runaway".

Omission of the emitter bypass capacitor would allow AC current feedback which reduces gain just as an open cathode capacitor will do in tube circuits. In practice however, we find the gain reduction in transistor circuits to be much larger than that caused in tube circuits by an open capacitor, where the resistor is the same in both cases. In a tube circuit, the gain might be reduced 10 dB, while the transistor circuit gain could be decreased by 20 to 30 dB.

The fourth type of heat stabilization uses a diode (of the same material as the transistor) as a voltage regulator.

How Critical Is Forward Bias?

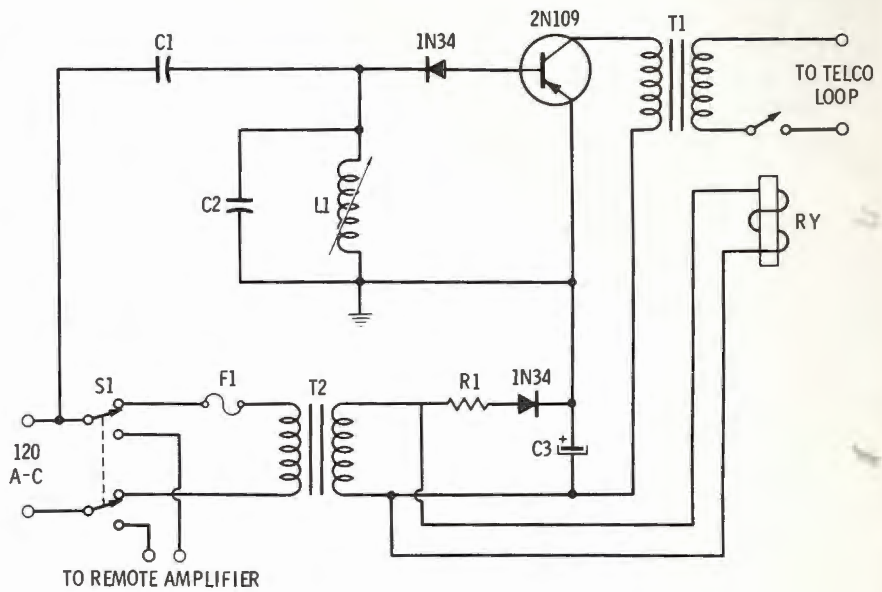
A short answer to that question is: extremely critical. Transistors normally produce far more gain than tubes, so we would expect a percentage change in forward bias to cause more change in output current and gain than in tube circuits.

Next month we will discuss a unique transistor phenomena, the gain reduction that occurs when the bias is either raised or lowered from the optimum voltage.

ENGINEER'S EXCHANGE

Remote Problem

Keeping Material On The Circuit



PARTS LIST

L1 = MILLER 6300 OR EQUIV.	T1 = 30K/500 OHMS
RY = POTTER BRUMFIELD KA5AY	T2 = 6.3V 1 AMP
C1 = 100pf, MICA	S1 = DPDT (SEE TEST)
C2 = 200pf, MICA	R1 = 270
C3 = 500mfd/25VOLT	F1 = 1/2 AMP

Fig. 1

This unit is the outgrowth of living with an average of 25 remote program circuits for a period of many years. Certainly, line failure is no stranger to us. Many of these circuits are 20 to 30 miles long and of course include from 1 to 4 telco repeat amplifiers. Some of these circuits involve permanently installed remote amplifiers which the client turns on and off.

This unit will keep test program material on the circuit at all times. The loop can be routinely checked the day before it is needed and right up to program time. One of these was used for more than 5 years on a particularly troublesome line and it "saved the day" at least 10 times.

Perhaps this will suggest other uses and refinements. Actually, one of the "module" code-practice oscillators can be used instead of the tuner. One caution on this point; a high-frequency tone will sometimes transmit very well on a long cable circuit with "one side open" and will sound nearly normal whereas such a circuit will not pass any lows at all.

The circuit: L_1-C_2 is tuned to your station. C_1 furnishes an effective antenna connected to one side of the power line. A good ground is essential. S_1 is a DPDT which replaces the line switch in the permanently installed remote amplifier. Either the remote amplifier or the monitor circuit is on the line at all times. The relay applies the test circuit to the program line. This can be a DC relay, if one is at hand, by using a series diode and a 150mfd./25 volt capacitor across the relay to obtain the 6 volts DC.

Luther Crumbaugh
KGER
Long Beach, Calif.

Getting Those Base Ammeter Readings

The chief at the small radio station faces weekly frustration calibrating the remote reading base ammeter. He reads the base ammeter, then jogs into the station to calibrate the remote meter. Or, if the calibration control is out at the antenna, he adjusts it while someone else (usually an announcer) gives readings over an intercom.

This problem can be avoided. Two meters, one at the antenna base and one inside, are connected in series. As there is no shunt element, the two meters must read the same current. Thus the meter inside the station tracks with the meter at the antenna and the chief can watch the latter while adjusting the calibration control.

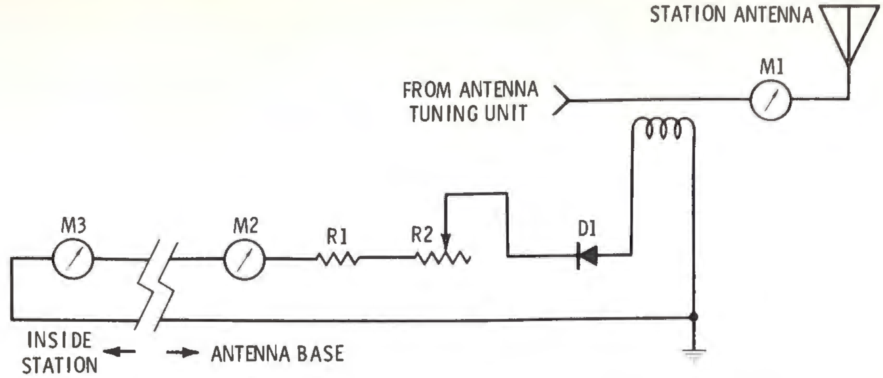
Try to use two meters identical in scale as well as manufacturer. An 0-50 microamp meter can be read as 5 RF amperes full scale, or an 0-100 microamp meter for 10 RF amperes full scale. These ranges should meet telemetering requirements for almost any antenna current encountered in small AM stations.

Many different sampling devices may be used. "Linearizing Antenna Current Indicators," by C. G. Cunningham, **Broadcast Engineering,** May, 1966, page 48, offers many ideas. I used a solid state diode feeding calibrating resistance in series with the meters. The high impedance seen by the diode causes it to operate in the microamp range, assuring good linearity. The pickup loop delivers just enough RF voltage to the diode to result in proper current through the microammeters and series resistance. The resistance is chosen to keep peak voltage within the diode's rating.

