TELE-TECH

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TELEVISION • TELECOMMUNICATIONS • RADIO

Photo: Dr. Harvard B. Vincent, Director of Product Development, American Structural Products Co., Toledo, Ohio, inspects face plate of a new 16-in. all-glass rectangular television bulb. The bulb at left is emerging from an annealing lehr on a special asbestos carrier.

Microwave Frequency Standard for Radar • Audio Equalization by Selective Negative Feedback • Cathode Ray Sweep Transformer with Ceramic Iron Core

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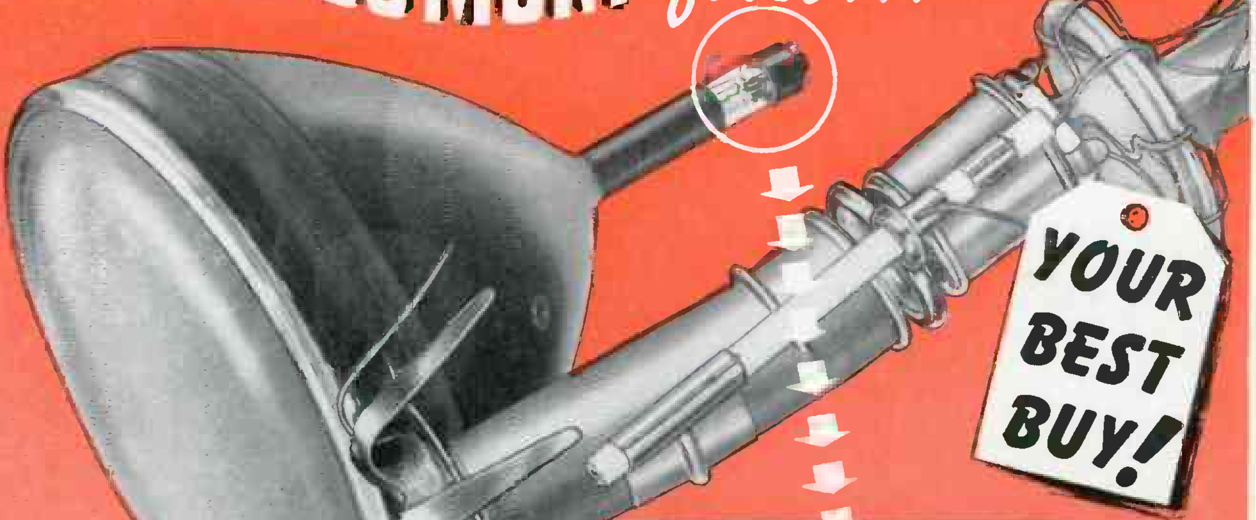
December • 1949 CALDWELL-CLEMENTS, INC.

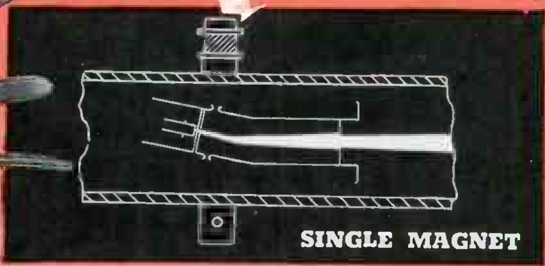
another DUMONT first...

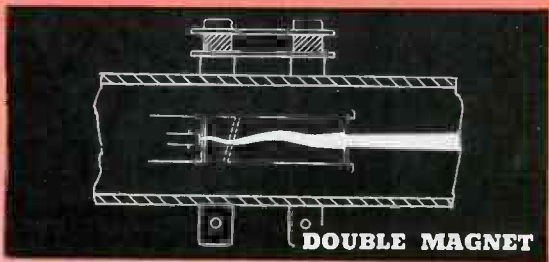


BENT-GUN Teletrons*

The new Du Mont Types 12RP4 and 15DP4 (replacing respectively Types 12JP4 and 15AP4) feature the exclusive Du Mont bent-gun. This ion-trap design eliminates ion-spot blemishes while maintaining an undistorted spot for maximum pictorial resolution. Meanwhile, lead-free glass reduces tube weight considerably. Five-pin duodecal base permits using the new half-socket for a significant saving, although old-type full-socket also accommodates these new tubes without modification.

Definitely "Your best buy!" For initial-equipment or replacement purposes — for superlative performance and longest service — insist on Du Mont Teletrons!





Above: Du Mont bent-gun principle, utilizing single ion-trap magnet. Space saved by eliminating double beam-bending magnet results in shorter neck length. Focussed-spot distortion eliminated by use of electrode parts designed to form symmetrical electrostatic fields in G_2 space. Lower-cost magnet.

Below: Conventional straight-gun design. Ion and electron beam is twisted by slanting electrostatic field between second grid and anode, requiring TWO bending magnetic fields. More costly beam-bender. Longer neck. Focussed-spot distortion.

Write for latest literature.

*TRADE MARK

FIRST WITH THE FINEST IN T-V TUBES

DUMONT Teletrons

ALLEN B. DU MONT LABORATORIES, INC. • TUBE DIVISION • PASSAIC, NEW JERSEY

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Edited for the 15,000 top influential engineers in the Tele-communications industry. Tele-Tech each month brings clearly written, compact, and authoritative articles and summaries of the latest technological developments to the busy executive. Aside from its engineering articles dealing with manufacture and operation of new communications equipment, Tele-Tech is widely recognized for comprehensive analyses and statistical surveys of trends in the industry. Its timely reports and interpretations of governmental activity with regard to regulation, purchasing, research, and development are sought by the leaders in the many engineering fields listed below

•

Manufacturing

TELEVISION • FM
LONG & SHORT WAVE RADIO
AUDIO AMPLIFYING EQUIPMENT
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Research, design and production of special types

TUBES, AMPLIFIERS, OSCILLATORS, RECTIFIERS, TIMERS, COUNTERS, ETC. FOR LABORATORY • INDUSTRIAL USE
ATOMIC CONTROL

Operation

Installation, operation and maintenance of telecommunications equipment in the fields of

BROADCASTING • RECORDING
AUDIO & SOUND • MUNICIPAL
MOBILE • AVIATION
COMMERCIAL • GOVERNMENT

DECEMBER, 1949

COVER: Dr. Harvard B. Vincent, Director of Product Development, American Structural Products Co., Toledo, Ohio inspecting face plate of a new 16-in. diagonal all-glass rectangular television bulb. These bulbs are designed to receive 100% of the transmitted picture information and will permit the housing of TV receivers in smaller cabinets. The 16 in. diagonal tube is said to fit into the cabinet of any 12½-in. table model now marketed and provides 138.7 sq. in. of usable screen area. It weighs 15¾ lbs., is about 18 in. long and has a 70° deflection angle. Other rectangular designs include bulbs with a 13-11/16 and an 18⅝-in. diagonal that provide usable screen areas of 97.8 and 189.3 sq. in. respectively.

CALDWELL-CLEMENTS, INC., Publication Office, Orange, Conn., Editorial & Executive Offices 480 Lexington Ave., New York 17, N. Y., Tel. Plaza 3-1340

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Designers

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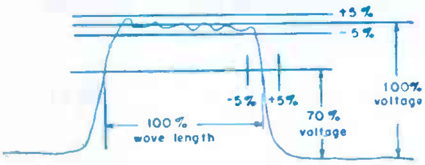
These 15-, 25-, and 50-va G-E voltage-stabilizer units are only a little over 2 inches high and about 9 inches long. They'll mount easily on a medium-sized radio or electronic instrument chassis and will give you an even, non-fluctuating 115 volts for your equipment whether your line voltage is 95 or 130. A special transformer circuit provides a stabilized output voltage within 1% of 115 volts for fixed, unity-power-factor loads.

Continuous operation under conditions of short or open circuits will not damage the stabilizer in any way. Since there are no moving parts, there is little maintenance to worry about. For complete information on voltage-stabilizer units of all sizes from 15-va to 5000-va, write for Bulletin GEA-3634.

AN EASY WAY TO PRODUCE SQUARE WAVES



Specially designed G-E Type-E networks will produce impulses which have definite, known energy contents and durations, and thus are ideal for converting a-c or d-c charging voltages into approximately rectangular square waves. These networks consist of capacitor and coil sections adjusted to close tolerances and hermetically sealed in single metal containers.

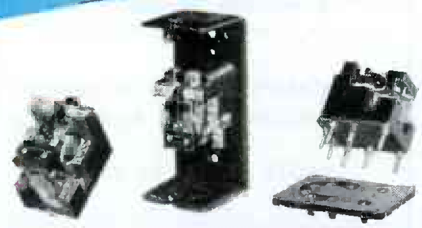
G. E. helped meet wartime radar demands with thousands of these units and now offers them for commercial use. They are available in a wide range of designs, impedances, ratings, and sizes for pulse lengths of 0.1 to 40 microseconds. See Bulletin GEA-4996.

GENERAL ELECTRIC

667-3

Digest

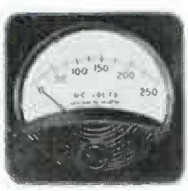
TIMELY HIGHLIGHTS ON G-E COMPONENTS



HEAVY-DUTY RELAYS THAT MOUNT 3 WAYS

This versatile, general-purpose, heavy-duty, a-c relay unit is available in three mounting arrangements: front connected, back connected, or plug-in connected. All three mounting types are available in open or enclosed models and are furnished in spst, dpst, or dpdt circuits. Heavy, long-lasting silver contacts carry 10 amps continuous. Normally-open forms make or break 45 amps; normally-closed forms make or break 20 amps. Relay coils come in 12-, 24-, 115-, or 230-volt, 60-cycle a-c sizes. D-c units are available in similar models. For full details see GEC-257.

ACCURATE BUT RUGGED



The new, modern-looking, easy-to-read 2½ inch G-E instrument line is improved inside as well as outside. A single, self-contained mechanism supported on an extremely strong Alnico magnet assures permanent alignment even under the most adverse operating conditions. This high-gauss Alnico magnet permits the use of a large air gap with a consequent smoother, non-sticking action. The greater torque-to-weight ratio means better damping and allows the use of heavier vibration-resisting pivots. Accuracy is 5% of full scale on rectifier types, 2% on all others. For complete details, send for Bulletin GEC-368.

SNAP-SWITCH INSTALLATION TIME CUT TO SECONDS

You'll have a firm electrical connection without the use of solder a few seconds after you begin to install this small but rugged Switchette. Only 1½ inches long and weighing only 9 grams, this 230-vac, 10-amp unit has solderless knife-contact terminals made of pure, tinned copper.

G-E Switchettes are available in a variety of forms and circuits, all of which have double-break contact structures. They're particularly well suited for electronic applications because of their low RF noise output (short contact-bounce).

For your convenience there are screw-terminal and soldering-lug types as well as this special quick-connect unit. Send for Bulletin GEA-4888.

A SMALL PACKAGE OF WELL-REGULATED HIGH VOLTAGE

You get both high voltage and good regulation with small lightweight G-E precision rectifiers. This may interest you if you need compact, well-regulated, high d-c voltage sources for cathode-ray tubes, television camera tubes, radar indicator scopes, electron microscopes, Geiger-Mueller counters, or similar jobs.

These supplies are hermetically sealed and oil-filled. Typical units have outputs of 7 kv at 0.1 ma.—have only 3.5% deviation for every 0.1 ma load and output ripple of less than 1%. Size—only 6" x 6" x 7". Weight—8 lbs. For further data, write: General Electric Company, Section 667-3, Schenectady 5, N. Y., giving complete information on the proposed application with specifications required.

General Electric Company, Section F667-3
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:

- ☐ GEA-3634 Voltage stabilizers
- ☐ GEA-4888 Switchettes
- ☐ GEA-4996 Capacitor networks
- ☐ GEC-257 Heavy-duty relays
- ☐ GEC-368 Instruments

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NEW PRESTO
PORTABLE TAPE RECORDER

PRESTO'S PT-900 is the answer for delayed sports broadcasts—field recording—wherever there is a need for a portable recorder of complete broadcast quality. Look at these outstanding engineering features:

• Three separate heads for superior performance (and for monitoring direct from tape). One head each to erase, record and play back. • 3 microphone channels with master gain control in recording amplifier. • Large V.U. meter with illuminated dial to indicate recording level, playback output level, bias current and erase current, and level for telephone line. • 2-speed, single motor drive system. Toggle switch to change tape speeds from 7½" to 15" per second.

Don't choose your tape recorder until you see the *new* Presto Portable Tape Recorder. Write for complete details today.

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WORLD'S GREATEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT AND DISCS

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PERFORMANCE

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To insure dependable circuits in your product, specify the capacitors that perform reliably under extremes of temperature and climate —

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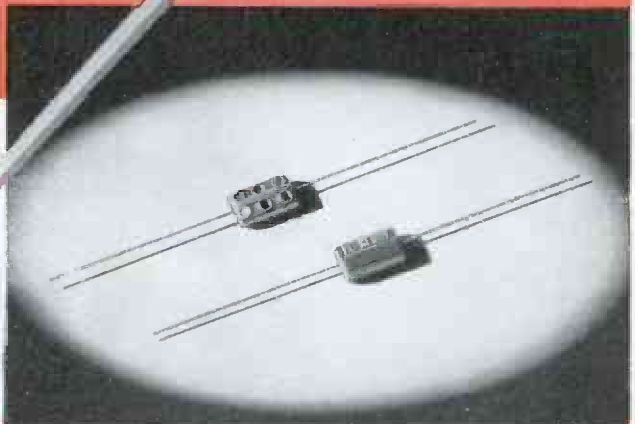

These fixed mica dielectric receiving capacitors maintain their reputation for dependable operation under all conditions by passing rigid tests before leaving the factory. Tests include temperature co-efficient and capacitance drift, humidity, life, insulation resistance, etc. In addition these tiny condensers are sealed for salt water immersion. All tests are run at double their working voltage.

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Specify Pretested Capacitors by El-Menco . . .

THEY GIVE EXACTING PERFORMANCE UNDER CRITICAL CONDITIONS

CM 15 MINIATURE CAPACITOR

Actual Size 9/32" x ½" x 3/16"
For Television, Radio and other Electronic Applications
2 — 420 mmf. cap. at 500v DCw
2 — 525 mmf. cap. at 300v DCw
Temp. Co-efficient ±50 parts per million per degree C for most capacity values.
6-dot color coded.

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Write on your firm letterhead for Catalog and Samples

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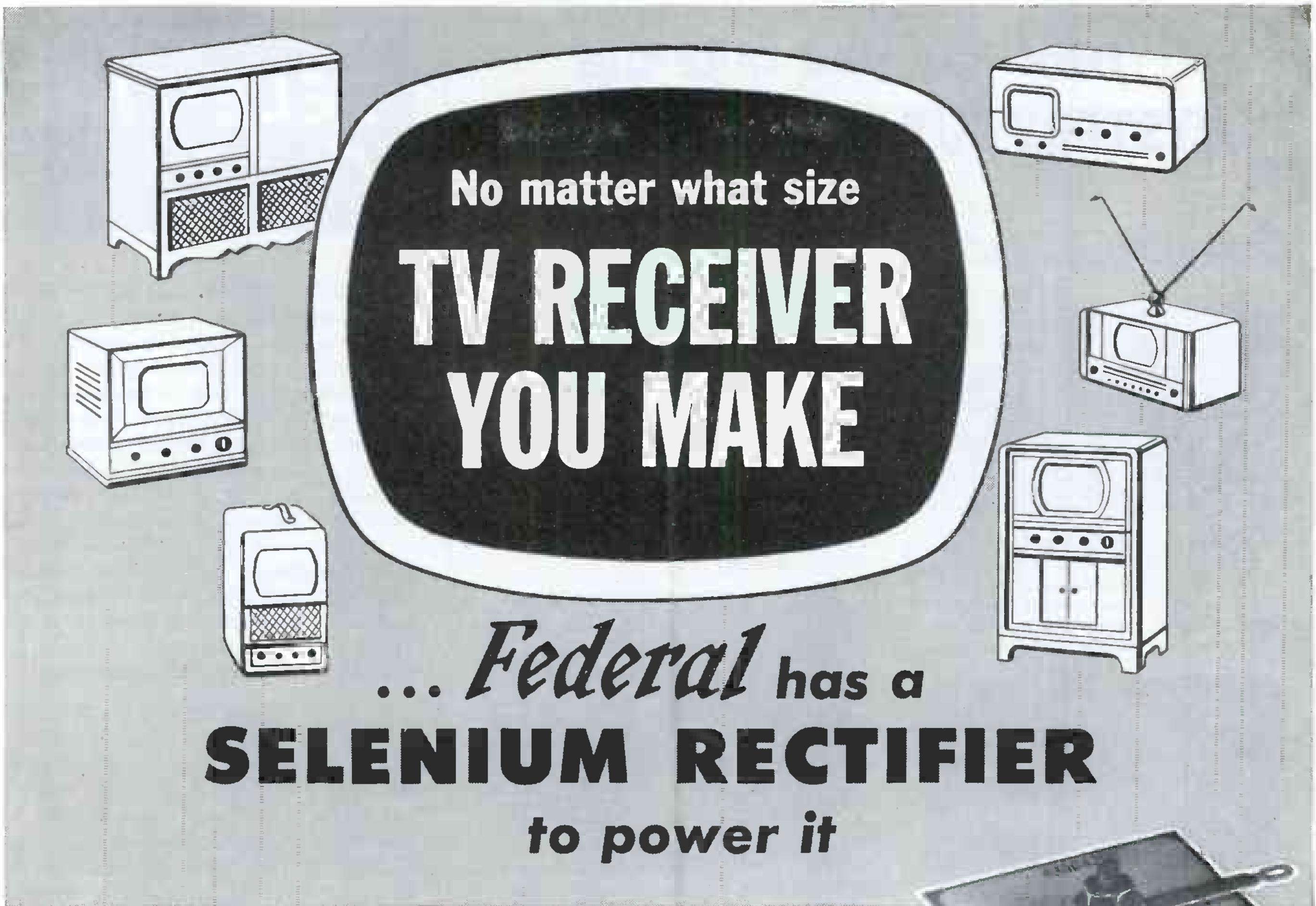
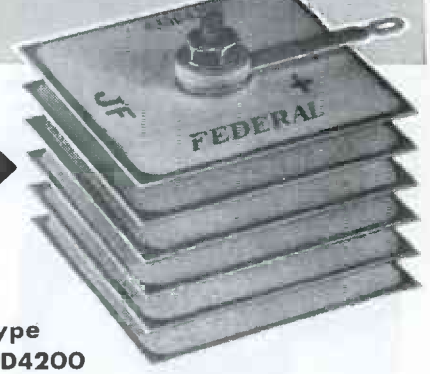


New 350 Ma. Miniature Selenium Rectifier brings to the largest TV consoles the same savings in weight and cost now being made in smaller sets



Type 439D4200
D.C. Output—350 Ma.

NOW—from the smallest to the largest sets—you can power your *complete* line of television receivers with Federal's weight-saving, money-saving Miniature Selenium Rectifiers.

Federal's line of Miniature Rectifiers... including the latest addition, the 350 ma. model... is *engineered* to meet the power requirements in *all* television receivers—regardless of screen-size or the number of tubes. Two small rectifier stacks, two capacitors and a resistor are all that's required—components that can be mounted anywhere in your chassis and remove *pounds* of useless weight.

Leading television manufacturers designed Federal selenium rectifiers into 7″, 10″, 12″ and 16″ television receivers during the past two years. Now this proven, simple and *efficient* method of supplying B+ power for television receivers can be used in even the largest direct-view receivers. For complete information or engineering data write to Dept. F-666.

Send for Federal's new Miniature Selenium Rectifier Handbook . . . 48 pages of valuable design data. Available for 25 cents (coin only).

Federal Telephone and Radio Corporation

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SELENIUM and INTELIN DIVISION, 900 Passaic Ave., East Newark, New Jersey

In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
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TELE-TIPS

TWELVE-FOLD EXPANSION of radio-electronic manufacturing facilities would be needed in event of a war emergency, according to an inside estimate now circulating in Washington. We have previously guessed that our present great plant capacity would have to be doubled or tripled, but semi-official figures, based on the enormous requirements of radio, radar and electronic equipment for planes, ships, tanks, defense nets, etc., now "up" such needed expansion to 12 times existing factories. These estimates pale 1944's miracle $6 billions output into insignificance!

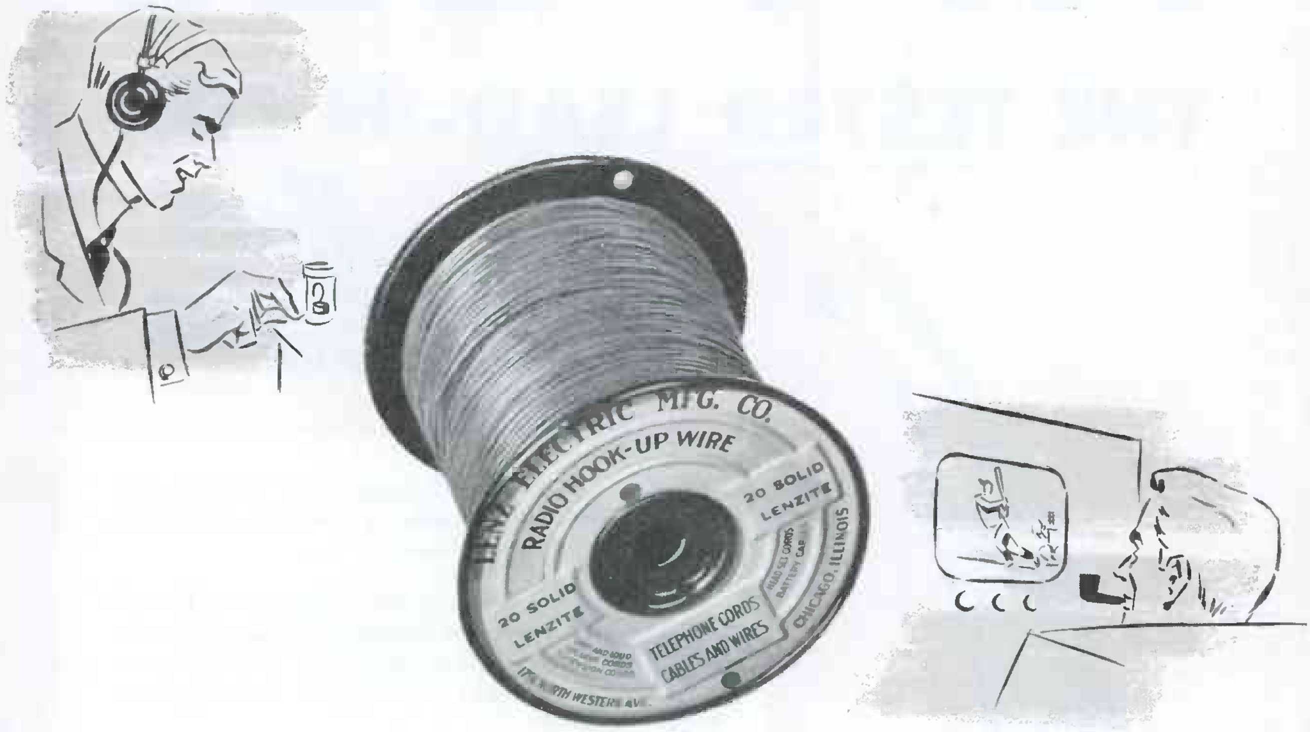
U. S. PURCHASING CHART OK!—With the recent Washington activity on unification of the Armed Forces, we have been asked whether sweeping changes will not soon follow in Uncle Sam's purchasing channels as charted by Tele-Tech on pages 14 and 15 of our October issue. Such changes will actually come very slowly, as unification proceeds from the top (where it is still having hard going). Also, since money appropriations are made to the individual agencies and will probably continue so, our chart is expected to "stand up" as a good guide for a couple of years at least.

TV-FM SETS SOAKED 10% TAX if they have continuous FM tuning. This is the new ruling of the Bureau of Internal Revenue, which under law must tax FM and AM radio receivers. The Bureau seems still at a loss as to how to evaluate the taxable radio portion of TV sets and is studying the matter and listening to manufacturers' protests.

SHIPS ONLY 50% RADAR-EQUIPPED—The American shipping industry has spent almost $6,000,000 for radar installations since the end of the war, this included the more than $1,000,000 for commercial radar in making eighty-seven installations in the last 12 months. The market for such installations is nowhere near saturation, since only 54% of the vessels of 63 reporting companies are yet fitted with radar equipment.

87 TV STATIONS ON AIR, as we go to press, latest being at Kansas City, Mo., Jacksonville, Fla., and Columbus, Ohio. Television-station applications pending before the FCC still number 351.

from crystal set to television



LENZ has served the radio industry!

When the radio industry first appeared on the American scene 25 years or more ago, the Lenz Electric Manufacturing Co. was ready with the facilities required for the production of needed wires.

These facilities have grown with the industry, all through the days of the crystal set, right down to the present boom in Television equipment, Lenz Wires and Cables, have been used in the production of millions of electronic units of all kinds and their component parts.

Lenz will continue to be a leading source for properly engineered underwriters approved Plastic and Textile Hook-Up, Wires, Cables, Shielded Lead-Ins, and Harnesses for all types of electronic equipment, A.M., F.M., Television and Communications. Consult Lenz, now as always your source for engineered wires and cables designed for the job.

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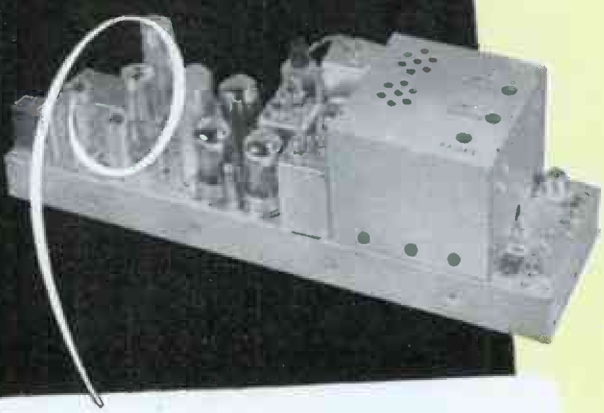
A MUST IN ALL ADJACENT CHANNEL SYSTEMS



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Even better than ever before! *Proved* by past performance —now *improved* through specialized experience. Customer reports are unanimous in acclaiming Motorola's superior performance, endurance and freedom from obsolescence: Proof that top quality costs *you* less in the long run.

A revolutionary, voice wave slope-limiter invented by Motorola Engineers to improve the utility of 2-way radio: eliminates channel "spillover"—protects communication's intelligibility—increases the voice dominance over noise and keeps radiated power within useful channel limits.

A symbol of Motorola's continued leadership. Instantaneous Deviation Control satisfies the FCC, July 1, 1950 modulation control regulation.

A pace setting development of the Motorola Research Laboratories, the world's largest laboratories devoted exclusively to the development of F.M. 2-way radio equipment.

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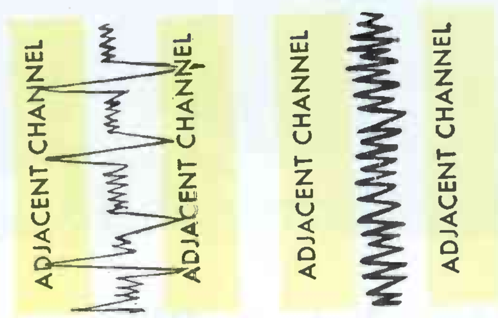

WITHOUT I.D.C.	WITH I.D.C.
1. Unlawful overmodulation.	1. Instantaneous automatic limiting of modulation deviations.
2. Interference with channel neighbors.	2. Maximum protection of channel neighbors.
3. Loss of speech intelligibility on weak signals.	3. Preservation of speech intelligibility for signals both strong and weak.
4. Decreased average per-cent modulation.	4. Increased average percent modulation.

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F M 2-WAY RADIO

THE BEST COSTS LESS IN THE LONG RUN!

New Higher Power Electron Tube with All-Ring Seals

Now Available for Full Power Operation Up to 110 mcs/sec.

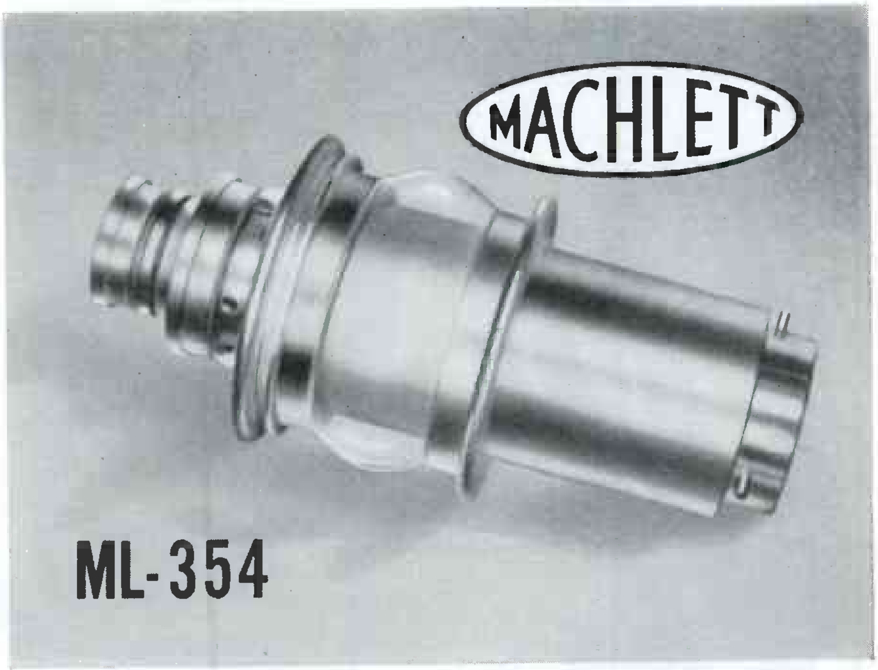
The availability of the Machlett ML-354, a compact, super-power water and forced-air cooled triode for operation up to 110 mcs/sec. in FM, AM, TV and industrial service is a contribution of significant proportion to progress in all fields of electronic development. The tube is provided with coaxial filament, grid, and plate seals, making it ideally suited to cavity-type circuits.

