Electronics World

APRIL, 1963
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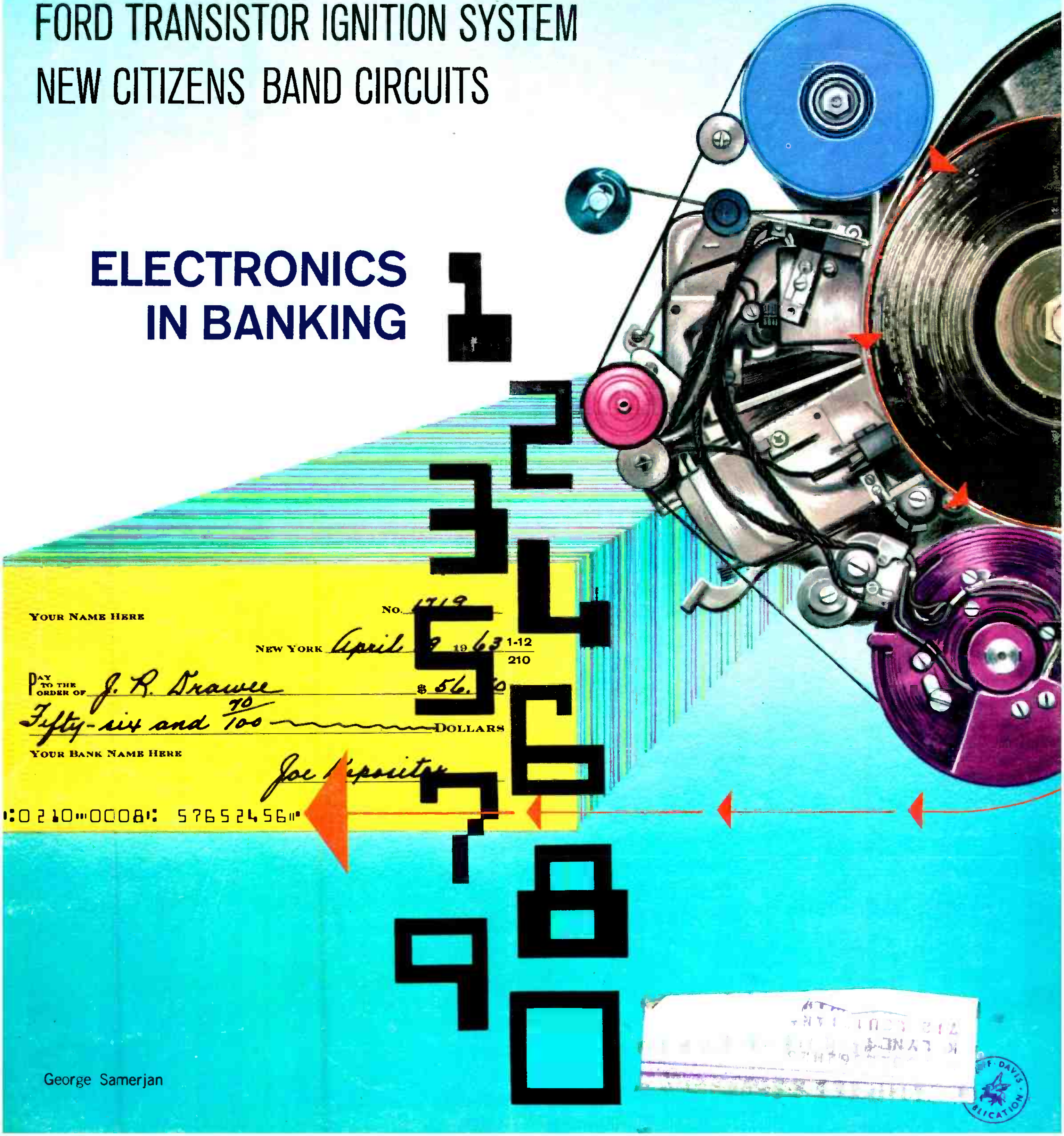

George Samerjan

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CIRCLE NO. 103 ON READER SERVICE PAGE

8-6-2

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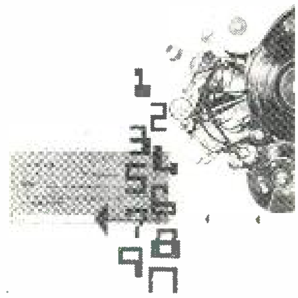
Electronics World CONTENTS

APRIL 1963 / VOL. 69 NO. 4

MONTHLY FEATURES

Electronics World



THIS MONTH'S COVER symbolizes the operation of the Magnetic Ink Character Recognition system now being widely used by banks to help them handle 13 billion checks a year. Shown at the right is the magnetic-head assembly of an IBM reader-sorter. The checks, with the special numbers imprinted on them in magnetic ink, are transported through this assembly. One head magnetizes the numbers and another head reads these numbers. The checks are then sorted automatically by the machine for further processing. For complete details, see page 29. (Cover by George Samerjan)

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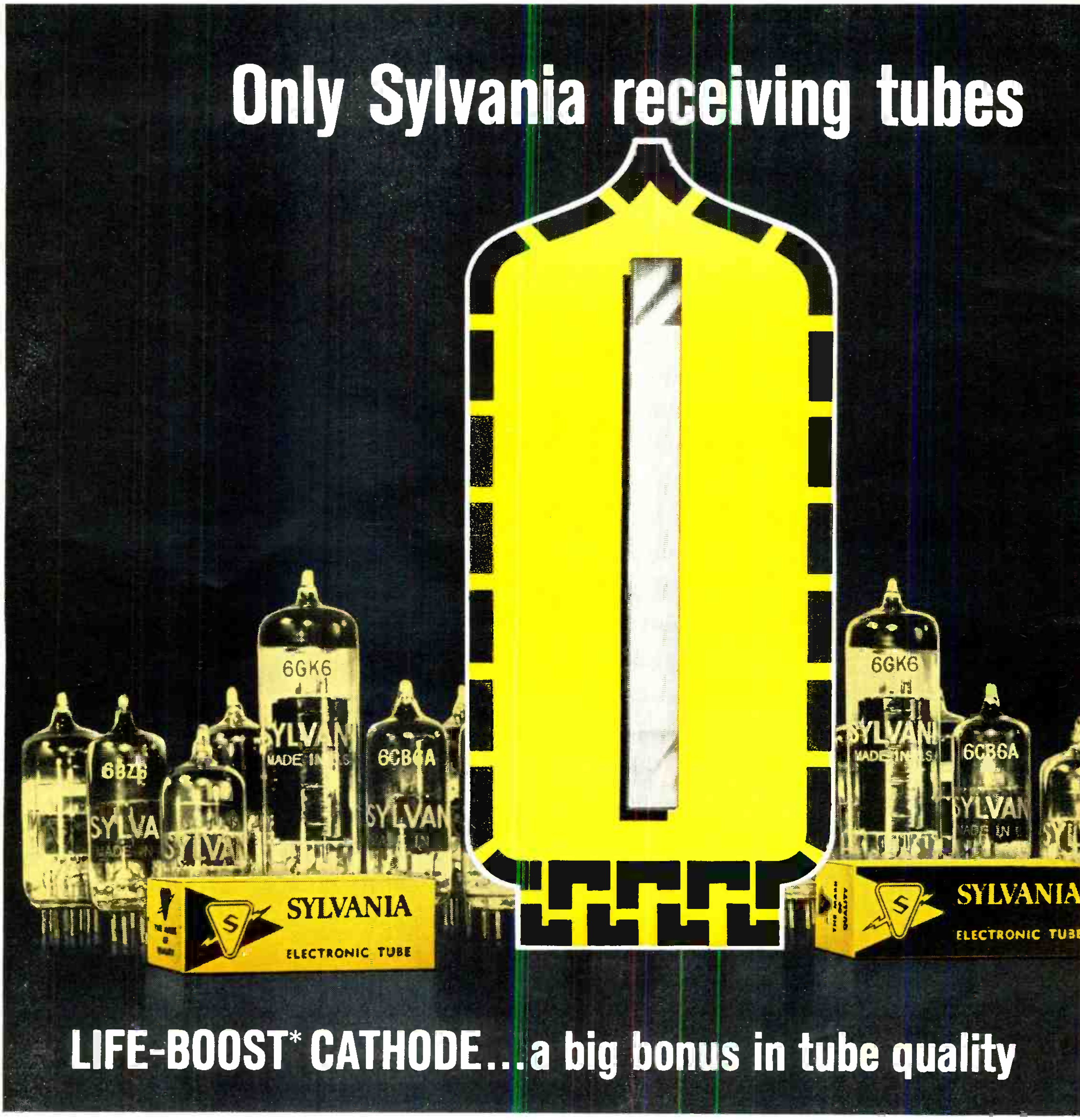

Sylvania's exclusive LIFE-BOOST Cathode is putting new life into tubes—and sales. This latest evidence of Sylvania leadership in tube technology offers benefits you can really sell: it virtually eliminates performance slump, a major cause of profit-stealing callbacks. Besides stability, it produces significantly better tube life and uniformity. More than 90 types already have LIFE-BOOST, with more on the way...and it's being heavily promoted in national magazines and by mail. *Trademark

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CIRCLE NO. 153 ON READER SERVICE PAGE

COMING NEXT MONTH

SPECIAL FEATURES

Recording-Storage Tubes & Their Applications — Alvin S. Luftman, product-line manager of Raytheon's Display Devices Operation, discusses the operating principles and uses of these special cathode-ray tubes in which visual information is written in the tube, stored, and read either instantaneously or after a period of time. Such devices are currently being used in bright-display radar presentations for harbor and air-traffic control.

Latest Advances in Touch Control — New circuits that switch at the touch of the finger are gaining popularity. C. E. Atkins of Tung-Sol describes how balanced neon oscillators in combination with solid-state switching devices permit equipment to be operated by means of body capacity. Circuits will handle 30-40 watts directly or more power, via relay, for industrial use.

HOW TOUGH ARE THE PROPOSED CB REGULATIONS?
There has been a lot of talk about proposed changes—and some users feel they will be deprived of their "rights." R. L. Conhaim takes the opposite view and points out the important advantages that can accrue to all legitimate CB users under the new rules.

HYSTERESIS-LOOP PLOTTER
Construction of a handy device which, when used in conjunction with a scope, permits the display of comparative measurements involving the quality of laminations used in transformers and inductors.

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You can build this compact, output-transformerless amplifier at moderate cost, using readily available parts. It will deliver medium power at low distortion.

DIRECTORY OF JAPANESE RADIO IMPORTERS AND MANUFACTURERS
An alphabetic listing of brand-names plus information on the importer and/or manufacturer of most Japanese transistor sets to be found on the U.S. market.

TUNABLE PHASE-SHIFT AUDIO FILTER
If you are having trouble copying one station out of the many presently crowding the amateur and commercial bands, building this accessory may solve your problems.

All these and many more interesting and informative articles will be yours in the MAY issue of ELECTRONICS WORLD . . . on sale April 18th.

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. . . for the Record

By **W. A. STOCKLIN**
Editor

$15.1-Billion Electronics Market In 1963

ANOTHER year has passed, and once again, the electronics industry has achieved an unbroken record of yearly sales increases since 1949. The Electronic Industries Association accumulated sales volume in 1962 showed an increase of 2.8 per-cent over the previous year. There seems little doubt, particularly after President Kennedy's recent State of the Union Message in Congress, that 1963 will show a further increased dollar sales volume. EIA's predictions are that the electronics industry will reach $15.1-billion in 1963, which will make it the fourth largest in our country.

It is interesting to note that the government's military expenditures for electronic equipment in the coming year are expected to reach an all-time high of $9-billion, which is almost 60 per-cent of the total U.S. electronics output. (See Table below).

Unit sales of transistors will, according to L. Berkeley Davis of *General Electric,* increase to between 280 million and 310 million transistors. However, as Mr. Davis pointed out, if current price trends continue and the product market continues to change as it has over the last months, industry's dollar volume from sales of transistors will do well to equal the $289-million figure of 1962.

Sales of integrated semiconductor circuits can be expected to increase dramatically in 1963. Although last year's sales were below $5-million, the current interest displayed by users indicates that a market between $10-million and $20-million is expected to be realized by the manufacturers of these devices for 1963.

The coming year should also see a continued healthy growth in the markets for semiconductor rectifier devices. It is expected that there will be a $20-million increase over the 1962 volume of $166-million.

Although written off many times by a number of industry forecasters because of foreign competition and displacement by semiconductor devices, the domestic receiving tube industry continues to be a major segment of the electronic components industry.

Depending on the strength of the general economy, 1963 factory sales may be as high as $230-million to $270-million. This compares with a $295-million sales volume in 1962. According to *General Electric,* 9.7 million TV picture tubes will be sold domestically. The total market should be about $221-million.

According to Ross D. Siragusa of *Admiral Corporation,* 1963 television sales should be in the neighborhood of 6 million black-and-white and 700,000 color sets. *Admiral* alone expects to produce 100,000 color sets in 1963.

Although the industrial electronics market is not as impressive today as the government and military aspects of our industry, it is still viewed as an area that will offer the greatest potential for expansion during the coming years. As pointed out by Charles F. Horne, President of EIA, the profit ratios seem to be much brighter in this area when compared to the other segments of our industry. It seems quite obvious that our accelerated government and military expenditures will certainly bring mounting pressures for profit controls and restrictions upon the decision-making powers of company managements.

While signs point to a prosperous 1963 and a progressive future, one serious problem still exists within the industry. There is a greater need for qualified electronics engineers and technicians than existed a year ago. A downtrend in the supply of trained technical personnel has continued now for quite a few years and there are no signs that this will change. Unfortunately, there are less engineering students graduating from our colleges today than in the past. It has been estimated that by 1970 there will be a shortage of 2¼ million electronically oriented technicians, not to mention the shortage of engineering personnel. ▲

	1962	1963
Consumer	$ 2.3–billion	$ 2.5–billion
Industrial	2.4–billion	2.7–billion
Military	7.6–billion	9.0–billion
Replacement	.8–billion	.9–billion
Total	$13.1–billion	$15.1–billion

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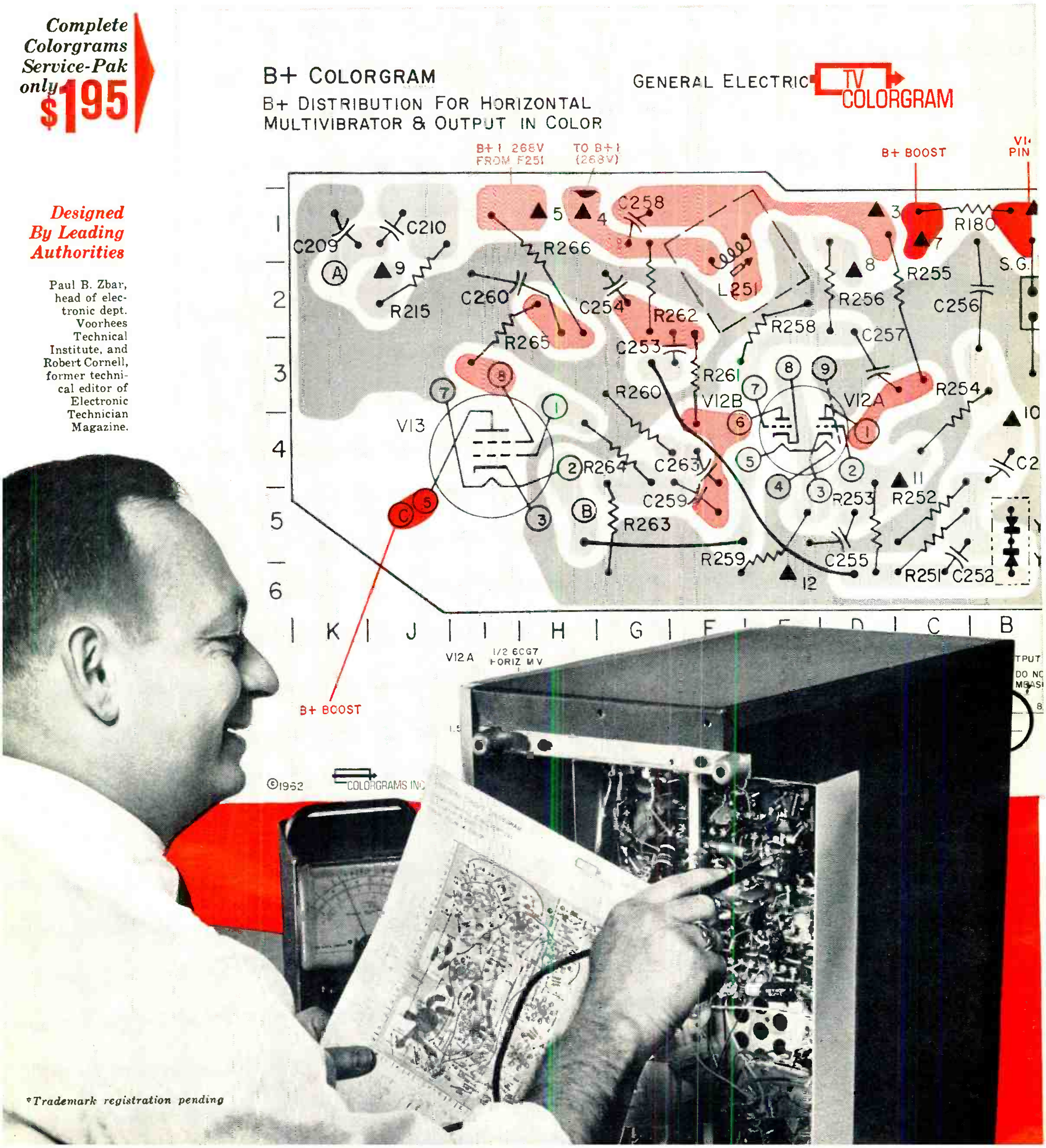

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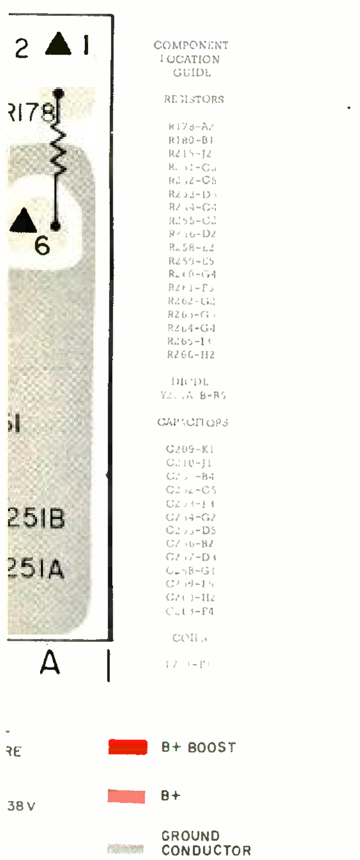

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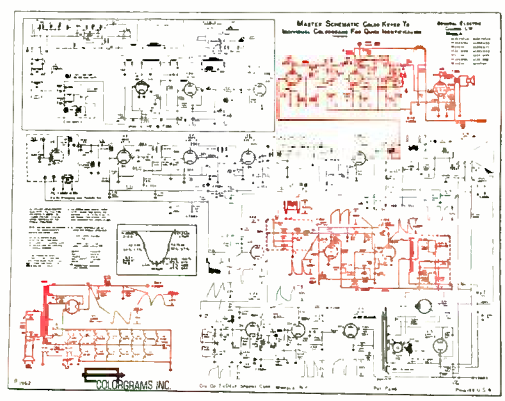

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CIRCLE NO. 111 ON READER SERVICE PAGE

LETTERS FROM OUR READERS

TV TECHNICIANS REPLY

To the Editors:

Tell the TV technician who griped in your last month's issue to throw away his screwdriver and sell shoelaces for a living. I also happen to work in TV service, but consider myself a professional in the broad and varied field of electronics. My files are well stocked with primary TV service data (which no magazine can supply, anyhow) and I keep up with anything new that comes along. I don't need armchair experts to keep telling me what slug to turn on which transformer. If I couldn't make out without such crutches, I'd put a lock on my shop door.

Going from lasers to acoustical lenses in one issue, or fuel cells to diathermy in another, suits me fine. I look forward to the new surprises in every issue. I read your magazine at home, with my shoes off. No other monthly makes that claim on me.

BEN MARTINSON
St. Louis, Mo.

To the Editors:

Getting my tough dogs fixed for me is not the reason I read your magazine. If we must be practical, I think I would be less capable at TV repair if I lost my active curiosity about everything else in electronics. I also need an all-inclusive publication to keep me in touch with what is being done by my many friends who work for manufacturers, in industrial plants, and elsewhere. In addition, who can tell what we who service sets today—or work anywhere else in the field—will be called on to do tomorrow? I don't know a better way of staying in touch with the changing world of electronics than with ELECTRONICS WORLD. Keep up the fine job.

RICHARD DEPEW
Pittsburgh, Penna.

* * *

BUSINESS RADIO

To the Editors:

Our attention has been called to an article entitled "The Business Radio Service" published in the December, 1962 issue of ELECTRONICS WORLD. In paragraph 6 of the article is the statement, "The base-station operator must have an operator's license, or an operator's permit, and both the holder of the station license and the operators must be U.S. citizens."

The radio operator license (permit) requirement has been waived for normal rendition of service in the case of almost all of the stations in the Business Radio Service, including base stations, and an unlicensed person, after being authorized by the station licensee, may operate them in such circumstances. With regard to the matter of citizenship, the Commission does not require that unlicensed persons operating radio stations under a waiver of the license requirement be citizens of the United States.

There are many thousands of people operating stations who are not required to hold radio operator licenses and the publishing of advice to the contrary tends to generate applications for licenses which are not needed. This is a matter of concern to the Commission because of the limited facilities and staff available for processing operator applications.

BEN F. WAPLE
Federal Communications Commission
Washington, D. C.

* * *

TV-FM ANTENNA DESIGN

To the Editors:

I read with great interest your article in the November issue of ELECTRONICS WORLD entitled "Design for an All-Purpose TV-FM Antenna." I immediately constructed it according to the drawings but using 18 rather than 20 gauge wire. There was one measurement which did not seem to fit, by which I mean the position of the central nail did not give a straight line between the two apexes. However since that was toward the high end and I am not at the moment interested in u.h.f. I placed it in the "straight-line" position.

As constructed I compared it with my existing antenna, which is a 7-element "standing-wave" type mounted about 20 feet above the roof. My version of yours was suspended inside the attic. On FM yours was slightly superior throughout the whole band. On TV the 7-element array was superior on channels 2, 5, and 11, slightly superior on 4. Your type of antenna was better on channel 3. A most interesting result was found on channels 7, 8, and 9. Channel 8 is the local station and very strong. On your type the set was hopelessly overloaded, but at the same time I could get quite acceptable signals from 7 and 9, the latter a very weak and unreliably received New York station. Channel 7

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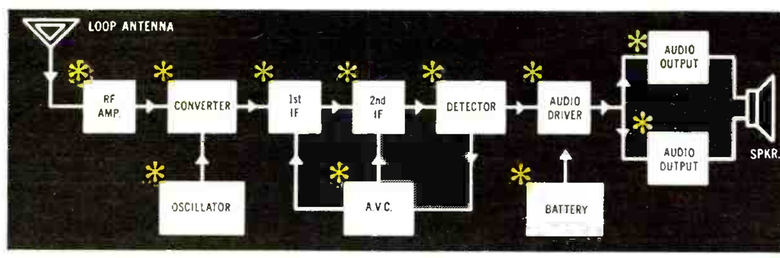

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has never been received well on the 7-element antenna, and channel 9 not at all. On the other hand channel 10, which can be received irregularly on the 7-element antenna, produced nothing on your type.

I have a strong suspicion that if your antenna, as built by me, were better made with larger diameter elements, it would prove somewhat superior throughout even though it was mounted inside the attic some 20 feet below the other. I live some 7 miles inland and about 300 feet up. New York is about 80 miles away.

A. M. Payne
Yale University
New Haven, Conn.

Thanks to Reader Payne for his interesting report on the performance of the antenna. Some of our readers have pointed out some minor inaccuracies in a few of the dimensions. The dimensions to the tip-point nails should be considered as correct, while the dimensions to the nails on the central strut should be considered as approximate guide-line dimensions. These latter should be adjusted as required to preserve the zig-zag layout shown in Fig. 4. Incidentally, the 1.49-foot dimension shown should have been 1.35 feet.—Editors.

* * *

FM STEREO ADAPTER

To the Editors:

Many thanks to Mr. Helber for his timely and ingeniously simple design for an "out-of-sight" FM stereo adapter (November, 1962 issue).

For other readers who may contemplate building the unit, there might exist some question regarding the inclusion and/or proper adjustment of input level control, *R11*. I have found this control is essentially unnecessary (a fixed resistor of 4700 ohms is suitable and will reduce the unit's cost by nearly $2), since virtually all systems will have one or more level controls between the stereo adapter and speakers. If, however, it is decided to stay with the relatively extravagant potentiometer, its ultimate setting is an uncritical matter of choice.

Also, for those prospective builders who (such as myself) do not have an audio signal generator readily available, the author's alignment instructions may be easily modified to employ the actual 19-kc. pilot tone fed to transistor *V4* from the tuner, when the latter is tuned to a known stereo broadcast. Alignment of *L1* and *T1* can then be accurately accomplished "by ear," although it should be noted that the range of *L1* is quite broad with ambiguous points of response, and its proper adjustment should be nearer the maximum, rather than minimum, inductance setting.

John A. Jurick
Midwest City, Okla. ▲

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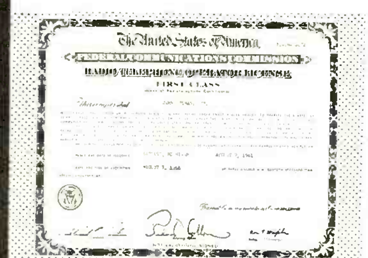

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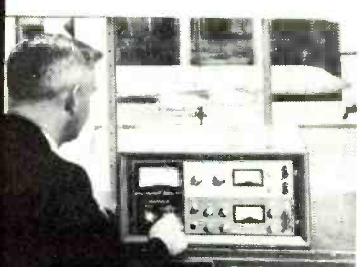

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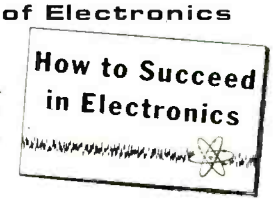

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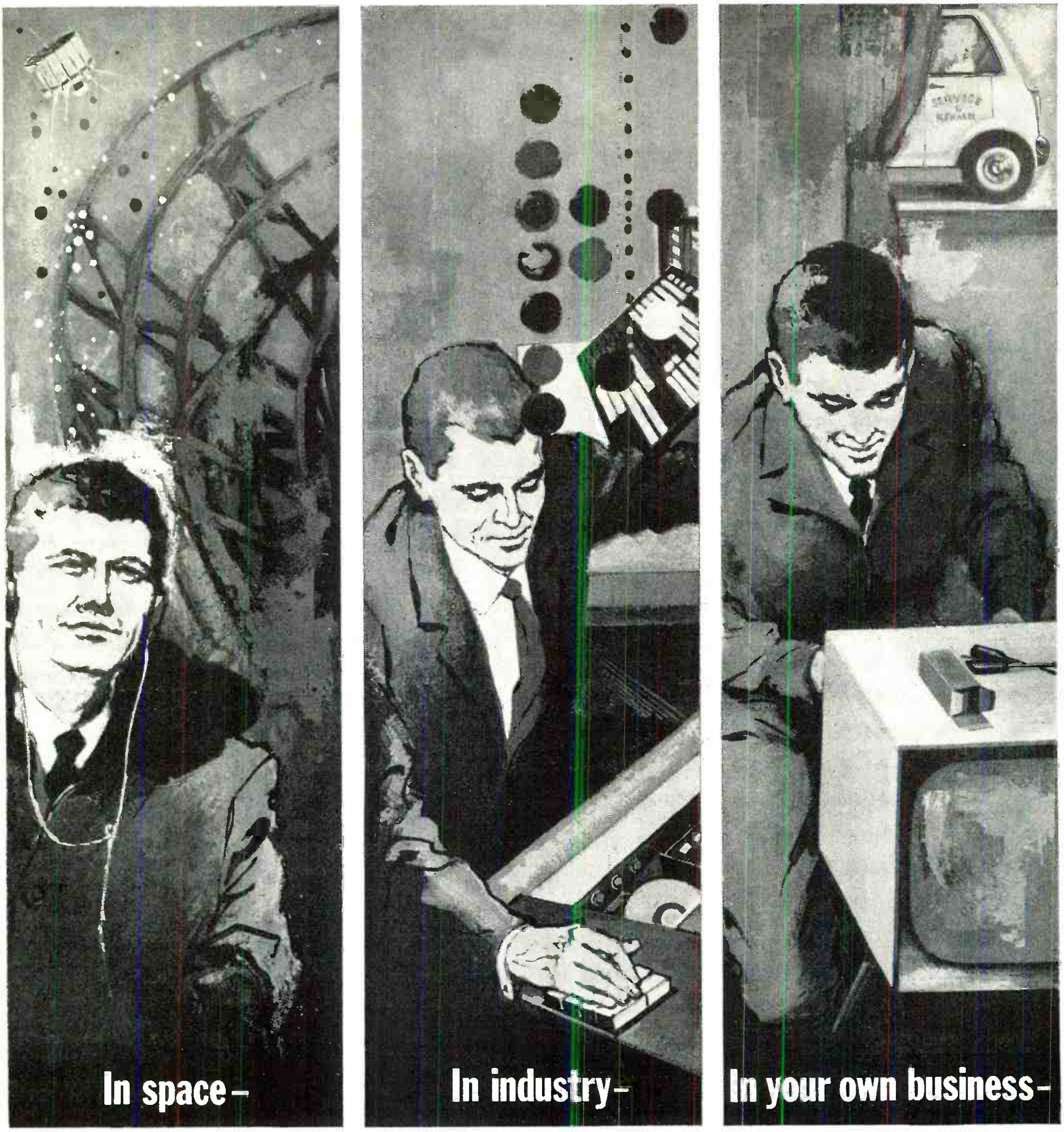

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INDUSTRIAL TITLES	THIS IS THE RCA TRAINING THAT WILL HELP YOU GET IT!	QUALIFICATION
Engineering Aide, Lab Technician, Field Service Engineer, Test Engineer, Technical Instructor	Electronics Technology (T-3)	High School Grad with Algebra, Physics or Science
Electronic Technician, Field Technician, Computer Technician, Broadcasting Technician, Customer Service Engineer, Instrument Technician	Industrial and Communications Electronics (V-7)	2 yrs. High School with Algebra, Physics or Science
TV Serviceman, Electronic Tester	Electronics and Television Receivers (V-3)	2 yrs. High School with Algebra, Physics or Science
Transistor Circuits Specialist	Transistors	Radio background
Junior & Senior Detail Draftsman	Electronic Drafting (V-11, V-12)	2 yrs. High School with Algebra, Physics or Science
Color TV Service Technician	Color Television	Television background
Industrial Electronic Technician	Automation Electronics (V-14)	Radio and Transistor Background
Technical Writer	Technical Writing	Electronics background
Computer Service Technician	Digital Computer Electronics (V-15)	Radio and Transistor Background
Console Operator, Junior Programmer	Computer Programming (C-1)	College Grad or Industry sponsored
Radio Code Technician	Radio Code	8th Grade
Preparatory	Preparatory Math & Physics (P-1)	1 yr. High School
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• **Free Placement Service.** RCA Institutes graduates are now employed in important jobs at military installations such as Cape Canaveral, with important companies such as IBM, Bell Telephone Labs, General Electric, RCA, and in radio and TV stations all over the country. Many have opened their own businesses. A recent New York Resident School class had 93% of the graduates who used the FREE placement service accepted by important electronics companies, and had their jobs waiting for them on the day they graduated!

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Radio aligner, Repairman, Tester	Radio-Electronic Fundamentals	8th Grade
Black & White TV Service Technician	Television Servicing	Radio Background
Color TV Service Technician	Color Television	Black & White Television
Automation Technician	Automation Electronics	Radio or Electronics Fundamentals
Transistor Circuits Specialist	Transistors	Radio or Electronics Fundamentals
Transmitter Technician, Communications Specialist	Communications Electronics	Radio or Electronics Fundamentals
Junior Draftsman	Electronic Drafting	8th Grade
Coder, Programmer, Analyst	Computer Programming	High School Grad plus 1-year business experience

• **Voluntary Tuition Plan for Home Training Courses.** This plan affords you the most economical possible method of home study training. You pay for lessons only as you order them. If, for any reason, you wish to interrupt your training, you can do so and not owe one cent. No other obligations! No installment payments required!

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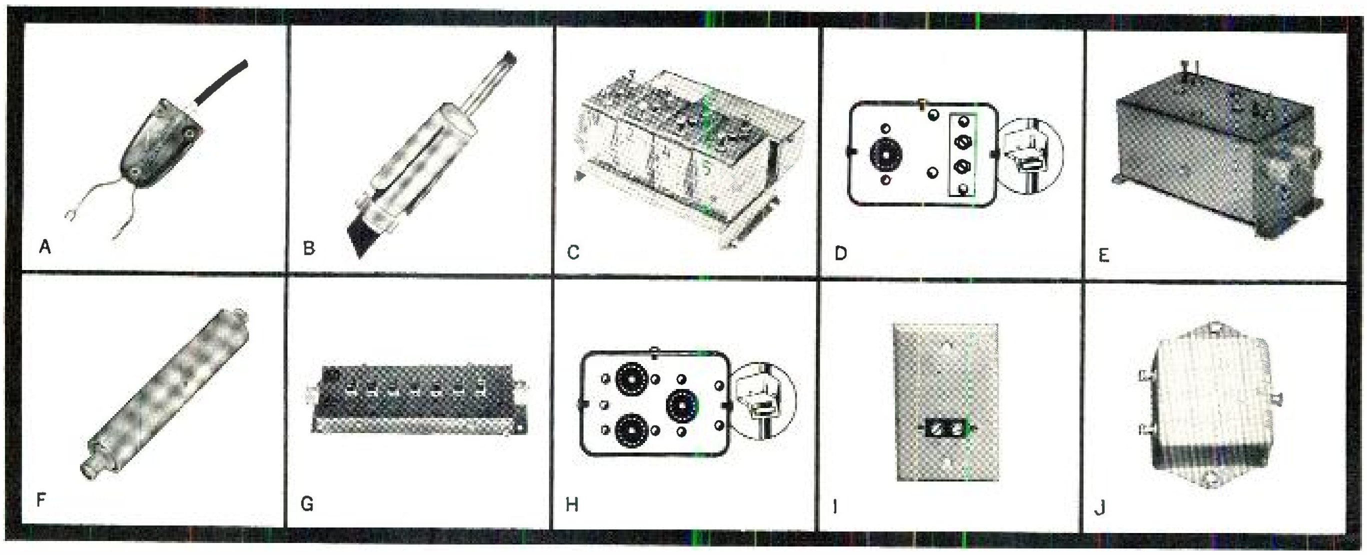
the little things
that make MATV installations
better . . . easier

BLONDER-TONGUE MASTERLINE ACCESSORIES

"For want of a horse a kingdom was lost"—for want of an effective reliable accessory—the investment in the major equipment in a Master TV antenna system can go down the drain. These Blonder-Tongue engineered MATV accessories will bring out the full potential of any system and deliver the cleanest, strongest signal to the individual TV receivers. What's more, these accessories will slice hours from installation and maintenance time.



A. MATCHING TRANSFORMER, "CABLE MATCH" Save installation time. Save money with the lowest cost, quality matching transformer available. Provides exact match between 75 ohm coax and 300 ohm TV set input. Housed in high impact plastic to eliminate grounding problem with 'hot chassis' TV sets. Uses new Blonder-Tongue solderless AUTOPLUG for secure coax connection, easy disconnect. No more unbraiding coax, no more soldering. Heavy duty output leads with spade lugs for easy connection to TV set terminals.

B. CONNECTORS (SOLDERLESS, PUSH-ON)
P-75S—Solderless AUTOPLUG (illustrated). Major improvement of well known Motorola type auto plug. No need to strip braid or solder inner or outer conductor. Very rugged and reliable.

P-59T—Solderless UHF type male plug for RG-59/u cable
P-11S—Solderless UHF type male plug for RG-11/u cable
QOP—Solderless QD plug for RG-59/u
POU—Push-on UHF plug for RG-59/u
POB—Push-on Benconector plug for RG-59/u
M-73—Solderless Benconector plug for RG-59/u
M-71—Benconector plug for RG-11/u

C. FILTERED MIXERS/SPLITTERS, MODEL MX Versatile units can be used to combine TV/FM signals from several antennas; combine adjacent channels; split the signals from a broadband antenna or from a broadband amplifier and balance channel signal strength from a broadband antenna.

D. OUTDOOR BALUN, MODEL MB-b Outdoor, weather-protected balun matches 300 ohm and 75 ohm lines. Uses UHF type of SO-239 connectors for 75 ohm cable.

E. TUNABLE TRAPS, MODELS MWT-2 & MWT-3 With only these two traps, MATV installers can attenuate any undesired frequency in the entire VHF/FM band. No need to stock a great number of traps MWT-2 covers 54-108 mc; MWT-3 covers 174-216 mc range. Further, the traps provide at least 60 db attenuation of any VHF/FM frequency with virtually no loss to desired frequencies. They can be tuned simply with an off-the-air signal and TV set for most applications. Type SO-239 connectors.

F. FIXED ATTENUATOR, MODEL FA Least expensive attenuator on market. Available with 3, 6, 10 or 20 db of attenuation. Should more attenuation be needed, it's easy enough to cascade FA's. Quick disconnect connectors make installation easy.

G. VARIABLE ATTENUATORS, MODELS SA-7 and SA-3 Model SA-7 is accurate enough for lab measurements. Installer can select any attenuation from 0 to 62 db in steps of 1 db. Can be used for all frequencies from 0 to 216 mc. The SA-7 can be temporarily connected into any portion of a MATV system to determine optimum attenuation at that point. The SA-3 is a 3 switch attenuator for any frequency from 0 to 216 mc. Selection of attenuation from 0 to 38 db is in these steps: 0, 6, 12, 18, 20, 26, 32 or 38 db.

H. OUTDOOR 2-WAY HYBRID SPLITTER/MIXER, MODEL MOC-2b High quality hybrid splitter/mixer. It can be used to split or combine any signals from 10 to 216 mc, making it suitable for sub-channel systems. Internal insertion loss is less than 0.3 db. Excellent back-match. UHF type SO-239 connectors. Weatherproof.

I. INDOOR FLUSH-MOUNTED TAPOFF, TF-731B A favorite with installers because it combines a matching transformer with a 17 db tapoff. Saves installation time—no soldering, no stripping, no unbraiding cable. 75 ohm bridged input for coax; patented stripless screws for 300 ohm output.

J. INDOOR MOUNTED SPLITTERS, TS-772 & TS-774 TS-772 (illustrated) low cost hybrid 2-way splitter can be used to split or combine RG-59/u cable. TS-774, inexpensive 4-way quasi-hybrid splitter.

These are just a few of more than hundreds of carefully engineered accessories that make TV installation more efficient and easier. For specifications or data sheets, write: Dept. EW-4.

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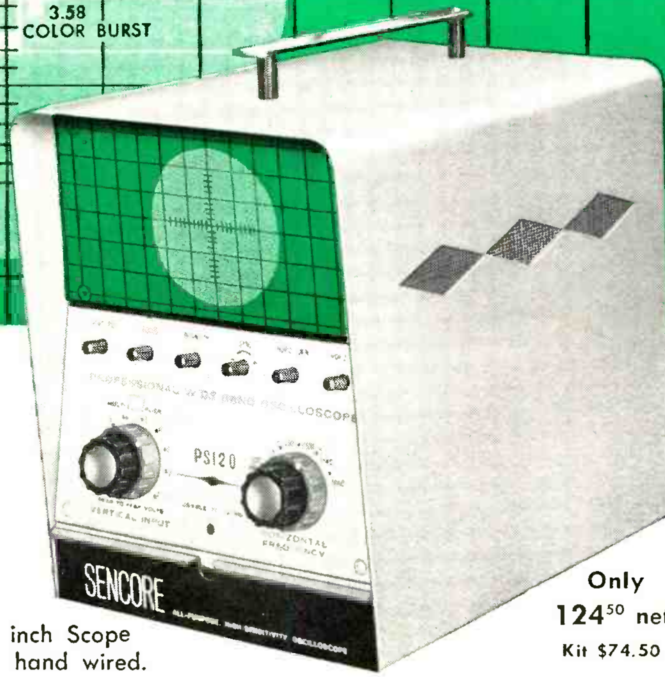
as easy to use as a voltmeter

3.58 COLOR BURST

- **A new 3 inch Extended View Portable Scope with New Features and Performance Unmatched by even the most Costly 5 inch Oscilloscopes**



NEW
SENCORE PS120 PROFESSIONAL WIDE BAND OSCILLOSCOPE

Lowest priced Wide Band 3 inch Scope anywhere. All hand wired.

Only 124^50 net
Kit $74.50

Here it is, the scope that technicians, engineers and servicemen from coast to coast have been demanding. A portable wide band scope that can be used on the job anywhere, yet has the highest laboratory specifications for shop or lab. Cumbersome color TV sets, remote audio and organ installations and computers are just a few of the jobs that make owning a scope of this type so essential. Why consider a narrow band scope, when for only a few dollars more, this professional wide band sensitive scope equips you for any job.

• The PS120 provides features never before offered. Only two major controls make the PS120 as easy to use as a voltmeter. Even its smart good looks were designed for functional efficiency. New forward thrust design, creating its own shadow mask, and full width calibrated graph increase sharpness of wave form patterns. A permanent chromed steel carrying handle instead of untidy leather strap and a concealed compartment under panel for leads, jacks and AC line cord make the PS120 the first truly portable scope combining neatness with top efficiency.

• Electrical specifications and operational ease will surpass your fondest expectations. Imagine a wide band scope that accurately reproduces any waveform from 20 cycles to 12 megacycles. And the PS120 is as sensitive as narrow band scopes . . all the way. Vertical amplifier sensitivity is .035 volts RMS. The PS120 has no narrow band positions which cause other scopes to register erroneous waveforms unexpectedly. Another Sencore first is the Automatic Range Indication on Vertical Input Control which enables the direct reading of peak-to-peak voltages. Simply adjust to one inch height and read P-to-P volts present. Standby position on power switch, another first, adds hours of life to CRT and other tubes. A sensitive wide band oscilloscope like the PS120 has become an absolute necessity for trouble shooting Color TV and other modern circuits and no other scope is as fast or easy to use.

S P E C I F I C A T I O N S

WIDE FREQUENCY RESPONSE:
Vertical Amplifier—flat within ½ DB from 20 cycles to 5.5 MC, down—3 DB at 7.5 MC, usable up to 12 MC.
Horizontal Amplifier—flat within —3 DB from 45 to 330 KC, flat within —6 DB from 20 to 500 KC.

HIGH DEFLECTION SENSITIVITY:

		RMS	P/P
Vertical Amplifier—	Vert. input cable	.035V IN.	0.1V/IN.
	Aux. vert. jack	.035V IN.	0.1V/IN.
	Through hi-imped. probe	.35V IN.	1.0V/IN.
Horizontal Amplifier—		.51V IN.	1.44V/IN.

HIGH INPUT RESISTANCE AND LOW CAPACITY:

Vert. input cable	2.7 Meg. shunted by approx. 85 MMF
Aux. vert. input jack	2.7 Meg. shunted by approx. 20 MMF
Through hi-imped. probe	27 Meg. shunted by 8.6 MMF
Horiz. input jack	330 K to 4 Meg.

HORIZONTAL SWEEP OSCILLATOR:

Frequency range—	4 ranges, 15 cycles—150 KC
Sync Range—	15 cycles to 8 MC usable to 12 MC

MAXIMUM AC INPUT VOLTAGE:

Vertical input cable— Aux. vert. jack— Hi-imped. probe—	1000 VPP (in presence of 600 VDC)
Horiz. input jack—	approx. 15 VPP (in presence of 400 VDC)

POWER REQUIREMENTS:

Voltage—	105-125 volts, 50-60 cycle
Power consumption—	On pos. 82 watts Stby. pos. 10 watts

SIZE: 7″ wide x 9″ high x 11¼″ deep—weight 12 lbs.

The PS120 is a must for color TV servicing. For example, with its extended vertical amplifier frequency response, 3.58 MC signals can be seen individually.

S E N C O R E
ADDISON 2, ILLINOIS

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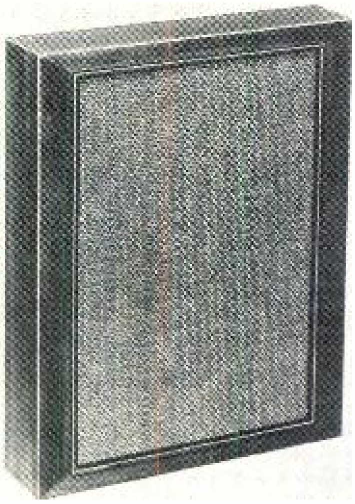
AUDIO PRODUCTS TESTED BY HIRSCH-HOUCK LABS

Heathkit AS-22 "Profile" Speaker System
Fisher FM-200B Stereo Tuner

Heathkit AS-22 "Profile" Speaker System

For copy of manufacturer's brochure, circle No. 57 on coupon (page 21).



THE *Heathkit* AS-22 "Profile" speaker system is designed for installation where space is at a premium. It is 25½" high by 19½" wide by 5" deep, and may be stood on one edge on a cabinet or on the floor. It is equipped with hanging hooks for mounting on the wall like a picture, which is an excellent way to fit a pair of stereo speakers into a small or crowded room. Net weight is 25 pounds.

The AS-22 is a three-way system, with a 10" woofer in a ducted-port enclosure, a 6" mid-range speaker, and a 3½" tweeter. The mid-range and high-frequency speakers have fully enclosed backs to protect them from the woofer back pressure. The crossover is at 2250 cps, at a 6 db/octave rate. The frequency division between the two higher frequency speakers depends on mechanical crossover action.

The internal volume of the enclosure is only about 0.75 cubic foot, but the ducted-port design (using a bent cardboard tube to fit within the 3" internal depth of the cabinet) results in surprisingly good low-frequency performance.

The manufacturer of the system gives its frequency response as ±5 db from 55 to 12,500 cps, with a nominal power rating of 25 watts of program material. Its impedance is 8 ohms.

We measured the frequency response in a typical mid-wall position such as might be used if the speaker were hung or standing on a cabinet. Response was plotted automatically with eight different microphone positions throughout the room, and averaged to obtain a single composite curve. This curve has been corrected for the calibration of our test microphone.