The pickup loop shown in the photograph consists of several turns of hookup wire taped firmly to the rf line. The number of turns is adjusted empiracally as is the value of the calibrating control.

Whether a commercial or composite sampling device is used, it must be fed into the two meters in series. This makes the weekly calibration much easier.

Ronald Pesha
Lawrence,
Kansas



M1 = STATION R-F AMMETER
M2, M3 = IDENTICAL D-C MICROAMMETERS
D1 = 1N34, ETC.
R1 = ABOUT 4700,000 OHMS. SEE TEXT
R2 = ABOUT 100,000 OHMS. SEE TEXT

Remote Base Reading

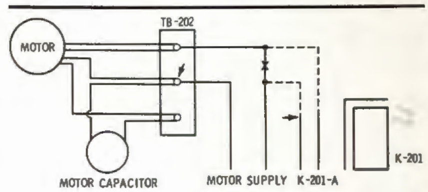
Cartridge Motor Bearing Cures

Older tape cartridge playback units sometimes develop motor bearing problems under heavy use, particularly in warm locations. Here is a corrective modification worked out for the Collins ATC PB-150, and applicable to similar units.

As the units aged, motor bearings often "froze" on heavy commercial days. The situation became worse when new units were installed in the control room and the old playbacks were used on remote broadcasts. Announcers on remotes seldom removed a cart until the machine was needed for another spot. As on many machines, the motor on the PB-150/190 runs as long as there is a cartridge in the slot.

The circuit diagram of our machines showed a set of unused contacts on the relay that activates the solenoid used to pull up the drive puck. On our ATC models, this relay is K-201 and the unused contacts are K-201-A.

By rewiring one side of the drive motor supply through the contacts which close with relay activation, the motor does not start when a cart is inserted, and will not run until the "start" button is pressed to play the cart. The motor then stops as soon as the cue tone de-activates the puck solenoid. (Rewire only the actual lead to the motor; breaking the circuit ahead of "S-202" will defeat the relay supply.)



UNDERSIDE OF PB-150 UNIT CUT AT "X" AND REWIRE AS SHOWN BY DOTTED LINES. (FAN MAY BE ATTACHED AT POINTS SHOWN BY ARROWS.)

The motor start time—at least on the units we modified—is fast enough to prevent "wow." The motor picks up speed before the puck engages the capstan. Although this idea would not work with machines having quicker engagement, it has functioned very well with those of considerable engagement travel. (The relay contacts which turn on the motor should be set to make as soon as practical upon relay activation, and should be cleaned and adjusted periodically.)

Relay contacts are bridged with a .05 600V capacitor such as used elsewhere in the units for suppression.

On models with no unused relay contacts, a supplementary relay could be used, activated by the same source as the solenoid relay. (An aditional relay—one with heavier contacts—might be a good idea anyway, although no problems have been encountered.)

As an added precaution against heating, we installed a small record player motor and fan inside the machine. There is room in the PB-150 for a small fan inside one of the perforated side panels. The fan motor was connected to the original motor-start wiring points, so that it comes on as soon as a cart is inserted and runs until the cartridge is removed.

Jack Thornton
KBND
Bend, Oregon

Equalizing telephone lines for remote radio pickup Part I

By David Talley*

Remote pickups have been used since the early days of radio broadcasting to supplement studio programs. They are an extension of the studio microphone often used for sporting events, such as baseball and basketball games, for on-the-spot news coverage and for important public gatherings especially during elections.

The current widespread use of taped programs for delayed broadcasts does not nullify the need for remote pickups. Because remote facilities may be used for both live and delayed broadcast programs, stations using remote programming may attract a larger audience by utilizing the live broadcast. Few people would care to listen to the delayed broadcast of a football game after the game had been played and the score announced.

Remote radio pickups are usually comprised of the following elements which are illustrated in Figure 1:

Microphones and associated amplifiers at the program pickup point or remote location; the program transmission facility (normally a leased telephone line) and the necessary interface equipment at the broadcast studio for properly receiving the remote audio program and its subsequent transmission.

Wireline Facilities

The type of transmission facility employed between the remote pickup point and the studio is the controlling link in this broadcasting chain. If it were feasible and economical to insall a UHF radio link (assuming FCC approval) for this purpose, there would be no wireline transmission and interface problems. The radio link could satisfactorily provide a 100-15000 Hz transmission facility between the remote location and the broadcast studio and there would be no need to install equalizing and other interface devices at the studio end.

*Telecommunications Consultant
New York, N.Y.

Wireline facilities however, are primarily utilized for remote radio pickups. They are usually leased from the local telephone company for the duration of the remote broadcast program. Several types of program circuits can generally be furnished for connection to remote pickups within the area served by the broadcast station. These circuits are normally provided for use on an occasional basis in accordance with the telephone company's tariffs. The following is a listing of typical program lines in the ascending order of their costs:

Schedule D: 100-3500 Hz (3 kHz)—For speech. Schedule B: 100-5000 Hz (5 kHz)—For speech and music. Schedule BB: 100-8000 Hz (8 kHz)—for speech and music. Schedule BBB: 100-15000 Hz (15 kHz)—FM Program Circuit. Dual channel is required for stereophonic use.

For many AM broadcast purposes, the 3 kHz program facility may prove satisfactory especially if speech only is to be transmitted from outdoor events such as, golf matches, meetings or baseball games. In general, it is desirable to utilize the 5 kHz program line for most remote pickups, but for important musical programs, the 8 kHz facility should be used. The 15 kHz program line need only be considered for use with FM broadcasting stations.

However, the same telephone cable-pair used for a Schedule D or 3 kHz circuit would not necessarily be suitable for a 5 kHz or 8 kHz program facility. In many instances, the 3 kHz telephone line, like almost all cable pairs used for subscribers telephone service, would be bridged to other cable pairs serving the particular central office area. The resultant increased capacitance and impedance changes may make it very difficult to properly equalize the line for either 5 kHz or 8 kHz transmissions. Therefore, the electrical characteristics of the telephone line determine the design of the equalizer and other interface equipment required at the studio end.

Distortion Effects of Telephone Line

When currents of a wide band of frequencies are transmitted over a telephone line not specifically equalized for these frequncies, distortion will result. This distortion is of two types. There is first, amplitude distortion which results because the loss or attenuation of the telephone line is not the same at all frequencies being transmitted and secondly, delay distortion caused by the currents of various frequencies requiring different time intervals to build up and decay.