Superior Design Features

Developed to satisfy the need for higher-power electron tubes in broadcast, communications, research, and industrial services, this all-ring-seal triode is of a balanced electrical and mechanical design. Its low plate impedance makes it ideally suitable for broad band applications. All electrodes mount directly from heavy copper cylinders, resulting in a structure which is far superior, electrically and mechanically, to conventional water-cooled electron tube design; all glass-to-metal seals are of Kovar, and the large diameter seals give increased strength and freedom from excessive heating at electrode contacts. The tube incorporates a high-conductivity, heavy-wall copper anode. The integral anode water jacket and quick change water-coupling, contribute to easy and rapid tube replacement. The cathode is a 16 strand self-supporting thoriated-tungsten filament, completely balanced and stress-free throughout life. The rigidly supported grid and cathode are designed to give uniform anode heating. The grid is capable of unusually high heat dissipation contributing to maximum stability of tube performance and circuit operation.

Wide Application

The foregoing design features and characteristics are incorporated in the ML-354 triode, developed by Machlett Laboratories, Inc., Springdale, Conn. The ML-354, having basic design features usable over a wider range of power and frequencies than has been heretofore available in triodes, finds applications, among others, in high-power AM, FM and TV broadcasting, cyclotron and synchrotron oscillators and in induction and dielectric heating. (Adv.)



DESCRIPTION

The **ML-354** is a compact, general purpose, high power electron tube designed for operation at full power up to 110 mcs/sec. It is an all-ring-seal water and forced-air-cooled triode capable of giving in excess of 50 kilowatts output power at 108 mcs/sec. in grounded grid circuits with 10 kilowatts driving power. Considerably higher power is available at lower frequencies. This tube is ideally suited for cavity operation, and its low plate impedance is advantageous for broad band applications. Features include Kovar glass-to-metal seals, sturdy electrode structures, integral anode water jacket, and quick change water coupling. The cathode is a stress-free self-supporting thoriated-tungsten filament.

GENERAL CHARACTERISTICS

Electrical

Filament Voltage	12.5 volts
Filament Current	220 amps
Amplification Factor	25
Interelectrode Capacitances	
Grid-Plate	65 uuf
Grid-Filament	83 uuf
Plate-Filament	2.4 uuf

Mechanical

Mounting	Vertical, Anode Down
Water-flow on Anode	
for 75 KW Dissipation	45 gpm
for 50 KW Dissipation	30 gpm
Air Flow on Seals	
to limit glass to 165°C.	220 cfm
Net Weight, approximate	40 lbs

MAXIMUM RATINGS: Radio-Frequency CW Oscillator

	Max. Freq. 50 mcs/sec.	*Max. Freq. 110 mcs/sec.*	
DC Plate Voltage	15	9	kVdc
DC Plate Current	13	13	Adc
DC Grid Voltage	–1.6	–1.6	kVdc
DC Grid Current	2.5	2.5	Adc
Plate Input	195	100	kW
Plate Dissipation	75	50	kW

For complete technical data on the ML-354 high power, all-ring-seal triode, write to Engineering Department,

MACHLETT LABORATORIES, INC.
Springdale, Conn.

Distributed by Graybar Electric Company

MACHLETT OVER 50 YEARS OF ELECTRON TUBE EXPERIENCE

NEW

Mallory Spiral Inductuner* Gives Better Performance at Lower Costs!

Outstanding Advantages of the new Mallory Spiral Inductuner:

1. ***A single control for easy selection and fine tuning of any television or FM channel.***
2. ***Excellent stability eliminates frequency drift.***
3. ***Supplied in three or four-section designs.***
4. ***Far more quiet operation; free from microphonics.***
5. ***Greater selectivity on high frequency channels.***
6. ***Eliminates "bunching" of high band channels. Covers entire range in only six turns.***
7. ***Simplifies front end design and production.***
8. ***Reduces assembly costs.***

**Reg. trade mark of P. R. Mallory & Co., Inc. for inductance tuning devices covered by Mallory-Ware patents.*

There are hundreds of thousands of Mallory Inductuners in use today—all giving trouble-free service. And now, the *new* Mallory Spiral Inductuner is the biggest news in television for better performance and lower cost.

You can eliminate many costly methods on your assembly line with the new Mallory Spiral Inductuner. It permits faster alignment and far simpler front end design and assembly than any other system.

The Mallory Spiral Inductuner provides for infinitely accurate selection from 54 to 216 megacycles . . . gives FM tuning at no extra cost!

Check the advantages of the Mallory Spiral Inductuner. Improve the performance of your sets, and step ahead of competition at the same time at a cost that will surprise you.

Get in touch with Mallory now for complete information.

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O. H. CALDWELL, Editorial Director ★ M. CLEMENTS, Publisher ★ 480 Lexington Ave., New York (17) N. Y.

FOR A CONTINUOUS TV BAND!—Television's needed expansion is now held up for another indeterminable period, while color-TV, uhf, and the vhf "freeze" are debated endlessly before the FCC.

Yet a very simple solution would give TV all the channels and station allocations it will need for several years, while the uhf problem is being mastered.

The answer to TV's dilemma is to get the Government to release some of its own preempted frequencies just above TV channels 7 to 13. Then television could have six to ten more adjoining channels, all in the general vicinity of the present TV bands.

Compared with the uhf alternative, such a solution will immeasurably simplify TV transmitter and receiver design and construction, and permit immediate increase in the number of TV cities and stations.

GOVERNMENT "HOGS" 42%—Even if the Government gave up such spectrum-space it would be losing no vital facilities. Rather, the result would be to whittle the huge Government chunk of the radio spectrum down to more common-sense proportions. For the Government is now squatting on far more radio channels than it can ever use in peace-time. Such channels are of use only for training and experimentation in ordinary times. And, of course, in case of war, all the channels of the whole spectrum are automatically turned over to Uncle Sam.

In fact, of the presently available radio spectrum, up to 30,000 MC, 42% is now occupied by Government demands (which by law are served first, **before** the FCC gets the "leavings" for distribution to the public). In terms of total radio facilities, all the broadcasters (AM, FM, and TV) now occupy approximately 5%; general and industrial commercial (including mobile, aviation and marine) 46%; and amateurs 7%.

CHANNELS UNUSED AND WASTED—Thus we have the anomaly that while the filled and crowded radio and TV channels are serving millions, (with more urgently needed),—yet 20 times this spectrum space is lying virtually unused and silent, as any cruising all-wave listener can prove to himself by a 24-hour run up and down the kilocycles.

Radio and television now take leading position as important and widespread services to the public. They should no longer be hamstrung and throttled, while a little group of Washington bureaucrats and minor departmental clerks casually and irresponsibly pick off unneeded choice frequencies, to be kept unused and wasted,—making millions go without the priceless boon of TV!

CORRECTION PLEASE!—On page 63 of the magazine "Electronics" for November 1949, McGraw-Hill asserts:

"Back in 1930 McGraw-Hill coined the word electronics."

That is not true.

The facts are that a year before, in 1929, after M. Clements had outlined and proposed a magazine embracing the increasing and diversified uses of the vacuum tube, (which magazine he had proposed calling "Electrons"), he and O. H. Caldwell, discussed plans for the new magazine with Dr. John Mills of Bell Labs, who suggested a term already being used in England, "electronics". This Bell Lab's suggestion Clements and Caldwell then adopted. So the word was evidently coined before 1929, and undoubtedly used abroad in science nomenclature long before the magazine ever appeared.

We think it would be interesting to run down the actual origin and early use of the term "electronics" and will be glad to receive from readers any clues or references to pre-1929 applications of the word.

"ELECTRON" IN 1891; "ELECTRONIC" IN 1914

In 1891 Dr. G. Johnstone Stoney coined the word "electron" and gave the ultimate particle of electricity its now-familiar name.

And in 1913 or 1914, Hugo Gernsback and Donald McNicol inform us, Dr. E. F. W. Alexanderson of General Electric, perfected what he then called an "electronic" amplifier. See Archer's "History of Radio", page 120.

Also, in 1919, Lloyd Espenschied reminds us, the term "electronic" appeared in reference to a vacuum-tube category, in the Gherardi-Jewett paper on "Telephone Repeaters". See Proceedings A.I.E.E., November, 1919.

Highlights of FCC Color-TV

None of the transmission systems presented are considered adequate. CBS indicates RCA has most to offer. CTI system to be shown next February.

By *FRANKLIN LOOMIS*

THE situation at the opening of the color hearing, weeks ago, was that, in response to the Commission's invitation, three groups of researchers proposed their color system for possible standardization for use in a 6 MC channel. CBS demonstrated and proposed their 405-line, 144 field, rotating filter disc, *frame sequential* system which had been developed some years ago. RCA demonstrated their recently-improved 525-line, 60 field, all-electronic, *dot sequential* system. Color Television, Inc. (CTI), described, but did not have ready for demonstration, a 525-line, all-electronic, *line sequential* system.

Observers noted the smooth showing of the CBS system which had been developed to near-peak performance. RCA, presenting a system that had just emerged from the research laboratory, showed for the first time, new band-saving developments, such as: Dot Interlace; Sampling and Multiplex Transmission. There had been insufficient time to perfect the details of the system. We assumed apparatus difficulties obscured system limitations. On the other hand, in the case of CBS the limitations of resolution, flicker and brightness, picture size, lack of compatibility with present monochrome transmissions were more fundamental because they were largely due to system limitations. The RCA apparatus went back to the laboratory for refinement before the side-by-side comparative test of the two systems, together with the present monochrome system, which is scheduled for November 21 and 22. In February, before cross examination in the hearing starts, there will be another comparative test which will include the CTI system. Thus the outcome of the hearing may not be known until after the middle of 1950.

For technical descriptions of the three systems and a comparison of their characteristics the reader is referred to p. 18-20 of October TELE-TECH and p. 24-26 of the November issue. All the direct testimony has now been presented in the Color Hearing so it is the purpose of this report to give some of the highlights of interest to the communication engineer.

Engineering Testimony

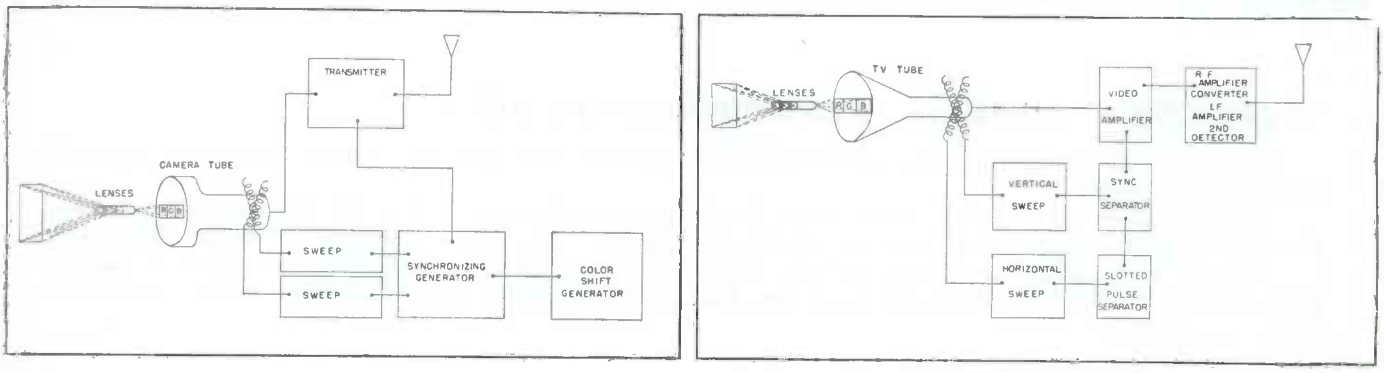
The Joint Technical Advisory Committee presented an excellent report advising the Commission of their finding regarding the three color systems. To the engineering reader the JTAC data indicates that the RCA system has the most to offer.

Speaking for the Radio-TV industry, RMA offered the results of study by its engineering groups of the color situation. Strong recommendations were made for a 100% compatible system so that the 3,000,000 black - white receivers which will be in the hands of the public by the end of 1949, will not be denied the reception of color transmissions (received in monochrome, of course). It happens that neither CBS nor CTI are members of RMA, but by invitation both firms had representatives (who usually voted) at technical meetings. It must be remembered that RMA has initiated and carried on TV standardization for many years. As to color standards they do not think the time for these have arrived.

The opposite view was expressed by CBS who placed a very complete case in the record. There is not sufficient space to comment on this in detail. Some observers wondered why, if many months are to elapse before a color decision is made, Dr. Goldmark and his engineers do not do what he indicated he would like to do, namely, bring out a more modern system that would have the advantages of increased detail and 100% compatibility. The development of a picture "storage tube" for the receiver would be the electronic answer to a CBS prayer. Similarly the introduction of a single 3-color picture tube to take the place of the three-tube arrangement in the RCA receivers would be a great step forward.

The statements explaining the RCA system were well-written but due to the unfamiliar features, new

Figs. 1 and 2: Block diagram of CTI color transmitter (left) and receiver which will be demonstrated in comparative FCC tests next February



Demonstrations

system developed to near peak performance. JTAC data DuMont says color will not be ready for 10 years

to TV engineers, the reaction, even after seeing a picture in color, was: Is this too complicated to maintain in the home? Of course it is natural that band-saving means which allow a 525-line picture to be transmitted in color in a 6 MC channel will add apparatus to the usual monochrome receiver. We thought such a black-white receiver was complicated some years ago.

CTI, also offering a system with new features, had trouble explaining how it would work. Simplified diagrams are shown in Figs. 1 and 2. From a paper analysis—pictures were not yet on the air—several engineers believed that interline flicker, or "crawl", would cause the picture quality to be judged inferior. Seeing is believing and we will have to wait until the February demonstration in Washington.

The inventor of a direct-view color tube for receivers, Prof. Geer, told the Commission about the tube he had patented but never built. It is to have a glass viewing screen composed of a multiplicity of glass pyramids, each of which constitutes a picture element. Each pyramid is coated on each of its three sides with phosphors producing respectively red, green and blue colors. Three guns, mounted at 120° from each other and at right angles to one set of pyramids' sides, operate to scan the screen to produce pictures in color. DuMont has tried to perfect a similar tube. The practical troubles lie in constructing the screen and working out the unusual "keystone" correction circuits.

Philco's Report

Philco's thoughtful contribution to the record indicates that their research laboratories have made extensive tests, in monochrome, on: the CBS system; various types of interlaced line scanning proposed by CTI; dot interlace, sampling and multiplex transmission, all used in the RCA system. With this background they report to FCC that it is too soon to set up standards for color. Philco was the first to emphasize the serious transition problem that would confront the TV industry if a non-compatible system was chosen. The FCC was urged to follow these principles: (1) Give the public the right to have color or monochrome at their option; (2) U. S. A. should have only one standard for monochrome and color; (3) No degradation in picture quality when color is transmitted; (4) TV service for the present receivers in the hands of the public must be maintained; (5) No experimenting at the expense of the public.

DuMont did not mince words in telling the FCC that color is not ready and will not be for 10 years. The public demand for color, assumed by some Commissioners, simply is not there. The three proposed systems were analyzed, their faults shown and it was concluded that none of them was capable of giving a picture of sufficient brightness, size or quality for the home. The showing, on the platform at the hearing, of a converter for CBS

(*Continued on page 50*)

Fig. 4: CBS hand-held color converter. Unit contains a small three color disc driven by a synchronous motor and makes it possible to receive color pictures on a monochrome receiver modified to receive the new scanning frequencies. A simple change in the receiver scanning circuits, controlled by a two-position switch, adjusts operation to either color or monochrome standards

Fig. 3: DuMont's showing of a "converter" for CBS color designed for receiver with a 19 in. tube, while a stunt, must have impressed observers with unwieldy impracticality of such a mechanical disc. The converter is about 5 ft. high and weighs about 700 lbs.

Unique Engineering Design

Complete separation of camera and studio controls sets style of

By JOHN H. BATTISON, Associate Editor

CONSTRUCTION of the new WOR-TV studios at 20 West 67th Street, New York City has been highlighted by the incorporation of many new engineering ideas. Most of these have not been used before and the installation when completed will present a new concept of television studio engineering design.

With the object of obtaining optimum facility of operation with economy of personnel, and at the same time providing maximum operating flexibility for all units of the installation the following features were incorporated: combination master control and camera control room; camera control room completely divorced from studio control room; automatic or manual one control video and audio switching; cable patch panel for camera selection to permit any desired combination of studio, camera and studio control switchers; special studio control switcher to provide choice of twelve signals to any one of seven director's monitors in each studio control room.

Floor and equipment layout plans of the studio control rooms, and the master and camera control rooms are shown in Figs. 2 and 3. Discussing the former first, it is noted that the three control rooms for the two studios and film projection room are identical in that each contains seven monitors—standard RCA TM-1A's, a 60 button switcher and an RCA 76-B4 audio console modified by the addition of two OP-7 four channel microphone mixers. One of these combination consoles is shown in Fig. 1. Before proceeding further, examination of the audio equipment discloses some unusual features.

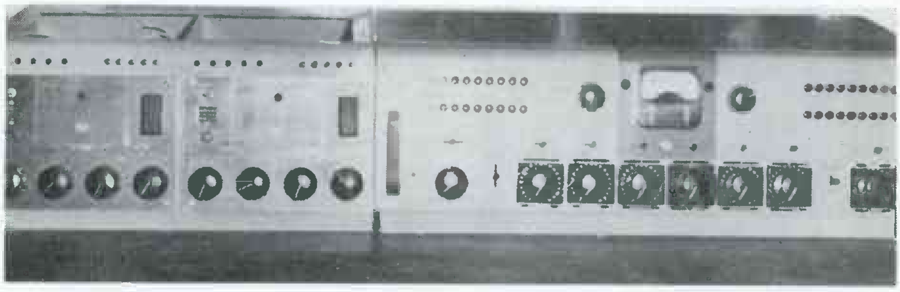


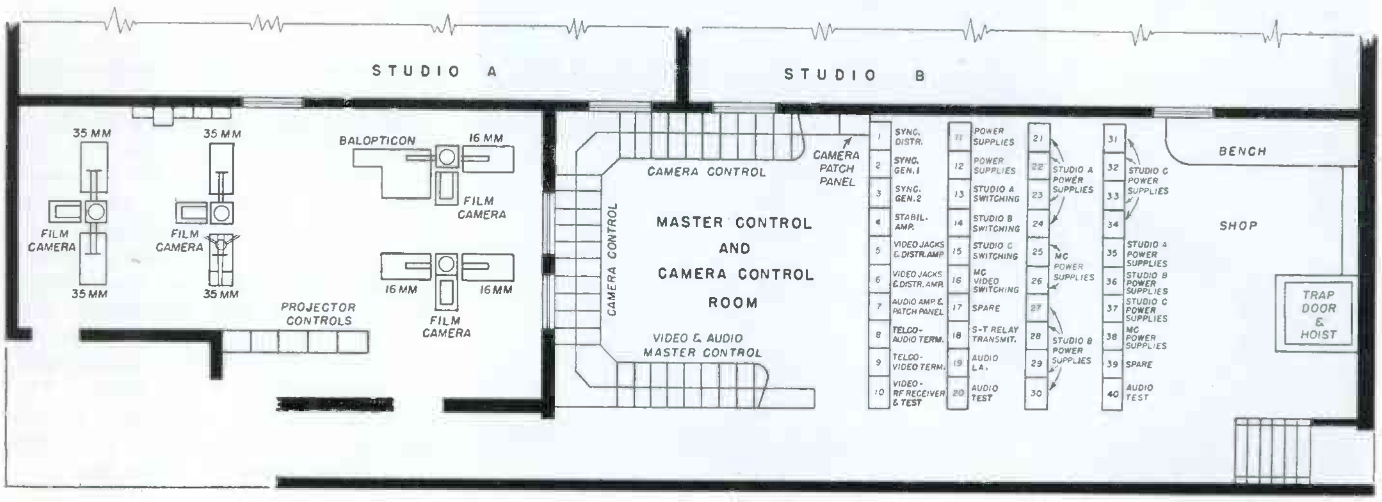
Fig. 1. Standard console with two OP-7 four channel mixers adds audio flexibility

Audio Equipment

Each studio has five groups of four microphone outlets, feeding into two OP-7 submixers. Groups can be selected at will by relay operation so that either mixer group appears at any position in the studios in use. The outputs of the OP-7 mixers appear at two microphone fader positions on the 76-B4 consoles. Also appearing at these consoles are the remote input lines, film audio, additional microphones, and turntable outputs.

All the audio equipment is mounted on a custom built desk which incorporates a Commercial Sound amplifier rack mount. Each of the three studio control rooms contains two turntables for music and effects which are of course brought out to the 76-B4 consoles. Included in the accommodation on this floor level are two small announce studios which can be used to produce news or intimate interviews. Control of these studios is available from either control room. Master audio control is incorporated with the master control for video and will be described coincidentally with it since, as will be seen, it is really an integral part of the video control switching.

Fig. 2. Compact control room and rack layout assembles all important equipment in one area for increased efficiency



Featured in WOR-TV Studios

future developments in operational efficiency of TV studios

The video panels in the two studio control rooms are identical as is the equipment in the film chain control room which is located between these two. Fig. 4 gives an idea of the appearance during installation of the seven RCA TM-1A monitors mounted in one long rack to form the director's video panel. The output of four studio cameras, two preview or special effect circuits and the line monitor can be seen simultaneously on these seven tubes. In addition any one of twelve signals can be selected at any time by use of the control panel illustrated in Fig. 6, and situated at the extreme right hand end of the console top.

This panel, which was designed by the staff of WOR-TV, has 60 push-buttons to enable any combination of video signals to be presented on the seven monitors. For example, there is a double row of preview buttons which makes it possible for the director to select and set up any desired effect before he needs to use it on the air and to watch its adjustment on the preview screen to obtain optimum performance. This is a great advantage over the usual arrangement in which the director has to hold his breath until the effect is over before he knows whether it will appear the way he visualised it. There is also provision for the future addition of an automatic effects panel where merely pushing a button will set the desired effect, such as a wipe or disolve, into operation. In order to simplify operation and reduce confusion when a number of buttons have been depressed telephone indicator lamps are incorporated in the switch mechanisms and controlled by a pair of contacts on the relays which illuminate the buttons in use. All switching operations are carried out by relays. In operation, the control panel is very similar to a standard switcher with extra inputs and combinations available, and the effects preview feature.

To obtain maximum flexibility of equipment use, a video patch panel was installed in the master control room. This is shown in Fig. 5 in the process of assembly. To avoid having to remove the standard cable plugs from the ends of the camera cables special ring clamps were built into the rear of the patch panel so that the only extra cabling work required was making the patch cords. With this panel any combinations of eight cameras can be switched to any studio and control room in the same manner in which audio is patched around a studio.

Master Camera Control

The heart of technical operations at WOR-TV is the combined master and camera control room. This is the place where the most radical departure from conventional TV operational design has been made. Heretofore practically the only other television station to separate camera control from studio control was the BBC station at Alexandra Palace in England. At the latter the producer cannot see into the studio and has only two preview screens for watching action, picture control being effected in a separate room. At WOR-TV the producer-director has seven screens on which he can

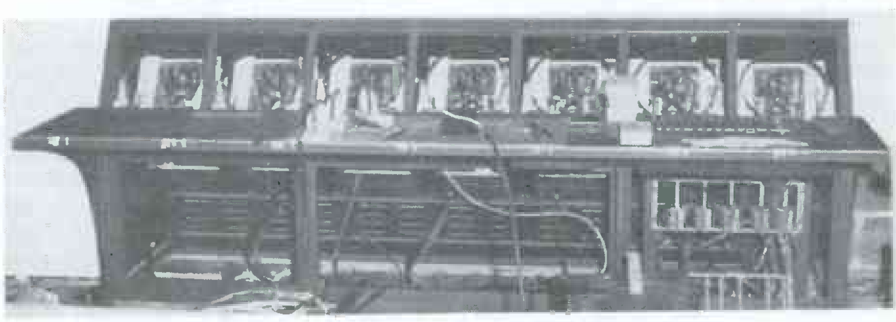
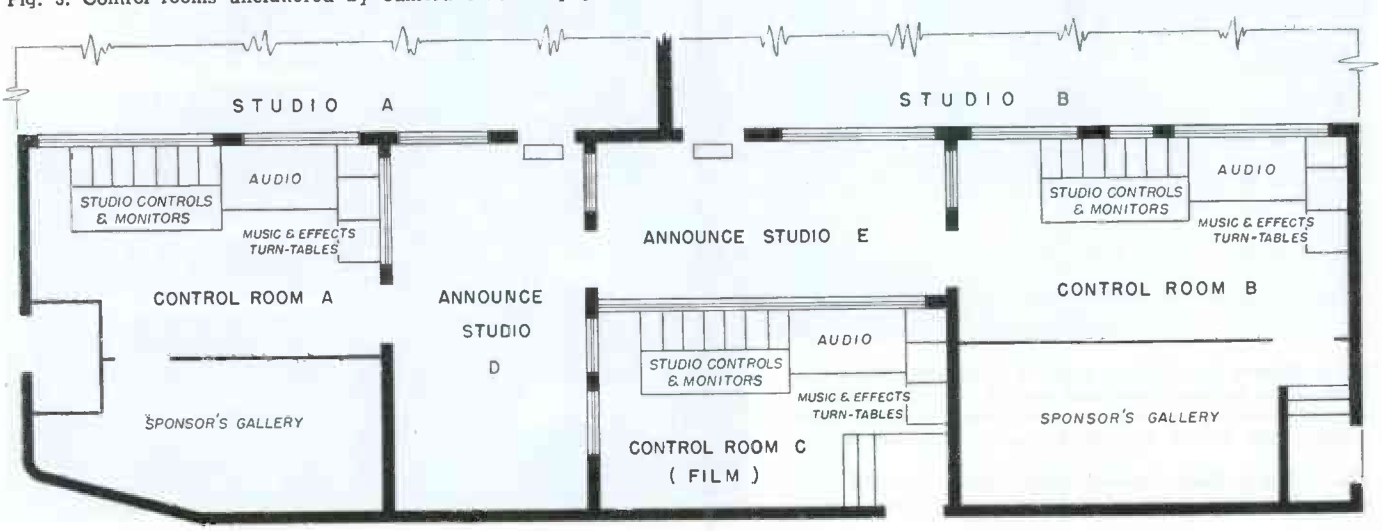


Fig. 4. Seven position studio control monitor composed of TM-5A monitor assemblies mounted on one long desk with 60 button switcher just visible at extreme right.

Fig. 3. Control rooms uncluttered by camera control equipment are unique features of new WOR-TV studios for network originations



WOR-TV STUDIOS (Continued)

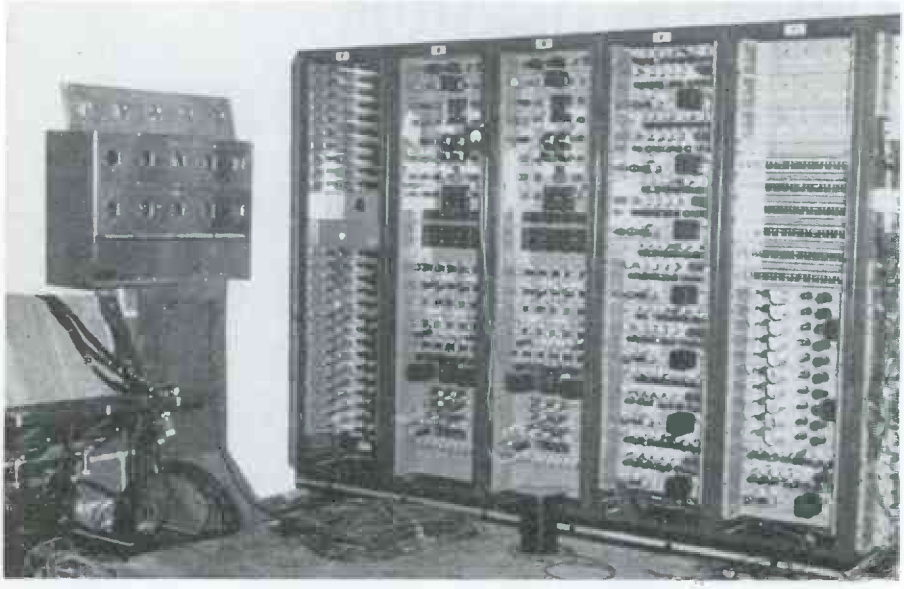


Fig. 5. Shown on wall at extreme left is special camera patch panel for handling cameras like audio lines. Cable plugs are mounted here to avoid cutting cables

view any picture plus the ability to see into the studio and camera switching and audio control (including turntables).

Above the studio control rooms is master control. The layout of this room ,which is still under construction, is shown in Fig. 2. The two long monitor consoles directly across the room from the entrance are the camera controls. It is hoped that integrating them in this manner will result in more economical operation since fewer technicians will be required, and in the event that a chain fails, repairs can be effected without disturbing the director who is concentrating on his program, or if impossible to repair, another camera can be patched in by use of the video patch board already described.

