OCTOBER, 1960

ELECTRONICS WORLD

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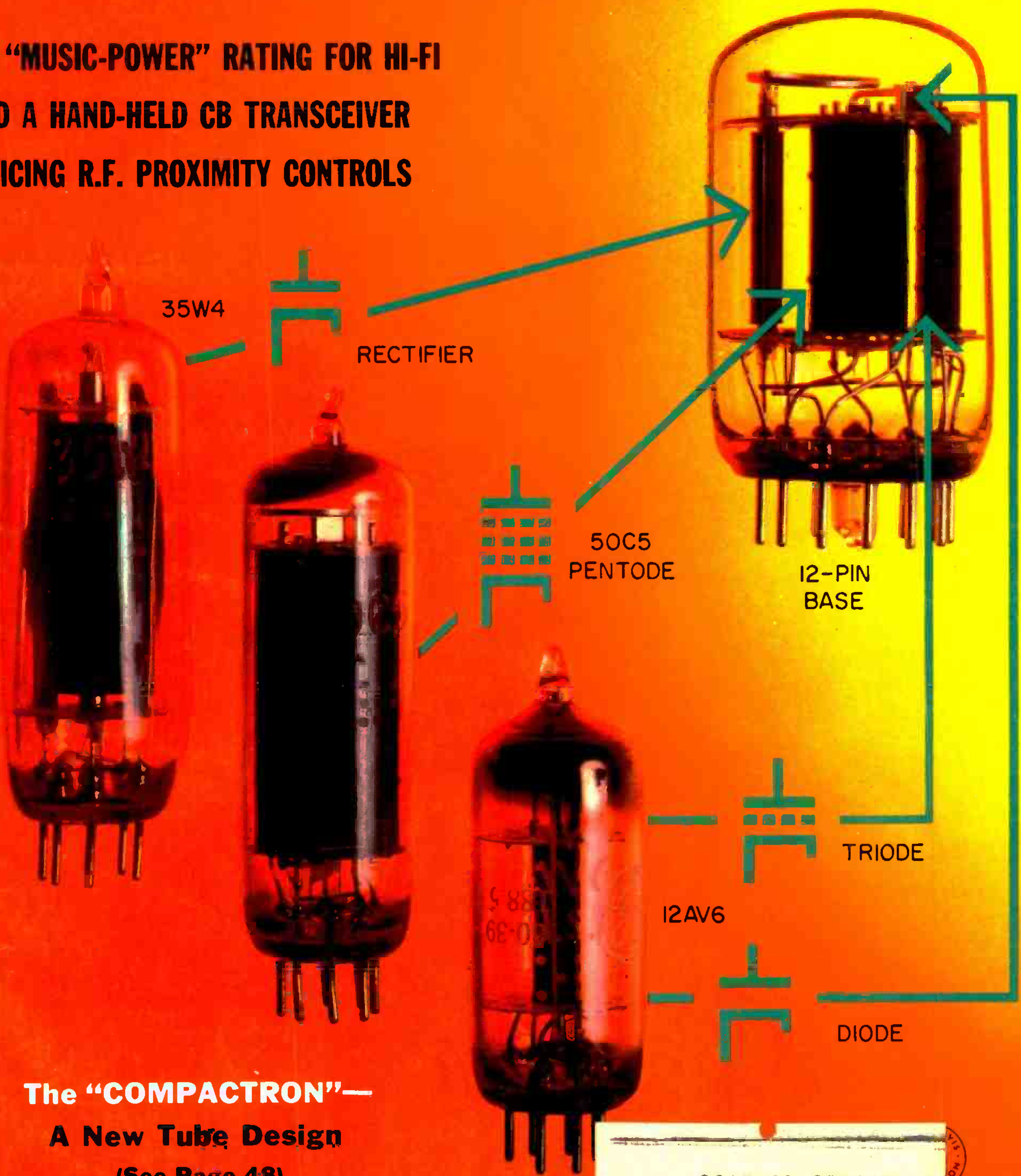

The "COMPACTRON"— A New Tube Design

(See Page 48)

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ELECTRONICS WORLD

OCTOBER, 1960

VOL. 64 ▪ NO. 4

First in radio-television-audio-electronics

CONTENTS

GENERAL ELECTRONICS AND INDUSTRIAL

HIGH FIDELITY AND AUDIO

TELEVISION-RADIO

TEST EQUIPMENT

COMMUNICATIONS AND AMATEUR

ELECTRONIC CONSTRUCTION

DEPARTMENTS

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...for the Record

By **W. A. STOCKLIN**
Editor

THE SOARING SIXTIES

AT the beginning of each new decade, much thought is given as to what the coming era holds in store for us. Despite the comments we have heard and the "educated guesses" which have appeared in print, we believe that one of the most thought-provoking analyses we have yet encountered is one presented by Hiram L. Fong, Senior U. S. Senator from Hawaii, in his talk before the graduating class at Tufts University.

We feel that Mr. Fong's comments deserve wider dissemination and we would like to quite, in part, from his commencement address.

"Educationally comprising the upper 5% of our population, college graduates will have a decided advantage in potential earning power over non-college workers. The job outlook for college graduates is excellent, with starting salaries higher by some 4 to 8 per-cent over a year ago. Long-range prospects are likewise auspicious. It is anticipated that within a few years if we do not have new methods and new machinery, there will be a shortage of manpower to produce the goods and services needed to sustain the American standard of living.

"The economic indicators of the next 15 years show that we will be a nation of 240 million people, 60 million more than today, with a labor force of about 95 million producing goods and services totaling 900-billion dollars.

"Translated into other tangibles, these vital statistics mean that we will build millions of dwelling units, thousands of miles of roads, and many, many bridges, dams, and flood-control projects. We will need some 77,000 more doctors, 34,000 more dentists, and a third of a million more nurses than we have today.

"Not only are there jobs for everyone, but there is also a wide choice of careers. A few years ago, there were no electronics industries, no atomic energy projects, no missiles or rockets or space vehicles. New vocations, created in the past ten or fifteen years, run the full spectrum of man's pursuits and offer careers undreamed of only a few decades ago.

"You are on the threshold of a very interesting, fascinating, and rewarding era, witnessing what promises to be the birth of a new 'Golden Age'.

"All around you life's pace has quickened. From sails to steamboats and from pushcarts to motor vehicles embraced thousands of years. Today, speed and power change within decades or less. In the first six decades of this century in America, changes have been greater than in all the thousands of years of mankind's history. It was only 18 years ago, in 1942, that Enrico Fermi discovered the principle of atomic chain reaction that launched us into the Atomic Age. Scarcely had this era dawned when 15 years later, in 1957, we found ourselves in the Space Age with the first Sputnik.

"Fifteen years from now, supersonic airplanes will bring Paris within two hours of New York and Geneva about three hours from Los Angeles. Space travel will approach reality. In 1961 we hope to launch our first man into space with safe return; about 1970, to transport an American astronaut to the moon; and perhaps by 1975, to other places. . . .

"Men of wisdom and learning throughout the ages have cautioned that the use of leisure time wholly for fun, pleasure, and comfort renders life narrow and empty. Gratifying only material wants does not satisfy the soul. Lasting satisfaction, contributing to the fullness of life, comes from cultivating in one's heart a spirit of charity and service toward all men and from devoting a portion of one's life to benefit mankind.

"Therefore each of you ought to ponder how, with your particular talents and in your particular circumstance, you can serve family, friends, community, nation, and mankind."

Senator Fong was one of the most interesting persons we have met and his presentation was both thoughtful and dynamic. After analyzing his comments, it is almost impossible not to be optimistic about the coming decade. One fact stands out—the population growth in the next ten years will be unprecedented in our history and with this growth will come tremendous opportunities.

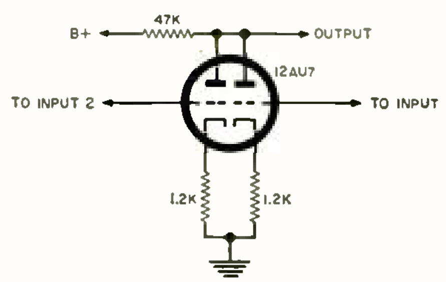
An increase in our working force—whether in the fields of medicine, construction, etc.—means an increasingly important role for electronics. Electronics, in many ways, is like an octopus with its tentacles reaching into every other industry and profession. An increase in population means more TV sets, radios, and hi-fi equipment. Increased demands by the medical profession will generate many new types of electronic equipment. Expansion of the construction and related industries means more electronic equipment for communications and automation. Thus it seems that no matter what career one chooses, electronics will play a vital role in the Soaring Sixties. —30—

Letters from our Readers

AUDIO DISTORTION METER

To the Editors:

The article "Simple Audio Distortion Meter" by Richard Graham on page 57 of the April, 1960 issue of ELECTRONICS WORLD has some interesting ideas, but there is one point that seems doubtful. I believe that the author's choice of a 6AS6 multigrid mixer in his circuit was



unfortunate. This type of mixer has a multiplicative type of action, and will not give the true additive mixing which the device needs. It might be better to replace the stage with a double-triode common-plate mixer such as shown in the above figure.

CHARLES ERWIN COHN
Chicago, Illinois

We are glad to pass along Reader Cohn's suggestion for improving our distortion meter.—Editors.

* * *

RADAR SPEED TRAPS

To the Editors:

I have read with particular interest your article "Radar Speed Meters and Traffic Controls" in the June issue of ELECTRONICS WORLD. It gives me some concern that you omitted any suggestion that speed meters as now used by the traffic officers are decidedly not infallible.

Like yourself and all good citizens, I recognize the urgent need for traffic laws and their proper enforcement, and I appreciate the great boon the "radar" speed meters have been to the embattled police. But I believe that the car riders, the police, and the courts should be advised that the reliability of the evidence provided by these instruments is by no means 100 per-cent.

Because none of those parties involved in a "radar arrest" and trial has, in general, any technical knowledge of electronics, the defendant finds himself in court bearing the burden of presumed guilt and of proving himself innocent. This is contrary to the basic principles of American jurisprudence. In order to even attempt to prove his innocence, the accused must engage the services of an attorney and an expert. This is a very considerable expense in order to avoid what is usually a very paltry fine. Even then he is not usually likely to win acquittal because of the "aura of infallibility" which has been built up, undeservedly, about the device.

"Radar" speed meters are not only *not radar*, but may provide unreliable evidence due to errors falling in any one or in all of the following four categories: (1) system limitations, (2) equipment limitations, (3) improper use of equipment, (4) incorrect interpretation of results.

Even if the device were as reliable, say, as the chase car's speedometer, which is certainly not the case, there are so many possibilities of error in the other three categories that neither the courts, the police, nor the arrested party should assume the speed-meter data to be accurate without specific proof and corroborative evidence, beyond a reasonable doubt, and this must be furnished by the prosecution.

I feel that it would be a disservice to the multitude of honest citizens who, in spite of veracious assertions of their innocence, have been or may be arrested and convicted on the mechanical "evidence" of this fallible device if you did not publish some statement calling attention to the facts which I have pointed out in this letter.

J. KELLY JOHNSON, E. E.
Fellow, IRE
Licensed Professional
Eng. in N. Y. and Ill.
New Canaan, Connecticut

The following is an excerpt from Author Buchsbaum's reply to the above reader's comments.—Editors.

Dear Mr. Johnson:

This is in reply to your letter concerning speed control radar. When considering this topic originally, I realized that its several aspects could each merit a full-length article. Since our magazine is primarily a technical journal, I have concentrated on the technical aspects rather than the legal or utilitarian considerations.

The problem of speeding obviously cannot be solved by the apprehension and punishment of the violators, but this approach does at least reduce the size of the problem. Any method of apprehension and punishment of a law violator—speeder, burglar, or adulterer—depends on the virtues and failings of police and judges. These human characteristics greatly outweigh any inaccuracies of the police tools.

You are quite correct in your list of

(*Continued on page* 12)

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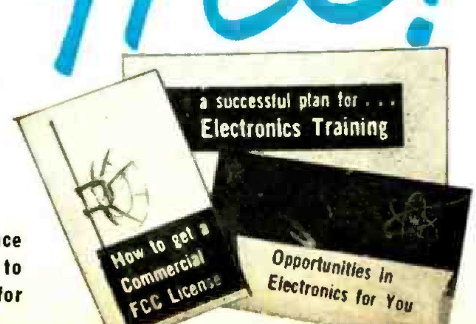

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equipment limitations, but the main purpose of using speed control radar is to deter speeders. It is not expected to guarantee absolute justice. There is far less likelihood of an unjust speeding ticket with a properly set up electronics system than there is with the previous method of the chase by the patrolman.

Justice can never be assured by the electronic or by any other device, nor can injustice be prevented. You will surely agree that the entire system of traffic courts is hardly conducive to a fulfillment of the principles of American jurisprudence. The idea that one can pay a traffic ticket at a smaller cost than a court hearing is certainly unjust, but it is practiced widely. As concerns the outcome of so-called "radar arrests," the records of the New York State and City police show that in 95 per-cent of such arrests, the offender pleads guilty. In 3 per-cent, doubt or confusion as to the identity of the offender is the main reason for a trial. In the remaining 2 per-cent, the offender challenges either the radar equipment or the veracity of the operating patrolman.

When used with warning signals and sufficient publicity, electronic speed control certainly can reduce speeding considerably. The police have ample statistics to prove their contention that speed control radar cuts the accident rate substantially, and that alone seems to warrant its use.

WALTER H. BUCHSBAUM
Bellerose Manor, New York

* * *

MORE ON THE FM BOOSTER

To the Editors:

The FM amplifier that Francis A. Gicca describes in your April, 1960 issue may be fun to build and less expensive than a "store-bought" amplifier, but it certainly lacks many of the features which a commercial antenna-mounted FM amplifier possesses.

We agree with the author when he says that "low noise is of paramount importance." After this statement, however, we hear nothing more on the subject and the author gives no figures on the noise performance of the finished unit. Using available data, we can calculate that an amplifier of the 6AK5 triode-connected cascode type would have a theoretical noise figure of 4 db in the FM band. In actual practice, a realizable set performance of about 5.0 db could be obtained. However, the author's design has thrown away some gain in the input circuit by mismatching a balanced 300-ohm antenna by simply connecting one side to ground. We can safely estimate then, that the over-all noise figure is probably between 7 and 9 db.

This is only the beginning of the story, though. In a weak-signal area, the antenna is almost always located at as great a height above ground as practicable. The signal must then travel between 50 and 150 feet before it reaches the FM receiver. This attenuates the signal (but not the noise)

(Continued on page 16)

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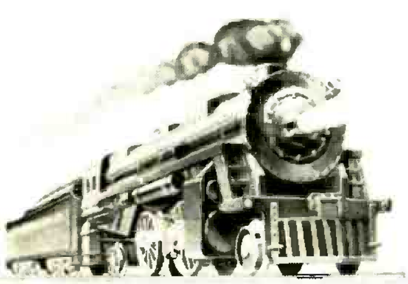

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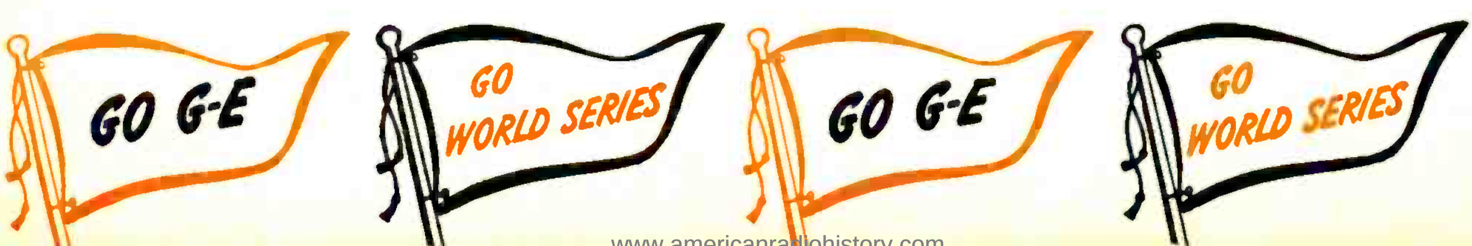

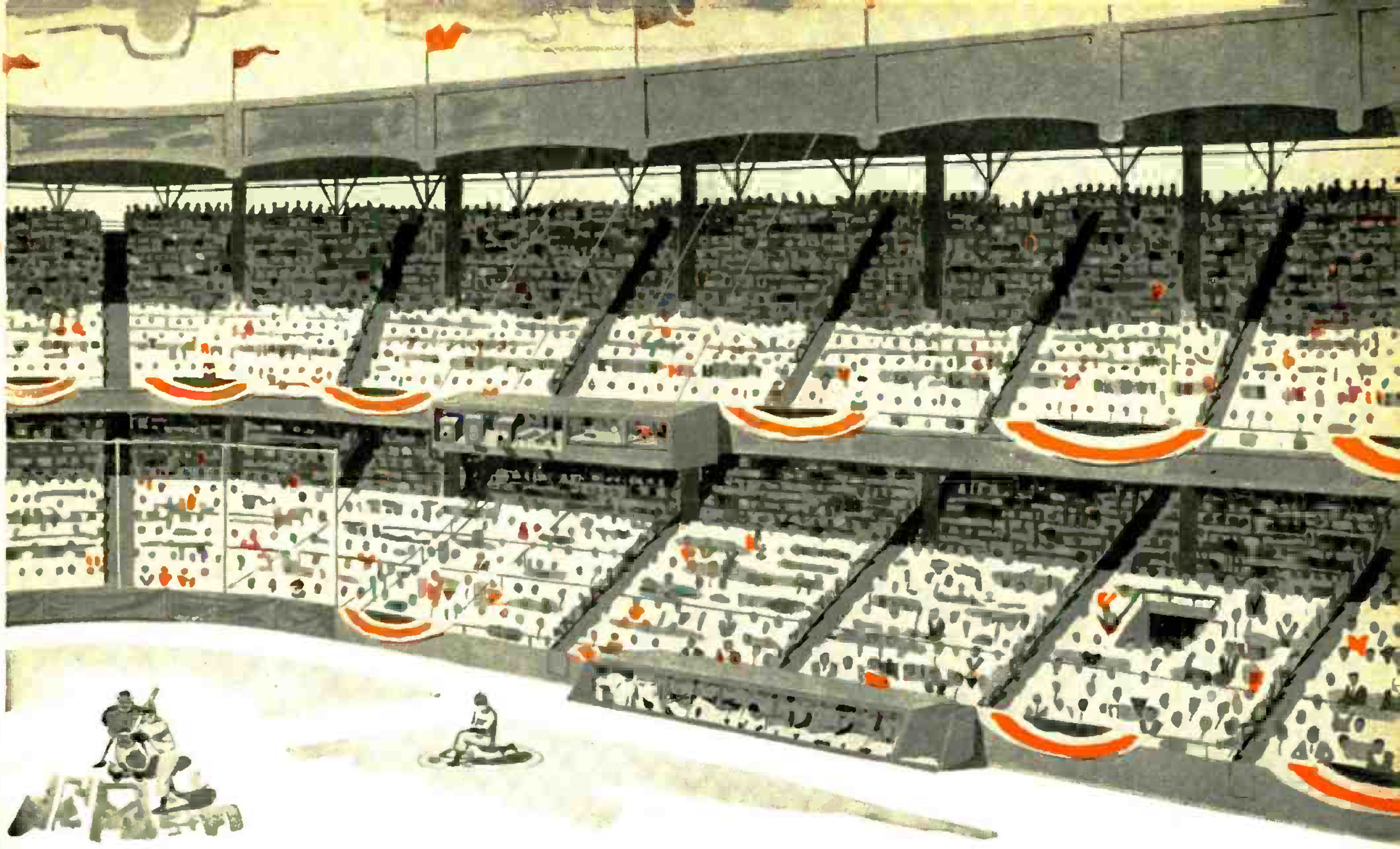

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by another 1.5 db approximately. The resulting noise figure of the entire installation is then made poorer by 1.5 db. (This loss goes up by six times when the transmission line is wet.) The resulting system noise figure can then be estimated to be between 8 and 10 db.