Amplitude distortion in telephone circuits decreases the strength of the higher frequency currents more than the lower and therefore slightly narrows the transmitted frequency band. Amplitude distortion is very harmful to effective program transmission but can usually be corrected by the installation of an equalizer or other filter interface devices.

Delay distortion is distinctly different and is more difficult to correct. Its effect on speech and music is to prolong the interval of time required for the signal wave to build up to its full amplitude and the time needed for it to die down. Delay distortion effects may cause a slurring over the beginning and a dragging out of the ends of the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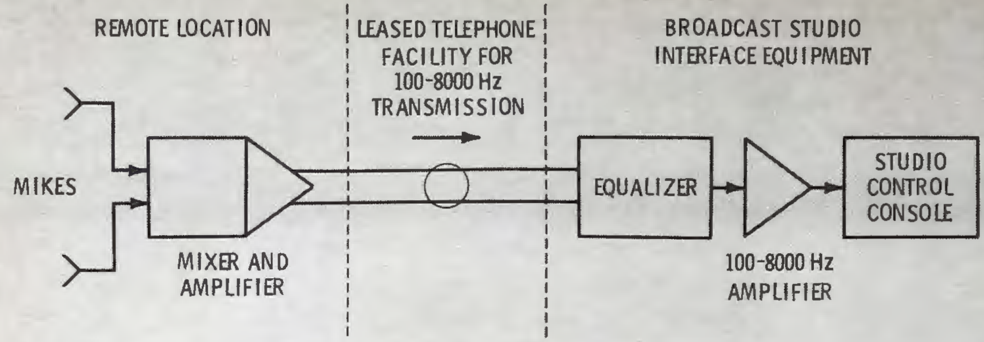

Fig. 1 Basic circuit elements of remote radio pickup.

voice sounds, thus imparting an unnatural character to the speech by giving it a hissing or fuzzy sound. The characters of a musical selection would be similarly affected. Considering the relative small distances (up to about 15 miles) usually involved for remote radio pickups, the delay distortion effects of leased telephone lines usually may be disregarded.

Transmission Theory Applied to Lines

A telephone line, such as a pair of wires in a cable, is fundamentally a medium for wave propagation. Voice- or audio-frequency transmission over a telephone line is electrical wave propagation in which the energy is confined to a particular bandwidth or channel such as the 100 to 8000 Hz frequency band normally used for radio program transmissions. The same general axioms covering energy propagation apply to telephone transmission lines. These precepts may be summarized as follows:

1. The amount of audio-frequency energy attenuated by the telephone line depends on the line constants or elements. They may be defined as combinations of distributed capacitance(C), distributed inductance(L), and the distributed resistance, both in the series form(R), as that of the conductors, and in the shunt or leakage form(G).

2. The speed of propagation or velocity at which the wave travels, depends upon the electrical characteristics of the telephone line as established by these line constants.

3. Energy will be reflected whenever the wave passes the junction of one transmission line with another, if the two lines have different electrical characteristics. This reflection of energy will result in a voltage standing-wave-ratio (VSWR) greater than 1, because of the change in the line's characteristic impedance.

Capacitance Effects

The capacitance of a cable pair increases with the size of its conductors, assuming the same separation between conductors and equivalent insulating material. This capitance is normally expressed in microfarads per loop mile. For example, 19 gauge cable has a capacitance of 0.084 uF/mile and 22 gauge is rated at 0.082 uF/mile. The distributed capacitance causes a capacitive reactance(Xc) to develop in the telephone line because of the changing audio currents. As a result, some of the audio-frequency currents would be shunted across the line and less of the energy would reach the studio end. Because Xc decereases as the frequency increases, the shunting effect of the capacitive reactance on the audio currents becomes greater with increased frequency.

Inductance Effects

The program wireline circuit also has inductance(L) distributed throughout its length. This inductance decreases as the diameter or gauge of the cable pair decreases. A counter-voltage is induced in the cable pair by the changing audio currents because of this series inductance. This counter-voltage or effect is termed inductive reactance (XL) and increases with frequency in accordance with the general formula for inductive reactance in Figure 2.

Line Resistance and Leakage Effects

The direct current (DC) resistance of a cable pair or telephone line is determined by the Ohm's Law measurements, usually indicated in ohms per loop mile. If a six mile long telephone circuit has a DC resistance of 275 ohms per conductor, its loop resistance will be 550 ohms. When audio-frequency currents are transmitted over a cable pair, the distributed resistance depends on the frequency of these currents and the wire size. This variation of resistance with frequency is caused by the "skin effect" of the alternating currents. That is, the currents of the higher audio frequencies tend to travel along the outer surface of the conductor instead of inside the wire. Consequently, the AC resistance or R of the cable pair will be greater than its measured DC resistance to voice-frequency currents.

Another effect, although normally very small, is the leakage between the conductors of a cable pair. Temperature and humidity changes effect this leakage factor which is called shunt conductance(G). It may also be expressed as the reciprocal of resistance.

This leakage acts as a shunt across the cable pair to the audio currents in a manner similar to that caused by a parallel resistance. Although it results in an additional loss to the transmission of audio signals along the telephone line, its effects may be generally disregarded in transmissions from remote pickup locations.

The second article in this series on the equalization of telephone lines for use in remote pickup will deal with the causes of the problems encountered in this area, how equalizing can eliminate these problems and the design and testing of an equalizer and other interface equipment required at the receiving end of the telephone line.

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Before joining the CPB, Macy served as chairman of the U.S. Civil Service Commission under both President Johnson and the late President Kennedy, and was executive vice president of Wesleyan University, Middletown, Conn. from 1958-1961. During his tenure at CSC, he introduced the use of television for employee and supervisory training and development through broadcasts on WETA, Washington's educational TV station. He was a consultant to the American Foundation for Continuing Education and participated in a major two-year study on Education for Public Responsibility as a consultant to the Fund for Adult Education.

Sir Charles Moses, secretary-general of the Asian Broadcasting Union, Sidney, Australia, will be the featured speaker at a general session, Wednesday morning, Nov. 12, at the convention. The subject of Sir Charles's address will be international broadcasting.

Sir Charles entered broadcasting in 1930 as an announcer and sports commentator for the Australian Broadcasting Commission in Melbourne. He became the ABC's Controller of Talks and School Broadcasts in 1934 and was appointed general manager in November, 1935, a position which he held for 30 years until he retired in 1965 to become secretary-general of the ABU.