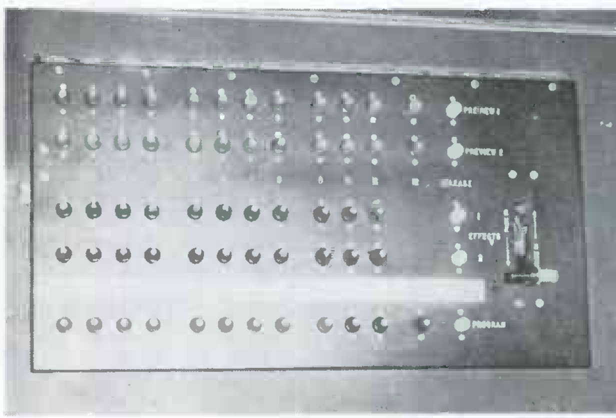
Immediately to the left are the master control boards. A close up of one is shown in Fig. 7. Each unit consists of a monitor and a switcher. The lower section of each monitor incorporates a VU meter, master gain and monitor speaker gain controls for audio channel control. Since there are four monitors it is possible to watch the program line, and three preview signals. A total of six inputs including three studios, film and remote lines feeds to the master control. Four output circuits are provided, two to the transmitter at North Bergen, N. J., one for network feed and one for video recording or "spare". All switching throughout the installation is done by relays with a complicated interlocking system.

The video switcher permits switching audio and video at the same time by setting the center toggle switch to the lower position. In this position audio is switched with the video from the old to the new program source. With the switch up, control is independent, and audio has to be switched separately.

Two Sets of Panels

Each unit consists of two identical sets of two panels, a small upper tally panel to show which circuits are in use, and a presetting panel for setting up the next video and audio combinations. If both video and audio operation is desired from say, studio "A", with automatic switching of audio with the video, the button for studio A is punched on the panel not showing "in use". This lights the preset tally. With the control switch, bottom center, set to "controlled by video" the equipment is ready for the changeover. On pressing the "video transfer" button both video and audio are switched. This lights the tally "video plus audio" on the panel in use. Assuming that it is desired to continue video from studio A and take audio from studio C, studio C audio button is depressed on the panel in use. When it is time for the change, the control toggle is flipped to "independent control" and audio is automatically transferred to studio C while video continues from studio A. If the next shot is from studio B, that button is depressed on the preset panel and the video transfer button is depressed. As soon as the

(Continued on page 54)



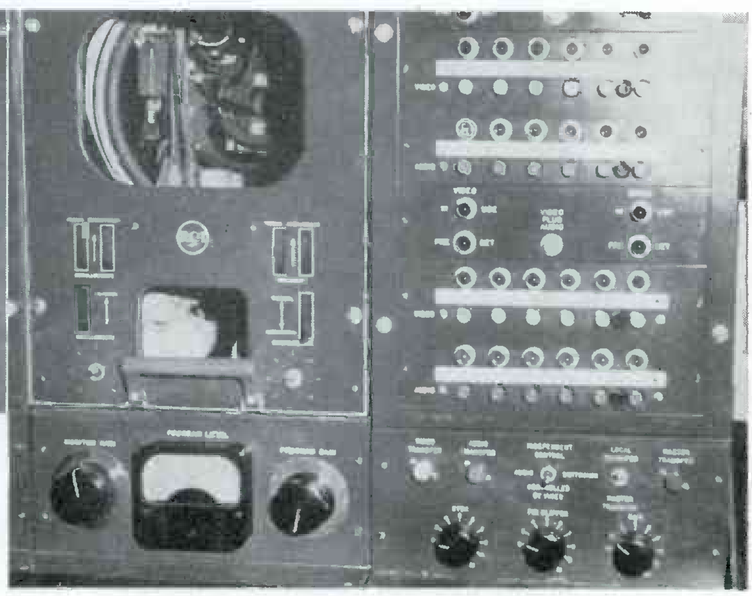


Fig. 6. (Above) Special sixty position studio switching panel installed at extreme righthand end of directors' consoles. Buttons depressed are illuminated by lamps mounted under panel; light shines through buttons which are plastic.

Fig. 7. (Right) Master control video monitor and switching panel. Four units are used to operate studio video outputs

A Universal Ceramic Iron Core Sweep Transformer

Newly designed units may be employed for all magnetically deflected picture tubes ranging from 8 to 19 in. in size and operate at increased efficiency

By C. E. TORSCH, *Cathode Ray Sweep Systems Engineering, Receiver Division, General Electric Co., Syracuse, N. Y.*

PART ONE OF TWO PARTS

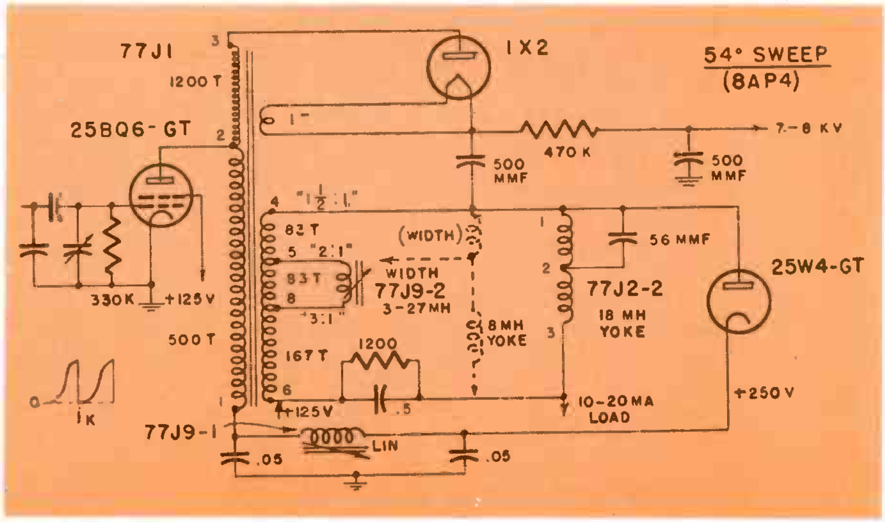


Diagram illustrating 8AP4 type circuit. An 8 kv sweep is obtained from a 125-v B supply. 25BQ6-GT tube acts as driver and single 1X2 is used as the high voltage rectifier

GREATLY increased sweep and high voltage system efficiency, compared to 1948 designs, is now obtainable by the selection of matched circuit elements and application of existing tube performance theory to TV receiver design. The introduction of ceramic iron as a preferred magnetic sweep system core material is now a commercial reality and opens up further possibilities of improvement in associated parts.

The horizontal sweep output and high voltage transformer is the most profitable item to examine for ease of improvement with the present availability of the ceramic iron cores. A newly designed unit, the G.E. 77J1 sweep transformer incorporating a ceramic core, has proven versatile in application to directly viewed picture tubes from 8AP4 and 19AP4 designed to operate at supply levels from 125 to 325 volts with power tubes such as 19BG6-G, 6AU5-GT, 6BQ6-GT or 6BG6-G, and with damper tubes such as the 6AS7-G, 5V4-G or 6W4-GT within all rating limits to produce adequate sweep and high voltage power with a single 1B3-GT rectifier at 8 kv for the 8AP4 (54° sweep) and at 14 kv for the 19AP4 (67° sweep).

Design factors for the transformer arise from the circuit application and include: picture size, picture tube sweep angle and anode voltage; B supply voltage; available choice in deflection yoke impedance, efficiency and "Q" during retrace; existing driver and damper tube current and surge voltage ratings; available transformer mounting space, interchangeability with existing transformers; and last, but not least, available core materials.

It was proposed that a design be established flexible enough in application to fit physically and electrically most present and near future direct view sweep applications and to allow for its future adaptation with considerably different types of yokes, driver and damper tubes. This aim was met in physical size and mounting; a pair of taps on the extended secondary winding appear to allow a wide choice of yoke and tube matching conditions, as exemplified in accompanying circuit diagrams. The design will be considered from yoke loading, damper, driver, high voltage rectifications, winding ratio, and core aspects.

Load Impedance Requirements

The evolution of 1½-in. throat diameter yokes for a sweep of 40°-80° picture tubes during the past decade has been closely followed by the writer. In 1944 he chose an inductance in the vicinity of 8 millihenrys for the horizontal yoke windings for 67° maximum sweep angle units. This inductance appears to produce a satisfactory load for matching many types of damping tubes at their most effective ratings for sweeps of 50°-67° tubes operating at 6-30 kv anode levels. The 8 millihenry coils require peak values of sawtooth current of about ½ to 1 ampere for the above range of anode voltages. This current is readily produced by available power tubes such as the 6BG6-G through voltage step-down ratios between 2:1 and 3:1 in the matching transformer, using a single power tube for direct viewed picture tubes, two in parallel for projection picture tubes.

Surge voltages in the yoke due to the rapid peak current reversal during the 10 microsecond blanking interval are readily limited to 1500 peak volts in the 8 millihenry coils. This voltage is easily insulated in present windings by inclusion of a "Formex" coating on the coil conductor, and series operation of the winding halves. High speed winding is practical with the wire size and moderate number of turns in the inductance chosen, and economy in material costs is favorable compared to the premium usually paid for the fine wire of the same total weight wound into higher impedance coils.

As damper tube insulation has been improved, the trend is now to raise the impedance of yoke windings connected directly across the damper to stay within the current rating of economical diodes such as the 6W4-GT. With the transformer design considered here, the standard yoke impedance is retained by merely operating the damper tube at either of two higher impedance taps, at 1.5 or 2 times the yoke voltage. These secondary extensions are of sufficiently tight coupling to the yoke section that leakage reactance decoupling does not result in appreciable "ringing" effects in the yoke current wave during the damping cycle. As the new higher impedance yoke windings become available and economical the secondary taps will readily match approximately double or quadruple the present standard impedance.

Due to high frequency (15750 cycle repetition rate) of the horizontal sweep, the resistive component of the horizontal winding impedance is not of prime significance as long as the current wave shaping circuits can be adjusted to compensate for the small IR drop relative to the main L di/dt reactive voltage drop.

High effective shunt resistance losses limit the speed of retrace and the efficient recovery of reactive energy stored in the yoke and transformer during the last half of the trace period. The retrace yoke current wave is approximately a cosine function, reversing the peak yoke current in half a cycle of an 80-100 KC oscillation of energy stored in the yoke and its matching transformer during trace. This reactive energy passes from positive peak coil current at the end of sweep, into the charge of all distributed winding capacitances to a voltage peak, occurring just as the yoke current passes through zero towards a negative peak at the start or the subsequent trace. The voltage peak is utilized for the picture tube anode supply and the current control is taken over by the damper tube after the negative peak has passed.

Damper Tube Requirements

The above mentioned yoke current switching transient surge of voltage places an insulation burden on associated damper tubes during their non-conducting interval. This is particularly true if the tubes are at secondary extension taps at which up to double the yoke voltage swing occurs. Circuit parameters should be adjusted to favor insulation at all critical points and to utilize the principle of retracing as slowly as possible within the available blanking interval. This will minimize voltage stresses on driver and damper tubes through reduction of the retrace yoke current wave slope, setting as it does, the L di/dt surge product. High voltage rectifier regulation is noticeably improved in a high efficiency sweep system which has slower retrace due to the broader high voltage pulse produced for anode supply rectification.

Reliable insulation has been designed into the structure of new damper diodes of the 6W4-GT type. Button stems (familiar in 1B3-GT tube base construction) have been utilized together with slotted mica tube element supports to improve inverse voltage safety factor. Cathode coatings have been made more rugged mechanically to accompany the high electrical perveance required. The present 2000 volt inverse rating of the 6W4-GT permits it to be operated at the transformer secondary extensions and accomplish its function with a lower percentage loss of stored yoke energy through power feedback loops. Several types of power feedback loops are later described operating the diode within 2000 peak inverse volts and within its 125 ma. average current rating. The current rating should be fully utilized in preference to operating the diode at a tap which would cause its inverse voltage ratings (as indicated in 14 kilovolt 67° picture tube sweep conditions described later) to be exceeded.

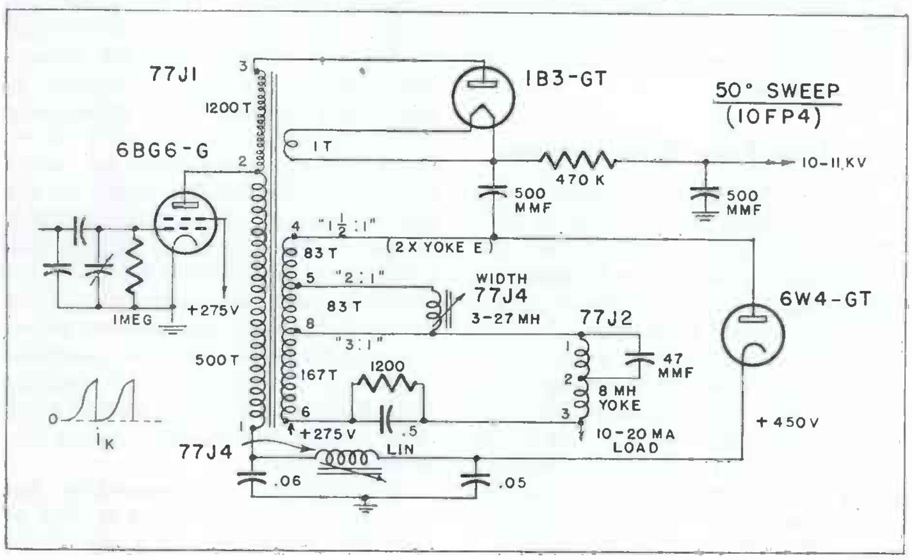
The damper tube heater-to-cathode insulation should not be subjected to high peak voltage surges where it is already under dc stress. The 450-volt rating of the 6W4-GT is met by connection of the secondary of the transformer to the yoke and B supply voltage in such a way that negative voltage surges appear on the damper plate during retrace and only small ripple voltages are superimposed on the dc between heater and cathode.

Driver Considerations

Power output tubes such as the 6BG6-G have been considered standard in recent years and have been picked for high perveance and adequate, though expensive plate insulation. Many previous output systems have operated the driver tube at positive voltage surges approaching the 6000 volt peak rating of the 6BG6-G and negative plate surges in the order of 1900 volts. The negative plate surge is conducive to undesired internal oscillations (Barkhausen-Kurz) of the output tube resulting in unwanted r-f radiation back into the receiver headend, ultimately visible in the received picture as a bar or series of vertical dark bars at random intervals across the screen. The present design considered in this paper minimizes both positive and negative primary surge voltages induced from the yoke current switching by extremely tight winding coupling (approximately 99%) and relatively high distributed capacitance in the primary-secondary system compared to the tertiary winding and rectifier load.

Average power tube plate current

10FP4 circuit for 275-v B supply and power feedback feeding only the driver plate circuit



of 75 ma. will adequately sweep a 14 kv cathode ray beam in a 19AP4 picture tube through the full 67° angle, with a 325 volt B supply and the 8 millihenry yoke at the 3:1 voltage ratio tap of the transformer secondary.

The same power tube will, within rating in another application, sweep a 53° angle at 12 kv anode picture tube operation with a 250 volt B supply and furnish additional vertical sweep power supply voltage and its own screen supply at higher voltage than is obtainable directly from the B supply.

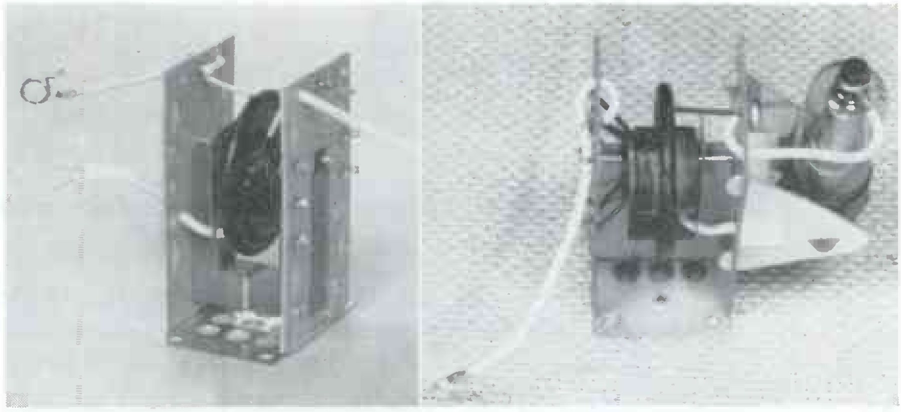
Power tube plate voltage surge in both of the above instances is approximately only 3300 volts in the 12 kv sweep system. At this level, use of newly developed single ended power tubes will bring a decided cost reduction and permit a single tube of either type to be used up to and including the 19AP4 application described above. Utilization of the new tubes; requiring low screen voltage avoids the unwanted r-f radiation of the driver back into the receiver head-end.

Use of a special shortened sweep yoke permits full 80° sweep of non-commercial model picture tubes operating at 14 kv anode potential, with the standard 77J1 transformer with a single 6BG6-G driver from a 350v power supply, within all tube rating limitations.

Use of the 25BQ6-GT with the new transformer permits full horizontal sweep of the 54° 8AP4 picture tube and produces an 8kv picture with only 125 volts of filtered supply power, within all tube ratings.

A 10 kv picture tube anode operation and the core flux gives rated filament temperature at design center conditions. For appreciably higher anode voltage operation, a series resistor should be added to the diode filament to limit the filament dissipation to the ¼ watt rating by optical comparison methods. A 500 mmf capacitor provides adequate filtering of the synchronous, line frequency ripple, in relation to maintaining anode voltage over 53 microseconds of picture line trace. If the negative side of the filter capacitor is pulsed during retrace with the negative surge appearing on the full transformer secondary winding, an additional thousand volts of anode supply is obtained relative to the available sweep power. Proportionately less anode voltage increase results from utilization of either of the secondary taps instead of the full winding.

To limit the short circuit current developed by the transformer a series resistor is required in the high voltage diode output lead. This resistor limits the dc flowing directly through the transformer tertiary and primary from the B supply by way of the power feedback loop. The resistance value is selected to limit the short circuit current to less than 5 milliamperes in accordance with Underwriters' Laboratories specifications. A second filter capacitor (grounded on the negative terminal) at the load end of the limiting resistor is essential to reduce the additional ripple introduced by pulsing the negative terminal of the first filter capacitor. The second filter capacitor is generally constituted by the picture tube bulb capacitance between internal second anode coating and the grounded external conducting coating.



(Left) Physical appearance of the new GE type 77J1 transformer which uses a ceramic iron core. (Right) Notches are provided in the phenolic terminal boards to allow for the addition of auxiliary mounting plates to hold a wafer socket for the high voltage rectifier

Winding Ratios

For efficient output stage operation the matching transformer should consume a minimum of energy developed by the driver for the yoke. Friend has indicated the desirability of establishing an open-circuit secondary inductance of at least 4 times the yoke inductance when transformer primary-secondary winding coupling is obtainable in the neighborhood of 99% as in the new unit discussed. It should be noted that too low a level of applied voltage of coils on the winding under test will produce incorrect bridge measurements of coils on ceramic iron cores. It has been found that a stepdown ratio from primary to secondary between 2:1 and 3:1 is desirable with a driver tube of the 6BG6G variety. With a higher voltage B supplies, the 3:1 ratio is favored for yoke connection for an 8 millihenry yoke, providing the damper yoke is operated above the yoke. Friend has indicated the voltage on the secondary taps. These secondary taps thus correspond to operating the damper at 2:1 and 1½:1 stepdown voltage levels respectively, compared to the driver. Power feedback connections may be established as indicated by Schade, connecting the driver (primary) winding to the damper cathode, through an adjustable ripple delay network for sweep linearity adjustment.

Faster yoke current retrace will be obtained by operating the yoke at the "2:1" section of the secondary, reducing the anode supply turns ratio to less than 6:1. However, less reactance is reflected into the primary by this connection and considerably higher driver tube current will be required for the same sweep, which is fortunately offset by a reduction in the B supply voltage requirement.

A simplified universal sweep control coil has been devised for use as either linearity control in the power feedback loop mentioned above, or in shunt with a portion of the secondary winding, as a width control, between the "2:1" and "3:1" output taps. This control is also provided with a ceramic iron core to provide wide adjustment range and present reliable insulation of the core stud in the event of dc voltage breakdown of the coil form in overload conditions.

The core around which the design is built was determined in size by the desired winding clearance window; of adequate cross sectional area (0.3 sq. inch) for securing high shunt inductance relative to the yoke with moderate winding size of rugged wire sizes; and in shape by the novel mechanical suspension of core and coil.

(*Continued on page* 49)

A Microwave Frequency

Cylindrical copper resonators, produced in quantity as secondary frequency

By R. R. REED & M. S. WHEELER,
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IN the microwave region of the radio spectrum the quartz crystal fails as a source of precise r-f energy except through the use of an elaborate and expensive electronic multiplying process. The desired centimeter wavelength can be arrived at by starting with some convenient low frequency and using multipliers and selecting the proper harmonics, but the method is neither simple or compact.

Radar applications, however, demand a standard of frequency in this very same microwave range. One important wartime application was the radar beacon, which is now being applied to peacetime navigational uses. Planes searching out enemy targets or friendly airfields had severe limitations because of the definition available in the existing equipment.

The radar beacon enabled the plane to receive certain marking signals much stronger than the ordinary faint radar return. These signals were produced by small transmitters placed at prearranged positions. Beacon signals, due to their relatively greater strength, could be readily identified, and by certain coding systems could be identified much as a ship at sea identifies a lighthouse. In order to prevent the enemy from using them to advantage, these beacons were normally "silent" and only transmitted for a short time when interrogated by a properly coded radar beam.

AFC Systems on Plane & Beacon

It was necessary that both the plane and the beacon be automatically frequency controlled to enable each to "tune in" on the other, since the plane personnel had insufficient time to tune to the beacon and the majority of beacon transmitters operated unattended. Hence, some simple and compact frequency standard was required in fairly large quantities as a reference for these afc systems.

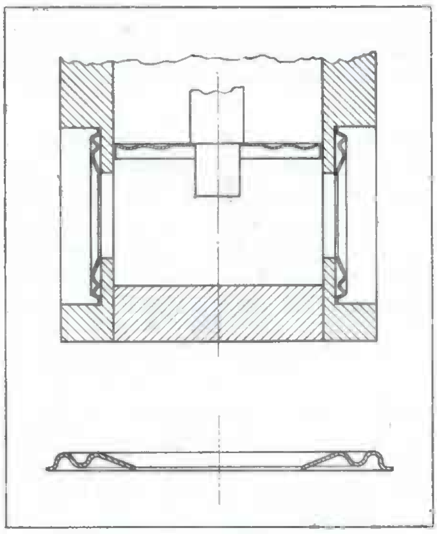


Fig. 1: Closed copper cylinder with windows in opposite wall sides forms resonant cavity. Size of cylindrical copper post extending from one end of cavity controls resonance

The resonant frequency of a cavity was selected for this purpose. This selection is appropriate in the 3 cm band because a resonant cavity has quite practical physical dimensions, and because the device can be made sharply resonant, making it possible to accurately measure and adjust the center frequency to a prescribed value.

Taking special precautions to minimize resonant frequency change with operating conditions, a manufacturer can adjust a cavity using as elaborate equipment as desired for a primary standard and produce a device accurate enough for use as a frequency standard in maintaining a beacon system at the required frequency.

The particular type of cavity to be discussed was developed primarily by the Westinghouse Research Laboratories and is produced at the Westinghouse Lamp Division, Bloomfield, New Jersey.

This cavity is a closed copper cylinder (Fig. 1) with windows in opposite sides of the cylindrical wall. A small cylindrical copper post extends from one of the ends. This device has much the same electrical properties as the familiar resonant circuit exhibits at lower frequencies. The two windows function as the input and output terminals, allowing the resonant circuit to be coupled on one side to a generator and on the other to a load. The dimensions of the post control the resonant frequency to a great extent. Hence the post may be considered as a tuning device of the circuit.

Since the dielectric constant of air depends on its pressure, relative humidity and temperature, the cavity is evacuated and hermetically sealed to eliminate the effect of a change in dielectric causing a change in resonant frequency. Having eliminated these effects, one must then compensate for thermal effects on frequency.

As was previously indicated, the resonant frequency of the cavity is quite sensitive to the post dimensions. This is evident if one considers the face of the post and the opposite end of the cylinder as plates of the condenser element of a resonant circuit. Hence it is possible to compensate the frequency shift due to temperature by means of a small adjustment in the spacing between these "condenser plates". This can be done by rigidly attaching the post to the rest of the cavity through a proper length of two materials of dissimilar temperature coefficients of expansion (copper and invar were used). The resonant cavity is completed by a flexible diaphragm. As the temperature is changed, the nose is moved axially with respect to the rest of the cavity, effectively changing the capacitive reactance and compensating the frequency shift due to expansion or contraction of the rest of the cavity. By such methods it is impossible to limit the resonant frequency shift for a temperature change from $-40°$ to $100°$ C to ± 0.3 MC on a device which is mass produced.

There is also a possible frequency shift due to creep of the rigid linkage between post and diaphragm.

Standard for Radar Applications

standards, operate over 9250 to 9300 MC range; maintain accuracy of ± 0.8MC

This has been anticipated and all production cavities are aged to minimize this effect. Because of this aging process, the tubes do not have the originally set resonant frequency, but are allowed to vary within ±0.3 MC of the nominal value. Once aged, however, the cavities will have no frequency shift due to creep beyond the ±0.3 MC.

Device Unaffected by Humidity

It is thus possible to produce a device relatively insensitive to temperature and completely insensitive to pressure and humidity effects. It then remains to arrange the method of setting the device against some primary frequency standard.

To achieve this result, and at the same time determine the Q of the cavity, a method was devised at the Westinghouse Research Laboratories with the assistance of the MIT Radiation Laboratory. The particular system described is for a cavity to be resonant at 9280 MC (Fig. 2). On a cathode ray tube, superimposed upon a response-versus-frequency trace of the cavity in question, are intensifications on the Z-axis of the cathode ray tube, spaced equally either side of the standard reference frequency. This produces rather sharp dots on the trace centered at a precise frequency and with the frequency difference between the dots known and adjustable. For measurements a little to one side or the other of the standard frequency, the center of the dot system is adjustable to plus or minus a very small part of the standard frequency. This difference is only known with 3% accuracy, but it is such a small part of the total that little precision is thereby lost.

Frequency measurements, then require setting the dots (at some convenient frequency difference from one another) symmetrically upon the frequency response trace and measuring the deviation of the center of the dot system from the standard by beat frequency means.

At the same time, the loaded Q of the device may be calculated from the bandwidth at some fraction of the total power, say at the Kth power point. Thus, the difference frequency between the dots is adjusted until the stand on the Kth power ordinate of the frequency trace and the frequency between them is read as the bandwidth at Kth power. Loaded Q is then given by:

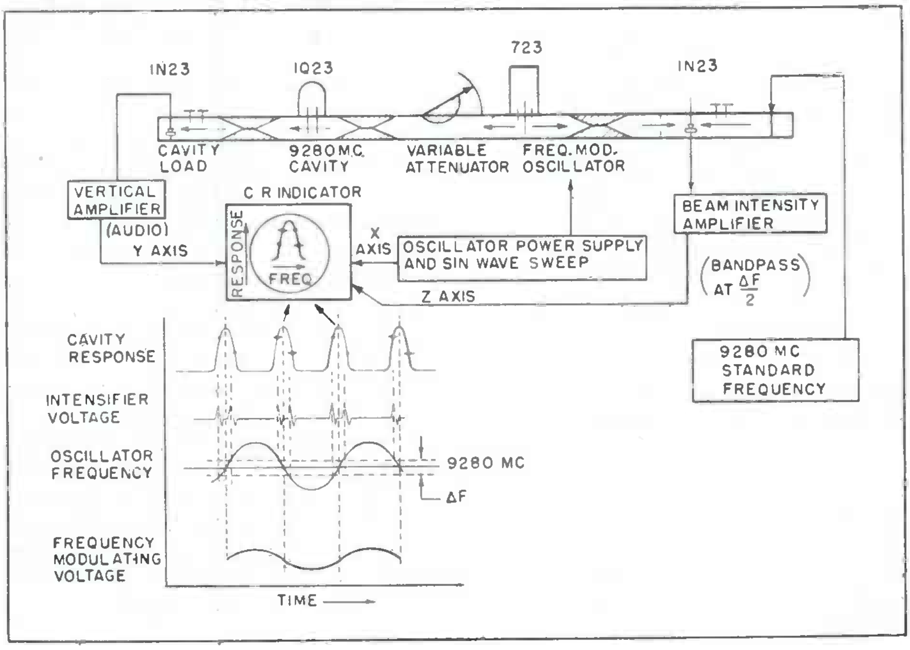
$$Q_L = f_o/f_k\sqrt{(1-K)/K}$$

To be more specific, 3 cm energy is transmitted from an oscillator (723A/B) in two directions. Most of it goes to the left (Fig. 2) through a fixed and a variable attenuator, through the cavity, and drives a 1N23 crystal which rectifies the r-f and supplies a voltage to an audio frequency which, if it falls within proportional to the square of the r-f voltage envelope. This amplifier gives the vertical deflection to the cathode ray oscilloscope. A smaller part of the 3 cm energy is transmitted to the right through elements presenting a high impedance to the wave. Loading is accomplished by another IN23 crystal. In addition, the 9280 MC standard frequency is fed to this crystal. The response is proportional to the rpoduct of these two signals, giving the difference frequency amplifier approximately the narrow band pass of the Z-axis amplifier, intensifies the trace on the cathode ray tube.

The source of this 9280 MC signal is a 5 MC crystal-controlled-oscillator adjusted to zero beat with WWV (Fig. 3). This signal is multiplied 32 times in frequency doubling circuits and then fed to a 1N21B crystal, selected because of the high r-f power it will withstand. The 58th harmonic is the 9280 MC signal desired and is conducted to the waveguide, together with all the rest of the harmonics. The proper harmonic is chosen by a wavemeter. This 5 MC source alone would be sufficient for measuring 9280 MC cavities. It would be desirable, however, to measure the error by which the cavities deviate from the nominal value. This is done by adjusting the 9280 MC signal with an interpolation oscillator that is adjustable about the 5 MC point by, at most, a few KC. The difference frequency is measured by a continuously indicating electronic frequency meter.