An amplifier mounted at the antenna avoids this difficulty by "fixing" the signal-to-noise ratio by amplifying at the antenna. Incidentally, there is no problem of supplying power to the amplifier because 24 volts a.c. go up the same twin-lead through which the amplified r.f. comes down.

DONALD DWORKIN
Project Engineer
Blonder-Tongue Labs., Inc.
Newark, New Jersey

Here is a portion of Author Gicca's reply to the foregoing letter.—Editors.

Dear Mr. Dworkin:

I certainly agree with your general comments concerning the importance of low-noise performance in an FM amplifier. However, I must still defend the approach taken in the circuit used for this article.

A low-noise figure in an r.f. amplifier is obtained by careful circuit choice and design *and* by careful circuit construction. The former is a science, the latter an art. As much noise improvement can be obtained with careful construction as with careful design. As a result, optimum noise performance with a given circuit can be obtained only after several versions are constructed using varied configurations.

It is, therefore, not unusual to expect a commercial FM booster to exceed the noise performance of a home-made unit. My unit attempted specifically to compete with an FM antenna within the same price range. This it does. It cannot compete with a commercial unit in the important area of noise performance. However, my unit's performance is adequate to pull in nearly all marginal stations.

For example, assume that the user's FM receiver has a noise figure of 5 db and that the booster has a noise figure as high as 10 db. Incidentally, the noise figure of the booster was not measured due to the unavailability of a reliable thermal noise generator in the FM band. If a signal is received which is 10 db below the receiver's limiting level, the detected signal will be quite noisy. However, with the booster, the signal level is increased by 20 db, or ten times, while the noise level is only doubled. This is sufficient to cause the receiver to limit effectively allowing the station to be received without noise.

FRANCIS A. GICCA
Senior Engineer
Raytheon Co.
Bedford, Massachusetts

Our thanks to Author Gicca for providing this additional explanatory material regarding his FM booster. We hope this clears up all the questions in our reader's minds.—Editors. —30—

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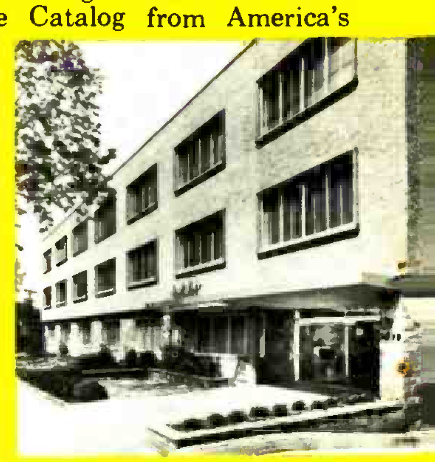

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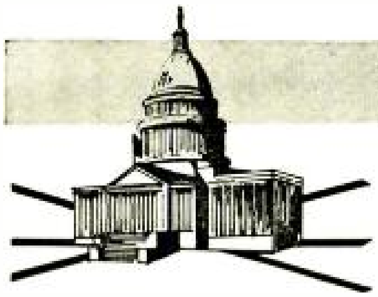

Spot News

Latest Information on the Electronic Industry

By ELECTRONICS WORLD'S WASHINGTON EDITOR

ELECTRONICS CITED AS VITAL TO NEW OCEANOGRAPHIC STUDY PROGRAM—Electronics will play a key role in the recently announced expanding oceanographic research projects, according to a report by the House Committee on Science and Astronautics. Vacuum-tube and transistorized equipment not only offers the means of resolving the problem of "seeing without being seen", the report noted, but permits the measurement of temperature gradients, layers of plankton which scatter sound and noise of the sea itself. Electronics, it was stressed, can make the ocean transparent via underwater surveillance systems. It will not be too long, the Committee's review added, before we will have the counterpart of surface radars serving as crisscrossed networks of the sea—submarine beacons radiating sound beams for the guidance of underwater craft.

ELECTRONIC SCOUTING SYSTEM USING UNMANNED JET DRONE DEVELOPED—A push-button electronic scouting system, using a turbo-jet drone, which will enable battlefield commanders to learn instantly—without risking a single soldier--what is going on in enemy territory, has been unveiled by the Department of the Army. The system, designated AN/USD-5, consists of advanced ground and airborne equipment and an unmanned, combat surveillance drone which sends back information while in flight. It will operate day or night, under all weather conditions, fly at low altitudes and at high speeds, and cannot be fooled by camouflage. According to Lt. Gen. Arthur G. Trudeau, Army Chief of Research and Development, this new electronic scout is the "greatest single advance in the surveillance art...as modern as the Army missiles for which it will search out targets".

TV BOOSTERS AUTHORIZED FOR THE ULTRA-HIGHS—TV boosters—which amplify and retransmit signals of the parent station on the same channel—have received the official blessing of the FCC. According to a recently issued report and order, the new TV booster licenses will be granted to licensees of u.h.f. stations to fill in shadows which might extend out to 68 miles. Such stations will be allowed to operate with a maximum effective radiated power of 5 kilowatts.

COMPATIBLE DISTANCE-MEASURING EQUIPMENT TO BE INSTALLED BY FAA—A number of compatible distance-measuring equipment systems (DME) to provide distance capability will soon be in operation in many airports, according to the Federal Aviation Agency. DME will be combined with VOR navigation equipment to enable pilots to locate aircraft positions accurately as they fly across the country in good weather or bad.

WEATHER RADAR FENCE NOW IN OPERATION--To cover more territory and accelerate early warnings, a 3000-mile weather radar fence has been placed in operation along the coastline from Portland, Maine to Brownsville, Texas. Commenting on this advanced-type of weather reporting system, Secretary of Commerce Frederick H. Mueller said that surveillance of dangerous storms will now be better than ever before in the history of the Weather Bureau's warning service. High-powered radar, developed for this acute detecting purpose, are capable of scanning a 200,000-square-mile area. The radar and reconnaissance reports, resulting from such scanning, reveal where the storm is, its intensity, and speed and direction.

OVER $40-MILLION MILITARY-ELECTRONICS CONTRACTS ISSUED—Various branches of the military have released over $40-million contract awards recently. In one instance, involving an expenditure of nearly $3-million, the Rome Air Development Center has blueprinted an advanced target data processing system. It is expected that the program will result in the design of a photogrammetric (photo-mapping) technique which will accept various types of intelligence data and supply topographic charts of the area covered by the intelligence data. Elsewhere, twelve radio-communications central systems, costing nearly $11-million, were ordered by the Army. The system, designed to provide switched radio service to battle areas, similar to conventional telephone service, will include a radio central with v.h.f. transmitters mounted in a weapons carrier on a three-quarter ton truck, while subscriber stations, transmitters, and receivers will be used to provide more channels of information and more communications systems in a given zone.

-30-

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This 38 year old training organization — called RTS, that's Radio-Television Training School — wants to establish a string of Radio-TV Repair Shops in principal cities throughout the U. S. So far, a great many such shops are NOW IN BUSINESS AND PROSPERING. We are helping and training ambitious men to become future owners and operators of these shops in all areas.

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find out how you can open

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2. Complete laboratory of test equipment.
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4. Basic inventory of tubes, parts, supplies.
5. Complete advertising and promotional material.
6. Plans for shop arrangement.
7. Instructions on how to go into business.
8. Continuous consultation and help.
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10. The right to use the Famous Trade Mark.

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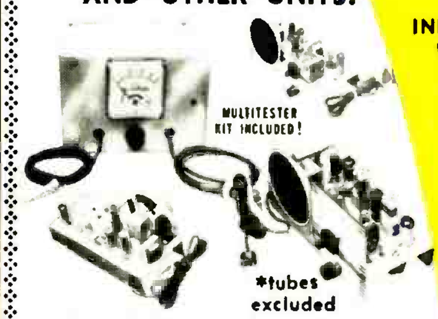

*tubes excluded

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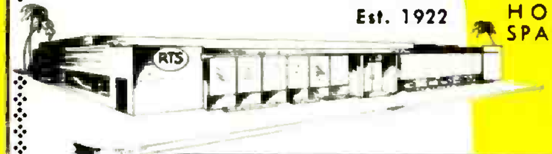

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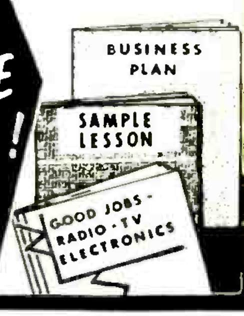

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British Stereo Broadcasts

By **PATRICK HALLIDAY**

Two compatible systems are currently being investigated.

ALTHOUGH experimental stereo programs with national coverage are transmitted in Britain for an hour on alternate Saturday mornings by using two separate stations (one of which is normally the television sound channel), the *British Broadcasting Corporation* is moving cautiously on initiating a regular stereo service.

BBC men have pointed out that a full stereo service would pose serious economic problems because of extra studio and transmitting equipment which would be needed and also because a radical change would be necessary in the line distribution of programs on which the British networks depend heavily.

Meanwhile two systems, requiring only a single transmitter, are under investigation. The *EMI* "Percival" system in which a narrow-band signal providing directional information only is derived from the original left- and right-hand channels and carried on a subcarrier at about 22 kc. At the receiver, the left-hand channel is obtained by multiplying the single audio signal by the directional information (by means of a Hall multiplier) while the right-hand channel consists of the audio signal with the left-hand channel subtracted from it. A big advantage claimed for this system is that the effective loss of transmitter range is equal to a transmitter power loss of only about 2 db.

An alternative system, which is being actively promoted in the United Kingdom, uses time multiplexing and has been developed by G. D. Browne of *Mullard.* In this system the two channels remain independent but are radiated alternately for half-cycle periods at a frequency of 32.5 kc.—the resulting complex signals being used to frequency modulate a single transmitter. At the receiver, the output from the discriminator, at the 32.5-kc. sampling frequency, is used to phase-lock a local oscillator at this frequency. By 90-degree phase shifting the output from the oscillator, two sine waves are obtained in-phase with the sampled signal. The original stereo channels can then be recovered by a mixing process. Thus the receiver decoder stages comprise only an oscillator and two mixers. It is claimed that the theoretic cross-talk between channels is as low as −45 db, permitting the system to be used, if required, for simultaneous radiation of bi-lingual or other independent transmissions.

Both the *EMI* and the *Mullard* systems are compatible. —30—

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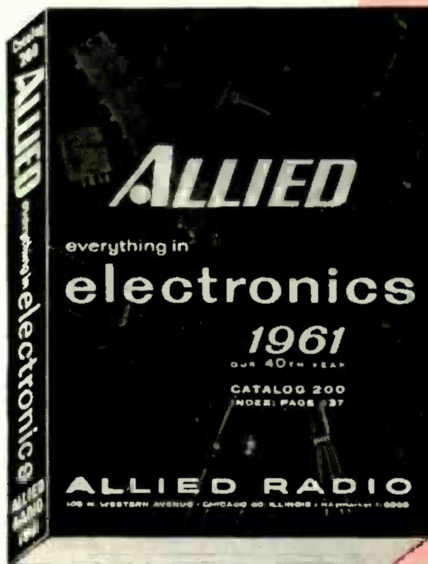

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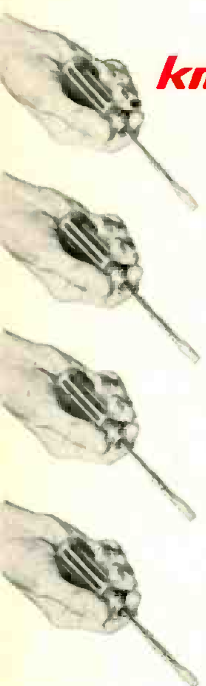

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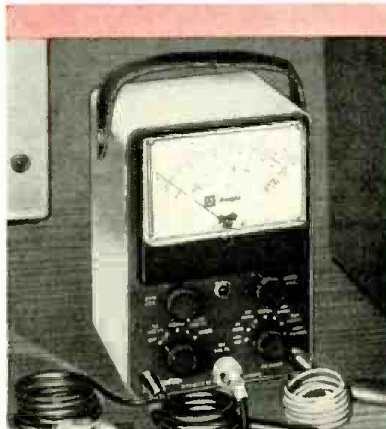

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	Shield	A	B	C	D	E	F	G	H	I
Lubrication After Rubbing For 90 Sec.	GOOD	Fair	Very Poor	Poor	Good	Poor	Very Poor	Good	Poor	Fair
Cleaning After Rubbing For 90 Sec.	GOOD	Good	Good	Good	Good	Fair	Poor	Good	Fair	Poor
Protection After 30 Sec. Exposure to H_2S Gas	GOOD	Fair	Fair	Good	Good	Fair	Very Poor	Good	Very Poor	Good
Protection After 2 Hours Exposure to H_2S Gas	BEST	—*	—*	2nd Best	5th Best	—*	—*	3rd Best	—*	4th Best
Flash Characteristics	None at 200°F.	—*	—*	Greatest tendency	Boils at 70°F. Tendency to ignite	—*	—*	Tendency to ignite	—*	Slight tendency to ignite
Attack On Plastic Material	NO	—*	—*	Yes**	Yes**	—*	—*	Yes**	—*	Yes**

*Not tested further following sub-standard performance in 30-second exposure test.

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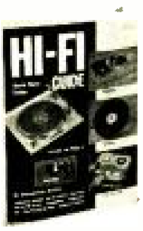

2751. HI-FI GUIDE—STEREOPHONIC SOUND, Hoefler

A "how-to" book on hi-fi, written in simple language. Will help you buy the right equipment and see that you get the most out of your stereo or monaural investment. $2.50

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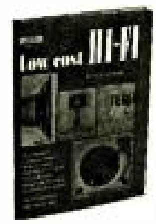

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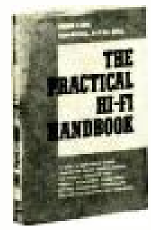
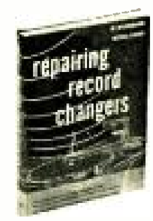


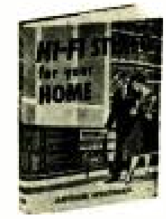
2755. THE PRACTICAL HI-FI HANDBOOK, King

A guide to high fidelity sound reproduction for the service engineer and amateur. Chapters on amplifiers, loudspeakers, pickups, microphones, record players, disc, tape and stereo. $5.95



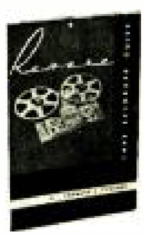
2756. REPAIRING RECORD CHANGERS, Ecklund

A practical manual on repair of mechanical elements of record changers, including pickups, needles, changer actions, motors, drives, tripping, dropping and shut-offs. Also magnetic recorder repairs. $5.95



2760. HI-FI STEREO FOR YOUR HOME, Whitman

Tells what stereo is, how it differs from hi-fi, how it works, how it affects home listening habits, and how to install and maintain it. Complete list of terms defined. Generously illustrated. $3.50



42. REVERE TAPE RECORDER GUIDE, Tydings

The first non-technical book to provide useful information on the Revere Tape Recorder. Also a basic guide to the entire field of tape. Will show you new uses and add to your enjoyment. $1.95

49. TAPE RECORDING GUIDE, Marshall

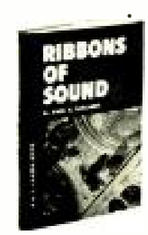
Designed to help you get the most out of your tape recorder, whether for business, pleasure or professional use. A handy guide to have around, no matter what equipment you own. $1.95

2750. ELEMENTS OF MAGNETIC TAPE RECORDING, Haynes

Here's how to get professional results with tape the way the experts do. Complete nomenclature, basic techniques, how to splice and edit, how to repair and maintain your recording equipment. $7.95

2754. MAGNETIC TAPE RECORDING, Spratt

Designed to give principles of magnetic recording and to enumerate characteristics of both the medium and the machines. Excellent for adapting magnetic recording to special needs and wider applications. $8.95

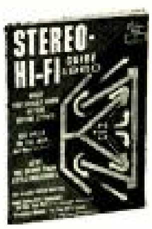


2757. RIBBONS OF SOUND, Barleben

A handbook on the fundamentals of magnetic tape recording simply and interestingly presented. Factual information you can use no matter what type or make of recorder you own. Paper, $2.50. 2772. Cloth, $3.50