During his term as chief executive for ABC, Sir Charles was responsible for introducing broadcasting in school systems throughout Australia; setting up the federal structure of ABC; establishing orchestras in every state, and introducing the ABC's independent news service.

In the international sphere, his status and achievements have led to his being made a member of the Councils of the recently established International Broadcast Institute, Rome, Italy; of the International Council of the Prix Jeunesse Foundation, Munich, Germany, and of the Asian Mass Communication Information and Research Center, Singapore, Malaysia.

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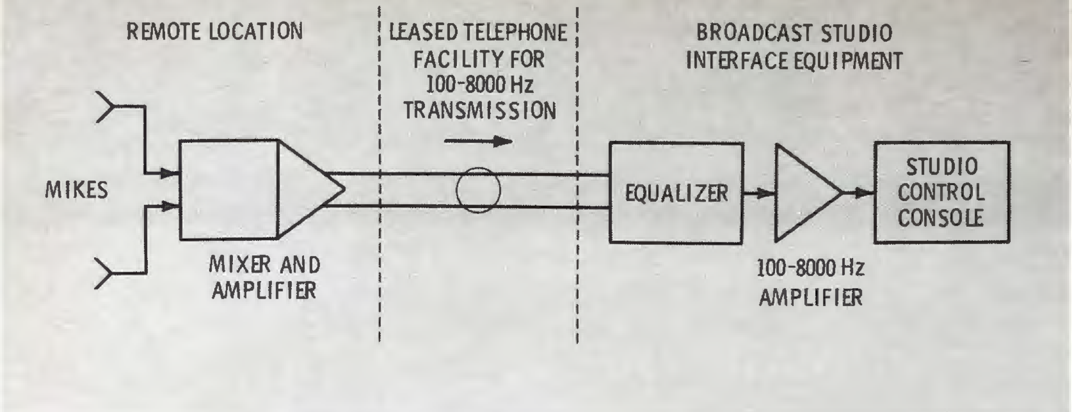

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TECHNICAL DATA

For further information, circle data identification number on reader service card.

101. **AEROVOX CORPORATION**—A 24-page catalog describes the company's complete line of precision instrument switches. Complete mechanical and electrical specifications are included for Series 14, 18, 22 and CES switches. Information is also provided on proper switch selection, prewired terminal boards, multiple deck units and MIL and hi-rel types. The switches may be used in computers, telemetering systems, test equipment, instruments, programming and automatic check-out equipment.

102. **ANDREW CORPORATION**—Catalog #26 contains product information and engineering data on microwave, fixed station and telemetry antennas, antenna positioners, Heliax® flexible coaxial cables and elliptical waveguides, coaxial switching and pressurization equipment and system accessories. The catalog features new product and system developments for military, broadcast and commercial applications.

103. **AMPHENOL DISTRIBUTOR DIV.** — Connectors, sockets and switches plus a new line of ten coaxial cable/connector assemblies are described in a general line catalog. Included are the 131 Series precision and 5116 Series Subminax rf connectors, tube and relay sockets, test and tip jacks, microphone connectors and home and industrial type ac plugs and receptacles. Photographs, line drawings, electrical characteristics and mechanical specifications are provided.

104. **B & K INSTRUMENTS, INC.**—Full specifications, applications and photographs of the Model 4117 Piezoelectric microphone are given in a two-page bulletin. The microphone is said to have dynamic range up to 140 dB sound pressure level. The bulletin suggests uses for the microphone with B & K sound level meters and sound distribution compensating systems in theaters, public adress systems and machinery monitoring systems.

105. **BECKMAN INSTRUMENTS, INC.** — Insulation test equipment, electronic test and measuring instruments, high-voltage power supplies and automatic component testers are covered in a 32-page catalog. Complete technical data and specifications are provided in the section on insulation test equipment. The high-voltage power supplies

section covers models ranging from packaged units to heavy-duty types for operation up to 50 kV.

106. **COHU ELECTRONICS**—Selection of vidicon image tubes for television cameras is the subject of data sheet 6-296. Operating characteristics, an illumination formula, tube selection table and special performance data in the two-page sheet describe the choice of vidicons available for TV cameras and applications.

107. **ECKEL INDUSTRIES, INC.**—"Anechoic Chambers," an 8-page illustrated publication discusses enclosures with An-Eck-Oic® wedge construction, engineered for acoustic research and testing usages. Portable chambers are also covered. Included in the brochure, #69063, are methods of testing within chambers, photograph of these techniques and brief specifications.

108. **GENISCO TECHNOLOGY CORP.**—The key features of the model 10-236 magnetic tape recorder are described in a recent bulletin. The recorder has a 300 foot tape capacity, Cobelt drive, variable tape speeds from 7½ to 120 ips and 14 channels of record.

109. **HALLICRAFTERS COMPANY**—The electrical and mechanical characteristics of a line of frequency instrumentation products are described in catalog #094-005173. Included are frequency synthesizers, multipliers, dividers, crystal frequency standards, precision crystal oscillators and component ovens.

110. **HEWLETT - PACKARD** — Application Note #922, "Applications of PIN Diodes," describes the use of PIN diodes in microwave switches, attenuators and phase-shifters. Included is a description of how the electrically-controllable resistances of the diodes at RF and higher frequencies are applied to a variety of circuits. Other sections discuss techniques for maximizing power handling capability and the effects of package parasitics on performance.

111. **JFD ELECTRONICS CO.**—The master antenna TV systems products guide is a catalog of solid state 82 channel MATV equipment. Included are antennas, preamplifiers, amplifiers, AGC units, filters, mixers, tapoffs, matching transformers, splitters, FM converters, traps, coaxial cable, connectors and terminators.

112. **LECTRONIC RESEARCH LABS**—Bulletin 92 is a presentation of microwave/waveguide components and equipment. Special sections are included on ferrite circulators and isolators, dummy loads, antenna horns, coaxial and waveguide switches, coaxial attenuators and terminations and slotted lines.

113. **NATIONAL SEMICONDUCTOR CORP.**—"National/883" is the title of a new brochure describing the Mil-Std-883 reliability program. The report describes the background, production and flow of 883 standard parts through processing and ordering.

114. **OAK MANUFACTURING CO.**—A catalog, "Distributor Switches", describes a line of low-power switches now available to electronic parts distributors. It contains data on rotary, pushbutton, lever and slide switches. Included are photographs, line drawings of electrical characteristics, mechanical specifications, prices and a cross reference selection guide.

115. **RADIAL CONTROLS** — An eight-page catalog covers over 50,000 available instrument knobs. Dimensions, price and choice of ten different colors are included. Knob models include round, index flange, pointer, pointer flange, concentrics and spinner type.