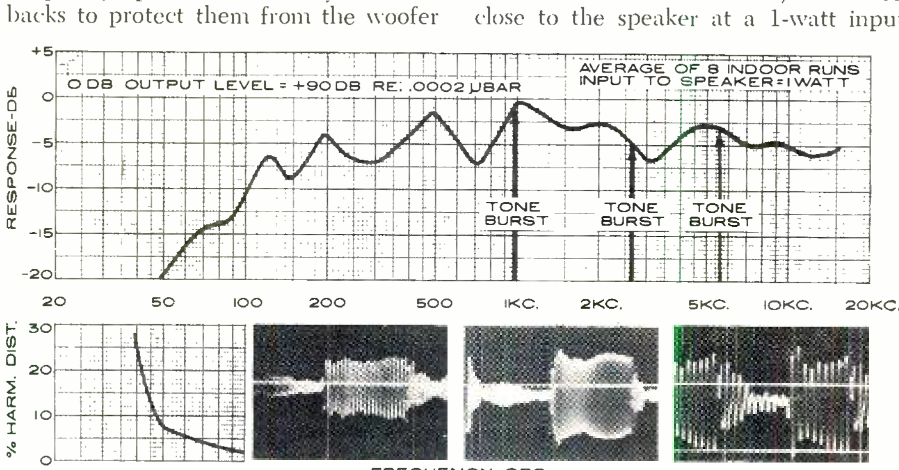
The measured response was ±5 db from 100 cps to over 15,000 cps. The over-all curve is quite smooth and free from peaks or holes. The low-frequency response falls at 12 db/octave below 150 cps, although this portion of the response curve could probably be enhanced by corner or floor mounting.

The harmonic distortion, measured close to the speaker at a 1-watt input level, was 1.7% at 100 cps, rising slowly to 7% at 50 cps. Below that frequency it rose sharply but little useful output could be obtained at lower frequencies. If played at reasonable levels, the system responds well to bass boost which can improve its low-end performance without causing excessive distortion. It is a moderately efficient system, producing an average sound pressure level of +85 db referred to 0.0002 dyne/cm.^{2} in a typical room with an input of 1 watt.

Our tone-burst measurements indicated that the transient response was not too good at most frequencies. On the other hand, one does not expect (or find) the same performance in low-priced speaker systems as in the higher priced systems.

In listening tests, the over-all effect was a pleasing one. There is an illusion of more bass than really exists. Record surface noise seems to be slightly accentuated by comparison to some very smooth (and expensive) tweeters used on high-priced speaker systems. However, there was nothing in our measurements to indicate the presence of any high-frequency peaks. The sound can perhaps be best described as slightly hard, or bright. We found that some bass boost and treble cut made the AS-22 sound remarkably like some speakers costing four times as much.

The AS-22 is sold only in kit form. The cabinet is pre-assembled, only an hour or two being required to complete the system. With an unfinished birch cabinet, the system sells for $49.95. With a handsomely finished walnut cabinet, it is $54.95. ▲



Fisher FM-200B Stereo Tuner

For copy of manufacturer's brochure, circle No. 58 on coupon (page 21).

THE *Fisher* FM-200B is a deluxe FM stereo tuner, with an unusual number of operating conveniences and circuit refinements. It features the "Golden Cascode" r.f. amplifier, with a 6DJ8 tube, followed by a 6CW4 nuvistor mixer, and a 6CW4 oscillator. There are five i.f. stages, four of which act as limiters. The wide-band ratio detector drives the two feedback-stabilized audio amplifiers directly for mono and, through a built-in circuit, for stereo.

The power: 50 watts
The price: $129.50
The builder: You

(It could only be a Fisher StrataKit.)

The KX-100 stereo control-amplifier kit would be an astonishing value under any label—50 clean watts for less than $130 plus a few evenings of highly entertaining work. But the fact that it is a **Fisher** amplifier, with all the built-in quality that the name implies, makes it the most remarkable buy of the entire stereo era.

The KX-100 is an authentic StrataKit. The StrataKit method of kit construction is the exclusive Fisher development that enables a totally unskilled and inexperienced person to achieve the same result as a professional laboratory technician. You can't **help** ending up with a faultless Fisher product when you build a StrataKit.

In addition to more watts per dollar, the KX-100 features all the standard control and switching facilities plus a few remarkable extras: A front-panel headphone jack with speaker silencing switch; full tape monitoring facilities with the famous Fisher Tape-Play System; a High Filter switch; and a revolutionary new circuit that permits direct connection of a center-channel speaker without using an additional amplifier! Yes, all that for **$129.50***.

The KX-200 StrataKit, a highly advanced 80-watt stereo control-amplifier kit with built-in d'Arsonval bias/balance meter and volume-controlled center-channel speaker output, **$169.50***.

The KM-60 StrataKit, world's most sensitive FM Stereo Multiplex wide-band tuner available in kit form, **$169.50***.

The KS-1 3-way speaker kit, only Slim-Line loudspeaker system in kit form, **$59.50****.

THE FISHER

The Kit Builder's Manual

FREE! $1.00 VALUE! The Kit Builder's Manual: a new, illustrated guide to high-fidelity kit construction.

Fisher Radio Corporation
21-38 44th Drive
Long Island City 1, N. Y.

Please send me without charge The Kit Builder's Manual, complete with detailed information on all Fisher StrataKits.

Name____________________

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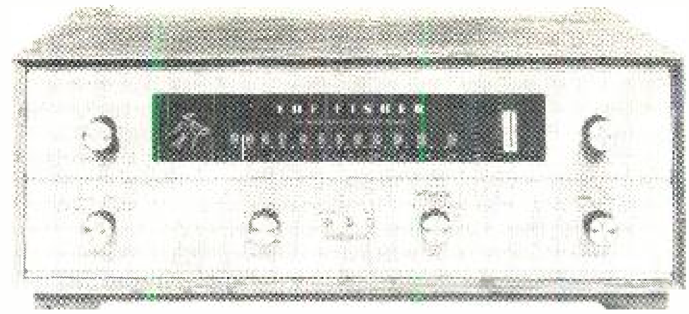
*Walnut or mahogany cabinet, $24.95. Metal cabinet, $15.95. **In unfinished birch. $64.50 in unfinished walnut. Prices slightly higher in the Far West.
Export: Fisher Radio International, Inc., Long Island City 1, N.Y. Canada: Tri-Tel Associates, Ltd., Willowdale, Ont.

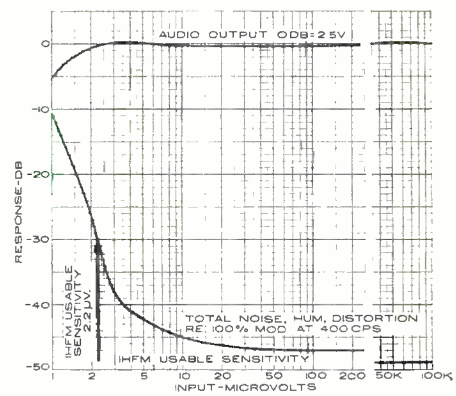


As in other *Fisher* stereo tuners, the multiplex circuits use a pair of four-diode switches to extract left- and right-channel information from the composite detected output. The FM-200B has a.f.c. operating through a voltage-variable silicon capacitor in the oscillator circuit, and interstation muting. The muting circuit is unconventional and very effective. It uses the rectified output of a separate r.f. oscillator to cut off the last limiter stage in the absence of a signal. A signal above a pre-determined threshold level at the preceding stage cuts off the oscillator and allows the signal to reach the ratio detector.

These features obviously describe a very fine FM tuner. However, the additional automatic circuits of the FM-200B add greatly to its usefulness. For example, it has an automatic mono/stereo selector, which switches from mono to stereo when the received signal has a 19-kc. pilot carrier. The relay which does the switching channels the detector output to the multiplex chassis and then to the audio amplifiers, as well as lighting a green light on the panel. If desired, it can be disabled for mono reception of weak stereo broadcasts. A stereo subchannel filter is available for use under adverse conditions.

The a.f.c. selector switch has two degrees of correction, plus an automatic "Microtune" position and an "Off" position. In "Microtune," the 60-cps hum picked up by one's body from nearby power wiring actuates a relay when the tuning knob is touched, cutting off the a.f.c. When a station is tuned in, and the knob is released, the a.f.c. is switched on and a red light on the panel lights up.

The muting threshold is adjustable from a front-panel knob, which also has an "Off" position. An amber light indicates when the muting is in use. Other front-panel controls include an audio level control, and a combined a.c. power switch and sensitivity switch. This can reduce the sensitivity by about 20 db for use near a strong local station. There is a tuning meter, which is hardly needed for tuning in a station, but is very handy as an indicator of relative signal strength

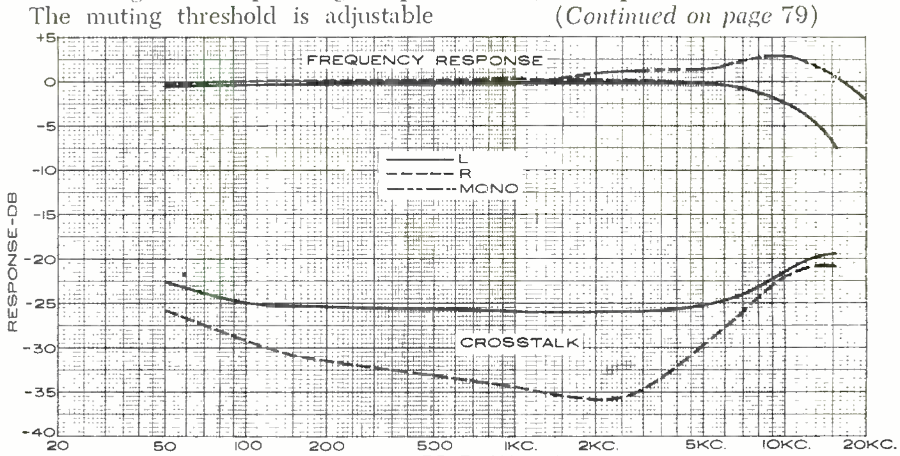


when rotating a directional FM receiving antenna.

The measured IHFM usable sensitivity of the Model FM-200B was 2.2 µv. Its limiting action was exceptionally fine, and it will deliver fully quiet, distortion-free reception with about 3 µv. of signal. The distortion at 100% modulation was also unusually low, about −48 db or 0.4%. The capture ratio was the best we have measured to date, a remarkable 1.8 db. Hum was −60 db relative to 100% modulation.

The mono frequency response was ± 2.5 db from 20 to 20,000 cps. In stereo, the response was down 2.5 db at

(*Continued on page 79*)



EYE-OPENER!

Unique new Telstar Instant Home Demonstrator by Channel Master sells boosters by the hundreds ...and you can get it free!

Turn "snow" into "dough"! Sell Channel Master's outstanding Telstar Boosters—hundreds of them—**during routine service calls.**

Channel Master's Telstar Instant Home Demonstrator gives startling, dramatic "split-second proof"... that Telstar Boosters step up TV and FM gain. It puts into your hands the kind of powerful selling tool—a "house-to-house," before-and-after comparison test—that you've never had but always needed.

Want to know how you can get an Instant Demonstrator **free!**... For full facts... **call your Channel Master Distributor now!**

Now there are 2 TELSTARS—both with built-in lightning protection!

1. Improved, easy-to-install TELSTAR TV/FM Booster (Model 0023A) with 4 set coupler.
2. New Telstar FMX for FM/STEREO (Model 0025) with 2 set coupler.

Fast, easy, light, compact! Comes pre-wired with booster already mounted — ready for instant use in customer's home. No climbing up on masts—no time-consuming hookups.

CHANNEL MASTER CORP.

ELLENVILLE, NEW YORK

CIRCLE NO. 108 ON READER SERVICE PAGE

108 KITS
and FACTORY-WIRED too!

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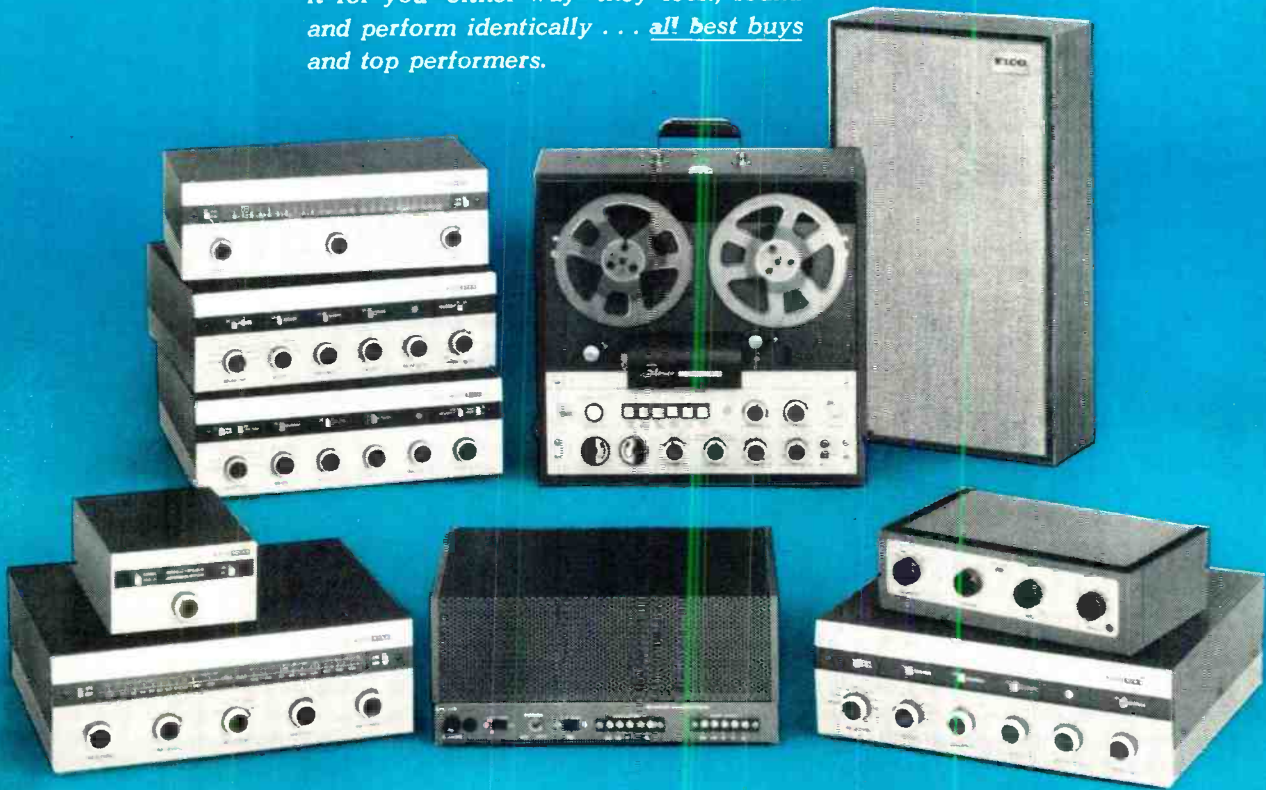

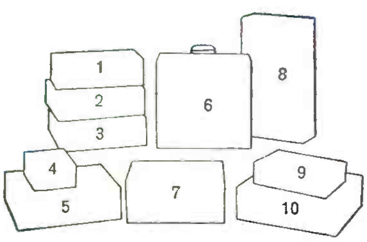

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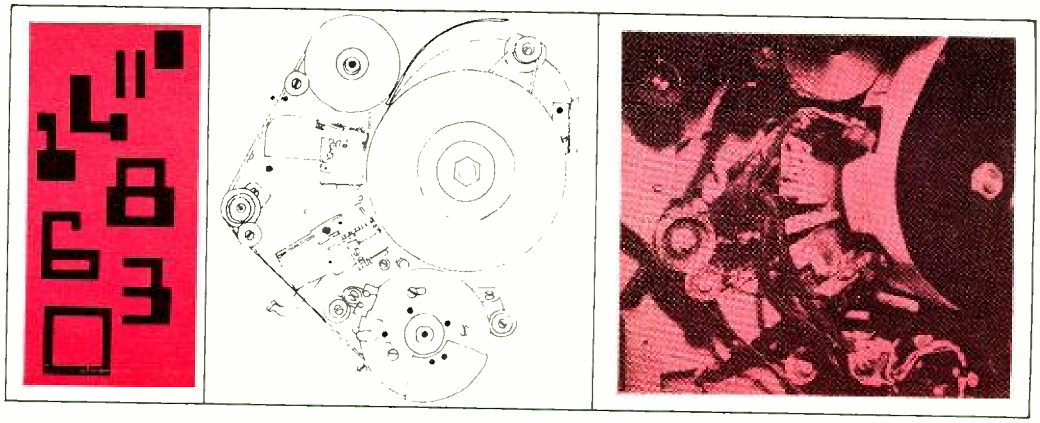


By KEN GILMORE

Bankers have turned to the electronics industry for help in meeting the great paper challenge of 13 billion checks a year. Description and operation of the Magnetic Ink Character Recognition system now used to do bank accounting quickly and accurately.

ELECTRONICS IN BANKING

THIRTEEN billion times this year--more than 50-million times every working day—someone signs a check. By 1970, experts estimate, the number of checks flowing through financial channels will have passed the 20-billion mark.

The flood of paper generated by U.S. business is threatening to strangle banking completely. Consequently, bankers are turning in desperation to the electronics industry for help. And leading electronics firms—*Burroughs, General Electric, IBM, National Cash Register*, and many others—are working at top speed to design and produce enough electronic equipment to help bankers meet the great paper challenge.

MICR and Computers

At the heart of the vast electronic banking network now being built across the country is MICR—*M*agnetic *I*nk *C*haracter *R*ecognition. Several years ago, bankers realized that conventional methods wouldn't do the job much longer. Computer bookkeeping was an obvious answer. But it wasn't that simple. Much of any bank's load is transit business; checks pour in drawn on other banks all over the country. These checks have to be sent back to their points of origin through a vast network of clearing houses, Federal Reserve Banks, and correspondent banks. At each step, records must be kept.

By the time a check gets through the complex national clearing system, it may have been handled by dozens of clerks dozens of times and involved in scores of financial transactions. Obviously, any electronic system designed to take over this complicated procedure would have to be national in scope. Every bank's operation would have to be standardized so that the same documents could be run through everyone's machines.

The first step toward such a system was made in 1956. The American Bankers Association studied the problem, decided that a magnetic ink system would be the best approach. The giant Bank of America was already having trouble hiring enough people to keep up with its soaring paper work. So in 1957 it hired Stanford Research Institute to work out the details of the magnetic ink proposal.

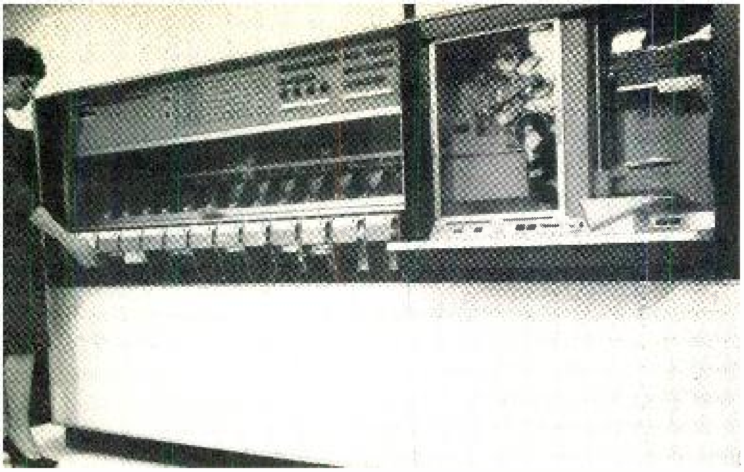
Stanford scientists designed a series of magnetic characters (Fig. 1) which would be readable by both human beings and magnetic sensing devices. *General Electric* got the job of building the equipment, and came up with a system called ERMA (Electronic Recording Machine Accounting) which made use of a *G-E* computer attached to paper handling machines made by *Pitney-Bowes* and *National Cash Register*.

Bank of America cautiously put ERMA to work in 1958, but kept bookkeepers on the job—just in case. Within a few months, however, it was obvious that ERMA could not only do the job faster than people, but more accurately as well. Other duties were found for the bookkeepers.

ERMA was so successful that the American Bankers Association met and decided that MICR would be an ideal system for national standardization. In the years since, MICR systems have been installed in scores of banks across the country. Already, nearly 70% of the checks now flowing through the Federal Reserve System bear the small magnetic numbers on the lower edge which indicate that they can be handled on electronic check-handling equipment.

How MICR Works

Numbers to be automatically read are printed on checks in an ink containing iron oxide, similar to that used to coat magnetic recording tapes. The check slides past a permanent magnet which magnetizes the oxide in the letters, then passes a read head similar to those used on audio tape recorders (Fig. 3). The magnetized numerals induce a voltage in the reading head; these signals are fed into logic circuits which translate



Magnetic readers, such as this IBM 1419, sort checks by reading magnetic numbers (at right) and pile them into pockets at left.

The operator is using an inscriber to imprint the dollar amount on each check in magnetic ink. Then the machines take control.

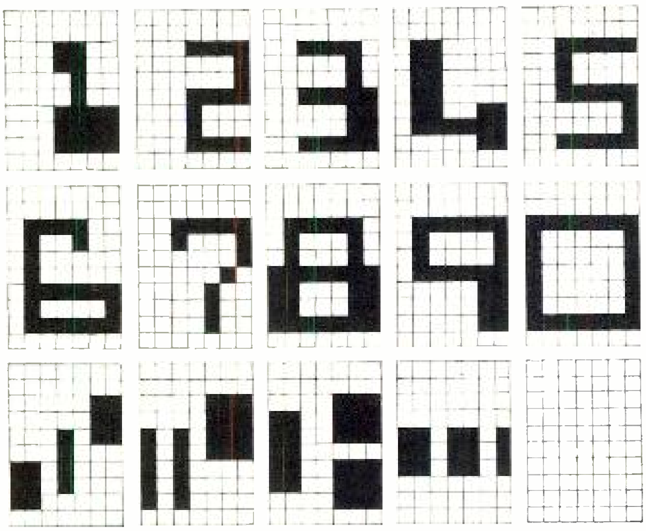


Fig. 1. The series of magnetically printed characters used.

them into specific numbers. At the same time, the signals can be used to operate paper-handling equipment—sorters, for example—so that each check is routed to the proper place without human intervention.

Center of the MICR system is the magnetic character itself. The letter to be read (Fig. 4A) travels past the read head. The magnetic flux density of the character passing the head is proportional to the area of the character at any given point, as shown in Fig. 4B. As the reading head passes over the part of the number in the second column of the grid, for example, the density is high. In columns 3, 4, 5, 6, and 7, it is relatively low; in 8, high again. Fig. 4B charts this flux-density variation.

The magnetic flux, of course, induces a voltage in the reading head as it moves past. The large change in flux from column 1 of the grid to column 2 produces the high-amplitude peak at *A* (Fig. 4C); the smaller flux change causes the smaller peak at *B* (since the change here is from a higher to a lower flux density, the peak is reversed in polarity); peaks *C* and *D* are generated on a similar principle. Each of the different standard MICR numbers produces its own unique pattern of positive and negative peaks (Fig. 2).

Machine Operation

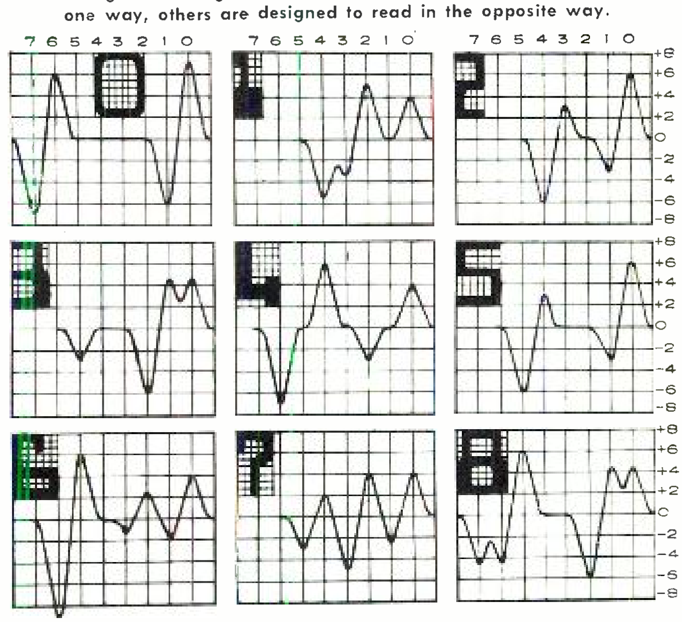
Fig. 5 shows the *Burroughs* circuitry in simplified block diagram. This fairly typical circuit recognizes the various pulse patterns and translates them into numbers. When the number to be read travels across the recording head, it covers each grid column in 32.5 μsec. The output of the reading head is fed through an amplifier into a delay line. Between each delay line reading station (numbered 0 to 7) is a built-in delay of 32.5 μsec. Thus as the pulse *A* (Fig. 4C) enters the delay line and travels along it, pulse *B* follows exactly 32.5 μsec. later. When the whole character has been read into the delay line, pulse *A* appears at reading station 0, pulse *B* at station 1, pulse *C* (five grid columns behind) at station 6, and so on, as illustrated in Fig. 6. The delay line is arranged to reverse the polarity of the negative pulses, so that all pulses show up at the reading stations as positive (Fig. 6B).

These pulses are applied in parallel to the fourteen resistor networks which form the buffer amplifier input circuits (Fig. 5). Each of these resistor nets is designed to apply the maximum signal to the input of the buffer when the signal which that buffer is designed to recognize comes along. In the case of the zero, for example, two high-amplitude signals appear at reading positions 0 and 7, low-amplitude signals at 1 and 6. The resistive network is designed so that when that particular combination of signals appears, maximum signal is applied to the zero input buffer. Resistors at the inputs of the other buffers discriminate against this combination of signals, and little gets through to the inputs of the other buffers.

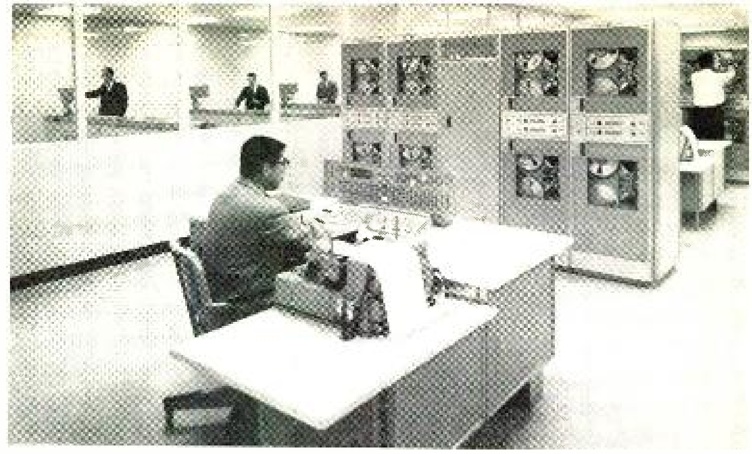
To make the discriminatory action of the buffers even more positive, a voltage is developed at the buffer output across the diode which back biases the outputs of the other buffers and prevents them from producing an output signal. The buffer putting out the strongest signal, in other words, cuts off all of the others. At the same time, the K amplifier develops a 75% feedback signal and applies it back around to the input of the buffers. This signal, opposite in polarity to the input signals from the delay line, is strong enough to bias to cut-off the input stages of all buffers except the one in control—or in this case, the zero buffer.

At this point, a sensor in the delay line senses that the char-

Fig. 2. Signals produced by the various numbers. Note that these were scanned from right to left rather than from left to right as in Fig. 4. Some machines are designed to read one way, others are designed to read in the opposite way.



The document handling or sorter-reader section of Bank of America's Electronic Recording Method of Accounting system.



The computer control console (foreground) and the memory tape storage units that are utilized in the ERMA system discussed.

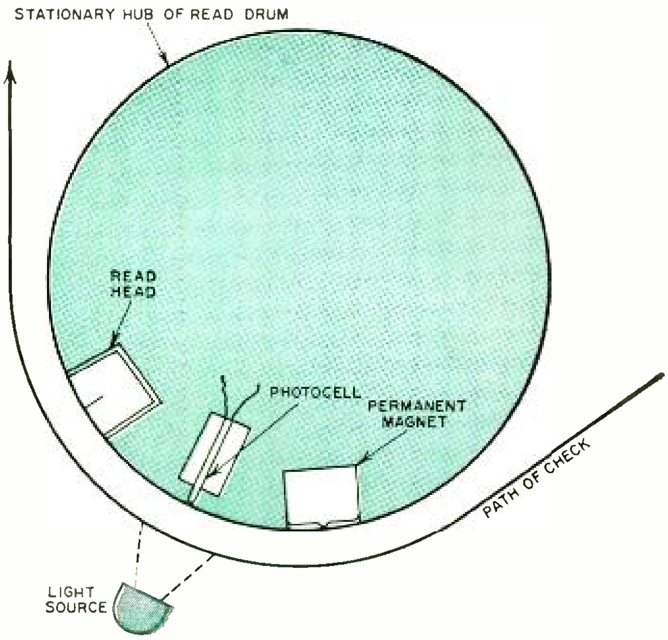


Fig. 3. As check is transported around drum, the magnetic numbers are first magnetized and then read by a tape head. Light-sensing device tells logic circuit check is on way.

acter has been completely fed into the line and is ready to be read, and turns on the voltage comparators. Of course, only one buffer is developing a signal at this point, so only that comparator—the one associated with the operating buffer—goes into operation. Its output signal turns a series of flip-flop circuits in the encoder storage on and off in a certain pattern, which digitally represents the number just read. The digital signal is then fed from the output of the reader into a computer or used to control equipment. The reading logic then wipes itself clean and gets ready to read the next character, which by this time is beginning to come into the delay line in preparation for its next job.

A Different Approach

Most MICR readers operate similarly, although the circuit details may vary. But one—the *IBM* machine—is quite different. The *IBM* reading head is divided into 30 tiny separate sections (Fig. 7), each of which develops its own signal as the lines of magnetic flux cut through it. Actually, only ten segments are used at any one time, but the additional segments allow for reading numbers above and below the normal position, and numbers specially placed on certain kinds of card checks. As the diagram shows, segments 1, 11, and 21 are wired in parallel, as are 2, 12, and 22, etc. Thus only ten output signals are developed, no matter where the number is with relationship to the head. (The *Burroughs* approach, by the way, also uses a head wide enough to read numbers higher or lower than normal. No special arrangement is needed, however, since the same signal is developed whether the number passes near the top or near the bottom of the magnetic gap.)

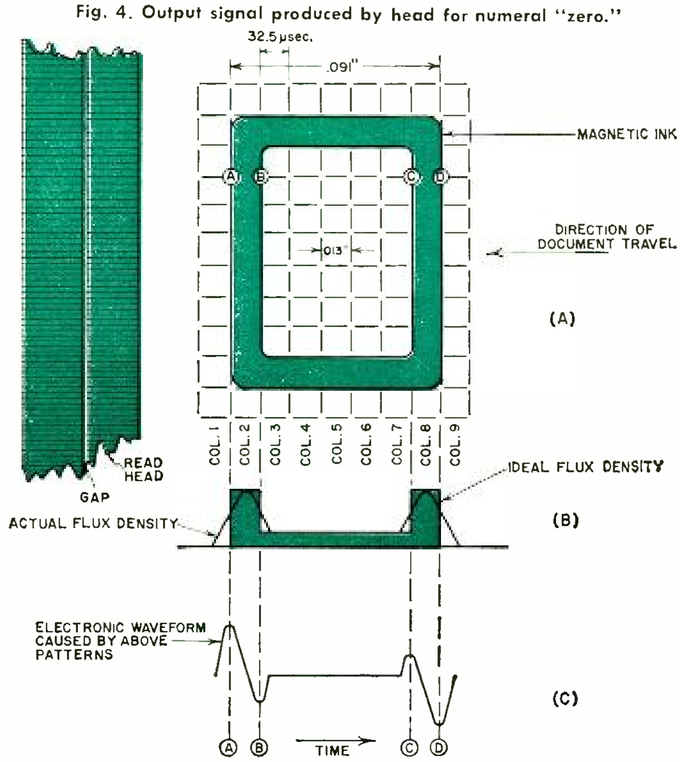
As a number sweeps across the *IBM* read head, the output of each of the ten segments in operation is sampled seven times. At each sampling, the head senses either the presence or absence of magnetic flux. The segmented head, in other words, senses 70 different areas as the number sweeps across it, and determines whether each has magnetic ink or not.

The signals developed by this sampling are applied to a matrix of flip-flops, each one of which will be either on or off, depending on the presence or absence of ink in the corresponding square. A logic circuit samples each of the flip-flops, senses the particular combination of "on's" and "off's" present, and translates this pattern into terms of numbers being read. Not every one of the flip-flops must be in the proper condition, incidentally. If a large enough percentage is on, and this percentage could not possibly be interpreted ambiguously, the logic circuit will still recognize the number being read. Consequently, the machine can read even mutilated figures.

The Banking System

With magnetic character reading, almost all banking procedures are becoming automated. A simple example shows how the completed system will work. Suppose you make a deposit into your checking account at "Your National Bank." Among the items you deposit are your paycheck, a refund

Fig. 4. Output signal produced by head for numeral "zero."



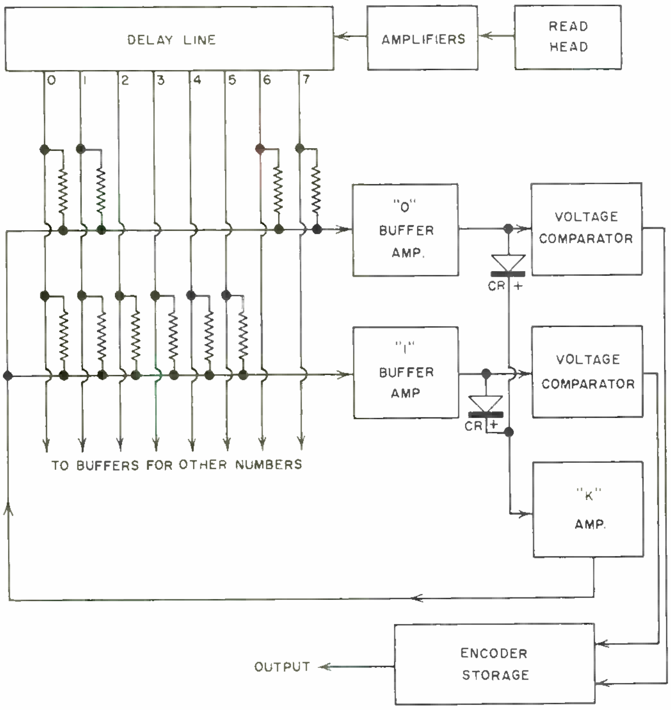


Fig. 5. Simplified block diagram of one type of reading unit.

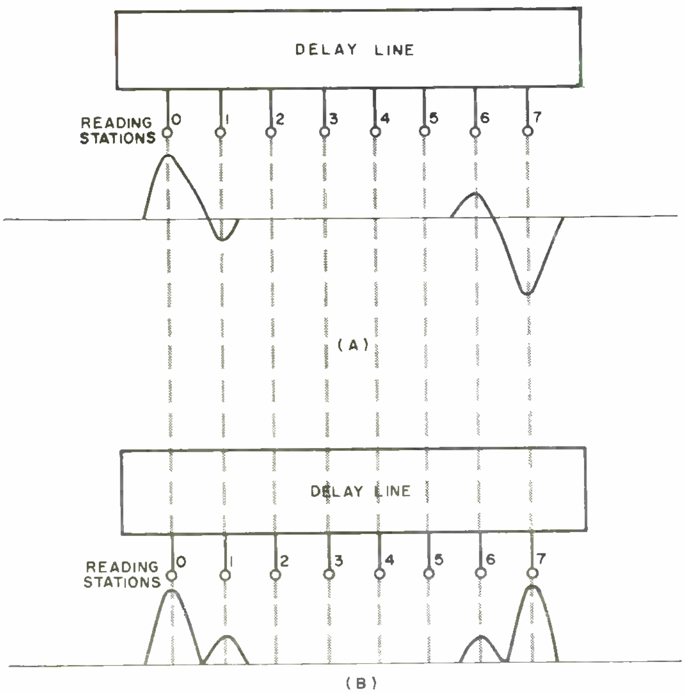


Fig. 6. Outputs at various reading stations of the delay line shown here before (A) and after (B) polarity reversal.

from a company in California—across the country from where you live—on an order it couldn't fill, and a check from your neighbor, Joe, paying you back the $56.70 he borrowed.

Your deposit slip, you notice, has MICR figures along one edge. So have all the checks you are depositing. A teller in the bank takes your deposit, passes it along to a clerk who puts the items—the deposit slip and the three checks—into an inscriber. He then writes in the dollar amount along the bottom edge in magnetic ink. That's the last time anyone will have to touch the checks, although they may travel across the country and be involved in many transactions before they finally get back to their various writers.

Take a closer look at one of the checks after it comes from the inscriber. The row of numbers across the bottom (Fig. 8) is divided into four groups, although you may not be able to tell where each one starts and stops by looking. The first group on the left is a routing-transit symbol. If you deposit a check in a bank other than the one it is drawn on, that symbol tells the bank where to send the check to collect the money. The number in the upper right-hand corner of the check, written as a fraction, contains the same information (you'll notice that the same numbers are present). The bank clerk reading the fraction has traditionally done this routing by hand.

The second group of figures is the account number of the individual or firm which wrote the check. When it gets back to the writer's bank, that number will tell a computer from which account to withdraw the money. The third group is process control—this gives the home bank's computers any special instructions they must have to handle the check properly. The fourth group is the dollar amount of the check. As you can see, it agrees with the written face value.

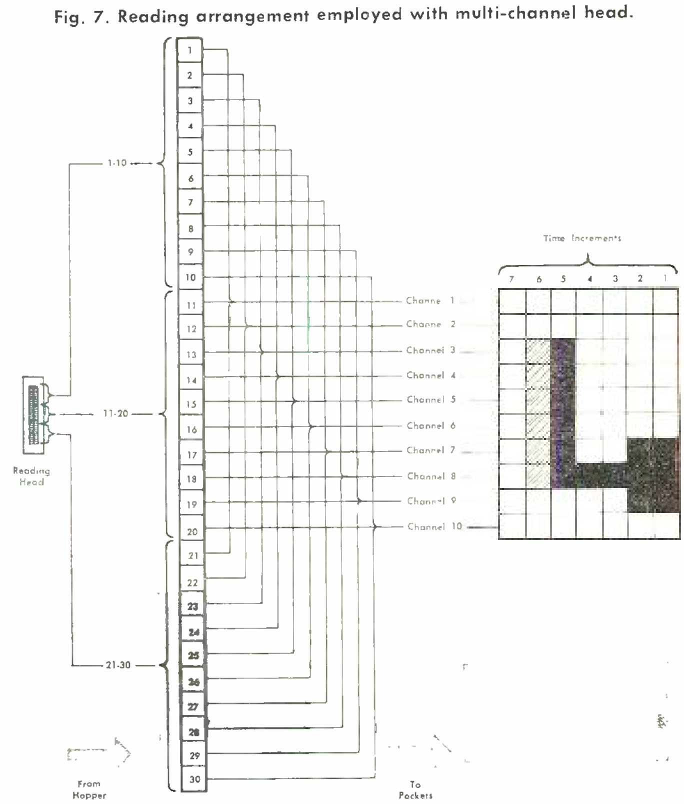
The first two groups of figures were printed on the check before it was ever written. If your bank has switched over to electronic bookkeeping, you'll find these numbers on the blank checks in your pocket now. The only figure the inscriber added was the dollar amount and, in some cases, the process control number. Frequently, the process control number is not employed at all.

With the dollar amount written in, all important data is now recorded in magnetic ink and the computers can take over. The three checks you deposited are sent through a sorter (Fig. 9) which reads the routing numbers and separates the checks into piles. Joe, it so happens, has an account in the same bank as you have, so his check is sorted into a pile which goes into the bank's own bookkeeping system. A computer there will simply subtract the amount from Joe's account and add it to yours, and at the same time cancel the check and slip it into a pocket where it is collecting all of Joe's checks which come in. At the end of the month, it will look over the record of what went on in his account during the month and add up the figures, then print out his bank statement automatically.

Your paycheck, meanwhile, dropped into another pocket in the sorter. This pocket is set aside for checks drawn on the

(*Continued on page* 70)

Fig. 7. Reading arrangement employed with multi-channel head.



COIL-WINDING NOMOGRAM

By A. L. TEUBNER / *Designing single-layer air-core inductors for use in transmitter tanks, loading coils, and matching networks is simplified by employing this easy-to-use chart.*

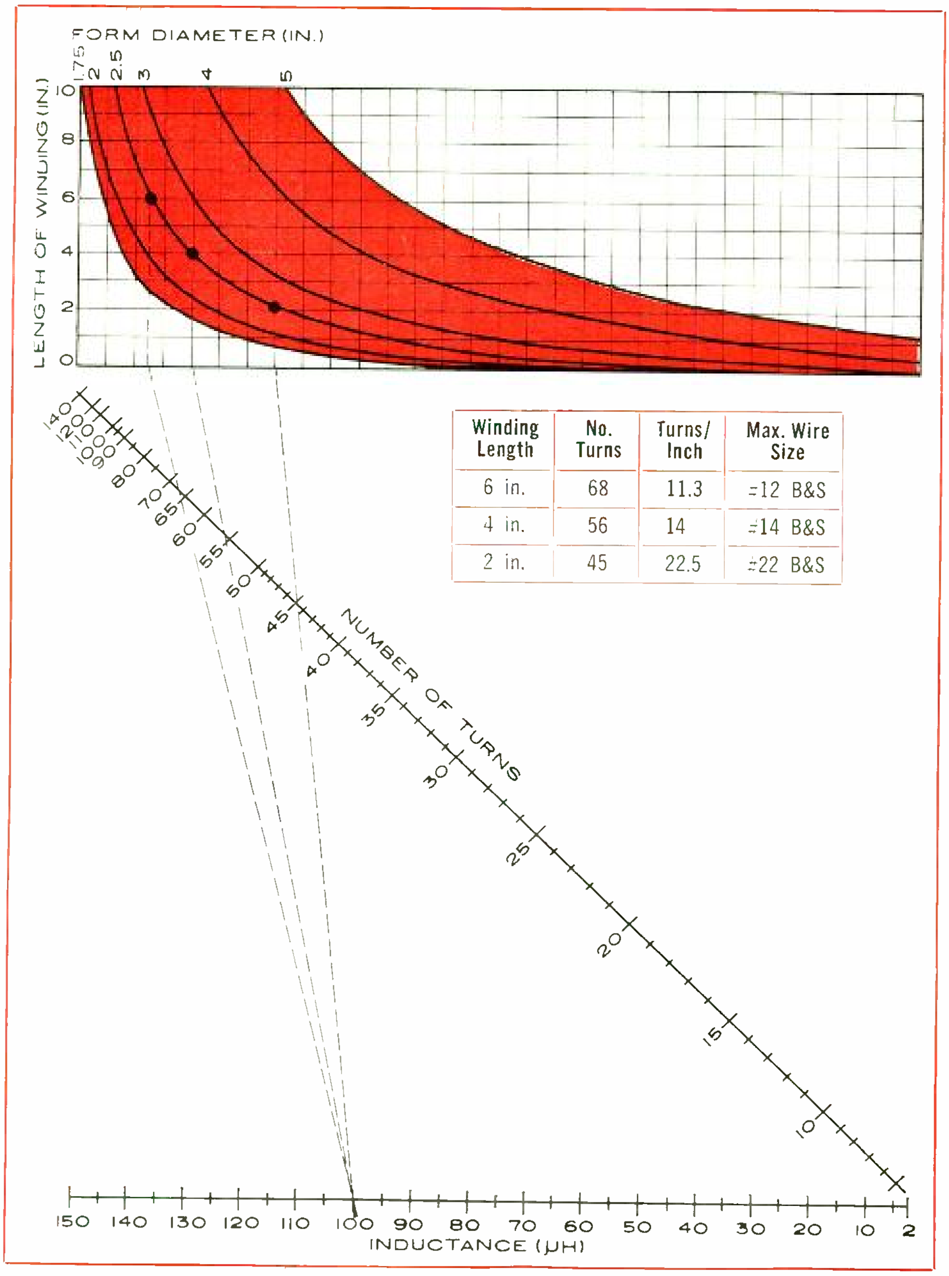
THIS nomogram was constructed to eliminate much of the pencil pushing involved in designing single-layer inductors in the range of values normally required for amateur transmitters, loading coils, and feedline matching networks. Since inductance, for a given form diameter, is related to both the number of turns and the winding length, the number of combinations of these two is limited only by the form length, at one extreme, and the minimum desirable wire size, at the other. This diagram makes it easy to discover the available range and to strike a good compromise. It can also be used in reverse to calculate the inductance of a "junk-box" coil. The scales are based on a simple approximation formula for single-layer air-core coils which should give sufficiently accurate results for radio-amateur use up through ten meters.

The formula employed is: $L = a^2n^2/(9a + 10b)$ where L is the inductance in μhy., a is coil radius in inches, b is coil length in inches, and n is the number of turns.

As an example of the design problem using the nomogram, assume that you need a 100-μhy. loading coil, and have on hand a 2½" diameter form, 6" long. On the nomogram, find the point where the curve corresponding to a diameter of 2½" crosses the line for 6" of length. From this intersection project downward to the bottom edge of the graph portion. Then connect the point just found to the 100-μhy. mark on the inductance scale, using a straightedge. The point where the straightedge crosses the center scale gives the number of turns, in this case 68. Repeating the procedure for lengths of 4 and 2 inches yields 56 and 45 turns, respectively.