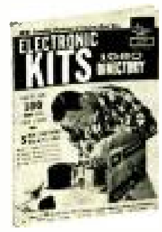
2758. TAPE RECORDERS AND TAPE RECORDING, Weiler

An ideal sourcebook of information on all aspects of tape recording. Covers all fundamentals necessary to realize full potential of your tape equipment. Special sections on accessories. $2.95



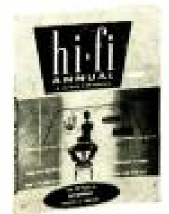
2000. STEREO HI-FI GUIDE, 1960 Ziff-Davis

1960 edition features 60-page exclusive by Joseph Marshall on components and how they work. Includes "what you should know before buying stereo". Complete, interesting, invaluable! $1.00



2002. ELECTRONIC KITS DIRECTORY, 1960. Ziff-Davis

New 1960 edition lists over 750 kits, latest models, prices and features for hi-fi kits—preamps, amplifiers, tuners, speakers — ham radio, SWL, Citizens Band. Fun and education. $1.00

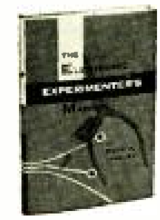


2004. HI-FI ANNUAL & AUDIO HANDBOOK, Ziff-Davis

1960 edition. Prepared by the editors of Electronics World. An excellent advanced guide to theory, construction and circuitry. Over 40 pages on stereo amplifiers and equipment. $1.00

2005. HI-FI DIRECTORY & BUYERS' GUIDE, Ziff-Davis

1960 edition. World's only complete listing of all hi-fi and stereo equipment, components and accessories. Five big sections, data on more than 1200 components, over 1,000 illustrations! $1.00



2006. ELECTRONIC EXPERIMENTER'S MANUAL, Findlay

With a few dollars worth of basic tools and this book to guide you, you can explore the wonder-world of electronics experimentation more completely than ever before. 10 big sections. $4.95

2769. THE ELECTRONIC MUSICAL INSTRUMENT MANUAL, Douglas

Covers every design phase of the modern electronic musical instrument — including theory, schematics of organ circuits, the science of sound as well as the art of music. $7.50

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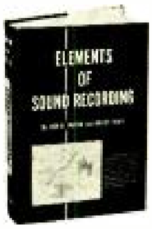
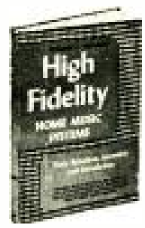
2762. FROM MICROPHONE TO EAR, Slot

A complete survey of the technique of sound recording and reproduction, discussing the entire chain from microphone to loudspeaker. A practical book for music-lovers as well as sound technicians. $4.95



2764. ELEMENTS OF SOUND RECORDING, Frayne and Wolfe

A discussion of basic problems in sound recording and reproducing for the designer, engineer, technician and student. Covers acoustics, vacuum tubes, audio amplifiers, etc. 686 pages, 483 illustrations. $12.00



2766. HIGH FIDELITY HOME MUSIC SYSTEMS, Wellman

Authoritative advice on choosing the right type of system for your needs with practical information on the functions of each unit—selection, assembly and installation. $4.50

2767. HIGH FIDELITY TECHNIQUES, Newitt

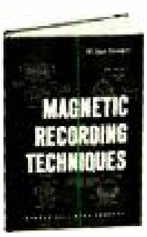
A comprehensive treatment of both the principles and practice of modern high fidelity sound systems – how to plan a new system, how to improve an existing one. A goldmine of hi-fi information. $7.50

2771. HI-FI HANDBOOK, Kendall

How to plan your home music system, choose the best components, install your system easily and maintain it by yourself. All these, and ways to save money, are presented in this basic book. $3.50

2759. TECHNIQUES OF MAGNETIC RECORDING, Tall

Translates the complexities of a science into practical, easy-to-follow techniques. New ideas, new standards, especially for the amateur who wants a good working knowledge of magnetic recording. $8.50



2763. MAGNETIC RECORDING TECHNIQUES, Stewart

Covers the technology of magnetic recording methods and devices for engineers and technicians concerned with their application in audio, TV, communications, computers and other fields. $8.50

2765. YOUR TAPE RECORDER, Marshall

Based on 2500 experiments with almost every type of recorder, this book helps to eliminate trial and error under all conditions. Includes illustrations of 55 magnetic recorders with specifications. $4.95

2768. MAGNETIC RECORDING, Begun

Thoroughly covers the theory of magnetic recording, various types and makes of recorders, their applications and performance measurements. Includes chapter on important research problems. $5.00

2770. HOW TO USE A TAPE RECORDER, Hodgson and Bullen

Written to help business and home recorder owners to learn how to get full value from their machines. Explains basic working of tape recorders and accessories as modern tools of communication. $4.95

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Within the Industry

IRA KAMEN, space technology expert and authority on electronics systems, has been elected president of *Portland Industries* of South Portland, Maine.

Upon accepting his appointment, Mr. Kamen unveiled far-reaching plans to convert the huge Portland facility into an advanced scientific center for the production of complex products in space technology and the sonar and nuclear fields. The company recently completed fabrication and installation of a Bomarc Missile base at Bangor, Maine.

Mr. Kamen's more than twenty years experience in the electronics industry includes development patents in TV; vice-president of *General Bronze Corporation;* consultant to *RCA, Paramount Pictures Corporation,* the U. S. Navy, *Temco,* and other organizations. He is also the author of five textbooks and 150 technical papers.

* * *

RAY W. LUNSTEAD has been appointed manager of *Ward Leonard Electric Company's* electronic distributor division. Formerly assistant manager, he joined the company in 1941 . . . **JEFFREY J. BOWE** has been named department head at *Sperry Rand Corporation's* semiconductor division; while **ROBERT B. WRIGHT** has been appointed director of industrial relations for the division . . . **BURTON R. COHN** has been named general manager of *General Transistor Corporation's* systematics division. Prior to joining the company in 1958, Mr. Cohn was production manager of *Radio Receptor Co.* . . . **J. A. MILLING,** president of the Photofact division of *Howard W. Sams and Co.,* has been re-appointed chairman of the distributor relations committee of the Electronic Industries Association . . . **FRED W. EDWARDS** has been elected to the new position of vice-president-engineering of *Standard Kollsman Industries, Inc.* He had been the company's chief engineer, having joined the firm in 1946 . . . **GEORGE A. SCHUPP** has been appointed director of engineering for the consumer products division of *Magnavox.* He comes to this company from *General Electric* . . . **EDWARD L. DEGENER,** general manager of *National Radio Institute,* has retired after 42 years with the school. At the same time **HAROLD E. LUBER** was upped to the post of executive vice-president and **EVERETT A. COREY,** who recently joined the school, was named special assistant to the president, **J. MORRISON SMITH.**

* * *

STANDARD COIL PRODUCTS CO. INC. has changed its name to **STANDARD KOLLSMAN INDUSTRIES INC.** as the result of majority action by the company's stockholders . . . **CAVALIER AND COMPANY,** 922 King Street, Wilmington, Del., has established a custom optical lens and quartz-crystal grinding and polishing division geared especially to the requirements of electronic and research-development laboratories . . . The formation of a new company to manufacture silicon solar cells, silicon photocells, and related items has been announced. The company, **SOLAR SYSTEMS, INC.,** is occupying a modern, air-conditioned building at 8241 N. Kimball Ave., Skokie, Ill. Jerome Kalman, formerly with the *Hoffman Semiconductor Division,* is general manager of the new firm . . . The stockholders of **FAIRCHILD CAMERA AND INSTRUMENT CORPORATION** and **ALLEN B. DU MONT LABORATORIES, INC.** have approved a merger of the two corporations, with *Fairchild* the surviving company.

* * *

WALTER E. PEEK has been named vice-president, marketing, of *Centralab,* the Electronics Division of *Globe-Union, Inc.*

The position is a new one created in keeping with an administrative re-organization of the parent company to give each product division greater operating autonomy than in the past.

Mr. Peek was formerly the division's general sales manager. He has been with the firm since 1953 and active in the electronic industry since 1930.

At the same time the company announced that Bruce E. Vinkmulder, formerly assistant general sales manager, has been named marketing manager of the division.

* * *

SYLVANIA ELECTRIC PRODUCTS INC.'s Advanced Device Research Laboratory has been moved from Northlake, Ill. to Waltham, Mass. It is anticipated that the laboratory will then be moved from Waltham to Woburn, Mass. early in 1961 . . . **LAMART CORP.** of Clifton, N. J., has moved to a new location at 16 Richmond St., also in Clifton. The company expects to double its production output as a result of the move . . . **VITRO CORP. OF AMERICA** has announced the opening of a West Coast

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* * *

JOHN R. MEAGHER has been appointed manager of electronic instruments merchandising for the Distributor Products Department, *RCA* Electron Tube Division.

An authority on radio and television servicing, Mr. Meagher has lectured before service groups in virtually every state in the nation. In the 1920's, he edited *Wireless Age*. Later Mr. Meagher went into research laboratory work. In 1936 he joined *RCA* and has since served as technical editor, field engineer, author, and lecturer on test equipment.

He developed the TV dynamic demonstrator, an outgrowth of the original radio demonstrator which he devised in 1936. In 1946 he compiled the *RCA* "Pict-O-Guide" as a TV servicing aid. His color "Pict-O-Guide" was published in 1957.

* * *

THOMPSON-RAMO-WOOLDRIDGE INC. of Canoga Park, Calif., will manufacture and sell its RW-300 digital control computer in the European Common Market through a newly formed subsidiary with headquarters in Paris. The new organization, called *Compagnie Europeenne d'Automatisme Electronique*, is part of the firm's international division and is capitalized at $1,500,000 . . . **TEXTRON, INC.** has established **BELL AEROSPACE CORP.** as a wholly owned subsidiary for the manufacture of rocket engines, electronics, helicopters, and servo-mechanical systems.

* * *

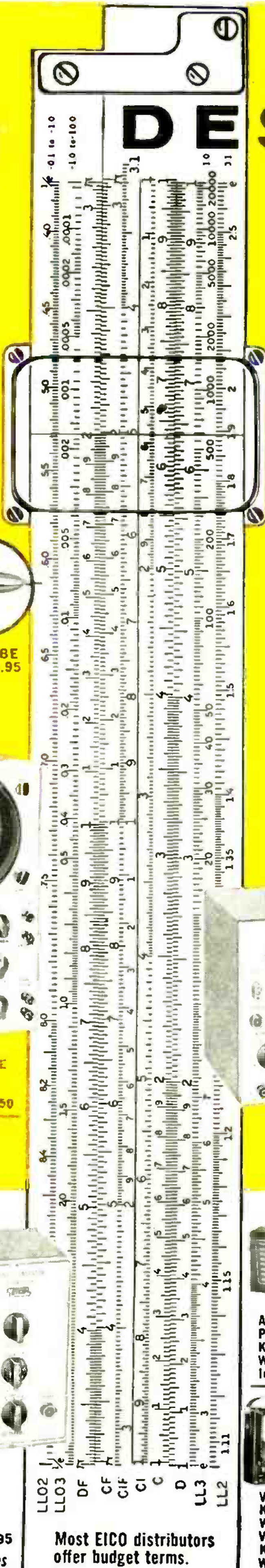
WALTER L. SCHOTT has been named manager of the distributor sales division of *International Rectifier Corporation*, El Segundo, Calif.

Mr. Schott, who founded *Walsco*, and later headed the *Audiotex* division of *General Cement-Textron*, will now direct all activities of the *International Rectifier* distributor network, which includes 90 authorized industrial distributors and over 600 parts jobbers.

* * *

DR. SORAB K. GHANDHI has been appointed manager of solid-state circuit research for *Philco Corporation's* re-

(*Continued on page* 114)



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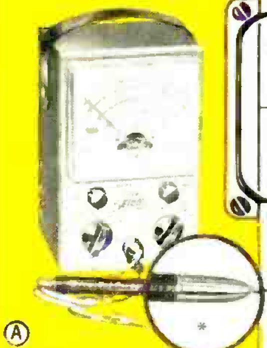

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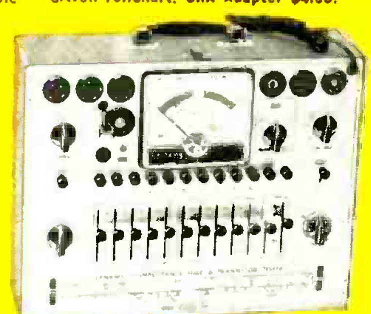

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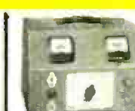

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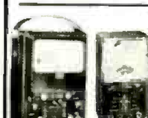

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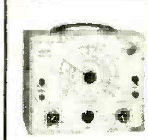

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This author's provocative view is that this amplifier rating is a step in the right direction, however it may not tell the whole story about hi-fi performance.

By NORMAN H. CROWHURST

THE question that triggered this article is, "Does the new Music Power Rating help tell the quality of an amplifier? If so, how?" The answer to this question will be covered later, but mainly some concepts, notions, and viewpoints need clarifying first. There will be some explaining to do—why the particular Music Power Output definition, as used by the IHFM (Institute of High Fidelity Manufacturers) standard for rating amplifiers, was chosen, as well as what it can tell us.

For a long while, the accepted methods of rating or specifying amplifier performance have been recognized as inadequate for assessing the relative merit of different products. This has been correctly related to the fact that music, or other program material, is different in many respects from the pure-tone sine waves used for testing amplifiers.

These two standards differ in two respects: all test tones, whether one or two sine waves, or a square wave, are applied steadily, while the tones in music are constantly changing, often rapidly. Apart from their transient nature, musical waveforms are much more complicated than anything used for testing, even when the tones are steady.

Some Viewpoints

Engineers in the high-fidelity industry have, for some time, been concerned by this discrepancy. Some have tried to do something about it and some have even dared to try and make an amplifier whose first job was to sound good, even if its specifications didn't read quite as impressively! But these engineers soon ran into opposition.

Some people either are not able to listen critically or else don't believe their ears. They want something in print that they can show around, proving that the product they have is better. We have no argument with this attitude. The difficulty is, what figures can we provide that really prove something? The notion of music power output originated with engineers: it should be a way of rating amplifiers which will more nearly evaluate how "loud" they will sound, than does the conventional power output rating.

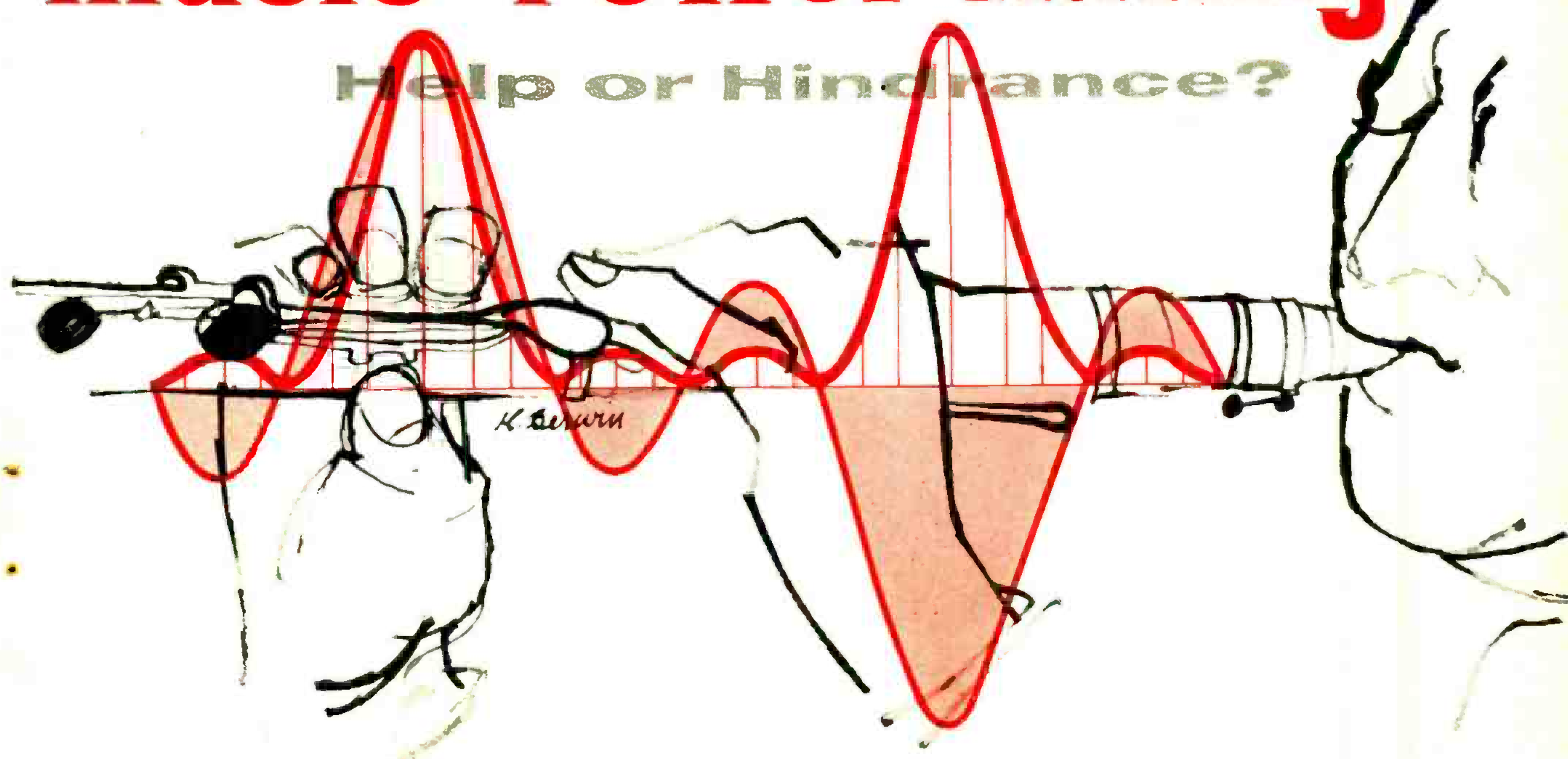
One prohlem is that steady power tests force the amplifier to deliver its maximum power continuously. Musical program material calls for maximum power for only short periods of time. Why not see what an amplifier will produce when the demand is not continuous?