116. **RHG ELECTRONICS LAB.**—Catalog #704 describes the company's line of microwave transmitters, receivers and components. It contains specifications on over 300 models of microwave FM transmitters, receivers, mixer preamplifiers, linear and log amplifiers, discriminators, filters and multipliers and FM microwave re-

lay equipment including air-to-air and air-to-ground relay links and portable and fixed ground stations. Photos and technical specifications are included.

117. **ROME CABLE**—Low voltage power and control cables are described in "Rome XLP Insulated 600 Volt Power & Control Cables" (R-600-1). The bulletin contains specifications and splicing recommendations and information about pulling tensions, bending radii and pulling compounds.

118. **SONY CORPORATION**—Two data sheets on new video equipment are available. One describes the Model EV-320 color and monochrome video tape recording system. The sheet includes complete specifications, standard and optional accessories and a list of equipment applications for video equipment. The second data sheet details the model SEG-1 special effects generator, which provides effects such as switching, fading, superimposing or wiping two video signals.

119. **SPARTA ELECTRONIC CORP.**—An illustrated information folder covers the model 726 automatic program controller. The controller will provide 15, 30 and 60 minute format control for up to 24 hours, automatic on-time ID's, a priority interupt channel and overlap cueing. Technical information and specifications are included.

120. **SYLVANIA ELECTRIC PRODUCTS**—A brochure describing a systems approach to equipment support training offered to government and industry by Sylvania is now available. The systems approach identifies and evaluates course presentation.

121. **TELEMATION, INC.**—Two short-form catalogs are available for CATV and ETV, closed circuit and broadcast systems. The 12-page brochures include brief descriptions and illustrations of the company's line of television cameras, control equipment, switchers, film and optical systems and other equipment.

123. **TRIAD CORPORATION**—A new data sheet describes film movements. Included are a standard series for 16mm, 35mm, and 70mm film. Other items include film drive motors and takeup motors, movements for wide film and some examples of special movements.

124. **TRIPLETT CORPORATION** — A technical bulletin features a new battery-operated, handsize, solid state Volt - Ohm - Milliammeter model 310-FET. The bulletin provides a complete listing of all electrical and mechanical features and accessories.

125. **WABER ELECTRONICS**—A catalog containing a complete line of pre-wired power outlet boxes including more than 400 standard models and 150 illustrations is now available. Included are a variety of multiple pre-wired power outlet boxes for industry, institutional, school and home laboratory use.

NEW PRODUCTS

(Use circle number on reader service card for further information)

Channel Governor

Cable television system operators can now offer subscribers FM band reception through the use of two new solid state FM channel governors, developed by **Anaconda Electronics, Limited,** Vancouver, B.C.

Designated as Models 8710 and 8711, these crystal-controlled FM levellers are available for any FM frequency and will operate on input signals as low as –30 DBmV. The channel governor maintains a constant output level through input signal fading by means of a delayed AGC and limiter circuitry.

The new equipment has frequency ranges of 88 MHz to 108 MHz with an IF frequency of 20 MHz. Input levels range from a minimum of 30 microvolts to a minimum of 3 millivolts; there is no maximum when FM pads are used.

Other specifications include: band width, 250 KHz; stability, .005% crystal-controlled; and output level, adjustable from +35 to +50 DBmV. Shipping weight is six pounds and mounting requires a 19-inch rack and 3½ inch panel.

Circle Number 55 on Reader Reply Card

TV Demodulator

The new fully-transistorized TV Demodulator Type AMF of **Rohde and Schwarz** demodulates monochrome and color TV signals with color subcarriers (NTSC, SECAM and PAL) as well as TV sound signals on lower VHF, upper VHF and UHF. Good electrical characteristics and a sturdy mechanical design make this vestigial-sideband receiver with Nyquist slope a high-grade monitoring and measuring instrument.

The sound trap preceding the video demodulation can be switched off; the instrument has then a constant amplitude and group delay time up to 5 MHz.

The following measurements and checks can be made: (on the picture transmitter) display of the transient response, measurement of the video frequency response, the group delay time and the grey-scale distortion, monitoring the modulation of the transmitter for the 10% residual carrier by means of a switch-selected line synchronous zero reference pulse, monitoring the picture quality during monochrome and color transmissions; (on the sound transmitter) measurement of the AF frequency response, the modulation distortion, the intercarrier signal-to-noise ratio and monitoring the sound quality during transmission.

Demodulator

Circle Number 56 on Reader Reply Card

Digital Multimeter

A new digital multimeter introduced by **Philips Electronic Instruments** can make readings as low as 10 microvolts and 10 picoamperes and yet combines bench-application operating convenience with high flexibility teleprinter/recorder outputs for production line use.

Accessories allow 2 millivolt—140 volt RF voltage measurements at frequencies at high as 700 MHz.

Maximum resolution is 10 picoamperes in the 14.00 nanoampere range, and 0.01 ohm in the 14 ohm range. DC voltage readings are accurate to 0.1 percent ±1 digit, with a maximum resolution of 10 microvolts in the 14.00 millivolt range.

Circle Number 57 on Reader Reply Card

Plug-in Multimeter

Hewlett-Packard's new Model 5268A Frequency Multiplier Plug-in is an economical new approach to the problem of how to get good resolution when measuring low frequencies with an electronic counter. In operation, Model 5268A multiplies the frequency of a CW or pulse-train input signal by 10, 100, or 1000, depending upon the setting of a front-panel switch. It then applies the multiplied frequency to the counter. For a given gate time, the counter's resolution improves by the multiplying factor; or for a given resolution, the gate time can be decreased by the multiplying factor.

As an example of what the new Frequency Multiplier can do, suppose the frequency of a 60 Hz input signal is to be measured in one second. Counting the frequency directly, the counter would read 60 ±1 count. With Model 5268A, the reading becomes 60.000 ±2 counts in the least significant digit for the same one-second gate time. Alternatively, the gate time can be reduced to one millisecond and a reading of 60 ±1 count can be obtained in 1/1000 of the previous time.

Circle Number 58 on Reader Reply Card

Digital Ohmmeter

Push button operation of CALICO Model 8303 allows selection of 9 ranges from 1 ohm full-scale to 100 megohms full-scale. Accuracies are ±.02% of reading and ±.01% of full scale. The non-blinking readout presentation features five Nixie® digits, including overrange, with true electronic storage to prevent operator fatigue.