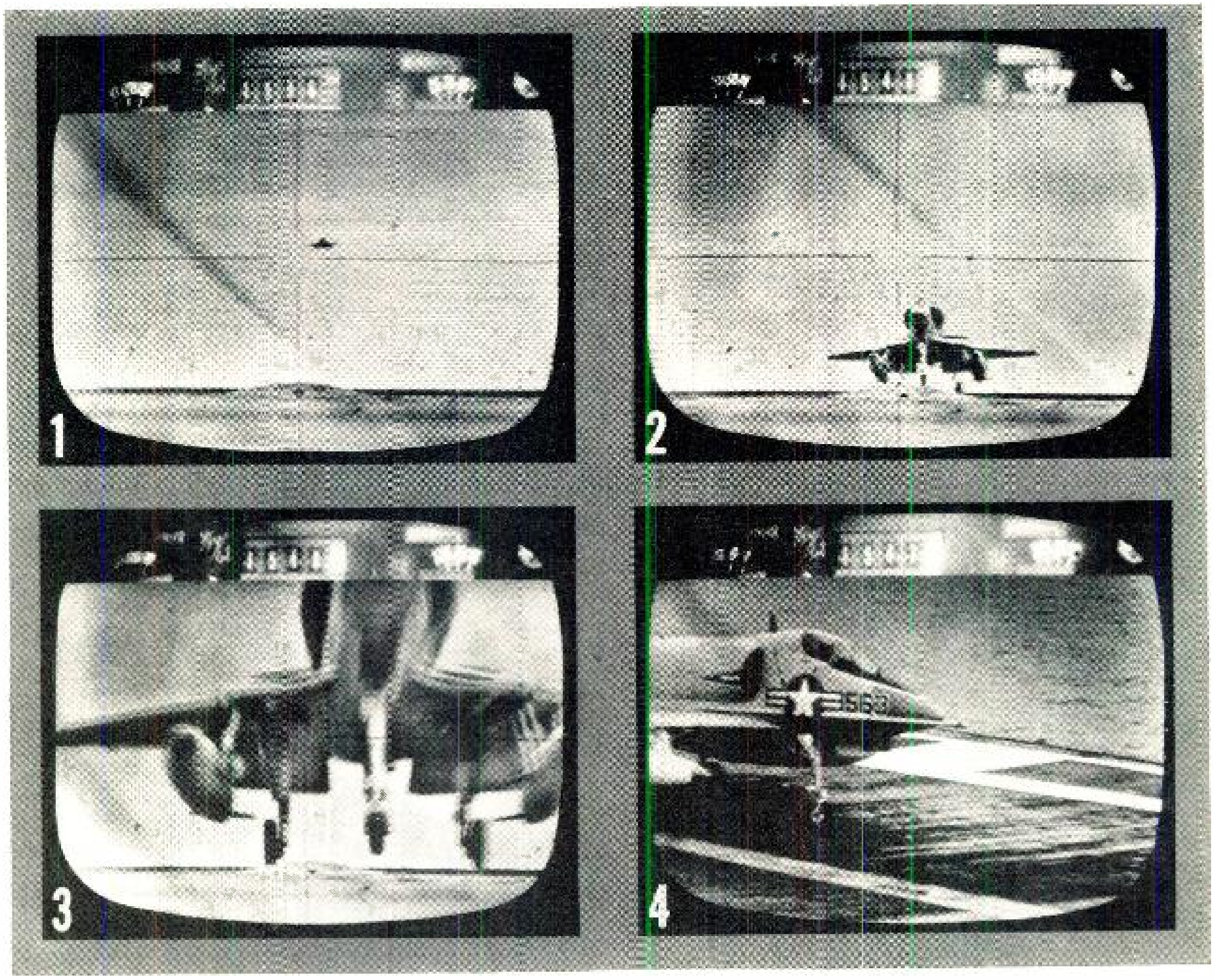
After dividing length by turns, we refer to a copper-wire table and find that the largest sizes of enamelled wire that we can use are Nos. 12, 14, and 22, in order of decreasing winding length. These results are summarized in the table. The final choice will be influenced by such things as the expected r.f. current and potential gradient, and the desired "Q" of the coil.

Calculating the inductance of an existing coil follows the same general procedure, except that the point on the horizontal axis corresponding to length and diameter is connected with the known number of turns, and a straightedge will lie on the inductance value. Since the nomogram was designed for the reverse problem, some combinations may not fall on the inductance scale. ▲



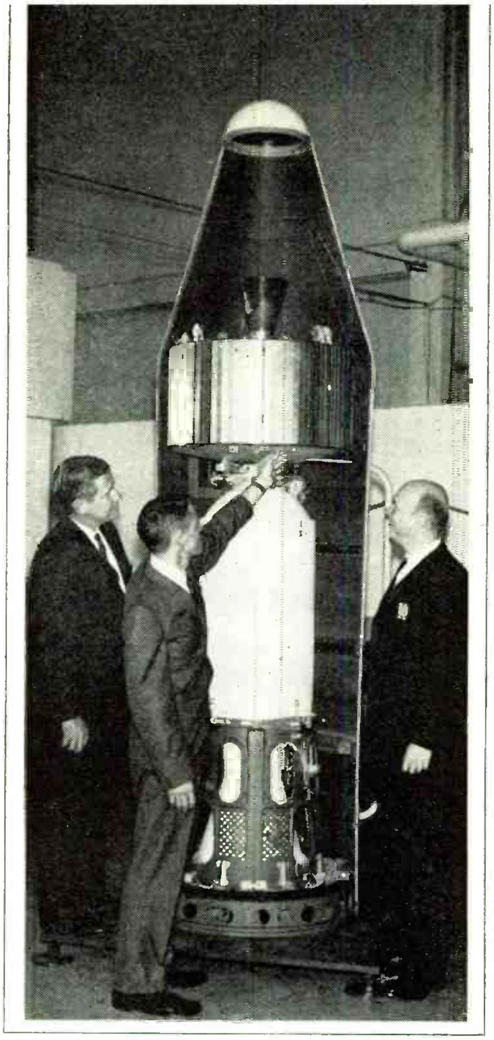
Winding Length	No. Turns	Turns/ Inch	Max. Wire Size
6 in.	68	11.3	#12 B&S
4 in.	56	14	#14 B&S
2 in.	45	22.5	#22 B&S

RECENT DEVELOPMENTS in ELECTRONICS

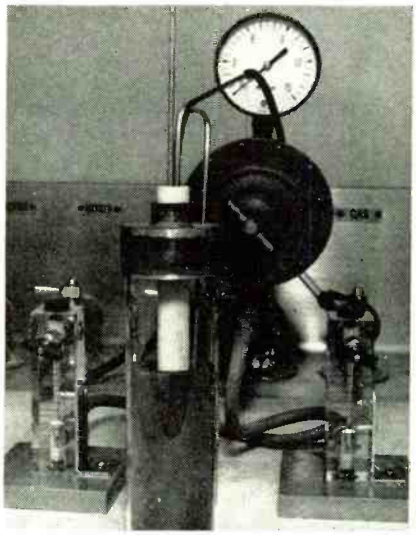


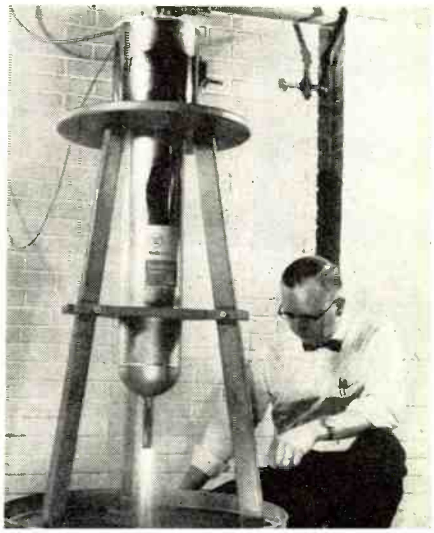
Videotaped Jet Carrier Landing. The sequence of photos shown above were taken from a shipboard television monitor displaying a jet carrier landing as recorded by a Pilot Landing Aid Television system (PLAT). This system is now being installed aboard 10 U.S. Navy carriers by Ampex Corporation. A television camera mounted in the center line of the carrier deck spots the plane at the beginning of its landing approach, and follows it to the touchdown. A second TV camera on the carrier's superstructure then takes over. Cross hairs on the monitor assist the landing signal officer in talking the pilot down to a safe landing. A minute-by-minute record of time, air speed, wind velocity, time, and flight number are shown on the dials at the top of the screen. Audio recording of the conversations between the pilot and the landing signal officer are made on the same tape along with the video information. Hence, the Videotape recording makes a complete record of each landing, day and night, for immediate playback and analysis by pilots. The recording equipment employed is the latest broadcast version of the Ampex Videotape recorder, which was introduced in 1956 initially for television networks and stations.

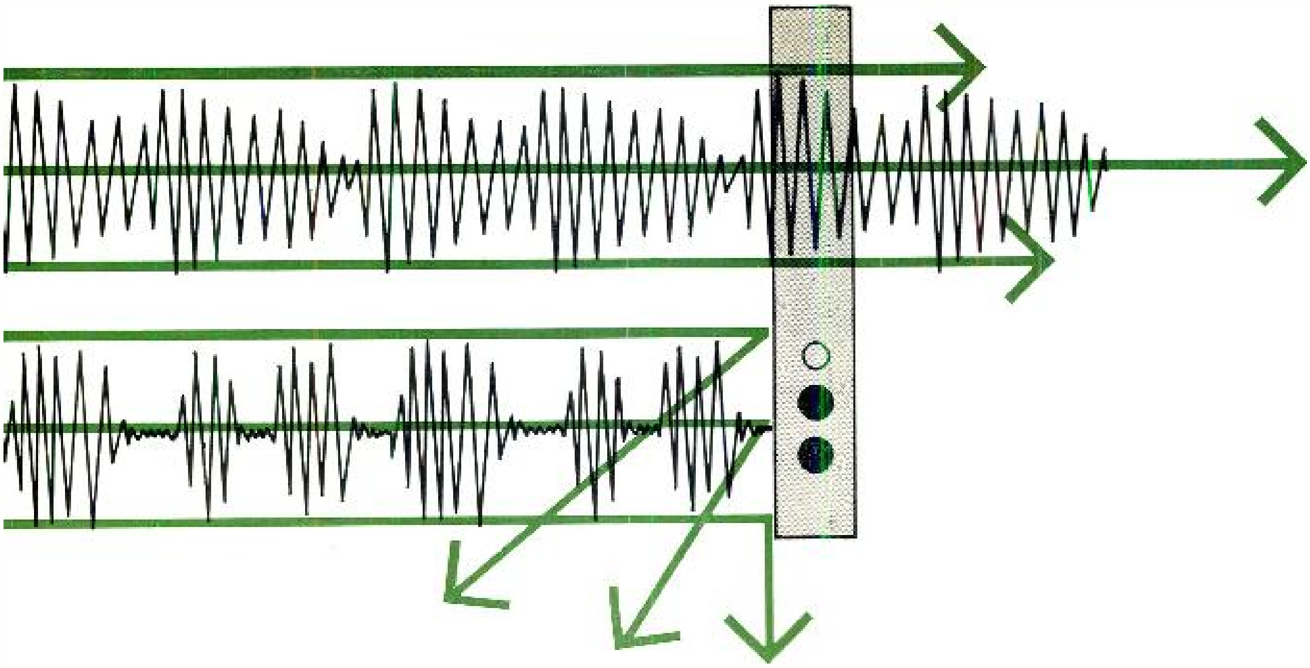
"Syncom" Communications Satellite. (Right) Prototype of NASA's "Syncom" synchronous orbit satellite is being inspected here along with third stage of rocket that will carry it through space early this year. The Hughes-built satellite is expected to be placed into orbit thousands of miles above the earth and at such a speed as to keep its position constant with respect to a point on the earth. **Magnetic Stripe Ledger.** (Below) A ledger card with a magnetic stripe on its reverse side forms the basis of a new IBM product line. The stripe stores alphabetic and numeric information. The alphabetic storage ability minimizes manual typing of entries during accounting procedures and increases output speed and production.



Efficient Laser Pump. (Below left) Sperry Rand research scientist watches emission from gallium arsenide diode in liquid nitrogen as experimental progress on use of diodes as pump sources for lasers. Laser output efficiencies close to 85% have been claimed. **Experimental Fuel Cell.** (Center) A new fuel cell using zirconia solid electrolyte (white cylinder) is being worked on by G-E scientists. Natural gas and oxygen, heated when the cell is placed inside an electric furnace, produce electrical energy directly without the use of any moving parts. **Superconducting MHD Generator.** (Right) Combining in a single device two major new scientific developments—superconducting magnets and magnetohydrodynamic (MHD) power generation—the first superconducting MHD generator goes into operation at Westinghouse Research Labs. The vertical tank houses the magnet, immersed in liquid helium, through which white-hot gases pass to convert the energy from the intense heat directly into electrical energy.







MUSIC/SPEECH DISCRIMINATOR

By FRANK D. GROSS

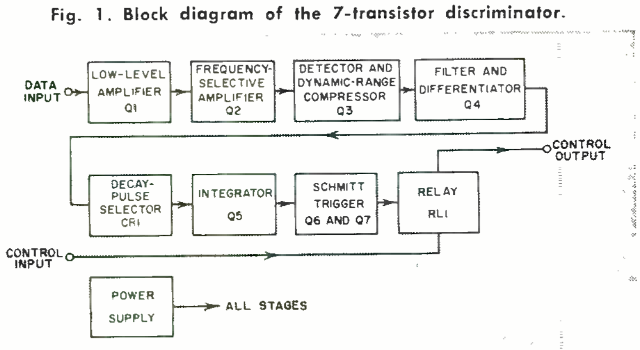
Design and construction of a device that can reject all speech and pass all music. Unit provides continuous background music either for listening or for recording.

CERTAIN radio broadcast commercial-elimination systems leave much to be desired in matters of performance as they are generally limited to a single FM station in any area, they are available on a rental-only basis, and they are generally limited to a specific receiver and audio system.

Several years ago two commercial-elimination systems made their appearance in a technical journal.[1,2] These devices were music-speech discriminators which provided a muting-type of control signal when speech only was present in the program material, and provided a pass-type of control system in the presence of music only. These devices operate well on any high-quality program source, *e.g.*, no singing commercials, and reasonable pauses between musical selections and speech passages. As this is typical of most FM-only stations, and certain AM stations, a wide range of program material operates well with these devices, giving 100% commercial and news elimination.

After constructing and testing one of these devices, the author decided that a solid-state music-speech discriminator (MSD) could be built with certain advantages over the previous all-tube systems, specifically with regard to size, flexibility, separation, temperature, and over-all system cost. The basic function of the two devices is similar, but the solid-state version achieves its operation through significantly different circuitry. The device is self-powered and is readily adaptable to a variety of audio systems. There are many applications for such a device. The MSD can provide continuous background music in such locations as doctors' and dentists' offices and retail stores, without being limited to one program source or a monthly rental fee. Attached to a home hi-fi center, the MSD can perform the same function. Used backwards, the MSD can be pressed into service as a "superpage" unit with certain plant audio systems or serve as a news monitor. The device may also be used to automatically "borrow" music while tape recording, without the customary editing and splicing. This device is a seven-transistor unit, the size of two books, and can be home constructed at a total cost of a little less than $30.00.

Fig. 1. Block diagram of the 7-transistor discriminator.



Theory of Operation

The nature of music and speech differ markedly in one respect: their decay rates. Decay, or the fall time in most music, is very gradual, indefinite, overlapping, and poorly damped while speech syllable (phoneme) endings are sharp, distinct, highly damped, and repetitive. Fig. 1 is a block diagram of the system that provides a control signal based upon this difference. The low-level audio signals from the program source are impedance-matched in the low-level amplifier stage, Q1. This is a conventional stage, needed because of drive requirements. The frequency-selective amplifier, Q2, has a frequency response that is limited to passing only mid-range signals (350-1400 cps). This stage amplifies speech signals with telephone quality and eliminates hum and sibilant sounds, bass instruments, hiss, noise, and the higher frequency musical components. These components would tend to mask or confuse the mid-range decay informa-

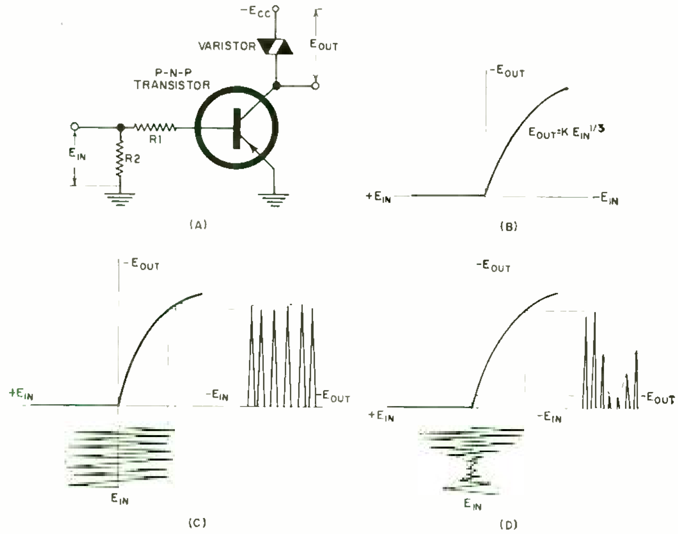


Fig. 2. (A) Detector and dynamic-range compressor circuit. Positive signals back-bias the stage and are lost. Negative signals are non-linearly amplified due to varistor characteristic. (B) Transfer characteristics of the stage. (C) Small amplitude variations, typical of music, are considerably reduced in amplitude. (D) Large amplitude variations, typical of speech decay, are considerably increased in size.

tion. This stage also eliminates any multiplex or commercial-killing ultrasonic signals that may be present. The third stage is a detector and dynamic-range compressor, consisting of an unbiased transistor and a varistor collector load. This stage removes the bottom half of the audio signal from further processing and amplifies signals in such a manner that the minor signal variations are reduced considerably, while the major signal variations are considerably amplified. This operation is explained and detailed in Fig. 2.

The net effect of this operation is to significantly reduce the gradual musical variations, while greatly enhancing the speech attack and decay variations. The amount of compression is on the order of the cube root of the input signal variations. This circuit performs considerably better than the drawdown limiter or logarithmic amplifier used in previous tube units.

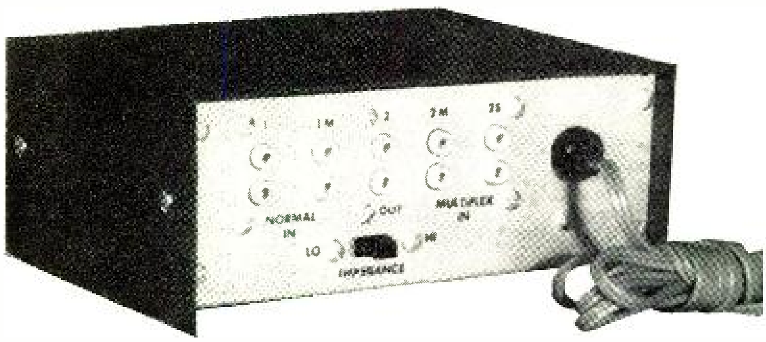
The fourth stage is a filter and differentiator. The filter removes all audio frequencies and leaves only the audio envelope with its attack and decay information. The differentiator then extracts the attack and decay information, which appears as a varying series of pulses. This is simply an *RC* high-pass network. Diode *CR*1 is the pulse selector, which rejects all attack pulses, and all decay pulses below a critical adjustable magnitude.

At this point in the circuit, speech consists of a series of sharp repetitive decay pulses, while music consists only of a random pulse or two of considerably smaller magnitude and much wider spacing. The actual music-speech discrimination has been accomplished. All that remains is the conversion of these decay pulses into a useful "on-off" type of control signal.

These decay pulses are caught by the integrator *Q*5, which rapidly charges a large capacitor, but turns off between decay pulses to force the capacitor to gradually discharge over a second path. This second path is the Schmitt trigger *Q*6 and *Q*7. When the average capacitor voltage exceeds a critical value, the control relay is energized. This capacitor also provides a delay after the last decay pulse to permit complete muting during a speech passage between words and phrases. The Schmitt trigger prevents relay chatter or marginal operation by always presenting a very high or a very low relay voltage. The operation of these stages is indicated by the waveforms of Fig. 3.

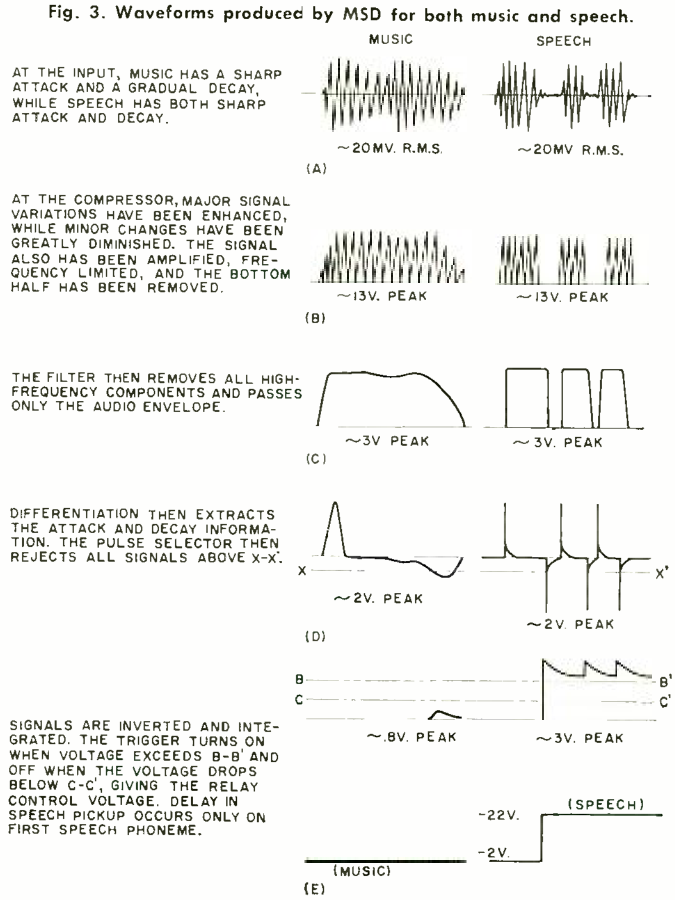
There are six controls in the circuit: three variable and three switched. A "Level" control establishes the level of the audio input signals. A "Separation" control determines the minimum level of decay information sent to the integrator, while the "Delay" control adusts the time delay of the Schmitt trigger, variable from .7 to 2 seconds. A "Tune" switch defeats the MSD while tuning the receiver. The remaining two switches are the "Power On-Off" and the "Impedance" selecting switch for the input audio connection.

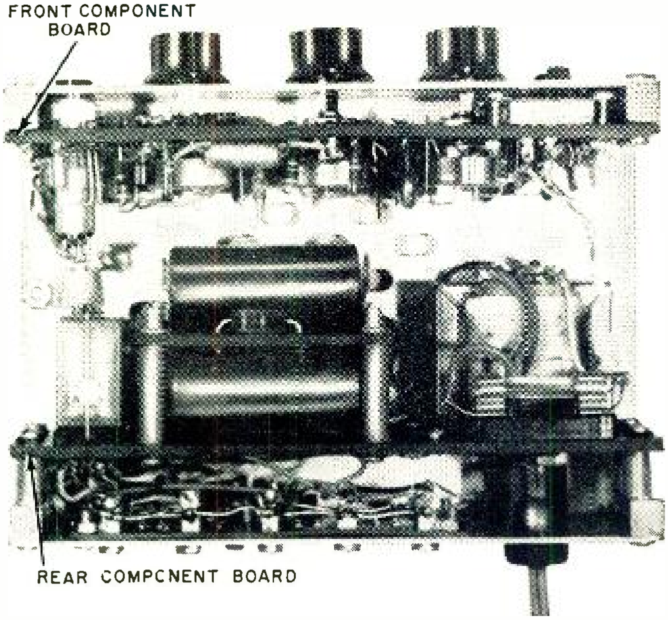
Front view of the MSD unit. The green and red indicator lamps at extreme right show presence of music or speech.



Rear view showing interconnecting jacks and impedance switch.

Fig. 3. Waveforms produced by MSD for both music and speech.





Top view with cover removed. Note use of two circuit boards.

The circuit diagram of the unit is shown in Fig. 4. All parts are conventional and low in cost. The transistors are industrial silicon types and are readily available.

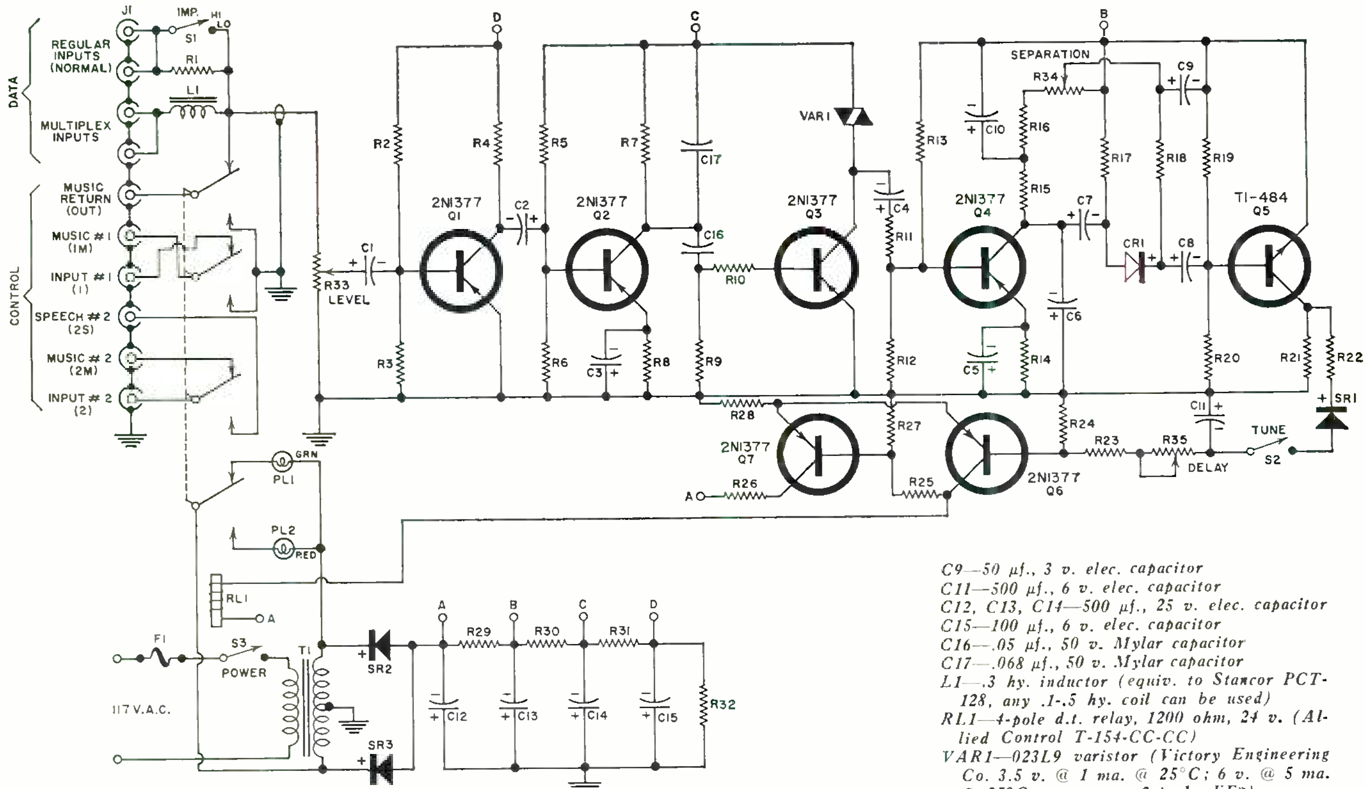
The flexibility of the circuit comes about from its variety of possible inputs and control functions. A dual regular input is provided. This permits return of the incoming audio from the tuner to the amplifier or preamplifier. An impedance switch matches the input to the MSD and has a "Lo" (5000-ohm) position for use after a cathode-follower or low-impedance line, and a "Hi" (33,000-ohm) position for use after a plate-coupled output. A dual multiplex input is also provided, which will use a low-impedance multiplex line without degrading the multiplex signals. *L*1, a .3-henry cup-core inductor, provides pre-emphasis equalization for the MSD only. The multiplex line is unaffected by the series compensation.

Four basic control functions are provided by the relay: (1) The input signal appears at an output jack during musical passages; (2) an isolated input is switched to one output jack during speech and a second output jack during musical passages; (3) an isolated input is switched to an output jack during musical passages; and (4) dual pilot lamps light red for speech and green for music. All four functions are completely independent and isolated from each other. All the input/output connections are accomplished by a ten-gang multiple phono jack—a surplus item. By proper use of this jack bay, the MSD will work into virtually any audio system.

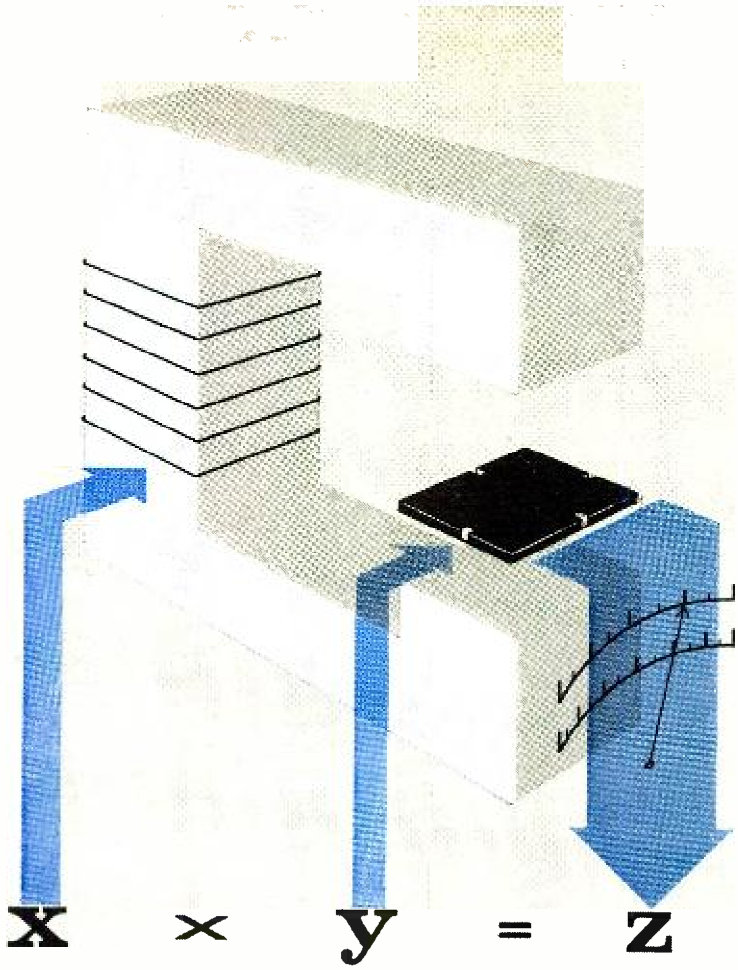
The internal power supply is conventional, using two silicon rectifiers in a center-tapped configuration to provide d.c. circuit voltages of 25, 20, 15, and 6 volts to the various stages

(*Continued on page* 73)

Fig. 4. Schematic diagram and complete parts list for the music-speech discriminator constructed by the author.



R1—27,000 ohm, ½ w. res.
R2—270,000 ohm, ½ w. res.
R3, R6, R12—10,000 ohm, ½ w. res.
R4, R7, R15—4700 ohm, ½ w. res.
R5—150,000 ohm, ½ w. res.
R8, R14—470 ohm, ½ w. res.
R9—3900 ohm, ½ w. res.
R10—18,000 ohm, ½ w. res.
R11, R19—22,000 ohm, ½ w. res.
R13—180,000 ohm, ½ w. res.
R16—750 ohm, ½ w. res.
R17—12,000 ohm, ½ w. res.
R18—47,000 ohm, ½ w. res.
R20—680,000 ohm, ½ w. res.
R21, R24, R25—5100 ohm, ½ w. res.
R22—47 ohm, ½ w. res.
R23—1000 ohm, ½ w. res.
R26, R27—820 ohm, ½ w. res.
R28—22 ohm, ½ w. res.
R29—180 ohm, ½ w. res.
R30—270 ohm, ½ w. res.
R31—6200 ohm, ½ w. res.
R32—2700 ohm, ½ w. res.
R33—5000 ohm linear-taper pot
R34—750 ohm, linear-taper pot
R35—2000 ohm linear-taper pot
C1, C8—10 μf., 25 v. elec. capacitor
C2—1 μf., 25 v. elec. capacitor
C3, C5, C10—50 μf., 6 v. elec. capacitor
C4, C6, C7—4 μf., 25 v. elec. capacitor
C9—50 μf., 3 v. elec. capacitor
C11—500 μf., 6 v. elec. capacitor
C12, C13, C14—500 μf., 25 v. elec. capacitor
C15—100 μf., 6 v. elec. capacitor
C16—.05 μf., 50 v. Mylar capacitor
C17—.068 μf., 50 v. Mylar capacitor
L1—.3 hy. inductor (equiv. to Stancor PCT-128, any .1-.5 hy. coil can be used)
RL1—4-pole d.t. relay, 1200 ohm, 24 v. (Allied Control T-154-CC-CC)
VAR1—023L9 varistor (Victory Engineering Co. 3.5 v. @ 1 ma. @ 25°C; 6 v. @ 5 ma. @ 25°C; exponent = 3 in $I = KE^n$)
J1—Multiple phono jack strip, 10-gang (Burstein Applebee 18A394)
PL1, PL2—48 v. pilot light (Eldema #4590, socket #4594)
F1—½ amp., 250 v. fuse (AGC-½)
S1, S2, S3—S.p.s.t., 1 amp slide switch
T1—42 v. c.t. @ .5 amp power trans. (Femco TRP-2712 or larger equiv. Stancor TP-1 with two 18-volt secs. in series)
CR1—1N34A diode
SR1, SR2, SR3—500 ma., 600 p.i.v. power diode (1N2071 or equiv.)
Q1, Q2, Q3, Q4, Q6, Q7—2N1377 transistor (Texas Instrument)
Q5—T1-484 transistor (Texas Instrument)



The HALL EFFECT

By JOHN R. COLLINS

The phenomenon was recognized long ago as a curiosity. New materials are rapidly moving it out of the laboratory and into a growing number of practical devices.

GREAT progress is being made toward moving a rather ancient principle—the Hall effect—out of the laboratory and into practical use. Electronics exhibits, manufacturers' catalogues, and advertisements display an increasing number of products incorporating Hall devices now available for purchase. And the end is not in sight—new applications appear continually in the literature. Unquestionably there are still more Hall devices on drawing boards than on production lines.

While the Hall effect dates back to 1879, it remained a sort of scientific curiosity for more than half a century. With the advance of semiconductor technology, however, it has become possible to make Hall units with the necessary sensitivity, stability, and output.

The major emphasis thus far has been on instruments for measuring magnetic fields or determining the magnetic properties of materials. In addition, however, Hall devices are used for current and power measurements and as function generators, transducers, multipliers, and isolators.

The Hall effect refers to the influence a magnetic field has on a stationary current-carrying conductor. Perhaps the easiest way to visualize the effect is by thinking of the familiar motor principle. A current-carrying conductor which is cut by a magnetic field will be subjected to a thrust which will cause it to move at right angles to both the direction of the current and the direction of the magnetic field. This principle is the basis of operation of d.c. motors and the D'Arsonval meter movement.

A natural question is, what happens if the conductor is restrained so that it is not free to move? Edward H. Hall found the answer through his experiments at Johns Hopkins University more than 80 years ago. Using a thin strip of gold leaf as a conductor, Hall showed that a difference in potential ("Hall voltage output" in the diagrams) will appear across opposite edges of the strip under these conditions. This is illustrated in Fig. 2A.

The explanation of the effect lies, of course, in the deflection of electrons in the current stream to one side of the conductor by the influence of the magnetic field, as shown in Fig. 2B. The same sort of deflection may be observed in a magnetic-deflection type cathode-ray tube. In some semiconductors, positive

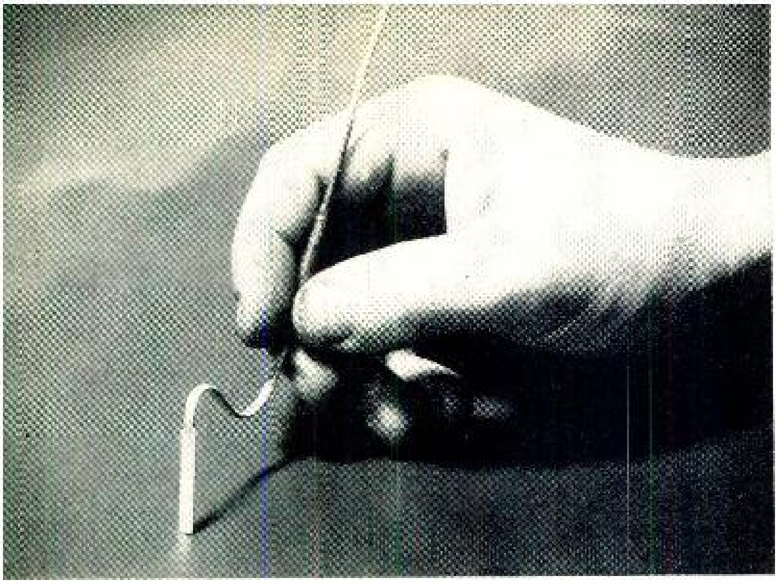
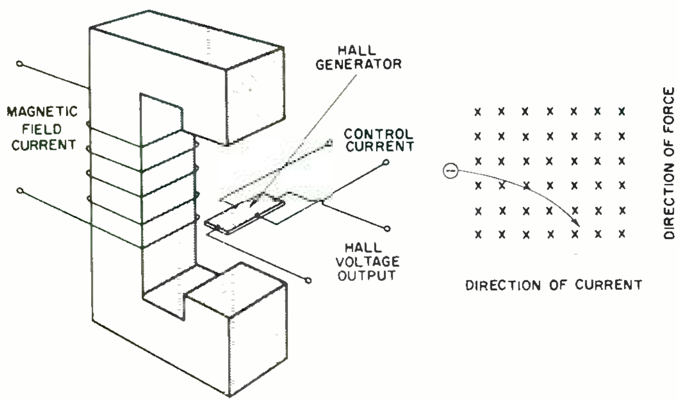


Fig. 1. Flat probe by Radio Frequency Labs used to detect transverse fields. InAs element is embedded near blade tip.



(A)

Fig. 2. (A) Hall voltage develops in the conductive strip. (B) Path of deflected electron. Direction of flux is into page.

Fig. 3. Sensitive gaussmeter by Bell measures small fields.

charges ("holes") are the majority carriers, and these are also deflected by the magnetic field. The concentration of like charges at one edge of the conductor produces a difference in potential as would be expected. This is called the Hall voltage.

The magnitude of the Hall voltage is directly related to the strength of the magnetic field. As electrons are deflected to one side, the negative charge thus produced tends to oppose the movement of more electrons to that edge. A condition of equilibrium is reached when this repelling force exactly balances the impelling force of the field's magnetic strength.

The relationship among the several factors which determine the Hall voltage is expressed by the following formula: $V_h = R_h/d \times I \times B \times \sin\theta$. V_h = Hall voltage in volts, R_h = Hall coefficient (described below), I = current in amperes, B = magnetic flux density in gauss, d = thickness of conductor in centimeters, and θ = angle between I and B. In the usual case, where I and B are at an angle of 90° with respect to each other, the sine of θ is 1 and can be ignored.

Materials

Early experiments with the Hall effect were limited because of the lack of suitable materials and although many different metals were tried (including antimony, cobalt, sodium, and zinc), the results were far from satisfactory. Resistance of the materials was low, making it difficult to obtain a Hall voltage large enough for practical purposes. When materials of higher resistance were used, the efficiency declined to such an extent that the device became virtually useless.

Experiments show that there are two factors which determine the suitability of materials for Hall effect use. First, the mobility of the charge carriers (either electrons or holes) must be high. This is obviously important since carrier mobility determines the response to an applied force and hence the sensitivity of the device.

High mobility, however, tends to reduce the resistance of the device so that impedance matching becomes a serious problem. The best way to overcome this difficulty without lowering the efficiency is to reduce the number of carriers by purifying the material. These considerations are expressed in the following formula for the Hall coefficient: $R_h = \mu/\varsigma$ where μ is the mobility, a measure of drift velocity of the carriers, expressed in terms of drift per centimeter per second for a potential gradient in volts per centimeter, and ς is a measure of the concentration of the carriers per cubic centimeter of the material.

The Hall coefficient thus serves as a figure of merit in selecting materials for use in Hall devices. Indium antimonide (*InSb*) has the greatest carrier mobility and hence the highest efficiency of any material thus far discovered. It is quite temperature-sensitive, however, and this fact has limited its use. Instead, many Hall devices now employ either indium arsenide (*InAs*) or indium arsenide phosphide (*InAsP*). These materials have a carrier mobility substantially greater than either germanium or silicon and, while not as efficient as *InSb*, they are considerably less temperature-dependent than indium antimonide.

Hall Generators

A Hall generator is a solid-state multiplying device which is designed to produce a Hall output voltage proportional to the product of the control current and the magnetic field. It is constructed by forming semiconductor material into a thin wafer and attaching leads to each of the four sides. Two opposite leads are for conducting the control current, and the other two are the Hall output voltage leads. The wafer is attached to a thin, insulating panel and the unit is encapsulated in epoxy resin.

The Hall-voltage formula above shows that the output increases as the thickness of the conducting wafer decreases. It is advantageous, therefore, to make the wafer as thin as mechanical strength will permit. In addition, the panel on which it is mounted should be made thin so as to fit into the small air gaps found in practical equipment.

Intermetallic elements, such as *InAs* and *InSb* are very brittle, making it difficult to machine them to very thin sizes. A solution to this problem is to vacuum-deposit the material in a thin film on a glass or ferrite substrate and to connect leads to opposite sides before encapsulation.

The *Helipot Division* of *Beckman Instruments, Inc.* produces units in this manner, depositing *InSb* in a film only 7 microns (0.00028″) thick on a substrate plate 0.012″

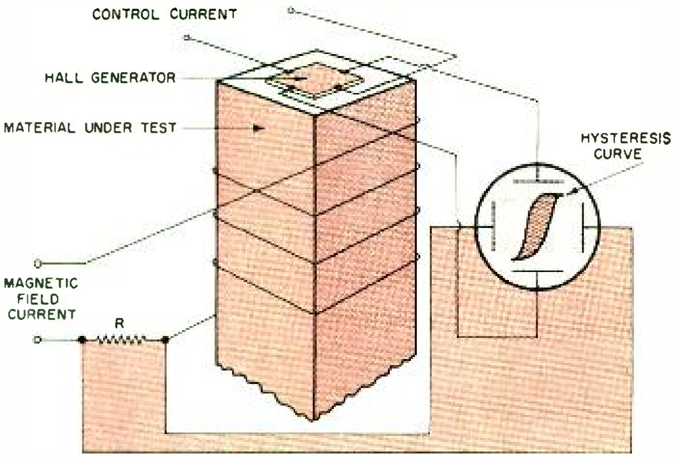


Fig. 4. Test assembly for tracing hysteresis curve on scope.

thick. These units are extremely sensitive because of their thinness and because of the high carrier mobility of *InSb*. Some will give Hall output voltages of 2 volts per ampere-kilogauss.

Deposited-film construction provides a large surface-to-volume ratio which helps dissipate heat—an important factor since *InSb*, as already mentioned, is extremely temperature-sensitive. The thinness of the film places a limit on the amount of current that can be handled, however, so it is necessary to strike a balance among several variables in order to obtain a sensitive Hall generator which will have reasonable dimensions and still be capable of handling practical currents.

Fabrication of Hall generators is a delicate operation which requires careful attention to construction details. One source of error results from improper alignment of the Hall output voltage leads on the edges of the wafer. Unless these are exactly positioned at equipotential points, a voltage will exist between the contact points whenever there is current flow, even with zero magnetic field. The effect, known as the resistive null voltage, can be compensated for by a resistive network, but unless this is done the generator will give false readings and the error will increase with the current.

The speed of response of a Hall generator is extremely fast, ranging well into the megacycle region. By itself, however, a Hall generator is an incomplete unit, since a magnetic circuit is needed for its operation. The inherent slowness of magnetic circuits usually limits the final speed which can be attained in Hall circuits.

Gaussmeters

One of the most important applications of the Hall generator is detecting and measuring magnetic fields. For this purpose, it has the advantage over more conventional instruments in that relative motion is not needed between the magnetic field and the pickup element. It is only necessary that the control current (which can be either a.c. or d.c.) be a known quantity. Hall-effect gaussmeters are shown in Figs. 3 and 10.

Since it is often necessary to measure magnetic flux in narrow air gaps, the Hall generator is usually mounted in a probe which is connected through a cable to the gaussmeter instrument. Various kinds of probes have been developed to meet the different conditions of use. A transverse probe (Fig. 1) is used to detect fields directed toward the probe's flat side, while an axial probe (Fig. 7), with a small Hall generator mounted flat at its end, is used for fields directed towards the tip. Probes less than 0.02" thick are available for making measurements in very narrow air gaps.

Through the use of a probe, an operator can determine the area where flux density is greatest and, since the Hall output is greatest where the generator element is perpendicular to the magnetic field, it is easy to find the field direction. Information of this kind is especially useful when checking for flux leakage in the vicinity of transformers or relays.

For very accurate work, the gaussmeter is zeroed while the probe is in a special zero-gauss chamber which shields the sensitive element from the earth's field (about 0.5 gauss) and any stray magnetic fields. Also, standard magnets of known strength are used to calibrate the gaussmeter.

A very sensitive gaussmeter with 12 full-scale ranges from 0.1 gauss to 30,000 gauss is shown in Fig. 3 and in block diagram form in Fig. 9. The circuit is entirely transistorized. An oscillator feeds a 1100-cps, 100-ma. control current through the sensing element. In the presence of a magnetic field, the Hall output voltage will be an 1100-cycle

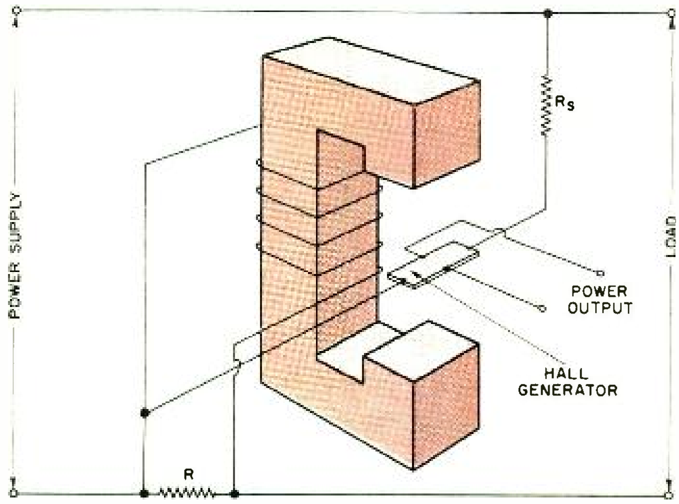


Fig. 5. Hall wattmeter renders power as product of E and I.

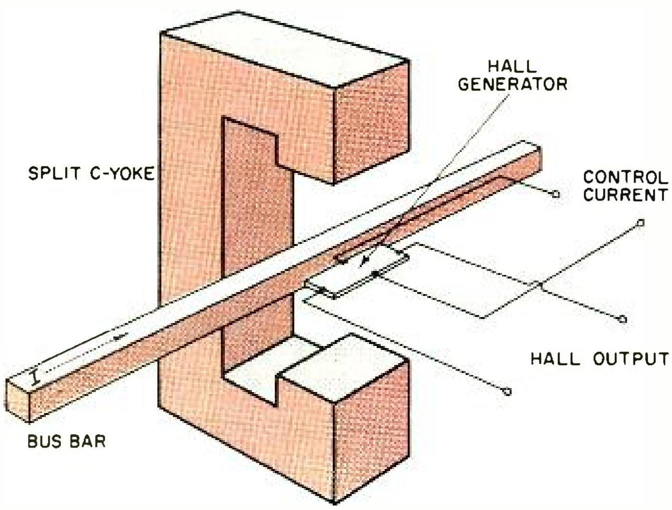


Fig. 6. Hall element and split C-yoke make clip-on ammeter.

voltage which is amplitude-modulated by the magnetic field being measured.