To trace the cavity response, the 3 cm oscillator is frequency modulated by a 60 cycle sine wave voltage which at the same time sweeps the X-axis of the cathode ray oscilloscope. Assuming at first that the

Fig. 2: Simplified circuit diagram showing method of setting cavity against a primary frequency standard. Phase relationship of various waveforms applied to CRO are indicated



cavity is exactly at 9280 MC as well as the standard frequency, and that the Z-axis amplifier is set to amplify 2 MC, there will be a signal in the X-axis amplifier every time the oscillator strays from the center frequency by ±2 MC. For the short period of time that this difference frequency is in the band pass of the Z amplifier there will be an intensification of the trace. However, because of the finite delay time of the amplifier, the dots will be displaced somewhat from their expected positions.

This explains the choice of sine wave sweep, as this delay would cause an error in the frequency measurement. Sweeping the response curve alternately from left to right and then from right to left, however, produces four dots on the trace, and thus to compensate for the delay, the four dots are centered symmetrically upon the trace for frequency measurement.

Let us now estimate sources of error in the precision measurement. The secondary standard crystal oscillator may be readily set to, and maintained, within one cycle of WWV's 5 MC signal. There is an error due to the 3% accuracy of the difference frequency measurement. The magnitude of this error decreases with the frequency difference and becomes zero with no differential. To choose an average value of difference frequency of 500

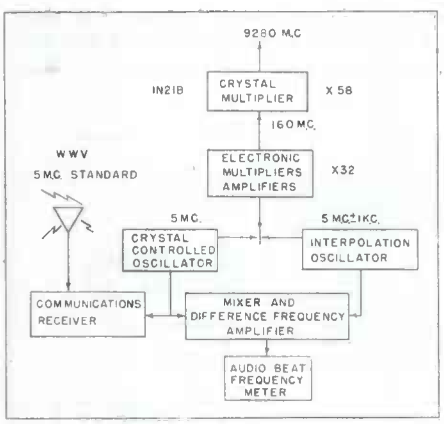


Fig. 3: Block diagram of circuit that provides the 9280 MC primary frequency standard

cycles, the error would amount to 15 cycles. This total error of 15 cycles at 5 MC would amount to 15 × (9280/5) = ±0.028 MC at X band. In addition, the error in aligning the spots was found to be approximately ±0.036 MC giving a total error of:

(1) oscillator setting—1 cycle or ±0.002 MC
(2) 500 cycle differential 3% error—15 cycles or ±0.028 MC
(3) operator error—±0.036 MC

0.066 MC

The r-f load on the cavity affects the resonance to some extent, so that resonance is specified at matched load. Mismatch in the load, then, is a source of error as well as any distortion produced in the response trace due to amplifier distortion or to sweeping the test frequency through the resonance of the cavity too rapidly. Considering these sources of error, it is estimated that the frequency of resonance can be measured to one part in 150,000.

In addition to the above errors, in measuring the loaded Q three percent order of magnitude errors are introduced in determining the Kth power point through the variable attenuator calibration, and in the measurement of bandwidth through the calibration of the Z-axis amplifier. This measurement is then with much less precision. It is estimated that this can be held to about one part in 20.

Insertion Loss of Cavity

Insertion loss of the cavity is measured with about the same accuracy as loaded Q by the method of substitution. That is, the power to the load is measured (generally with a constant frequency signal) with the cavity in position in the guide. The cavity is removed and a continuously variable attenuator is increased until the load power returns to the same value. The insertion loss is given directly by the amount of attenuation required to bring the load power back to its original value. It is noted that in using this method no absolute power measurement need be made, nor is it even necessary that the power level indicator be a linear device, as the reading was at the same level for both measurements.

Having a very precise standard, the cavities are accurately set by slightly distorting the post connection after assembly. They are then aged until their frequency deviation due to creep is reduced to the aforementioned ±0.3 MC value.

In order to make this secondary standard more rugged, as well as provide a method of mounting to standard X-band choke flanges (UG-40/U or equivalent), the cavity is spring mounted in an aluminum block with openings the equivalent of X-band waveguide, and tapped holes in each face to fit the standard choke flanges. An alumin-

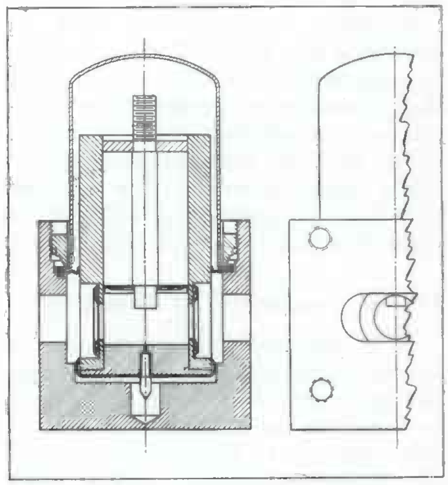


Fig. 4: Drawing showing the mounting arrangement of the resonant cavity with aluminum dome in place over tuning mechanism

um dome is placed over the tuning mechanism and the mount is so constructed as to permit pressurizing of the guide. This mounting arrangement is shown in Fig. 4.

Then the device has the following frequency deviation from nominal:

a. Due to setting error and creep ±0.3 MC
b. Due to ambient temperature— 40° to 100° C ±0.3 MC
c. Due to to pressure changes ±0.1 MC 100 mm to 2 atmospheres (due to small bowing of windows)
d. Due to vibration 10 g. ±0.1 MC

Total ±0.8 MC*

Other typical data: Loaded Q = 2000. Insertion Loss = 5 db.

The figure of ±.8 MC (appr. 0.017.) was quite suitable for beacon afc and would be sufficiently accurate for most microwave uses. However, for most laboratory use this error would be only ±0.3 MC, since the variation in temperature and pressure and the vibration would be negligible. It is also possible that this error could be further reduced by calibrating the device

(*Continued on page 55*)

*It is extremely unlikely that all variations would add in one direction. A total expected deviation of ± .5 MC is more likely.

Page from an Engineer's Notebook

Number 5. *Coaxial Impedance Matching Links*

Contributed by F. E. BUTTERFIELD, Andrew Corp., Chicago, Ill.

A HALF wave section of coaxial cable has frequently been used for impedance matching and for transforming from balanced loads to coaxial transmission line feeders. A general survey of this problem by H. E. Dinger and H. G. Paine, "Impedance Matching Half Wave Transformer" appeared in Tele-Tech, (May 1948, pages 41-43). Broadcast engineers are concerned primarily with measurements on unbalanced loads (balanced loads occur only occasionally) and would welcome the ability to apply this technic to balanced loads without an elaborate equipment setup. The half wave transformer approach permits accurate measurement of balanced loads with coaxial line measuring equipment, retaining the great advantages of the completely shielded circuits.

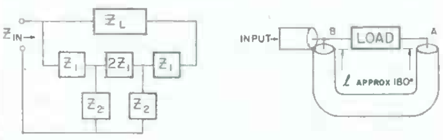
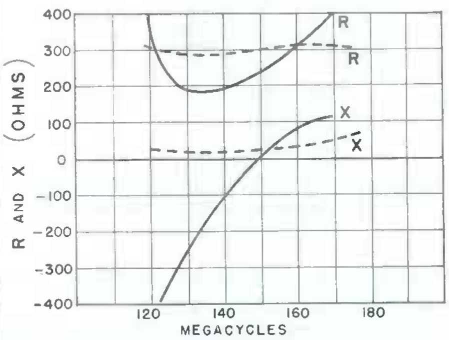


Fig. 1: Half wave transformer (right) with its network equivalent shown at left.



Figs. 2 and 3: Measured impedance of resistor (dotted) and of folded dipole (heavy lines).

Furthermore, the use of coaxial line to feed all types of antennas is universal. The conversion from balanced antenna to coaxial line is sometimes difficult. The half wave transformer offers a simple conversion method which has a band width greater than ordinary antennas and which, under certain conditions, can even compensate for antenna impedance changes to produce a system with improved band width characteristics.

The circuit employed is shown in Fig. 1, along with its equivalent where two "T" sections have replaced the line. Solution of the mesh equations for the latter circuit results in:

$$\frac{Z_{in}}{Z_o} = \frac{1}{2}\left(\frac{\frac{Z_L}{Z_o}\frac{1}{\sin^2 a} + 2j\cot a}{2 - j\frac{Z_L}{Z_o}\cot a}\right) - j\cot a \quad \ldots\ldots (1)$$

when $Z_1 = \frac{-j Z_o(\cos a - 1)}{\sin a}$,

$Z_2 = -j Z_o/\sin a$,

$a = \ell/2$, (ℓ in degrees)

$$\frac{Z_L}{Z_o} = \frac{2(2 Z_{in}/Z_o + j\cot a)}{1 - \cot^2 a + j(2 Z_{in}/Z_o)\cot a} \quad \ldots\ldots (2)$$

This is the form in which the expression can most readily be applied to actual measurement problems. Z_{in}/Z_o is easily found by means of a slotted line. The impedances are expressed in terms of Z_o, since that is the form in which they are usually obtained in connection with transmission line charts.

Transformer length, l, must be determined with the greatest possible accuracy. With the short lengths in the 100 to 500 MC region, the most suitable method of determining l is to short circuit the transformer at its load end, A, and find the frequency for which short circuits placed at the input end, B, make no change in the position of the null on the slotted line.

A high frequency resistor measuring 320 ohms on a good ohmmeter was measured with a transformer which was one half wave length at 142.5 MC. R_L and X_L are shown on Fig. 2 for a 55 MC range. No particular attempt was made to reduce lead inductance so the measured reactances are not necessarily attributable to the resistor. A folded dipole antenna was also measured over this range and yielded the impedance characteristic shown on Fig. 3. (heavy lines).

Equation (2) may be rationalized and separated into real and imaginary parts. If Z_{in}/Z_o is set equal to $R_{in} + j_o$,

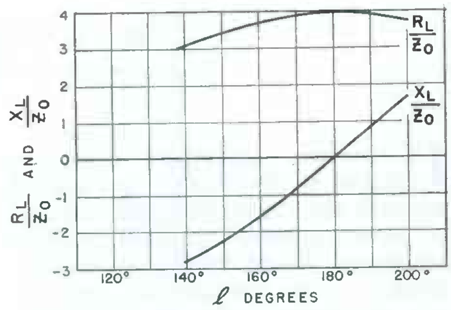


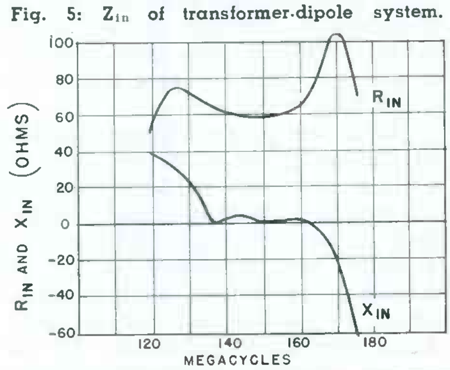
Fig. 4: Load impedance needed for $Z_{in} = Z_o$.

$$\frac{R_L}{Z_o} = \frac{4 R_{in}/Z_o}{(\cot^2 a - 1)^2 + 4(R_{in}/Z_o)^2\cot^2 a} \quad \ldots\ldots (3)$$

$$\frac{jX_L}{Z_o} = -j\frac{4[2(R_{in}/Z_o)^2\cot a + \cot a/2(\cot^2 a - 1)]}{(\cot^2 a - 1)^2 + 4(R_{in}/Z_o)^2\cot^2 a} \quad \ldots\ldots (4)$$

The $R_{in} = Z_o$ values, plotted in Fig. 4, have the same direction of slope as the resistance and reactance curves of a half wave length center fed antenna, suggesting impedance compensating properties. Fig. 5 is the input impedance to an antenna-transformer system where the transformer is a half wave length at about 165 MC. A true balanced to unbalanced converter is indicated by the fact that the same values are obtained with the center of the unfed side of the antenna connected to the cable ground. The curves of Fig. 4 can be modified by various steps; for instance, the Z_o of the transformer can be changed, effectively changing R_{in}/Z_o, or the transformer can be made one and a half wave lengths long which makes the impedance variations more rapid. Acknowledgment is made to Peter Andris for posing the original problem and for valuable criticism.

Fig. 5: Z_{in} of transformer-dipole system.



An Application of Frequency

Circuit having relatively few components provides flexible audio frequency extremities a 28 db emphasis is obtained in maximum equalize position

By JONATHAN EDWARDS & THOMAS J. PARKER,
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In general, equalizers are employed to distort in a prescribed manner the frequency pass-band of a given system. In this manner emphasis, de-emphasis, or equalization to an overall flat response can be obtained. The choice of system response is determined primarily by the intelligence being passed and the use to which that intelligence is to be put. For the average radio listener, equalization takes the form of the familiar tone control which is a pass-band distorting device without much effective range. For the engineer the need for equalization of system response arises in a great number of instances. The most prominent examples of where equalization is used are in the numerous types of recording, long line communications, and in the vestigial sidebands of television. In the home it is not necessary to have calibrated tone controls for as a rule the listener merely adjusts his control until the resulting program material sounds most pleasing to his ear. For commercial uses, however, calibrated controls are a must if reset features and accurately known characteristics are to be available.

The equalizer described in this article is of this latter class, having switch positions providing 80 different pass-band characteristics. While the system described is designed for more exacting applications, its simplicity coupled with its tremendous effective control range makes it inexpensive and even desirable to apply to home sound reproducing systems.

Up to the present time, methods of obtaining equalization may be divided into two broad categories. In the first, inductors and capacitors in resonant and anti-resonant circuits are combined either in feedback or feed-through configuration to provide the desired pass-band frequency distortion. In the second category, resistance and capacitance elements are used in a somewhat similar manner to obtain the necessary pass-band distortion.

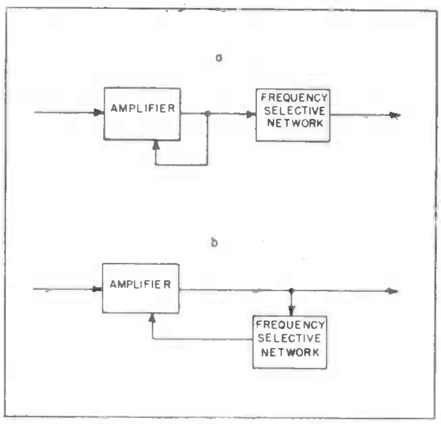


Fig. 1: Block diagram of a negative feedback equalizer showing (a) feedthrough configuration which provides attenuation and (b) the feedback configuration to provide boost

Poor Transient Response

A major disadvantage inherent in the inductor-capacitor configuration is the poor transient response evident in the trailing oscillations produced when the system is excited by signals whose rise or fall time is short compared to the circuit time constants. These oscillations occur in inductor-capacitor circuits which are necessarily under-damped to obtain a sharp transition between pass regions and attenuate regions of the pass-band characteristic. This can be observed in an after-ringing of such steep-wave-front sounds as bass drum notes and cymbal crashes. In addition to the poor transient response, there is the practical problem of obtaining inductors which are not subject to the influence of stray fields and which are of sufficiently high Q at the low audio frequencies. These last difficulties can be overcome to a large extent with toroidal coils provided the inherent low frequency self-resonant effects can be tolerated.

Resistance-capacitance combinations also have presented a problem in that in order to obtain a sharp transition between the emphasis region and the attenuate region, comparatively complicated circuitry has been employed.[1] In addition, the resistance elements introduce an effective insertion loss for the equalizing network which must be compensated with additional amplifying stages. As a secondary effect of the dissipative action of the resistor, it is difficult to arrange the resistance-capacitance circuitry so that a control to vary the response in one portion of the pass-band will be independent of a control for another portion of the pass-band.

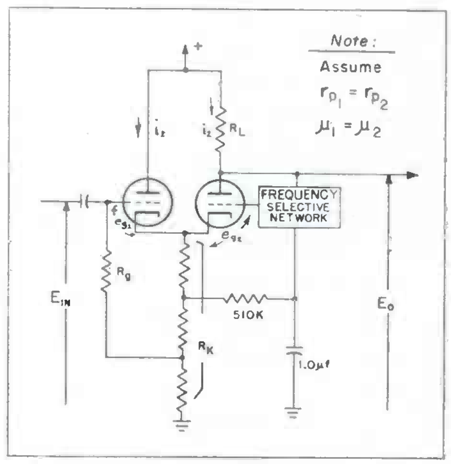


Fig. 2: Cathode coupled boost amplifier

The disadvantages of the resistance-capacitance combinations are offset somewhat, however, in that the physical size and weight of these components are considerably less than are required for the inductor-capacitor combinations. Even more important is that the cost of the resistor-capacitor combinations is but a fraction of the cost of the components of the inductor-capacitor combinations.

Regardless of the method of producing the desired pass-band char-

Selective Negative Feedback

equalization using resistive and capacitive elements. At bandpass with a 30 db de-emphasis recorded in maximum attenuate position

acteristics, compensation for boost or attenuation of the frequencies of greatest energy level must be provided to maintain the apparent volume level at a constant value. Fletcher[2] has shown that with speech and music these frequencies of greatest energy level center around 400 cps. If, in obtaining a given desired relative pass-band characteristic, the level of the frequencies centering around 400 cps. are boosted or attenuated, gain compensation must be applied to maintain a constant apparent volume level. As a rule, then, where large positive slope or large negative slope characteristics with respect to mid-band frequency levels are desired, considerable compensation must be applied through the use of vacuum tube amplifiers.

In applications where boost alone is desired simple circuits providing very wide range of control with little mid-frequency variation can be obtained through the use of frequency selective negative feedback. By varying the amount of frequency distortion in the feedback network, the output response of the amplifier will be controlled. It will be shown, in fact, that for high gain amplifier stages, the pass-band response characteristic will be very nearly the reciprocal of the frequency characteristic of the feedback network. This application of negative feedback not only provides a considerable range of control but also minimizes amplitude distortion throughout the region of the feedback frequencies.

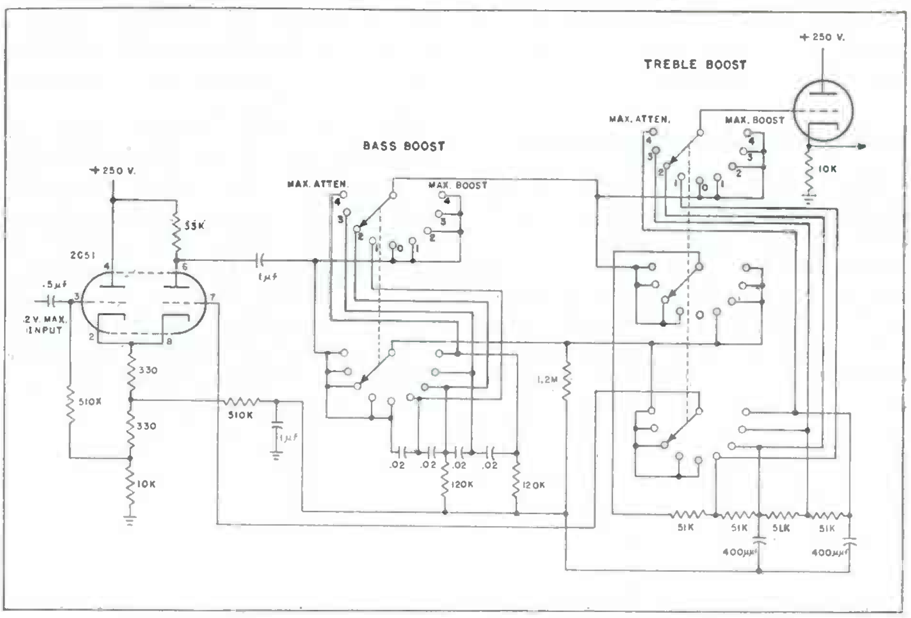


Fig. 4: Schematic diagram of the complete negative feedback pass-band equalizer circuit

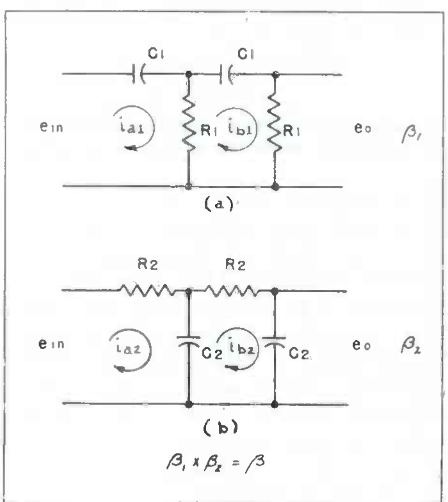
In equalizers where attenuation alone is desired, amplifier stages are not required and feed-through circuitry can be employed.

The basic equalizer used in these experiments is shown in Fig. 1 and consists essentially of two units, an amplifier stage and a frequency sensitive network. The amplifier stage with no feedback has a mid-band gain of approximately 30 db. The frequency sensitive network is used in a dual role. In a feed-through configuration, this network is used to provide attenuation of some frequency components in the pass-band. This same network when switched into a feedback loop for the amplifier stage will boost in amplitude the frequency components formerly attenuated by the network. At frequencies attenuated in the feedback loop, the percentage feedback is reduced, and more nearly full gain of the amplifier stage is realized.

The amplifier employed is shown in Fig. 2 where in reality the frequency sensitive network is composed of two simple resistance-capacitance networks. The first of these, associated with the bass boost-attenuate switch, is a two-section high-pass network with a half-power frequency of approximately 130 cps. The second network, associated with the treble boost-attenuate switch, is a two-section low-pass network with a half-power frequency of 3900 cps. These corner frequencies are sufficiently separated that throughout the middle frequencies centering around 400 cps. there is little interaction between the two networks. With this arrangement, then, the bass response and the treble response of the equalizer can be varied independently with but slight change of the equalizer response at the mid-frequencies.

The high-pass network associated with the bass boost-attenuate switch has a positive slope below its half-power frequency approaching 12 db. per octave. Three additional taps are provided on the bass boost-attenuate switch for slopes which approach 9 db., 6 db., and 3 db. per octave below the half-power frequency. These four

Fig. 3: Resistance-capacitance networks to provide frequency selective characteristics (a) high-pass network (b) low-pass network



SELECTIVE NEGATIVE FEEDBACK (Continued)

switch positions which are connected in a feed-through configuration comprise the attenuate section of the bass boost-attenuate switch. Four additional switch positions connecting the high-pass network in a feedback configuration comprise the bass boost section of this switch. On the ninth switch position, the attenuator network is removed from the circuit to give a flat overall response.

Treble Boost-Attenuate Switch

The action of the treble boost-attenuate switch is quite similar to that of the bass boost-attenuate switch except that its associated low-pass network gives a negative slope approaching 12 db. per octave above the half-power frequency of 3900 cps. As was the case with the

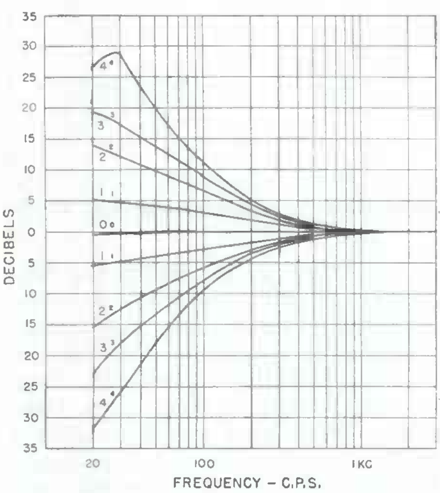


Fig. 5: Low frequency response characteristic curves for negative feedback equalizer

bass boost-attenuate switch, there are provided four switch positions for feed-through configuration, four positions for feedback configuration and one position for the flat overall response. The diagram of Fig. 4 shows the complete equalizer circuit while Figs. 5, 6, and 7 are the frequency versus gain responses measured for different switch settings.

For purpose of analysis, two distinct conditions of operation may be considered, namely, the feed-through case for attenuation alone and the feedback case for boost alone. Simplified block diagrams of these two conditions are shown in Figs. 1a and 1b. In these two cases, the action of the bass boost-attenuate switch and the treble boost-attenuate switch may be considered independently thus simplifying the analysis appreciably. The error introduced by doing this will be of the order of one or two db. for the frequencies around 400 cps., and will be negligible at either frequency extremity.

In the simple case, it is convenient to define the transfer characteristic of the attenuator network simply as β, which is a complex function of frequency.

For the feed-through case, as shown in Fig. 1a, the amplifier stage is connected for 100% feedback thus giving the stage a gain of approximately unity. The output of the equalizer in this case becomes:

$$E_o/E_{in} = \beta \qquad (1)$$

where β from Fig. 3 is the product of the individual transfer functions of the two networks which are cascaded in the equalizer:

$$\frac{e_{o_1}}{e_{in_1}} = B_1$$

$$i_{b_1} = \frac{\begin{vmatrix} [R_1-(j/wC_1)] & e_{in} \\ -R_1 & 0 \end{vmatrix}}{\begin{vmatrix} [R_1-(j/wC_1)] & -R_1 \\ -R_1 & [2R_1-(j/wC_1)] \end{vmatrix}} = \frac{e_{in} R_1}{[R_1-(j/wC_1)][2R_1-(j/wC_1)]-R_1^2}$$

Now $e_{o_1} = i_{b_1} R_1$, and

$$B_1 = \frac{R_1^2}{R_1^2-(1/w_1^2C_1^2)-3j(R_1/wC_1)} = \frac{1}{1-(1/R_1wC_1)^2-3j(1/R_1wC_1)}$$

Define $f_1 = 1/R_1wC_1$

$$B_1 = \frac{1}{1-(f_1/f)^2-3j(f_1/f)}$$

In network (b) of Fig. 3, define $f_2 = 1/R_2\omega C_2$ then:

$$B_2 = \frac{1}{1-(f/f_2)^2-3j(f/f_2)}$$

In the equalizer under discussion, these two networks are connected in tandem so that: $\beta = \beta_1\beta_2$.

Frequency Characteristics

It should be noted that in general the corner frequencies f_1 and f_2 are chosen sufficiently far apart that the transfer function can be simplified to two different β's for calculating purposes. Specifically to determine the low and high frequency characteristics:

$$B_{low} = \frac{1}{1-(f_1/f)^2-3j(f_1/f)}$$

$$B_{high} = \frac{1}{1-(f/f_2)^2-3j(f/f_2)}$$

For the feedback case the block diagram of Fig. 1b applies. In this configuration the attenuator network is placed in the feedback path of the amplifier to obtain frequency emphasis. A more detailed diagram for this feedback case is shown in Fig. 2. For this figure the grid-to-cathode voltages are:

$$e_{g_1} = E_{in} - (i_1 + i_2) R_k$$

$$e_{g_2} = B E_{out} - (i_1 + i_2) R_k$$

and the loop voltage equations obtained are

$$i_1(r_p + R_k) + i_2 R_k = \mu e_{g_1} = \mu[E_{in} - (i_1 + i_2) R_k]$$

$$i_1 R_k + i_2(R_L + r_p + R_k) = \mu e_{g_2} = \mu[B E_{out} - (i_1 + i_2) R_k]$$

where $E_{out} = - i_2R_L$. Solving for the current i_2, and substituting, we obtain

$$\frac{E_{out}}{E_{in}} = \frac{\mu R_k R_L}{\frac{r_p R_L}{(\mu+1)} + \frac{r_p^2}{(\mu+1)} + 2r_p R_k + R_L R_k + \frac{\mu B r_p R_L}{\mu+1} + \mu B R_k R_L}$$

With $\mu >> 1$ and with r_p, R_K and R_L of the same order of magnitude, this equation can be written to a very close approximation

$$\frac{E_{out}}{E_{in}} = \frac{1}{\frac{(2r_p/R_L) + 1}{\mu} + B} \qquad (2)$$

where β is again a complex function of frequency, and μ and r_p are the amplification factor and the plate resistance respectively of the two similar triode tubes. In equations (1) and (2) the magnitude of β may vary between zero and unity.

Inspection of equation (2) shows that for the practical case, where $r_p < R_L$ and $\mu >> 1$, that equation (2) reduces to $E_{out}/E_{in} \approx 1/\beta$. This means, therefore, that an attenu-

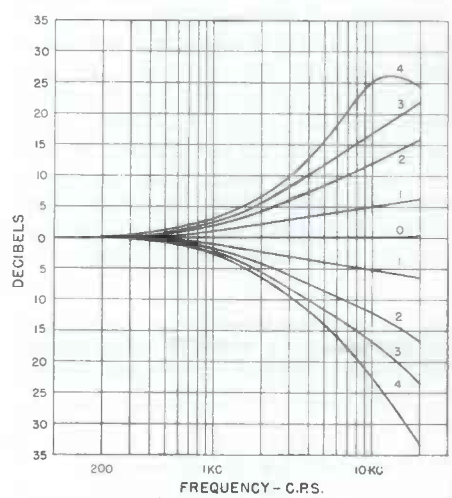


Fig. 6: High frequency response characteristic curves for negative feedback equalizer

ator network in the feedback loop of a high gain amplifier stage will vary the gain of that stage in a manner reciprocal to the transfer function of that attenuator network. The converse of this is true also. To develop a frequency selective amplifier stage with a prescribed response curve, it is necessary to place in the feedback loop a network with a response inverse to the desired response.