If you put just one or two cycles of a frequency through an amplifier you can see its performance during such a short burst but you cannot measure it because the meters won't have time to "get up to" whatever the reading is. To overcome this, the method specified by the IHFM involves the maintenance (artificially), from an external source, of the voltages that sag under continuous power for long enough to get the reading.

This sounds good, when it is explained to you, otherwise it might appear to be "cheating a bit." Next, you want to know what the "answers" mean. And that is a good question. Until most audiophiles and hi-fi equipment makers use the music power rating, the more familiar continuous output power will also be given. So your question is: which is better, an amplifier that has both ratings the same, or nearly the same, or one for which the

Music-Power Rating

Help or Hindrance?



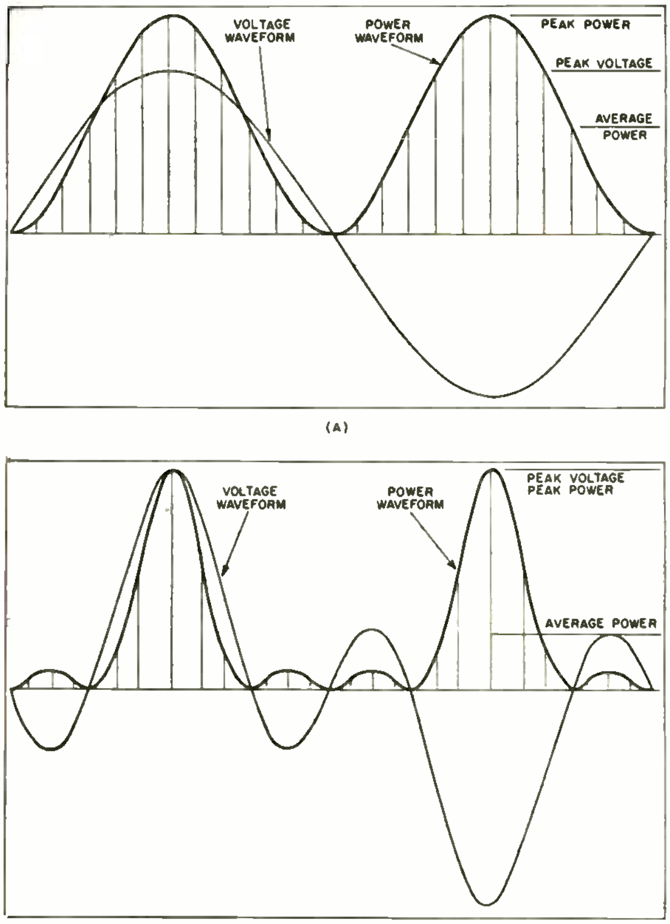
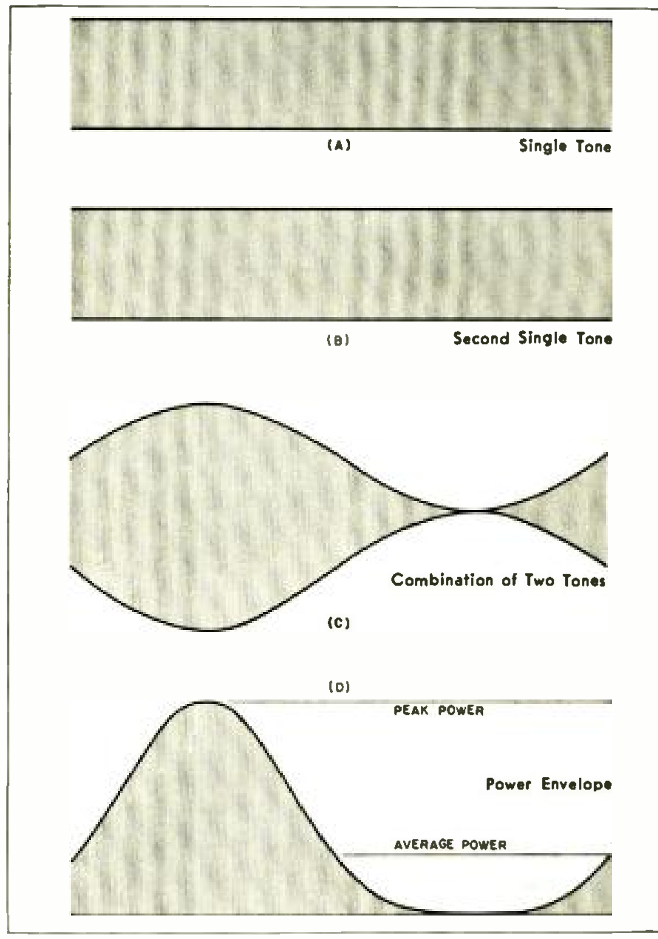


Fig. 1. Comparison of voltage and power waveforms for (A) simple sine wave and (B) musical tone consisting of a fundamental with considerable third harmonic.

Fig. 2. The effect of combining two tones of different frequency on the relationship between the peak and average power.



music power is appreciably higher than the continuous power?

Pursuing this question reveals the fact that an amplifier with good power-supply regulation will have ratings which are closer together while one whose power supply provides poorer regulation will show a greater difference between continuous and music power ratings. Surely the amplifier with the better regulated power supply is the better amplifier? Put it this way: do you want quality watts per dollar or are you looking for the highest power irrespective of cost?

One amplifier may have both ratings at 25 watts. Another unit, by spending part of what the first spent on the power supply on other features, may give 25 watts continuous but also manages 35 watts music power as well. The second amplifier will undoubtedly provide greater clean music volume—other things being equal—than the first unit.

But we have no objection to a third amplifier that gives 35 watts measured both ways, if the manufacturer can make it competitively. It is an even better amplifier than the second one, but whether it is worth paying the 30% to 40% higher price is up to the buyer to decide.

This is, roughly, the way the new music power rating works out. It is a step forward, but some engineers are still not satisfied. While it does come nearer to some aspects of how an amplifier performs on music, it still misses some points.

Another Look at Waveforms

What is the true relationship between the power in a musical program and the maximum power as measured by a single tone? This is the question the new music power rating does not really touch because both ratings, by definition, measure *average* power. Average *music* power can have a number of different connotations, while the average power of a sine-wave output is unambiguous.

It was the transient nature of music power that dictated the new rating. But even a steady tone, such as that played by a single instrument, can have quite a different average power from that of a sine wave, in terms of what an amplifier can handle. See Fig. 1.

The limitation to the handling capacity of an amplifier is the instantaneous *peak* power it can deliver. The peak power of a 10-watt sine wave is 20 watts. But a musical tone with 20 watts peak may very well have an average power of less than 5 watts—even as a single continuous tone. That is really the first basis for differences.

It affects the rating question in two ways. First, the lower "waveform factor" means the regulation will not hurt even a sustained tone's power as much as with the test sine waves (*unless the sustained tone is sinusoidal, approaches a square shape, or has a "waveform factor" such that its average value is higher than a sine wave—Editor.*) Second, it alters the picture as to what "average power" itself really means.

Next point: music consists of many tones played at any single instant—most of the time. Each tone has a different frequency. At a frequency corresponding to this difference, the peaks of two tones will coincide. At each such coincidence, it is the voltage, not the power, that adds to determine the total peak. If peak voltage doubles, peak power is quadrupled, as shown in Fig. 2.

Suppose each of three tones has an average power of .5 watt and a peak power of 2 watts. If the impedance is 8 ohms, each peak will be 4 volts. Three of them will reach occasional "spikes" of 12 volts (Fig. 3). This is a power of 18 watts, although the average is only 1.5 watts. If a pedal tone is also present, it may need a further 5-watts average with perhaps 18-watts peak, also 12 volts. Now we need 24 volts, which is 72-watts peak, for just a pedal tone and trichord, totalling an average power of 6.5 watts. See Fig. 4.

The more complex the music, the greater the basic factor between average and peak power. You may have noticed that orchestral music at a certain nominal output power does not seem as loud as, say, a jazz combo.

This is because the ear recognizes the sum of all the average powers. To make the reckoning easy, let's assume each instrument contributes 0.5 watt average power and needs 2 watts or 4 volts peak.

A four-piece combo will give 2 watts average, but needs 16 volts or 32 watts peak power. A 40-piece orchestra will give 20 watts average, but needs 160 volts or 3200 watts peak power! Nobody has that kind of power, so assume we play with the same margin of safety against possible distortion: the four-piece combo can be played at a realistic level of 2 watts average from a 16-watt amplifier (32 watts peak); but the orchestra will have to be turned down to only one-fifth of a watt *total average*, to stay within 32 watts peak.

This explains why a much bigger amplifier is needed to handle good orchestra music, even though the sound doesn't seem any louder—if as loud. It also explains why no single music power rating, based on an average, can ever be completely practical.

With so many variables, the only point of common reference between amplifiers and the music they handle is *peak* power. This is what determines when the amplifier starts to distort the music. The average power that corresponds to this peak power depends entirely on the music, not the amplifier. The "waveform factor" may react on the power-supply regulation to modify the peak capability according to what the average power is. But even the worst power-supply regulation usually makes little difference on this, with most kinds of *music*.

There was a move, some years ago, to rate amplifiers by peak power. Proposed with honest intentions, it was based on similar reasoning but the simple two-to-one relationship for test sine waves led to its serious misuse.

Give a Dog a Bad Name!

The intention was not to just double the number already on the amplifier nameplate, but this is what many companies did. The peak power intended was what the amplifier could handle on peaks, representative of the relative duration encountered in music. But insufficient explanation, plus the urge by some just to use bigger numbers, led to confusion.

Some firms measured peak power the way the IHFM now defines music power. It was really a short-term average power. Others double the number they already had, based on the mathematical sine-wave relationship. Yet others doubled the short-term average power, giving the instantaneous peak value of such a wave—and the highest number of all.

This last figure was really the most logical and, if everyone used it, would be the most informative regarding amplifier performance because it does relate directly to the musical program the amplifier can handle.

But the fact that so many methods of rating were used, led many to believe that the "good old standard" watts were "honest watts", with the obvious implication that the others were cheating — "just doubling the numbers to make the amplifier look bigger!"

This was understandable. If the new number really told something extra about the amplifier's performance, it was useful. But most often it was obtained by the arithmetical operation of multiplying by two. This had no value, except to further confuse the already confused consumer.

Experiences like this are difficult to live down. On the committee that discussed the new IHFM music power rating, several engineers favored the use of a *peak* music power rating. This would double the figure as presently defined. But they remembered the hangover of adverse criticism from the last attempt and compromised by using the present definition.

Pots and Kettles

This compromise is not unreasonable when you consider some other factors. Most important among these: what does the power rating of a loudspeaker mean? It is intended to be the electrical input power the speaker can handle, as delivered by the amplifier. A 10-watt speaker with 10% efficiency (and that's high) should be able to

(*Continued on page* 108)

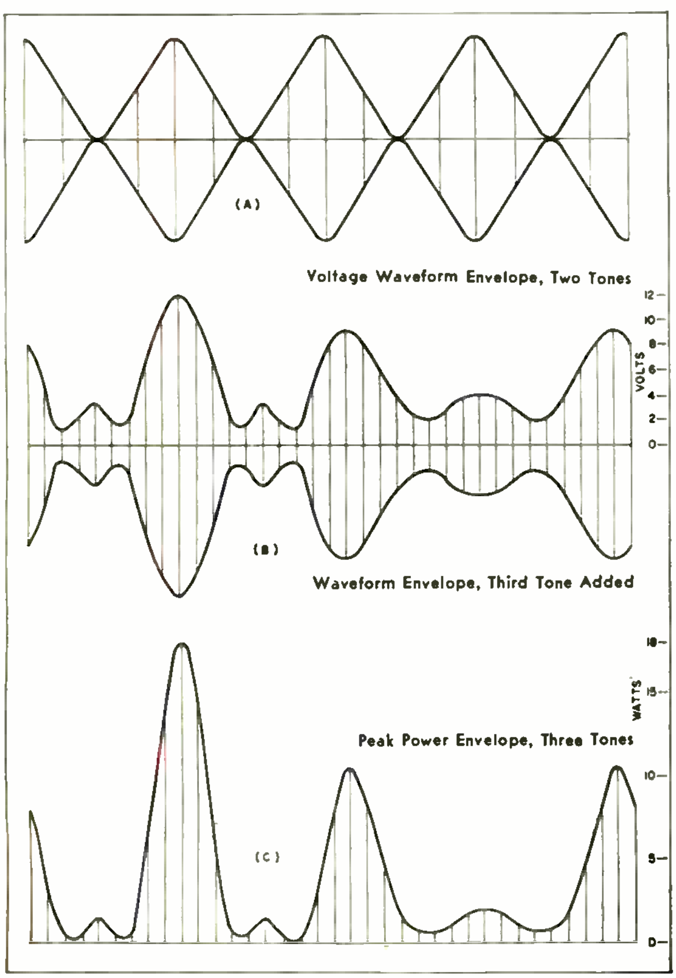
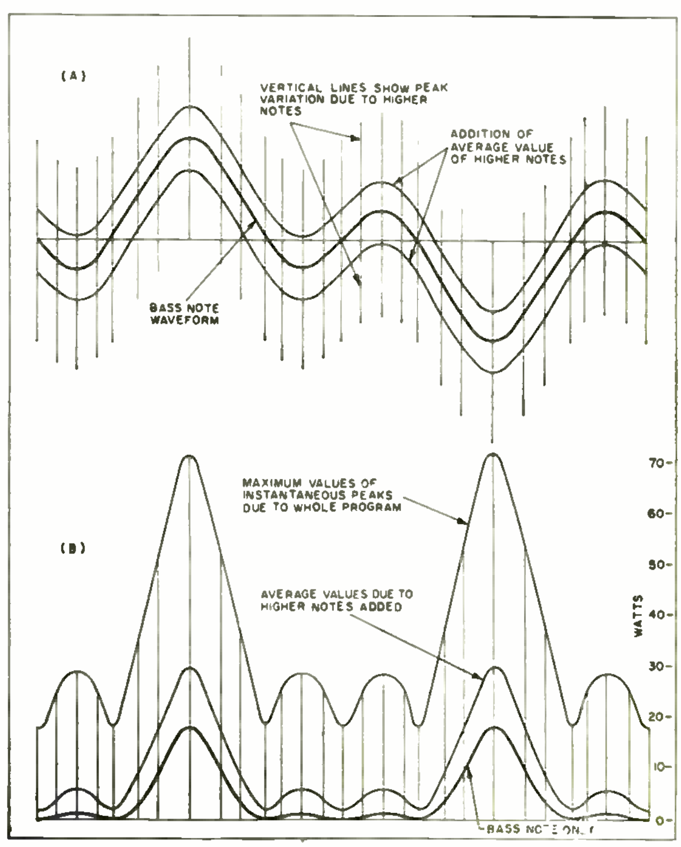


Fig. 3. Voltage and power relations that exist in an audio amplifier when three different tones are combined.

Fig. 4. Voltage and power levels that exist in musical phrase in which there are 1 bass and 3 mid-range notes.



Audio-Ultrasonic Pickup Circuit

By **HAROLD REED**

Simple, sensitive circuit operates relay when placed near signal-carrying circuits. May be used as sound-operated relay from 20 cps to 500 kc. at inputs as low as 3 mv.

THE author required a simple circuit that could be used for inductive pickup service over a wide frequency range with very low signal input voltages and with a total parts cost of under $10.00. In addition, since a circuit was wanted that would energize a relay from the minute 25-cycle a.c. field of a telephone ringer coil, it was decided to "breadboard" a circuit to see what could be done. Since the cost had to be kept low, an extremely sensitive, expensive relay was taboo. The final circuit, for which all parts are readily available, is shown in Fig. 1.

Circuit Description

Any induced a.c. signal picked up by the pickup coil, L_1 is amplified by the first transistor stage, V_1. The output from this stage is rectified by the shunt-type diode rectifier circuit—a circuit using two crystal diodes CR_1 and CR_2. A transistor d.c. amplifier, V_2, follows the rectifier with the control relay in the collector circuit.

The relay is a 4000-ohm unit. Other 4000-to 8000-ohm relays may be used. The *Cardwell* BK-7-B, shown in the diagram, has adjustable sensitivity and has been available on the surplus market at a low price ($1.50) for quite a while.

The experimenter may use other general-purpose transistors but the crystal-diode rectifiers should be of the high-conduction type as shown. Capacitor values may be changed if wide-frequency-range operation is not required.

If a different relay is used, it may be necessary to change the value of capacitor C_4. If this is too large, the relay pickup and drop-out may be delayed due to the charge-discharge time of the capacitor. If it is too small, relay chatter may occur at lower frequencies.

Measured Data

Total current drain of the circuit with no input signal is 1.8 ma. Under this condition the d.c. current through the collector-relay leg of transistor V_2 is 0.2 ma. With an input signal of 3 millivolts at 1000 cycles, the V_2 collector current increases to 1.5 ma. A compilation of required input voltages over various frequency ranges for closure of the relay is given in Table 1. The signal source used for these measurements was an audio signal generator. The upper frequency limit was not checked since the generator on hand only went to 500 kc.

Tested Applications

To use the circuit as a telephone ringer pickup, the telephone pickup coil is placed under the telephone cradle. Many audiophiles and experimenters use these pickup inductors for recording telephone conversations. By employing a plug and jack arrangement, the same pickup coil may be used for either purpose. When the telephone pickup coil is in place, relay RL_1 will pull in when the telephone bell rings. The induced a.f. voltage peak at the input to C_1 measured 15 millivolts with the circuit set up 50 feet from the phone. The relay contacts complete the battery circuit to a miniature bell or buzzer and lamp, or both. Tests were not made to check maximum distance the circuit could be used from the phone but it worked up to 50 feet, using twisted-pair telephone wire run to the coil L_1. Thus, wire leads can be run to various locations, such as outdoors, to the ham shack, etc. where the telephone bell may be inaudible, and the circuit plugged in at any of these points. It is handy, too, for the hard of hearing. Many persons can hear on the phone but cannot hear the bell beyond certain distances from the phone.