A portion of the oscillator output is fed back into a summing circuit where it is used to cancel out a major portion of the signal caused by the magnetic field. High amplifier gain then permits small changes in field strength to be studied in detail. After amplification, the signal is demodulated to obtain a d.c. or a low-frequency a.c. signal proportional to the magnetic field. This signal deflects the panel meter and may also be used to operate control circuitry or an oscillograph.

Gaussmeters of this kind are especially useful for studying small changes in a magnetic field, hence their name "incre-

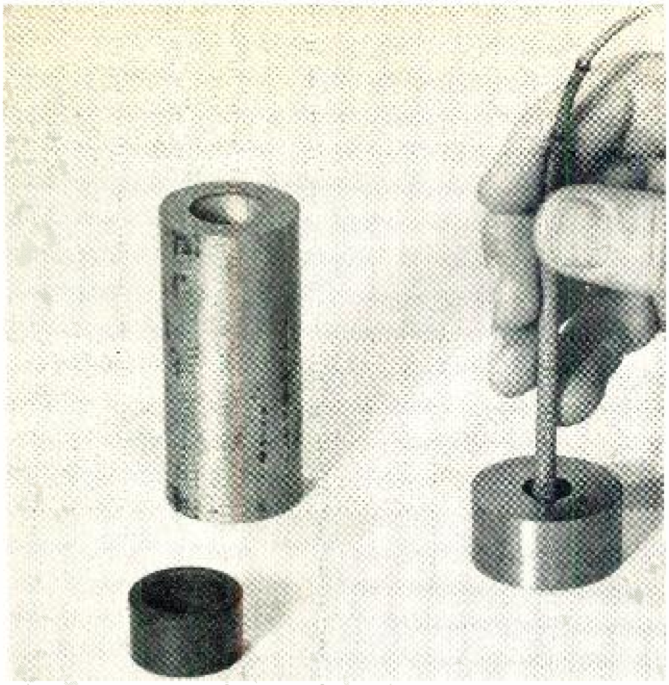


Fig. 7. An axial gaussmeter probe, with element mounted flat at its end, for detecting fields directed toward its tip.

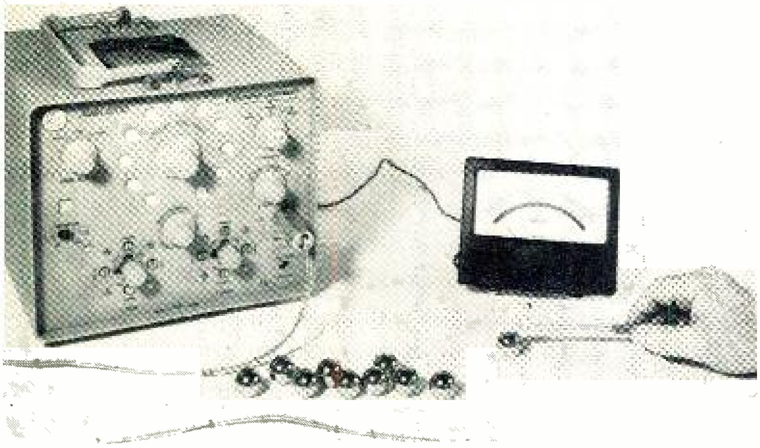


Fig. 8. Two matched probes are used in this differential gaussmeter by RFL. It can detect flaws in magnetic materials.

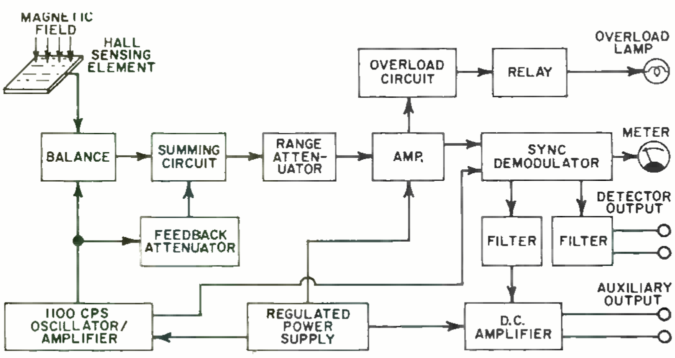


Fig. 9. How the amplified Bell gaussmeter of Fig. 3 works.

mental" gaussmeters. Since the signal and the detector are synchronized, the circuit rejects out-of-phase signal components, a factor which tends to reduce the effects of noise. Among other applications, they are useful for evaluation of magnetic ink, tape, and magnetic memories.

A different gaussmeter is shown in Fig. 8. It utilizes two matched probes which are mounted parallel to each other at a fixed distance apart. The system is supplied by a 3000-cycle oscillator, and separate constant-current amplifiers furnish the control current to each probe. The current through each element is held constant to insure that its output will be exactly proportional to the magnetic field at that point. The Hall voltage output of one probe is inverted and added to the voltage output of the other—which amounts to subtracting the two outputs. The difference voltage is displayed on the meter, which can be detached from the instrument itself for convenient viewing.

Differential voltmeters of this kind are useful for measuring the gradient of the magnetic field in connection with locating and measuring flaws, anomalies, and residual magnetism within ferromagnetic materials. Uniform fields, such as the earth's, do not affect the readings regardless of the position of the probe.

It is notable that many sensitive gaussmeters employ a.c. for the control current and thus have an a.c. Hall output voltage. The advantage is that a.c. is easier to maintain at a constant level since it is not subject to the drift problem encountered in d.c. Also, such a.c. voltages are much easier to amplify.

While many Hall-effect gaussmeters are employed for intermittent measurements, they are also useful in continuous applications. One of the most demanding applications is the monitoring and controlling of the magnetic field of a mass spectrometer. The field must be maintained at an extremely constant level in order to make possible the delicate analysis carried on by a mass spectrometer. Even when the voltage of the electromagnet power supply is kept at a constant level, the current and the magnetic field may vary because of resistance changes due to temperature fluctuations. A Hall-effect gaussmeter is used to monitor the field and to act as the sensing element in an automatic control loop.

Hysteresis Curve Tracer

A special adaptation of the Hall effect is in the measurement of the hysteresis of magnetic materials. The key to the way a magnetic core will perform in a particular application is its hysteresis curve, which shows how the flux density in the core varies with the cycling of an a.c. magnetic field. A fast, accurate means of plotting the hysteresis curve is a necessity for development work and in manufacturing many kinds of magnetic devices. Hall generators are especially useful for such analysis because they measure the instantaneous field without any time lag. The hysteresis loop can be displayed on an oscilloscope.

The basic elements of such a curve tracer are shown in Fig. 4. The magnetic core to be tested is placed in the center of a coil through which is passed an a.c. current which is in phase with the control current. A voltage drop is obtained by means of a resistor inserted in the path of the winding and the voltage thus obtained is applied to the horizontal plates of the oscilloscope. The Hall device is placed in contact with the magnetic test material so that the magnetic field will be perpendicular to it. The Hall voltage thus derived is applied to the vertical plates of the oscilloscope. The result will be a typical hysteresis curve.

Power Measurement

A Hall generator, as mentioned before, is fundamentally a multiplying device, producing an output that is proportional to the product of the control current and the magnetic field. Since power is determined by the product of current and voltage ($P = E \times I$), it is only necessary to have the control current proportional to the circuit voltage and the magnetic field proportional to the circuit current in order to obtain a Hall voltage proportional to the circuit power.

A generalized wattmeter circuit employing a Hall generator is shown in Fig. 5. A shunt, R, is provided so that only a portion of the circuit current flows through the coil and a series dropping resistor, R_s, limits the voltage applied to the Hall generator. The selection of values for the two resistors depends, of course, on the amount of power involved.

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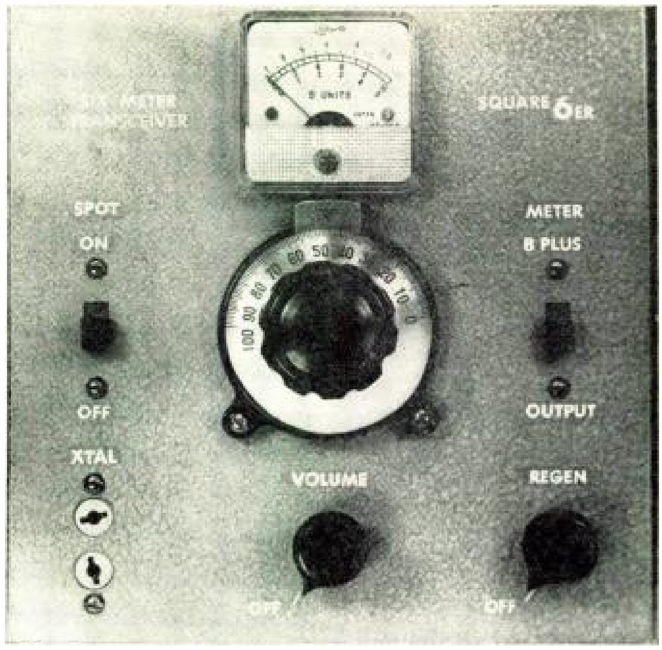


COMPACT 6-METER TRANSCEIVER

By MELVIN LEIBOWITZ, W3KET
and CHARLES PAPPAS, W3TND

Construction of a simple-to-install, low-power-drain, 8-watt ham rig that is easily moved from car to shack.

Front view of the 6-inch-square 6-meter transceiver.

THE six-meter band has much to offer in the way of QRM-free local contacts, exciting DX, and is the most practical frequency for mobile operation. Yet hams, for the most part, ignore this portion of the spectrum in wholesale numbers despite the fact that they pride themselves on "working all bands." This is a carryover from earlier days when it was difficult to get equipment to work at this frequency and the band was thinly occupied. The band is well occupied today and, thanks to modern tubes and techniques, reliable communication can be carried on with equipment that is simpler and less powerful than would be required on lower frequencies.

The transceiver to be described here runs 8-watts input, which will give a ground wave range of from 40 to 50 miles when used with a beam antenna. Mobile range will be 15 to 20 miles. Cost of construction should be less than $75.00

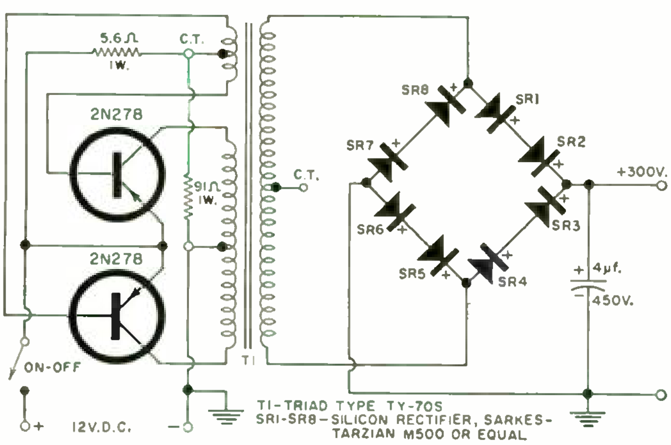


Fig. 1. Transistor supply used by authors for their rig.

and for this sum we obtain a complete station that is easily transferred from car to shack. Inasmuch as a half-wave antenna for 6 meters is only 9 feet long, the rig may be used as a portable in hotel rooms while on vacation and business trips and for other temporary services.

The transceiver consists of a superregenerative receiver with r.f. stage and a highly efficient three-stage transmitter (Fig. 2). A common audio section serves both the transmitter and receiver. The pentode section of *V5* is used as a tuned r.f. stage to isolate the detector from the antenna and to provide some gain. The triode section of the same tube is the detector. Regeneration is controlled by varying the plate voltage by means of *R16*. Plate voltage to this stage is regulated at approximately 60 volts by *PL1*, an NE-2 neon lamp.

This simple receiver exhibits sensitivity, a.v.c. action, and noise-limiting properties that would be hard to duplicate in a much more elaborate superheterodyne. It is true that its tuning is somewhat broad but this is desirable in a receiver designed for mobile and net operation. The regeneration control has been brought out to the front panel as its use is very important in obtaining maximum performance from the receiver.

The transmitter employs inexpensive 8+ megacycle crystals operating on the third overtone in a Robert Dollar circuit. This circuit was chosen for its simplicity, reliability, and freedom from TVI-producing harmonics. The triode section of *V1* serves as the crystal oscillator with output on 25 megacycles. The pentode section of the same tube is a frequency doubler, producing output at 50 mc. A 12BY7A (*V2*) is used as a straight-through final amplifier. This tube is easy to drive and does not require neutralization. The result is a transmitter that modulates upward with good linearity and no frequency modulation.

A single 6CZ5 (*V3*), driven by a 12AX7 (*V4*), serves both as modulator for the transmitter and audio amplifier for the receiver. A carbon mike was chosen for use with this rig as it is inexpensive and rugged.

Switching from transmit to receive is accomplished through a push-to-talk circuit and relay *RL1*. A d.c. relay, used as

Table 1. Listing of the voltage measurements on the rig.

PIN #	6AU8 (V1)	12BY7A (V2)	6CZ5 (V3)	12AX7 (V4)	6AN8 (V5)
1	0	0	250/300	50/0	0/20
2	−9.5/0	−12/0	——	0/0	0/.8
3	175/0		0/0	.1/0	0/0
4	12	0	6	12	12
5	6	0	0	0	6
6	0	6	0	120	0/200
7	−7/0	220	17/20	0	0/55
8	200	200	——	1/1.1	0
9	250	0	240/300	——	0/1.1

All voltages measured from numbered point to ground with v.t.v.m. Supply voltage equals 300 on receive, 250 on transmit. Where two figures are given the first is the voltage on transmit, the second is voltage on receive.

its control circuit, is included in the mike cord as an a.c. relay would cause hum. Power for the relay is taken off the filament circuit then rectified and filtered by *SR*1 and *C*30. This circuit has been arranged for use with a negative ground. Reverse the polarity on both *SR*1 and *C*30 if your car has a positive ground. The relay has three poles. The first set transfers the antenna from the receiver to the transmitter. The second set completes the speaker circuit on receive and grounds the transmitting tube cathodes to transmit. The third set of contacts switches plate voltage from the receiver to the microphone amplifier (*V*4*A*).

A frequency-spotting switch has been included. The cathode of the oscillator tube is grounded in the "Spot" position while the cathodes of the other tubes are left open. This produces a signal that is of the proper strength for spotting without overloading the receiver.

Construction

The transceiver is constructed in a 6-inch-square *LMB* #666C cabinet and matching chassis. Use of this combination is recommended as, unlike other more conventional cabinets, the chassis extends to the walls of the cabinet and there is no wasted space inside. The top, bottom, and two sides of this cabinet are removable, and all parts become readily accessible. Constructional details are obvious from the photos.

One item which cannot be seen clearly in the photo is an "L"-shaped copper shield which is placed across the 12BY7A socket. The short side of the shield is soldered across the socket between pins 1 and 9 and pins 5 and 6. The longer side of the shield rests flat against the cabinet wall and supports the tuning capacitors of the last stage. The shield serves two purposes. It shields the grid terminal of the 12BY7A from the plate and also provides a low inductance common ground for the stage. The output stage will oscillate without this shield so it must not be omitted.

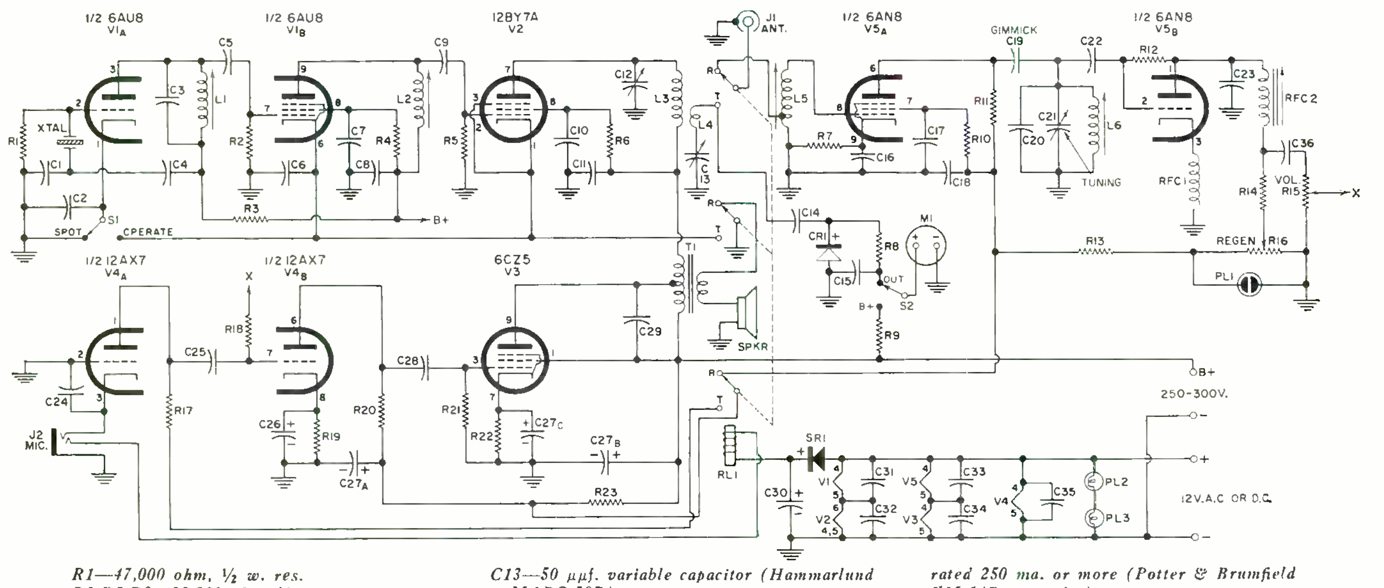
Some care should be exercised before mounting the speaker and audio-output transformer. Make sure that these two components clear each other in the vertical direction before drilling any holes.

The receiver tuning capacitor, *C*21, is mounted on a small angle-bracket bolted to the chassis. This capacitor was cut down from a 25-μμf. variable. We used only two plates, one stator and one rotor. This gave us bandspread coverage of 50 to 51 megacycles over 180 degrees. We suggest that the builder start with four plates and then remove plates, one at a time, until the desired bandspread is obtained.

The meter used was a 1½-inch, 0-1 ma. d.c. type with built-in lamps. Most parts stores now stock meters of this size although you may not be able to get an illuminated one. If this happens, go to a model railroad hobby shop and purchase two of the tiny lamps used on HO-gauge railroads. These lamps are extremely small and two of them will fit in the miniature meter case without trouble. Carefully remove the meter case and drill two small holes on the side. Insert the lamps and bring the leads out the holes in the side of the case. Seal the holes with radio cement. These lamps are designed to work on 12 to 16 volts and should be connected in parallel, not in series. Enough light spills out of the meter to illuminate the tuning dial. Don't be lazy and eliminate these lamps. You will find this a very valuable feature when operating mobile at night.

Circuit diagrams for two typical power supplies are shown.

Fig. 2. Superregenerative receiver is combined with a three-stage transmitter in this 50-mc. ham transceiver.



*R*1—47,000 ohm, ½ w. res.
*R*2,*R*5,*R*8—22,000 ohm, ½ w. res.
*R*3,*R*4—15,000 ohm, 1 w. res.
*R*6—47,000 ohm, 1 w. res.
*R*7—220 ohm, ½ w. res.
*R*9—510,000 ohm, ½ w. res. ± 5%
*R*10,*R*17,*R*20—220,000 ohm, ½ w. res.
*R*11—4700 ohm, 1 w. res.
*R*12—10 megohm, ½ w. res.
*R*13—100,000 ohm, 1 w. res.
*R*14—150,000 ohm, ½ w. res.
*R*15—1 megohm audio control
*R*16—20,000 ohm linear-taper pot
*R*18,*R*21—470,000 ohm, ½ w. res.
*R*19—3300 ohm, ½ w. res.
*R*22—330 ohm, 2 w. res.
*R*23—10,000 ohm, 1 w. res.
*C*1,*C*5,*C*9,*C*22—50 μμf. disc ceramic capacitor
*C*2,*C*4,*C*6,*C*7,*C*8,*C*10,*C*11,*C*15,*C*16,*C*17,*C*18, *C*23,*C*24,*C*25,*C*31,*C*32,*C*33,*C*34,*C*35,*C*36—.001 μf., 1000 v. disc ceramic capacitor
*C*3—15 μμf. disc ceramic capacitor
*C*12—20 μμf. variable capacitor (E. F. Johnson #20M11)
*C*13—50 μμf. variable capacitor (Hammarlund MAPC-50B)
*C*14—10 μμf., 1000 v. disc ceramic capacitor
*C*19—2 μμf. gimmick (two pieces of insulated hookup wire twisted together for 1½")
*C*20—5 μμf. disc ceramic capacitor
*C*21—25 μμf. variable capacitor (see text)
*C*26—25 μf., 25 v. tubular elec. capacitor
*C*27—20/20/20 μf., 350/350/25 v. can elec. capacitor
*C*28—.01 μf. disc capacitor
*C*29—.005 μf., 1000 v. disc capacitor
*C*30—100 μf., 15 v. tubular elec. capacitor
*CR*1—1N34 diode
*J*1—S0239 coaxial receptacle
*J*2—Two-circuit jack
*M*1—0-1 ma., 1½-inch d.c. meter (see text)
*PL*1—NE-2 neon glow lamp
*PL*2,*PL*3—Meter lamps (see text)
*RFC*1—10 μhy. r.f. choke or J. W. Miller #RFC-50
*RFC*2—20-100 mhy. adj. iron-core choke (TV width coil used in authors' unit)
*RL*1—3-pole d.t., 12 v. d.c. relay, contacts rated 250 ma. or more (Potter & Brumfield KM-14D or equiv.)
*SR*1—750 ma., 400 p.i.v. silicon-diode rectifier
*S*1,*S*2—S.p.d.t. slide switch
*T*1—Audio output trans. 5000 ohms c.t. p-to-p to 3.2 ohm v.c., 5 watts or larger
Spkr.—4" square PM speaker, 3.2 ohm v.c.
Xtal.—8 mc. crystal
*L*1—16 t. #24 en. closewound on ¼" slug-tuned form (J. W. Miller #4500)
*L*2—8 t. #24 en. closewound on ¼" slug-tuned form (J. W. Miller #4500)
*L*3—6 t. B & W #3003 Miniductor
*L*4—2 t. B & W #3003 Miniductor at ground end of *L*3
*L*5—10 t. #24 en. closewound on ¼" slug-tuned form, tapped 2 t. from ground end (J. W. Miller #4500)
*L*6—8 t. #24 en. closewound on ¼" slug-tuned form (J. W. Miller #4500)
*V*1—6AU8 tube
*V*2—12BY7A tube
*V*3—6CZ5 tube
*V*4—12AX7 tube
*V*5—6AN8 tube

Fig. 3 is a typical a.c.-operated supply and Fig. 1 is for the transistor d.c. supply used by the authors. The transistor supply does not have to be used as there are plenty of surplus dynamotors and vibrator power supplies on the market at reasonable cost. The transistor supply is recommended as being the more efficient and since it has no moving parts will require the least maintenance. No constructional details have been furnished for the power supplies as they are straightforward and the average builder should have no trouble. Power requirements are approximately 300 volts at 100 milliamps and 12 volts a.c. or d.c. at 1.2 amps.

Adjustment and Operation

Initial adjustment of the receiver is best done with a signal generator or well-calibrated grid-dip meter. Lacking either of these instruments, align the transmitter first and then align the receiver by means of the transmitter used as a signal source. Switch S1 should be in the "Spot" position.

Turn on the transceiver and allow a few minutes for the tubes to warm up. Advance the regeneration and volume controls approximately half-way. A loud hiss should be heard. If you do not hear the superregenerative hiss, advance the regeneration control until you do. Set the receiver tuning capacitor to maximum capacity. Set the signal generator (modulated) or grid-dipper to 50 mc.

Couple the signal generator to the antenna terminal of the transceiver. Adjust the signal generator for maximum output. Turn the slug in *L6* through its range. The signal generator should be heard clearly at some point. The regenerative hiss will also disappear at the same point. Reduce the output of the generator until you can barely hear it. Adjust *L5* for maximum signal, keeping the generator output low so as to avoid receiver overloading. Turn off generator.

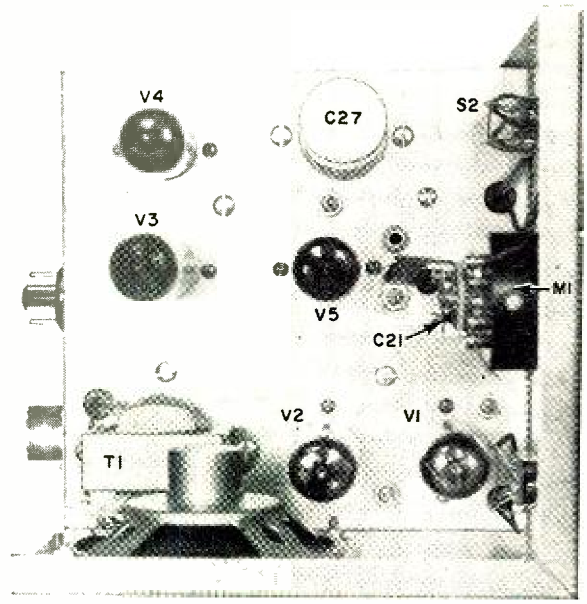
Coupling capacitor *C19* should now be adjusted. The detector should be coupled fairly tightly to the r.f. stage. Too tight coupling will keep the detector from regenerating while too loose coupling will cause a loss of sensitivity and the detector will probably squeal and motorboat. Reduce the regeneration control to minimum. Slowly advance the control. The detector should start to regenerate with a smooth and gradual action with the control at one-third to one-half scale. If the coupling seems to be too tight, undo a few turns of gimmick capacitor *C19* but do not cut the wire as you will probably wish to make this adjustment while listening to a weak signal.

Maximum receiver sensitivity is obtained right at the threshold of regeneration. Advance the control beyond this point to receive extremely strong local signals.

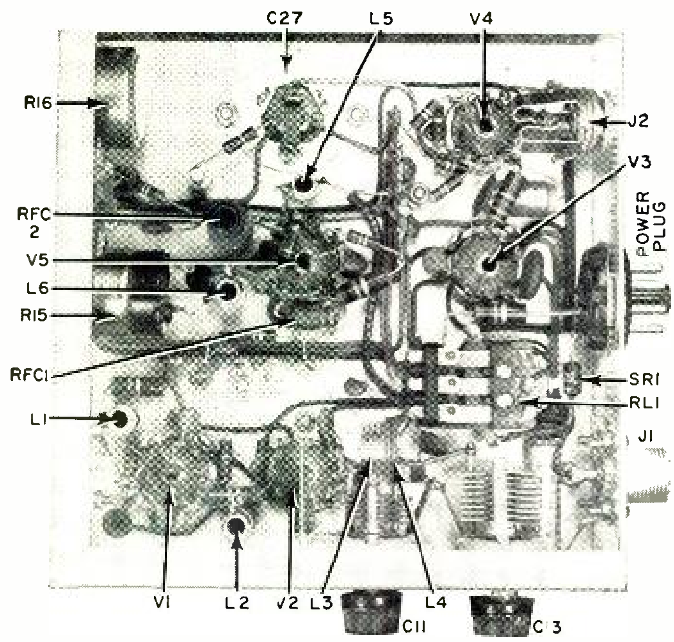
Turn the signal generator on again and tune capacitor *C21* to minimum capacitance on the dial. Tune the signal generator until it is heard on the receiver again. Take plates off of the tuning capacitor, one at a time if the frequency coverage is too great and the bandspread is too small. Check carefully with the generator after each plate has been removed as it is easy to go too far.

The transmitter is tuned with the aid of a #48 or #49 pilot lamp connected to a three-turn coil about ½-inch in diameter. Plug in the highest frequency crystal that will be used in the transmitter. Slide the coil over the end of *L1*. Press the push-to-talk switch and adjust the slug in *L1* for maximum output as indicated by the brilliancy of the lamp. Tune slightly higher in frequency past the point of maximum output. This is necessary to insure easy starting of the oscillator. Tune *L2* in a like manner but do not go past the maximum output point.

Switch the meter to "Output." The antenna should be connected to the rig at this time. Adjust *C12* for maximum indication on the meter. Adjust *C13* for maximum output. Go back to *C12* and re-peak it for maximum. A meter connected in the plate circuit should now read about 27 ma., indicating an input of about 8 watts, depending on the plate voltage. ▲

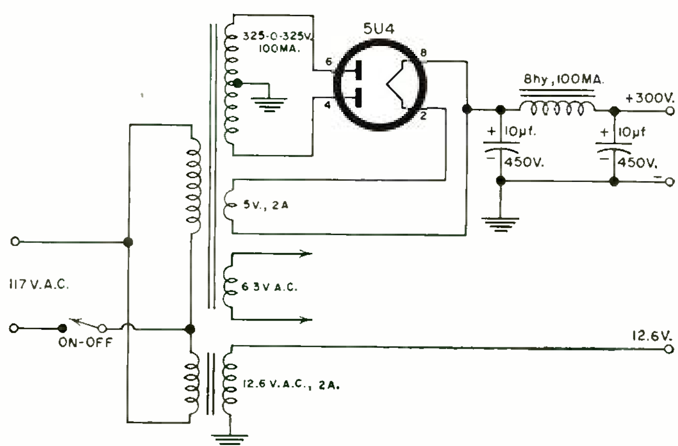


Top view of the chassis showing location of tubes.



Underchassis view shows uncrowded but compact arrangement.

Fig. 3. This conventional a.c. power supply may also be used.



TRANSISTOR IGNITION SYSTEM

By J. OLDHAM / Ignition Products Engineering, Ford Motor Company

Design and performance results on new "Perma-Tuned" system, which promises increased point and plug life, easier starts, better high-speed performance, and improved fuel economy.

FORD has introduced on its 1963 models a new transistorized ignition system. This system is called the "Perma-Tuned" system and is available on the largest *Ford* trucks equipped with gasoline engines, and also will be available later this model year on some of the larger passenger car engines. To our knowledge, these cars and trucks will be among the very first production vehicles of any make to employ a transistorized ignition system.

Transistor-Switching Advantages

In recent years the introduction of power transistors has opened new design areas to the ignition engineer. Using a transistor as an electronic relay, it appeared that the breaker contacts could be used as a keying or triggering device to time the ignition pulses, while the transistor would actually perform the task of conducting and interrupting the main primary current.

Although the *Ford* transistor ignition system uses the same breaker points as the conventional ignition system, their function has been changed. This change in function reduces the current the breaker points must handle from 5 amperes to less than 1 ampere, and also changes the type of circuit in which the contacts are operating from an inductive type circuit to a pure resistive circuit. Under these new operating conditions, the life of the breaker points is virtually limitless.

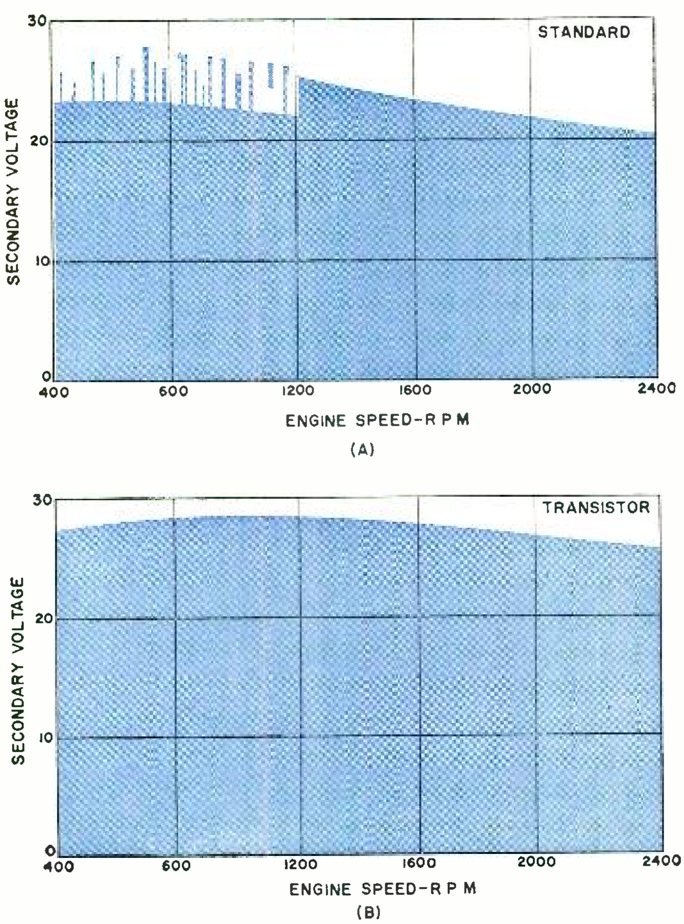
Further examining this transistorized ignition system and the conditions under which it operates, we find the time constants of the basic circuit can be reduced substantially. Since the time constants of the transistor system are less, the primary current will build up to a higher value before the breaker points are opened. Having a higher percentage of current build-up when the breaker points open increases the voltage available at the spark plug, as shown in Fig. 2. Here we see that the voltage available from the transistor system is approximately double that from a standard system at maximum engine speed.

An additional advantage of the transistor ignition system is that the quality of the switch does not deteriorate with time, and since the breaker points are now switching a light non-inductive load, the available voltage to the spark plug will remain substantially constant throughout the life of the ignition system.

A further important feature is the absence of the arcing found in the conventional ignition system. Consequently, even at cranking and low engine speeds there is no reduction in available voltage. These characteristics result in the ability of the transistor ignition system to operate satisfactorily with spark plugs which would be considered "worn out" in the conventional ignition system. At low engine speeds the transistor ignition system provides only a slight increase in available voltage over a well-tuned standard ignition system. However, due to the lack of arcing, it is able to fire much more consistently than a conventional system.

Fig. 1 shows a comparison of secondary voltage output from the two systems. This graph is an artist's representation of an oscillographic recording taken at an ambient temperature of $-20°$ Fahrenheit. Here we see that due to arcing, the standard ignition system does not supply a constant voltage and often misfires completely or suffers severe degradation in performance. The arcing which occurs in the standard ignition system not only manifests itself in misfires and

Fig. 1. Due to arcing at slow speeds, the standard ignition system (A) suffers degradation of performance compared to that obtainable with transistorized system, as shown in (B).



reduction in available voltage, but also we find that the rise time of the secondary voltage is influenced by contact arcing.

Since the ability of an ignition system to fire a fouled plug or shunt resistance load is largely dependent on the rate of voltage rise in the secondary circuit, it has been found that the transistor system, with its more stable characteristics, provides a significant improvement in ability to fire fouled spark plugs. This phenomenon is shown in Fig. 3 which represents oscillographic recordings of four consecutive secondary voltage pulses from the transistor and standard ignition systems. It will be noted that the four pulses of the transistor system are superimposed whereas the wide variation in rate of voltage rise encountered in the standard system is readily apparent.

Design Objectives

The need for an ignition system with improved durability and reliability characteristics was recognized several years ago. A project was initiated to investigate the various methods by which the transistors available at that time could be utilized in the ignition system. The objectives of this program were to improve the over-all reliability and durability of the ignition system in the following areas: (1) increase distributor breaker point life, (2) extend spark plug life, (3) improve engine starting characteristics, (4) improve long-range fuel economy, (5) eliminate blued points, and (6) improve high-speed performance.

During 1960, transistors with improved voltage and turn-off characteristics became available. It was not until this time that a transistor ignition system could be developed whose output characteristics could equal those of the conventional standard ignition system.

Circuit Operation & Features

The circuit diagram of the *Ford* transistor ignition system currently in production is shown in Fig. 4. Examination of this circuit shows that it contains some interesting features.

The use of a toroidal driver transformer and base resistor results in improved performance over a simpler basic transistor circuit. The driver transformer is incorporated to optimize the inherent fast-switching characteristics of the transistor. A fast-switching transistor is a prerequisite if the transistor ignition system output voltage characteristics are to be equivalent or superior to those of a standard ignition system. The use of this switching device enables us to maintain a uniform rate of secondary voltage rise, irrespective of the transistor parameter tolerance normally found in a production lot of transistors. The base resistor serves to control the amount of current that flows through the breaker points.

The cold-start relay, zener diode, and 40-μf. electrolytic capacitor protect the transistor from transient conditions which would cause its maximum specified ratings to be exceeded. Some transient conditions can be guarded against in the basic design of the system by properly specifying the transistor. Other transient conditions cannot be covered by transistor specifications because of economic reasons, or because of the nature of the transient voltage involved.

The cold-start relay is included to prevent abnormally high input currents to the transistor system during the engine cranking cycle. This relay is normally closed and is so calibrated that it will remain closed, allowing a portion of the ballast resistor to be bypassed if the battery voltage is less than 11 volts during the start cycle. If the battery voltage exceeds 11 volts, the relay contacts will open, allowing the full ballast resistor to remain in the circuit throughout the cranking cycle.

The zener diode serves the dual purpose of limiting the forward voltage across the transistor to a value below the transistor breakdown voltage and damping the reverse voltage across the transistor under the condition that the ignition coil attempts to oscillate more positive than the battery.

The electrolytic capacitor on the battery side of the transistor has been incorporated for protection against transient voltages originating in the basic vehicle electrical system. In many instances, it has been found that system transient voltages force the transistor to switch in such a manner as to substantially exceed its power dissipation capabilities.

Since the zener diode does not offer any protection against load line changes, the addition of the capacitor was found necessary to prevent failures due to voltage transients. These transients may reach damaging levels due to malfunction or failure in other parts of the car's electrical system.

Field-Testing Program

The final circuit design is the result of an extensive field program which was undertaken in the development of the transistorized ignition system.

In conducting our field-test program, one hundred and eighty-five transistor ignition systems were installed in passenger cars and commercial fleet trucks. The fleets in which these units were installed varied from those which were meticulous in their operation and maintained very accurate

(*Continued on page 75*)

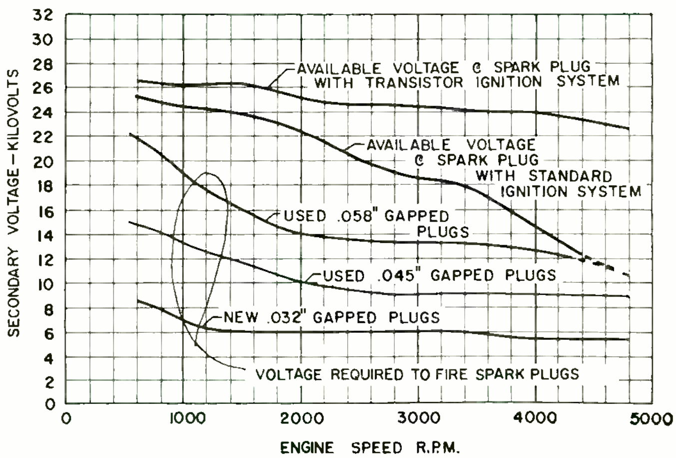


Fig. 2. Available voltages produced and needed at the plugs.

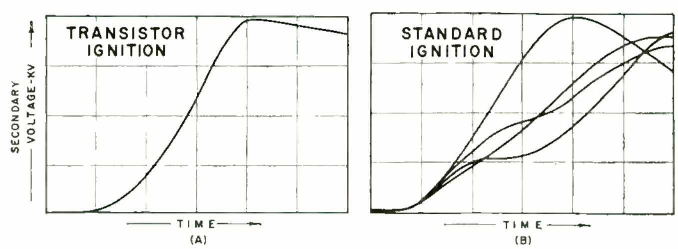
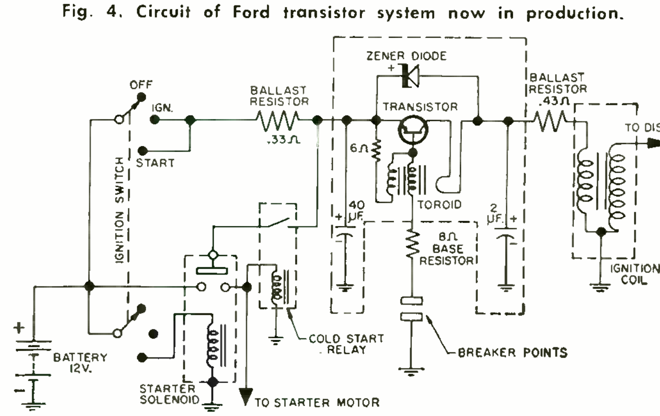


Fig. 3. Four consecutive voltage pulses from the transistor (A) and standard (B) ignition systems. All four pulses exactly coincide in the case of the transistorized system.

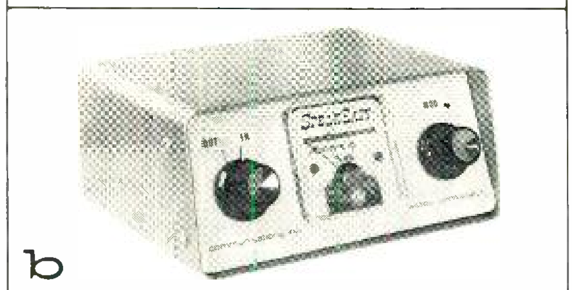
Fig. 4. Circuit of Ford transistor system now in production.

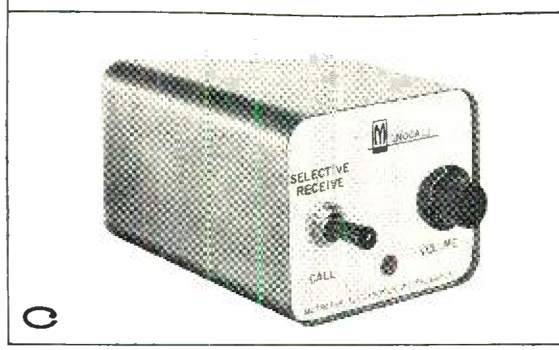


NEW CITIZENS BAND CIRCUITS

By LEN BUCKWALTER

Description and operation of a transceiver using frequency synthesis to make 11 crystals do the work of 46, an accessory to boost modulation level, and a selective calling attachment.

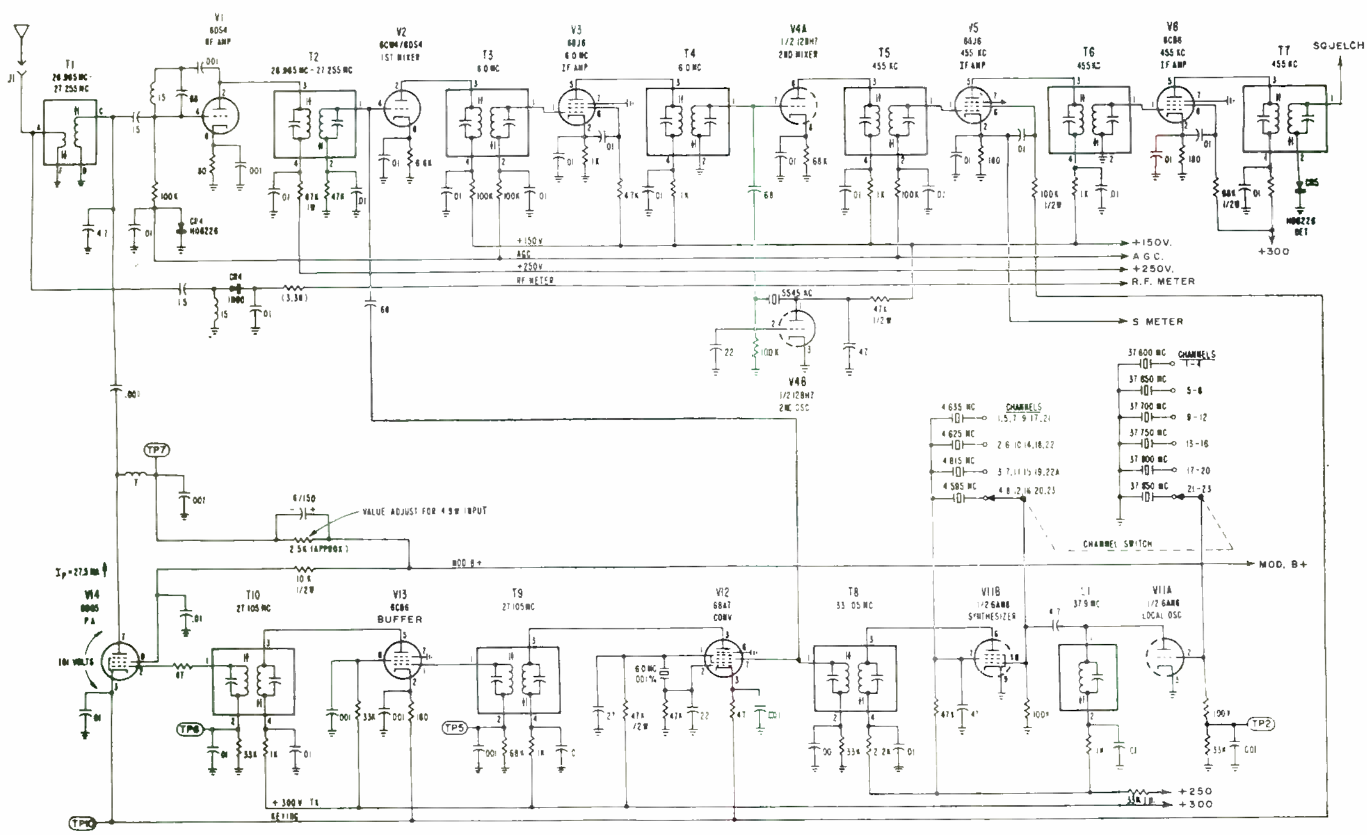




Prompted by the spectacular growth of CB radio over the past four years, the equipment manufacturer has not been caught unaware. With a welter of new and unusual circuits, he is meeting the brisk demand by CB-ers for transceivers and accessories that outperform their earlier versions. Typical are three circuits discussed below. Subsequent articles will cover other CB products of unusual interest.

These circuits represent such gains as 23-channel coverage with a fraction of the crystal complement ordinarily required. A representative unit of this type is *Polytronics'* "Spectramatic" with its use of "frequency synthesis." In the accessory category, there is the "SpeakEasy" by *Communications, Inc.* It is designed to boost audio modulation of any rig close to the efficient 100% level. Our third example is *Metrotek's* "Monocall." As a selective-calling attachment, it applies a fresh design approach to the problem of rejecting undesired signals of other stations. Let's examine each of these circuits and their special features in some detail.