There are two extreme values of the transfer function which warrant further mention. These cases are for 100% feedback where $\beta = 1$, and for zero feedback where $\beta = 0$. For the case of 100% feedback, the output of the equalizer becomes:

$$\frac{E_{out}}{E_{in}} = \frac{\mu}{\mu + 1 + (2r_p/R_L)}$$

which has a value slightly less than unity. Similarly, for no feedback, the full equalizer output is realized,

$$\frac{E_{out}}{E_{in}} = \frac{\mu R_L}{R_1 + 2r_p}$$

Of considerable interest is the transient response of the system which is determined by the transient response of the attenuator network. (This is valid only when tube and circuit stray capacities and inductances can be neglected which is generally the case at audio frequencies.) Consider the lowpass filter as given in Fig. 3b

$$\left.\begin{aligned} R_2 i_{a_1} + \frac{1}{C_2}\int i_{a_2}\,dt - \frac{1}{C_2}\int i_{b_2}\,dt &= E_{in} \\ -\frac{1}{C_2}\int i_{a_2}\,dt + R_2 i_{b_2} + \frac{2}{C_2}\int i_{b_2}\,dt &= 0 \end{aligned}\right\}$$

Transforming by the Laplace transform method, it follows that

$$R_2 I_{a_2} + \frac{1}{C_2 s} I_{a_2} - \frac{1}{C_2 s} I_{b_2} = E(s)$$

$$-\frac{1}{C_2 s} I_{a_2} + R_2 I_{b_2} + \frac{2}{C_2 s} I_{b_2} = 0$$

Solving for $I_{b_2}(s)$,

$$I_{b_2}(s) = \frac{E(s)}{C_2 s\{R_2 + (2/C_2 s)\}\{R_2 + (1/C_2 s)\} - (1/C_2 s)^2}$$

For a step input function, $E(s) = 1/s$

$$I_{b_2}(s) = \frac{1}{C_2 R_2^2}\left[\frac{1}{(s-\alpha)(s-\gamma)}\right]$$

$$\text{where } \alpha = \frac{-3+\sqrt{5}}{2R_2C_2} \text{ and } \gamma = \frac{-3-\sqrt{5}}{2R_2C_2}$$

By the Laplace transform, the time function is obtained

$$i_{b_2}(t) = \frac{1}{C_2 R_2^2}\,\frac{1}{(\alpha-\gamma)}\,[e^{\alpha t} - e^{\gamma t}]$$

$$\text{Now } e_{out_2} = \frac{1}{C_2}\int_0^t i_{b_2}\,dt = \frac{1}{C_2^2 R_2^2}\left[\frac{1}{\alpha}e^{\alpha t} - \frac{1}{\gamma}e^{\gamma t}\right]_0^t =$$

$$\frac{1}{C_2^2 R_2^2(\alpha-\gamma)}\left[\frac{1}{\gamma} - \frac{1}{\alpha} + \frac{1}{\alpha}e^{\alpha t} - \frac{1}{\gamma}e^{\gamma t}\right] =$$

$$1 - \frac{1}{2\sqrt{5}}\left[(3+\sqrt{5})\,e^{\frac{(-3+\sqrt{5})t}{2R_2C_2}} - (3-\sqrt{5})\,e^{\frac{(-3-\sqrt{5})t}{2R_2C_2}}\right]$$

Note that the transient response is non-oscillatory since neither exponential term has an imaginary exponent. With the circuit constants given in Fig. 4, the delay in response of the network to a step input can be readily calculated. For example, the time necessary for the output voltage to reach 99% of its steady state value is approximately 31 milliseconds which is about the same relative magnitude as the build-up time of a musical note in most instruments.

The high-pass filter obviously will preserve the steep wave front of a step input and consequently eliminate the need for transient analysis.

The tube type 2C51 was chosen for this equalizer for several reasons. This tube type has a μ of the order of 35 while at the same time the g_m is large. In addition, the internal construction of the tube is such as to reduce microphonic action to a minimum. The small physical size of the tube makes possible the construction of the equalizer in a small space. (The tube type 6J6, which has characteristics quite similar to those of the 2C51, was rejected because of its tendency to be highly microphonic.)

Cathode coupling between the two stages was chosen to permit mixing of the input signal on the cathode and of the feedback signal on the grid of the amplifier triode without interaction between these two signals.

The two triodes have their grid returns to taps on the cathode resistor to provide bias to more favorable operating points on the triode characteristic curves. The input cathode follower triode is biased to −4 volts while the amplifier triode is biased to −2 volts. These bias values limit the input

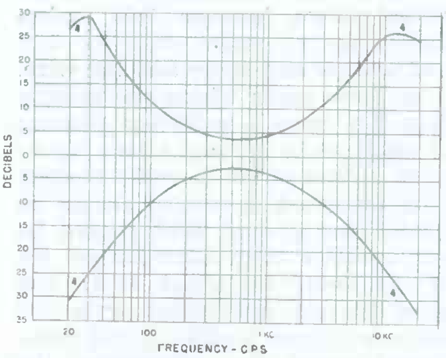


Fig. 7: Frequency response curve for negative feedback equalizer (a) both controls for max. boost (b) controls for max. attenuate

signal to approximately 2 volts peak since input voltages greater than this would cause severe distortion by driving the amplifier triode grid into conduction or by driving the tube to cutoff.

The degenerative action of the grid return to the cathode tap in the equalizer input results in a very high input impedance. This permits the operation of this equalizer directly from the output of a high impedance source such as a crystal pickup or a high impedance amplifier stage. Where operation of this equalizer from a low impedance source such as a low impedance transmission line is desired, a trans-

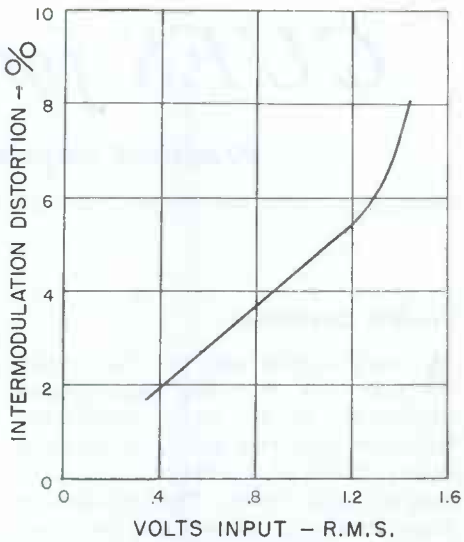


Fig. 8: Intermodulation distortion for cathode coupled boost amplifier—no feedback

former matching the low impedance line to a high impedance grid may be used. In cases where the signal power is relatively large, the transmission line may be terminated directly in a resistance load, to which the input of the equalizer is connected. In either case, care must be taken not to exceed a maximum of 2 volts peak input to the equalizer.

The degenerative action of the grid return to a cathode tap is not desired in the amplifier triode, however, so a low-pass filter section of long time constant is placed in the grid return path of that triode. This filter provides a dc return for the triode grid but eliminates ac coupling between the cathode tap and the amplifier triode grid.

In any amplifying system there will arise non-linear distortion which usually is a function of the input signal level. To give a measure of the distortion in the cathode coupled amplifier, inter-modulation tests were made using a combination of a 12 KC signal and a 40 cps signal. For these tests the negative feedback was reduced to zero so that the system band-pass would be flat to include the testing signals and at least the second harmonic of the uppermost frequency. Fig. 8 gives an indication of the intermodulation distortion to be found for the various input signal levels. These distortion figures, however, are higher than are encountered in the equalizer because of the negative feedback applied in that circuit. It is inherent in a negative feedback amplifier that the distortion of the amplifier will be reduced by a factor proportional to the per-

(*Continued on page 50*)

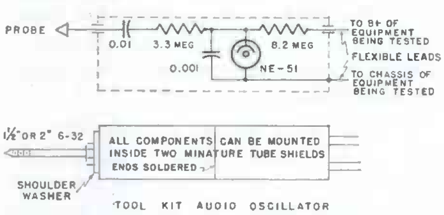
CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Toolkit Oscillator

A very useful tool for the engineer in checking equipment continuity is an audio oscillator, however very few desire to carry a heavy piece of precision test gear around with them. The miniature neon oscillator shown in the diagram was designed to fit into the pocket or tool box. It consists essentially of two miniature tube shields with the bottoms butted together and soldered. A 1½ in. 6-32 bolt fastened to one end of the shield using a shoulder washer makes a good probe, while two flexible leads 3 or 4 ft. long with alligator clips on the ends extend from the other. These connect to the power supply of the equipment under test and feed power to the oscillator.

The frequency can be varied by changing the value of the series resistor, varying the "B" plus or the shunt capacity across the neon tube. A unit built with the values shown, with 10% tolerances, and used with a power supply of 300 volts from a small P.A. system, generated an audio tone of approximately 100 cps with an output of about 4 volts.—KEN COOK, KMBC, Kansas City, Mo.



Circuit diagram, component values and general appearance of the toolkit audio oscillator

* * *

Lightning Protection

IN areas subject to considerable lightning grounding the tower is of paramount importance. Driving four 4 ft. to 6 ft. grounding stakes, 1 or 2 ft. from the tower and connecting to the tower leg does not seem to be sufficient. If grounding stakes are to be used one should be used as close as possible to the base of each leg and these should be started in holes dug with a post hole digger or equivalent, down to 6 or 8 ft. A galvanized steel stake or post should be driven as far below this as is possible and left extending above the ground a couple of feet. The grounding wire should be a large copper lead equivalent to a trolley wire or the like and dropped into the hole loosely with considerable excess well distributed as the hole is filled in. This permits good ground contacts in parallel with the stake. At the surface of the ground the stake should be bolted in good contact with trolley wire grounding lead with a couple of ¼ or ½ in. bolts with clean areas between the stake and the wire and with the wire lead wrapped around the bolt, uncrossed, in such a manner that flat and continuous contact is obtained to the stake. The lead should not be crossed over and bolted down because this makes only a point contact with the bolt and washer and stake and the wire.

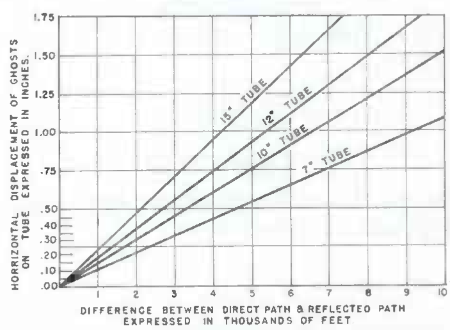
In those cases where the ground does not have a sufficient amount of moisture or in cases where lightning strikes often a radio ground wire ploughed-in system should be used. This ground lead should be run radially from each corner leg of the tower for about 25 ft. and good contact maintained with the leg in a manner similar to that mentioned above for connecting the ground wire to the stake. The ground wire should be connected with more than 1 bolt to a thoroughly cleaned surface.

In cases where a flexible coaxial line take-off from the tower extends more than a few feet to a building it is important that the messenger cable be well grounded at both ends. At the tower end it can, of course, be grounded to the tower and at the building end it should be grounded by a heavy copper cable such as is used at the tower end with a ground stake installation as used for the tower leg. Particular attention must be paid to getting a good and continued good electrical connection between the grounding wire, the messenger cable and the coaxial line at the entrance point. This ground wire and connection should be sufficient to carry very high currents to ground and maintain very low impedance. The impedance to ground at this point must be maintained many times lower than all of the impedances within the building, or radio equipment combined, to ground. This means that the area of connection to the messenger in the cable should be large and secured extremely tightly in a manner that will maintain a pressure tight connection.

Lightning current may be many thousands of amperes and a high impedance somewhere along the line will result in extremely high voltages. There have been cases of holes burnt into the side of ⅞" line between wrap-lock point where the wrap-lock was not torn off.

* * *

TV Ghost Displacement Chart



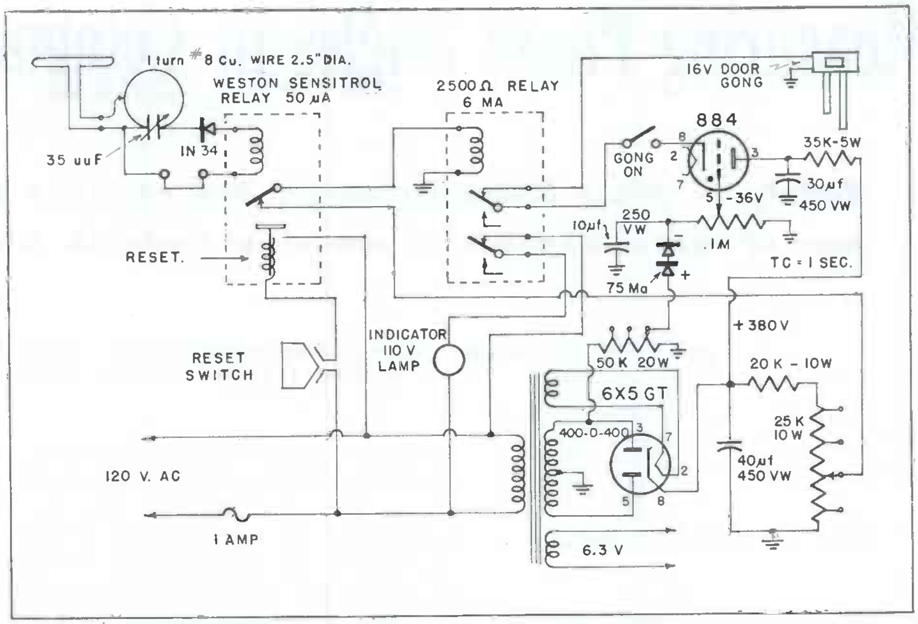
The chart above provides a quick means of calculating the distance to objects causing image reflections in reception. Based on the standard 53 micro-second horizontal sweep it enables engineers to determine which buildings are causing reflections without making involved calculations.

* * *

FM Off-Air Indicator

MANY broadcasting stations are supporting dual AM-FM operations, and duplicating the AM program to keep FM expenses low. The transmitter is generally located in the same building and supervised by the AM operator. The operator frequently maintains the AM monitor at a higher level of volume than the FM monitor speaker and consequently it is possible for the FM transmitter to fail and for the transmitter operator to be unaware of it.

In order to assure proper supervision of the FM transmitter an "Off the Air" indicator was designed. Initially, the device used a tuned circuit coupled to a rectifying crystal which in turn operated a 1.5 ma. 10,000 ohm relay. The circuit was fed from the pick-up loop in the FM transmitter final amplifier which also excited the FM frequency-modulation monitor. Since it was felt that the excitation from the lower stages in the transmitter could fail and allow the final amplifier to go into self oscillation and thus not trip the indicator, it was decided to operate the unit from a separate antenna mounted on the transmitter building, about 600 feet from the transmitting antenna. Circuitry employed is shown in the schematic diagram.



Pictured above is the circuit diagram of the Off-Air Monitor. Simplicity of design is the keynote, and lack of critical adjustments makes for stable operation.

In describing this circuit, the tap on the tank coil controls the sensitivity. When tuning initially, the shorting bar across the insulated tip jacks is removed and a 0-1 ma. meter is placed in the circuit. Resonance is indicated by maximum reading on the meter, but care should be taken to limit the current flowing through the Weston coil to approximately 100 µamp. The tuned circuit should be adjusted exactly to the transmitter frequency and the clip moved until the 0-1 ma. meter reads between .05 and .1 ma. The Weston relay has magnetic contacts on the zero current end of the scale, so that when the relay is not energized the hand comes to rest immediately. The relay contacts are the meter hand and the zero current end rest.

In normal operation the FM transmitter is on the air, and the second relay contacts are open. The 30 µf. condenser charges slowly through the 35,000 ohm resistor connected to 380 volt line. When the above mentioned relay closes, the thyratron cathode is connected to ground (B—) so the 30 µf. condenser discharges at once, energizing the gong solenoid. If the relay contacts remain closed the thyratron de-ionizes and the cycle repeats indefinitely.

With the FM transmitter operating normally, and the indicating device properly tuned and adjusted the Weston relay remains open.

Assume the transmitter goes off the air. The Weston relay loses excitation and the contacts will close. This allows the 2,500 ohm relay to operate thus closing the two sets of contacts on this relay. One set lights 120 volt indicator lamp. The second set allows the 30 µf. condenser to discharge through the gas tube and the winding of the gong solenoid, thus initiating the one second ringing cycle.

When the transmitter is placed back on the air, the warning condition obtains until the push-button switch is operated thus separating the magnetic contacts on the Weston relay. When the switch is released, the meter movement operates until the energizing current is again removed by transmitter failure. When this meter relay is opened, the secondary relay drops out opening the lamp and the gong circuits and placing the device in the alert position.—H. Eidson, Jr., WIS-FM, Columbia, S. C.

The three photographs below show the front and rear views of the indicator chassis. On the right can be seen the alarm gong mounted on the rear door of the rack. Lower left illustration shows method of mounting the tuning inductance, and input tap.

* * *

Send In Your Ideas!

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Our usual rates will be paid for material used.

Measuring Phase Angles in Communication Circuits

Variety of direct indicating meters find extensive application in development of amplifiers using large amounts of feedback, filters, and control circuits

By E. E. BREWER, *Convair Engineering Designer, Radio & Electrical Laboratory Consolidated Vultee Aircraft Corp., San Diego 12, Calif.*

PART TWO OF TWO PARTS

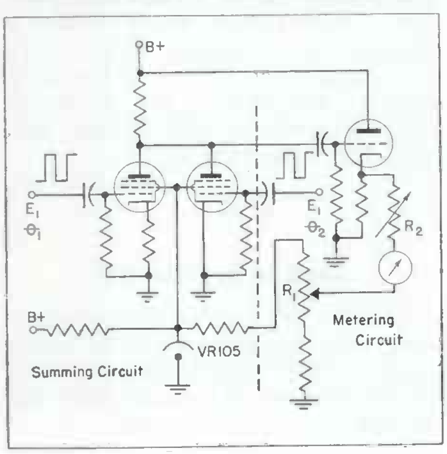
CONVENTIONAL summing circuits are generally of the type shown in Fig. 9. The grids of the summing tubes are excited respectively by the square waves of each channel and the plates are paralleled with a common load resistor. When the grids are at phase opposition, the plates remain at their static operating point and no AC voltage appears at E_o. As the phase angle of the exciting voltages departs from 180 degrees, a square wave of gradually increasing width appears at E_o and reaches its maximum width when the grids are excited in phase. Two ways of metering this square wave are shown in Fig. 9a and 9b and each have their commendable features. Fig. 9a represents a cathode follower type of metering circuit where the meter is in shunt with the cathode load resistor. The metering tube is so biased as to respond to only the positive halves of the square wave. Since the cathode is at a positive potential under static conditions, the meter is returned to a zero balancing potential through the potentiome'er R_1. R_2 is the sensitivity adjustment and positions the meter for 0 degrees or full scale reading. Another metering circuit in the form of a bridge is shown in Fig. 9b. The diode sections V_1 and V_2 act as rectifiers of the AC voltage appearing across resistor R_1 and apply positive and negative voltages respectively to the grids of tubes V_3 and V_4. As the width of the square wave increases, the grids of V_3 and V_4 are excited for longer periods of time and the average voltage between the plates will increase. The average meter reading is a direct function of the width of the square wave or the phase angle between the input waves. For optimum performance of this circuit, a carefully balanced diode and metering tube are required.

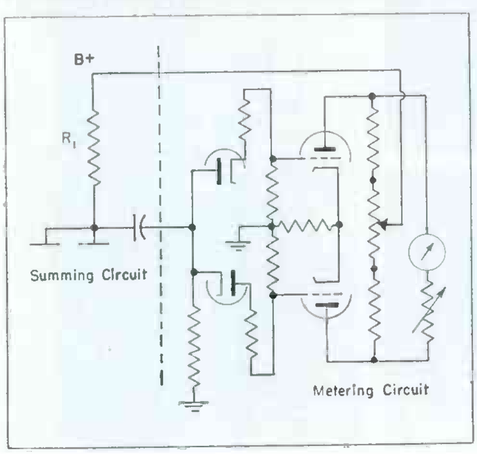
The circuit of Fig. 9c represents another summing and metering circuit which yields good results. With no signal applied to the grids of V_1 and V_2 the static voltage at the cathodes is sufficient to cut off the current through V_3. When V_1 and V_2 grids are at phase opposition their effect upon the cathode voltage is cancelled and tube V_3 remains cut off. When the phase varies slightly from 180 degrees, the wave from one channel does not completely cancel the wave from the other channel and for an instant tubes V_1 and V_2 are cut off allowing current to flow through V_3. As the phase angle departs farther from 180 degrees, V_3 is allowed to conduct for longer and longer periods until 0 phase angle is reached when V_3 conducts for a full ½ cycle. V_3 acts as a back biased gated diode whose conduction time is a function of the phase angle hence its average current is a function of the phase angle.

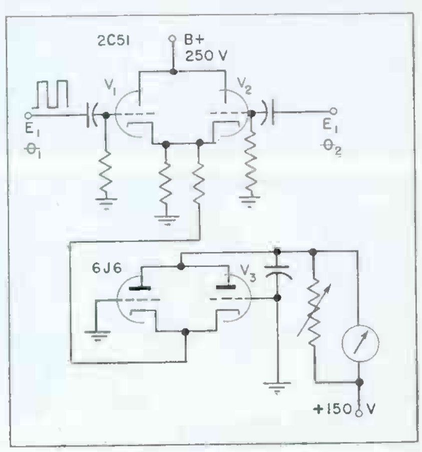
Accuracy Limitations

With regulated power supplies, hand picked parts, and excellent engineering, the electronic portion of a good phase meter can hardly be accurate and linear over full scale to much better than ½%, or 0.9 degrees on a 180 degree scale. With a meter movement accuracy of ½% there is another possible error of 0.9 degrees. True enough, these errors might cancel but they can be additive. With quadrature

Fig. 9a: (Left) Cathode follower type metering circuit where the meter is in shunt with the cathode load resistor. Fig. 9b: (Center) Bridge type metering circuit where the average meter reading is a direct function of the phase angle between the input waves. Fig. 9c: (Right) Another summing and metering circuit wherein V3 acts as a back biased gated diode whose conduction time is a function of the phase angle







switching and an expanded scale, the accuracy can be improved by reading less than 180 degrees as full scale. Super phase meters and null indicators are practical where harmonics of the subject signals are measured. Since the phase angles of the harmonics change with the order of the harmonic, the scale can be expanded by a factor of ten to one by reading the phase angle of the tenth harmonic. Any degree of scale expansion is possible by making measurements of the appropriate harmonic. A large amount of work of this type has been done at Convair but is beyond the scope of this paper.

In Fig. 10 are shown some direct indicating phase meters which have been constructed at Convair along the lines suggested above. The instrument second from left has a usable range of 30 to 15,000 cycles and may be used directly on circuits of 0.5 to 40 volts level. The widespread acceptance and frequency use in the Convair Electronics Laboratory is indicative of their utility. They are particularly helpful in the development and construction of amplifiers utilizing a large amount of feed-back, filters and control circuits.

Fig. 10: Four phase measuring units developed for use at Consolidated Vultee Aircraft Corp.

It is hoped that this paper may have been helpful to others engaged in a similar type of work.

ACKNOWLEDGMENTS

Circuits Figs. 4, 7, 9c Patents pending—R. V. Werner, assignee CVAC
Circuit Fig. 9a Patent pending—W. F. Davis, assignee CVAC

Raymond Guy Elected IRE President for 1950

Raymond Guy, President of IRE, 1950

ELECTION of Raymond F. Guy, Manager of Radio and Allocations Engineering for the National Broadcasting Co., and Sir Robert Watson-Watt, Governing Director of Sir Robert Watson-Watt and Partners, Ltd., of London, England, as president and vice president, respectively, of the IRE for 1950 was announced last month by the Board of Directors at Institute headquarters, 1 East 79th Street, New York 21, N. Y.

Mr. Guy, who will observe his 30th consecutive year as a broadcast engineer in 1950, started as a radio amateur in 1911. He became a member of the staff of WJZ, in New York, in 1921 when it began operations as the world's second licensed broadcasting station. Sir Robert, who received the IRE Fellow Award in 1947, for "his early contributions to radio and his pioneering work in radar", is considered England's outstanding radar authority.

Candidates elected as directors-at-large for the 1950-1951 term are: William R. Hewlett, vice president of Hewlett Packard Company of Palo Alto, Calif., and James W. McRae, Director of Electronic and Television Research of Bell Telephone Laboratories, Inc., Murray Hill, N. J.

Regional Directors

The election of regional directors for 1950-1951 is announced as follows: North Atlantic Region, Prof. Herman J. Reich of the Electrical Engineering Dept., Dunham Laboratory, Yale University; Central Atlantic Region, Prof. Ferdinand Hamburger, Jr., of the School of Engineering, Johns Hopkins Univ., Baltimore, Md.; Central Region, John D. Reid, Manager of Research of Crosley Division of Avco Manufacturing Corp., Cincinnati, Ohio; Pacific Region, Prof. Austin Eastman, head of Dept. of Electrical Engineering of the Univ. of Washington, Seattle, Wash.

Prominent in all technical phases of the radio industry during the growth period of AM, FM, Short Wave and Television broadcasting, Mr. Guy has been with NBC since 1929. He has participated in numerous International Conferences on radio in Havana, Mexico City, Montreal, and Washington. Sir Robert has been Deputy Chairman of the Radio Board of the British Cabinet and Scientific Advisor on Telecommunications for the Air Ministry. Prof. Hamburger is a Senior Member and all other officers and directors are Fellows of the Institute.

Thinner Crystal Oscillator Plates for VHF Applications

New grinding technics and equipment developed at the National Bureau of Standards permit lapping 100 MC crystals that are 0.001-in. thick

THE increasing interest in high frequencies for radio communication is accompanied by a demand for very thin quartz crystal oscillator plates having fundamental frequencies up to 100 MC or even higher. The usual crystal grinding methods and machinery, however, have proven inadequate for producing plates of the required thinness. In the course of an investigation of this problem, L. T. Sogn and W. J. Howard of the National Bureau of Standards have modified conventional techniques to overcome these difficulties.[1] The improved equipment, capable of producing quartz crystals 0.001-in. thick with a high degree of parallelism and flatness, can also be used for grinding equally thin wafers from a variety of other materials. A promising application, for example, is the production of extremely thin dielectric plates for miniature radio condensers.

In crystals whose fundamental frequency is in the higher range, the thickness of the quartz plate determines the frequency and the higher the frequency the thinner the crystal must be. For example, a crystal with a fundamental frequency of 100 MC is about 0.001-in. thick. Its surfaces must be parallel within a few millionths of an inch. To manufacture such crystals it has been necessary to modify the usual lapping procedures and to design equipment suitable to the modification.

Ordinarily, crystals are carried in a planetary path between two abrasive-charged lapping plates by a thin apertured disk called a nest. Nests thinner than 0.005-in. do not have the strength required to carry the crystals. Because the nest must be thinner than the crystals to permit their abrasion, crystals produced by this method have maximum fundamental frequencies of about 20 MC.

The initial problem therefore was to make the crystal thickness independent of the nest thickness. The solution involved various replacements for the customary top lapping plate and related changes in the design of the nest.

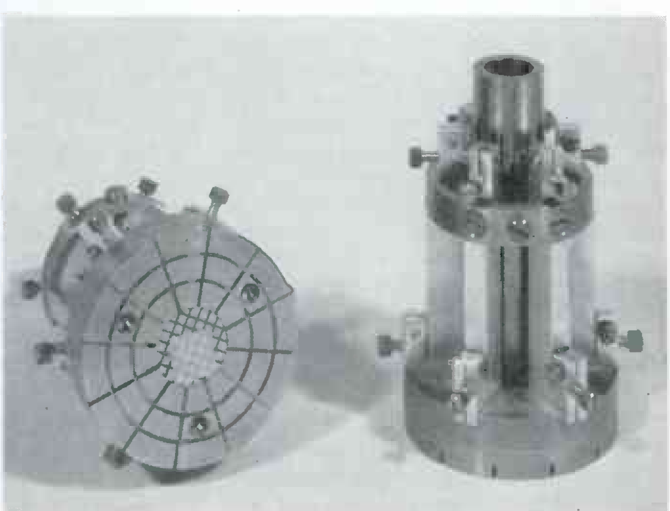
In the first modification the crystals were individually cemented to small steel blocks which were used in place of the top plate to supply lapping pressure. A conventional nest carried the cemented units over the lower lap. Because of difficulties inherent in this method of mounting, the crystals became wedge-shaped. Crystals were next lapped, using the same equipment with the pressure blocks resting freely on the crystals. This process however did not correct contour defects and the rate of lapping had to be reduced to prevent the blocks from being separated from the crystals.