FREQUENCY (cps)	INPUT SIGNAL VOLTS TO CLOSE RELAY
20-30	.006
30-50	.005
50-200,000	.003
200,000-400,000	.004
400,000-500,000	.005

Table. 1. Signal voltage required to operate the relay at various signal frequencies.

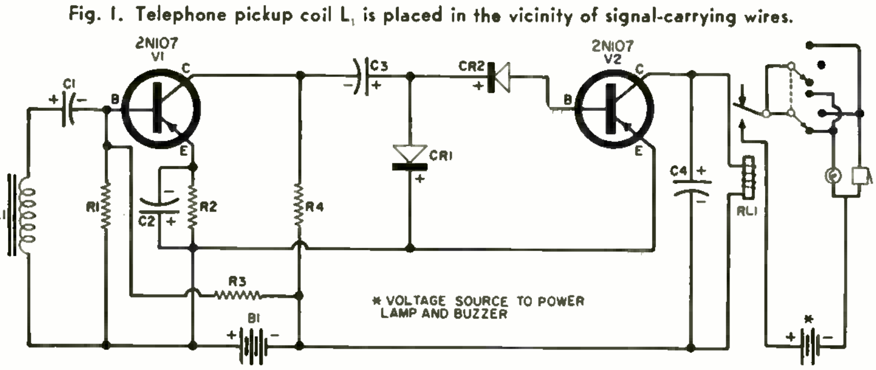
The circuit may be used as a voice-operated relay. If the pickup coil is placed near the output tranformer of an audio amplifier, the relay will operate when an audio signal passes through the amplifier. Thus the operator may speak into a microphone connected to the amplifier to close relay RL_1, whose contacts would energize another relay to start a tape recorder mechanism or other device. This second relay can be set up to lock in and released when desired by means of a push switch. The author found that the relay would pull in when speaking into a microphone with the pickup coil placed near the loudspeaker voice coil and the gain control of the amplifier set for normal listening level.

Another useful application is in connection with motor-operated devices. The relay will close and open as a motor starts and stops. The relay contacts can then be used to operate other relays or devices for safety purposes, "fail-safe" applications, etc. The telephone pickup coil is not absolutely essential for this service. A coil from a discarded magnetic phono cartridge or plate-circuit relay will suffice as the pickup probe. Using a phono-cartridge coil probe the relay operated positively from the induced a.c. signal of the motor of an electric razor when the probe was held one inch from the razor case.

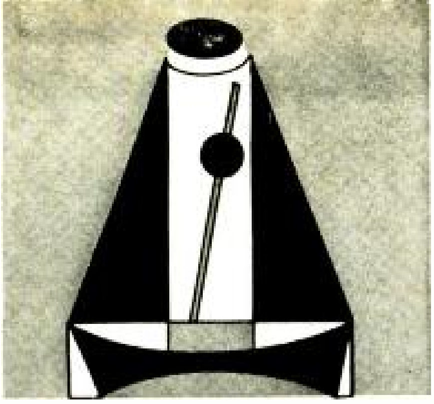
The circuit can be employed to measure relative a.c. field intensity levels.

(*Continued on page* 133)

Fig. 1. Telephone pickup coil L_1 is placed in the vicinity of signal-carrying wires.



R_1—2200 ohm, ½ w. res.
R_2—1000 ohm, ½ w. res.
R_3—39,000 ohm, ½ w. res.
R_4—7500 ohm, ½ w. res.
C_1—500 µf., 3 v. elec. capacitor
C_2—25 µf. 25 v. elec. capacitor
C_3—2 µf., 25 v. elec. capacitor
C_4—1 µf., 15 v. elec. capacitor (see text)
CR_1, CR_2—Crystal diode (Sylvania 1N56A)
RL_1—4000-ohm relay (Cardwell BK-7-B or equiv.)
L_1—Telephone pickup coil (Argonne AR-20)
B_1—22½-volt battery (Burgess U15 or equiv.)
V_1, V_2—"p-n-p" transistor (G-E 2N107)



Electronic Metronome

By **HAL WITTLINGER**/RCA Electron Tube Div.

Easy-to-build one-transistor circuit produces loud ticks and blinking light indication over range 40-220 beats/min.

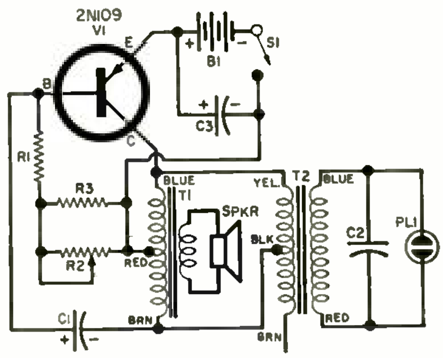
THE metronome, that venerable mechanical timer of the musician, can now be replaced by a simple, compact, and inexpensive single-transistor device. The electronic "beat-keeper" to be described not only generates the typical loud, crisp metronome tick, but also provides visual beat indication. Power is supplied by a 9-volt battery.

Circuit Description

The schematic diagram for the electronic metronome is given in Fig. 1. An *RCA* 2N109 transistor is used as a blocking oscillator and a resistor-capacitor network (R_1, R_2, and C_1) provides the necessary oscillator timing. Transformer T_1 couples a pulse of the correct polarity to charge capacitor C_1 and to bias the transistor beyond cutoff. In addition to charging C_1, T_1 also couples this pulse to the speaker.

Discharge of C_1 takes place through resistors R_1, R_2, and R_3. When the resistance of R_1 and R_2 is raised, the time required to discharge C_1 is increased. A decrease in the values of R_1 and R_2 has the opposite effect. The range covered by the "rate" potentiometer, R_2, goes beyond the 40 to 208-beats-per-minute range found on most mechanical metronomes. This extended-range feature insures complete coverage with the normal distribution of components.

The relatively high voltage generated during the pulse period is applied to another transformer which steps up this pulse voltage to light the NE-51 neon lamp. A 120-µµf. capacitor is placed across the lamp to "tune" the circuit for a symmetrical pulse. This arrangement insures maximum brightness for both electrodes of the lamp.



R_1—68,000 ohm, 1/2 w. res.
R_2—1 megohm miniature volume control (Lafayette VS-40 or equiv.)
R_3—1 megohm, 1/2 w. res.
C_1—4 µf., 6 v. elec. capacitor
C_2—120 µµf. disc capacitor
C_3—50 µf., 15 v. elec. capacitor
PL_1—NE-51 neon lamp
S_1—S.p.s.t. switch (on R_2)
B_1—9-volt battery (RCA VS309A)
T_1—Miniature output trans. 500 ohms c.t. to 3.2 ohms, 100 mw. (Lafayette TR-95 or equiv.)
T_2—Miniature driver trans. 10,000 ohms to 2000 ohms c.t. (Lafayette TR-96 or equiv.)
Spkr.—2 1/2" speaker with 10 ohm v.c. (Lafayette SK-66)
Case—3" x 2 3/8" x 1 3/8" baffle case (Lafayette MS-315)
V_1—"p-n-p" transistor (RCA 2N109)

Fig. 1. Circuit diagram of metronome.

Construction

The entire unit is built on a small aluminum chassis which is then mounted in a *Lafayette* MS-315 speaker baffle. A piece of 1/16" aluminum is cut and bent to fit snugly around the speaker within the case. The "rate" potentiometer holds the chassis in place.

The jack is removed from the top of the case and two holes are cut to accommodate the rate control and neon lamp. A piece of No. 18 wire wrapped around and soldered to the base of the lamp permits easy mounting.

Operation

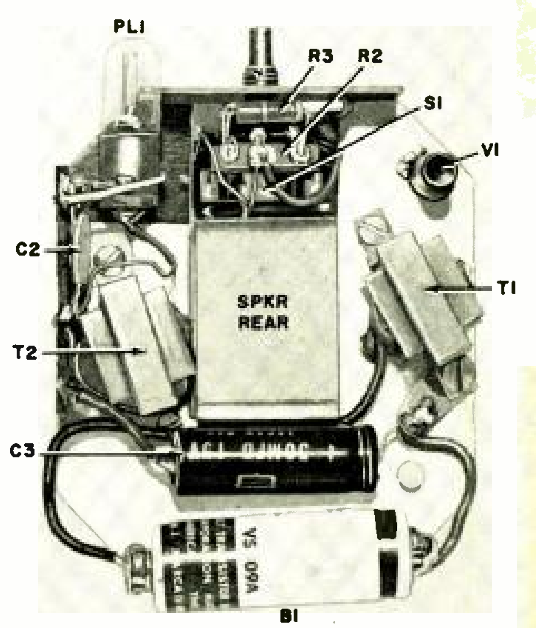
After the metronome is wired, connect the battery and turn the unit on. One tick should be heard immediately. A decrease in the resistance of R_2 should cause the number of ticks to increase. Coincident with each tick the neon lamp should flash.

Both electrodes in the lamp should glow with equal brilliance. If one electrode glows brighter than the other, C_2 is probably not optimized for the

(*Continued on page* 82)

Metronome is built into small plastic speaker baffle. Note how beats-per-minute calibrations are on rate-control knob.

The home-built chassis plate is cut and shaped to fit the cabinet. An aluminum "case" may be used to surround speaker.



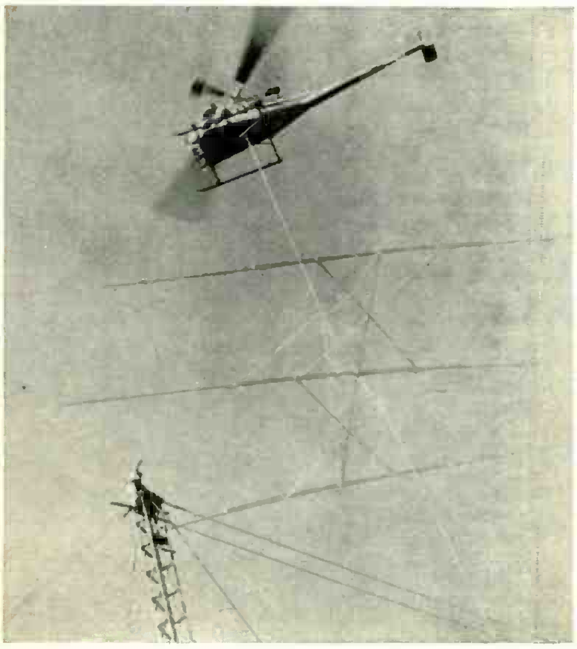
Largest Microwave Radio Installation

What is believed to be the largest microwave radio installation in the world is being completed by *Collins Radio Co.* in California. There are 33 microwave transmitters and 33 microwave receivers at the Santa Cruz Island junction repeater station serving the Pacific Missile Range, headquartered at the Naval Missile Center, Point Mugu, Calif. The microwave relay connects to Pt. Mugu, 31 miles away; to San Nicolas Island, 53 miles away; and to a repeater station at Point Arguello, 69 miles away. The system provides radar video channels, carrier channels for communication and data between sites, and teletypewriter channels. Channels are also provided for transmission of azimuth and angle-mark information used in a radar surveillance system as well as signals for synchronizing 10 precision tracking radars located at the several major operating points.

High-Reliability Resistors for Missiles

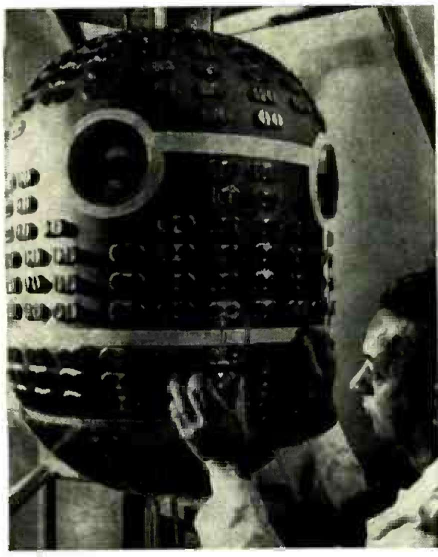
A new approach to the problem of reliability achievement in resistors has been developed by *International Resistance Co.* in connection with a contract for work on high-stability, metal-film resistors for use in the Air Force "Minuteman" ICBM. The resistors, now being turned out in pilot production, are permitted only one failure in one-quarter billion unit hours. Each of the components delivered by the company will have its personal history attached. Complete records on all raw materials and process characteristics will be maintained and individual punch cards or tabulations of individual resistor values will be available. Workers coming in contact with the high-reliability parts wear over-clothing which aids in keeping the manufacturing area ultra-clean and free of dust. Humidity and temperature are also carefully controlled during the manufacture.

Recent Developments in Electronics



Antennas Installed by Helicopter

Two antennas were recently installed atop 112-foot towers for Stanford University Radioscience Laboratory in only 16 minutes by means of a *Hiller* helicopter. Using a quick-release cargo hook under the belly of the copter, the pilot picked each antenna off the ground, flew it to an awaiting tower and, hovering almost motionless in the air, lowered each gently into a socket where it was clamped into place by a technician. The antennas will be used to receive signals bounced off the ionosphere from a station 5000 miles distant.

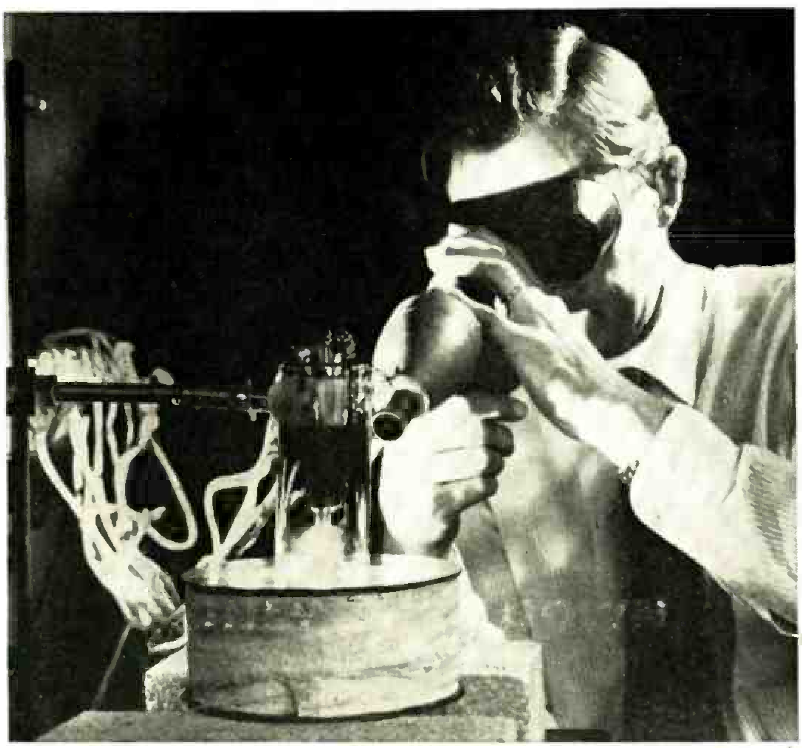


◀ Thermoelectric Generator

SNAP 1-A, "big brother" of the grapefruit-sized SNAP-3 generator which was unveiled by President Eisenhower last year, is prepared for electrical tests at the *Martin Co.* in Baltimore. Heat from tightly sealed pellets of an atomic waste material, Cerium-144, will be converted directly and continuously into 125 watts of electrical power by hundreds of thermocouples which dot the outer skin of the device. The complete *S*ystem for *N*uclear *A*uxiliary *P*ower weighs 175 pounds and uses no moving parts. The new system promises more power than any energy unit launched into space so far. Some systems combine solar cells with chemical batteries for high wattages, but these operate intermittently. Also, SNAP can generate power while in the sun's shadow.

▲ Bridge-Installed Radar

Service engineer is shown above checking out a new radar installed atop the control room of vertical lift bridge in Duluth, Minn. The radar looks 32 miles out into Lake Superior in one direction and across the harbor in the other to warn bridge-tenders when ships are approaching in heavy weather. The new *Raytheon* radar will speed traffic of cars and ships while protecting the draw from ships which might approach too fast in heavy weather. The radar is a conventional shipboard type with a 10-inch scope and six range scales from 1 mile to 32 miles.

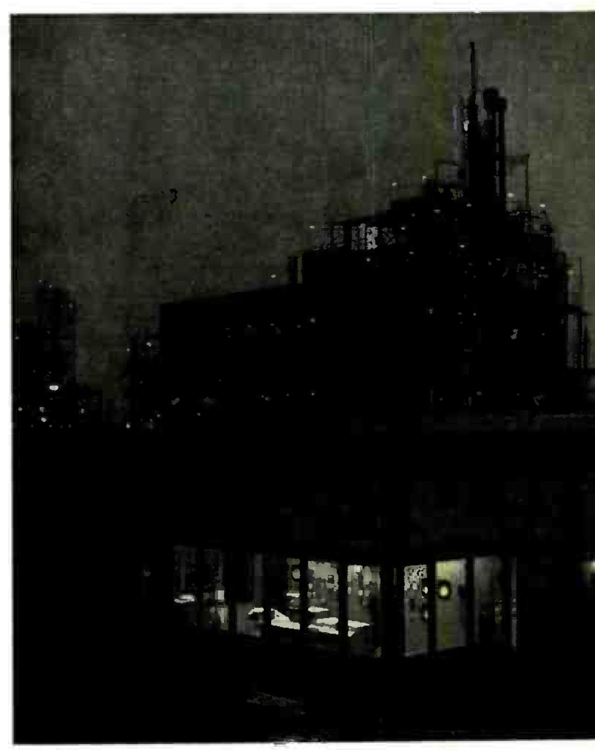


New Thermionic Converter Tube ▲

Elements of a new type of thermionic converter tube, suspended over a circular magnet, are examined with a pyrometer at the *RCA Laboratories*. The new tube, capable of converting heat directly to electric power, is under development for space vehicles and as a possible low-cost, mass-production power source for earth-bound uses. The tube functions within range of temperatures produced by burning ordinary fuels, such as gasoline and natural gas, as well as solar heat in space.