Resolution of .01% and 20%

overranging are provided in all 9 ranges. The **California Instruments** unit input cable features four-wire Kelvin compensation, terminated in gold-plated Kelvin clips. Resistance is measured at the points of contact with the test sample only, thereby eleminating errors attributable to input cable resistance. Input circuits are completely protected against inadvertent voltage inputs. (An input voltage of 115 VAC, for example, will not damage the instrument.) Recovery to within the specified accuracy is instantaneous upon removal of the input voltage.

The IC plug-in card construction and associated circuits are enclosed in an electronically guarded compartment which achieves 120 dB of common mode rejection. The meter is designed to reject noise and transients on the AC power line. BCD printout is available as an option.

Circle Number 59 on Reader Reply Card

Phono Cartridge

Shure Brothers Inc. has announced a new version of the Shure V-15 Type II Super Trackability Phono Cartridge, which delivers even greater trackability in base and mid-frequency ranges than does its predecessor.

Although the new V-15 Type II model looks the same as the previous model, it represents advances in continuing to increase trackability, not only at select and discrete frequencies, but across the entire audible spectrum at the lightest possible tracking forces.

It is capable of tracking the majority of records at ¾ gram, including those containing heavily modulated bass drum, tympani, organ pedal, bassoon, tuba, or piano passages. In the past, records containing this type of material may have required increasing the tracking force of most cartridges to avoid bass flutter or IM distortion.

Circle Number 60 on Reader Reply Card

Portable Reference Light

Here is a unique item for use in setting correct color balance of color monitors and receivers.

The new **Power-Optics** Bloctube is a simple, light-weight, but sturdy device consisting of a 12-inch long, ⅝-inch diameter, 6500K, long life fluorescent tube, together with a photographic step wedge inside a clear, high impact acrylic tube held firmly at each end in molded, shock absorbent fittings.

The materials for both the tube and the photographic wedge have been selected for their color neutrality over the required spectral range. The tube is independent of ambient temperature and voltage fluctuations.

The Bloctube is used in the black and white mode and held horizontally across the receiver or monitor tube face. By direct comparison at the appropriate brightness level, the picture, which is arranged to display a suitable monochrome test signal, can be adjusted for color balance at Illuminant D_{6500} and correct brightness.

Circle Number 61 on Reader Reply Card

Resistance Unit

Phipps & Bird, Inc. of Richmond, Virginia, has announced a new hand-size Resistance Substitution Unit that can be used as a decade resistor or as a voltage divider, for instant repair and troubleshooting. It provides a flexible and accurate source of resistance for the determination of resistance values in development circuits.

The new instrument can be used in schools, laboratories, and for use in electronic research. In addition, because of the modest price, it will enable every technician to have his own sophisticated resistance substitution unit.

Seven decade ranges provide 1 to 1,111,110 ohms in 1 ohm steps. All resistors are 1% tolerance, ½ watt. The unit is supplied in a shielded aluminum case 4" x 6" x 1½".

Circle Number 62 on Reader Reply Card

Volt-Ohmmeter

The new Model 116 Solid State Volt-Ohmmeter by **Electronic Measurements Corporation** offers all the advantages of an AC-operated VTVM—accuracy, stability and versatility—but eliminates all its disadvantages: there's now no plugging into an AC outlet, no waiting for warm-up, no bulky size.

By virtue of its FET design, it achieves low loading (DC input Z is 11 megohms; AC input Z is 1 megohm) as well as a sensitivity that is 500-times that of a standard 20,000 ohms-per-volt volt-ohmmeter. Its 4½" 200 microamp meter and solid state circuitry are protected against burnout. The housing is high impact bakelite, with handle useable as instrument stand. Zero center position is available.

The unit offers: an FET transistor, 4 silicon transistors and 2 diodes; four Peak-To-Peak AC voltage ranges: 0 to 3.3, 33, 330, 1200 volts; four RMS AC voltage ranges: 0 to 1.2, 12, 120, 1200 volts; four DC voltage ranges: 0 to 1.2, 12, 120, 1200 volts; four resistance ranges: 0 to 1K, 0 to 100K, 0 to 10 meg., 0 to 100K, 0 to 1000 meg.; and four dB ranges: –24 to +56B. Size 5¼" x 6¾" x 2⅞".

Circle Number 63 on Reader Reply Card

Stereo Preamp

QRK Electronic Products announces the availability of a monaural and Stereo Equalized Pre-Amplifier with more "headroom". These equalized turntable pre-amplifiers, called "Ultimate I and Ultimate II", will produce +10 dBm output at .08% distortion with a signal to noise ratio of 75 dB and a separation between channels in excess of 60 dB. They are supplied with self-contained power supply and balanced magnetically shielded output transformers.

Circle Number 64 on Reader Reply Card

FM Modulation Monitor

McMartin Industries, Inc. has developed a new FM modulation monitor calibrator. Designated as Model TX-300, it simplifies monitor calibration test procedures. In addition, it reduces the time required for precise determination of ± 75 KHz deviation (100% modulation) of transmitters operating in the FM broadcast band. The new calibrator is capable of modulation percentage measurements to within 0.25 dB accuracy.

The receiver portion of the TX-300 consists of an input mixer which produces a 10.7 MHz intermediate frequency, resulting from the heterodyning of the FM transmitter operating frequency. The 10.7 MHz signal is filtered, amplified and detected and the detector output signal is displayed on a front panel null indication meter.

Operation of the TX-300 is based on Bessel functions and requires only a few minutes from setup to completion.

Circle Number 65 on Reader Reply Card

Keyer Parts
(Continued from page 10)

R-37	2.7 K	R-48	100 K
R-38	3.3 K	R-49	27 K
R-39	39 Ohms	R-50	15 K
R-40	1 K	R-51	2.2 K
R-41	1 K	R-52	120 K
R-42	250 Ohms	R-53	120 K
R-43	680 Ohms	R-54	4.7 K
R-44	2.2 K	R-55	2.5 K, 2W—AB type
R-45	2.2 K	R-56	68 Ohms 2 watt
R-46	2.5 K POT, 2W- AB type	R-57	2.2 K ½ watt
R-47	150 K	R-58	68 Ohms 2 watt

48 ¼ watt 5% resistors in the following values

3	3.3 K Ohms	4	39 Ohms
2	4.7 K Ohms	2	75 Ohms
1	10 K Ohms	3	240 Ohms
1	15 K Ohms	8	680 Ohms
1	27 K Ohms	7	1 K Ohms
1	100 K Ohms	4	2.2 K Ohms
4	120 K Ohms	5	2.7 K Ohms
1	150 K Ohms	1	3.0 K Ohms