(A) "Poly-Comm 23 Spectramatic" Tuning



ELEVEN crystals do the work of 46 in the *Polytronics'* transceiver. Using the technique of "frequency synthesis," all-channel coverage is achieved by 11 crystal combinations which are heterodyned to 46 discrete frequencies; 23 for transmit and 23 on receive. The heart of the frequency synthesis function is in the lower right section of the schematic. The channel switch, a ganged unit, controls two banks of crystals. In the interests of clarity, not all of the switch contacts are shown. However, it is easily possible to determine which two crystals are being energized by finding the desired channel number in each row. For example, if the transceiver were dialed to channel 1, the two top crystals (4.635 mc. and 37.600 mc.) are connected. With channel 10, the combination is 4.625 mc. and 37.700 mc., etc.

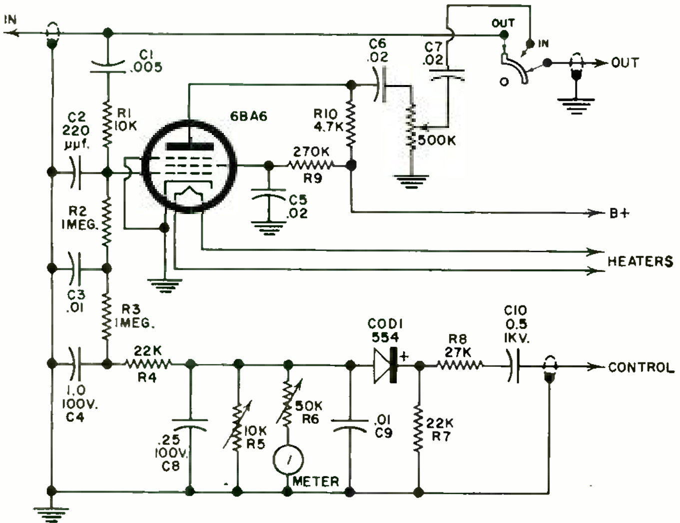
Since the switch is now shown on the lowermost crystals, we will use this pair to trace circuit action. They comprise the working combination for channel 23. Let's assume that the unit is on transmit, necessitating an r.f. output on 27.255 mc. The two crystals proceed to oscillate; the 37.850-mc. unit in the local oscillator *V11A*—the 4.595-mc. crystal with synthesizer *V11B*. The tubes serve as individual oscillators, but note how their r.f. outputs are mixed as *V11A* couples energy into the synthesizer tube via *L1*. The beating together of signals in *V11B* produces a 33.255-mc. difference. This is applied to converter *V12* where a second heterodyne process occurs. *V12* is a mixer-oscillator. Its crystal frequency is 6 mc. and the resultant emerges as 27.255 mc. (or 33.255 − 6 mc.) In the buffer, *V13*, drive is developed and the 27.255-mc. signal is applied to the r.f. amplifier, *V14*.

To trace the sequence of events on receive, consider again the two original crystals; 4.595 mc. and 37.850 mc. An identical mixing process recurs in the synthesizer tube, *V11B* and again a 33.255-mc. difference emerges. However, the principal signal pathway is now from *T8* up to the grid of the first mixer (*V2*) in the receiver section. Here it mixes with the desired signal, channel 23, from r.f. amplifier *V1*. The mixing product of the two signals is 6 mc. (33.255 mc. − 27.255 mc.). Examination of the first i.f. amplifier reveals that it is on 6 mc. and the signal readily enters the i.f. strip for processing in the conventional manner.

If similar calculations are made for other channel switch positions, it becomes apparent that the 23 combinations can synthesize any CB frequency.

The matter of frequency tolerance is especially important in the "Poly-Comm 23." During the transmit mode, for example, three separate oscillators are in operation. If their nominal frequencies were to drift, the resulting error could conceivably lead to an out-of-tolerance condition. This is prevented by use of .001% crystals, instead of the usual .005% units found in most CB transceivers.

(B) Communications, Inc. "SpeakEasy"



Potentiometer *R5* is a variable load to permit a reference-level adjustment; a nominal −4.5 volts is set to agree with 100% modulation during the calibration procedure. The nearby pot, *R6*, determines the range of the modulation meter situated on the unit's front panel. During the initial set-up the transceiver is modulated 100% by sine-wave audio, but the meter pointer is adjusted to read 6 db below this point. This yields higher accuracy during normal voice modulation by compensating for meter inertia.

The control voltage ultimately reaches the grid of the 6BA6 tube. Note how this e.m.f. is keyed to the modulating voltage within the CB rig; growing increasingly negative as modulation percentage rises. The time constant of the *RC* filter in the grid circuit is such that the voltage does not undergo long-term change, but varies rapidly at the syllabic rate of the voice. At this point it is applied to the tube as control-grid bias.

The other major pathway commences at the upper left through the terminal marked "In." From this point, microphone signals are introduced to the tube grid. The ensuing audio amplification is subject to the bias action of the control voltage. If a weak syllable is spoken, negative bias quickly drops and tube gain imparts added gain.

The properties of the tube itself play an important role in the speech-compressing action of the circuit. A 6BA6 is a pentode of the remote cut-off (or variable-*mu*) type widely applied in a.v.c. circuitry for its non-linear characteristics. In the "SpeakEasy," it acts to prevent clipping of the waveform when audio approaches or exceeds the 100% modulating level. If input signal and bias override a desired pre-set level, the gain of the 6BA6 flattens and remains at a relatively fixed level. This obviates the need for harmonic filtering as required in clipper circuits.

In the final step, the processed signal emerges from the tube and passes through a 500,000-ohm pot which allows matching output level to a variety of transceiver inputs.

AS AN accessory which connects into a microphone lead, the "SpeakEasy" is designed to increase "talk power." Most CB rigs readily strike *peaks* of 100 per-cent modulation, but the more realistic figure is *average* level. Given a typical speech waveform, average modulation usually hovers down in the 20% to 30% region. In a circuit which utilizes a type of fast a.v.c. action, the "SpeakEasy" tends to raise the figure as closely as possible to 100% without creating overmodulation and splatter in adjacent channels.

The principal signals through the circuit—low-level audio and a tube-controlling bias—can be traced in the schematic. First, we'll consider the setting up of the control voltage. Through an external lead, a sampling of audio from the transceiver's modulation transformer is introduced to the "Control" input, at the lower right. In transit through the diode and resistor-capacitor network, the signal is rectified and filtered.

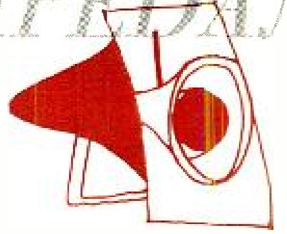
(C) Metrotek "Monocall"

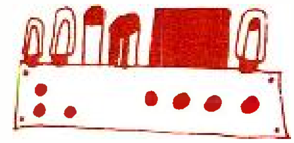
SELECTIVE calling, long the province of commercial two-way radio, is gaining acceptance for CB use. The essential reason remains the same; the annoyance of other traffic on the channel is eliminated. Only those units equipped with the proper tone code can open up the monitoring receiver.

The "Monocall" adds this function to any CB transceiver with a few interconnecting wires. Unlike the simple one-tone system, it relies on a two-tone code of extremely short dura-

(*Continued on page* 64)

SIMPLIFIED AUDIO IMPEDANCE MATCHING





By JAMES E. PUGH, Jr.

Assembling a balanced system from equipment on hand always makes problems. Solve them quickly by turning switches on a handy aid.

Fig. 1. There are several ways of packaging the "match box," but none has to be more elaborate than the author's version.

THOSE WHO deal with audio systems involving a variety of equipment and flexibility of arrangement, like public-address systems, must often combine units of different characteristics. Impedance matching and reconciliation of various output levels or efficiencies can be quite a problem, particularly at the output of an amplifier and if one wishes to make the most of equipment already on hand.

The author's solution is a technique that depends on a simple device, the impedance "match box." His version combines a universal output transformer having several primary and secondary taps with three rotary switches, three input-output terminals, and a housing. Other arrangements, best suited to individual needs, are possible. Before dealing with variations or the method of use, let us consider the particular version.

A *UTC* S-14 output transformer, rated at 10 watts, is connected as an autotransformer (Fig. 3), with each tap wired to the same position on three different single-pole, 8-position, non-shorting, rotary switches. Each switch connects to an external binding post. Even if the user makes changes, he probably will not have to depart much from the simple physical layout shown (Figs. 1 and 6).

The transformer's primary taps (values in parentheses, Fig. 3) are rated at 2500, 4000, 7000, and 10,000 ohms, the secondary taps at 8, 15, and 500. For the best distribution of available impedances, an autotransformer connection with windings in series aiding was used, as in Fig. 3. That is, the 10,000-ohm primary tap was connected to the 500-ohm secondary tap. The impedance at each tap with the "Common" connection made to the bottom of the transformer through switch S3 is indicated in the illustration.

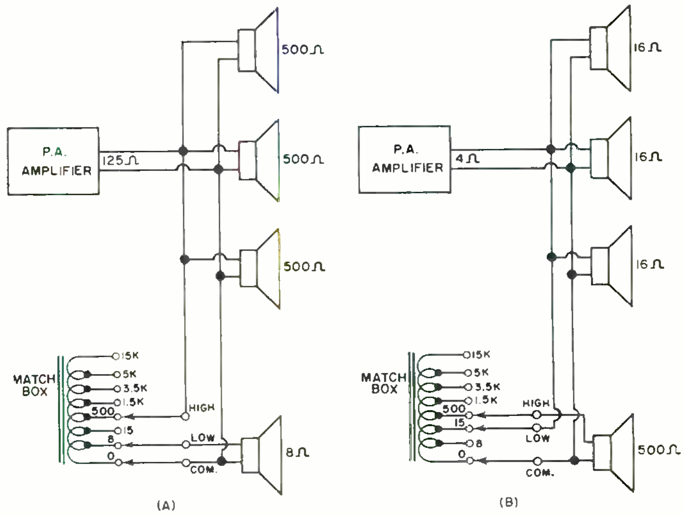
Variations

Depending on such factors as desired audio quality, power to be handled, or impedances of interest, the user may elect to use another transformer or connect it differently. The number of switch positions will depend on the number of taps he will end up with. He may elect to dispense with the switches altogether, bringing each tap out to its own, labeled binding post or terminal.

If he uses a different arrangement, or if he wants even more combinations than those indicated (referred to the bottom of the transformer as common, with S3 in position 1), he will have to determine impedances himself. If an impedance bridge is not available, there are several ways of doing this. For example, a signal voltage of known amplitude can be applied to a winding of known impedance, and the output amplitude across the unknown winding can then be measured. Squaring the ratio between the two voltages then gives the impedance ratio between the two windings. The latter figure is multiplied by the known impedance to determine the unknown one.

To illustrate: a signal is fed to the 500-ohm winding (input across "Common" and "Low" posts, output from "Common" and "High" posts; S1 in position 8, S2 in position 4,

Fig. 2. (A) Matching a speaker to others of higher impedance. (B) A similar situation, but the match is to a lower impedance.



and S3 in position 1). Voltage ratio between the signals is found to be 5.5:1. Impedance ratio is therefore 30:1. Since the smaller winding is known to be at 500 ohms, the larger becomes 15,000 ohms. Make up a chart of needed impedance values together with associated switch positions and paste it on the case.

Applications

The best way to illustrate the versatility of this time saver and watt stretcher is with actual cases. A common type of case is the one in which several similar pieces of equipment are to be driven by the same source, but the impedance of one unit is different from that of the others. Specifically, suppose you have covered an area with three similar, 500-ohm speakers. Another speaker is needed to fill in an uncovered part of the area, but you only have 8-ohm speakers left.

You could shunt the low-impedance unit across the other three and connect across a lower-impedance output connection on the amplifier, but the 8-ohm speaker would load the 500-ohm units, making them practically useless. You could run a separate line from the odd speaker back to another output connection on the amplifier, but this may be too time-consuming, too expensive, or otherwise undesirable.

Instead, you use the match box at the odd speaker, connecting the latter across the box's 8-ohm tap (or nearest tap to that value) as in Fig. 2A. The box's 500-ohm winding is then connected in parallel with the other 500-ohm speakers, and connection is made to the amplifier output that comes closest to the 125-ohm shunt impedance. With mismatch avoided, efficiency is maintained. Conversely, if the odd speaker had a higher impedance than the others, the matcher could have been used to step down the feed to the odd unit, as in Fig. 2B.

For separate control, monitoring, or other reasons, a remote amplifier with a high input impedance must sometimes be driven by a main amplifier feeding speakers or other equipment. A separate, high-impedance take-off from the main amplifier may be undesirable because it will pick up hum. A low-impedance line across the feed to the speakers may not provide sufficient input level. The solution (Fig. 5): a low-impedance line across the speaker is fed to a low-impedance tap on the matcher, installed near the remote amplifier. A high-impedance tap on the matcher feeds the remote amplifier. Less important than the transformation is the fact that signal voltage is stepped up without the danger of picking up hum.

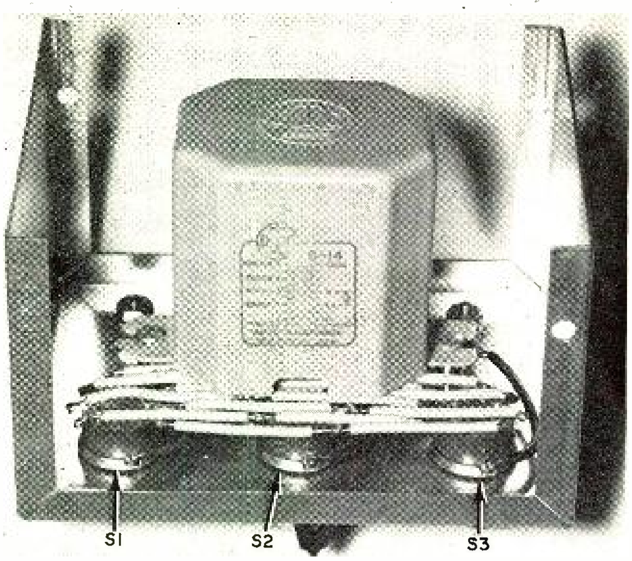


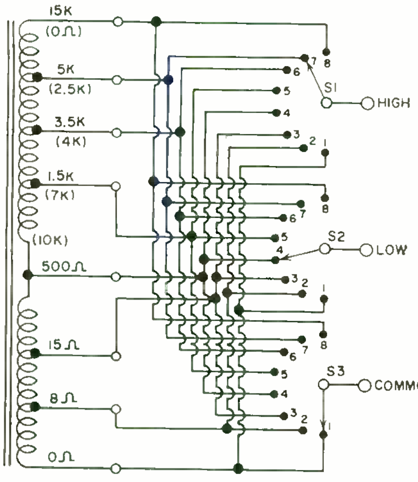
Fig. 6. Whatever transformer is used, mounting it and wiring the switches should be as simple as it was in this version.

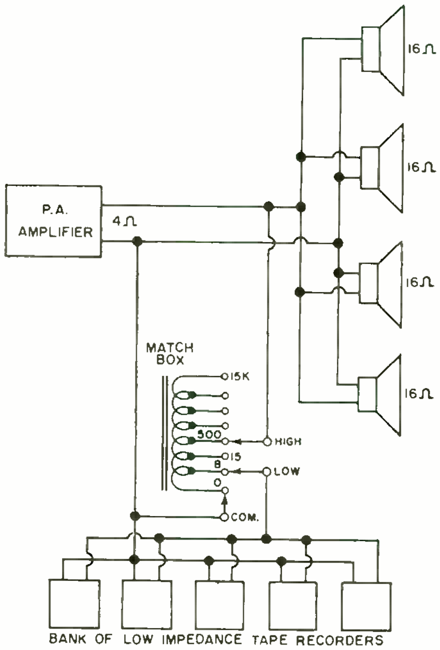
Another common situation: several low-impedance devices must be fed from a main amplifier already feeding speakers. This can load down the amplifier considerably. For example, a bank of tape recorders will be added, and it is desirable to drive them at their low-impedance inputs. In this case, the recorders are connected across the appropriate low-impedance tap of the match box (Fig. 4) and the line from the main amplifier is connected across the highest impedance tap that will provide adequate signal for the recorders. The author has driven as many as 10 recorders in this way with no noticeable loading on the amplifier output, whereas, without the match box, a single recorder with low input impedance results in a detectable drop in audio level from the speakers.

A fourth application, but not the last possible by any means, involves the need to change the output level to one speaker or more in a group. Assume, for example, that four identical speakers are being fed by the same amplifier. One, however, is used in a small, enclosed area, whereas the other

(*Continued on page* 95)

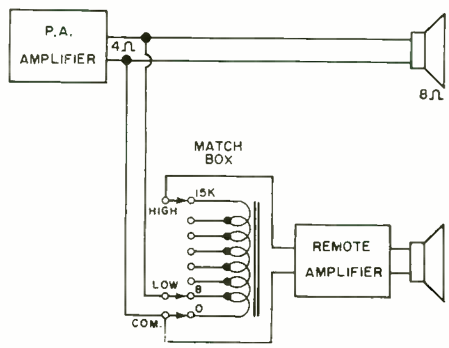
Fig. 3. Three switches and a multi-tap output transformer, wired for optimum choice of impedances, provide virtually unlimited possibilities for integrating odd components into a balanced system.





◀ Fig. 4. Several low-impedance recorders and several speakers must be fed simultaneously. Recorder input level must be maintained and the speakers must not be loaded. It can be done, as shown here.

Fig. 5. Matching a low-impedance line from the speaker output to a remote amplifier—with the desired input level.



TOSHIBA TRANSISTOR SUBSTITUTION DIRECTORY

TOSHIBA NO.	TYPE AND SERVICE	AMERICAN	
		NUMBER	MFGR.
2SA49	P—bc. i.f. amp.	2N137	ETC, G-E
		2N140	ETC, RCA, SYL
		2N412	ETC
		2N412	ETC, RCA, SYL
		0C44	AMP, PHIL
2SA50	P—h.s. sw.	2N583	ETC, RCA
2SA52	P—bc. con.	2N409	ETC, SYL
		2N410	ETC, RCA
		0C45	AMP, PHIL
2SA53	P—bc. i.f. amp.	2N135	ETC, G-E
		2N136	ETC, G-E
		2N139	ETC, RCA, SYL
		0C46,0C47	AMP
2SA57	P—vhf. amp.	0C171	AMP
2SA58	P—s-w. i.f. amp.	0C169,0C170	AMP
2SA65	P—h.s. sw.	2N111,2N111A	ETC
		2N112,2N112A	
		2N382,2N383	ETC, SYL, TUNG, UST
		2N394	ETC, ITC, G-E, UST
		2N395	G-E, RAY, SYL, TI
2SA66	P—h.s. sw.	2N113	ETC
		2N123	ETC, G-E, ITC
		2N396	CPC, G-E, GI, RAY, SYL, TI, ITC
		2N396A	G-E, GI, ITC, SYL
2SA67	P—h.s. sw.	2N114	ETC, GI
		2N311	ETC
		2N397	CPC, ITC, RAY, SYL, TI, UST, G-E
		2N415,2N415A	ETC
		2N518	ETC, G-E
2SA72	P—h.f. amp.	2N247	SYL
		2N370	RCA, SYL
		2N372	RCA
		2N544	SYL
		MC103	PHIL
2SA73	P—bc. con.	2N371	RCA
		2N374	RCA, SYL
		MC101,MC102	PHIL
2SA74	P—vid. amp.	2N1065	CPS, ETC, GI
2SA76	P—vhf. amp., con.	2N1023	RCA
		2N1066	RCA
2SA78	P—h.s. sw.	2N1384	RCA
2SA92	P—s-w. osc.	2N1636,2N1637, 2N1639	RCA
2SA93	P—s-w. mix.	2N1634,2N1638	RCA
2SA175	P—h.f. amp.	2N384	RCA
2SA200	P—l.f. amp.	2N1124	PHIL
		T1000,T1001, T1796	PHIL
2SA229	P—vhf. amp.	2N500	PHIL
		2N588	PHIL, SPR
		2N700	MOT
		2N769	PHIL, SPR
2SA230	P—vhf. amp.	2N502A	PHIL
2SA236	P—bc. i.f. amp.	2N373	RCA, SYL
2SA239	P—uhf. osc., mix.	2N499	GI, PHIL, SPR
2SA240	P—vhf. amp.	2N502,2N503	PHIL
2SA276	P—h.s. sw.	2N501	ETC, PHIL, SPR
		2N559	ETC, WEC
		2N741	MOT
		2N768	PHIL, SPR
2SA277	P—m.s. sw.	2N581	CPC, ETC, GI, ITC, RCA, TUNG
2SA278	P—m.s. sw.	2N311	ETC, GI
2SA282	P—m.s. sw.	2N315	ETC, ITC, UST
		2N315A	CPC, ETC, GI, ITC, UST
		2N394	ETC, G-E, ITC, UST
		2N395	G-E. RAY. SYL. TI
2SA282 (cont.)		2N404	CPC, ETC, G-E, GI, MOT, RCA, SYL, RAY, TI, TUNG
		2N413	CPC, ETC, G-E, ITC, RAY, UST, TUNG
		2N413A	ETC, G-E, GI, UST
		2N414	CPC, ETC, G-E, GI, ITC, RAY, SYL, TUNG, UST
		2N414A	ETC, GI, SYL, UST
		2N416	CPC, ETC, GI, ITC, UST
		2N425	CPC, ETC, GI, ITC, MOT, RAY, TUNG, UST
		2N426	CPC, ETC, ITC, MOT, RAY, SYL, TI, TUNG, UST
		2N427	CPC, ETC, G-E, GI, MOT, RAY, SYL, TI, TUNG
		2N428	CPC, ETC, G-E, GI, ITC, MOT, RAY, SYL, TI, TUNG, UST
		2N481	ETC, ITC, RAY, UST
		2N482	ETC, ITC, RAY, SYL, UST
		2N483	ETC, ITC, RAY, SYL, UST
		2N508	ETC, G-E, MOT
		2N520A	CPC, ETC, GI, ITC
		2N528	WEC
		2N529-2N533	ETC, GI
		2N578	CPC, ETC, GI, ITC, RCA, TI
		2N658	ETC, RAY
		2N1280,2N1284	ETC, ITC, UST
		2N1303	CPC, ETC, G-E, GI, RCA, SYL, TI
		2N1305	CPC, ETC, G-E, GI, RCA, SYL, TI
		2N1352,2N1353	ETC, ITC, UST
		2N1413,2N1414, 2N1415	G-E, MOT
		2N1471	ITC
		2N1681	TUNG
		GT123,GT167, GT1065	GI
		TR-34,43,44, 45,320,321, 383,482,TRC-45,70,72	ITC
		UST760	UST
2SA283	P—m.s. sw.	2N396	CPC, ETC, G-E, ITC, RAY, SYL, TI
		2N404A	G-E, GI. SYL, RCA, TI
		2N484	ETC, RAY, SYL, UST
		2N485	ETC, ITC, RAY, UST
		2N521	ETC, GI, ITC, UST
		2N521A	CPC, ETC, GI, ITC
		2N579	CPC, ETC, GI, ITC, RCA, TUNG
		2N597,2N598	CPC, ETC, GI, PHIL
		2N659,2N662	CPC, ETC, RAY
		2N1093	TI
		2N1281	ETC, ITC, UST
		2N1319	RCA
		2N1351,2N1355, 2N1356	ETC, ITC, UST
		2N1684	SYL
		GT1606	GI
		TRC44,TRC71	ITC
		UST761	UST
2SA284	P—m.s. sw.	2N397	ETC, ITC, RAY, SYL, TI, UST
		2N398	CPC, GI, MOT, RCA, UST
		2N417	CPC, ETC, GI, ITC, RAY, TUNG, UST
		2N486	ETC, ITC, RAY, UST
		2N522	ETC, GI, ITC, UST
		2N522A	CPC, ETC, GI, ITC
		2N580	CPC, ETC, GI, ITC, RCA, TUNG

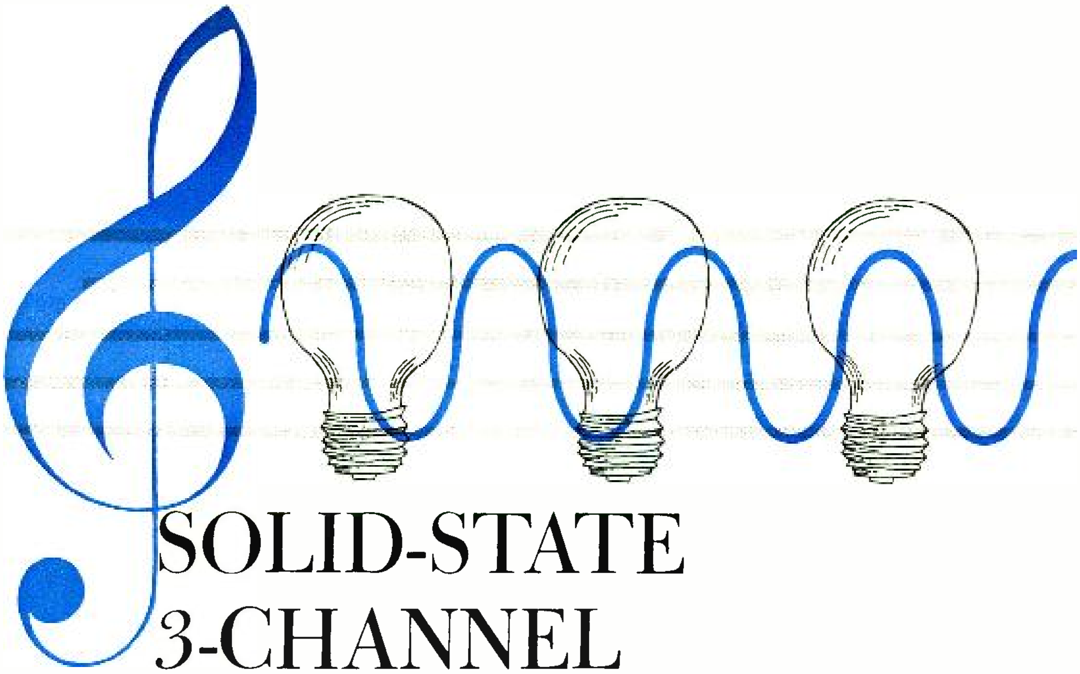
TOSHIBA TRANSISTOR SUBSTITUTION DIRECTORY (cont.)

TOSHIBA NO.	TYPE AND SERVICE	AMERICAN	
		NUMBER	MFGR.
2SA284 (cont.)		2N582	CPC, ETC, GI, ITC, RCA, SYL, TUNG
		2N584	ETC, RCA
		2N599	CPC, ETC, PHIL, GI
		2N660,2N661	CPC, ETC, RAY
		2N1017	ADV, CPC, ETC, ITC, RAY, UST
		2N1282	ETC, ITC, UST
		2N1307	CPC, GI, RCA, SYL, TI
		2N1316-2N1318	ETC, ITC, UST
		2N1457	ETC, ITC, UST
		0C43	AMP, PHIL
2SB13	P—bc. i.f. amp.	2N1121	ETC, G-E
		2N1217	G-E
2SB25	P—a.p. amp.	2N235A	BEN, CLE, SYL
		2N235B,2N236A	BEN, CLE
		2N236B	BEN, SYL
		2N297	BEN
		2N297A	BEN, CLE, DEL, MOT
		2N419	BEN
		2N553	DEL
		2N555	MOT
		2N1039	ETC, TI
2SB26	P—a.p. amp	2N155	BEN, CLE, RAY
		2N234A	BEN
		2N255,	BEN, CLE
		2N256,2N257	BEN, CLE, SYL
		2N301	BEN, CLE, RCA
		2N307	BEN, RCA, SYL, TUNG
		2N307A	BEN, SYL, TUNG
		2N351,2N376	RCA
		2N351A	MOT
		2N352,2N353	PHIL
		2N376A	MOT
		2N399	BEN, SYL
		2N400	BEN
		2N401	SYL
		2N554	MOT
		2N1038	ETC, TI
		2N1261-2N1263	MIN
2SB40	P—m.s. sw.	2N280	AMP, ETC
		2N519	ETC, GI, ITC, SYL, UST
		2N519A	CPC, ETC, GI, ITC
2SB43	P—a. amp.	2N556-2N558	ETC
		2N649	ETC, RCA
2SB44	P—a. amp.	2N34	ETC, G-E, SYL
		2N36	ETC, SYL
		2N37	ETC, SYL
		2N104	ETC, RCA
		2N131A,2N132A	ETC
		2N188	ETC
		2N190,2N191	ETC, G-E
		2N192	ETC, G-E
		2N361,2N362	ETC, ITC, RAY, UST
		2N363	
		2N405	ETC, SYL
		2N406,2N408	ETC, RCA, SYL
		2N422	ETC, SYL, UST
		2N460	ETC, ITC, TUNG
		2N461	ETC, ITC, TUNG
		2N591	ETC
		2N1192	MOT
		GT74,GT87	GI
		0C70,0C71,0C72	PHIL
2SB46	P—a. amp.	0C75	PHIL
2SB54	P—a. amp.	2N360	ETC, ITC, RAY, UST
		2N569	ETC
		2N631	RAY, UST
		2N571	ETC
		2N1128-2N1130	PHIL
		2N1191-2N1193	MOT
		GT82,GT109	GI
2SB55	P—a. amp.	2N462	ETC
		2N1008A, 2N1008B	BEN, ETC, SYL
		0C77	PHIL
2SB56	P—a. amp.	2N109	ETC, RCA, SYL
2SB56 (cont.)		2N180,2N241, 2N265	ETC
		2N281,2N282	AMP, ETC
		2N563	ETC
		2N564	ETC, GI, ITC
		2N565	ETC
		2N566	ETC, GI, ITC
		2N567	ETC
		2N609-2N613	ETC, WHE
		2N632,2N633	ETC, ITC, RAY, UST
		2N1008	BEN, ETC, SYL
		0C72,0C76	PHIL
2SB62	P—a. amp.	2N1218	SYL
2SB64	P—l.s. sw.	2N1073A	BEN
2SB65	P—a. amp.	2N1115	ETC, G-E
2SB67	P—m.s. sw.	2N271,2N271A	ETC
2SB69	P—l.s. sw.	2N1073	BEN
2SB90	P—a. amp.	2N46	RCA
		2N47-2N49	PHIL
		2N105	ETC, RCA
		2N535	ETC, PHIL
		0C53,0C54, 0C56	AMP
		0C57,0C59	AMP, PHIL
2SB91	P—a. amp.	2N535B	ETC, PHIL
		2N536	PHIL
		0C55	PHIL
2SB97	P—a. amp.	2N535A	ETC, PHIL
		0C58,0C60	AMP, PHIL
2SB122	P—h.v. sw.	2N268	BEN, CLE
		2N268A	CLE
		2N1040	TI
		2N1202	MIN
2SB123	P—l.s. p. sw.	2N456	CLE, RCA, TI
		2N561	ETC
		2N669	MOT
		2N1073B	BEN
		2N1314,2N1315	AMP
		2N1667,2N1668, 2N1669	AMP
2SB123A	P—a. amp.	2N1666	AMP
		CTD1311	CLE
2SB126	P—a. amp.	2N176	BEN, MOT, RCA
2SB149	P—h.c. sw.	2N456A	TI
		2N1168	DEL
		0C29,0C35,0C36	AMP
2SB150	P—sw.	2N398	CPC, GI, RCA, UST
		GT34N	GTC
2SB189	P—a. amp., mp.	2N43A	ETC, G-E, UST
		2N223-2N227	ETC, PHIL
		2N241A	ETC, G-E, SYL
		2N291	ETC
2SB200	P—a. amp., mp.	2N185	ETC
		2N270	ETC
		2N1370,2N1371, 2N1382,2N1383	TI, ETC
		0C74,0C79	AMP, PHIL
2SB201	P—m.p. sw.	2N319,2N320	ETC, G-E, MOT
		2N321	ETC, G-E, MOT, UST
		2N586	ETC, RCA
		2N1125	PHIL
		0C80	AMP, PHIL
2SB202	P—a. amp., mp.	2N1273,2N1274	TI
2SB231	P—l.s. p. sw.	2N378	TUNG
2SB235	P—a. amp., h.p.	2N174	DEL, MOT, RCA, TI
		2N174A	DEL, TUNG
		2N574A	MIN
		2N677B	BEN, SYL
		2N678B	BEN
		2N1099	DEL, MOT, RCA
		2N1146,2N1146B, 2N1147B	CLE

TOSHIBA TRANSISTOR SUBSTITUTION DIRECTORY (cont.)

TOSHIBA NO.	TYPE AND SERVICE	AMERICAN	
		NUMBER	MFGR.
2SB235 (cont.)		2N1358 2N1412 2N1555,2N1559 CTP1296,CTP1297, CTP1503,CTP1551, CTP3504	DEL, MOT, RCA DEL, MOT, RCA DEL, MOT, RCA CLE
2SB236	P—a. amp., h.p.	2N173 2N278 2N574 2N677,2N677A, 2N678A 2N1011 2N1031,2N1031A, 2N1032,2N1032A 2N1558 CTP1226,CTP1504, CTP3503,CTP3508	DEL, MOT, RCA, TI, TUNG DEL, TUNG MIN BEN, SYL BEN, CLE, DEL, MOT BEN MOT CLE
2SB237	P—a. amp., h.p.	2N176 2N277 2N678 2N1147 2N1557 CTP1508,CTP1550	BEN, MOT, RCA DEL, TUNG BEN CLE MOT CLE
2SB257	P—a. amp.	2N175	ETC, RCA, SYL
2SB265	P—a. amp.	2N323 2N324 2N331 2N422 2N464,2N465 2N466,2N467 2N564,2N566, 2N568 2N570 2N1265/5 2N1288 GT20,GT34, GT122,GT1604	ETC, G-E, SYL, UST ETC, G-E BEN. ETC, GI, ITC, MOT, RCA, UST ETC, RAY, SYL, UST ETC, GI, ITC, MOT, RAY, SYL, UST ETC, GI, ITC, MOT, RAY, SYL, UST ETC, GI, ITC GI, ITC SYL G-E GI
2SC11	N—sw.	2N211 2N212 2N216 2N233 2N233A 2N515,2N516, 2N517	ETC ETC, SYL ETC ETC, SYL ETC ETC
2SC13	N—bc. i.f. amp.	2N94,2N94A 2N438, 2N439 2N448,2N449 2N1058 2N1198	ETC, SYL CPC, ETC, GI, SYL CPC, ETC, SYL ETC, G-E SYL ETC, G-E
2SC14	N—m.s. sw.	2N440 2N312	CPC, ETC, GI, SYL ETC, GTC
2SC16	N—h.s. sw.	2N1409,2N1410	GI, PSI, RHE
2SC17	N—m.f. amp.	2N754,2N755	TEC
2SC19	N—h.s. sw.	2N560 2N1252,2N1253 ST1527,ST1528	NAS, WEC FSC, GI, ITC, RHE, TI TEC
2SC20	N—h.f. amp.	2N1205 ST1523,ST1524	TRAN TEC
2SC21	N—h.f. p. amp.	2N1208,2N1209, 2N1212 2N1657	TRAN RAY
2SC43	N—a.f. amp.	2N214 2N1059	SYL ETC, SYL
2SC44	N—bc. i.f. amp.	2N213,2N213A	SYL
2SD43	N—l.s. sw.	2N444A 2N647 GT229,GT949	CPC, ETC, GI ETC, RCA GTC
2SD44	N—bc. i.f. amp.	2N35 2N228	ETC, G-E, SYL ETC, SYL
2SD44 (cont.)		2N306 2N1010 2N1310,2N1311 2N1312	ETC, SYL ETC, RCA CPC, ETC, GI CPC, GTC
M8062A	P—a. amp.	2N207B 2N535A 0C58,0C60	PHIL ETC, PHIL AMP
M8062B	P—a. amp.	2N105 2N207A 2N535B 0C53,0C54,0C56 0C57,0C59	ETC, RCA PHIL ETC, PHIL AMP AMP, PHIL
M8062C	P—a. amp.	2N207 2N535 2N536 0C55	PHIL ETC, PHIL PHIL AMP
M8099	UNI—l.s. sw.	2N489-2N494	G-E
M8105	N—m.s. sw.	2N445A	CPC, ETC, GI
M8116	P—h.s. sw.	2N602-2N604 2N1395	CPC, GTC, SYL RCA
M8120	N—h.s. sw.	2N377 2N377A 2N385 2N385A 2N388 2N388A 2N438A 2N439A 2N440A 2N446,2N446A 2N447 2N585 2N587 2N634, 2N634A 2N635 2N635A 2N697 2N1090 2N1114 2N1169,2N1170 2N1302 2N1304 2N1306 2N1605 2N1605A 2N1624 2N1672 2N1685 GT903,GT905 GT947-GT948 GT1607,GT1609	CPC, ETC, G-E, GI, SYL CPC, SYL CPC, ETC, GI, SYL CPC, GI, SYL CPC, ETC, PHIL, G-E, GI, SYL CPC, SYL, RCA. TI CPC, ETC, GI, SYL CPC, ETC, GI, SYL CPC, ETC, GI, SYL CPC, ETC, GI ETC, GI CPC, ETC, GI, RCA, SYL CPC, ETC, SYL CPC, ETC, G-E G-E CPC, ETC, G-E G-E FSC, HSDC, ITC, NAS, PSI, RHE, SSD, TEC, TI, UST CPC, ETC, GI, MOT, RAY, RCA ETC, SYL RCA CPC, ETC, RCA, SYL, TI CPC, ETC, G-E, RCA, SYL, TI CPC, G-E, SYL, TI GTC, RAY, RCA, SYL GTC, RCA, SYL GI GI SYL
M8121	N—h.s. sw.	2N699	FSC, ITC. NAS, RHE, SSD, UST, TI
M8126	N—h.s. sw.	2N698	FSC, NAS, RHE, SSD, TI

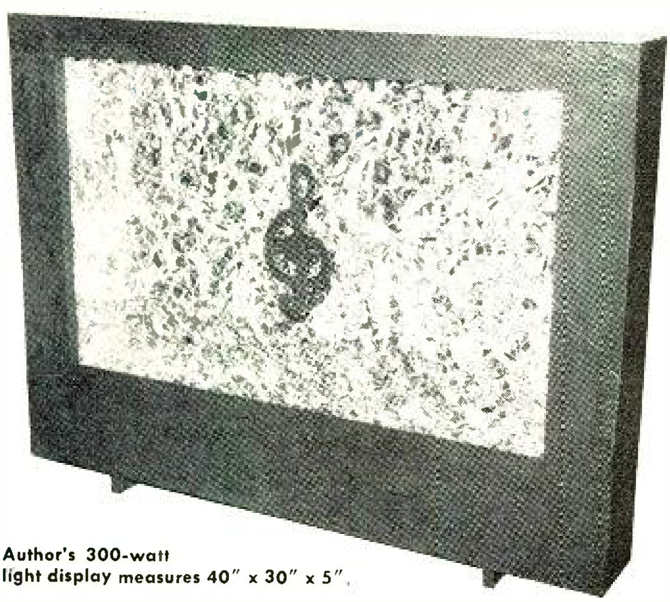
P—"p-n-p"; N—"n-p-n"; a.amp.—audio amplifier; a.p. amp.—audio power amplifier; a.amp. mp.—audio amplifier, medium power; a. amp., hp.—audio amplifier, high power; bc. con.—broadcast converter; bc. i.f. amp.—broadcast i.f. amplifier; bc. osc.—broadcast oscillator; h.f. amp.—high-frequency amplifier; h.s. sw.—high-speed switch; h.c. sw. —high-current switch; hv. sw.—high-voltage switch; ls. sw.—low-speed switch; l.s. p. sw.—low-speed power switch; m.s. sw.—medium-speed switch; m.p. sw.—medium power switch; s-w.i.f. amp.—shortwave i.f. amplifier; uhf. amp.—u.h.f. amplifier; vid. amp.—video amplifier; vhf. amp. con.—v.h.f. amplifier-converter; UNI—unijunction. AMP—Amperex, BEN—Bendix, CLE—Clevite, CPC—C. P. Clare Transistor, DEL—Delco, ETC—Electronic Transistor Corp., G-E—General Electric, GI—General Instrument Corp., HSDC—Hoffman Semiconductor Corp., ITC—Industro Transistor Corp., MOT—Motorola, MIN—Minneapolis-Honeywell, NAS—National Semiconductor Corp., PHIL—Philco, PSI—Pacific Semiconductors, RAY—Raytheon, RCA—Radio Corp. of America, RHE—Rheem Semiconductor, SPR—Sprague, SSD—Sperry Semiconductor Corp., SYL—Sylvania, TEC—Transitron, TI—Texas Instruments, TUNG—Tung Sol, UST—U.S. Transistor Corp., WEC—Western Electric.



SOLID-STATE 3-CHANNEL COLOR ORGAN

By DONALD LANCASTER

Construction of a well-designed display device that produces changes in the color intensity and hue in step with musical signals. Can be connected to hi-fi amplifier and will handle 1 kw. of light power.



Author's 300-watt light display measures 40" x 30" x 5".

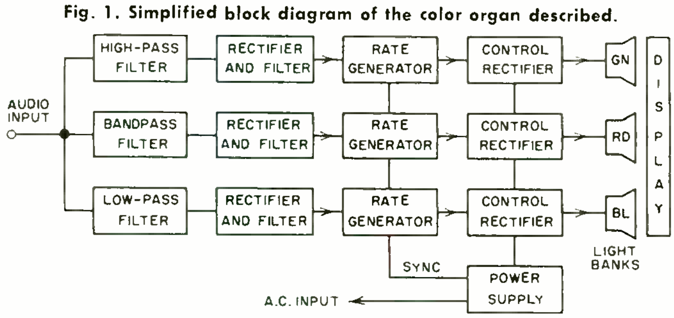
A COLOR organ may be broadly defined as any device that somehow relates a lighted display to an associated musical background. This is usually done in such a way that various colors correspond in some manner to certain frequencies in the musical selection.

A color organ typically consists of three filters separating the high-, mid-range-, and low-frequency component of the music, followed by circuitry allowing the control of the three primary light colors in a suitable display. In the past, color organs have been either too large or too small in scope or performance for average home hi-fi use; also, high cost and a "too electronic looking design" have discouraged popular acceptance. It is felt that the present design overcomes some of these objections.

The color organ to be described consists of two units, a control box the size of several books, and its associated display, the size of a bookshelf. The former is capable of handling up to 360 watts per channel of regular 120-volt light bulbs, parallel connected, giving a total power capability of around one kilowatt. The control box operates off the loudspeaker terminals of any music system and consumes less than one watt of audio power. Efficiency is over 97% at full output, and control-box heating is negligible. Power "on-off," red drive, blue drive, and green drive are the only controls necessary. The over-all level is adjusted to meet average listening requirements by changing taps inside the unit; once set on a given music system, adjustment is unnecessary. The filters that separate the music into its components are adjustable to select the portions of the audio spectrum and to compensate for the nature and quality of the program material.

Fig. 1 is a block diagram of the system. It is first nec-

Fig. 1. Simplified block diagram of the color organ described.



essary to divide the audio spectrum with the filter system. This is accomplished by a high-pass, bandpass, and low-pass filter network. Adjustable *LC* filters were chosen for their availability, their uniformity, and their steep slopes beyond cut-off.

Next, it is desirable to derive a d.c. control voltage from the filter output. A drive control at this point adjusts the maximum value of a given filter output. This is followed by a rectifier and filter network.

The actual illumination level is controlled by varying the duty cycle of the a.c. wave impressed on the load. This is shown in Fig. 2A. For convenience, alternate cycles are inverted by means of the full-wave rectifier to insure only positive or zero values of voltage. This does not affect load power.

A silicon-controlled rectifier (SCR) in series with each lamp load behaves as a simple switch, turning on when its gate is pulsed and remaining on for the rest of the cycle. The SCR turns off as its anode voltage approaches zero.

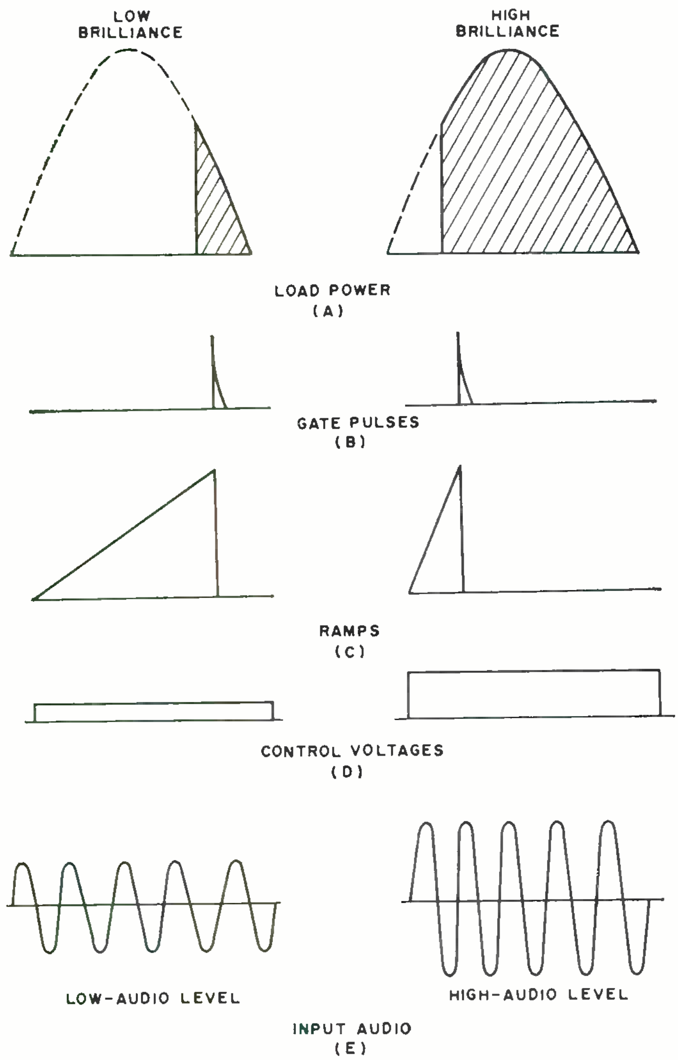
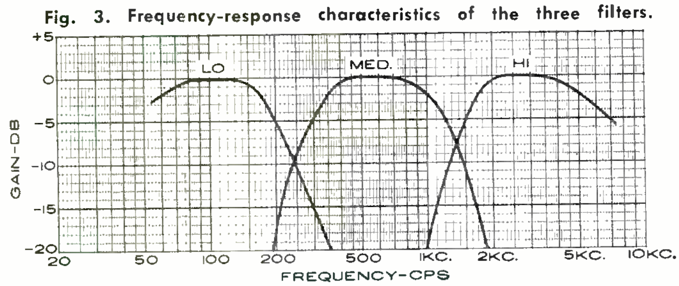


Fig. 2. Waveforms showing response of one channel to audio input.