Computer-Controlled Chemical Plant ▶

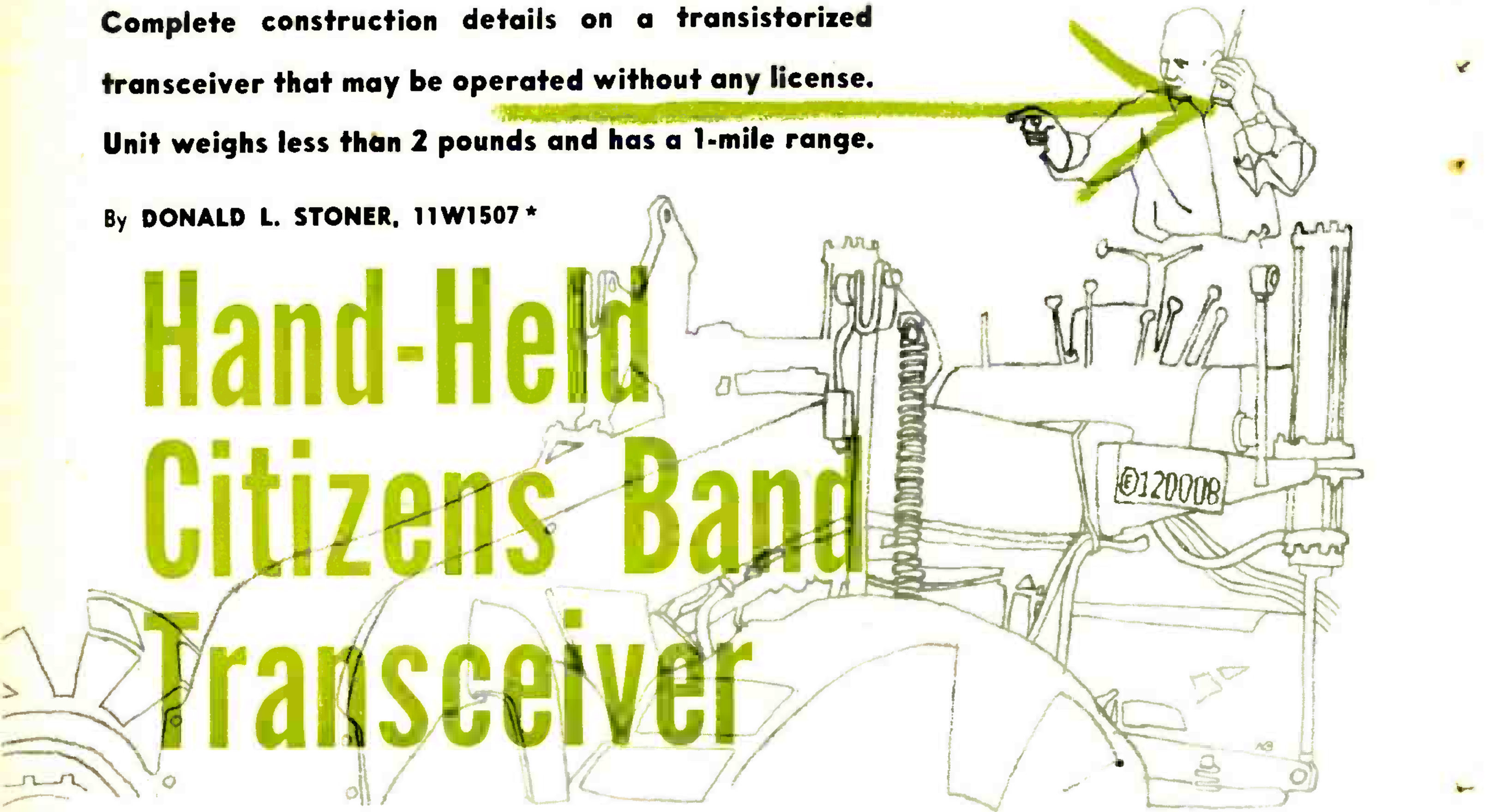
The *B. F. Goodrich Chemical* Co. plant at Calvert City, Kentucky uses a *Ramo-Wooldridge* digital control computer to control and monitor two distinct chemical processes. On-line computer control of an industrial manufacturing process requires a special type of computer which can read information directly from process instruments, compute guides for optimizing process performance from the data it receives and from equations stored in its memory, and send signals directly to control devices in the process plants, thereby eliminating the human operator from the control loop.



Complete construction details on a transistorized transceiver that may be operated without any license. Unit weighs less than 2 pounds and has a 1-mile range.

By **DONALD L. STONER, 11W1507** *

Hand-Held Citizens Band Transceiver



THE author has long been fascinated by "walkie-talkies" and the novelty of "pedestrian portable" operation. One of his earliest units was a raspy, single-tube, two-meter transceiver built in a cigar box about the time the 958A "acorn" tubes appeared on the surplus market. The author's hybrid transistor/tube version for the six-meter band appeared in the July 1959 issue of this magazine.

The latest project, a completely transistorized 11-meter Citizens Band transceiver, represents more "fun on the hoof" than all the other portables combined. One important reason is that this miniature two-way radio station needs *no license* when used in conjunction with other similar portables. Thus, the neighbor or wife can use the transceiver without making a license application.

Recently the unit was "worth its weight in gold" while checking out a television interference complaint. The unlicensed neighbor replied over the air to such questions as "Does that improve the picture?" or "Do you see the interference now?", while adjustments were made at the offending transmitter. The troublesome condition was quickly corrected with the aid of this little transceiver. Obviously, there are many other uses that will occur to the reader, such as antenna orientation and testing, Civil Defense exercises, and various applications that require you to be in two places at the same time.

The Circuit

This transistor transceiver is built around three printed circuit subassemblies, made by *International Crystal Mfg. Co., Inc.* and shown in Fig. 1.

The receiver is a one-transistor superregenerative detector connected in a common-base configuration. Feedback is provided by C_4 and the stage is biased by R_1 and stabilized by R_2. The frequency of the receiver is determined by the tuning of coil L_1 in conjunction with the circuit capacity.

Audio output from this subassembly is coupled to transformer T_1 on the audio amplifier/modulator chassis. This assembly uses a *Texas Instruments* 2N185 (V_4) voltage amplifier and a *TI* 2N238 (V_5) audio power amplifier. Transformer T_1 provides the impedance stepdown and the voltage dividers R_{11} and R_{12} supply forward bias for V_4. The stage is stabilized by R_{13}. Audio output is coupled to the power stage (V_5) by T_2 and forward bias appears at the junction of R_{11} and R_{15}. Resistor R_{16} (100 ohms) provides d.c. degeneration for stability. In the "receive" position, audio output is coupled through T_3 to the speaker *via* section *B* of switch S_1.

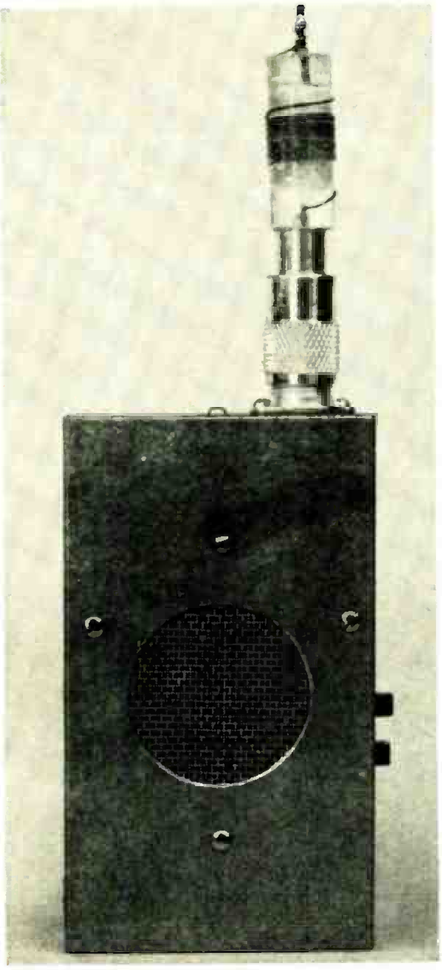
On "transmit," the speaker is coupled to the input of the amplifier (the speaker is used as a microphone on "transmit"), through the "pad" composed of R_9 and R_{10}. This drops the audio voltage generated by the "mike" to prevent overmodulation and, at the same time, damps out resonant peaks in the speaker response. The amplified mike voltage appears at the collector of V_5 and serves to modulate the collector of V_3, the power amplifier.

The transmitter board uses an *RCA* "drift" transistor (V_2, a 2N371) as a common-base oscillator. The crystal is impedance-matched by capacitive divider C_7 and C_8, which are 5% components for maximum frequency stability. Forward bias is applied to the base of the oscillator through voltage divider R_4 and R_5. The r.f. output is coupled to the power amplifier stage from a low-impedance tap on the oscillator coil, L_2. Bias for the amplifier appears at the junction of R_6 and R_7. The d.c. degeneration of V_2 and V_3 is obtained across R_4 and R_8 respectively. The amplified r.f. energy appears across L_3 as a modulated envelope. The signal is coupled to the antenna from a low-impedance point on L_3.

The antenna system consists of a 36-inch length of "piano wire" which is sold at model airplane supply stores. A base-loading coil (L_4) resonates the whip and case at 27 mc. and is shown in the photo on the next page.

The combined battery and antenna switching circuit may be confusing to some and should be explained at this point. There are three functions which must be switched in the transceiver. On "receive," the antenna must be connected to L_1 (through C_1), the battery supply (−9 volts) is connected to the bias resistor (R_1), and the speaker is connected to the amplifier *output*. On "transmit," the antenna is connected to L_3 (through C_{11}), the battery is applied to the oscillator, and the speaker is connected to the *input* of the amplifier. Since double-pole switches are inexpensive and compact, these were selected for use in the transceiver. The antenna and battery changeover func-

* "Electronic Publications," Box 137, Ontario, California.



The transceiver uses five transistors and is a self-contained two-way radio station.

tion is accomplished in one section while the other section switches the speaker. Choke RFC_2 serves to isolate the antenna signal from the transmitter "B−," while RFC_3 isolates the battery. Connected in this manner, the switch section handles both the r.f. and battery potential with no apparent losses.

On "receive," the oscillator and final amplifier cannot conduct for they have no forward bias. The final, or power amplifier, will not conduct even though collector voltage is applied.

The detector "B−" circuit must be decoupled from the audio to prevent motorboating and oscillation. Decoupling resistor R_{14} also serves as an r.f. choke as explained earlier. Capacitor C_{22} filters the voltage and prevents audio oscillation. No regeneration control is used, but the receiver performs very well with battery voltages ranging between 6 and 10 volts.

Construction

As mentioned earlier, the "heart" of the transceiver is three subassemblies manufactured by *International Crystal*. However, if you are inclined to "home-brew" this equipment, it may be accomplished in one of several ways. The circuit boards may be purchased separately from *International* or you can make them yourself. Actually there is nothing magic about the circuit boards, except they save a little wiring time. If you don't care to use circuit boards, the components could be mounted on the metal cabinet in regular chassis style. Place the transformers in about the same position as shown in the photos. Mount suitable terminal strips between the transformers and secure the components (including the transistor leads) to the terminal lugs. The receiver coil (L_1) slug could project through the side of the case for external tuning.

To aid the "home-brew artist," the components specified in the parts list have been tested in the unit and performance is identical to that obtained with the *International* components. The transformer lead color codes are different, however. In addition, there is *no* commercial equivalent for T_1 and it is necessary to modify the transformer specified in the parts list in the following manner: Clean out the glue between the winding and the frame with a sharp, thin blade. In this space wind 50 turns of #38 enamel wire, around the core and through each gap in the core "window." The ends of this winding replace the two black wires of T_1 in Fig. 1. The blue lead of the TY-56X (T_1) would go to eyelet *B*, the red wire to eyelet *C*, the black wire would connect to the junction of R_{11} and C_{15}, one green lead would go to the base of V_4 and the other green lead would be taped up and not used. The TY-56X can also be used for T_2, however the yellow lead shown in Fig. 1 would be black and the other green lead would be unused. The TY-44X is a perfect substitute for T_3 and the black and white wires are left disconnected. Of course, any similar transformers can be used if the correct connections are made. Reasonable substitutions can be made for the other components as well.

Back view of front panel before chassis is mounted. Note felt covering speaker frame.

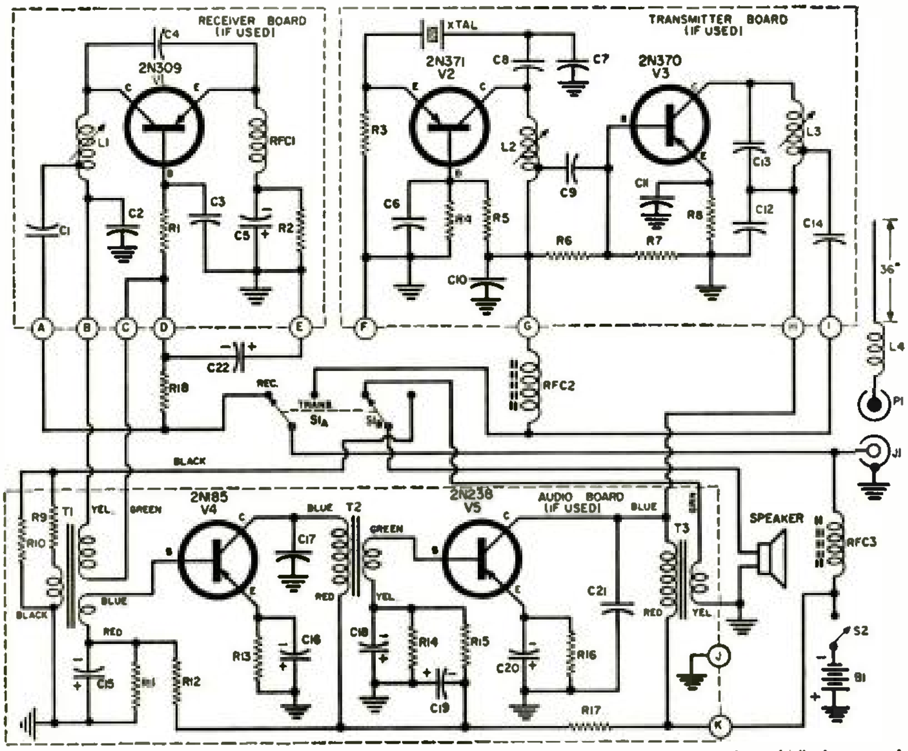
The transmitter section *must* be pre-assembled and aligned to comply with Part 19.17 (d) (Citizens Radio Service) of the Commission Rules, dated effective November, 1959. However, if you intend to use the device under the provisions of Part 15 (Low-Power Communications Device) it would appear that the entire unit could be "home grown."

Getting down to the mechanical details, the transceiver is constructed in a 5¼" x 3" x 2⅛" *LMB* chassis box. The audio and receiver sections are mounted on the bottom with 4/40 hardware. The transmitter board is mounted vertically at the end of the box on four "L" brackets. All adjustments are accessible without drilling holes in the case. The speaker, grille, antenna connector, and battery are mounted on the other half of the chassis box. The connector is mounted with two 4/40 bolts and a ground lug is placed under one of the nuts. Three wires (speaker, antenna, and battery negative) and chassis ground connect the two halves of the box.

The lettered terminals shown in Fig. 1 were arbitrarily assigned by the author to make construction easier. They correspond to eyelet terminals on the printed-circuit boards. There is no need to connect the ground terminals *E*, *F*, and *J*, since they are automatically grounded when the chassis boards are mounted. However, ground eyelet *E* was used to ground one black T_1 lead and the positive end of C_{22}. The yellow lead of transformer T_3 was conveniently grounded to eyelet *F*.

When laying out the transceiver, the author had difficulty finding a spot for resistors R_9 and R_{10}. To avoid having

Transceiver may be built from these three subassemblies, which are available with all parts mounted. The unit may also be built "from the ground up" if desired.



R_1—220,000 ohm, ½ w. res.
R_2, R_{15}—1000 ohm, ½ w. res.
R_3, R_8—470 ohm, ½ w. res.
R_4, R_7, R_{11}—2200 ohm, ½ w. res.
R_5, R_6, R_{12}—18,000 ohm, ½ w. res.
R_9—33 ohm, ½ w. res.
R_{10}—3.3 ohm, ½ w. res.
R_{14}—1500 ohm, ½ w. res.
R_{13}—8200 ohm, ½ w. res.
R_{16}, R_{17}—100 ohm, ½ w. res.
R_{18}—3300 ohm, ½ w. res.
C_1—220 µµf. disc capacitor
C_2, C_6, C_9, C_{10}, C_{11}, C_{12}—.01 µf. disc capacitor
C_3—.001 µf. disc capacitor
C_4—22 µµf. disc capacitor
C_5—20 µf., 25 v. elec. capacitor
C_7—150 µµf. 5% NPO disc capacitor
C_8, C_{13}—15 µµf. 5% NPO disc capacitor
C_{14}—470 µµf. disc capacitor
C_{15}, C_{16}, C_{18}, C_{20}—100 µf., 3 v. elec. capacitor
C_{17}—.005 µf. disc capacitor
C_{19}—50 µf., 15 v. elec. capacitor
C_{21}—.0068 µf. disc capacitor
C_{22}—10 µf., 10 v. elec. capacitor
Xtal.—Third overtone crystal (International F-609)
J_1—U.h.f. antenna jack
P_1—U.h.f. antenna connector
RFC_1—54 t. #36 en. scramble wound on 1 neg., 1 w. res. (self-resonant at 27 mc.)
RFC_2, RFC_3—39 µhy. choke, self resonant at 27 mc. (J. W. Miller #4628)
L_1—15 t. #24 en. closewound on ¼" slug-tuned form, tapped at 1 t. (J. W. Miller #4500 or equiv.)
L_2—15 t. #24 en., closewound on ¼" slug-tuned form, tapped at 2 t. (J. W. Miller #4500 or equiv.)
L_3—15 t. #20 en., closewound on ⅜" slug-tuned form, tapped at 2 t. (J. W. Miller #4400 or equiv.)
L_4—17½ t. #22 en., closewound on ⅜" polystyrene rod. Do not cement in place until adjusted.
T_1—Input trans. 10,000 ohms to 2000 ohms with 8-ohm winding (Triad TY-56X modified and color coded per text)
T_2—Interstage trans. 10,000 ohms to 2000 ohms (Triad TY-56X modified and color coded per text)
T_3—Output trans. 2000 ohms to 8 ohms, 10 ma. primary current (Triad TY-44X, color coded per text)
S_1—D.p.d.t. slide switch
S_2—S.p.s.t. slide switch
Spkr.—8-ohm, 2¼" speaker
B_1—9-volt mercury battery (RCA VS312 or equiv.)
1—5¼" x 3" x 2⅛" chassis box (LMB J880)
V_1—2N309 transistor (Texas Instruments)
V_2—2N371 transistor (RCA)
V_3—2N370 transistor (RCA)
V_4—2N185 transistor (Texas Instruments)
V_5—2N238 transistor (Texas Instruments)

Printed circuit assemblies available from International Crystal Mfg. Co., Inc., 18 N. Lee St., Oklahoma City, Okla. The receiver and audio circuit boards (boards only) may be obtained from Irving Electronics Co., Box 9222, San Antonio, Texas.