1	3½" Gray blank rack panel
1	3½" Blank bathtub chassis
10	Chassis mount BNC connectors UG 290/U
10	Cable mount BNC connectors UG 260/U
1	12.6 Volt filament transformer (Thordarson 26 F 67 or equiv.)
2	1N4736A 6.8 volt Zenir Diodes (or equiv)
4	1 Amp/50--volt diodes (HEP 170)
1	40319 RCA transistor
1	2N3053 RCA transistor
4	1000 UF/15 Volt capacitors
1	HKL indicating fuse holder
1	Pilot Lamp Assembly for #327 Lamps
7	Asst. Test points
2	RCA CA-3036
1	RCA CA-3005
1	RCA CA-3001
2	RCA CA-3018
23	RF Chokes-Miller 9310-40 (No Subs)
24	56pf Ceramic Capacitors (Aervox ADM-10-560)
2	3 Pole 12 Position Ceramic Switches (Centralab PA-2009 or Equiv.)
1	Dual 200 Ohm c.t. Pot
10	100 Ohm 1%, resistors
1	Molded AC cord with plug
3	AB series pots (500 Ohm, 2.5K, 2.5K)
2	Omite AFR 252 M, 2.5K Pots (No Subs)
1	AB series POT, 5K, with shaft lock
20	Elect. caps 100UF/15 Volt (Spragus TE-1162 or Equiv.)
1	2N3638A
1	2N3856
2	680 Ohm ½ watt Res.
2	2N708
2	68 ohm 2 watt Res.
1	2.2K ½ watt Res.
1	4.7 K ½ watt Res.
1	2.5 K Pot (Any type)
1	.02 UF/50 Volt (or higher) Cap.
1	10 Volt/1 watt Zenir Diode
6	6 Terminal, terminal strips

PEOPLE IN THE NEWS

Lang Accepts IEC's Philippine Position

G. William Lang of Elgin, Ill., Engineering Consultant to the president and vice president of WGN Continental Broadcasting Company, has accepted an assignment with the International Executive Corps. He will serve as a volunteer executive to the Associated Broadcasting Company in Manila, Philippine Islands.

Lang is a pioneer in the radio field. He built his first broadcast transmitter in 1922 for station WFAU in Boston. In 1924, he joined the Westinghouse Company Broadcasting Division at stations WBZ-WBZA in Boston and Springfield, Mass. Lang joined WGN in Chicago in 1929 and has served as an engineer for radio, FM and television and as Chief Engineer of Radio.

Since its beginning in 1965, IESC has sent executives like Lang to over 1535 enterprises in 44 countries in Latin America the Middle East, Africa and South and East Asia. Its volunteer executives have worked on food production, health standards, textile and apparel manufacture, investment and banking systems, industrial processes, merchandising and market programs, mining and natural resource development, government and educational services and communications and tourist facilities.

Send Your News Of Staff Honors And Changes To Broadcast Engineering

Sherman Is Named To Engineering Post

John M. Sherman has been named Director of Engineering for Midwest Radio and Television, Inc. by Lawrence F. Haeg, president of the corporation.

Sherman was responsible for engineering at WCCO Radio and WCCO Television. Now his sphere of influence has been expanded to cover WCCO-FM and the company's CATV properties.

J. M. Sherman

A pioneer in broadcast engineering, Sherman has been a consultant in assisting applicants in putting both radio and TV stations on the air. He has been responsible for the establishment of four TV stations and more than a dozen radio and FM stations through the years.

Other Appointments

Recently-elected officers of the California CATV Association are **Keith Burcham,** Coachella Valley Television, president; **Vernon Gill,** Times Mirror Co., vice president; **Kester Kreig,** TelePrompTer of Santa Cruz, vice president-technical; **Geoffery Nathanson,** Harriscope Cable Corp., secretary and **Bill Hargan,** Comas Signal Corp., Pinnole, treasurer.

Harry W. Hoth, president of KRDO Radio and TV in Colorado Springs, Colorado has been named that state's Broadcaster of the Year by the Colorado Broadcasters Association.

Engineers On the Move: Promotions and Appointments

New Engineering Chiefs

Elmer Smalling III has joined the Westinghouse Broadcasting Co. and KYW-TV in Philadelphia, Pa. as chief engineer. He succeeds **Charles Magee** who is now with Westinghouse Broadcasting in New York City as manager of engineering for all stations.

Smalling is a member of the Royal Television Society of London, the IEEE, SMPTE, SBE, the Franklin Institute of Phlidalphia and the American Chemical Society.

O. T. Lester, engineering technician, has been promoted to maintenance supervisor at Kaiser's WKBF-TV Cleveland, Ohio. Lester joined the station in 1967 before it began operation.

He was previously a technician with WKTR-TV, Dayton, Ohio.

Paul Steele, producer/director at WBZ-TV Boston, has joined Kaiser-Globe Broadcasting's WKBG-TV in a similar capacity. Steele previously was supervising producer/director at WTMJ-TV, Milwaukee.

Jerry D. Blandenbeker has been made chief engineer for WGHP-TV, High Point, N.C. He was formerly assistant chief engineer wtih WLWI-TV in Indianapolis, Indiana.

Charles Paul Crossno, electronics engineer for Continental Electronics Mfg. Co., has joined Wagenvoord Broadcasting Co., as director of engineering. His engineering responsibilities will also include the company's AM/FM facility in New Orleans and station KRBE in Houston, Texas.

Robert O. Donahue has joined WJZ-TV, Channel 13, Baltimore, Md. Donahue came to WJZ-TV from KDKA-TV, Pittsburgh, WJZ-TV's sister Group W (Westinghouse Broadcasting Company) station.

He is a member of the Society of Broadcast Engineers and the Society of Motion Picture and Television Engineers.

Lawrence A. Wilkinson has been named chief engineer of Metromedia's KNEW Radio in San Francisco. He is replacing **Fred West** who has joined KNEW-TV as chief engineer.

Wilkinson was chief engineer at WCBM in Baltimore.

E. Allen Brown has been named chief engineer of radio stations WJEJ and WJEJ-FM, Hagerstown, Md. He succeeds Harry E. Hager.

Brown is active in amateur radio and is a member of the Antietam Radio Association. He has been with the Hagerstown Broadcasting Co. since 1968.

Call For Technical Papers Given By National Associations

A call for papers has been issued for the Joint Conference on Automatic Test Systems to be held April 14-16 in Birmingham, Warwickshire, England.

The conference will be concerned with the present state of the automatic test field and the probable direction of future developments. Papers will deal with industrial, transport, avaiation and military applications, the techniques available and under development and the operational problems presented by the employment of automatic test and performance evaluation systems.