To permit faster lapping with some control of the movements of the block and crystal relative to each other, both were closely confined in an accurately machined opening of a small steel plate. When

(*Continued on page 56*)

(Left) Recently developed inkwell apparatus permits easier inspection of individual quartz crystals as they are ground. Inset shows an unassembled view of the lapping apparatus

(Right) Tall plunger apparatus is modification of inkwell type. Bearing-point screws replace the close fitting bore and are locked in position by transverse screws in slots in the uprights



New Lab & Test Equipment

Field Intensity Meter

A radio interference and field intensity meter, the Stoddart NM-10A, has been designed to provide laboratory precision and

dependability and to withstand the rigors of all-weather field operation. This unit accurately measures field intensities of signals and r-f disturbances existing in space and may be used as a 2-terminal voltmeter (balanced or unbalanced), frequency selective over the 14-250 KC range. Effective noise bandwidth varies from approximately 55 to 400 cps over the frequency range. Image rejection is better than 50 db and I-F rejection is greater than 60 db. Operation is from 105-125 v. or 210-250 v., selected by a toggle switch inside the power unit. Single phase power source may be any frequency between 50 and 1600 cps.—**Stoddart Aircraft Radio Co., 6644 Santa Monica Blvd., Hollywood 38, Calif.**

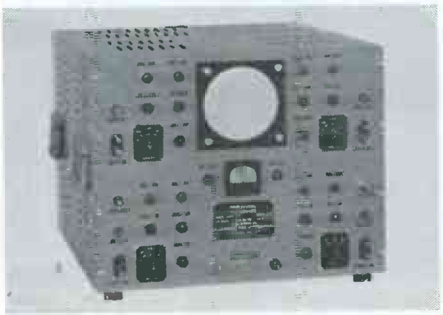
Complex Wave Generator

A new device, known as a complex wave generator, will generate any waveform and will provide a fundamental, and 2nd, 3rd, 4th

and 5th harmonics in any percentage, in relative phase, and independently variable. The frequency of the fundamental may be varied from 50 to 3000 cps and the amplitude of any harmonic may be varied from 0 to 100% of the fundamental. The fundamental and all harmonics are derived from the same 2 beating oscillators so that no synchronizing problem exists. Phase shifting is done at a single frequency by means of a simple, substantially linear phase shifting circuits.—**Alfred W. Barber Laboratories, 34-04 Francis Lewis Blvd,, Flushing, N. Y.**

4-Channel Oscilloscope

As many as 4 variables can be indicated simultaneously on the single 5-in. flat-faced



tube of the H-43 cathode ray oscilloscope. Designed primarily for use with a continuous film type of recording camera, this unit is normally supplied with the Fairchild type, F-246A, oscillo-record 35mm camera (f/2.8 or f/1.5 lens), but may be used in conjunction with larger drum cameras. The CR tube is the 54SW which operates at 4500 v. overall acceleration. Separate focus, intensity, and positioning controls are provided in each of the 4 channels, and positioning in horizontal and vertical directions is possible. Terminals, accessible from the rear, provide direct connection to all deflector plates.—**Electronic Tube Corp., 1200 Mermaid Ave., Philadelphia 18, Pa.**

Oscillograph-Record Camera

Type 314-A oscillograph record camera serves for single frame exposures of stationary patterns as well as for continuous recording

of constantly-changing phenomena. For continuous recording the film is continuously variable from 1 in. per min. to 5 ft. per sec. For low- and medium-frequency phenomena, the signal is applied to one deflection axis of the oscillograph and the film moved at right angles to it, giving a continuous recording along the length of the film. For high frequency work the sweep of the oscillograph is used, and each sweep recorded across the film, with the film motion displacing each successive sweep.—**Allen B. DuMont Laboratories, Inc., 1000 Main Ave., Clifton, N. J.**

Impedance Measuring Device

Facilitating the measurement of impedances from 0.1 to 100,000 ohms, through a wide range of frequencies, the Impedometer pro-

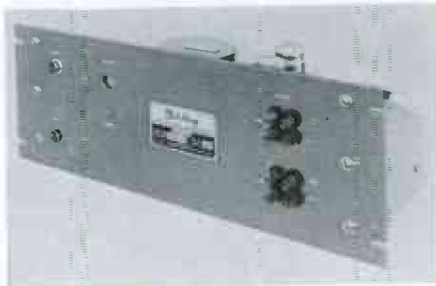
vides simple, convenient means for comparing the voltage drop across the unknown impedance and the voltage drop across a resistive standard, when the same current is flowing in both circuits. In making this comparison, the Impedometer is used in conjunction with a suitable oscillator and a vacuum tube voltmeter.—**Electrodyne Company, 899 Boylston St., Boston 15, Mass.**

DC Amplifier

Amplifier and power supply of model EDA-M1, a high-gain DC amplifier, are separate units and may be removed from the cabinet mounting for installation in a standard relay rack. Frequency response is from DC to 100 KC ±30% and gain is 25,000. Drift is less than equivalent of 0.5 mv. input in 5 minute period. Maximum output voltage 400 V peak to peak. —**Electronic Tube Corp., 1200 East Mermaid Lane, Philadelphia 18, Pa.**

Frequency Standard

A new frequency standard, employing a 100 KC crystal, has a 24-hour frequency stability of 2 parts in 10 million when subjected



to line voltage fluctuation of as much as 10%. Under adverse conditions of temperature, humidity and semi-portable operation the instrument will maintain an accuracy of 2 parts in 1 million for 30-day period without resetting. A Bliley GT cut quartz crystal unit temperature stabilized to within 0.1°C. in a specially designed oven using a mercury thermostat and external relay is the frequency source. Terminals are provided for sine wave or harmonic output at high impedance and low impedance. Power supply is self contained.—**Bliley Electric Co., Erie, Pa.**

UHF Oscillator

Model 112 UHF oscillator covers a frequency range of 300 to 1000 MC and incorporates the same type of oscillator used in

model 84 standard signal generator. Frequency calibration is accurate to ±0.5%. Maximum output voltage, varying with frequency, is between 0.3 v. and 2 v. The output voltage is not calibrated in absolute value; however, an output dial calibrated in db makes possible relative voltage measurements. Provision has been made for the use of a direct current power source when maximum stability is required.—**Measurements Corp., 116 Monroe St., Boonton, N. J.**

TV Signal Generator

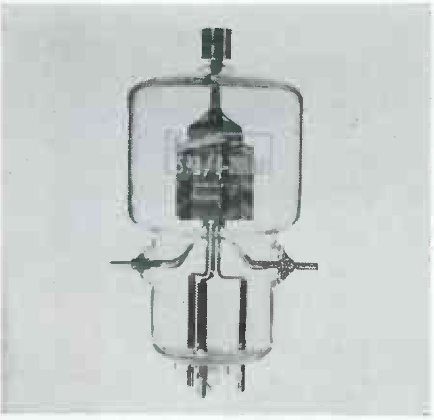
Model TV-30 television signal generator is said to enable alignment of television I.F. and front ends without the use of an oscillo-

scope. Frequency ranges are: 18-32 MC; 35-65 MC; 54-98 MC and 150-250 MC. without switching. Audio modulating frequency is 400 cycles (sine wave). Cabinet measures 6 × 7 × 9 in.—**Superior Instrument Co., 227 Fulton St., New York, N. Y.**

New Parts for Design Engineers

Triode

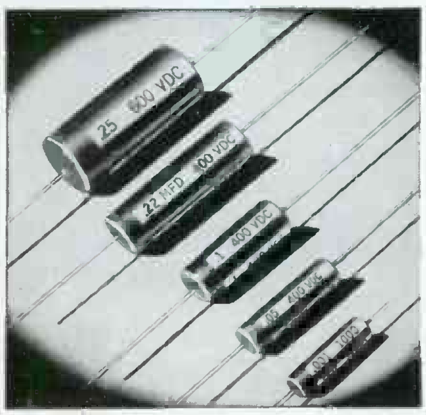
A vacuum tube which is directly interchangeable with the type 592 has been patterned after the famous Eimac VT327A radar



pulse tube. This commercial version is a general purpose VHF triode and is suitable for oscillator and power amplifier applications. The plate is constructed with exclusive Eimac pyrovac plate material giving long life and the ability to take large momentary overloads. The tube may be used as a power amplifier at frequencies as high as 125 MC.—**Eitel-McCullough, 237 San Mateo Ave., San Bruno, Calif.**

Tubular Capacitor

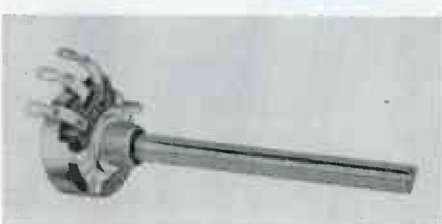
Instead of the customary molded-case tubular construction requiring time-consuming production molds and accounting for higher



cost, the type 87 capacitor is molded in its own paper tube. The impregnated capacitor section is placed in a paper tube and sealed at a cost approaching that of conventional paper tubulars yet providing heat- and humidity-resistant qualities of the order of the best plastic tubulars. Thus the type 87 looks like a conventional paper-tube tubular with ends that are sealed with rock-hard Duranite. An overall wax dip further adds to the high humidity-resistant characteristic. — **Aerovox Corp., New Bedford, Mass.**

Controls

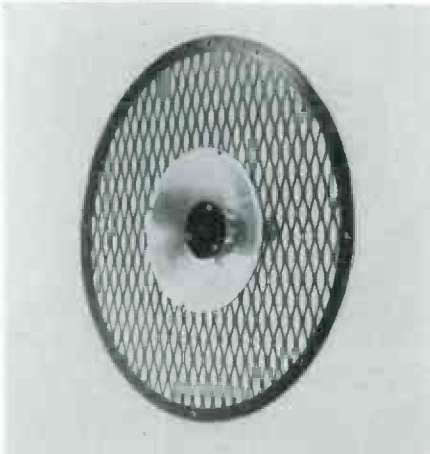
A complete line of 59 entirely new, small-Q controls with unique shaft features has been developed for meeting TV, AM, and FM replacement needs with maximum efficiency and minimum stocks. In line with the trend toward miniaturization, units in this new line



measure only 15/16 in. in diameter. All controls are equipped with the "Knob Master Fixed Shaft" which is proportioned so that it will fit at least 90% of the ¼-in. shaft knobs (knurled, spring-type, flat or set-screw) without any alteration except cutting to length. No shaft inserts are required. The "Knob Master Shaft" may be split lengthwise and the ends spread for fitting to oversize or worn knobs.—**International Resistance Corp., 407 North Broad St., Philadelphia 8, Pa.**

High Frequency Tweeter

Masco model HFT-100 high frequency tweeter is designed to meet high quality standards by providing an upper frequency



response of better than 15 kc. Intallation is simple and requires no additional space. The existing cone speaker is unscrewed, the screen with high frequency unit attached is placed over the corresponding holes of the cone speaker, and then the assembly is screwed back in place. No filter network is required. —**Mark Simpson Manufacturing Co., 32-28 49th St., Long Island City 3, N. Y.**

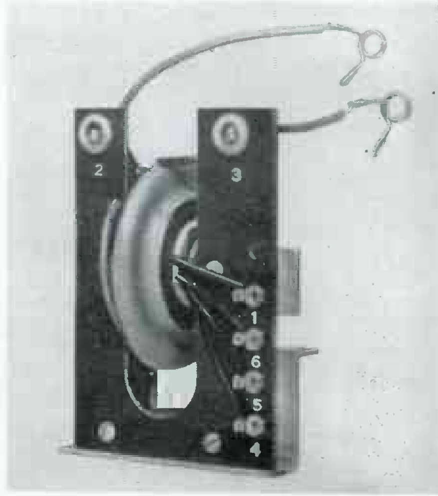
Rectangular TV Tube

As well as being the shortest 16-in. television tube on the market, the Hytron 16RP4 provides a directly-viewed picture on a rectangular screen. In spite of the increased

viewing space, the 16RP4 takes approximately the same amount of cabinet space as a round 12-in. tube. Weight is about two-thirds that of the 16-in. all-glass round tube. Magnetic focus and deflection are employed and no high voltage isolation is required.—**Hytron Radio & Electronics Corp., Salem, Mass.**

Horizontal Output Transformer

A new development in power supplies, utilizing laminated microsil, can be employed to eliminate one tube or can be furnished as



a complete power supply with the tube, high-voltage capacitor and resistor networks attached. A special manufacturing process enables this coil to operate with minimum corona radiation and low heat factor. Coils are wound for 10-, 12-, and 16-in. picture tubes and can be furnished for voltage doubler circuits also.—**El-Rad Mfg. Co., 4087 Broadway, Chicago 13, Ill.**

Preamplifier

Model 130H preamplifier has been designed to equalize low frequencies and provide necessary gain for magnetic pickups. It is self-

powered, operates with any high quality, high input impedance amplifier and is said to be superior to most broadcast station equipment in its frequency response and accuracy of equalization.—**Pickering & Co., Inc., Oceanside, N. Y.**

8 1/2-in. TV Tube

While having characteristics similar to the standard 7JP4 (left) and being interchangeable with it, the new 8½-in. Raytheon 8BP4

(right) offers an increase in useful screen area of approximately 50%. The use of a low-loss mica-filled base has reduced electrical leakage, allowing better high voltage operation. List, $27.75—**Raytheon Manufacturing Co., 55 Chapel St., Newton 58, Mass.**

TV & Communications Components

TV Link

A complete crystal-controlled television high-frequency link, the FTL-27A, has been developed, consisting of a transmitter, re-

ceiver (illustrated), and 2 parabolic antennas. The system operates in the 1990-2110 MC band allocated by the FCC specifically for television relay and pickup service. Single-hop program transmission up to 45 miles is possible. Long distance tandem operation, depending upon propagation elevation, and antenna gain can be provided.—**Federal Telecommunication Laboratories, Inc., 500 Washington Ave., Nutley 10, N. J.**

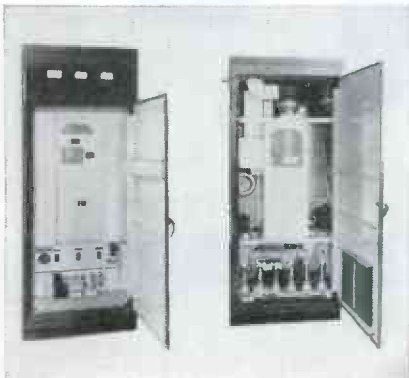
Mobile Radio Control Unit

A 60-button selective calling box has been designed for use at the fixed station installations of a mobile radio system. When this new

"Quick-Call" unit is used, it is not necessary for the operator at the control point to activate every receiver in the system when he wants to contact only one. Pressing a button on the control box corresponding to the desired receiver will operate that receiver and not any other in the system.—**Motorola, Inc., 4545 Augusta Blvd., Chicago, Ill.**

TV Transmitter

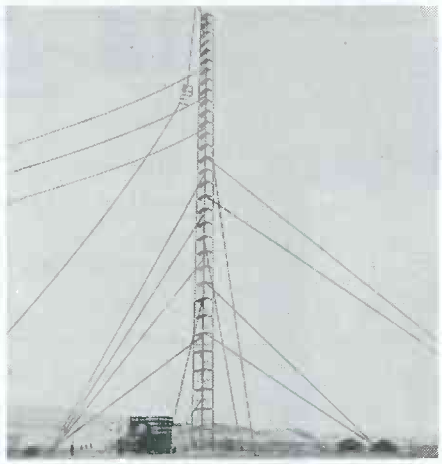
The power amplifier unit in the basic Acorn TV transmitter steps up the output rating from 500 watts or 1 kw, to 2½ kw or 5 kw, respectively. Overall floor space required for



the combined transmitter equipment is approximately one-half that required for other 5 kw transmitters in service today, because with less stages, less tubes, no water-cooling system, a self-contained blower system, and no vestigial side band filter, the entire transmitter is housed in a cabinet measuring 27-in. deep and 15-in. long. Single-stage power amplifier uses a pair of air-cooled tubes whose initial cost is below $200 each. The same tube types are used in the visual and aural transmitters, thus reducing the spare requirements and having the added advantage that tubes which show signs of weakening after many hours' service can be shifted from the 5 kw visual transmitter to the 2.5 aural in order to gain maximum tube life.—**Allen B. DuMont Laboratories, Inc., 2 Main Ave., Passaic, N. J.**

Aluminum Alloy Tower

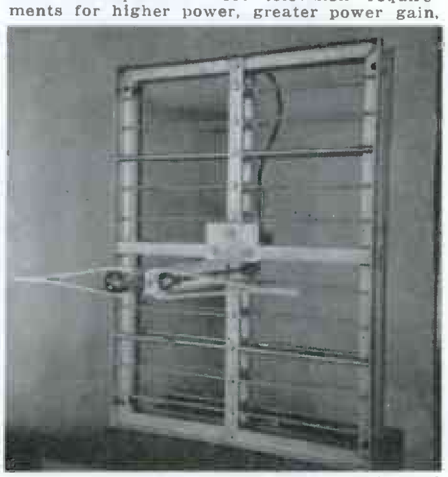
An aluminum alloy tower 204 ft. high, made up of 6-ft. sections (34 in illustration) has been developed which can be erected by



a crew of 6 men in 6 hours and dismantled by the same number of men in 3 hours. A single 6-ft. section, weighing 100 lbs., is shown being hoisted to the top of the tower. Each tower section is complete with stairway, platform, diagonal bracing and guard rails; no nuts, bolts or tools are required for erection. The tower is supported by guy wires (all are not shown in photo) and outboard platforms to provide additional platform area at any level are available.—**Up-Right Scaffolds, Division of Up-Right, Inc., 1013 Pardee St., Berkeley 10, Calif.**

TV Antenna Unit

A new super-gain-multi-layer antenna has been developed to meet television requirements for higher power, greater power gain,



and directional effects. A close-up view of the dipole and screen combination of a single unit is shown in the illustration. Each one of these units measures 30 x 46 in. and weighs about 100 lbs. Because of the many possible arrangements of the individual dipole and screen combination units in a tower-mounted array, higher or lower power gain may be achieved in any desired direction. —**Radio Corporation of America, RCA Victor Div., Camden, N. J.**

Telephoto Lens

The Video Reflector F 8 telephoto lens, made by the makers of the well-known "Zoomar" lens, has a focal length of 40 in.

and an overall length of only 16 in. Since its optical center is offset, the F 8 can be used on a TV camera turrent with 3 other lenses without cutting into their fields. Inasmuch as there is only one refractive element of very low power in it, the lens has no chromatic aberrations. It is fully corrected for spherical aberration. The astigmatism and the curvature of the field are negligible. Weight of the complete unit is 6 lbs.—**F. G. Back Video Corp., 292 Madison Ave., New York 17, N. Y.**

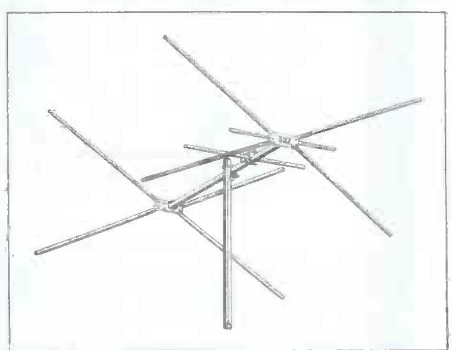
TV Booster

A new, high gain, all-channel TV booster, known as the "Standard Booster", boosts signals 10 times on high channels, more on low

channels and has a low signal-to-noise ratio. The unit has a simplified 2-knob control; one knob controls a 3 position switch that turns on the TV set only, or the TV set and the booster. Turning off the booster automatically turns off the TV set.—**Standard Coil Products Co., Inc., 2329 North Pulaski Road, Chicago 39, Ill.**

TV Antenna

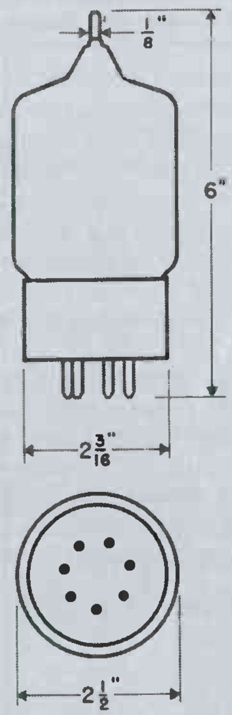
A new TV antenna of unusually rugged construction has been developed to withstand long exposure on rooftops without reduction



of electrical performance. Known as the "Bi-Con", it is a modified conical type antenna with separate high-frequency and low-frequency reflector elements. List: $13.50. A stacked array of 2 units with half-wave spacing and a suitable matching stub has been designed for fringe areas. List: $29.50.—**Insuline Corp. of America, Long Island City 1, New York**

A NEW, VASTLY IMPROVED 4E27

- MORE RUGGED PLATE-LEAD
- PYROVAC PLATE
- OVERSIZE PLATE
- NON-EMITTING GRIDS
- MECHANICALLY RUGGED
- MOULDED-GLASS HEADER
- LOW-LOSS LEADS
- EASILY COOLED STEM



EIMAC PENTODE TYPE 4E27A/5-75A

Encompassed in the structure of this new version of the 4E27 are many outstanding improvements that now will guarantee performance-dependability to users of this tube type.

The plate-lead of this new Eimac 4E27A/5-75A pentode is of larger diameter than the protype* providing a low-loss, low inductance, more rugged lead. The plate itself is larger assuring a good reserve dissipation capacity above its 75 watt rating. It is made of Eimac Pyrovac plate material, which lengthens the life of the tube and enables it to withstand high momentary overloads.

Primary grid emission has been eliminated and secondary characteristics stabilized through the use of Eimac processed grids. Perfected beam-action and permanent alignment are assured through well engineered internal-element mounts.

The unique moulded-glass header eliminates a base on the 4E27A/5-75A. This simplifies lead cooling, minimizes lead losses, and provides precision alignment of base-pins.

The stability and high power-gain characteristics of this new Eimac pentode make it an excellent VHF or video power amplifier. It is equally well suited for conventional power amplifier service.

Further information and detailed characteristics concerning this latest product of Eimac engineering research may be had by writing the Application Engineering Department of Eitel-McCullough, Inc.

* Lead connector is supplied to make this new tube directly interchangeable with 4E27.

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EITEL-McCULLOUGH, INC.
San Bruno, California

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Follow the Leaders to **Eimac** REG. U.S. PAT. OFF. **TUBES**

WASHINGTON
News Letter

Latest Radio and Communications News Developments Summarized by Tele-Tech's Washington Bureau

FCC HAS TWO MONTHS' "BREATHER" IN COLOR TV—During these next two months of December and January, the FCC Commissioners and top staff officials are able to take a "breather" from the uninterrupted "diet" of color television hearings which had been in progress since early September and will have a chance to analyze the testimony of approximately a score of topmost radio manufacturing and telecasting officials who had paraded before the Commission on the witness stand.

The hearings resume Feb. 8, according to the FCC timetable when this issue of Tele-Tech went to press, and principal item of direct testimony then will be the views of top American Telephone & Telegraph Co. and Western Union officials as to the transmission between cities of color video programs on the coaxial cable and microwave radio relay systems.

COMPARATIVE DEMONSTRATIONS OF GREAT VALUE—The comparative color television demonstrations of the systems of Columbia Broadcasting System and the Radio Corporation of America, transmitted by the National Broadcasting Co., contrasted with the Du Mont black-and-white telecasts, staged during the third week in November, were of great value to the FCC in its most important task of launching color video. While the CBS system again produced excellent results, the RCA color video was greatly improved over the mid-October showings by RCA and the latter result gave impetus to the prevailing viewpoint of the radio manufacturing industry that the new color TV system should be compatible so existing receivers will not be obsolete.

At best, since the cross-examination proceeding will last until early spring, there appeared little prospect of a decision by the Commission on the inauguration of color television until the late spring of 1950 or possibly not until the early summer. Then a year of field testing may be in order before the art is offered to the public and the manufacturers produce the new color TV transmitters and receivers.

"FREEZE" IS DELAYING TELEVISION GROWTH—Black-and-white television's growth is still halted by the "freeze" on the construction of new television stations which has been in effect since September 30, 1948, and, unless the pressure from the television industry and the public is able to blast loose an earlier "thawing", the present outlook on the premise of a color television decision first is that *the "freeze" will remain in effect until next summer.*

Certain segments of the Commissioners, spearheaded by Commissioner Robert F. Jones, feel color television should be decided first before allocations are made in the ultra-high frequency region and the "freeze" lifted, but the radio manufacturers and telecasting networks and stations feel television's progress is being blocked when some 350 applications for TV station construction permits are shelved completely by the "freeze".

Questioning by FCC Commissioner George E. Sterling, former Commission Chief Engineer, during color video hearings in November indicated that he was inclined toward disposing of the questions of polycasting and field testing during the present color TV proceeding stage, so as to clear away those subjects before taking up the UHF allocations.

MOBILE RADIO SERVICES CAN BUILD BACKFIRE—Opposition of certain television industry elements to inclusion of frequency assignments between 450 and 500 megacycles for broadband operations to take care of the badly crowded "lower" spectrum for mobile radiotelephone services may become a "cropper". The TV interests feel the UHF usable spectrum should be devoted entirely for color television and their reasoning is understood to have won substantial support of certain Commissioners.

But, just as Congressional leaders instigated the drive for color video, a backfire in Congress against excluding the broadband UHF operation might well be started since the mobile radio services run the gamut of many major industries of the country—petroleum, power and gas utilities, forestry, highway construction, railroads, busses, trucks, taxicabs, etc.

WEBSTER GIVES SOUND ADVICE—Able engineer-member of the FCC, Commissioner E. M. Webster, gave the mobile radio services some excellent advice in his recent address before the Transportation Division of the American Petroleum Congress in a four-point program for the best technical establishment of mobile radio systems and better utilization of frequencies.

He proposed the mobile radio services should approach the establishment of all new systems with the following yardsticks: (1) more attention to system design in location and separation of base stations; (2) encouragement of manfacturers to develop radio equipment capable of adjacent channel operation in the same area; (3) development by manufacturers of equipment to operate in the largely unexplored and unused superhigh portions of the spectrum; and (4) establishment of best possible standardized operating procedure like those used by the armed services, maritime and aviation interests.

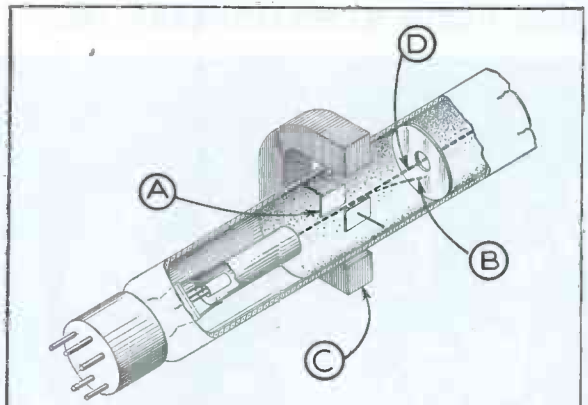
National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Eidtor

IT'S SYLVANIA AGAIN!

ION TRAP IN SYLVANIA TELEVISION TUBES ASSURES HUNDREDS OF HOURS FREE FROM SCREEN BURNS

HERE'S HOW IT WORKS . . .



A. Electrostatic field
B. Ions are bent away from normal axis of tube by electrostatic field
C. External magnet neutralizes the effect of the electrostatic field on the electrons
D. Electrons follow a straight line

Heavy ions are thus trapped in the electron gun while the electrons pass through to strike the fluorescent screen.

Owners of television sets equipped with Sylvania Television Picture Tubes report their screens still bright and unblemished after more than 1000 hours' use. Much credit for this top quality performance belongs to Sylvania scientists who hold the basic patents on the magic "ion trap." With this device these scientists prevented destruction of the fluorescent screen by heavy ion bombardment. So successful is this ion trap that now many other major TV tube makers are using it under agreements with Sylvania.

These same Sylvania Television Tube scientists are now developing shorter large-screen picture tubes and special tubes for uhf television. Their continued research makes the Sylvania label your guarantee of the newest and finest in television picture tubes. Sylvania has a complete line of all-glass and glass-metal types for television and general purpose cathode ray applications. They are available now from your Sylvania Distributor.

Write for free characteristics and TV set complement chart. Advertising Department, Box R-1212, Emporium, Pa.

SYLVANIA ELECTRIC

RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES, SIGN TUBING; LIGHT BULBS; PHOTOLAMPS

TELE-TECH's NEWSCAST

New York Will Have Million TV Sets by Xmas

With the nation's output of television receivers now reaching well above 300,000 a month, and 23% of these coming into the New York metropolitan area, there will be over one million TV sets in operation in New York City and suburbs by Christmas. These million television sets, with their antennas and installation costs, represent an outlay of nearly half a billion dollars by New Yorkers and suburban dwellers.

Television is the fastest growing industry and medium of the century. In the New York area, with a television audience already reaching five million, television has today a public contact that compares with the total circulation of all the metropolitan newspapers combined. For the whole country more than a million television receivers will be produced during the closing quarter of 1949, bringing the total output for the year above 2,700,000 TV sets.

New WJZ-TV Transmitter Site on Empire State Bldg.

WJZ-TV, ABC's flagship in New York City, will be soon be in new quarters in the Empire State Building. It is understood that final plans call for the transfer of the present 5 kw, transmitter from the Hotel Pierre, but in the meantime a 500 watt transmitter will be used to provide interim service. An antenna system made by RCA and consisting of a ring of horizontal dipoles with current sheet reflectors will encircle the top of the tower. With a reported estimated unity gain this will provide a maximum ERP of 5 kw, which radiated from a height of approximately 1300 ft. will give even better service than the 29.5 kw, ERP from 565 ft. at the old site.

Color TV Field Tests

On November 22, the FCC recessed the color hearings until February 6, when a comparative test of the three proposed systems will be held. At the same time the FCC requested CBS, RCA and CTI to make suitable receivers and converters available to the general public so that a period of field tests may be held. The FCC hopes that by putting receivers in the hands of reputable members of the public sufficient performance data may be gathered to assist them in deciding the color question. The broadcasting companies concerned were asked to transmit at least one hour of color TV daily for at least 30 days so that some idea of the public response may be obtained. Tests are expected in New York, Washington, San Francisco and possibly in Philadelphia.

First Mexican Color TV

Experimental television transmissions in color and monochrome from a station in Mexico City mark the first TV operations in Mexico. The station is run by Gonzales Camerena, chief engineer of XEW, Mexico City whose owner, Emilio Azcarraga is also an applicant for a TV license. A number of commercial shows are sponsored by government agencies and advertisers with ten of Mexico's twenty-odd TV receivers installed in stores and at the fair where the programs originated. The color process is understood to be similar to the CBS system.

RMA to Submit Proposal to FCC on Color Television

A plan for the immediate establishment of an industry-wide National Television System Committee to formulate color TV standards acceptable to all manufacturers has been approved by the Radio Manufacturers Association for submission to the FCC. RMA's board of directors authorized the RMA television committee to take this action at concluding sessions of a 3-day directors' meeting held last month in the Hotel Roosevelt, New York City.