Fig. 3. Frequency-response characteristics of the three filters.



Control box (8" x 6" x 4") can handle 1 kw. of lighting power.

Figure 2B illustrates the gate pulses that are required.

The remaining block, as shown in Fig. 1, is the key to the control-box operation. This is the rate generator. This circuit converts the d.c. control signal from the filter to a time delay that determines when in the cycle the SCR will fire. Note that the greater the d.c. control signal, the *earlier* in the cycle the SCR will fire. This is accomplished by a saw-tooth oscillator, which always starts as the a.c. cycle passes through zero and stops, or discharges, after reaching a predetermined value. A gate control pulse is produced during the discharge. The input d.c. control signal determines the *slope* of the saw-tooth, and thus the time delay. A large d.c. control voltage will cause a steep slope and a very early discharge and SCR firing; a small signal will cause a gradual slope and a firing near the end of the cycle; while no signal at all will prevent the SCR from firing during that cycle. A synchronizing circuit always fires the rate generator during the zeroes of the a.c. voltage. This assures the same delay for a given control signal.

The SCR is also triggered at the a.c. zeroes, but will not remain on at this point. The net effect is to produce a negligibly small pulse of load power at this point—one that is not visible. Fig. 2C illustrates the ramps produced while Fig. 2D represents the control voltages, and Fig. 2E shows the original audio signals that produce the indicated result.

A detailed explanation of the rate generator and SCR theory is available elsewhere and will not be repeated here.

It should be noted that full-wave control of the light bulbs exists and, unlike some thyratron controls, the bulbs will light to full normal brilliance if enough audio signal is present. The forward drop of the SCR is considerably less and thus the SCR is more efficient than a gas thyratron.

Circuitry

The circuit diagram of the color organ is given in Fig. 4. Considering the obvious first, *S*1 is the power switch and must be capable of handling full-load current. As d.c. bridge circuitry is employed, a fuse is a desirable and necessary item. This, too, is rated at maximum load current. *PL*1 serves as the indicator and receives its voltage through the reactive drop of *C*15. *SR*1, *SR*2, *SR*3, and *SR*4 are the inverting power diodes. These handle the total load current and must withstand the peak inverse of the applied line voltage. Zener diode *CR*4 and *R*1 serve the dual function of providing a stable voltage for the rate generators and also provide the synchronizing pulses required to fire the rate generators as the a.c. voltage swings through zero. *R*1 is a high-wattage unit that develops considerable heat and thus it should be located well away from the rate-generator circuitry.

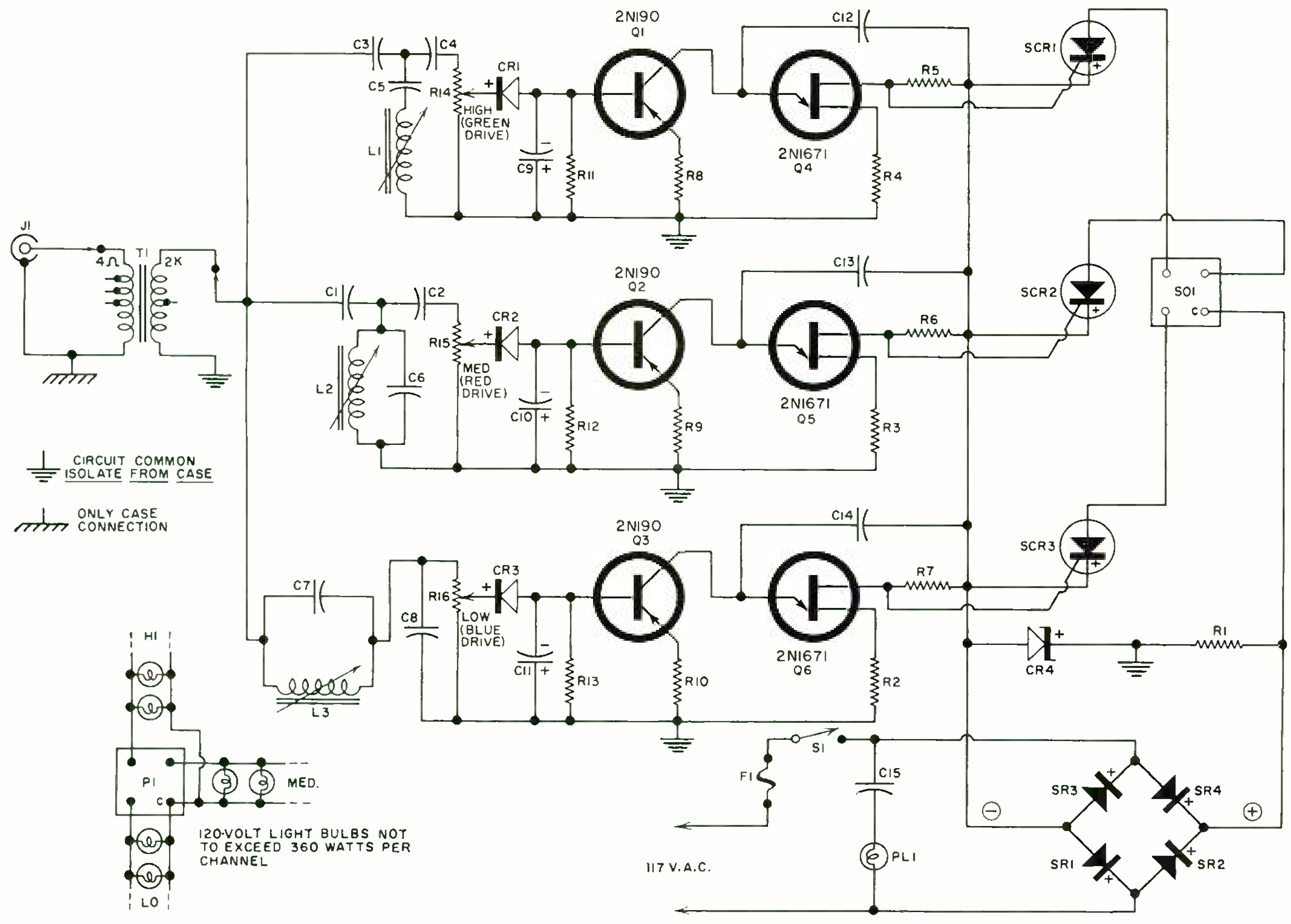
Having dispensed with the power-supply circuitry, the signal flow through the circuit may be traced. The signal enters *via* shielded cable to transformer T1. T1 serves two important purposes: First, it allows a suitable choice of drive signal and impedance matching and second, T1 isolates the bridge circuitry from the music system. Should any part of the circuit beyond T1 be grounded, the full line voltage will appear across CR4 causing the immediate and untimely death of this component, as well as possible other damage. Also note that a person coming in contact with this common may encounter *twice* the normal line voltage between this common and the nearest earth ground such as a radiator or water pipe. As long as the only case connection is made at J1 and as long as T1 remains in the circuit, there is no potential shock hazard.

The signal splits beyond T1 and enters the filters. The filters are, respectively, an *m*-derived high-pass, a prototype bandpass, and an *m*-derived low-pass filter. The response curves are shown for typical inductor settings in Fig. 3. The steep slopes give brilliant crescendos of color as the crossover point is reached in the music content. The inductors used employ variable ferrite cup cores which have the advantages of very small size, wide tunability, and negligible external field. Their disadvantages are very high cost and a lack of ready availability. A single cup core is capable of providing as much as 6 henrys ± 2 henrys inductance in a two cubic inch package. The cup core finds wide application in tone telemetry systems. Suitable substitutes are discussed later in this article.

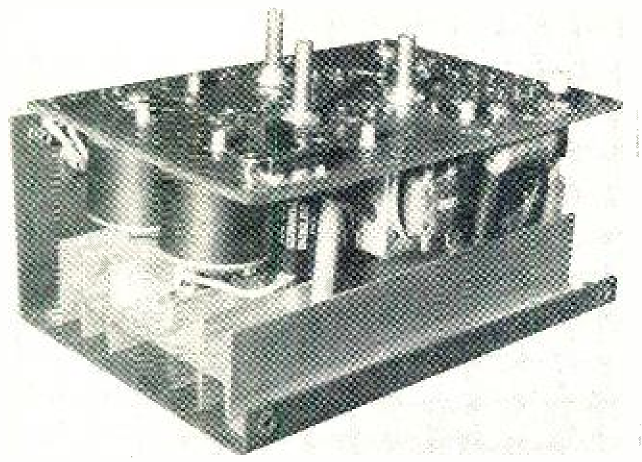
Very little, if any, interaction was noted, so no isolating impedances are used between the filters. R14, R15, and R16 are the drive-control potentiometers and are 2-watt linear-taper controls. CR1, CR2, and CR3 rectify the separate channel audio signals. These signals are filtered by C9-R11, C10-R12, and C11-R13. These capacitors differ in value since more filtering is required in the lower frequency channels. Excessive filtering causes objectionable time lag effects, while insufficient filtering allows audio to foul up the rate generators.

Q1, Q2, and Q3 are the slope generators. They are *p-n-p* transistors. The apparent collector-emitter impedance is a

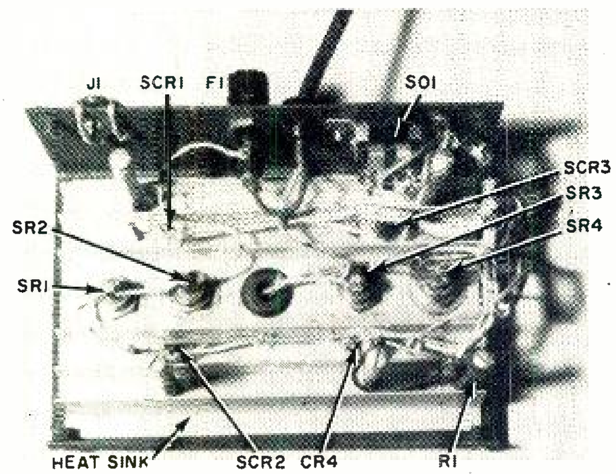
Fig. 4. Schematic of the color organ. Silicon-controlled rectifiers driven by unijunction transistors operate the light bulbs.

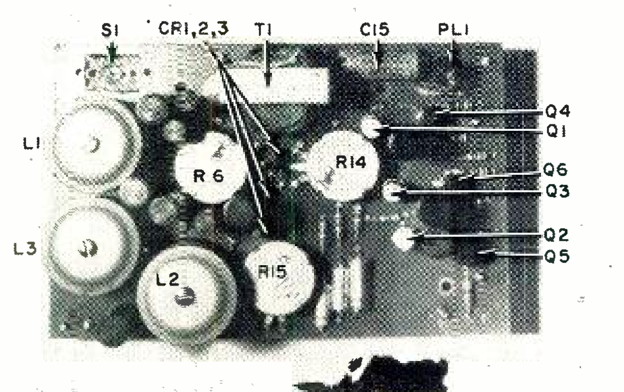


R1—3000 ohm. 10 w. wirewound res.
R2,R3,R4—390 ohm, ½ w. res.
R5,R6,R7—47 ohm, ½ w. res.
R8,R9,R10—3300 ohm, ½ w. res.
R11,R12,R13—4700 ohm, ½ w. res.
R14,R15,R16—5000 ohm. 2 w. linear-taper pot
C1,C2,C5,C8—.1 μf., 200 v. capacitor
C3,C4—.02 μf., 200 v. capacitor
C6—.15 μf., 200 v. capacitor
C7—.015 μf., 200 v. capacitor
C9—1 μf., 25 v. elec. capacitor
C10—5 μf., 25 v. elec. capacitor
C11—10 μf., 25 v. elec. capacitor
C12,C13,C14—.033 μf., 200 v. capacitor ± 10%
C15—1 μf., 200 v. paper or oil-filled capacitor
SR1,SR2,SR3,SR4—1N250, 10 amp., 200 p.i.v. power diode
CR1,CR2,CR3—1N34A, 100 ma., 50 v. diode
CR4—1N1820. 20 v. 10 w. zener diode
SCR1,SCR2,SCR3—Silicon-controlled rectifier (Texas Instruments Type T1-40A2, 200 v. p.i.v.)
L1—.25 hy. variable inductor (see text)
L2—1.5 hy. variable inductor (see text)
L3—4.5 hy. variable inductor (see text)
T1—Universal audio output trans. 4-14,000 ohm pri. to 2,4,8,16 ohm sec. (see text)
PL1—28 v., 40 ma. pilot light (Dialco)
F1—3AG 8-amp fuse
J1—Audio connector (coax.)
S1—S.p.s.t. heavy-duty slide or toggle switch
SO1—Female connector (Jones S-404AB)
P1—Matching plug (Jones)
Q1,Q2,Q3—2N190 "p-n-p" transistor (or equiv.)
Q4,Q5,Q6—2N1671 unijunction transistor
Substitutes for cup-core filters:
L1—UTC #VIC-8, Triad #C-47V, Stancor #C-2317
L2—UTC #VIC-12, Stancor #C2327, Thordarson #26C40, Triad #C-21V
L3—UTC #VIC-14, Triad #C-6X, Thordarson #26C42, Stancor #C-1706
The UTC units are tunable toroids and are higher in cost than fixed values. All other are non-variable fixed inductors. Filter values might require alteration.



Control box of the color organ shown here with cover removed.





Heat sink and chassis-mounted co[illegible] shown at the top. At the bottom is the circuit board and associated components.

function of the base drive current. This variable impedance serves as a variable resistance, which, respectively, charges timing capacitors *C*12, *C*13, or *C*14. These capacitors are discharged after reaching a critical value by unijunction transistors (UJT) *Q*4, *Q*5, and *Q*6. A pulse is produced across *R*4, *R*3, or *R*2 as the respective UJT fires. This is the gate-control pulse. *R*8, *R*9, and *R*10 serve as current-limiting resistors, while *R*5, *R*6, and *R*7 act as the respective UJT load resistances. It may be noted that the circuitry from the d.c. filters onward is simply in triplicate.

The heart of the unit is the three silicon-controlled rectifiers *SCR*1, *SCR*2, and *SCR*3, rated to handle maximum channel load current and peak forward line voltage. The units chosen, the *Texas Instruments* Type TI-40A2, represent a good compromise in performance, economy, and availability. *SO*1 is the output jack which should be female for safety reasons. It should be capable of handling total display current.

The display circuitry is straightforward, consisting of three strings of lamp sockets sharing a common connection. Heavy cable should be used between control box and display since up to 9 amperes of current may be handled.

Display Considerations

The display, as chosen, is intended for home hi-fi use or as a frontispiece for a small band. Its size and configuration are primarily determined by the materials available and the over-all effect desired. The unit measures 40″ x 30″ x 5″, not including the small feet, and is constructed of 3/16″ plywood, using glue and small wood screws. The reflective liner is simply heavy-duty aluminum foil (freezer foil) crumpled and stapled in position to the back panel of the display. The display unit is finished flat black. A white Formica top adds a professional touch and saves some surface finishing. The treble clef is merely ornamental and is supported by two long 8-32 machine screws. The display has a dozen cleat sockets in the bottom for the light bulbs. These are wired as follows: low (blue), low (blue), low (blue), med. (red), low (blue), med. (red), med. (red), hi (green), med. (red), hi (green), hi (green), hi (green). This was found to give a uniform spectrum of color and avoids sharp discontinuities between color channels. Regular 25-watt, 120-volt colored light bulbs are used. Note that four lamp bulbs are used for each of the three channels and they would consume 100 watts of power per channel with the lamps fully lighted. In operation about 70 watts is used per channel. As the circuit stands, as many as fourteen 25-watt bulbs could be handled in each of the three channels, if considerably more light is desired.

Additional lights across the top of the display would balance the final appearance, but this is hardly necessary. The display is quite visible even under high room illumination. The best over-all color effect is obtained in a subdued lighting area. The control box is capable of driving three or four displays simultaneously, or a single large display.

Packaging

The control box is a spot-welded steel box with a brushed aluminum top plate and is finished in heavy gray wrinkle. The electronic components fall naturally into three groups.

The first group is the chassis-mounted parts, which consist of the input and output connectors, the line cord, and the fuse. The second group consists of all high-current devices, which mount on a piece of extruded heat sink, using insulated mounting techniques. The power diodes, *R*1, the zener synchronizing diode, and the three silicon-controlled rectifiers mount on this sink. In continuous operation, a slight temperature rise of the sink will be noted, but hardly enough to justify venting the control box.

A printed wiring board mounts the third group of components, consisting of the cup cores, the rate generators, all small parts, the switch, and the pilot light. Interconnections are made by way of solder terminals and small wire jumpers. Spacers separate the circuit board and the heat sink. A ⅛″ circuit board was used, single copper clad.

Four rubber feet and three *Raytheon* color-cap knobs complete the package; the knob colors correspond to the channel colors and are in the relative position as the channels appear in the display. The top plate is 1/32″ aluminum, wire brushed and anodized with lye. Decals and a plastic spray coat complete the construction of this panel.

Home Construction

The shop methods and production techniques used in the construction of this unit are merely for convenience and, by making several obvious changes, the unit may be easily duplicated by the home constructor.

The use of a larger box and wired circuitry is recom-

(*Continued on page* 76)

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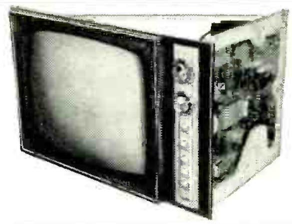

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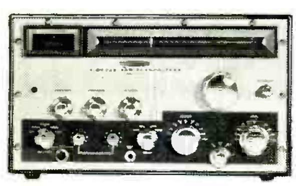

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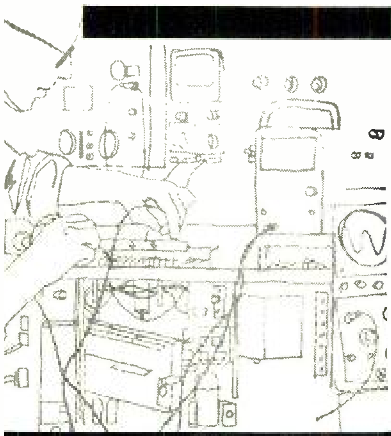


MAC'S ELECTRONICS SERVICE

By JOHN T. FRYE

Parts Improvement

FOR the past half hour Barney had been busy checking stock and preparing a parts order for the salesman due that afternoon. Now he and Mac, his employer, were taking a short break.

"Mac, I'll bet you've seen a big change in replacement parts during the time you've been servicing," the youth suggested, hoping to start the older man reminiscing and so stretch out the recess.

"You can say that again," Mac agreed as he lighted his pipe. "I became interested in servicing just as battery radios were going out and all-a.c. jobs were coming in; so I remember the parts used in both types quite well. Actually battery sets didn't have many parts. Tubes, sockets, coils, tuning capacitors, audio transformers, filament rheostats, earphone and speaker jacks, cone or horn-type speakers—that about covered it.

"A battery set 'chassis' was usually just a board with a Bakelite panel screwed to the front edge. The parts were mounted on top of the board, and all the wiring was in plain view when you raised the hinged lid of the radio and peered in. For that reason considerable effort was made to pretty up the wiring. Shiny tinned bus bar leads always ran parallel to one edge or the other of the board, with precise right-angle bends being carefully executed to accomplish this. Fancier jobs used square bus bar or lengths of colored spaghetti tubing slipped over the rigid wiring."

"That probably looked pretty, but I'll bet the unnecessarily long leads didn't contribute much to efficiency," Barney observed.

"You know it!" Mac agreed and then continued: "Coils in these TRF sets varied in shape and construction, but they were uniformly huge in size—at least by modern standards. A common type consisted simply of a couple of windings on a Bakelite tube some two or three inches in diameter, but another called the 'binocular coil' had the wire wound in figure-eight fashion around two smaller Bakelite tubes mounted side by side. The 'spider web' coil was also a favorite. In this the wire was woven in and out of radial slots cut into a circular sheet of Bakelite or between wooden spokes jutting from a central hub. These coils were mounted right out in the open with no shielding; so they had to be well separated to prevent interstage inductive coupling."

"Why were they so large?"

"I'm not sure, but I suspect the design engineers were trying to achieve as high a '*Q*' as possible with these air-core coils in order to improve selectivity and develop as much voltage as possible across the tuned circuits. They needed all the selectivity and gain they could get. Then, too, it was common to measure the sensitivity of these early receivers by seeing how far you could receive on how short an antenna. A set with these big coils acting as so many loop antennas would have a great deal of signal interception without any wire attached to the antenna post at all."

"How about fixed capacitors?"

"Only two or three mica capacitors, including the one across the grid-leak of the detector, were used in the battery sets. These were sandwiches of interleaving brass and mica sheets. Each brass sheet had a little tongue with a hole in it that protruded from one end or the other of the sandwich, and a hollow rivet fastened each set of tongues together to form a terminal. The capacitors were bolted into the circuit with screws through these rivets. The 'sandwich' was held together with a metal band crimped around it or by being clamped between two boards of wax-impregnated fiber. One of these units was five to ten times as large as a modern mica capacitor of similar value and voltage rating.

"Naturally there were no filter capacitors in the battery sets, but the a.c. receivers had to have them. The first a.c. sets used separate 'power packs' to supply filament and plate voltage. This pack ordinarily rested on a shelf of the console cabinet below the chassis shelf and was connected to the chassis by a multi-wire cable. The power pack contained the power transformer, filter chokes, filter capacitors, rectifier tube, and occasionally a line ballast resistor. Filter capacitors were of the tinfoil-and-waxed-paper type and were all arranged inside one pitch-filled can."

"What did you do when a filter capacitor shorted?"

"First we tried to burn the short open with high-current a.c. If the fuses gave up before the short circuit did, we next tried to find room inside the crowded power pack for an outboard replacement. Failing there, we usually replaced the whole filter can. Some neat and hardy souls actually melted the pitch in an oven, hauled the whole sticky mess from the can, removed the defective unit, wired in a replacement, put the capacitors back in the can, and poured the re-melted pitch over them."

Mac paused to relight his pipe and then continued with a grin: "The first time one of those design engineers tipped his console cabinet back too far and had the power pack fall out and rip all the wires loose from the connecting board, he decided to put the power supply on the chassis. The wet electrolytic capacitor came along at about the same time. The first ones were copper cans about the size of a pint fruit jar. A clamping ring attached this can, that was also the negative electrode, to the chassis. Two or three threaded positive electrodes stuck up through a Bakelite cap crimped in the top of the can. Each cell was usually rated at 8 μf. at 450 volts. A little rubber nipple the size of a lead pencil eraser covered a hole in this cap and was intended to take care of gas expansion. Before long this nipple rotted, and when you turned the chassis over to get at the wiring the gooey electrolyte ran out all over your bench.

"The first paper bypass and coupling capacitors were simply miniature versions of the filter capacitors. They, too, were potted in metal cans bolted to the chassis. One manufacturer used his own brand of Bakelite-cased coupling and bypass capacitors and thereby earned the undying hatred of practically all service technicians. Solder lugs were attached to the top of the case with hollow rivets, and leads from the capacitor foils were brought out through these rivets, pulled taut, wrapped around the lugs, and soldered. Heating expansion soon pulled the leads loose from the foil and created the most maddening form of intermittent you ever saw. A standard service tool of the era was a broken needle thrust into the end of a little wooden stick. This needle was pushed down a rivet hole alongside the lead and worked around. If this caused the signal to go and come or change in volume or caused the set to break into oscillation, you knew you had found *one* intermittent capacitor; but the receiver very likely had others. The first paper cartridge capacitors were poorly sealed, and they soon absorbed moisture and became leaky. It was not at all unusual to

CIRCLE NO. 130 ON READER SERVICE PAGE

change half a dozen capacitors in a receiver in for service on some other complaint."

"How about resistors?"

"Early carbon resistors were bulky, prone to change resistance, and not color-coded—at least with a universal code. Each manufacturer had his own way of marking resistors to indicate value. Leads, instead of coming out axially, were wrapped around the ends or attached to metal caps slipped over the ends of the resistor. High wattage wire-wound resistors were generously employed as bleeder and voltage divider resistors, and they opened up frequently and had to be replaced. A special type of resistor that consisted of a strip of carbonized paper wound spirally around a ceramic form required still more frequent replacement.

"Speakers for the a.c. receivers were field-coil dynamics weighing considerably more than a whole clock radio does today. Heavy currents through the field coils were necessary to produce sufficient magnetism. Not only did this place a heavy strain on power supply components, but the coils themselves opened up very often. Hardly any two of them were alike. Physical dimensions varied widely; so did resistance values. Some coils were tapped to provide screen voltage or, if the field coil was in the negative lead, bias voltage. Removing the coil was often almost a blacksmithing job; and if you weren't mighty careful, you damaged the voice coil in the process and then had the doubtful pleasure of replacing the speaker cone in addition.

"The superheterodyne receiver brought us i.f. transformers, but they were big affairs compared to the peanut-sized units in transistor radios or even the miniature transformers used in tube sets today. Shield cans were usually four or five inches high and two or three inches in diameter. I.f. frequencies were anywhere from 150 kc. to 485 kc.; so a complete set of replacement transformers represented quite an investment for the serviceman.

"A tube stock, on the other hand, was amazingly simple. If you had a few 26, 27, 24, 35, 45, 47, and 80-odd type tubes, you were in business. Of course you might now and then need an oddball special tube for a *Sparton* receiver or a 71A for an early a.c. set, but you certainly didn't need the hundreds of replacement types we must stock today. Tube quality, however, was not nearly so reliable; and we replaced lots and lots of tubes.

"We replaced several items you might never think of today. Take tuning capacitors, for instance. Those TRF jobs used four-section capacitors all on a single shaft. Plates warped until you could no longer keep them from rubbing, or plating on those plates loosened and shorted out the capacitors, making replacement mandatory. How long has it been since we replaced a tuning capacitor? For that matter, since when have we put a new interstage or power transformer in a radio? or a line-cord resistor? or an antenna coil? or a saturable reactor that causes the dial lighting to change color when the broadcast station is tuned in?"

Mac knocked the ashes from his pipe against the palm of his hand before he continued. "The point I'm making is that replacement part business in radios has been going down hill steadily for years. Had it not been for the advent of TV with a whole new bunch of parts to stock and replace, this would have been obvious much sooner; but now TV replacement part business is going the same way.

"Simplification of circuitry accounts for some of this. Engineers are working constantly to do the job as well or better with fewer parts. Then electronic components are improving all the time. They are smaller, lighter, better, and more durable. As for tubes, do-it-yourself tube checkers certainly have cut into our tube sales. All of these have combined to cause a slow but steady reduction in the number of parts we sell per unit serviced."

"What can we do about it?" Barney wanted to know.

"The only thing we can do is shift more of the charge to service to make up for loss of income from parts sale," Mac said. "It's easy to justify this. There's no comparison between the training necessary to service the myriad of complicated radio and TV sets on the market today and the few simple types of radios sold when I started. The same goes for service equipment. I have twenty-five dollars invested in equipment now for every dollar I had invested then. Finally, the technician today is a long, long way from the parts-replacer of that early era. A great deal of our time and effort is spent in careful diagnosis and precise adjustment of the electronic equipment on which we work. A defective part, when it does go bad, is likely to be much harder to locate."

"I guess we can take our cue from the doctors," Barney suggested. "They used to sell practically all the medicine, but now that the drug stores have taken this over, they have just upped their fees for diagnosing and writing prescriptions."

"That's right," Mac agreed; "and now, if you think you have kept me talking long enough, is it all right if we get back to work?"

"Roger, Boss," grinned Barney, "but don't think this was nothing but a 'snow job,' I learned a thing or two, too!" ▲

ELECTRONIC CROSSWORDS

By DONALD W. MOFFAT

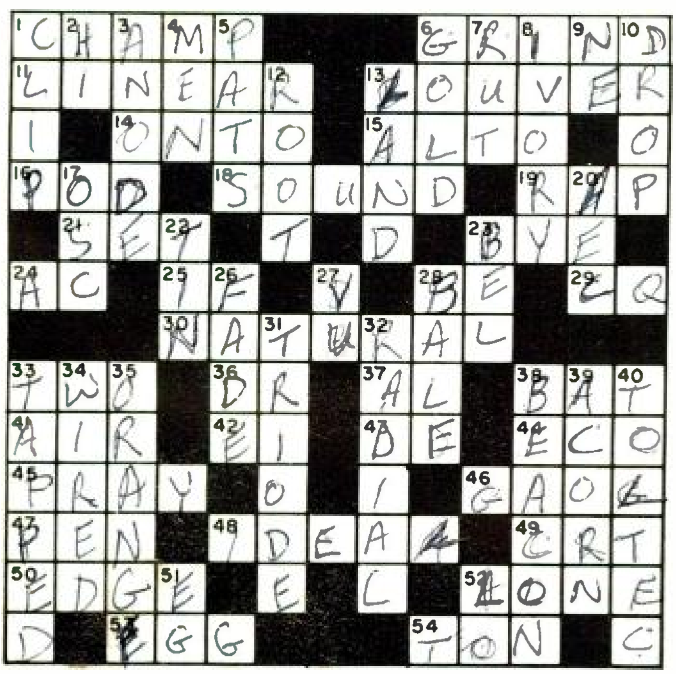
(Answer on page 94)

ACROSS

1. Person who usually wins.
6. Do this to raise crystal frequency.
11. Straight-line function.
13. Slotted cover.
14. Placed on.
15. The lowest female voice range.
16. Appendage on airplane.
18. Produced by a loudspeaker.
19. Action taken to check for microphonics.
21. Adjust to correct position.
23. Said when leaving (familiar).
24. Type of current necessary for a squirrel cage motor.
25. Before the second detector (abbr.).
28. Commonly alloyed with copper (chem.).
29. General ham call.
30. Unaffected.
33. Red on the color code.
36. 1/16 ounce (abbr.).
37. Man's nickname.
38. Used in national pastime.
41. Atmosphere.
42. Power formula.
43. Small destroyer (abbr.).
44. Cut-off voltage (abbr.).
45. Beseech.
46. British jail.
47. Writing tool.
48. Best.
49. Waveforms are seen on this (abbr.).
50. Farthest from center.
52. With no one else.
53. Yields chicken.
54. Large weight.

DOWN

1. Alligator _ _______.
2. Informal "hello."
3. Part of tube.
4. Homo sapiens.
5. Soft, friendly hits.
6. Expensive element often used for plating.
7. Worn path.
8. Elephant tusk.
9. Forty-five degrees (abbr.).
10. Reduction in voltage.
12. Exponent of 1/2.
13. Between grooves of phonograph record.
17. Generates signal (abbr.).
20. Government department responsible for controlling the atom.
22. Component of solder.
23. Ten decibels.
26. Loss of signal strength.
27. Unit of audio strength.
28. Large bundle.
31. Tube which has high plate-grid capacity.
32. Emanating perpendicular to axis.
33. Having intermediate connections.
34. Connected with wires.
35. Third band on a 12K resistor.
38. Transmitter for locating.
39. Small r.f. tube.
40. Indian succeeded by Aztec.
51. Grid voltage (abbr.).
52. Part of superhet (abbr.).



New CB Circuits

(*Continued from page* 49)

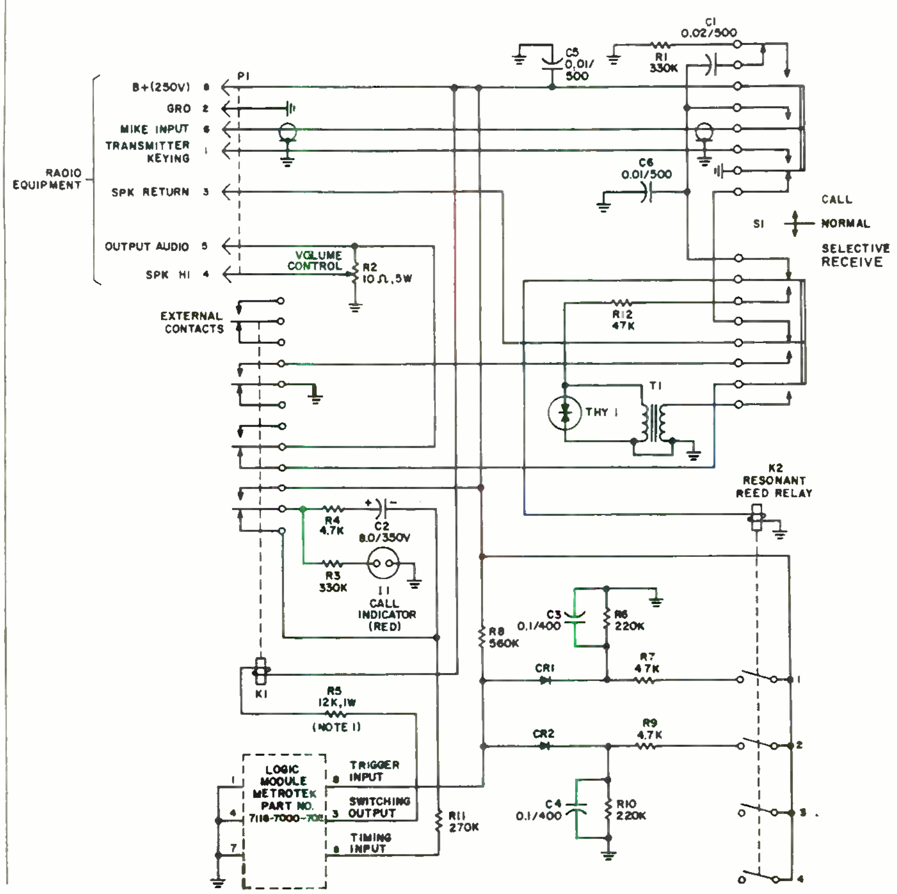
tion to reduce false responses from interference or heterodynes.

The diagram includes both encoder and decoder elements. During the encoder mode the device generates a two-tone signal which subsequently couples to the CB rig's mike input and modulates the transmitter. The action starts up S1 (upper right), a manually operated switch with the three positions indicated: "Call," "Normal," and "Selective Receive." In the following description, the center pole of each S1 section is visualized in the up, or "Call," position. As the switch is flipped to "Call," the B+ source is momentarily applied through *C*1 to the winding of the resonant reed relay, *K*2. A transient pulse of current surges through the relay coil causing reeds 1 and 2 to vibrate at their resonant audio rates. (The remaining reeds, 3 and 4, are kept immobile by mechanical damping sleeves. Two reeds are in use at a given time, but the total of four permits a choice of six possible two-tone combinations.)

The B+ pulse to the relay subsides in approximately 20 milliseconds and the two active reeds display rapidly decaying mechanical motion. During the brief interval which follows (about ⅛ second), magnetic flux changes create electrical currents precisely at the resonant frequency of each reed. Thus, two discrete signals of short duration are introduced to the CB mike input (upper left) and are transmitted as the two-tone code.

To discover what occurs at the receiving end in the decoding process, imagine the circuit in the "Selective Receive" position. All movable contacts on S1 are now visualized in the down position. The two-tone signal from CB audio output enters the unit through terminal 5 (upper left). It passes through various contacts, couples through step-up transformer *T*1 and reaches the winding of resonant reed relay *K*2. Since the correct code combination has arrived, reeds 1 and 2 are set into resonant motion. Reed output encounters two integrating-diode networks which serve to convert the signals to a single trigger pulse. This is passed to a computer-type logic module which can "decide" whether the correct reed relay closures have occurred. If they have, as in this case, relay *K*1 is energized and the call-indicator lamp is illuminated. Simultaneously, the CB speaker is connected and the operator hears the calling station.

At the end of approximately 10 seconds, *K*1 drops out causing the speaker and lamp to go off. The 10-second period may be varied over a range of 1 to 60 seconds by proper choice of *R*11, one component in the *RC* circuit that holds in relay *K*1 after the initial trigger pulse has entered the logic module. ▲



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 CIRCLE NO. 155 ON READER SERVICE PAGE

REPORT ON

NEW TEST EQUIPMENT

Description and performance of Fisher 300 multiplex generator and RCA WE-95A v.o.m. dynamic demonstrator.

Fisher Model 300 Multiplex Generator

For copy of manufacturer's brochure, circle No. 59 on coupon (page 21).

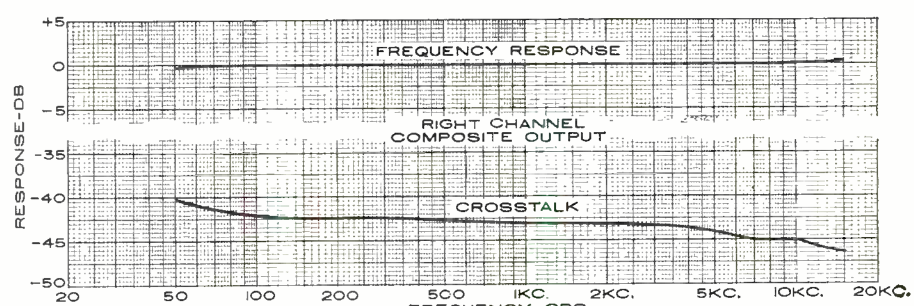
THE servicing or aligning of FM multiplex tuners or adapters requires specialized test equipment not often found in service shops. A multiplex generator is needed to produce the composite signal in accordance with FCC standards. The design and construction of such an instrument is not a simple matter and requires a good deal of engineering "know-how." Commercially manufactured multiplex generators usually sell for as much as $900 or more. For testing tuners, a laboratory-quality FM signal generator must be modulated by the composite signal. Generators with adequate bandwidth and phase characteristics ordinarily sell for $600 to $1400.

Obviously, a need exists for a reasonably priced instrument which can be used by service shops. The *Fisher* Model 300 multiplex generator was designed to fill this need, and does it very well. It contains the composite multiplex signal generating circuits, plus a 100-mc. r.f. oscillator and FM modulator, in a portable unit measuring 8" wide x 10" high x 12" deep and weighing only 17 pounds.

The multiplex generator circuits, like those in *Fisher* tuners, are of the switching type. The output of a 19-kc. crystal-controlled oscillator (factory set to within ½ cycle of 19 kc.) is doubled and used to drive two four-diode electronic switches. These switches chop the left- and right-channel signals at a 38-kc. rate. The chopped signals are combined in an output amplifier and passed through a low-pass filter to remove harmonics of the switching frequency.

The FM generator uses a triode oscillator, tunable from 97 mc. to 103 mc., and a pentode reactance modulator capable of a 300-kc. deviation with only 1% distortion. At the standard maximum deviation of 75 kc., the distortion is typically under 0.2%. Since modulation frequencies up to 300 kc. can be handled, the phase shift under 53 kc. is very small and full stereo separation is maintained.

The Model 300 has a peak-reading meter circuit, which gives a true indication of the deviation of the FM oscillator when a composite signal is applied. Ordinary v.t.v.m.'s are average-responding and cannot be used for this purpose. A built-in audio oscillator supplies either 1 kc. or 8 kc. to the left or right channels for checking stereo separation at middle and high frequencies. In addition to these frequencies, the modulation selector switch allows only the 19-kc. pilot carrier to be transmitted or external left- and right-signal inputs may be used to modulate the 100-mc. carrier. An especially useful feature is the position which modulates the left channel with 60 cps. For routine service alignment, the output of a tuner can be observed on an



oscilloscope and the separation optimized rapidly without the need to read a meter or switch channels. The widely different frequencies give a distinctive and easily recognized pattern on the scope.

On the front panel of the Model 300, in addition to the selector switch and left- and right-input terminals, are output terminals for the composite signal and the 10-kc. pilot carrier, and a BNC connector for the 100-mc. r.f. output. A shielded output cable with clips and BNC connector is supplied. There are individual level controls for the two channels and a composite signal-level control. The meter reads the r.m.s. composite level and is also calibrated directly in kilocycles deviation of the 100-mc. oscillator. There are capped adjustments for phase and amplitude of the 19-kc. pilot carrier, and two push-button switches which are used in making these adjustments. An oscilloscope is needed for pilot phase adjustment; all other normal operating adjustments are done without external instruments.

We measured the separation of the composite signal from the generator on an oscilloscope. It proved to be about 42.5 db over most of the audio range, decreasing to 40 db at 50 cps and actually increasing to 46 db at 15 kc. The frequency response was almost perfectly flat from 50 to 15,000 cycles per second.

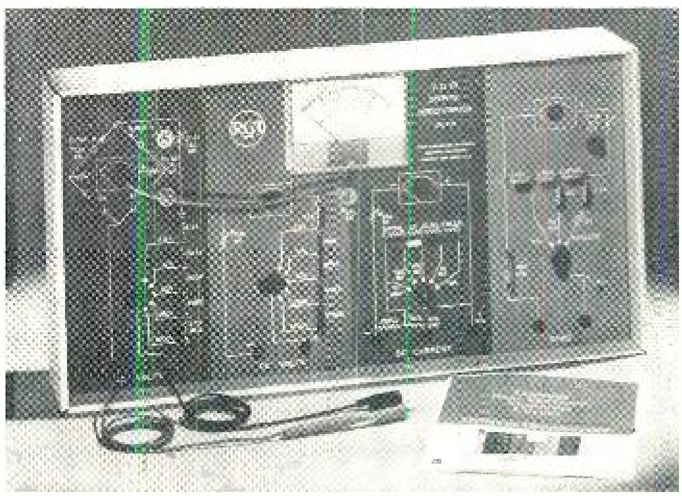
A good quality FM stereo tuner was checked with the generator. The separation and frequency-response figure we obtained agreed almost exactly with those measured with our regular lab signal generator and multiplex generator, which together cost about four times as much as the Model 300. The unit is designed primarily for stereo measurements and does not have a controlled or known r.f. output level. In fact, the output is so large that in most cases no direct connection to the tuner is required, leakage being more than sufficient.

The generator also makes a very good miniature FM stereo transmitter. Audio dealers in areas not served continuously by FM stereo broadcasts can modulate the Model 300 from the output of any good preamplifier (only 0.5 volt of audio is needed) and "broadcast" their own stereo programs to receivers being demonstrated in their stores. We tried this and found that the resulting sound was at least as good as anything we could receive off-the-air, and in some cases much better due to the absence of multipath effects.

Selling for $495, the Model 300 multiplex generator should be a valuable addition to any well-equipped high-fidelity sales or service organization. . . . . . .
Tested by Hirsch-Houck Labs. ▲

RCA WE-95A V.O.M. Dynamic Demonstrator

For copy of manufacturer's brochure, circle No. 60 on coupon (page 21).



RCA has been making "dynamic demonstrators" for training and instruction purposes for a good many years. We can still remember using a rather elaborate one to teach receiver circuits during the War. As we recall, this was a complete multiband superhet, with perhaps a dozen or so tubes, that was laid out on a large demonstration board. The circuit design was spread out so that the student could trace the circuit, and all the components were mounted on the board right next to their circuit symbols. Plug-tipped leads were used to connect, disconnect, or short out the various components so that faults could be simulated. Because all the parts were exposed, actual troubleshooting and alignment could be demonstrated and performed.

The latest in the line of such dynamic demonstrators is the WE-95A v.o.m. which we have just checked. The circuit used in *RCA's* production-type v.o.m. has been converted into this simple-to-assemble kit in which the parts are spread out on a colorful demonstration board for classroom use. To simplify the presentation, the circuits for measuring a.c. voltage, d.c. voltage, d.c. current, and resistance are laid out separately. To switch functions, it is only necessary to plug the meter and test leads into the particular circuits to be studied.

After the instrument has been assembled, it can be used for a wide range of measurements. There are five a.c. voltage ranges from 2.5 to 1000 volts full-scale (at 5000 ohms/volt); five d.c. voltage ranges from 2.5 to 1000 volts full-scale (at 20,000 ohms/volt); five d.c. current ranges from 1 ma. to 10 amp. full-scale; and three resistance ranges with mid-scale readings of 12, 1200, and 120,000 ohms.

The first step in checking out the meter was to go through the a.c. and d.c. calibration procedure outlined in the manual. We used a lab-type v.o.m. as our standard for comparison. Then we checked the d.c. voltage ranges by taking a large number of voltage readings and comparing them with our standard. We found all readings to be within an accuracy of ± 1% and ± 2%. Next, we compared a large number of a.c. voltage readings taken with the WE-95A and with our standard. All such readings fell within ± 2% of the values shown by the standard. The accuracy on both d.c. and a.c. was thus found to be well within the figures usually quoted for general-purpose or service-type v.o.m.'s. Next we measured a number of 1% resistors on the ohmmeter section of the meter. We found all readings to be either exactly correct or off by an insignificant amount.

Since some users might want to employ the v.o.m. for audio measurements, we decided to run a frequency response curve on the a.c. portion of the meter. There is no reason why a v.o.m. cannot be used for such measurements provided circuit impedances are not too high and the signal levels are above the millivolt range. Our audio generator covers the range from 20 cps to 1 mc. Using the lowest a.c. range on the v.o.m. and applying a constant 2 volts to the meter, we were pleased to find the response absolutely flat over the entire range of our generator.

The v.o.m. "dynamic demonstrator" is one foot high by two feet wide so that it can be seen from a distance. The sturdy cardboard box housing the unit can be used as a display stand in the classroom or as a carrying case. We would have liked the demonstrator to have had some sort of mounting brackets so that it could be hung on a classroom wall but these brackets can be readily added by the instructor. The v.o.m. demonstrator is a useful training aid for science classes in high school or for meter classes in technical trade schools, technical institutes, or more advanced schools where meters are studied. The kit is available for $37.95. ▲

CIRCLE NO. 144 ON READER SERVICE PAGE

Electronics in Banking

(Continued from page 32)

"Second National Bank" in your town—the bank on which your payroll check was drawn. At the end of the run, a computer figures out the total amount of all checks drawn on the "Second National," prints out a list. That list, along with all the checks, is bundled up and sent to the "Second National," where its sorters and computers subtract the proper amounts from all accounts and make records of their transactions.

The third check—the one from California—meanwhile had dropped into still another pocket. Your bank probably doesn't do enough business with the California bank to have a special pocket set aside for it. But the encoded magnetic number tells the computer which branch of the Federal Reserve System the California bank does business with. The check is then bundled up with all other checks bound for the Federal Reserve Banks.

When the bundle reaches the "Fed," it is again dropped into an MICR sorter, which separates out checks for each of the individual banks with which it does business, or for branches of the Federal Reserve in other parts of the country. A computer, of course, keeps track, adds up all the figures, and prints out all of the records needed by the bank itself.

Finally, your refund check, with others from across the nation, drawn on the same bank, all come together in one sorter pocket at the Federal Reserve branch nearest the bank on which they are drawn, are bundled up, and sent to the originating bank. There, the bundle is turned over to the bank's MICR system, which deducts the amounts of the various checks from the proper accounts, once again making all necessary records.

From the time the clerk in the first bank inscribed the dollar amount in magnetic ink, no one has had to look at, read, or handle the check, or do any of the bookkeeping connected with it—a true example of automation.