Fig. 1. Transceiver may be put together using commercially available subassemblies, already prepared printed boards, or it may be entirely "home-brewed" by builder.

to add another terminal strip, these two components were mounted on the audio board near T_1 and C_{15}. Five tiny holes were drilled in the clear area and one black T_1 lead clipped short. The resistor leads were pushed through the holes and the wires soldered together under the chassis. The mounting seems to be quite secure. If you whip up your own board, it might be advisable to add eyelets for these components.

Start the construction by mounting the boards (or components, as the case may be) in the approximate positions shown in the photographs. Locate a clear space for the switches and remove the boards before drilling these holes. Install the two slide switches (space at least ⅛ inch), the two-lug terminal strip (cut the tops to clear the transmitter board), and the two r.f. chokes. These components must be wired before the boards are permanently installed. It is suggested that an additional 4/40 hole be drilled in the space between V_5 and V_1. This point should be supported as the board might fracture if the set is dropped.

Resistor R_{18} is mounted on the receiver chassis between eyelets *A* and *D*, along with capacitor C_{22} between eyelets *D* and *E*.

The battery is mounted with a small aluminum bracket and 4/40 hardware. The speaker grille is a 2½" x 2½" piece of aluminum screening. Before installing the speaker, cover the holes in the basket (frame) by gluing on felt strips as shown in the photograph. Leave only the terminals exposed. This minimizes the "barrel" or tinny sound when the speaker is used as a microphone.

Testing

When wiring is completed and the switches are labeled, connect a milliammeter (0-25 ma.) in series with the battery. The unit, when energized, should draw approximately 10 ma. and typical superregenerative "hiss" should be heard. Tuning coil L_1 should bring in Citizens Band stations, when connected to an antenna. If the receiver does not "take off," check the detector current by inserting a 0-1 ma. meter at eyelet *B*. The current should be 1 ma. or less. If it is not, adjust the value of R_1 to give a reading of approximately 200-500 microamperes.

Switching to "transmit" should increase the battery current approximately 4 ma., which shows the oscillator and power amplifier are working.

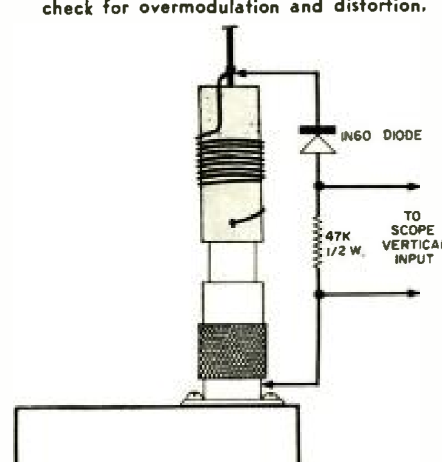
Before testing the transmitter, check the resonant frequency of the antenna loading coil while holding the transceiver in a normal manner. You must be holding the transceiver when this test is made as your body is part of the antenna ground-plane system. Hold the grid-dip meter coil near the loading coil (L_4) and check for resonance. You should see a noticeable dip near 27 mc. If it is high, compress the coil turns; if low, spread them apart until the dip occurs at exactly 27 mc.

Next connect a milliammeter in series with the lead to eyelet *H* and apply power to the transmitter. The current may be between 4 and 6 ma., indicating a power input between 28 and 42 mw. Remember that current in milliamps times collector voltage equals milliwatts. Any reading less than 100 mw. input is satisfactory. It is difficult to exceed 100-mw. input because of the resistance of T_3's primary.

You are required to have a radiotelephone license to adjust the transmitter if this unit is to be used in Class D service. The following information is given on the assumption that you hold the pertinent ticket. To check performance, adjust the oscillator coil (L_2) for the highest V_3 collector current con-

(*Continued on page* 112)

Fig. 2. Test setup used by author to check for overmodulation and distortion.



Troubleshoot with Basic Theory

By DAVID R. ANDERSON

Thinking takes much less time than unsoldering and routine checking, also yields better results.

EDITOR'S NOTE: *Troubleshooting via section analysis, based on logic and theoretical knowledge, is nothing new to most experienced hands. However, even amongst these, how many abandon logic in favor of random checking when it comes to pinpointing the exact defect? Is it to "save time" or is it due to mental laziness? Actually you can think faster than you can work with your hands. This article is worth the attention of the experienced as well as the beginner.*

EVERY electronic circuit is an entity that can be broken down into the components it contains, such as tubes, resistors, capacitors, and coils. The theory behind the operation of these components and their characteristics, as well as the theory behind operation of the circuits, is the basis of every course in electronics. It is no secret that a service technician, whether he is a beginner or a professional with many years of experience, can save a good deal of time and effort by applying this theory in his work.

Taken as a whole, a unit of electronic equipment is quite a complex affair. One of the first things an application of basic theory does is to allow the technician to simplify analysis and troubleshooting procedure by dividing the unit into individual sections or circuits. With theory, he can narrow things down even more, but this is less often done than the common technique of section division. However, before getting into theoretical analysis of specific component defects, a review of the initial sectioning off is worthwhile.

Each circuit may be considered an individual unit with an input and an output. In some cases, there may be more than one input or output. In other cases, such as the i.f. amplifier of a TV receiver, it is more convenient at first to consider the group of circuits (stages) contained therein as a single section.

Keeping to the TV receiver as an example, it may be divided into several portions, or blocks in a hypothetical block diagram, each of which has a particular function in either delivering a satisfactory picture to the screen or sound to the speaker. The tuner, i.f. amplifier, detector-video amplifier, sync amplifier-separator, horizontal-sweep—high-voltage system, vertical-sweep system, audio section, and power supply would be included in a typical breakdown of sections. There may be some interaction between sections with certain faults, but systematic checking will show this up. This procedure, of course, is not confined to TV sets. A division into functional sections is possible with test equipment, ham gear, hi-fi units, or any electronic equipment.

Even after this approach is followed until the fault is localized to a specific section, the possibilities of the technique have not been fully exhausted. Similar logical elimination can be applied to location of the specific fault.

Let us assume, to start, that we have a TV receiver in which there is no picture, although a full raster and sound are present. The technician reasons along these lines: since the sound must pass through the tuner, i.f. amplifiers (in an intercarrier receiver), and audio sections to reach the speaker, and sound is present, these sections are at least operating. Also since the circuits mentioned depend on the power supply, the latter must also be functioning. Since the intercarrier audio i.f. signal originates in the video detector, the latter is also operating.

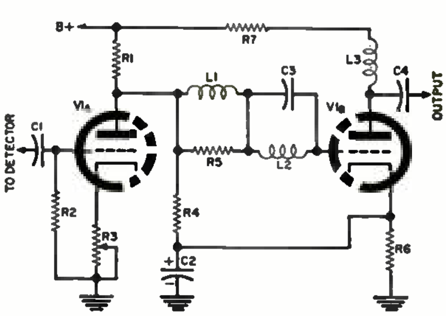
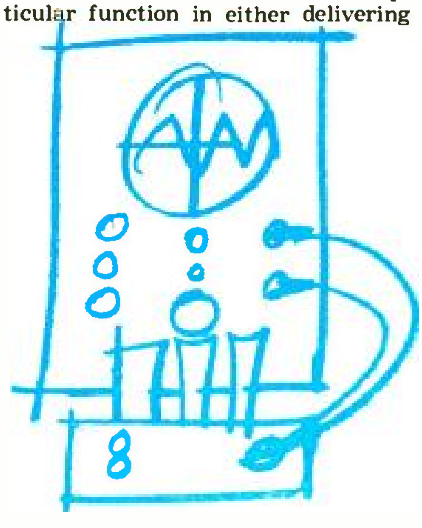


Fig. 1. This two-stage video amplifier can be analyzed before measurement.



Already a large portion of the receiver circuitry has been eliminated from primary suspicion. Other sections can also be set aside. Because a raster is present, the electron beam of the CRT is moving, and is being deflected across the screen both vertically and horizontally. Therefore, the sweep circuits are operating, as well as the picture tube's associated circuits. For example, the presence of the raster indicates that high voltage is being developed.

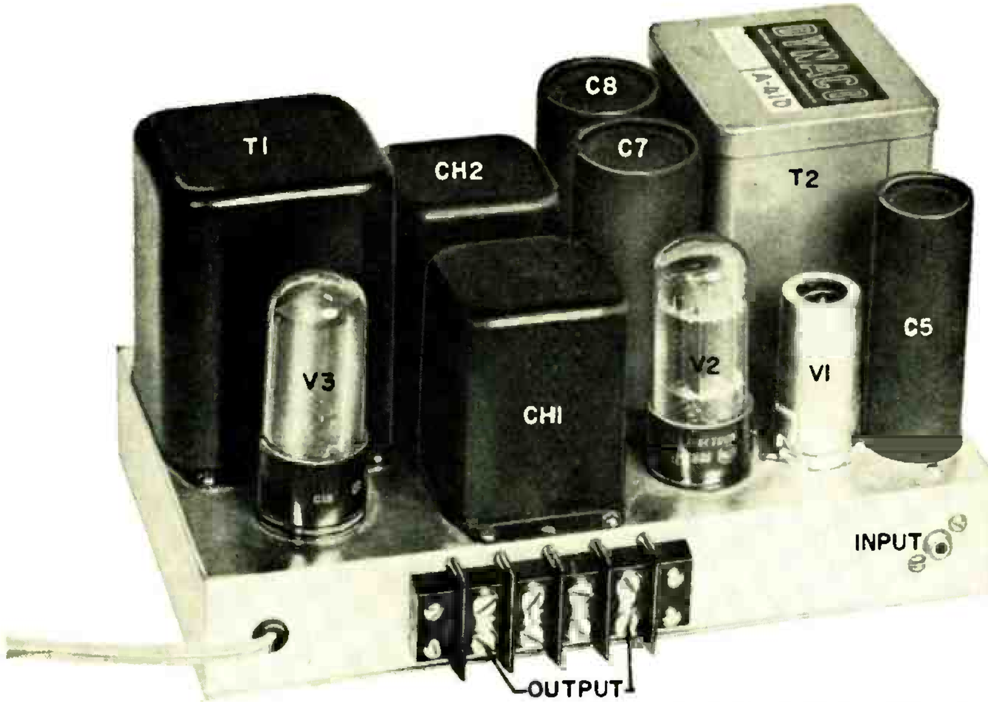
At this point, without using a single test instrument or making a single measurement, only the sync and video-amplifier sections remain open to suspicion. Since the complaint is that of no picture, it does not matter at this time whether the sync section is working or not. The technician is ready to concentrate his efforts on the video amplifier, and he is ready to bring his equipment into play.

Assume that the video amplifier in question is the single-tube, two-stage circuit of Fig. 1. The next step may vary depending on the technician's preference or the nature of the circuit. With a good oscilloscope or other equipment for observing the presence or absence of signal, the technician may resort to signal tracing for further localization before he undertakes voltage and resistance measurements. In a circuit that is reasonably uncluttered he may go directly to these measurements. In either case, he can reduce the number of tests required by logical use of theory.

This theory tells us that each component has its own normal effect on circuit action depending on how it is used; and also that it will have certain effects when it become defective. Thus in any circuit there will be a number of components that may be eliminated from suspicion because they could not cause the symptom for which the equipment is being serviced.

With reference to Fig. 1, components such as R_5 and C_3 would not be responsible for the symptom of no picture even if they were defective, because of the way they are used. They help determine frequency response of the video amplifier, but do not essentially couple signal or block d.c. If R_5 shorts, the path from the V_{1A} plate to the V_{1B} grid for d.c. and signal voltage already existed through L_1, L_2, and C_3. If R_6 be-

(*Continued on page* 138)

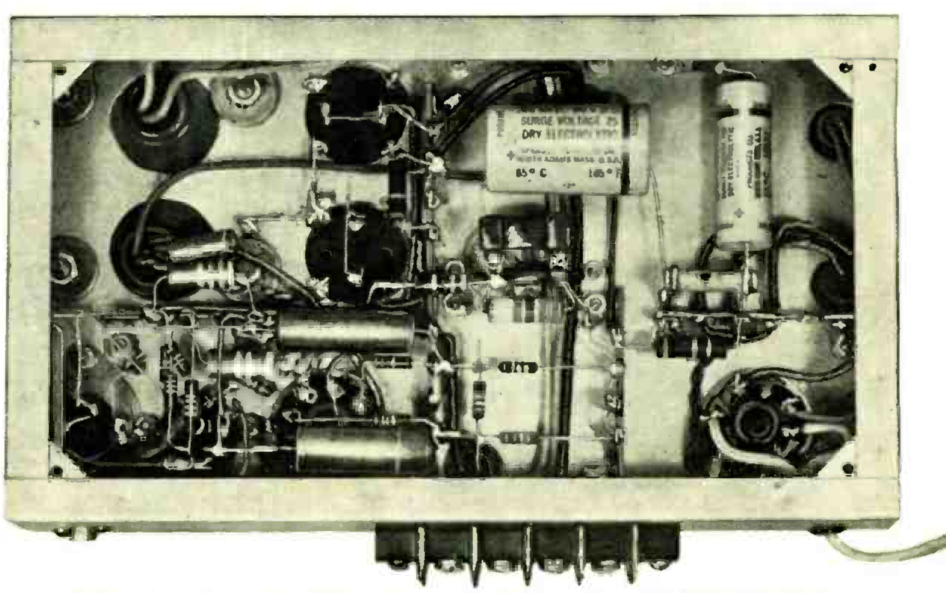


Amplifier with its built-in power supply is constructed on $9\frac{1}{2}" \times 5\frac{1}{2}" \times 1\frac{1}{2}"$ chassis.

Low-Distortion 3-Watt Audio Amplifier

By **E. WILLIAM BLUM**
Engineer, WLDS/WLDS-FM

Complete construction details on a low-power high-fidelity audio amplifier that has almost vanishing distortion. Circuit employs a single 6BX7 twin-triode tube in the unit's output stage.



Bottom view of amplifier which author constructed directly from schematic diagram.

THERE have been many low-power audio amplifier designs offered during the past few years but almost all of them lacked some quality or feature that was desired by the true audio enthusiast.

If you have an efficient speaker setup, the use of a high-power amplifier running at low level may not be the proper approach for several reasons. Although running a 20- or 40-watt amplifier at a half watt may result in low distortion, the residual hum may leave much to be desired—to say nothing of the waste of power and the danger of damaging a very expensive speaker. For these reasons, the amplifier to be described should meet the needs of the audiophile who uses efficient speakers and has a relatively small listening room.

First of all, the author wishes to give credit to Paul Popenoe, Jr., who originally described the circuit.[1] His amplifier was built and used for two and a half years with excellent results. Mr. Popenoe's amplifier was the inspiration for the circuit to be described. The author's amplifier incorporates several worthwhile improvements which make distortion and hum practically nonexistent.

The amplifier to be described was the result of three months' intensive research into the design of the best possible low-power, high-fidelity amplifier—without consideration being given to cost or complexity. It is interesting to note that the result was a fairly low-priced unit and one that is extremely simple circuit-wise — again proving that high quality and complexity need not go hand-in-hand.

This unit will deliver 3 watts with less than .25% harmonic distortion and less than .1% under 2.5 watts. Since most commercial audio oscillators and distortion meters have a combined threshold level of around .1% distortion, it was impossible to determine the exact low-level distortion. What makes this so remarkable is that this is accomplished with only 8.5 db of over-all negative feedback. This makes the amplifier sound absolutely clean with no coloration being added to the sound. Over-all negative feedback is not a cure-all for distortion and large amounts of it invariably cause some coloration of the signal. This is because the harmonics which are fed back pass through the non-linear stages causing more harmonics and more beats to appear in the output. True, these are very low in amplitude but can, nevertheless, be heard in the form of harshness, "unrealness", or coloration.

Cathode Linearization

By using only a small amount of over-all negative feedback, maximum stability can be achieved with an extreme frequency coverage so that "presence" is assured. The only real problem, then, is how to achieve low harmonic and IM distortion and this can be realized by the use of triodes. The 6BX7-GT is the best power triode available for this service. Not only does this tube have low plate impedance, drive easily, and exhibit above-average plate efficiency, but its grid-voltage/plate-current parameter is such that it responds amazingly well to a cathode-linearizing resistor (R_{13} on the schematic). The use of such a resistor is not too well known among audio men, but it can be extremely effective in reducing distortion in some cases. It is so effective in this amplifier that 2.25 watts output can be obtained with less than .2% harmonic distortion with no over-all feedback. This resistor does not decrease sensitivity so it is virtually an example of receiving "something for nothing".

Resistor R_{13} reduces distortion for the following reason: The amount of current rise in one tube may be larger than the amount of current fall in the other (the main cause of distortion in all tubes). This will cause the voltage across R_{13} to rise slightly which, in turn, increases the cathode bias on both sections by the same amount. This, then, causes a decrease in current in both sections and, if the correct value for R_{13} is chosen, the up-swing current and down-swing current become practically equal, greatly reducing distortion.

As might be suspected, the value of this resistor is extremely critical. It is also not the same value for all power levels and a compromise must be reached; .7 of maximum output power is about the right power at which to adjust this resistor. With this circuit, 2.25 watts proved to be the best point (6 volts across a 16-ohm load resistor). If this circuit is not duplicated exactly, the author recommends the use of a 50-ohm potentiometer, adjusting it for minimum distortion at 2.25 watts to determine the right value, then substituting a fixed resistor of the same value for the sake of stability and reliability. Because the distortion is so low at the dip, make this adjustment with the negative feedback loop disconnected.