R. C. Cosgrove, RMA president explained that the association's action "is based on the industry's experiences with a similar television committee which in 1941 drafted and recommended to the FCC standards for present black and white television receivers and broadcasting.

"At the request of the FCC, the industry at that time formulated standards for a service which has met with the approval of the public and which has permitted steady growth and improvement in the art of television. We believe a similar procedure for color television while it is still in the experimental stage will have equally constructive results."

FIRST NEW MEXICO EXHIBIT SPONSORED BY RADIO PARTS MANUFACTURERS, INC.

Some of the exhibitors and staffs from the first New Mexico Electronic Exhibit are shown on the steps of the Alvarado Hotel, Albuquerque, where the exhibit was held on Nov. 4-5. Gerald B. Miller, president of the Los Angeles chapter of The Reps, of Radio Parts Manufacturers Inc. (sponsors of the exhibit), is at the center of the group, wearing horn-rimmed glasses. Harold A. Kittleson, chapter vice president is at his left and Carl A. Stone, chairman of the chapter board of directors is at Mr. Miller's right

NEW "POLATRON" CR TUBES

Polatron material is applied to the face of a cathode ray tube in the Capehart-Farnsworth Tube Laboratory, Fort Wayne 1, Ind. This recently-developed coating filters the cathode ray's characteristic glaring white light, polarizes the light to reduce "flicker", and absorbs internal reflections in the tube

Cincinnati IRE Meet, April 29

The Cincinnati Section of the IRE will hold its Fourth Annual Spring Technical Conference on Saturday, April 29, 1950 at the Engineering Society Headquarters, Cincinnati, Ohio. Manufacturers' exhibits will be featured and the day's proceedings will be climaxed by a banquet.

Coming Events

December 4-7—American Institute of Chemical Engineers, National Meeting, William Penn Hotel, Pittsburgh, Pa.

December 9-10 — Southwestern IRE Conference, Sponsored by Dallas-Fort Worth Section, Baker Hotel, Dallas, Tex.

December 26-31—American Association for the Advancement of Science, 116th Annual Meeting, Hotels Statler, Governor Clinton, New Yorker, McAlpin, and Martinique, New York City.

January 11-13—Society of Plastics Engineers, Annual Conference, Hotel Carter, Cleveland, Ohio.

January 23-27 — American Standards Assoc., Five Day Seminar on Principles and Technics of Organizing Company Standardization Work, Room 501-A, Engineering Societies Bldg., 29 West 39th St., New York City.

January 30-February 3 — American Institute of Electrical Engineers, Winter General Meeting, Hotel Statler, New York City.

February 27—March 3—American Society of Testing Materials, Committee Week and Spring Meeting, Hotel William Penn, Pittsburgh, Pa.

April 5-7—Midwest Power Conference, Sponsored by Illinois Institute of Technology with cooperation of 18 universities and professional societies, Sherman Hotel, Chicago.

April 26-28—Armed Forces Communications Association, Fourth Annual Meeting, Astoria, New York City, and Fort Monmouth, N. J.

April 29—IRE, Cincinnati Section, Fourth Annual Spring Technical Conference, Engineering Society Hdqtrs., Cincinnati, Ohio.

PERSONNEL

James Bonelli has been appointed plant superintendent of Air King Products Co., Inc., Brooklyn, N. Y., manufacturers of radios, wire recorders and TV receivers. He was formerly associated with Olympic Radio as plant superintendent and chief engineer of Pilot and Fada Radio.

Albert E. Keleher, Jr., has been named manager of mobile radiophone sales of the Raytheon Manufacturing Co., Waltham, Mass. Before joining Raytheon two and one-half years ago, he had been an application engineer with Raymond M. Wilmotte, Inc., and manufacturing engineer with Western Electric and Bell Telephone Laboratories.

A. E. Bennett, former electronics consultant with the Air Force and recently chief engineer at Hoffman Radio Corp., Los Angeles, is now chief engineer and general manager of the Audiograph Co., San Carlos, Calif., manufacturers of magnetic tape recorders

Oliver W. Hayes, 21 Bonwood St., Newtonville, Mass. is now associated with the National Research Corp., Cambridge, Mass. where he is patent counsel. Before studying law, he received his B.S. in engineering from Brown Univ. in 1937. **Gordon R. Findlay,** also newly-affiliated with National Research Corp., is engaged in research in the field of applied physics.

John S. Muller has been made manager of the electronic sales department of the Corning Glass Works, Corning, N. Y. and in that capacity will be responsible for the sale of bulbs and other glass components to the TV and radio industries.

S. M. Weingast has been elected to the post of president and general manager of the Precision Apparatus Co., Inc., Elmhurst, N. Y. He was the cofounder (with the late Murray Mentzer) of the company 17 years ago and previously held the title of secretary-treasurer and director of purchasing. G. N. Goldberger, the company's chief engineer, is now vice-president in charge of engineering and treasurer of the corporation.

D. G. Reik has been appointed General Electric district representative with responsibility for the sale of replacement tubes and receiver parts in the Cleveland, Akron, Youngstown, Canton, Pittsburgh, Johnstown and Wheeling markets.

Albert E. Flad has joined Airborne Instruments Laboratory, Mineola, N. Y., as administrative assistant to **Robert F. Schulz,** who is in charge of the product engineering department, 127 Second Street, Mineola.

Ceramic Iron Core

(*Continued from page 25*)

It should be noted that "low level" measurements of permeability and "Q" of the core are not significant in relation to the high flux density operating level in application. Maximum effective permeability consistent with high temperature stability of core "Q" and production economy has been obtained compared to other currently available core materials. The dc core saturation is limited by two gaps of about 4 mils each.

The unique feature of a porcelain-like core in insulating quality permits high utilization of window width for winding traverse. No appreciable current would flow if cores of the more desirable grade of core material were to be directly placed across a potential of 10 kv. A protective lacquer has been applied to all exposed core faces to minimize the loss of core "Q" in the presence of high humidity tending to penetrate surface pores.

Sufficient clearance has been provided over the crest of the high voltage tertiary winding for prevention of arc-over to core, even in the event that the core were to become conductive for some unforeseen cause. Very little loss is entailed by provision of this safety measure. The entire core structure is insulated from chassis for the same reason.

(*Part Two of this article will appear in the January issue*).

Outmoded Communications Cause 10 Days Delay

Tom Sansom, a radio communications district representative for the General Electric Co. in Syracuse, N. Y., recently reported an incident which illustrates the cost of outmoded communications to one mining company in the West.

His report follows:

"I talked to a mine company today. A vital motor had conked out at their mine 200 miles away a week before my visit. The foreman put the motor in his jeep to go for repairs. He got 50 miles out and a wheel started off on a different cow train from the other three. Two days later a Navaho came along on his mustang and rode the foreman double 40 miles to the nearest trading post. A day later the mine office got word that the mine was shut down. Two days later the foreman got back to the mine with the motor. A week later a wandering Navaho rode in and passed the word that the mine was back in operation. Total cost to the company was 50 miners out of work for 6 days, no production for 10 days. We figured them a two-way radio job."

SELECTIVE NEGATIVE FEEDBACK

(*Continued from page 33*)

centage negative feedback. In fact, with the equalizer set for a flat frequency response characteristic, that is, with 100% negative feedback applied, the measured intermodulation distortion was approximately 1% for input signal levels up to 2 volts rms. Under conditions of normal operation, therefore, the amount of intermodulation distortion will be between the 1% value for conditions of large feedback and the value given in Fig. 8 for which condition there is no feedback.

In practice, the percentage feedback will be small only at the frequency extremities with the boost-attenuate switches in the maximum boost positions, for which condition the distortion at the frequency extremities will approach the values given in Fig. 8. It should be noted, however, that in normal program material the signal components being boosted at the maximum boost position of the boost-attenuate switches will generally be of small amplitude compared to the mid-frequency signal components. Because of this, the intermodulation products at the frequency extremities will be of small amplitude compared to the signal components at the mid-frequencies. The distortion products from the mid-frequency signal components, meanwhile, will be small, being of the order of 1%. The overall effect, therefore, is that the intermodulation products will be of small magnitude throughout the frequency pass-band of the equalizer, making it appear that the average distortion is of the order of 1%.

Care must be taken not to omit the input capacitor to the control grid of the input triode in Fig. 2. With the grid returned to the cathode tap, the resting potential to ground of that grid is approximately 70 volts, the cathode current being approximately 7 milliamperes. With the input capacitor omitted, resistance continuity to ground through the input circuitry may cause the input grid to be held to a voltage much lower than the 70 volts at which it rests normally. A lowering of the resting voltage of the grid of the input triode will give a corresponding drop in the cathode current which will reduce the bias voltage to the triodes. This reduction of bias voltages will cause distortion in the amplifier triode at lower magnitudes of input signal.

An output triode section may be provided to serve as an impedance transformation between the output of the attenuator network and the load to which the equalizer is connected. This stage may be an amplifier stage, a phase inverter stage or a cathode follower output stage as is needed to couple to the succeeding stage of the system.

REFERENCES

1. Lurie, William B., "Versatile Tone Control", Electronics. Vol. 21, No. 12., Pages 81-83; 1942.
2. Fletcher, Harvey, "Hearing, the Determining Factor for High Fidelity Transmission", Proc. I.R.E. Vol. 30, No. 6, Pages 266-277; 1942.

FCC Color TV

(*Continued from page 19*)

color, designed for a 19" tube in a DuMont receiver, while a stunt, must have impressed the commissioners with the unwieldy impracticality of such a mechanical disc. The converter, about 5 feet high, weighing 700 pounds, required two men to push it in place in front of the set. See Fig. 3.

The question of transmitting the

picture signal by FM instead of AM, as is now done, has a bearing on color so FCC invited Wilmotte, radio consultant, and Chapin, FCC Eng. Div., to testify on this subject. There is a slim chance that field tests of FM for picture transmission in the new UHF band may be requested by FCC.

Reactions to Commissioners' Questions

Early in the hearing it was evident that one of the commissioners had embarked on a one-man investigation to find out what was holding color back, why the CBS system should not be adopted now, and what was keeping color from the waiting American homes. His method of questioning was akin to that usual in Congressional hearings. The questions often showed, unfortunately, little knowledge of how television developments came about or how engineering standards were formulated. They were often of the type used by lawyers in attacking the opposing party. The stream of witnesses who had come to assist and advise the Commission and who were not culprits on trial, must have loved this treatment!

A second commissioner, appointed not on a basis of knowledge of the communication field, but selected from the legal field, took an active part in the questioning. In this case a little coaching from the FCC engineering staff, preferably from a member who knows first hand by experience how TV inventions are conceived and developed for the American home, how standards are proposed by the industry, field tested and finally submitted to FCC for approval, would have helped. In fact it would have speeded up the hearing and given the commissioner a view of the problem in true perspective.

What TV Needs Now

If these commissioners wished to investigate charges of monopoly or "smoke out" color TV from an industry who testified they were for it as soon as it was good enough, the hearing was rather unproductive. Just what was their purpose remains a mystery. Color TV standards are not worked out by lawyers nor are they advanced by methods mentioned above. For a steady, orderly increase in service to the public, the growing young giant, Television, needs now, on the part of the FCC: (a) Commissioners with better technical advisors; (b) more understanding of how the industry can be encouraged to best serve the millions of present and future set owners and (c) commissioners with open minds, unbiased by personal beliefs or political pressure were arriving at important decisions.

Sen. Johnson's Letter to FCC

Senator Johnson of Colorado, chairman of the committee to whom the FCC report, has recently written the Chairman of FCC a letter expressing his earnest hope that FCC "will promulgate quickly broad and *general* standards for color" so that it may be developed naturally. Had the senator substituted for "standards" the phrase "system characteristics" then communication engineers might go along with him. It would be highly desirable if FCC at this stage in the development of color and as an outcome of this hearing, signify what it thought were desirable characteristics, such as the number of lines, compatibility, etc. so that research laboratories could work toward this goal. It would give desirable assurance that the resulting system would come near conforming with the final standards to be set later and endorsed by the FCC only after they have been sufficiently field tested.

BOOKS

Electron Optics

By J. R. Pierce, published by D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York City. 197 pages.

This book is an attempt to present the minimum amount of theoretical material necessary to understand the principles involved in electron flow and focussing in electronic devices other than microscopes and camera tubes. In this it succeeds rather well, although there are perhaps more mathematics in the treatment than the indigent reader desires to struggle through to discover why things happen. It might have been possible to dispense with some of the derivations, and give only the operating formulae with a consequent increase in practical descriptions for the benefit of lazy readers who, like this reviewer, prefer to obtain information with as little mental effort as possible.

For the engineer who works with focussed electrons this is a handy reference book. The average engineer will find in it many interesting facts which he probably didn't know; the problem section at the end of each chapter is invaluable in this respect. Considerable information on electron guns and multipliers is included, and the indexing is done well.

NAB Engineering Handbook

By National Association of Broadcasters, 4th Edition, 1760 NW, Washington, D. C. Over 650 pages. Price $17.50.

The fourth edition of the famous Engineering Handbook of the National Association of Broadcasters contains FCC Rules and Regulations, Standards of Good Engineering Practice, design data, and a wealth of information on AM radio, television, FM audio engineering, and special articles. The book runs to nearly 700 pages.

Handsomely bound in a gold-embossed post binder and completely catalogued, the Engineering Handbook weighs just over six pounds. It is 2¼ inches thick, and the binder is capable of expansion to a four-inch thickness to receive later additions and expansions of material already included.

The fourth edition of the Handbook has been in preparation for the past two years, under the direct supervision of Neal McNaughten, NAB Engineering Department director. The project was begun by his predecessor, Royal V. Howard.

Considered an indispensable tool by the engineers of the radio and television industry, the book is sold at $17.50 to engineers not associated with NAB member stations, or to stations wishing extra copies. It is supplied free of charge to NAB members.

Space considerations preclude a review of all the sections in detail. However, certain sections deserving special mention such as the reproduction of the FCC Standards of Good Engineering Practice, are up to date as of July 15,, 1949, which is quite a feature in this area of frequent change. Propagation and studio problems are well covered, the information on DA's being particularly valuable. The sections on field and general engineering are most comprehensive, and the book concludes with an excellent selection of nomographs and other tabular information of great value to every broadcast engineer or designer.

New Sound Track for 16-mm Films Provides High-Quality Reproduction

A new type of 16-mm sound track has been developed by J. A. Maurer, Inc., 37-01 31st St., Long Island City, N. Y. In this new track, the familiar bilateral type of recording in a single line is replaced by a group of *six* smaller VA tracks, each a duplicate of the other and one-sixth the width normally employed. The multiple track thus contains twelve simultaneously modulated, identical areas.

With a group of six identical VA tracks in place of one, a variation even as great as 50% in the illumination in the projector sound scanning beam will still provide substantially undistorted wave form. This is because the variation over any individual modulated area of the new track is extremely small. Since the total signal reaching

Enlargement of new Maurer multiple sound track, shown in relation to a 16-mm frame

the photocell of the projector is the sum of the signals given by six individual tracks, each of which has very low distortion, the total reproduced signal has low distortion. Similarly, the harmonic distortion of wave form due to azimuth error is reduced.

Most television projectors, being rather slightly modified standard 16-mm equipment, will obtain the full effect of the improvement. Certainly the telecasting of more uniform high quality in 16-mm prints will be welcomed by viewers and thus make the filmed material more acceptable to stations and sponsors alike.

In line with the Maurer policy of protecting its customers to the maximum possible extent against obsolescence of equipment, the new multiple sound track will be made available as a conversion to present owners of the latest type of Maurer Recording Systems. Soon, all new Maurer Recorders will be supplied with this type of sound track as standard equipment. Precision Film Laboratories, Inc., 21 West 46th St., New York City, is equipped to re-record and reproduce the new multiple track as a standard operation on 16-mm prints.

WOR-TV STUDIOS

(Continued from page 22)

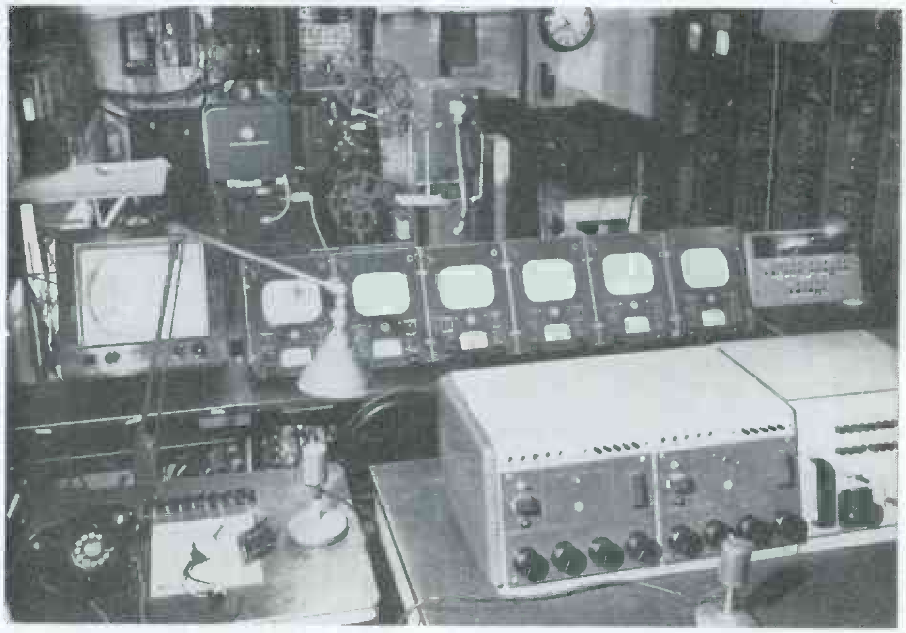


Fig. 8: Temporary master and studio control at the New Amsterdam Theatre on West 42nd Street, New York City where interim programs originate. Projection equipment is in rear

control switch is pushed down to "controlled by video" position, both circuits will be switched to studio B.

The final point of interest is the mas.er transfer control circuit. By means of this feature, control can be switched to anyone of the four master control panels if the corresponding switch is set to "master transfer". Then pressing the master transfer button on any unit completes the transfer. Along the bottom of the panel the stabilizing amplifier controls are brought out to remote controls so that any necessary adjustments to video quality can be made by the operator.

The fourth side of the master control room is given over to four rows of ten racks, containing over 130 regulated power supplies, stabilizing and distribution amplifiers, the relays, speech equipment and auxiliary apparatus such as low voltage dc distribution controls for the relays.

During the interim period between the time that WOR-TV went on the air and before the new studios are ready for use, operations have been continuing from the New Vanderbilt Theatre on West 42nd Street, New York City. Fig. 8, which is a view of the complete operations and control room taken from above the producer's desk. It shows how every inch of space has been used in the current operation. In fact, the area has the appearance of a submarine nerve center with its closely crowded equipment and optimum use of space. In the background can be seen a DuMont Flying Spot Scanner and GE 16mm film projector. This room is presently master control as well as studio operations, but after the change over takes place control will be transferred to the main studio building and it will become local studio control for the theater.

Microwave Standard

(*Continued from page 28*)

just before shipment and specifying an allowable ambient frequency variation. For example, a cavity is made and labelled "Resonant at 9280.17 MC ±.07 MC at 25° C. Keep ambient temperature between 0 and 35° C. $\triangle f/\triangle T=2$ KC/°C."

Cavities with the possible ±0.8 MC error are made in production at 9250 (1Q22), 9280 (1Q23), and 9310 MC (1Q24). Another is made at 9375 (1Q25) with the frequency error due to setting alone approximately ±0.3 MC (less accurate equipment) giving a total maximum possible deviation of ±1.1 MC.

Calculations have been made (Westinghouse Research Report SR-281, Holstein and Mayer) for designs of cavities over the range from 7900-9600 MC. It is believed that these calculations could be expanded and be valid over a range from 4,300-11,300 MC. By using different harmonics of the existing standard low frequency signals, a great number of standard frequency signals could be produced with existing test equipment, and the corresponding reference cavities produced.

Therefore, it may be concluded that this device could be expanded in use and cavities produced at many different frequencies in the vicinity of the X band for use in laboratories as fixed microwave frequency standards.

Duplicating Magnetic Tapes

The article entitled "Duplication of Magnetic Tape Recordings by Contact Printing" published in the November issue of Tele-Tech failed to include a footnote at the end of the text. For the benefit of our readers this note states:

"This is part of a paper presented by Dr. Robert Herr at the Fifth Annual National Electronics Conference in Chicago Sept. 26-28, 1949. The complete text of this paper will appear in Volume V of the 'Proceedings of the National Electronics Conference.'"

CRYSTAL OSCILLATOR PLATES

(*Continued from page 38*)

this assembly was carried by the nest through the lapping operation, abrasive, which worked into the narrow clearance between the block and plate caused binding. For this reason the plate opening was enlarged and the pressure block was centered by means of an apertured zinc sheet cemented to the top side of the retaining plate, thus eliminating binding and permitting the crystal to move laterally with respect to its pressure block. Although crystals lapped this way were wedge-shaped, experience which led to more successful models was gained.

The wedge-shaped crystals emphasized the need for designs which would assure parallelism. The attacks on this phase of the problem resulted in three variations of a model in which small blocks were rigidly attached to a lapped ring. The assembled blocks were trued against the lap until they were coplanar and parallel to the lay so that wedged crystals could be corrected to parallelism. To prevent uneven abrasion caused by the adhesion between the crystals and the blocks, the surfaces of the latter were broken up by cross-channels. In the first apparatus of this type, pentagonal blocks fitted into pentagonal nest openings. In the second variation, cylindrical plugs were used and the nest was eliminated by using a close-fitting collar around each plug to confine its crystals and by using spokes to drive the ring directly. The third variation was similar to the first except that round rather than pentagonal plugs and holes were used, and its nest was thicker and channeled to reduce sticking.

Of the three forms just described the nestless type was least satisfactory, chiefly because its excessive weight caused breakage. The third variation gave better results than the first because the plugs and holes were a more precise fit. Consequently crystals produced with the round plugs had less pronounced rims. Deviations from parallelism in crystals produced by both lapping units were radial rather than wedge-like. The rims accounted for most of the deviation, which did not exceed 0.00004-in.

Because of the difficulty in re-

WHEELER LABORATORIES MOVES TO NEW QUARTERS

Wheeler Laboratories, Inc., organized in 1947 to conduct radio research and engineering in special fields, has moved to larger quarters at 122 Cutter Mill Road, Great Neck, N. Y. Staff of 10 engineers and usual supporting facilities are housed in new building moving the ring and handling very thin crystals, a lapping method which permits much easier inspection of individual crystals has been evolved. The apparatus employed is an improved form of the square block and cell method and exists in two slightly different models—the inkwell and the tall plunger. The inkwell type has a conical exterior and is essentially a keyed and closely fitting plunger and cylinder. The crystal is attached to the plunger by means of a drop of oil; the unit is then inverted and placed on the lapping plate. The crystal is thus confined between the piston and plate by the cylinder walls. A nest drives a number of such units over the lapping plate. The tall plunger model differs mainly in having a taller piston sliding on bearing screws by which the amount of wobble can be precisely controlled.

Crystals have been lapped at the National Bureau of Standards to 0.001 inch with both these models. Breakage is almost nonexistent and the surfaces are quite flat and parallel. The limiting thickness for this equipment is not yet known since the difficulties of handling and properly measuring such crystals impose many new problems which remain to be solved.

1. "The Mechanical Production of Very Thin Oscillator Plates" by L. T. Sogn and W. J. Howard, NBS J. of Research, Vol. 43, (Nov. 1949) RP 2037

Tests for Qualification of Military Products

Attention is invited to the qualification approval stipulation appearing in most Military (JAN) specifications coming under the purview of the Armed Services Electro Standards Agency. This in substance is as follows:

In the procurement of products requiring qualification, the right is reserved to reject bids on products that have not been subjected to the required tests and found satisfactory for inclusion on the Army-Navy-Air Force Qualified Products List. The attention of suppliers is called to this requirement, and manufacturers are urged to communicate with the Armed Services Electro Standards Agency (ASESA), Fort Monmouth, N. J., and arrange to have the products that they propose to offer to the Army, the Navy, or the Air Force, tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by these specifications.

Information pertaining to qualification of products covered by these specifications and a complete index of the specifications may be obtained from the Armed Services Electro Standards Agency (ASESA), Fort Monmouth, N. J.

ANNUAL INDEX-1949

The Annual Index has been arranged by subjects for easy reference to related topics. The first figure indicates the month in which the article appeared; the second figure indicates the page

GOVERNMENT COMMUNICATION

INSTRUMENTS & MEASUREMENTS, TEST METHODS

MATERIALS, PROPERTIES OF

OSCILLATORS

PRODUCTION METHODS

RECEIVERS

(Continued on next page)

ANNUAL INDEX (Continued)

AUTHOR INDEX—1949

BULLETINS

Test Equipment

The new bulletin of Gawler-Knoop, Inc., Sales Engineers, 1060 Broad St., Newark 2, N. J. illustrates the test equipment of the various manufacturers and companies G-K represents. Test instruments are particularly applicable in research and development laboratories, production testing, industrial testing and quality control facilities. (Mention T-T)

Transformers

Triad Transformer Manufacturing Co., 2254 Sepulveda Blvd., Los Angeles 64, Calif., has compiled a 16-page catalog, illustrating, describing and pricing the entire line of Triad Transformers for original equipment, radio, television, and replacement applications. Special attention is called to Triad's Climatite treating, said to be an improved and exclusive vacuum impregnation process, used on all Triad transformers. (Mention T-T)

Cathode-Ray Oscillographs

Types 304 and 304-H cathode-ray oscillographs, successors to the famous 208-B, are the subjects of a new bulletin published by Allen B. DuMont Laboratories, Inc., 1000 Main Ave., Clifton, N. J. These new instruments have undergone a most rigid field test, at the DuMont Labs, and also selected laboratories and institutions throughout the country. (Mention T-T)

Capacitors, Resistors, Coils

Electrical Reactance Corp., Franklinville, N. Y., has published a 16-page brochure describing the history and manufacture of HI-Q products; capacitors, resistors and coils. Operations at the Jessup, Pa., Franklinville, N. Y., and Myrtle Beach, S. C. plants are covered. (Mention T-T)

Measuring Equipment

Analyzers, indicators and recorders are described in a bulletin released by the Cambridge Instrument Co., Inc., 3732 Grand Central Terminal, New York 17, N. Y. (Mention T-T)

Varnished Insulations

"The V. I. Story—Varnished Insulations in Electrical Engineering" has been written for and published by The Varnished Fabric and Paper Section of the National Electrical Manufactures Assoc., 155 East 44th St., New York 17, N. Y. The author is David O. Woodbury, well-known technical writer. Price, $1.00 (Mention T-T)

Antenna Handbook

The 6th edition of the "Johnson Antenna Handbook and Rotary Beam Instruction Book" has just been published by the E. F. Johnson Co., Waseca, Minn., and may be secured from Johnson jobbers for 60 cents. While the handbook serves as an instruction manual for the Rotomatic Beam, it also contains general information on antennas, transmission lines and methods of coupling. (Mention T-T)

Kinescope Insulation

Recommendations for the support and insulation of Kinescope RCA-16AP4 is the subject of a recently released RCA Electron Tube Application Note. The discussion concerns the structural features of the Kinescope which requires the use of new technics for supporting the tube, masking the picture face, and insulating the metal cone. Write to Tube Dept., Radio Corporation of America, Harrison, N. J. (Mention T-T)

Microwave Components

Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y., has announced the availability of a complete line of microwave test equipment components. Included are fixed waveguide pads, coaxial terminations, calibrated variable attenuators, slotted lines and probes, frequency meters, frequency standard multiplier and bolometers. Printed catalog is available to microwave research and operating engineers. (Mention T-T)

Theatre Television

A 16-page booklet entitled "Theatre Television-Facts Every Theatre Owner Should Know" has been released by the RCA Theatre Equipment Sales Div., Camden, N. J. RCA's two basic systems for theatre television are described; the instantaneous projection system and the intermediate film system. Copies may be obtained by writing to the Theatre Equipment Sales Div., Radio Corporation of America, Camden 2, N. J. and asking for Form 2R6154. (Mention T-T)

Soldering Products

The complete line of soldering products made by the P. Wall Manufacturing Co., 462 Erie St., Grove City Pa., and its new division, Harmic Manufacturing Co., also of Grove City, is described in the new Wall catalog. These products include gasoline and kerosene blow torches, self-generating alcohol blow torches, electric soldering irons, solder, paraffin supplies and compound kettles. (Mention T-T)

Insulation Resistance Measurements

The James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa., has recently published a 24-page booklet (21P8-15) which emphasizes the simplicity of making insulation resistance measurements with a "Megger" insulation tester. (Mention T-T)

Telemetering Systems

A 20-page, illustrated bulletin, GEA 5233, which describes the newest General Electric telemetering equipment for electric power distribution and industrial applications, has just been released by General Electric Co., Schenectady, N. Y.

The bulletin gives detailed information on the frequency type, torque balance-type, and photoelectric-type telemeters manufactured by GE. Included also are simple wiring diagrams of typical telemetering installations for various services, and descriptions, dimensions, and specifications of telemeters and auxiliary equipment, such as torque-balance converters and torque-balance load injectors. (Mention T-T)

TELE-TECH
Advertisers December 1949

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

WELLS RADIO-ELECTRONIC COMPONENTS

COAX-- CABLES AND CONNECTORS --TWINAX

A COMPLETE LINE OF LOW-LOSS CONNECTORS AND ADAPTERS FOR USE WITH RG CABLES. RUGGED CONSTRUCTION DIE CAST ZINC AND MACHINED BRASS SHELLS, HEAVILY SILVER PLATED. INSERTS ARE MICA FILLED AND POLYSTYRENE.