Rapid Expansion of MICR

Automated banking is spreading rapidly throughout the U.S., Canada, and England. And, of course, as more banks install the system, it becomes more valuable. In actual practice, a certain number of checks received by a bank every day will not be set up for magnetic character reading and will have to be handled manually. As more banks switch over, the proportion of those checks falls.

Already a significant number of banks have made the move. Although only a hundred or so of the nation's banks have actually installed equipment, many more have it on order. The ones who are already using it tend to be the nation's giant financial institutions, which handle a very large percentage of the total number of checks written.

Further, the system is spreading far more rapidly than anyone thought it would. The Federal Reserve System, for example, issued the surprising news last August that 68% of the checks clearing through its branches were now encoded. Just 18 months before, the figure stood below 20% of all the checks processed.

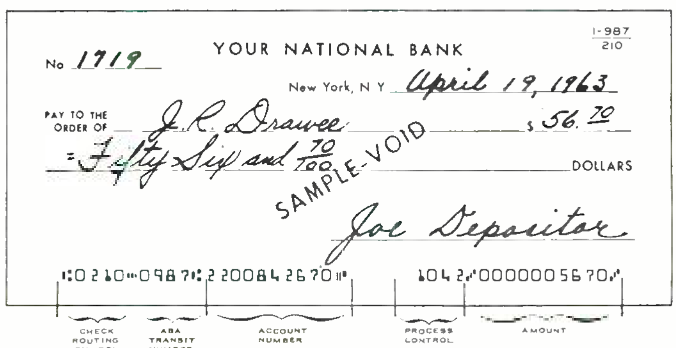
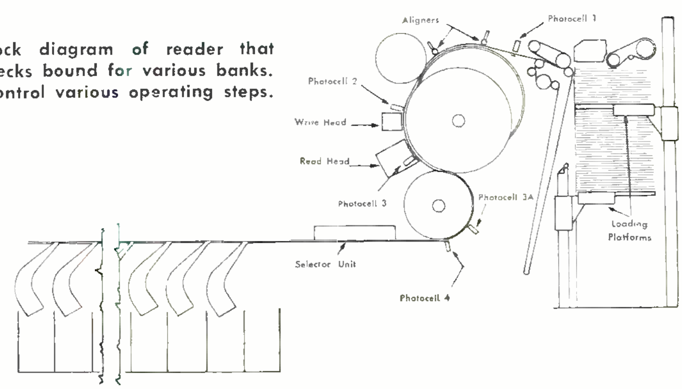


Fig. 8. Example of check showing the imprinted MICR numbers.

Fig. 9. Block diagram of reader that sorts out checks bound for various banks. Photocells control various operating steps.



Even banks which may not expect to have the new equipment for some time are beginning to issue magnetically imprinted checks, so that when the equipment does arrive, the checking system will be ready for instantaneous change-over.

The Federal Reserve survey showed that 97% of the country's more than 15,000 banks had begun to issue magnetic checks, although some have not begun to issue any significant percentage of their over-all total. Still, the figure represents a substantial jump over the previous year, when it was 50%. Authorities have estimated that virtually all of the nation's banking business will be handled automatically by 1965.

Other Computer Uses

Of course, checks are not the only documents banks have to deal with. Most of them offer scores of customer services, ranging from savings accounts to loans. And all of these take a lot of bookkeeping, too. Naturally, banks are turning over the bookkeeping chores in these fields to their computers. These other services in an average bank, though, require only a fraction of the time and effort taken by the checking operation. Most banks, therefore, are rushing to get their check handling automated; then, as time allows, are switching over other operations.

Of course, as with any new system, difficulties crop up. One bank faced a minor crisis when two ladies complained of the new figures showing up on the bottom of their checks. The ladies, who were numerologists, patiently explained to bank officers that the numbers disagreed with their stars. Bank officers, equal to the occasion, gallantly changed the account numbers.

The Bank of America may run into considerably more serious opposition if it puts into effect one of its plans. In the interest of efficiency, officers there hope to scuttle one of America's most cherished institutions: the paycheck. According to bank officers, they'd simply print out a deposit slip to an employee's account and mail it to him. The whole business of check handling on payrolls would be bypassed. The bank hopes to try the system on its own employees first, then later offer the service to its clients. Wisely, officials are proceeding slowly on this one.

Electronic banking may seriously interfere with another old tradition, too. With electronic machines furiously processing checks as fast as they come in and updating accounts daily – even hourly – the old custom of writing a check and then waiting a few days to deposit money to cover it may be on its way out. By the time you get your deposit to the bank, it will probably be too late. ▲

Microphone Volume Control

By ART TRAUFFER

Shielded control adjusts the volume right at microphone.

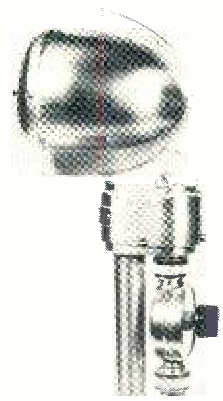


Fig. 1. Control mounted directly on mike.

THIS little shielded control unit lets you control volume right at the mike.

There's no need to run to a remote amplifier to adjust volume to the required level, or to reduce gain when acoustical feedback howl breaks out. With some types of mikes this unit can be connected between the mike head and cable, as shown in Fig. 1. With other types it can be connected between the mike head and stand. Or it can be connected directly into the cable close to the mike. The input and output connectors in this unit can be arranged to fit your own requirements.

Obtain a tin container about 1½" in diameter and about ⅝" deep having a friction lid, a one-megohm audio-taper subminiature pot, a standard female mike connector (*Amphenol* 75-MC1F or *Switchcraft* 2501F), a chassis unit (*Amphenol* 75-PC1M or equivalent), and a miniature knob to fit the volume control shaft.

The necessary three holes in the tin can are punched with a sharp tool and then enlarged to the required size with a rat-tail file. To provide more room inside the can the shanks of both mike connectors can be sawed off as required. The connectors are soldered securely to the can, using plenty of solder. The "ground" lug on the potentiometer is soldered to the lid of the can. Two rounded grooves are filed in the lid to fit over the connectors. After the unit is completed and tested, lock the can lid to the bottom of the can with a few drops of solder. ▲

Music/Speech Discriminator

(*Continued from page 38*)

through an *RC* type of filter network.

The low-level amplifier, *Q1*, is also conventional and is a common-emitter *p-n-p* transistor stage. The frequency-selective amplifier, *Q2*, is similar to the initial stage with the exception of the response-altering capacitors (*C2*, *C16*, *C17*).

The operation of *Q3*, the dynamic-range limiter and detector, is indicated in Fig. 2. A varistor does not directly obey Ohm's Law but instead has a voltage-current relation of:

$$I = KE^n$$

where n in this case is approximately three. Reversing this relation gives:

$$E = K'I^{1/3}$$

and in this particular circuit $E = E_{out}$ and $I = I_{collector}$. But collector current is equal to base current times the gain of the transistor, or: $I_c = H_{fe}I_b$ and I_b is determined mainly by the input voltage and *R10*. Combining all constants and substituting gives:

$$E_{out} = K''E_{in}^{1/3}$$

Thus, although all signals are amplified considerably, the amplitude variation at the output of this stage is noticeably less than the amplitude variation at the input. This stage will operate properly only when driven hard. Audio peaks should produce a varistor voltage of around 13 volts.

The filter stage, *Q4*, is once again similar to the initial stage, with the exception of filter components *R15* and *C6*. A portion of the collector load is bypassed by *C10* to provide a variable two-volt bias supply for the pulse selector. The filter has a cut-off frequency of 12 cps. Differentiation is accomplished by *C7-R17*, providing a 50-millisecond time constant and extracting all attack and decay information. The pulse selector is a biased diode that will only pass those decay signals above a variable (0-2 volt) threshold level. All attack information is removed by this biased diode.

The integrator stage, *Q5*, is an *n-p-n* switch gated by the decay pulses. When on, this stage rapidly charges the integrator capacitor *C11*. When off, *SR1* is back-biased, and the capacitor cannot discharge by this path. *C11* can only discharge through *R35*, *R23*, *R24*, *Q6*, and *R28*. Current flow through *R23* trips the Schmitt trigger and energizes the output relay. A detailed analysis of this stage is available elsewhere.[3] The trigger turns on with an input of 1.3 volts and turns off when input voltage drops below 1 volt.

Construction & Operation

The unit was designed in a package consisting of a U-shaped aluminum

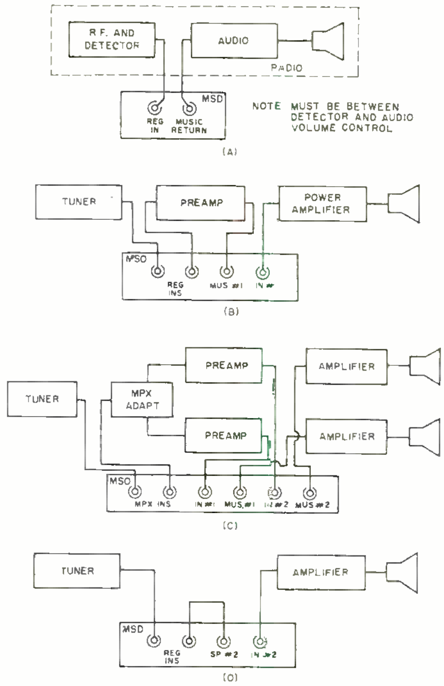


Fig. 5. System interconnections. (A) Connections to radio only. (B) Normal hi-fi or plant audio. (C) Stereo multiplex connections. (D) News-only monitor connections.

chassis and an overlapping 20-gauge steel cover. All circuitry except the input jacks and $L1$ are mounted on the two twin printed boards that face each other. The MSD measures 7" x 5" x 2½" and is finished in brushed aluminum and heavy grey alligator wrinkle. The photographs indicate parts locations and the assembly technique.

Home duplication of this device should present no problems provided certain obvious modifications are made. It is recommended that a larger package be used, perhaps a "Mini-box" and conventional terminal boards, instead of the punched chassis and printed wiring used. No component location is critical as long as leads remain sensibly short and suitable shielding is provided for the low-level circuitry.

The MSD may be system-connected in many different ways, some of which are shown in Fig. 5.

After installation, the MSD is switched to the "Tune" position until suitable program material is selected. All three controls are placed in their minimum positions. The level control is brought up to a setting such that the MSD triggers on a musical selection and is then advanced slightly beyond this point. Next, the separation control is advanced until the MSD does not trigger on music. The delay control is then adjusted during the first speech passage to eliminate any chopping. The unit is now correctly adjusted. As long as program material does not change radically, the MSD will operate properly without resetting controls.

This device works surprisingly well on high-quality FM stations, rejecting all speech and passing all music. The only music that will ever fool the MSD are certain guitar, bass, harp, or piano percussion solos; these are quite rare and are flatly rejected as if speech. Most all singers are passed, as are most forms of music. Speech passages overriding a weak musical background will be passed or rejected depending upon control settings. Control settings are a bit more critical on the average AM station giving somewhat reduced reliability, resulting in an occasional chopped passage or the passage of a singing commercial.

REFERENCES

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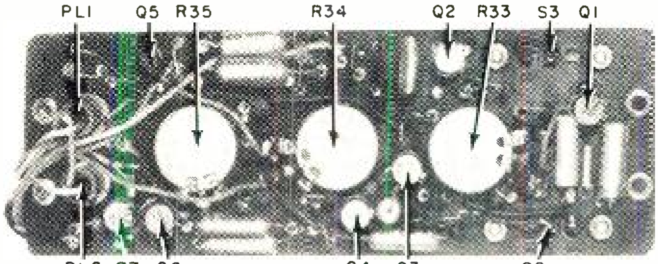
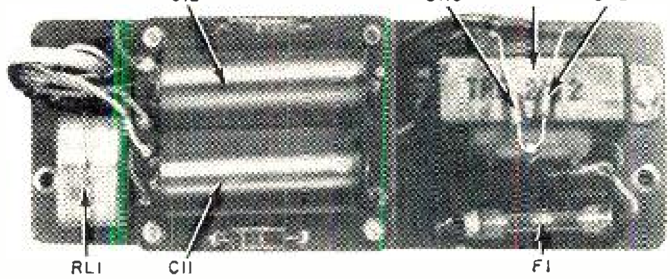
2. Ives, R. L.: "Music Pulse Analyzer Rejects Voice Signals," Electronics, April 1957.
3. Millman & Taub: "Pulse and Digital Circuits," McGraw Hill Book Co., New York, 1956. ▲



The front component board has transistors and controls mounted.

The rear circuit board has the power components mounted on it.



Transistor Ignition System

(*Continued from page 47*)

records to those which observed practically no preventive maintenance and, at the same time, kept very poor operating records.

The results obtained through this wide range of operating conditions in all cases clearly pointed out the superiority of the transistorized ignition system from a maintenance standpoint. In carefully controlled commercial fleets, where accurate records were kept and where we could follow the day-by-day maintenance on their trucks, it was found that the transistorized system required only a small fraction of the maintenance that was necessary in the case of a standard system.

One interesting development program carried out involved running twelve "Super Duty" trucks 280,000 miles with the standard ignition system and carefully observing the maintenance performed on these vehicles. The maintenance items which were carefully watched included replacing contacts, resetting timing, replacing capacitors, adjusting contacts, and replacing spark plugs. The same vehicles were then converted to the transistorized ignition system and allowed to accumulate an additional 922,000 miles. Examination of the daily service records of these trucks revealed that the transistorized system required only one-sixth the maintenance of the standard ignition system for equivalent mileages. This certainly demonstrates the maintenance superiority of the transistor system.

During the course of these tests, the individual drivers of these units often reported increased power and superior fuel economy. These comments served to confirm our belief that an over-all improvement in performance and fuel economy could be achieved over extended periods with the "Perma-Tuned" ignition system.

In order to substantiate this belief, a test program was initiated wherein sixty new "Super Duty" trucks were selected from a fleet where accurate records of operating costs were kept. One-half of these vehicles were equipped with transistorized ignition systems and the remainder equipped with new laboratory-tested standard ignition systems. To date, the 5-month average fuel economy for all types of operation shows approximately a 5 per-cent advantage in fuel economy for the transistorized system.

Based on the test program briefly outlined above, it is our feeling that we are offering, in our 1963 passenger car and truck lines, one of the most reliable and thoroughly tested ignition systems presently available in the automotive industry. ▲

Solid-State Color Organ

(Continued from page 58)

mended, employing a "Minibox" or equivalent. A block of aluminum or copper of fairly good size can replace the heat sink extrusion. The insulated mounting wafers and bushings provided with the zener, the power diodes, and the controlled rectifiers must be used and all circuitry must be isolated from the heat sink. The substitution of standard 6-32 hardware for the "Rivnuts" used is obvious.

The cup cores were custom-wound for this application and neither the cups nor their contained heat-formed coils are readily available. However, small filter chokes or filter reactors of similar inductance values are readily available at parts stores. Typical substitutes and their values are given in the parts list accompanying Fig. 4.

Liberal use of tie-points and possibly a component board or two should make wiring straightforward.

The power diodes may be purchased as surplus items, for a considerable cost savings can be realized on this item alone.

Component arrangement is not at all critical as long as all leads remain sensibly short. The power resistor *R1* should be spaced well away from the transistors. Heavy-gauge wire should be used for the higher current portions of the circuit. Be certain not to omit *T1* and be certain that the common bus does not contact either the case or external ground; failure to do so will give the zener diode a life measured only in milliseconds.

Crossover frequencies of 250 and 1400 cps perform reasonably well for all applications and represent the median values of possible crossover points.

"Tuning up" consists simply of attaching the unit to the 8- or 16-ohm loudspeaker terminals of the hi-fi sound system and adjusting the input taps on *T1* to give optimum performance. Moderate loading of the speaker may occur, dropping the volume level considerably in some cases, depending on the output impedance and power rating of the amplifier. Turning up the volume or loudness control on the unit will compensate for this effect.

Performance

Performance is surprisingly good and is singularly beautiful at moderate listening levels. Unlike other color-organ designs, the lights completely extinguish between passages, giving a weird and beautiful effect. The unit may be used with any audio equipment, but the use of a.c.-d.c. equipment is not recommended.

What about stereo? There are two answers to this: (1) use two color organs or, more practically, (2) add a "phantom" center output transformer and use this to drive the display.

No definite estimate of bulb life can be given since in over three months of continuous demonstration and use not one bulb has failed. Apparently, bulbs will last as long or possibly longer than they would under normal use.

Additional audio gain could be incorporated in the control box to allow operation from a microphone, but experiments showed that ambient noise levels, *i.e.*, conversation and traffic, posed quite a severe problem to this type of operation.

In use with a small band, the control box can be attached to the guitar or accordion amplifier.

Speech fed into the color organ can cause objectionable transients and, in some cases, it is advantageous to mute the organ during this type of program material.

It is felt that the present design is somewhat more desirable and practical than thyratron or vacuum-tube-controlled devices, giving more light and better performance in a somewhat smaller and more usable package. ▲

GRATICULE RETAINER RING

By CLARENCE A. ELLIOTT

If you own one of the earlier Heathkit oscilloscopes, you may be having trouble with the graticule. It may be either so tight that it buckles when in place or so loose that it falls out of the CRT shield. This difficulty can be easily overcome.

First, cut out a strip of aluminum or other sheet metal about 3/8 inch wide and 20 inches long. Next crimp the strip back and forth with a pair of pliers. If desired you can now paint it with flat black paint to reduce light glare.

Now trim the graticule, if necessary, so it fits loosely and set it in place. Bend the strip into a circle and place it in front of the graticule as shown in the photo below. The graticule can now be rotated for adjustment but is held firmly in place for use. ▲

The Hall Effect

(*Continued from page 42*)

In a practical wattmeter capable of measuring power in a.c. circuits at frequencies from 50 to 500 cps, the magnetic field is provided by a coil in the line circuit, and the control current is obtained from a stepdown transformer connected across the load terminals. The output is a double-frequency wave superimposed upon d.c. The double-frequency component is proportional to volt-amperes while the d.c. component is proportional to watts.

The Hall effect is extremely fast and if an oscilloscope is used as the output device instead of a conventional meter, it is possible to show instantaneous power. This is useful in studying transients which occur as fault currents when a circuit has been broken or interrupted.

Hall-Effect Ammeter

A hook-on ammeter is an instrument which can be used to measure current in a conductor when it is in close proximity to or hooked onto the conductor. The fact that the circuit does not have to be opened to allow the meter to be inserted in the current path is a great advantage, especially for measuring high bus-bar currents, and a convenience that saves both time and effort with a current of any magnitude.

By using a split C-yoke with a Hall generator (Fig. 6) in the air gap, a hook-on ammeter can be made which overcomes many of the difficulties in some other types of instruments. The control current, which can be either a.c. or d.c., is maintained at a constant level. The magnetic field which surrounds the bus bar supplies the field for the Hall generator. Since this field is proportional to the current in the bus bar, the Hall output voltage will also be proportional to the bus-bar current.

Other Applications

Many other ways of utilizing Hall generators have been devised. Some are already in limited use, many are still theoretical. A frequency doubler, for example, can be constructed using a Hall generator. If the same a.c. source is used for both the control current and the magnetic field, the Hall-output voltage will have an a.c. component with a frequency twice the frequency of the input. Similarly, the Hall generator can be used as a device for squaring functions. If the magnetic field and the control current are both driven by the same signal source, the output will be proportional to the *square* of the input.

The Hall generator can also be used as a function generator in an analog computer. In the discussion above, it was pointed out that the Hall output voltage

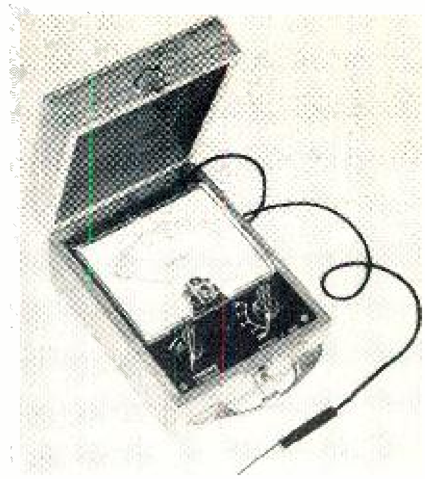


Fig. 10. A portable gaussmeter by Instruments Systems Corp., with its probe.

is proportional to the product of the control current, the magnetic field, and the sine of the angle between I and B. Accordingly, if the Hall generator is rotated in the magnetic field, it will produce a sine wave (or a cosine wave, depending on the point of reference).

Conventional function generators produce outputs whose amplitudes depend on the rate at which magnetic lines of force are cut by a conductor. The output of the Hall generator is independent of the speed of rotation, however, and it is therefore especially well adapted for very-low-frequency operation.

When very small d.c. signals must be measured, it is often convenient to convert them first to a.c., so that they can be readily amplified and to eliminate drift problems. A Hall generator is useful for this operation, which is known as "chopping." An a.c. magnetic field is employed, and the low-level d.c. voltage is impressed across the Hall control terminals. The output of the generator is then an a.c. signal that is equal to the product of two quantities: the magnetic field and the control current resulting from the d.c. voltage.

Another application in which Hall generators show promise is as isolators in microwave circuits. An isolator is a four-terminal, unidirectional, transmission device. Electron tubes and transistors used as amplifiers are examples of isolators, since they operate in one direction only.

A tunnel diode, on the other hand, is a two-terminal, bidirectional device. The fact that tunnel diodes have common input and output terminals makes it difficult to build multi-stage amplifiers in which they are employed. Effort is currently being devoted to using Hall devices in conjunction with tunnel diodes. If it is successful, the usefulness of both devices will be broadened by another configuration providing the necessary isolation of the input and output circuits. ▲

(Continued from page 26)

10,000 cps and 7.5 db at 15,000 cps. Channel separation was 25 to 35 db at middle and low frequencies, 18 db at 10,000 cps, and 12.5 db at 15,000 cps.

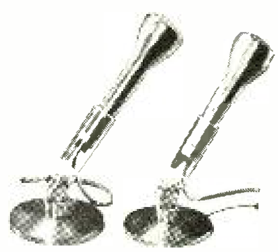
In our listening tests, the FM-200B proved to be equally outstanding. Almost any station which could be heard at all was fully quiet and usable for enjoyable listening (and we could hear 35 to 40 stations as we tuned across the FM band, with our antenna pointed west from New York). The quality was smooth and unstrained, with none of the raspiness or distortion which lesser tuners sometimes exhibit on weak or over-modulated signals. The automatic operation of the FM-200B was a great convenience, although we noted an occasional poor relay contact which interrupted one stereo channel. Turning the stereo selector to mono and back to automatic, to operate the relay, always cleared up this condition.

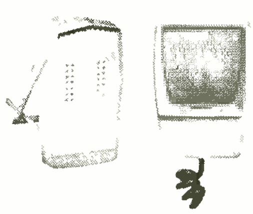
The FM-200B, without case, sells for $299.50. ▲

NEW INTERNATIONAL PHONETIC ALPHABET

A GROUP of the world's linguists—including Russians—met recently and agreed upon a new international phonetic alphabet to be used in radio communications. With the previous phonetic alphabet, there were many words or syllables that could not be pronounced readily by airmen, seamen, or other users of two-way radio. The new system, by the way, does not include Roger, Love, Queen, or Zebra. Following is the phonetic alphabet to be used now, along with the standardized pronunciation:

A	Alfa	AL-fah
B	Bravo	BRAH-voh
C	Charlie	CHAR-lee (or SHAR-lee)
D	Delta	DELL-tah
E	Echo	ECK-oh
F	Foxtrot	FOKS-trot
G	Golf	GOLF
H	Hotel	HOH-tel
I	India	IN-dee-ah
J	Juliette	JEW-lee-ett
K	Kilo	KEY-loh
L	Lima	LEE-mah
M	Mike	MIKE
N	November	No-VEM-ber
O	Oscar	OSS-cah
P	Papa	Pah-PAH
Q	Quebec	Keh-BECK
R	Romeo	ROW-me-oh
S	Sierra	See-AIR-rah
T	Tango	TANG-go
U	Uniform	YOU-nee-form (or OO-nee-form)
V	Victor	VIK-tah
W	Whiskey	WISS-key
X	X-ray	ECKS-ray
Y	Yankee	YANG-key
Z	Zulu	ZOO-loo





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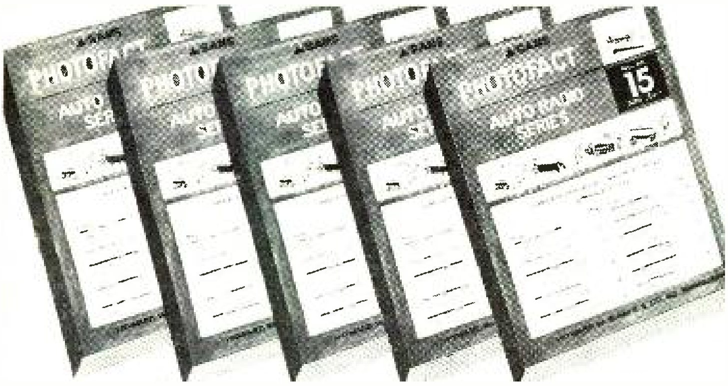

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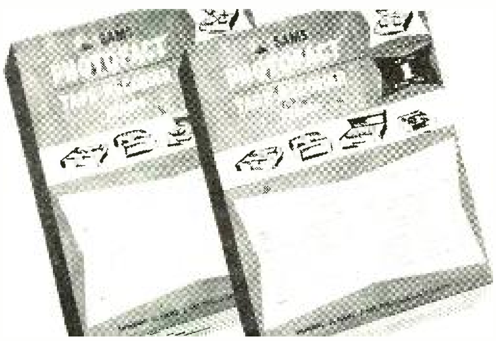

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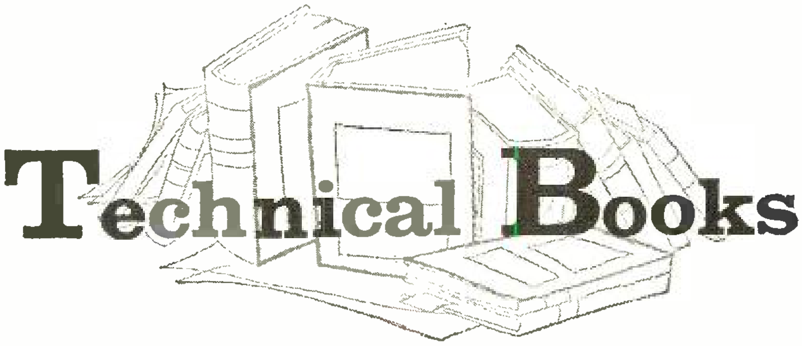

Technical Books

"ELECTRONIC TEST INSTRUMENT HANDBOOK" by Joseph A. Risse. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 283 pages. Price $4.95. Soft cover.

This book should meet the needs of the many persons who are seeking information about all types of test equipment, how it works, its capabilities, its limitations, and its applications. In addition to providing a thorough-going technical description of a dozen standard test instruments, the text covers special test instruments, precision and laboratory test units, audio and industrial gear. Servicing as well as operational data is included.

* * *

"RADIO REGISTRY" compiled and published by *Communication Engineering*, P.O. Box 629, Mineola, N.Y. Vols. 2 and 3.

These are volumes 2 and 3 in this publisher's comprehensive listing of licensees and operating frequencies used in transportation radio systems (Vol. 2) and business and miscellaneous radio systems (Vol. 3). Those familiar with these registries from previous years will find the format the same but all of the material up-dated and expanded for maximum coverage.

* * *

"PHOTOELECTRIC CONTROL" by Harvey Pollack. Published by *John F. Rider Publisher, Inc.*, New York. 134 pages. Price $3.50. Soft cover.

This is a primer on the theory and application of photoelectric phenomena as used in industrial electronics, written at the technical institute or trade school level. The author discusses photoelectric devices such as phototubes, photovoltaic cells, and photoconductive cells, explains how they work and how they can be connected into circuits to perform certain stipulated functions.

* * *

"USING THE SLIDE RULE IN ELECTRONIC TECHNOLOGY" by Charles Alvarez. Published by *John F. Rider Publisher, Inc.*, New York. 108 pages. Price $2.50. Soft cover.

This is a do-it-yourself handbook for those seeking mastery of the slide rule in order to speed the solution of basic electronics problems. Each chapter contains practice problems and practical examples so that the book can be used both as a reference text and a manual. The problems are presented progressively. There are 19 chapters, two appendices, plus a section containing the answers to the problems. The material, as presented, could also be used for classroom work.

* * *

"SERVICING ELECTRONIC ORGANS" by Carl R. Pittman & Eugene J. Oliver. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 188 pages plus block diagram. Price $4.95. Soft cover.

Since there are an estimated 1 million electronic organs in the hands of the public, this represents a fertile field for the enterprising technician who is willing to spend a little time learning the basic theory back of most commercial organ designs.

This volume assumes that the basic electronic circuitry is familiar to the technician and therefore covers only those electronic organ circuits peculiar to that instrument. Circuits, theory, maintenance, and adjustments of the major electronic organs on the market are covered along with detailed discussions of the operation and servicing of tone and pedal generators; sustain, vibrato, and tremolo oscillators; key switches; percussion, voicing and amplifier circuits; power supplies; and accessories.

* * *

"HIGH FIDELITY POCKET BOOK" by W. E. Pannett. Published by *George Newnes Limited*, Tower House, Southampton St., London W.C. 2, England. 311 pages. Price 40 s. net.

This British book is written for engineers, technicians, and those dealing in audio equipment sales and servicing. Although the author also suggests that the text is suitable for the home constructor and music lover, there is a rather high percentage of mathematics for a "popular" treatise. The text is divided into 12 chapters dealing with the production and propagation of sound, sound reproduction, power amplifiers, control units and preamps, AM and FM tuners, speakers and speaker enclosures, disc recording and reproduction, stereo discs, magnetic tape recording, and power supplies.

The equipment and techniques described are British but the fundamentals are the same and on that basis readers will find the text useful and informative.

° ° °

"SOLVING TV TOUGH-DOGS" by Robert G. Middleton. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 122 pages. Price $2.50. Soft cover.

Probably no service job causes more anguish and lost time than the so-called "tough dog." In this book the author has provided a practical and down-to-earth approach to recalcitrant TV sets. He outlines symptoms to watch for, how to interpret the symptoms, and the general principles for solving even the most misleading and difficult troubles.

° ° °

"FUNDAMENTALS OF MODERN SEMI-CONDUCTORS" by Barron Kemp & R. H. McDonald. Published by *Howard W. Sams & Co., Inc.*, Indianapolis, Indiana. 156 pages. Price $2.95. Soft cover.

This is basically a survey of present-day semiconductors to be found in today's electronics circuits. After a brief review of solid-state physics, the text describes the various specific types of diodes and transistor devices in use, including tetrodes, field-effect transistors, *p-n-p-n* types, mesa transistors, tunnel and other special diodes phototransistors, and other types.

° ° °

"HOW TO SOLVE PROBLEMS IN ELECTRICITY AND ELECTRONICS" by Henry Jacobowitz. Published by *John F. Rider Publisher, Inc.*, New York. 182 pages. Price $3.50. Soft cover.

Basic emphasis in this book is on practicality, with stress on handling problems that are likely to be encountered in day-by-day contact with electrical and electronic circuits.

The text material begins with simple problems in d.c. circuits and progresses through more complex problems in a.c. electricity, tubes, and transistors. ▲

Radio & TV News

Views on Industry Developments

THE VARIETY of interests involved in consumer electronics can become quite entangled. For example:

Extended warranties on TV receivers and the various forms of captive or controlled service that are associated with them constitute a paramount threat to the independent service industry, according to members of the latter group. Small service dealers feel these measures are deliberate inroads by big business (set manufacturers). Motivation would be provided by the fact that the nation's annual expenditure for repairing TV sets has become greater, in recent years, than the amount spent on buying new receivers. Plainly, there are more dollars in fixing sets than in making them.

But that doesn't necessarily make service more profitable, in the big-business sense. Nor does it mean that the manufacturers are pleased with their involvement. At least one set maker that would like to get the monkey off its back is *RCA*. Addressing the National Appliance & Radio-TV Dealers Assn., Raymond W. Saxon, marketing v.p. of *RCA Sales Corp.*, tried to sell service back to his auditors. As to elaborate guarantees, he said, "To offer . . . what we consider unnecessary warranty features is totally unrealistic . . . a warranty alone was never intended to be a merchandising tool." As to the appliance dealer, Saxon said, "the time may be now to restore what was once a profitable . . . segment of his business." In other words: "We don't want it; you can have it."

One of the factors that got manufacturers ensnarled in service, in the first place, is supposed public dissatisfaction with the quality of independent work. But people grumble over any service, good or bad. They resent having to spend on something they have already paid for and own, whether it be TV set, auto, or washing machine. The man who does the dirty work is also expected to play the role of scapegoat, whoever he is. The viewer's true preference is reflected in the fact that 99 per-cent of those handling TV repairs today are (or are employed by) independents.

When disaster strikes—when Dr. Kildare is in action but the set isn't—people need individualized attention to lean on. As with medical care, the horse-and-buggy approach is still the public choice. The efficient but impersonal handling of a large service organization may get the receiver going, but it cannot fulfill the greater need. And big business, nurtured on mass operation, is

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Featuring Tests Never Before Available To The Music Listener

Why We Make the Model 211 Available Now

Although there are many stereo test records on the market today, most critical checks on existing test records have to be made with expensive test equipment.

Realizing this, HiFi STEREO REVIEW decided to produce a record that allows you to check your stereo rig, accurately and completely, **just by listening!** A record that would be precise enough for technicians to use in the laboratory—and versatile enough for you to use in your home.

The result: the HiFi/STEREO REVIEW Model 211 Stereo Test Record!

Stereo Checks That Can Be Made With the Model 211

- **Frequency response—a direct check of eighteen sections of the frequency spectrum, from 20 to 20,000 cps.**
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- **Hum and rumble—foolproof tests that help you evaluate the actual audible levels of rumble and hum in your system.**
- **Flutter—a test to check whether your turntable's flutter is low, moderate, or high.**
- **Channel balance — two white-noise signals that allow you to match your system's stereo channels for level and tonal characteristics.**
- **Separation—an ingenious means of checking the stereo separation at seven different parts of the musical spectrum—from mid-bass to high treble.**

ALSO:
- **Stereo Spread**
- **Speaker Phasing**
- **Channel Identification**

PLUS SUPER FIDELITY MUSIC!

The non-test side of this record consists of music recorded directly on the master disc, without going through the usual tape process. It's a superb demonstration of flawless recording technique. A demonstration that will amaze and entertain you and your friends.

UNIQUE FEATURES OF HiFi/STEREO REVIEW'S MODEL 211 STEREO TEST RECORD

- **Warble tones to minimize the distorting effects of room acoustics when making frequency-response checks.**

Warble tones used are recorded to the same level within ± 1 db from 40 to 20,000 cps, and within ± 3 db to 20 cps. For the first time you can measure the frequency response of a system without an anechoic chamber. The frequency limits of each warble are within 5 % accuracy.

- **White-noise signals to allow the stereo channels to be matched in level and in tonal characteristics.**
- **Four specially designed tests to check distortion in stereo cartridges.**
- **Open-air recording of moving snare drums to minimize reverberation when checking stereo spread.**

All Tests Can Be Made By Ear

HiFi/STEREO REVIEW's Model 211 Stereo Test Record will give you immediate answers to all of the questions you have about your stereo system. It's the **most complete test record** of its kind—contains the widest range of check-points ever included on one test disc! And you need no expensive test equipment. **All checks can be made by ear!**

Note to professionals: The Model 211 can be used as a highly efficient design and measurement tool. Recorded levels, frequencies, etc. have been controlled to very close tolerances—affording accurate numerical evaluation when used with test instruments.

DON'T MISS OUT—ORDER NOW AND SAVE $1

The Model 211 Stereo Test Record is a full 12" disc, made from the finest virgin vinyl. For a limited time only, it is being sold by ELECTRONICS WORLD for $3.98. Starting July 1, 1963, we will sell this record for $4.98. Order now and save $1. Make sure you don't miss out on this special offer. Fill in and mail the coupon, together with your check ($3.98 per record) today!

FILL IN AND MAIL TODAY!

Stereo Test Record
Electronics World—Dept. SD
One Park Ave., New York 16, N.Y.

Please send me ______ test records at $3.98 each. My check (or money order) for $______ is enclosed. I understand that you will pay the postage and that each record is fully guaranteed.

Name ______________________________
(Please Print)

Address ______________________________

City ______________ Zone ______ State ______

SORRY—No charge or C.O.D. orders!
(Special price offer of $3.98 expires on June 30, 1963) EW 463

not geared for the "custom" nature of service. It cannot profit. The viewer cannot be pleased.

It will amuse many that the people to whom Saxon wished to return the service burden are the retail dealers: ". . . service . . . is undoubtedly the most neglected selling tool that a retailer has at his disposal . . . a warranty . . . should be considered part of the over-all service program which accompanies the sale of a home-entertainment product." To numerous dealers, this proposition is quite outmoded.

With growth and diversification in the home-entertainment field—and with heavy price competition from large-scale retailers—the sales and service functions have largely become divorced from each other. Retailers, preoccupied with the specialized wizardry of keeping prices down but profits up, often fail to maintain well-managed service departments. Service shops, surrounded by cut-price, volume retailers, are not eager to sell sets.

The quadrangular relationship among separate manufacturer, retailer, service dealer, and owner complicates the establishment of service responsibility for the set, at least while it is still new. Everybody has had a crack at the solution over the years, but there is yet to be a semblance of one that pleases all concerned parties. Any bright ideas from the audience?

More Equals Less

We vaguely recall a tale in which a small businessman, queried on how he was faring, answered, "Great. We were up 10 per-cent this year. If this improvement keeps up, we'll be bankrupt in two months." The story is brought to mind by some of the industry sales figures one sees. For example, the number of transistors made and sold by domestic manufacturers in 1962 was up about 20 per-cent as compared to 1961, but dollar volume was down about 3 per-cent.

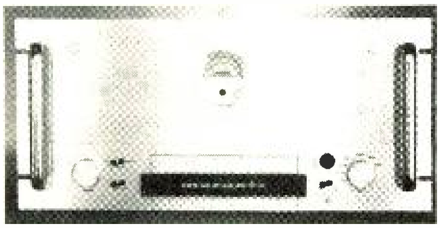
There may be nothing wrong in price reductions on transistors. Nevertheless, the same trend, rising unit sales coupled with declining dollar volume, has been showing up in recent years with such items as tubes, picture tubes, radios, and TV sets. Continued industry growth is gratifying, but competition can be rough and sheer volume isn't the only answer. Another indicator: the *Inland Credit Corp.*, following a survey covering hundreds of large corporations, headlines its report, "Liquidity Takes Nose Dive Among Radio and TV Manufacturers." In fact, liquidity, the critical ratio of cash and "near cash" to current liabilities, is at its lowest point since 1932. Manufacturers must understand just how that man in the cigarette ad feels. You know; the one who's smoking more but enjoying it less. ▲

New Products and Literature

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, simply fill in the coupon appearing on page 21.

CONSTANT-VOLTAGE AMPLIFIER

1 **Marantz Company, Inc.** has released its Model 9120 constant-voltage amplifier which may be fed any frequency between 20 and 20,000 cps (via an external audio signal generator) and



provides a choice of 120 or 28 volt a.c. output. Maximum continuous-duty power capability is 60 watts.

The instrument can be used to test aircraft instruments and other equipment that requires a line voltage frequency of other than 60 cps, for driving small shaker tables used for vibration and reliability analysis in miniaturized component testing, and for varying the rpm of small synchronous motors similar to those found in portable tape recorders and timing devices.

The unit is offered in either bench or rack mounting versions. It operates from 105-125 volt a.c., 50-60 cps power sources.

TRANSISTORIZED TV CAMERA

2 **General Electric Company** has announced development of a professional transistorized vidicon studio camera channel which the company claims is capable of handling up to 80 per-cent of today's studio shows at operating cost reductions of as much as 90 per-cent.

The Type PE-23 camera was designed especially for news, panel, and quiz shows and is also suitable for education television studio productions. In performance, the camera meets or exceeds EIA standards: it has 700-line horizontal resolution, a 10-mc. bandwidth, and a 60-gauss focus field. Reduced size, lower power requirements, and a reduction in heat are other features claimed for this new system. It is offered in various versions for console, desk, or rack mounting.

DIRECT-WRITING RECORDER

3 **Brush Instruments** is now marketing a new portable two-channel direct-writing recorder for test recording in the telephone industry. The new unit, known as "Telecommunications Mark II," incorporates an accurate 0.1 second timing marker, provision for remote control, and two

analog channels with a frequency response flat from d.c. to 100 cps.

In addition to the telephone industry, the new unit can be adapted to troubleshooting and analysis of pipeline control, electric utilities, and other systems where transient and coded pulses must be examined.

PRECISION POWER RESISTORS

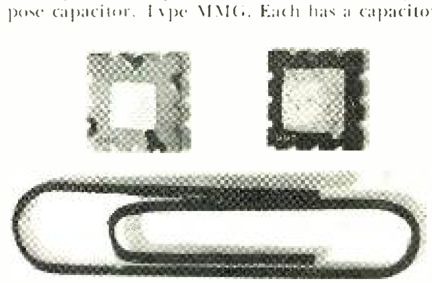
4 **Dale Electronics, Inc.** has available two new silicone-coated precision power resistors which offer high power ratings in relation to size.

These new additions to the firm's "G" line are rated at 6 and 15 watts. Resistance range is 10 to 30,000 ohms in the 6-watt version and 10 to 175,000 ohms in the 15-watt type. Tolerances of .05, 0.1, .25, .5, 1, and 3 per-cent are available.

CAPACITOR MICROELEMENTS

5 **Cornell-Dubilier Electronics Division** has developed two types of single-layer ceramic capacitor microelements for micromodule circuitry.

The new units are the temperature-compensating capacitor, Type MMC, and the general-purpose capacitor, Type MMG. Each has a capacitor



element made from a notched ceramic wafer 0.310 inch square and 0.010 inch thick with fired silver terminations.

To form a micromodule circuit, the wafer-shaped capacitor, resistor, inductor, transistor, and semiconductor elements are stacked in a square frame of 12 wires, 3 to a side. The module frame is encapsulated to form a unit 0.36" square with the height dependent on the number of wafers stacked in the module.

MICROWAVE TRAINING KIT

6 **Arra, Inc.** is now offering a complete microwave training kit operating in the X-band. The new kit, Model MT-1, has been designed for military, college, industrial, and vocational school training courses in microwave theory and application.

It consists of a complete microwave system capable of transmitting and receiving signals in the X-band. It is composed of three electrical components, a training manual, and various other microwave components and accessories. The kit is complete in itself and operates from any 117-volt, 60-cps source.

PORTABLE TACHOMETER

7 **The Pioneer Electric & Research Corporation** has announced the availability of its Model 21 portable electronic tachometer which is capable of measuring 0 to 2400 rpm with a high degree of accuracy.

Utilizing a cadmium sulfide photocell and a transistorized circuit, the unit will measure the

rpm of any revolving or reciprocating device with no electrical or mechanical contact of any kind. A contrasting marker is placed on the moving unit which is then illuminated by the tach's own light source. The photocell then detects the change each time the marker passes. The rpm rate is constantly displayed on the indicator dial.

The Model 21 is self-contained and carries its own battery power supply. It measures 7½" x 3¾" x 2½" and weighs 2 pounds.

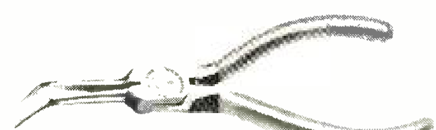
MINIATURE TRIMMERS

8 **JFD Electronics Corporation** is now offering a new line of miniature panel-mount precision piston trimmers which incorporate a modification of the firm's anti-backlash adjustment mechanism.

This new "Plus-C" series provides a wide margin of safety for high-reliability applications with 500-cycle adjustment life, exceeding Mil-C-14409A specifications by more than 600%. The telescopic design permits compact construction, useful in applications where package design space limitations are critical.

BENT-NOSE PLIER

9 **Mathias Klein & Sons, Inc.** has recently developed a new plier specifically designed for the electronics field. The needle nose of the new unit is bent to permit reaching into confined



space. A coil spring keeps the jaws open. The handles are covered with yellow plastisol for greater comfort and firmer grip.

The No. D338-5-1 2C measures 5 inches over-all.

VOLTAGE ADJUSTER

10 **Terado Corporation** is marketing two new voltage adjusters, #50-203 and #50-201, designed to normalize power line voltages to improve the performance of electrical equipment.

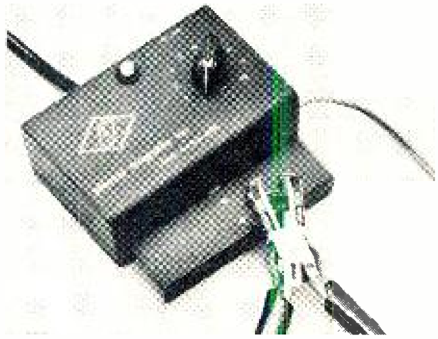
The Model #50-203 will handle loads up to 300 watts while the second unit has a capacity of 500 watts. The units will stabilize voltages from 95 to 135 volts at a normal 115 volts. Both units measure 5½" x 3" x 2¼".

PRODUCTION WIRE STRIPPER

11 **Pioneer Magnetics, Inc.** is now offering its Model PM-1056 thermal wire stripper which is designed for continuous production-line use

in the electrical, electronic, missile, and space industries.

The unit features interchangeable, plug-in, long-life heating elements which provide instant heat that "surgically" melts and severs the insulation collar, minimizing smoke and fumes



produced by other thermal stripping methods. The device can be used on wire gauges from #12 to #36 without adjustment or change of setting.

PRINTING IMPULSE COUNTER

12 **Landis & Gyr, Inc.** is in production on a compact, all-electric "Sodeco" printing impulse counter which provides six-digit readout and print. The instrument is available in tandem with simultaneous reading and side-by-side printing on a single chart. Designs suitable for decimal reading, for time counting, or for date registration are available. Features include panel mounting, plug-in connections, remote control, standardized case sizes, and zero reset.

TRANSISTORIZED ELECTRONIC COUNTER

13 **Weston Instruments Division** is currently introducing a fully transistorized electronic counter featuring 8-digit in-line readout of frequency, time interval, and period measurements.

The Model 2052 counter offers a frequency range of 0 to 20 mc. and input sensitivity of 50 mv. to 100 volts r.m.s. Frequency measurements are on a time base of .1, 1, and 10 seconds. Temperature range is 0 to 50° C and crystal stability is ± 1 part in 100 million.

The 31-pound unit measures approximately

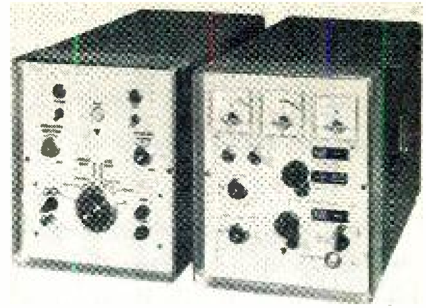
16" wide x 8" high x 14" deep. It is also available for rack mounting.