Papers should describe the progress made and the future prospects in any sphere of automatic testing and performance evaluation including: the determination of operational requirements; language; program preparation, proving and up-dating; measurement, stimuli, response and calculating devices; switching and connection networks; interface problems between automatic test system and items under test; control, command and communication systems; operation participation and man machine interfaces; management aspects and user organizational problems; use of test results for statistical purposes; the impact of automatic testing on equipment design and future trends.

Synopsis of proposed contributions are invited and should be sent no later than Oct. 31 to The Secretary, Organizing Committee for the Conference on Automatic Test Systems, The Institution of Electronic and Radio Engineers, 8-9, Bedford Square, London, W.C. 1, England.

The synopsis should be about 200 words long. Papers in final form will be due by Dec. 31.

Symposium Papers

Copies of the Proceedings of the 23rd Annual Symposium on Frequency Control have been printed and are available at $6.50 per copy through the Electronic Industries Association, 2001 Eye Street, N.W., Washington, D.C. 20006. The symposium was sponsored by the Solid State and Frequency Control Division, Electronic Components Laboratory, U.S. Army Electronics Command, Ft. Monmouth, N.J.

Included in the Proceedings are 42 papers presented during technical sessions on the following subjects: Trends in Frequency Control Applications, Fundamental Crystal Studies and Crystal Filters, Crystal Measuring Problems, Crystal Design Engineering and Processing, Oscillators, Synthesizers and Circuits, Timekeeping and Distribution, Atomic and Molecular Frequency Control and Optical Frequency Control.

Orders for the Proceedings, accompanied by a check made payable to EIA, should be sent to the Publications Committee, Annual Frequency Control Symposium, at EIA headquarters.

Associations Set Conference Dates

The long hot summer is over and, as the news indicates, the annual conventions are back in full swing. Since there are so many new products being exhibited and since preliminary session plans include many high interest technical papers, engineers and technicians with an eye on the future should now be selecting the seminars, symposiums and conventions pertinent to their jobs.

For a more complete list of meetings, see the Industry Calendar on page 76.

NAB Meets

The National Association of Broadcasters has announced that license renewals, cigarette advertising, community antenna television and pay-TV will be major topics of discussion during its six Fall Conferences in October and November.

Other highlights include a presentation on plans for the 1970 observance of broadcasting's 50th anniversary and a panel discussion on cost savings for radio and television stations.

Vincent T. Wasilewski, NAB president, will deliver the featured luncheon address at each day-and-a-half meeting.

The Conferences will be held in Chicago, Ill., Oct. 23-24; in Boston, Mass., Oct. 27-28; in Atlanta, Ga., Oct. 30-31; in Dallas, Tex., Nov. 13-14; in Denver, Colo., Nov. 17-18 and Portland, Ore., Nov. 20-21.

A panel on cigarettes, CATV and pay-TV will be moderated at each conference by Willard E. Walbridge, KTRK-TV, Houston, Tex., chairman of NAB's Board of Directors. Panelists will be five station executives and five NAB staff members.

A license renewal panel will feature top staff members of the Federal Communications Commission, NAB's general counsel and a member of the Federal Communications Bar Association.

KARB Conference

The second annual Kansas Association of Radio Broadcasters Managers' Seminar is scheduled for November 21 at the Ramada Inn in Lawrence, Kan. The seminar will include round table discussions of the current problems facing radio managers and upcoming legislative activities in the radio field.

INDUSTRY CALENDAR

OCTOBER

18-21 The North Carolina Association of Broadcasters will sponsor its annual fall convention at the Robert E. Lee hotel, Winston-Salem, North Carolina.

20-23 The fall conference of the Electronic Industries Association will be held in Los Angeles.

22-24 The Indiana Broadcasters Association annual fall convention at the Sheraton hotel in French Lick.

23-24 The Ohio Association of Broadcasters will hold its annual fall convention at Neil House in Columbus, Ohio.

29-31 The Illinois Association of Broadcasters annual fall convention at the Drake-Oakbrook hotel in Oakbrook, Illinois.

NOVEMBER

8-12 The annual convention of the National Association of Educational Broadcasters at the Sheraton-Park hotel, Washington.

9-12 The Marriott motor hotel in Philadelphia will be be the site of the annual seminar of the Broadcasters Promotion Association.

21 The Kansas Association of Broadcasters will host its annual fall management seminar at the Ramada Inn in Lawrence, Kansas.

DECEMBER

8-12 The National Association of Broadcasters will sponsor its annual engineering/management seminar at Purdue University in West Lafayette, Indiana.

15 The presentation of the first national awards in communications media by the American Civil Liberties Union will be held in New York.

JANUARY 1970

19-23 The winter meeting of the National Association of Broadcasters board of directors will be at the Sheraton Maui hotel in Maui, Hawaii.

26-29 The National Association of Religious Broadcasters will hold its annual convention in Washington.

Advertisers' Index

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Advertising rates in Classified Section are 15¢ per word, each insertion, and must be accompanied by cash to insure publication.

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IMMEDIATE OPENINGS: Qualify for any of the following positions: RCA CCTV Equipment, monochrome or color, TV Systems Engineers - Maintenance Technicians - Video Engineers - to work in either New York, New Jersey or California area. Write: RCA Rep., 1559 Jericho Tpke., New Hyde Park, New York 11040. tf

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, 3924 Wilshire Blvd., Los Angeles, California 90005. Telephone DU 8-3116. By Broadcasters—For Broadcasters. 11-68-tf

HELP WANTED—TECHNICAL
Combined AM-FM-TV facility in medium sized Minnesota market has opening for assistant chief engineer. College background preferred. Contact Broadcast Engineering, Dept. 232, 1014 Wyandotte St., Kansas City, Mo. 64105. 10-69-1t

CHIEF ENGINEER for full color network station in pleasant southeastern medium market, a scenic land of lakes and mountains. Fine educational facilities for your children in a community noted for its friendliness and charm. Our TV and radio stations are a part of a young, growing group. We offer excellent fringe benefits including profit sharing. Call Eddie Walker, Director of Engineering, WDEF-TV, Chattanooga, Tennessee. 615-267-3392. 10-69-1t

ENGINEERING POSITION

Senior Engineering Position will shortly become available in Canada. Duties include the overall maintenance responsibilities of a color Broadcast Origination Centre. Knowledge of Ampex equipment, color Telecine, plus a good solid state background are absolute requisites. Staff benefits are excellent. Salary commensurate with previous experience. Write in confidence to Broadcast Engineering, Dept. 234, 1014 Wyandotte St., Kansas City, Mo. 64105.

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