ALL ITEMS ARE IN STOCK FOR IMMEDIATE SHIPMENT.

SMALL SINGLE CONTACT CONNECTORS

83-1SP	STRAIGHT PLUG- With molded low-loss mica filled insert	$0.40
83-1SPN	3 PIECE PLUG- TAPERED BACK SHELL FOR .405" O.D.cables	.40
83-1T	"T" CONNECTOR for 83-1R Factory wired	1.50
83-1R	RECEPTACLE CHASSIS OR BOX TYPE- Low-loss mica insert	.40
83-1RTY	RECEPTACLE CHASSIS OR BOX TYPE- Polystyrene & mica insert	.45
83-1AP	ANGLE PLUG ADAPTER- Polystyrene insert- pin & socket	.40
83-1J	JUNCTION- For use with 83-1SP or 83-1SPN	.75

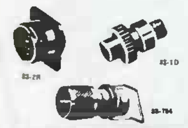
SMALL TWIN CONTACT CONNECTORS

83-22SP	TWIN PLUG- With low-loss mica filled dielectric insert	$0.85
83-22R	TWIN CHASSIS RECEPTACLE- For 83-22SP connector	.85

HOODS, CAPS, AND ADAPTERS

83-1H	HOOD- For RG cables, 8/U, 22/U, 63/U, 65/U, etc.	.10
83-1AC	CAP- For connectors 83-1R, 83-1RTY, 83-22R, etc.	.10
UG-175/U	ADAPTER- For adapting 83-1SP to accommodate RG-58/U	.20
UG-176/U	ADAPTER- For adapting 83-1SP to accommodate RG 59/U	.20
10H/177	CABLE CLAMP M-297 for use with British Connectors	.15

MISCELLANEOUS CONNECTORS



UG-18/U	$0.40	UG-85/U	$0.40	UG-187/U	$1.85	10H/528	$0.40
UG-21/U	.30	UG-87/U	1.00	UG-171/U	.45	10H/539	.40
UG-27/U	.80	UG-98/U	1.00	UG-191/U	.60	10H/565	.40
UG-29/U	1.00	UG-100/U	1.00	10H/390	.40	10H/701	.40
UG-30/U	1.50	UG-107/U	1.25	10H/391	.40	10H/702	.40

NAVY TYPE CI-49548 .... .40 — 83-2R LARGE TWIN RECEPTACLE .... .50

83-1D-PL-271 of SCR-522 .... .75 — PL-310 w/AN-3057-8 of SCR-522 .... .75

COAX AND TWINAX CABLES

AN NO.	NOMINAL IMPEDENCE OHMS	INNER SHIELD	JACKET MATERIAL	MAX O.D.	SPECIAL INFORMATION	PRICE PER FT NET
RG-7/U	97.5	COPPER	BLACK VINYL	.370		$0.04
RG-9/U	51	SILVER	GRAY VINYL	.420		.13
RG-10/U	52	COPPER	" "	.475	Armored	.07
RG-17/U	52	"	" "	.870	Sh.Lgth	.40
RG-18/U	52	"	" "	.945	Armored	.40
RG-21/U	53	SILVER		.332		.14
RG-25/U	47.1	COPPER	BLACK RUBBER	.500		.08
RG-25/U	47.1	"	COTTON	.475		.07
RG-26/U	48	"	BLACK RUBBER	.525	Armored	.11
RG-27/U	47	"		.675	Armored	.11
RG-28/U	48	"		.800		.20
RG-29/U	53.5	"	POLYETHYLENE	.184		.035

AN NO.	NOMINAL IMPEDENCE OHMS	INNER SHIELD	JACKET MATERIAL	MAX O.D.	SPECIAL INFORMATION	PRICE PER FT NET
RG-29/U	53.5	COPPER	COTTON	.178	Sh.Lgth	.08
RG-39/U	72.5	"	POLYETHYLENE	.305		.08
RG-41/U	68.5	"	BLACK RUBBER	.425		.08
RG-54/U	58	"	" VINYL	.275		.05
RG-55/U	53.5	"	POLYETHYLENE	.208		.07
RG-57/U	95	"	BLACK VINYL	.625	2 Cond.	.18
RG-74/U	52	"	GRAY "	.615	Armored	.18
RG-37/U	55	"	POLYETHYLENE	.184		.05
RG-59/U	72	"	"	.242	Sh.Lgth	.08
LOW-LOSS BEADED COAXIAL CABLES						
72/12	72	COPPER	BLACK VINYL	.480		.09
72-12W	72	"	"	.460	80' Coils Only	.06

NOTE THE FOLLOWING LIST OF SPECIAL OFFERINGS:

RG-7/U — This material is on the original manufacturers reels ranging from 2000 ft. upward..$37.50/M
100 foot coils .... .04/ft.

RG-29/U — This material is on reels of 2000 feet or more $27.50/M
100 foot coils .... .035/ft.

4--29/UW — Same as above except with cotton braid covering $25.00/M
100 foot coils .... .03/ft.

TRANSMITTING MICA CONDENSERS

STYLE "AA" — STYLE "A" — STYLE "C" — STYLE "B" — STYLE "D"

Manufacturers' Legend: 1-Aerovox; 2-Cornell Dubilier; 3-Faradon; 4-General Electric; 5-Illinois; 6-Mica-Mold; 7-Sangamo; 8-Solar; 9-Sprague

Cap. Mfd.	Wrkg. Volts	Mfr. Leg.	Price Each
STYLE "AA" CONDENSERS			
.02	3000	2	$4.50
.04	1000	2,7	3.50
STYLE "A" CONDENSERS			
2mmfd	1000	8	$1.65
STYLE "B" CONDENSERS			
.00003	3000	2	$0.70
.000047	3000	1	.80
.00005	3000	2,9	.75
.00005	3500	1	.80
.000065	2500	WE Co.	.70
.00007	1140	8	.80
.00007	3000	8,8	.75
.00009	3000	2,7,9	.75
.000091	3000	7	.80
.0001	3000	2,7,8	.80
.0001	5000	7	.90
.0001	5000	2,7	1.00
.0001	3000	1	.80
.000107	3000	1	.85
.00011	3000	8	.95
.00012	3000	8	.95
.00015	5000	3	1.00
.000175	1500	8	1.00
.0002	1800	8	1.00
.0002	3000	7,9	1.00
.0002	5000	1,8	1.05
.00025	2500	1	.80
.00025	5000	1	1.10
.0003	3000	9	.95
.0003	3000	2,7	.95
.0004	5000	2,7,8	1.10
.0004	6000	1	1.55
.00045	3000	7	.95
.0005	3000	7	.95
.0005	3000	3	1.00
.0005	5000	7	1.00
.00051	3000	7	.95
.00052	3000	1	1.10
.00056	2500	2	.95
.0006	2500	8	1.15
.00065	3000	8	1.05
.0007	3000	2	1.05
.00072	5000	1	1.15
.00075	2500	7	1.15
.00075	5000	8,9	1.15
.0008	3000	2,9	1.00
.0009	5000	2,9	1.25
.001	3000	7,8	1.05
.001	5000	2,7	1.05
.0011	5000	8	1.00
.00125	8000	8	1.10
.00137	3000	7	1.10
.0014	5000	7	1.10
.0015	3000	3	1.15
.0015	5000	1,2,7	1.10
.00175	2000	1,7	1.10
.002	3000	7	1.20
.003	2000	8	1.10
.004	3000	2,8	1.30
.005	2000	8	1.40
.005	3000	2	1.50
.005	5000	8,8	1.70
.006	3000	8	1.30
.006	2500	1	1.30
.008	5000	8	1.30
.0060	3000	8	1.40
.0075	5000	8	1.75
.008	2000	7,8	1.45
.01	2000	1,2,3	1.55
.01	600	7	1.50
.02	1000	7	1.50
.02	2000	2,8	1.60
.02	3000	8	1.60
.024	2000	8	1.60
.025	2500	1,2	1.80
.03	1500	3,7	1.60
.05	3000	3	2.00
.05	1000	3,7	1.70
.06	1000	8	1.70
.1	1000	8	1.75
.15	500	8	1.75

Cap. Mfd.	Wrkg. Volts	Mfr. Leg.	Price Each
STYLE "C" CONDENSERS			
.000005	2500	2	$0.40
.00005	600	7,8	.30
.0001	600	2,7	.30
.0001	1200	7	.35
.0002	2500	4,7,8	.40
.0002	600	2,7,9	.25
.0002	600	7	.40
.00022	2500	4	.40
.00024	2500	7,8	.45
.00025	2500	7	.55
.0003	2500	7	.45
.00039	2500	7	.40
.0004	600	7,9	.35
.00045	2500	2,7,9	.40
.0005	600	7	.40
.0005	1200	2,7	.35
.0005	2500	1,2	.40
.0006	2500	7	.40
.00065	600	9	.35
.001	2500	2	.35
.0011	1200	8	.45
.001	600	8	.40
.001	1200	2,7,8	.40
.001	2500	8,7	.45
.001	3750	8	.85
.0011	600	7	.35
.0015	2500	8	.40
.002	600	7	.35
.002	2500	1,2,8	
.002	1200	2	.45
.002	2500	1,2,8	.55
.002	1200	7	.80
.0022	2500	7	.60
.0024	2500	7	.40
.003	2500	2	.60
.003	1200	8,7	.60
.0036	2500	7,9	.60
.004	600	2	.60
.004	2500	2,7	.50
.0045	600	9	.50
.0046	600	9	.45
.0047	2500	8	.85
.005	600	7,8	.45
.005	1200	7,8	.45
.005	2500	8	.60
.0051	2500	8	.55
.0056	2500	8	.65
.006	1200	7,9	.60
.0068	1200	7	.55
.007	1200	8	.55
.0075	1200	8	.55
.008	1200	8	.60
.01	600	8	.55
.01	1200	2,7,8	.60
.01	1200	3,7,8	.85
.01	2500	7,8	.60
.0115	600	8	.40
.013	1200	7	.55
.015	2000	8	.60
.015	2500	7,9	.55
.0175	1200	2	.60
.02	600	7	.75
.0226	600	7	.35
.025	1200	t	.35
.03	600	4,8	.65
.03	2500	9	.60
.033	600	7	.70
.033	1200	9	.60
.04	600	7,8	.65
.073	250	8	.80

Cap. Mfd.	Wrkg. Volts	Mfr. Leg.	Price Each
STYLE "D" CONDENSERS			
.000025	1200	7	$0.25
.000035	600	7	.20
.00005	1200	2,6	.20
.00005	1200	1,7,9	.25
.0001	2500	2,8,9	.25
.0001	600	8	.25
.0001	1200	7,8	.25
.00015	2500	8	.30
.00015	600	2,8	.30
.0002	1200	2,7	.30
.0002	2500	9	.35
.00024	1200	9	.25
.00025	1200	6,8	.25
.0003	2500	6,8	.25
.0004	600	7	.30
.0005	1200	1,8	.30
.0005	2500	7	.35
.0005	1200	[illegible]	.25
.0006	800	8	.25
.00065	600	2	.25
.0007	600	8	.35
.00075	600	8	.30
.001	800	2,8	.35
.001	1000	8,8,9	.35
.001	2500	6,8	.40
.0011	600	1	.40
.002	1200	1,2,9	.25
.002	1000	7	.25
.002	600	1,7,8	.30
.002	2500	8	.35
.0022	2500	7,8	.40
.0025	2500	3	.25
.0025	1200	1	.25
.0027	600	2	.35
.003	600	8,7,8	.40
.0033	1200	2	.35
.004	600	2,7	.40
.004	1200	8	.35
.004	1250	7,8	.35
.004	2500	9	.35
.0044	600	8	.35
.0047	2500	8,8	.35
.005	2500	2,6,7	.45
.005	1200	7	.40
.0051	2500	8	.40
.006	600	1,2	.35
.006	1000	1,8	.35
.01	2500	2,7,8	.40
.01	1200	1,8,9	.45
.01	1200	2,8	.50
.01	2500	2,7,8	.50
.02	600	2,6,8	.35
.025	600	1,2	.35
.025	1200	1,7	.30
.027	600	8	.35
.03	800	2,8	.25
STYLE "F" CONDENSERS			
.0001	1000	5	$0.20
.0005	1500	5	.30
.00075	1500	7	.30
.001	1500	5,7	.30
.001	1500	7	.35
.002	2500	7	.40
.002	1500	7	.35
.003	1500	7	.40
.004	1500	8	.35
.0047	2500	[illegible]	.35
.005	1500	7	.40
.006	800	5	.40
.008	800	5	.45
.006	1500	7	.40
.01	2500	7	.45
.006	1500	5	.45

METAL DRAWN PAPER CAPACITORS

STOCK NO.	CAPACITY MFG.	DCW VOLTS	NO. OF LEADS & LOCATION	FIG.	MANUFACTURER'S NAME & PART NO.	UNIT PRICE
335-14	.06	400	2 SIDE	A	POTTER P-1017	$0.30
347-25	.05	600	1 SIDE	A	POTTER CO-503R	.25
347-10	.06	600	2 SIDE	A	MICAMOID - SPRAGUE	.35
335-30	.1	200	1 SIDE	A	MICAMOID	.25
407-19	.1	600	2 TOP	A	BELMONT A-48-4666	.35
407-39	.1	600	2 SIDE	A	INDUSTRIAL SPRAGUE C.D.	.35
335-7	.1	600	2 TOP	A	AEROVOX 174170	.35
407-12	.1	1000	2 SIDE	A	INDUSTRIAL	.55
335-3	.2	400	2 TOP	A	SOLAR 179330	.30
335-6	.2	600	2 TOP	A	SPRAGUE 195216	.35
347-4	.25	330AC	2 SIDE	C	AEROVOX 25 15 00-2	.35
335-15	.25	330AC	2 SIDE	C	SPRAGUE AEROVOX	.35
335-28	.25	400	2 TOP	A	SOLAR 188828	.30
335-31	.25	400	2 SIDE	A	SOLAR 176676	.30
335-2	.25	400	2 SIDE	A	AEROVOX 251249-3	.30
407-16	.25	400	1 SIDE	A	AEROVOX	.30
347-3	.25	400	2 SIDE	A	AEROVOX 251249-3	.30
449-2	.25	600	2 TOP	A	SPRAGUE A5491	.35
333-11	.25	600	2 TOP	A	C.D. DYRT6026	.35
335-29	.3	400	2 TOP	A	SOLAR 209185	.30
335-64	.35	400	2 BOTTOM	A	MICAMOID	.35
335-61	.5	120	2 TOP	A	POTTER CD-504N	.25
347-17	.5	200	2 SIDE	A	MICAMOID 10497	.30
335-11	.5	400	2 SIDE	A	SOLAR BR-105024-2	.30
347-5	.5	400	2 SIDE	A	SIG. C. TYPE CA-177A	.30
407-15	.5	400	2 SIDE	A	FAST	.30
407-18	.5	400	2 TOP	A	SPRAGUE GUDEMAN	.30
335-5	.5	600	2 SIDE	A	SOLAR 174171	.35
335-4	.5	600	2 TOP	A	C.D. 177400	.35
335-13	.5	600	2 TOP	A	SOLAR	.35
335-63	.5	600	2 SIDE	A	C.D.	.35
347-14	.5	600	2 BOTTOM	A	C.D. DYRB-6050	.35
337-43	.5	600	2 BOTTOM	A	SPRAGUE 300447-3	.35
407-24	.5	1000	2 TOP	B	GUDEMAN 7517-TN	.65
336-63	1	400	2 SIDE	B	SPRAGUE	.35
407-14	1	600	2 SIDE	B	MICAMOID	.45
333-45	1	600	2 SIDE	B	SPRAGUE	.45
407-21	1	600	2 SIDE	B	SPRAGUE MICAMOID	.45
335-48	1	600	2 END	D	AEROVOX	.45
335-58	1	1000	2 SIDE	B	C.D. DYR10100G	.70
347-38	1.25	100	2 SIDE	C	ELEC. UTILITIES CO-125	.35
347-21	1.25	100	2 SIDE	C	GUDEMAN CO-225	.35
335-56	2	600	2 BOTTOM	B	SPRAGUE	.40
333-42	2	600	2 SIDE	B	C.D. DYR-6200	.40
335-32	4	50	2 SIDE	A	C.D. SPRAGUE	.35
347-1	4	60	1 SIDE	B	AEROVOX C-60933	.35
347-27	4	60	2 SIDE	B	C.D. CA-275	.35
407-9	20	25	2 SIDE	A	INDUSTRIAL	.40
407-35	20	50	2 SIDE	A	SPRAGUE	.45
335-45	25	25	2 SIDE	A	AMER. COND. 5088	.40
449-3	25	40	2 BOTTOM	D	CD-2468	.45
347-43	25	50	1 SIDE	A	SPRAGUE D9260	.45
407-13	40	25	2 SIDE	A	MICAMOID	.40
347-42	50	25	1 TOP	A	C. D. 690308-4	.45
335-40	2 x .1	100	3 SIDE	B	POTTER BR-105027-5	.25
336-63	2 x .1	200	2 BOTTOM	A	CSI-1574	.25
347-7	2 x .1	200	2 SIDE	A	POTTER CP-204	.25
347-9	2 x .1	300	3 TOP	D	SOLAR SJ-362	.30
407-30	2 x .1	400	3 SIDE	A	SPRAGUE PB-5161-1	.35
333-44	2 x .1	400	3 TOP	A	SPRAGUE A-4816	.35
335-35	2 x .1	600	3 TOP	A	C. D.	.40
407-17	2 x .1	600	3 SIDE	A	C. D. - SPRAGUE	.40
407-36	2 x .1	600	3 BOTTOM	A	AEROVOX 630MB	.40
335-1	2 x .25	400	4 BOTTOM	B	#174060	.30
449-1	2 x .25	400	3 SIDE	A	ELEC. UTIL. C-364B	.30
347-8	2 x .5	100	3 TOP	A	AEROVOX A-109504	.25
335-55	2 x .5	400	2 BOTTOM	D	C. D. 1575	.35
407-4	2 x .5	400	3 SIDE	B	SOLAR - SPRAGUE	.35
335-43	2 x .5	600	3 SIDE	B	SPRAGUE P-9727	.40
407-31	.1 & .5	400	3 TOP	C	SPRAGUE PB-51613-I	.35
347-30	1 & .1	300	3 TOP	D	SPRAGUE P-3062	.35
347-18	3 x .1	200	3 SIDE	A	POTTER CP-304C	.30
335-21	3 x .1	400	3 TOP	A	C. D. A25096	.35
335-26	3 x .1	400	3 SIDE	A	AEROVOX - SPRAGUE	.35
335-23	3 x .1	500	3 SIDE	A	FAST	.40
335-12	3 x .1	600	3 TOP	A	C. D. - SOLAR	.45
335-42	3 x .1	600	3 SIDE	A	SPRAGUE P-9728	.45
335-44	3 x .1	600	3 BOTTOM	A	SPRAGUE - SOLAR	.45
335-27	.1	600	4 BOTTOM	B	SOLAR	.35
	.5	200				
	.2	200				

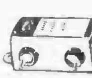


FIG. A

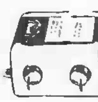


FIG. B

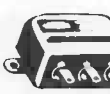


FIG. C

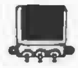


FIG. D

TUBES Guaranteed by WELLS

· TRANSMITTING · RECEIVING · INDUSTRIAL · SPECIAL PURPOSE

IMMEDIATE DELIVERY AT LOWEST PRICES IN OUR HISTORY

Check this list for exceptional values in magnetrons, cathode ray tubes, voltage regulators, transmitting tubes—also neon, pilot and flashlight bulbs. These are brand new, standard make tubes. Order enough for future needs directly from this ad or through your local parts jobber.

01A	$0.45
1B22	8.35
1N21 Xtal Diode	.65
1N21B Xtal Diode	.80
1N23 Xtal Diode	.80
1N23A Xtal Diode	.85
1N27 Xtal Diode	.85
1R4/1294	.65
1R5	.95
1S5	.95
1S21	1.10
1T4	.95
2C26	.35
2C26A	.45
2C34	.55
2J21A	11.45
2J22	9.85
2J26	8.45
2J27	14.45
2J31	9.95
2J32	14.85
2J33	19.95
2J37	13.85
2J38	12.95
2J48	14.95
2X2/879	.65
3A4	.35
3A5	1.05
3AP1 CRT	3.85
3B22	2.95
3B24	1.75
3BP1 CRT	3.75
3CP1-S1	1.95
3C24/24G	.47
3D6/1299	.65
3FP7 CRT	2.95
3HP7 CRT	2.95
3GP1 CRT	3.75
3Q5	.90
REL-5	17.95
5AP1 CRT	3.95
5BP1 CRT	2.95
5CP1 CRT	3.85
5GP1 CRT	6.55
5J23	14.25
5J29	14.25
5Y3G	.40
6A6	.90
6AB7	.95
6AC7	.90
6AK6	.80
6B7	.95
6BE6	.65
6C4	.45
6C6	.75
6C21	19.75
6D6	.60
6E5	.70
6H6	.50
6J5 GT	.50
6J6	.90
6N7/GT	.80
6R7G	.80
6SF5	.65
6SG7	.70
6SH7	.40
6SJ7/GT	.65
6SK7/GT	.65
6SL7/GT	.65
6SN7/GT	.80
6SQ7/GT	.60
7A4	.65
7A7	.65
7C4/1203	.40
7C7	.65
7E6	.65
7F7	.75
7H7	.75
7N7	.75
7Q7	.65
10/VT-25A	.40
10Y/VT-25	.45
12A6	.25
12K8	.65
12SF7	.70
12SH7	.40
12SK7	.60
12SL7/GT	.70
12SR7	.40
12x825 2 amp. Tungar	2.25
13-4 Ballast	.35
15R	1.40
FG-17	2.85
REL-21	3.25
23D4 Ballast	.45
25Z6 GT	.55
28D7	.40
30/VT-67 (For Walkie Talkies)	.75
33/VT-33(For Walkie Talkies)	.75
RK-34	.45
34	.35
39/44	.35
45 Spec.	.55
46	.60
EF50/VT250	.45
CEQ 72	1.10
72 3B24	1.75
VR-75	.90
76	.55
VR-78	.65
80	.45
FG-81-A	3.95
83	.85
83V	.95
89Y	.40
VR 90	.70
VR-92	.65
100R	3.25
FG-105	9.95
VR-105	.85
VU-111	.65
117Z3	.55
VT-127 English	.25
VT-127A	2.95
VR-150	.55
VT-158	9.85
FG-172	29.50
205B	1.95
211 (VT-4-C)	.65
215A	1.95
231D	1.30
282B	4.25
304TH	5.95
304TL	1.75
307A	4.25
316A	.75
350B	2.55
371B	.85
388A	4.95
417A	19.95
434A	7.45
446A	1.55
450TH	19.95
GL-471A	2.75
527	11.25
WL-530	17.50
WL-531	17.50
532A/1B32	3.55
GL-559	3.75
KU-610	7.45
HY-615	1.20
700B	9.95
700C	9.95
700D	9.95
702A	2.95
703A	4.85
705A	2.65
707A	19.50
707B	23.25
710A	2.15
713A	1.55
714AY	9.95
RK715B	7.95
717A	.90
721A	3.95
724A	8.65
724B	4.25
725A	19.95
726A	19.95
730A	11.95
801	.60
801A	.75
803	6.95
804	9.95
805	5.45
808	1.75
809	2.75
810	7.95
811	2.35
813	7.85
814	3.75
815	2.85
826	.49
829	3.25
830B	3.95
837	1.75
838	3.25
841	.55
843	.55
851	39.50
WL-860	2.55
861	32.50
864	.55
865	2.55
866A	1.30
869	26.50
869B	28.95
872A	2.45
874	2.15
878	2.15
930	2.20
954	.50
955	.55
956	.55
957	.55
991 (NE-16)	.30
1005	.35
1148	.40
1201	.75
1616	1.25
1619	.55
1621	1.25
1625	.45
1626	.45
1629	.45
1635	.95
2051	.96
7193	.35
8011	2.55
8012	4.25
8020	3.35
8025	7.50
9001	.70
9002	.45
9003	.65
9004	.45
9006	.45

NEON BULBS FOR RADIO USE

NE-2	$0.06
NE-15	.06
NE-16	.20
NE-20	.06
NE-21	.24
NE-48	.24
NE-51	.06

PILOT AND FLASHLIGHT BULBS

Stock No.	Mazda No.	Volts	Watts	Bulb	Base	Price
350-40	64	6-8	3CP	G-6	DC Bay	$0.07
350-31	67	12-16	1.5CP	G-4½	Min. Bay	.08
350-42	Spec.	12	6	S-6	Cand. Scr.	.11
350-30	1446	12	.2 amp.	G-3½	Min. Scr.	.07
350-14	48	2	.06	T-3¼	Min. Bay	.08
350-16	356	120	3	S-6	Can. Bay	.11
349-23	PR-10	6	.5 amp.	B-3½	Min. Flang	.08
350-19	Proj. Bulb	120	500W	T-20	Med. Pf	1.45
LB-17 C		24	.035 A	T-2	Tel. Base	.16
LB-88A		110	7W	C-7	Cand. Scr.	.17
LB-57A	53	12-16V	1 CP		Min. Bay	.07
LB-100A	Airplane Headlight	24V	239W	A-19	Medm. Pf	.38
LB-101	323	3	(Aircraft)	T-1¾	983	.22
LB-101A	LM-60	115V	250W	T-20	Med. Pf	.40
LB-102	1195	12-16	.50 CP	RP-11	DC Bay	.14
LB-102A	CC-13	110V	100W	T-8	DC Pf	.33
LB-102B	1491	2.4	.8 amp.		DC Bay	.14
LB-102C	3D2	28	(Airplane type)		DC Bay	.14
LB-104	313	28	.17 amp.	T-3¼	Min. Bay	.11
LB-105	1819	13V	.33A		Min. Bay	.12
LB-106	12A	12	.09-.11	T-2	Tel. Base	.14
LB-107	24-A2 WE	24	.73-.105	T-2	Tel. Base	.16
LB-108	8-14 Argon	105	2½ Watt		Med. Scr.	.22
LB-109	8 Telephone Type		Neon	T-2		.17
350-18	1677	24	17	T-3	Min. Scr.	.16

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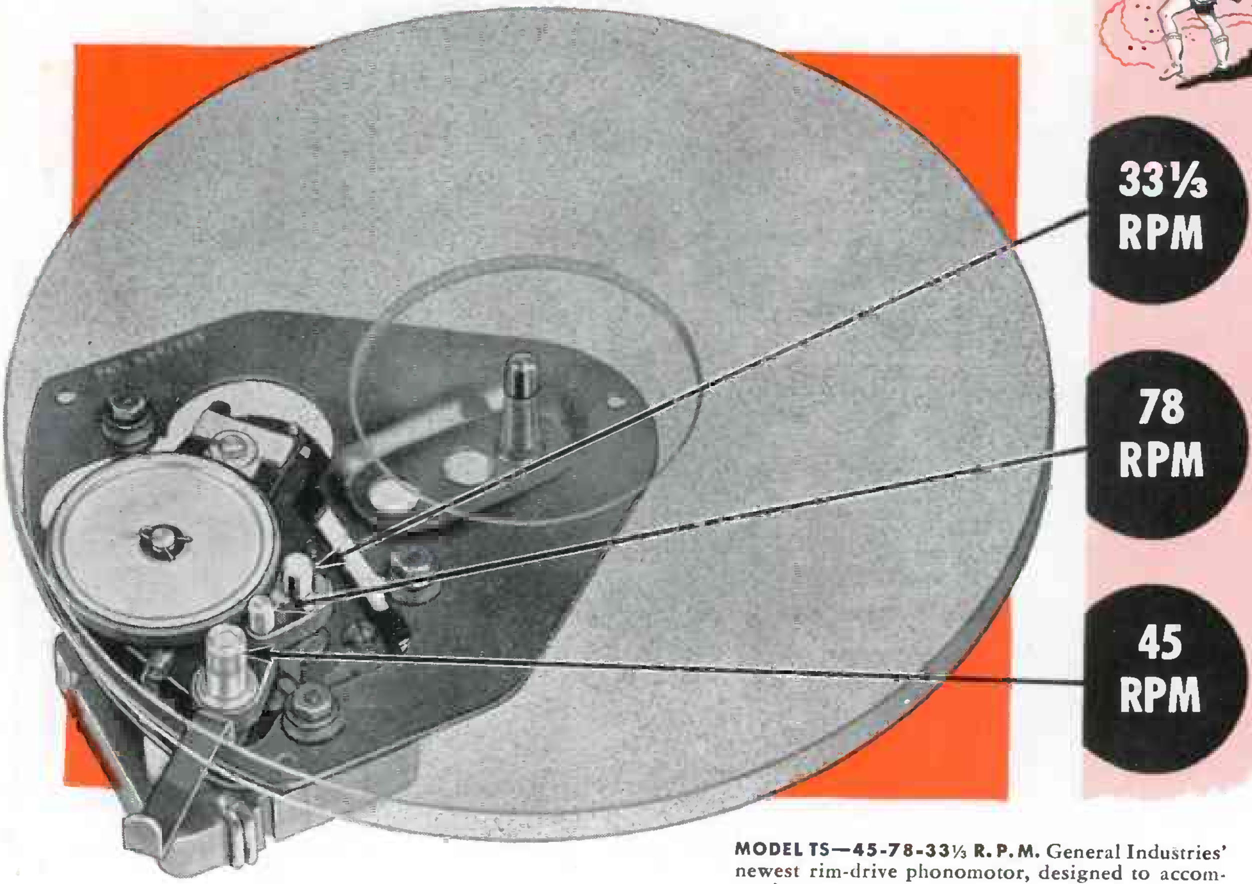

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