SEMICONDUCTOR TESTER

14 **Fairchild Semiconductor Instrumentation** has introduced a direct-reading instrument for testing transistors, diodes, and zener diodes. The Series 500 will perform sixteen tests in any sequence and in any combination. With a data logging capability from the digital readout, and subsequent data reduction, the instrument can be used for reliability control, engineering studies, and component evaluation.

OSCILLATOR & POWER SUPPLY

15 **Electronic Designs,** a division of **Maxson Electronics,** has just introduced a high-power u.h.f. oscillator and power supply with a range of 200 mc. to 2500 mc. Two units comprise the Model 1241. The first is a wide-band power oscillator with grid separation, dual cavity coaxial line using a disc-seal triode. The second unit, a power supply and modulator, provides internal, square, or sine amplitude modulation at 400 or



1000 cps and c.w. operation. Frequency range is covered in two bands.

Each unit measures 9½" x 12" x 20½". The set's shipping weight is 131 pounds.

THERMAL WIRE STRIPPER

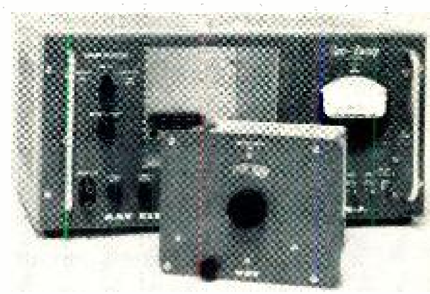
16 **Contact, Inc.** is now marketing a thermal wire stripper, Model WS-15, designed for hand stripping any type of plastic insulation from wire, including Teflon, without marring the conductor surfaces.

The unit itself can be used when working in confined areas since it measures only 5" long x ⅝" wide x ⅝" deep and weighs less than 3 ounces. It comes in two models, one with five fixed heat settings and one with infinite heat settings.

SWEEPING OSCILLATOR

17 **Kay Electric Company** is now offering a new extended-range model of its "Vari-Sweep" sweeping oscillator as the Model P-867.

The new unit plugs into the standard 2-220 mc. "Vari-Sweep" and extends its range upward



from 220 to 470 mc. Output voltage of the new head is 0.5 volt r.m.s. into 70 ohms.

FILM DIELECTRIC CAPACITORS

18 **Erie Resistor Corporation** has added a complete series of polyester film dielectric units to its capacitor line.

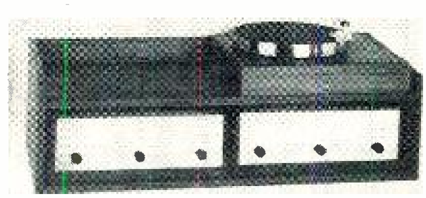
This new line was developed for applications requiring high capacitance, stability, humidity resistance, and high insulation resistance over a wide temperature range. Wide usage is expected in filter, bypass, coupling, and blocking applications.

The capacitors are housed in a moisture resistant molded epoxy case and come in bulk or reel packages for use in automatic insertion equipment.

HI-FI—AUDIO PRODUCTS

COMPONENT CABINETS

19 **Audio Originals** is currently introducing a wall component center of modern design and practical dimensions. The equipment enclosure



will accommodate tuners and amplifiers and has a flat surfaced top that can be used to house a changer/turntable or tape recorder. A record shelf at eye level completes the unit.

The equipment enclosure measures 37¼" long x 15¾" deep x 8" high. The record shelf is 37¼" long x 12¼" deep. Both are of rubbed oil-finished walnut and come completely assembled.

TAPE-HEAD TRANSISTOR

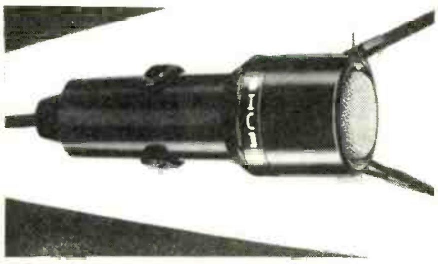
20 **Amperex Electronic Corp.** has developed a new germanium "p-n-p" transistor which is designed specifically for magnetic tape-head preamplifiers.

The AC107 is measured over the entire audio bandwidth which duplicates the actual conditions under which the transistor will operate in practical applications. When measured in this way, the transistor has a typical noise figure of 3 db from 30-15,000 cps.

The AC107 is available in a hermetically sealed all-glass case fitting a TO-1 outline.

LAVALIER MICROPHONE

21 **Shure Brothers, Inc.** has announced a new dual-impedance dynamic microphone specifically designed for lavalier use, the Model 560.



The unit weighs only 5 ounces and is less than four inches long. Finish is non-reflecting black. The cable is very flexible, small diameter, and two-conductor shielded. Frequency response is 40-10,000 cps with rising characteristics to 4500 cps. The polar pattern is omnidirectional. Impedance is high and 150 to 250 ohms.

COMMERCIAL SOUND SPEAKER

22 **Jensen Manufacturing Co.** has recently introduced a new 8-inch dual-cone extended range loudspeaker with a super-shallow profile having a depth of only 2-13/16 inches.

The Type C-835 is designed specifically for high-quality, trouble-free commercial distributed-sound installations. Frequency response is 35-18,000 cps and power rating is 10 watts. There is a 95-degree coverage angle and sound pressure level is 84 db at 10 feet for 1-watt input. Nominal impedance is 8 ohms and resonant frequency is 70 cps.

BATTERY-POWERED TAPE RECORDER

23 **Superscope, Incorporated** is handling the distribution of the new **Sony** Model 801A battery-operated tape recorder, a completely

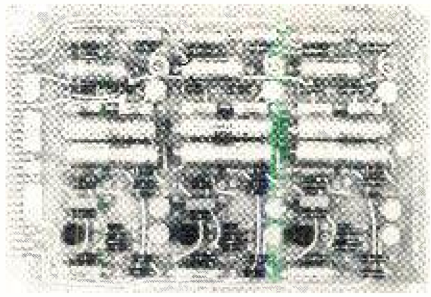
transistorized unit which operates at 3.75 and 1⅞ ips.

The machine will handle up to 5" reels. Frequency response is 90-9500 cps at 3.75 ips and 90-5000 cps at 1⅞ ips. Features include complete push-button operation, built-in microphone and speaker, vu meter for recording level and indication of battery condition, plus variable back-spacing lever to permit correction or repetition.

The instrument measures 12-4/5" wide x 1-4/5" deep x 3-17/20" high and weighs approximately 13 pounds. A fitted leather carrying case is available as an accessory.

SOLID-STATE AUDIO AMPLIFIER

24 **Astrodata Inc.** is now offering a three-channel modular amplifier which is designed for studio applications ranging from microphone input to line output. The Model 108 consists of



three 40-db amplifiers constructed on one plug-in circuit card. The amplifiers may be mixed or switched to produce pure mono or multi-channel stereo program channels.

Pertinent specifications include gain of 40 db (each of three channels); 600-ohm input impedance, output impedance less than 1 ohm; frequency response at +18 dbm output 20-20,000 cps ± 0.5 db, 3 db down at 7 cps and 70 kc.; maximum undistorted output +18 dbm; inverse feedback 57 db; and noise less than —122 dbm.

PORTABLE P.A. SYSTEM

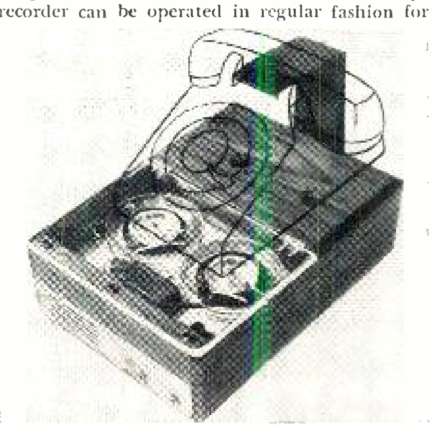
25 **Perma-Power Company** is marketing its "Ampli-Vox Roving Rostrum" as a self-contained battery-operated public address system which can now be provided with a microphone extension kit, permitting the simultaneous use of two microphones. The microphone extension kit includes a microphone with 10-foot cord, a mixer, and a 25-foot extension cord ready to plug in to the "Rostrum."

The "Rostrum" itself is a completely portable high-volume sound system, suitable for audiences as large as 500. Weighing under 34 pounds, and usable where there are no electric outlets, it is suitable for use outdoors as well as indoors.

PHONE ANSWERING/RECORDING UNIT

26 **Advanced Chemoptic Equipment Corporation** is now in production on the "Phone-Minder," a tape recorder that answers the telephone, emits the legally required "beep" tone while recording the caller's message, then says "thank you," and hangs up.

The unit requires no connection between the telephone and the recording device. The tape recorder can be operated in regular fashion for



transcribing the messages on the tape. Each tape is good for several hundred playings.

PARABOLIC CONE WOOFER

27 **Utah Electronics Corporation** has developed a heavy cone molded in a new parabolic shape which, when used in its G12P woofer, improves the useful bass frequency response by an octave.

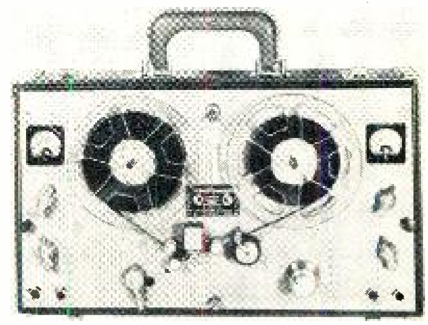
The curve of the new G12P rises steadily from about 20 cps, as tested in free air. The directional-grained, dual-diameter Alnico V magnet produces a flux density equal to 21.5 ounces of Alnico V as used in a conventional magnetic circuit. The woofer features a 1½"-diameter voice coil and four-way terminals. Response is 25-1500 cps with a peak power handling ability of 30 watts. An 8-ohm, 600-cps crossover is recommended.

STEREO TAPE RECORDER

28 **Amplifier Corporation of America** has developed a new battery-operated portable stereo tape recorder, the "TransFlyweight, Series 314."

This rugged, lightweight unit utilizes two clear channels for stereophonic recordings. It provides independent gain adjustment for each channel. Recordings may be fed into any dual-channel amplifier for stereo speaker playback.

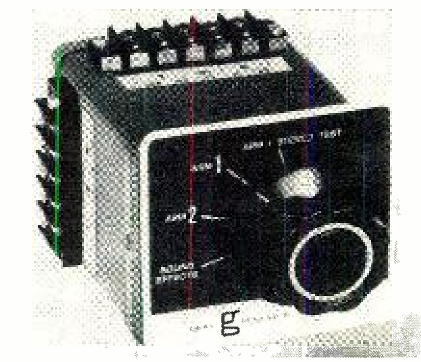
The electric motor operates from small dry replaceable or rechargeable batteries. Fully transistorized, two isolated inputs and two separate



vu meters are provided. Single and multi-speed models are available with tape speeds from 15/16 ips to 15 ips. The 7.5 ips and 15 ips models meet NAB standards. Over-all size is 5½" x 9" x 15½". Weight is 11½ pounds.

LOW-LEVEL AUDIO CONTROL

29 **Gray Research and Development Co. Inc.** is offering a new multi-purpose low-level audio control that permits smooth switching between two mono or stereo tonearms and also enables



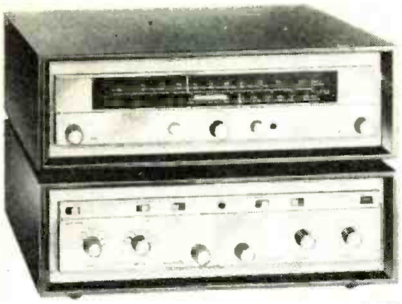
untrained personnel to check out a stereo system.

Called the 404 Tonearm Switch, the unit connects two tonearms to either a mono or stereo equalizer and permits the operator to shift from one arm to the other as needed in playing various type records. In record-cutting operations, the 404 provides groove noise information for adjusting and controlling heat on the stylus. The unit can be connected to the firm's 602-C equalizer, the 604-M/S equalizer, or most equalizers produced by other manufacturers.

COMPONENT STEREO KITS

30 **Paco Electronics Co., Inc.** has added an FM stereo multiplex tuner and an integrated stereo preamp-amplifier to its line of hi-fi kits.

The ST-55MX tuner features dual limiters, a Foster-Seeley discriminator, and a grounded-grid r.f. stage. It offers 30 db of separation. The circuit incorporates a full-wave power supply, an



electrostatically shielded power transformer, and twelve tubes (including rectifier). An EM84 tuning indicator is used.

The SA-50 is a 50-watt preamp-amplifier with 14 front-panel controls and switches. The unit has a frequency response of 30-90,000 cps ± 1.0 db. Harmonic distortion is less than 0.5% at 20 watts per channel output: IM distortion is less than 1% at full rated power.

Both kits are shipped in a unique package designed to reduce assembly time. The package forms a surface on a slant angle for easier work handling and each part is packaged with an identification number for logical sequential assembly.

CB-HAM-COMMUNICATIONS

SIX-CHANNEL CB MOBILE

31 **Browning Laboratories, Inc.** is now offering a six-channel mobile CB transceiver as the "Drake M-506."

The new unit is 8" wide x 3" high x 9" deep and is one of the smallest transceivers of its type

on the market. It is designed to be mounted in any car, boat, or other vehicle in a matter of minutes. Other features include a rear-lighted channel indicator, transistorized d.c. power supply, 5-watt plate power input, 3.5-watt power output to the antenna, harmonic suppression better than 50 db down, frequency stability of .005%, receiver sensitivity of 0.4 μv. for 10 db signal-to-noise ratio, and selectivity 5 kc. at 6 db adjacent channel 60 db down.

CB BASE-STATION MIKE

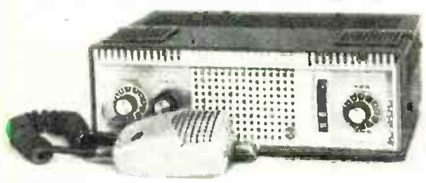
32 **The Turner Microphone Company** is now marketing a special model of its desk-type ceramic microphone for use in CB base-station operations. Designated the Model J-254C, the new unit has an extra set of contacts to allow wiring into any amateur or CB set on the market.

The unit operates by a touch bar "on-off" switch and lever-lock "on-off" switch. Response is 80-7000 cps with output —54 db.

CB UNIT FOR MOBILE/BASE USE

33 **RCA Electron Tube Division** has released a compact two-way CB radio, engineered for dependable short-range communications and designed for mobile, office, or home use.

The "Mark VIII" is housed in a rugged metal cabinet which measures only 3½" high x 11¼" wide x 8" deep, and weighs 8 pounds. The unit



operates on 117-volt a.c. with separate d.c. power supplies for 6- and 12-volt mobile operation available as optional equipment.

There are nine crystal-controlled transmit and receive channels, a continuously tunable receiver covering all 23 CB channels, noise limiter to reduce effects of ignition and similar interference, TVI traps, and maximum permissible CB transmit power of 5 watts plate input with 3 watts output or better.

SHORT-WAVE RECEIVER LINE

34 The Hallicrafters Co. has recently introduced a line of "World Range" short-wave radio receivers, featuring walnut cabinets designed to blend with virtually any living room, den, or recreation room decor.

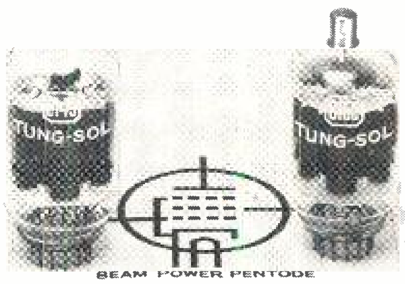
The Models WR-1500 and WR-1000 have three short-wave bands as well as an extended-range local broadcast band. The WR-1500 also covers the long-wave navigation and weather band.

Both models feature bandspread for razor sharp tuning, slide-rule dial, headset jack for private

listening, and b.f.o. for code reception. In addition, the WR-1500 offers a special jack for connection to an existing hi-fi system. Short-wave bands on the WR-1500 range from 1.6 to 31 mc., on the WR-1000 they range from 1.6 to 30 mc.

TUBES FOR MOBILE APPLICATIONS

35 Tung-Sol Electric, Inc. has announced the development of two new beam-power pentodes with increased output ratings to 40 watts. Designed as r.f. power amplifiers and oscillators



at frequencies up to 175 mc., the Type 8149 is a single-ended T-12 compactron design and the Type 8150 is a double-ended T-12 compactron design. Both types feature a center-tapped heater so that they may be operated from either a three-cell or a six-cell storage battery system. Suitable for mobile communications applications in class C telegraphy or telephony operation, they are rated for ICAS.

DIGITAL TELEMETRY SYSTEM

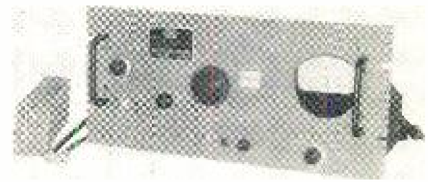
36 Gulton Industries, Inc. is now marketing a solid-state digital telemetry system as the "Veradat."

Used in applications where data must be gathered at a central control station from many remote locations, the new device can be maintained and operated by relatively unskilled personnel. The modular, transistorized unit is constructed of 2½" x 3" plug-in printed-circuit modules, facilitating maintenance and providing for future equipment modification.

The instrument can accept inputs from sensors which measure temperature, thickness, flow, strain, force, angle, sound, liquid level, or any other measurable parameter which can be converted into a voltage or current. Models are available with up to 32 analog data inputs per transmitter and up to 16 transmitter stations (512 data input points) per receiver.

SPURIOUS RADIATION DETECTOR

37 Barker & Williamson Inc. has introduced a new instrument for detecting harmonic and spurious radiations from radio transmitters. The Model HST Harmonic and Spurious Totalizer is



for use with transmitters operating between 2 and 32 mc. It measures harmonic and spurious radiation up to 90 mc. Undesirable emission 65 db below carrier can be detected within a matter of minutes.

The unit was especially designed for applications in radio communications stations where periodic checks are made on transmitters for spurious radiation.

FIVE-CHANNEL CB UNIT

38 Cadre Industries Corp. is currently introducing a five-channel, transistorized CB transceiver, the Model 515.

Modular construction of the transmitter, receiver, audio section, and power supply permits compact packaging and extremely low current drain. Built-in speech limiting, squelch, automatic gain control, and noise limiting provide good range and clarity.

Included are a.c. and d.c. power cords, a mounting bracket, and special dynamic microphone. The unit is housed in a charcoal and silver cabinet which measures 11½" x 3¼" x 5½" and weighs 6 pounds.

CB TRANSCEIVER

39 Concord Electronics Corporation has just introduced a 9-transistor CB transceiver, the Model TG-093. The unit transmits on normal CB frequencies with the maximum 100 mw. power input allowed by FCC regulations for license-free service.

A separate a.c. accessory is available, permitting the transceiver to be operated as a base station from house current. The unit comes with two plug-in crystals for transmitting and receiving on CB channel 9. Crystals for other frequencies are available. The unit comes complete with genuine leather carrying case for both transceiver and antenna.

MARINE DIRECTION FINDER

40 Bendix-Marine has added the "Navigator 410" to its line of radio-direction finders.

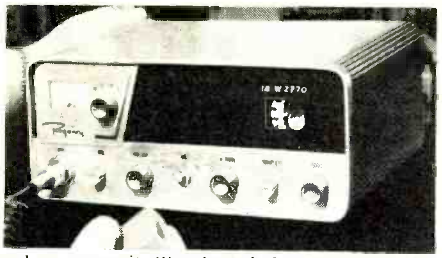
Billed as the smallest direction finder available with the consolan-beacon, broadcast, and marine bands, the new unit measures only 8" x 5" x 2½" and weighs just 2½ pounds.

Incorporating 8 transistors, the unit can be used as a pelorus for the taking of visual bearings on points of land. Sights are hinged at each end of the rotatable loop, and the azimuth

is engraved on the top of the shock-resistant plastic case. Power is supplied by four flashlight batteries. No external antenna is needed and a null-meter is used to sharpen the bearings.

CITIZENS-BAND TRANSCEIVER

41 Regency Electronics, Inc. has developed a "Range Gain" transceiver incorporating double-side-band reduced carrier circuitry which the company claims provides four times the coverage of previous CB units.



In addition, the new unit provides 23 crystal-controlled channels for transmitting and receiving, four-way illuminated meter with two scales, a meter which glows red on transmit, illuminated channel selector for all 23 channels, antenna-matching adjustment for resistive antenna loads of 30 to 75 ohms, four simple function-switch settings, and built-in power switch which activates a universal power supply.

MICROWAVE REFLECTORS

42 Rohn Manufacturing Co. has entered the microwave passive-reflector market with a new type of reflector made of Reynolds aluminum interlocking extrusions.

The company is now offering the reflectors in three standard sizes: 6 x 8 feet, 8 x 12 feet, and 10 x 15 feet. All-aluminum, the reflectors in these sizes weigh approximately 140, 280, and 438 pounds respectively. The extrusions can be shipped knocked-down to the erection site and snapped together and assembled in the field.

MANUFACTURERS' LITERATURE

INDICATING LIGHTS

43 General Electric Company has issued a four-page bulletin (GEA-7366) which describes its new line of CR103 Type C square indicating lights designed to blend with equipment of modern appearance.

Covered are full-voltage and transformer forms for use on motor control centers, operator panels, consoles, control desks and for panel building, electronic, and instrumentation fields.

The bulletin includes assembly details, illustrated installation and wiring instructions, dimensions and ordering information, and a section on ways to display legends, symbols, and instructions.

PANEL INSTRUMENT DATA

44 **The Triplett Electrical Instrument Company** has announced publication of its panel-meter catalogue No. 21-I. New products introduced include the slim, modern-styled 420-R and the latest edgewise 420-E panel meters.

The catalogue provides complete information for ordering, with ranges, prices, special items, and full technical data on each of the basic styles in the complete line.

ASSEMBLY TOOLS

45 **Techni-Tool, Inc.** is offering copies of its 24-page brochure entitled "Micro-Miniature Assembly Tools" which provides information on the latest in precision electronic pliers, superfine tweezers, and other items essential to the aerospace industry.

Over a hundred stock items, available on immediate delivery, are included in this fully illustrated publication.

SPECIAL SALE CATALOGUE

46 **Radio Shack Corporation** has just released a special 160-page sale catalogue which lists a large selection of the firm's "Realistic" line of hi-fi components and test equipment, records and pre-recorded tapes, radios, phonographs, electrical accessories, and electronic components for the hobbyist.

MOLDED MICA CAPACITORS

47 **Sangamo Electric Company** is distributing copies of its new 12-page mica capacitor bulletin, No. 2320, which contains complete engineering information on an extensive line of molded, wire-lead type, mica dielectric capacitors.

Graphs and charts have been used wherever practical to facilitate application of these capacitors. Complete listings for both commercial and military units are included.

LIGHT-MEASURING INSTRUMENTS

48 **Weston Instruments and Electronics Division** has issued a four-page data sheet covering an extensive line of light-measuring instruments.

Among the units described are sightmeters, illumination meters, footcandle meters, and footlambert meters for applications by industrial safety engineers, lighting engineers, public utilities, among others. Specialized instruments for measurement of TV studio illumination and for sunlight illumination studies are among the units described.

SELECTION CHART

49 **Cornell-Dubilier Electronics Division** has just issued a 17" x 22" wall chart showing a seven-step specifying procedure for MIL-C-25 capacitors. These capacitors are fixed paper-oil d.c. units in hermetically sealed metallic cases. The chart's main table shows terminal types, circuits, temperature characteristics, voltage, capacitance, and capacitance tolerance for each of the 17 illustrated case styles. Ten additional tables, graphs, and diagrams augment the main table.

CCTV APPLICATION DATA

50 **Kin-Tel Division** has issued a two-page bulletin entitled "Poolside TV Installation" which provides illustrations and details on the installation and use of the firm's 20/20 closed-circuit TV system at a ranch home to observe the pool and front door through the home television set.

CONDENSER MICROPHONE DATA

51 **B & K Instruments, Inc.** has announced publication of a 12-page technical brochure on its Series 4131/6 precision condenser microphone and accessory equipment.

The brochure contains a detailed description of the microphones and their cartridges. It describes the units, individual calibration, free-field corrections, a wide range of cathode followers, and arrangements for measuring, recording, and analyzing sound. Complete specifications are included.

HI-FI SPEAKER SYSTEMS

52 **Acoustic Research, Inc.** has issued a catalogue describing the performance of different models of its speakers in both technical and non-technical terms. Also described are the company's turntable and two books on high fidelity published by the firm.

CONVERSION-FACTOR CHART

53 **Precision Equipment Co.** has published a reference table for engineers in wall-chart form which includes such common conversions as inches to centimeters or watts to horsepower as well as many conversions less easy to locate in reference sources.

TESTING PARAMETERS

54 **Surprenant Mfg. Co.** has issued the first of its new series of "Service to Industry" bulletins under the title "Dielectric Testing Parameters."

Designed to assist quality-control engineers and inspectors in the correct use of their dielectric high-voltage-testing equipment, the publication is specially tailored to the needs of military and industrial users of wire and cable products.

FM STEREO BOOKLET

JFD Electronics Corporation has published a booklet "A Guide to Better FM Stereo Performance" which is being distributed through the firm's franchised antenna distributors.

The booklet explains the reasons why an FM stereo-engineered outdoor antenna is vital for properly balanced and separated stereo. It also clarifies the reasons why the multiplex subcarrier will not be strong enough to lock in the receiver's multiplex circuits if the signal and receiver input is inadequate because of an inefficient antenna system. ▲

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Answer to Electronic Crosswords

(Appearing on page 63)

C	H	A	M	P				G	R	I	N	D
L	I	N	E	A	R		L	O	U	V	E	R
I		O	N	T	O		A	L	T	O		O
P	O	D		S	O	U	N	D		R	A	P
	S	E	T		T		D		B	Y	E	
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			N	A	T	U	R	A	L			
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Simplified Audio Matching

(Continued from page 51)

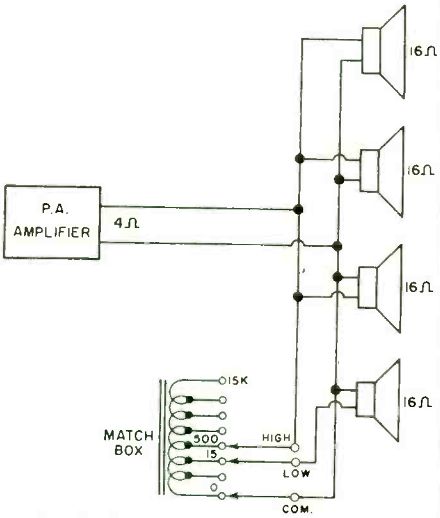
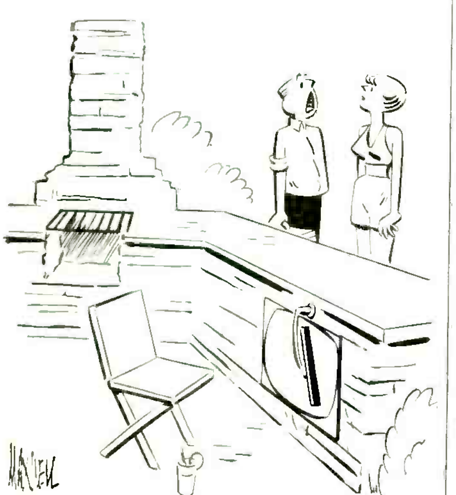


Fig. 7. Using the match box to adjust level in one speaker, without mismatch.

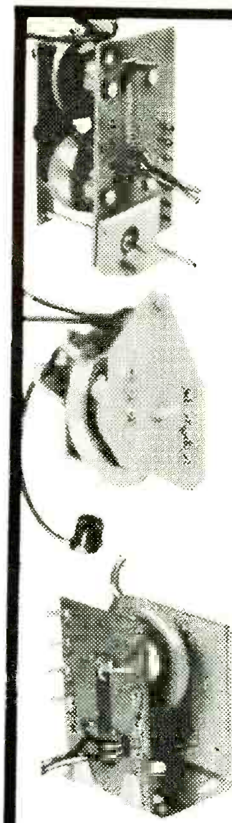
three are dispersing sound over larger areas. The output level is too great at the odd speaker.

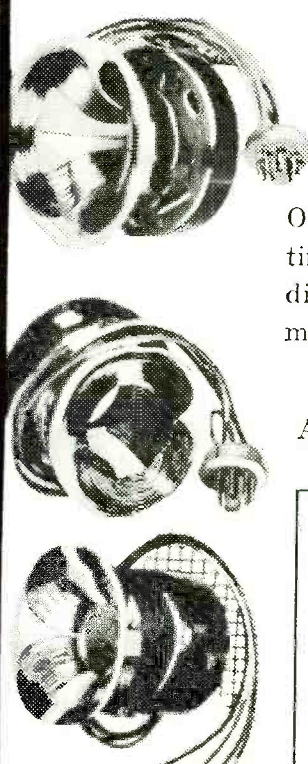
Impedance of the latter can be stepped up and signal to it stepped down with the arrangement in Fig. 7. Selecting the pairing of windings that will produce the desired level is a simple matter of rotating one switch, perhaps two. An *L*- or *T*-pad could be used instead as an attenuator. The point is, however, that such resistive networks involve power losses. Where many are used in a system, accumulated losses become uneconomical, mandating the use of a more powerful main amplifier. Transformer matching avoids such losses.

Anyone who tries the technique suggested may find that one good thing leads to another. He may decide that two or more match boxes can clear up nearly any sound-distribution problem he might run into. ▲



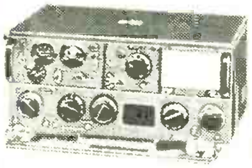
"The WHAT doesn't work on your TV set?"





AN/ART-13 100-WATT XMTR

11 CHANNELS
200-1500 Kc
2 to 18.1 Mc



$69.50 exc. used

Complete with Tubes

Famous Collins Autotune Aircraft Transmitter. AM, CW, MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier/clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP813's modulate 813 in final up to 90%, class "B." A Real "HOT" Ham buy at our low price!
AN/ART-13 XMTR, as above. LIKE NEW, checked out, guaranteed to be in perfect working order $119.00
0-16 Low Freq. Osc. Coil for ART-13 .... 7.95
24V Dynamotor for ART-13 .... 11.95
Same as above less meter 39.50
We carry a complete line of spare parts for above.

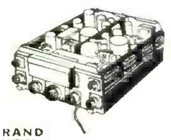
AN/APR-4 RECEIVER only, 38 to 4000 Mc in 5 tuning unit ranges. High precision lab instrument. Input 115 V60 cy. **Like New** $79.50
Tuning Units TN16, 17, 18 each $39.50
Tuning Unit TN19. **Brand New** $89.50
Tuning Unit TU54 .... $149.50

NAVY AIRCRAFT RADIO RECEIVER

ARB CRV 46151—190 to 9050 Kc in 4 bands, 6 Tube Superhet communications receiver, with local and remote tuning, band change. Sharp and broad tuning, AVC, CW, Illuminated dial. Complete with tubes and dynamotor.
BRAND NEW $49.50
Pwr Supply 110 V. AC. Wired 14.95
All Accessories for ARB Receiver in Stock

FAMOUS BC-645 TRANSCEIVER

15 Tubes 435 to 500 MC

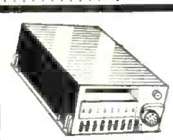


BRAND NEW

Can be modified for 2-way communication, voice or code, on ham band 420-450 mc. citizens radio 460-470 mc. fixed and mobile 450-460 mc. television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!); 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE-316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton.
Shipping weight 25 lbs. **SPECIAL!** **$19.50**
PE-101C Dynamotor, 12/24V input $7.95
UHF Antenna Assembly 2.45
Complete Set of 10 Plugs 5.50
Control Box 2.25

SPECIAL "PACKAGE" OFFER:
BC-645 Transceiver, Dynamotor and all accessories above. COMPLETE, BRAND NEW, While Stocks Last **$29.50**

ARC-3 RECEIVER!



Complete with All Tubes Exc. Used **$19.95**
Like NEW .... $29.50.
Crystal-controlled 17-tube superhet. tunes from 100 to 156 MC., AM., on any 8 pre-selected channels. 28-volt DC power input. Tubes: 1-9002, 6-6AK5, 1-12SH7, 3-12SG7, 1-9001, 1-12H6, 2-12SN7, 1-12SL7, 1-12A6.
110 V A.C. Power Supply Kit for above 15.00
Factory Wired and Tested 19.95

ARC-3 TRANSMITTER

Companion unit for above, tunes 100 to 156 MC on any 8 pre-selected channels. 9 tubes, crystal controlled, provides tone and voice modulation. 28V DC Power input. Complete with all Tubes: 3-6V6, 2-832A, 1-12SH7, 1-6J5, 2-6L6. Exc. Used .... Only **$18.95**
Like new condition $28.50
ARC-3 PUSHBUTTON CONTROL BOX $5.95

APR-5A UHF RECEIVER

The APR-5A is a superhet receiver with 2 frequency ranges: (1) from 1000 to 3100 megacycles, (2) from 3000 to 6000 megacycles continuous by means of interchangeable mixers using a single dial tuning control. It has a 10 meg. I.F. band width of 30 megacycles center. Operates from 80-115 V, 1 phase, 60-2600 cycles. Variable I.F. gain by use of a pot. Use for frequencies above 1000 megacycles to supplement range of APR-4 receivers. Like New, with all tubes **$69.50**

ACCESSORIES for BC-603, 683 RECEIVERS

EXTRA SET OF 10 TUBES FOR ABOVE brand new in original boxes $3.95

12 or 24V Dynamotor for Above.
Exc. Used $4.25 .... Brand New **$5.50**

AC POWER SUPPLY FOR BC603, 683
Interchangeable, replaces dynamotor. Has On-Off Switch. NO RECVR. CHANGE NEEDED. Provides 220 VDC @ 80 Ma. 24VAC @ 2 Amps $12.95

Complete 240-page Technical Manual for BC-603, 604 .... $3.15

BC-604 TRANSMITTER—Companion unit for BC-603 Rcvr. above. With all tubes. BRAND NEW **$8.95**
4-Section Antenna for BC-604, 684 Transmitters, Complete with mounting base. BRAND NEW .. $4.95
We carry a complete line of spare parts for above.

ARC-5/T-23 TRANSMITTER 100-150 Mc., includes tubes: 2-832A, 2-1625. BRAND NEW, with tubes **$21.50**
Excellent Used, less tubes $5.95

ARC-5/R-28 RECEIVER, 2-meter superhet, 100 to 156 Mc in 4 crystal channels, complete with 10 tubes. BRAND NEW, with tubes **$26.50**
Excellent Used, with tubes $23.50

TG-5-B TELEGRAPH SET

Made for USA Army Signal Corps. A dandy little field set for 2-way communication. Sturdy metal container, 6¾"x4¾"x4", with hinged covers, complete with telegraph key and headset. BRAND NEW, in carrying case with shoulder strap **$9.95**

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We specialize in the export of military surplus electronic equipment:

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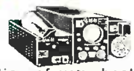
- In addition to items shown on this page, we have in stock or can obtain for export customers, military electronic equipment made for World War II, Korean War, and later.
- **IF YOU DON'T SEE WHAT YOU WANT HERE, WRITE US YOUR NEEDS. LET US QUOTE ON ANY GOV'T SURPLUS ELECTRONIC EQUIPMENT YOU SEE ADVERTISED ANYWHERE. INQUIRIES WELCOMED.**
- All packing and shipping is made directly from our own warehouse in NYC to give you substantial savings in handling costs.

SEND FOR LATEST FREE G & G BULLETIN OF SURPLUS MILITARY ELECTRONIC EQUIPMENT.

LORAN APN-4

FINE QUALITY NAVIGATIONAL EQUIPMENT



Determine exact geographic position of your boat or plane. Indicator and receiver complete with all tubes and crystal.
INDICATOR ID-6B/APN-4, and RECEIVER R-9B/APN-4, complete with tubes, Exc. Used, checked out, guaranteed to be in perfect working order $79.50
BRAND NEW $99.50
Receiver-Indicator as above, BRAND NEW $88.50
Shock Mount for above $2.95
INVERTER POWER SUPPLY for above APN-4. INPUT: 24 V DC @ 75 A. OUTPUT: 115 V AC @ 10.5 Amps. 800 cycles. Complete with two connecting plugs BRAND NEW $49.50
12-Volt Inverter Power Supply for above APN-4. Like New. P.U.R.
We carry a complete line of spare parts for above.

LORAN R-65/APN-9 RECEIVER & INDICATOR

Used in ships and aircraft. Determines position by radio signals from known xmitters. Accurate to within 1% of distance. Complete with tubes and crystal. Exc. Used, checked out, guaranteed to be in perfect working order. $104.50. Used, less tubes, crystal and visor, but with 3BP1 C.R. tube $29.50
INVERTER POWER SUPPLY for above APN-9. INPUT: 24 V DC. OUTPUT: 115 V AC. 800 cy. NEW $49.50
12-V. Power Supply for APN-9, like New P.U.R.
Shock Mount for above $2.95
Circuit diagram and connecting plugs available.
We carry a complete line of spare parts for above.

LORAN APN/4 OSCILLOSCOPE

Easily converted for use on radio-TV service bench.
LIKE NEW! Less tubes, but including 5" Scope, type 5CPI only **$14.50**

BENDIX DIRECTION FINDERS

For commercial navigation on boats.
MN26Y 150-325 Kc; 325-695 Kc; 3-4.7 Mc. Complete with tubes, dynamotor. BRAND NEW **$19.50**
MN28Y Receiver Control Box .... $ 4.95
MN26C Receiver 150-1500 Kc continuous tuning with 12 tubes and dynamotor. Used ... 18.95
MN26C Receiver as above, BRAND NEW 27.50
MN20E Rotatable Loop for above 4.95
MN52 Azimuth Control Box 2.95

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$12.95	$14.95
BC-454	Receiver 3-6 Mc	12.45	17.95
BC-455	Receiver 6-9 Mc	11.50	13.95
	1.5 to 3 Mc. Receiver Brand New		$17.95

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case, instructions **$8.95**
Factory wired, tested, ready to operate .. $12.50
SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only **49c**

2.1 to 3 Mc. Transmitter. Brand New $12.95
BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal, BRAND NEW .. **$9.75**
Like New $7.95
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal.
BRAND NEW **$10.95**
Like New $7.95
T19 TRANSMITTER ¾ m.c. complete with all tubes and crystal. Exc. Used **$9.95**
BC-696 TRANSMITTER 3-4 Mc Complete with All Tubes & Crystal. Like New **$11.95**
BC-456 Modulator .... USED 3.45 NEW 5.95
MD7 Modulator. Like New $9.95
ALL ACCESSORIES AVAILABLE FOR ABOVE

SCHEMATIC DIAGRAMS For most equipment on this page, each .. **65c**

Please include 25% Deposit with order—Balance C.O.D., or Remittance in Full. 50c Handling Charges on all orders under $5.00. All shipments F.O.B. Our Warehouse, N.Y.C. All Merchandise subject to Prior Sale and Price Change.

G & G RADIO SUPPLY CO.

Telephone: CO 7-4605
77 Leonard St. New York 13, N. Y.

BC-929 3-INCH SCOPE

Low cost station monitor and or bench scope. Has Horiz., focus, sweep, intensity controls. Tubes: 2—6SN7, 2—6H6, 1—6X5, 1—6G6, 1—2X2, 3BP1 CR Tube. Voltage req. 115V 400 cy. and 24 VDC. Complete with tubes, exc. used **$9.95**
BRAND NEW $12.95
Conversion instructions for 110V 60 cyc. AC .. 65c

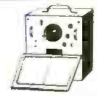
LM FREQUENCY METER

Crystal calibrated modulated. Heterodyne. 125 Kc to 20,000 Kc With Calibration book **$58.50**
Complete, Like New ....

BC-906 FREQ. METER—SPECIAL

Cavity type 145 to 235 Mc. Complete with antenna. Manual and original calibration charts included. **BRAND NEW. OUR LOW PRICE** **$12.88**

BC-221 FREQUENCY METER



SPECIAL BUY! This excellent frequency standard is equipped with original calibration charts, and has ranges from 125 Kc to 20,000 Kc with crystal check points in all ranges. Excel. Used with original Calibration Book, Crystal, and all tables—LIKE NEW!
Unmodulated .... **$72.50** Modulated $99.50
BC-221 1000 Kc Crystal Brand New $8.95

TEST SET TS-175 U. Portable crystal controlled heterodyne type unit used in field testing of CW or MCW RF Transmitters and Signal Generators. Range 85 to 1000 Mc. Power requirements: 6V DC and 135 VDC. Exc. Cond. **$269.50**
TS-170/ARN-5 TEST OSCILLATOR, portable, battery-operated, crystal controlled, for frequencies: 332.6 Mc., 338.6 Mc., and 335 Mc. Power input 1.5 VDC and 90 VDC. Less Batteries. Exc. Cond. **$22.50**

SCR-625 MINE DETECTOR

Complete portable outfit in original packing, with all accessories. Brand New **$27.50**

APR-1 Navy VHF-UHF radar search Receiver. 80 Mc to 950 Mc in 2 bands. **BRAND NEW** **$79.50**
TUNING UNITS for above: TN1, TN2, TN3, in stock

EE-8 FIELD PHONES

Talk as far as 17 miles! Dependable 2-way communication at low cost! Ideal for home, farm, field. Up to six phones can be used on one line. Each phone complete with ringer. Originally cost govt. $65.00 each.
Excellent Condition, checked out, perfect working order, complete with all parts. Each **$12.95**

MICROPHONES Checked Out, Perfect

Model	Description	EXC. USED	BRAND NEW
T-17D	Carton Hand Mike	$4.45	$7.95
RS-38	Navy Type Carbon Hand Mike	3.95	5.75

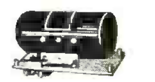
HEADPHONES Checked Out, Perfect

Model	Description	Excellent Used	BRAND NEW
HS-23	High Impedance	$2.49	$4.75
HS-33	Low Impedance	2.69	4.95
HS-30	Low Imp. (featherwt.)	.90	1.65
H-16 U	High Imp. (2 units)	3.75	7.95

TELEPHONICS—600 ohm Low Impedance HEADSETS, BRAND NEW, PER PAIR $3.25
CD-307A Cords, with PL55 plug and JK26 Jack .99
Earphone Cushions for above—pair .... .50

MOBILE-MARINE DYNAMOTOR

Model DM35



Input 12V DC. Output: 625 V DC @ 225 Ma, for press-to-talk intermittent operation. Shpg. wt. 14 lbs.
BRAND NEW **$14.95**

Type	Input	Output	Excellent Used	BRAND NEW
DM-32A	28V 1.1A	250V .05A	2.45	4.45
DM-33A	28V 5A 28V 7A	575V .16A 540V .25A	2.95	4.45
DM-34D	12V 2A	220V .080A	4.15	5.50
DM-36	28V 1.4A	220V .080A	1.95	2.95
DM-37	25.5V 9.2A	625V .225A	2.95	4.22
DM-43	28V 23A	925V .220A 460V .185A	—	14.50
DM-53A	28V 1.4A	220V .080A	3.75	5.45
PE-73C	28V 20A	1000V .350A	8.95	14.95
PE-86	28V 1.25A	250V .050A	2.75	3.85

(Table heading: OTHER DYNAMOTOR VALUES)

DM-42A DYNAMOTOR. Input 12 V DC @ 39 Amps. Output 515 V DC @ 215 Ma. and 1030 V DC @ 260 Ma. Wt. 38 lbs. BRAND NEW, each $6.95
DM-37 DYNAMOTOR. Input 25.5 V DC @ 9.2 A. Output 625 V DC @ 225 Ma. BRAND NEW. Each $3.25

CARTER GENEMOTOR

INPUT: 5.9 V DC @ 32 Amps.
OUTPUT: 405 V DC @ .270 Amps.
BRAND NEW, special **$8.95**

INVERTER made by Bendix. INPUT: 24VDC @ 1 Amp., OUTPUT: 26 VAC 400 cycles @ 6 volt-amps. .4 power factor, single phase. Mounted on filter base. LIKE NEW $3.25

2 VOLT BATTERY "PACKAGE"

1—2V, 20 Amp. Hr. Willard Storage Battery, Model #20-2, 3" x 4" x 5½" high $2.79
1—2V, 7 prong Synchronous Plug-in Vibrator 1.49
1—Quart Bottle Electrolyte (for 2 cells) 1.45
ALL BRAND NEW!
Combination Price **$5.45**

ELECTRONICS MARKET PLACE

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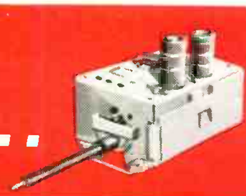

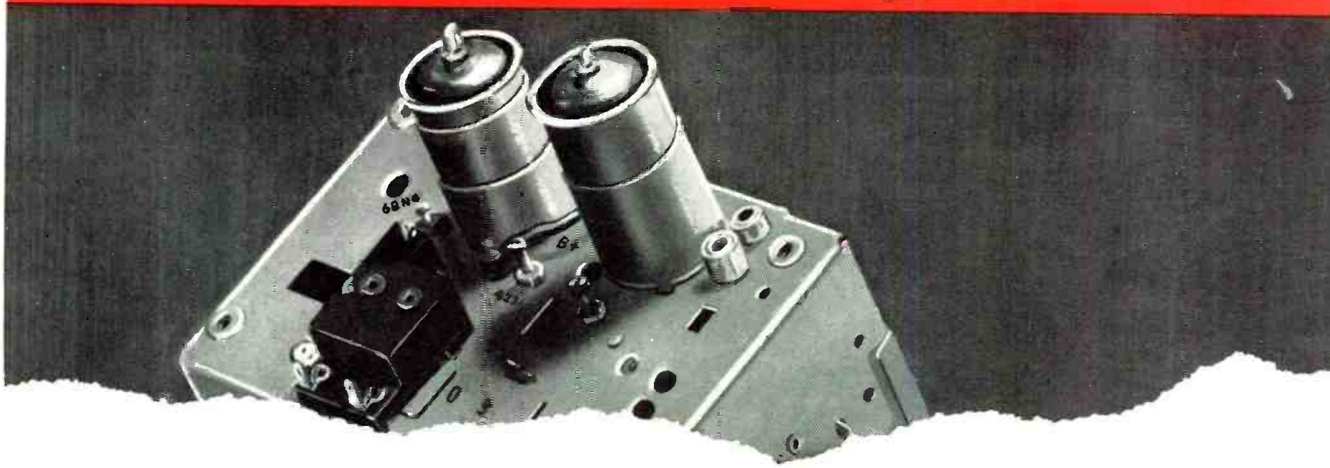

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