If the circuit oscillates when connecting the feedback loop, positive feedback is taking place; simply reverse the primary leads of the output connections going to the 6BX7-GT plates.

Other Circuit Features

The 240,000 grid-to-grid resistor helps to further reduce distortion, while the 1800-ohm resistors in the grids help to prevent ringing on sharp transients.

The *Dynaco* output transformer gives this amplifier low distortion at both ends of the audio spectrum plus extremely good transient response.

Most of the various phase-inverter circuits were tried but the split-load type was found to give the best performance. In addition, it is not critical as to tube condition and is simple. Because the phase inverter drives the 6BX7-GT directly, the amplifier will maintain its very low distortion month after month with no adjustments. Only the tubes require replacement and that is a once-a-year or longer proposition. This makes the amplifier practical for many applications. The 12AX7 works very well as a voltage-amplifier/phase-inverter and makes it possible to keep the tube line-up down to only three tubes, including the rectifier.

Filtering is employed lavishly in the power supply in addition to 40 volts d.c. on the heaters, but this pays off in extra low hum and IM distortion. Hum and noise checked out to 85 db below −.25 watt. With the input lead disconnected and your ear just a few inches from the speaker cone, no hum is discernible.

This amplifier checked out absolutely flat from 30 to 30,000 cps at 3.5 watts (clipping point) which were the extremes of the audio oscillator used for the tests. Since a 15-watt *Dynaco* output transformer plus .1-μf. coupling capacitors are used, the frequency response of this amplifier must exceed these figures by a wide margin.

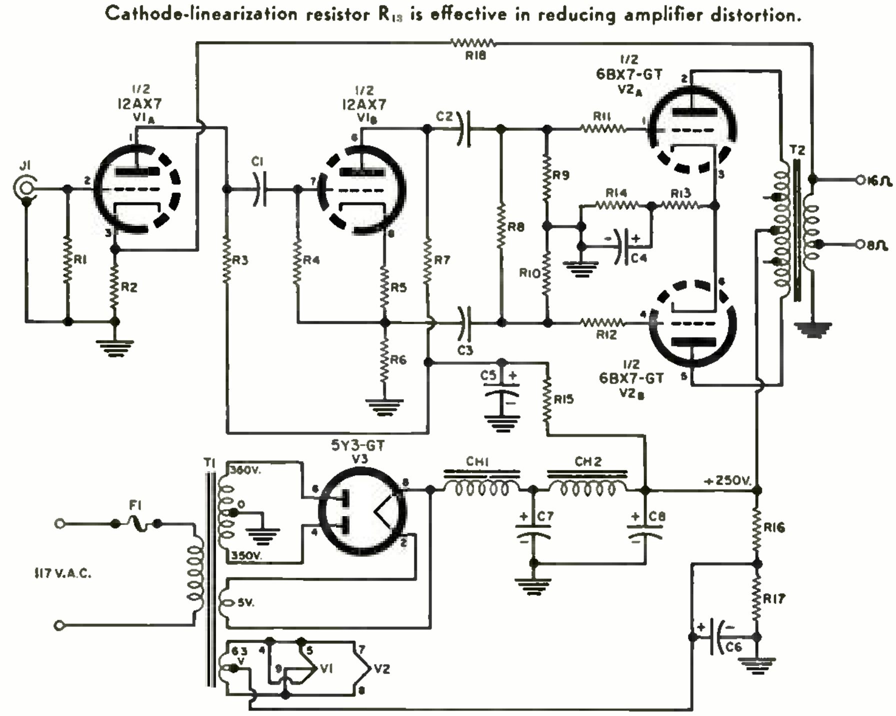
The damping factor is 8, which is completely adequate when used with a good speaker and enclosure.

This amplifier is sure to please even the most critical hi-fi fan and, if you build it, you will probably find that it has the lowest distortion of any component in your setup. It will provide a new listening experience for many.

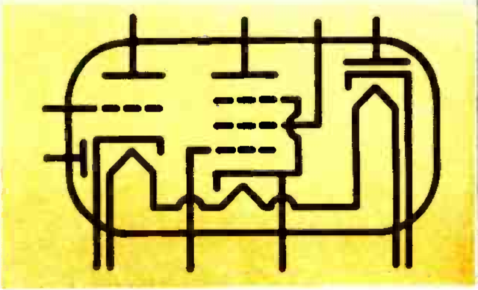
REFERENCE

1. Popenoe, Paul, Jr.: "Small Fi," Hi-Fi Guide and Yearbook, 1957 Edition. —30—

Cathode-linearization resistor R_{13} is effective in reducing amplifier distortion.



R_1, R_3—220,000 ohm, 1 w. res.
R_2—3300 ohm, 1 w. res.
R_4—470,000 ohm, 1 w. res.
R_5, R_{11}, R_{12}—1800 ohm, 1 w. res.
R_6, R_7—47,000 ohm, 1 w. res. ± 1%
R_8—240,000 ohm, 1 w. res.
R_9, R_{10}—220,000 ohm, 1 w. res. ± 5%
R_{13}—27 ohm, 2 w. res. ± 5% (see text)
R_{14}—430 ohm, 10 w. wirewound res. ± 5%
R_{15}—20,000 ohm, 2 w. res.
R_{16}—270,000 ohm, 2 w. res.
R_{17}—47,000 ohm, 2 w. res.
R_{18}—27,000 ohm, 1 w. res
C_1, C_2, C_3—.1 μf., 400 v. capacitor
C_4—250 μf., 50 v. elec. capacitor
C_5—60 μf., 350 v. elec. capacitor (Two 30-μf. sections in parallel)
C_6—20 μf., 150 v. elec. capacitor
C_7, C_8—80 μf., 350 v. elec. capacitor (Each two 40-μf. sections in parallel)
T_1—Power trans. 350-0-350 v. @ 55 ma.; 6.3 v. c.t. @ 2 amps; 5 v. @ 2 amps (Chicago PCR-55)
T_2—Output trans. 15-watt 8000 ohms to v.c. (Dynaco A-410)
CH_1, CH_2—15 hy., 55 ma. filter choke (Chicago RC-1555)
F_1—1 amp. fuse
J_1—Phono jack
V_1—12AX7 tube
V_2—6BX7GT tube
V_3—5Y3GT tube
1—9½" x 5½" x 1½" steel chassis



Compactrons:

Advance in Tube Design

Refinement of multi-function techniques results in advantages in cost, reliability, and equipment size.

PROMISES that semiconductor devices would eventually replace all vacuum tubes have been heard since the demonstration of the first operational transistor. To tube design engineers with the *General Electric Co.*, however, such forecasts have seemed arbitrary. These men saw certain advantages in tubes, actual and potential, that presaged a continuingly important role.

Acting on this faith, they embarked on a re-appraisal of the factors involved in tube design, to see whether they could not exploit possibilities to a greater extent than had heretofore been realized. Their success has been such that they are reluctant to call the new devices tubes. Thus the vacuum devices now emerging in this separate category are being called "compactrons."

What is a compactron? How does it differ from its vacuum-tube predecessors? Part of the answer appears on this month's cover, which features one of the first compactrons to be developed flanked by the three, conventional, miniature tubes (four tube functions) it replaces. Designed *for* use in a.c.-d.c. table radios, this single envelope houses a power-supply rectifier, an audio-output pentode, a detector diode, and a first-audio voltage-amplifying triode (providing the combined functions of the 35W4, 50C5, and 12AV6 found in many radios).

Combining it with one more compactron that comprises a pentagrid section (converter) and an r.f. pentode (i.f. amplifier), we can put together a tiny, two-compactron radio. In fact, *G-E* engineers have done just this. The two compactrons, shown to the right in Fig. 1, do the work of five conventional miniatures shown to the left in the same photograph. Equivalent diagrams for these units appear just below the tubes and compactrons themselves. A developmental model of the radio, beside its cabinet, appears in Fig. 3.

The manufacturer believes that the advantages which will make compactrons attractive include the following: they will be smaller than tubes, will outperform tubes and transistors, will feature high reliability and life, and will be less expensive than either tubes or transistors. In a stereo hi-fi amplifier, 7 compactrons will do the work of 10 tubes or 26 transistors. In the home radio mentioned, 2 compactrons are equivalent to 5 tubes or 7 transistors. In a black-and-white TV receiver, 10 compactrons will match 15 tubes and 3 diodes or 24 transistors and 11 diodes.

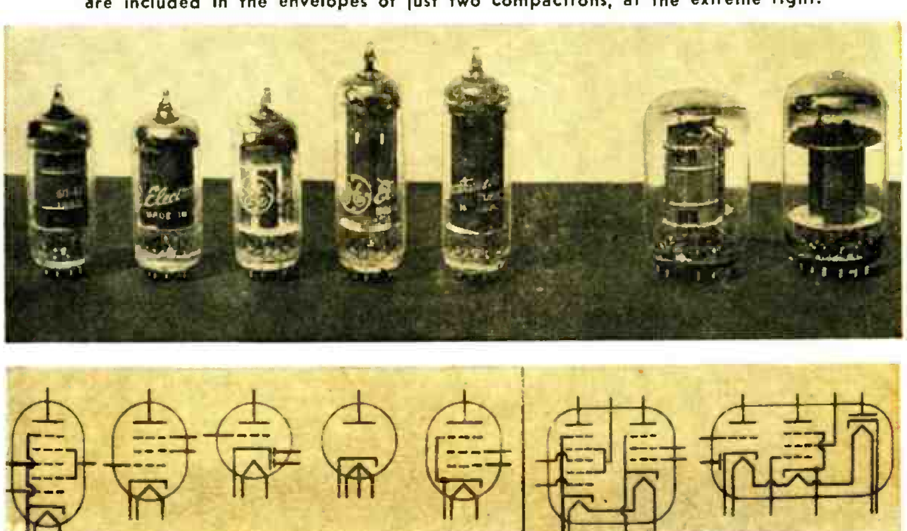
From the foregoing, a compactron simply would appear to be a single-envelope device in which the technique of housing as many tube functions as possible has been advanced to an exceptional degree. Yet this definition does not take into account all the distinguishing features that make compactron design possible. It also fails to account for the fact that some single-function units are included in the compactron line. To understand this advance in vacuum-tube technology broadly, we must explore specific characteristics one at a time.

Beginning at the bottom, we find that the all-glass envelope is designed around a 12-pin circle whose diameter is ¾ of an inch, larger than that of any conventional tube type. The number of pins, of course, is to take care of multi-function types, but the circle offers advantages even where single-function units are involved. The device will be solidly seated, and it adapts well to printed wiring in that there is adequate space to make connections to all pins. By assigning heater connections to pins 1 and 12, there is space to bring heavier printed wiring to these points if it should be necessary to carry higher current.

The wide, 12-pin circle also provides a good foundation for supporting internal structures. For the most part, points of support fall directly under the electrodes to which they are attached. In addition, the extra spacing between pins makes welding of internal connections easier, therefore more reliable. Simplified fabrication will be passed on to compactron users in the form of reduced costs. The development of interelectrode shorting or microphonism during use would appear to be reduced.

The compactrons thus far developed use a T-9 bulb with a diameter of 1⅛ inch, allowing space for multi-function structures. While bulb height will vary, it will be kept down by reason of

Fig. 1. All functions of the "All-American Five" used in a.c.-d.c. radios (left) are included in the envelopes of just two compactrons, at the extreme right.



the fact that the exhaust tip, which usually extends about 5/16 inch above the top of a standard miniature, is placed at the bottom of the compactron between the pins, where it is not wasting space. Thus a receiver designer would have to allow considerably less height, for the most part, than he would for conventional tubes. Compare the height of the compactrons in Fig. 1 with that of the tubes they replace. With a shorter unit, the space occupied will approximate a compact cube.

In some cases, like that of a single-function, horizontal-deflection amplifier now being developed, an envelope with a wider diameter (1½ inch, in this case) may be used. However, the pin circle will be unchanged. The wider bulb permits higher power dissipation. Even with the standard diameter, the width permits an interesting possibility. Flexibility in design and other manufacturing advantages may sometimes be obtained by disposing internal structures horizontally, as in Fig. 2, instead of using the vertical mounting common to most tubes. Horizontal mounting also often retains the desirable feature of low tube height.

The advantages of the generous pin circle are not exclusively structural. By connecting a plate (or other high-

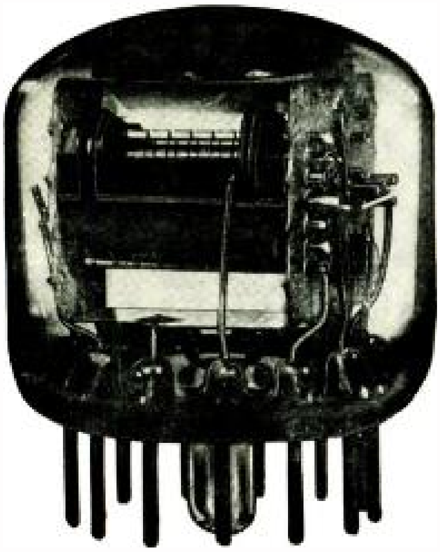


Fig. 2. Horizontal mounting of internal structures facilitates low seated height in this multi-function device.

voltage electrode) to one pin and leaving two unused pins on either side, a voltage isolation in the order of 10,000 volts can be achieved. This will permit the economy of removing the top cap in many designs (such as a horizontal amplifier, for example), since the relatively simple connection to the base can be made with safety.

Thus, even with compactrons limited to a single function because of the high voltages or power dissipation involved, there will be advantages. Improved reliability with reduced cost and size are anticipated.

However, most compactrons will be multi-functional devices, which means lower cost per function will be obtained by the elimination of extra bulbs, extra stems, and extra evacuation procedures. Not the least significant cost-reducing factor is the use of a single heater to activate all of the cathodes (as many as three) in a single envelope. This not only reduces initial cost to the equipment designer but, by keeping heater power requirements and heat dissipation down in use, will further improve reliability.

Take the case of the two-compactron radio. The unit shown on this month's cover has a tentative heater rating of 70 volts at 100 milliamperes. Its companion in the a.c.-d.c. radio (the pentode-heptode) is tentatively rated at 40 volts and 100 milliamperes, with the heaters of both compactrons in series across the line. The standard five-tube complement which the pair replaces draws 150 milliamperes—a 50 per-cent increase in total heater power.

In part, this reduction in required heater power is made possible by the use of a copper-base, aluminum-clad, iron plate material in compactron design. The copper layer efficiently reflects heat from the plate back to the cathode, where it is needed. Also, the use of new alloys in making the cathodes increases heat transfer from heater to cathode, improving efficiency further and cutting warm-up time.

So much for the features that characterize the compactron type. To what extent have results already been achieved? With many types in various stages of development, *G-E* has already announced pilot production of six units, available to equipment manufacturers on a sampling basis. In addition to the two for the radio, there is a compactron with two triodes and two diodes. It is intended for TV use as a combined horizontal oscillator, phase detector, and a.f.c. unit.

A compact beam-power pentode, for use as a horizontal-deflection amplifier in TV, is one of the few single-function types. Here are some of its characteristics: plate dissipation, 12.5 watts; perveance, 320 ma. at 60 volts; maximum plate voltage, 6500 volts; heater voltage, 6.3 volts; and heater current, 1.2 amperes. A companion "single" type is a damper diode, for use in television, with an average damper current of 165 ma. and a maximum heater-cathode voltage rating of 5000 volts. Last of the six initial units is a combined vertical oscillator and deflection amplifier (two dissimilar triodes) for TV.

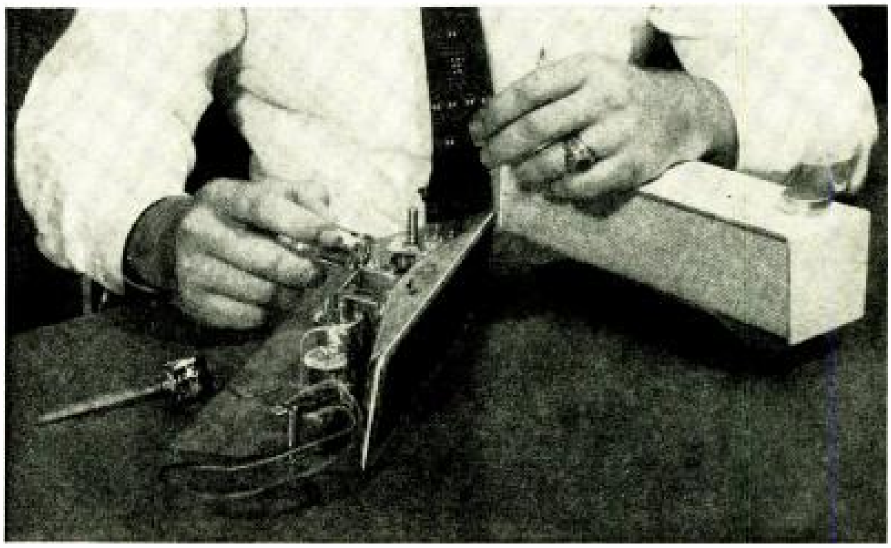
Now in the works are many other types. These include an alternate unit for use as the TV horizontal oscillator, phase detector, and a.f.c. correction circuit that will consist of two diodes, a triode, and a pentode. Nor are equipments other than TV receivers being neglected. Compactrons especially designed to meet the requirements of auto-radio design are being developed. All of these are expected to be in production within the next year. And this may simply be the beginning.

With growing technical expertise, it is hoped that the advantages already established will be enhanced even further as new designs come out. One possibility that design engineers are actively evaluating is that of including within the glass envelopes circuit elements that are usually added (resistors, capacitors) externally in the case of tubes. If this is in fact done, it can further enhance miniaturization and cost savings. Inclusion of such elements inside the vacuum may also pay noteworthy dividends in the form of improved reliability.

A possible disadvantage is the replacement cost when a multi-function compactron, instead of a single tube, becomes defective. However, *G-E* engineers feel that other savings may at least cancel this out. Lower initial equipment cost, cost per function, and reliability will be factors.

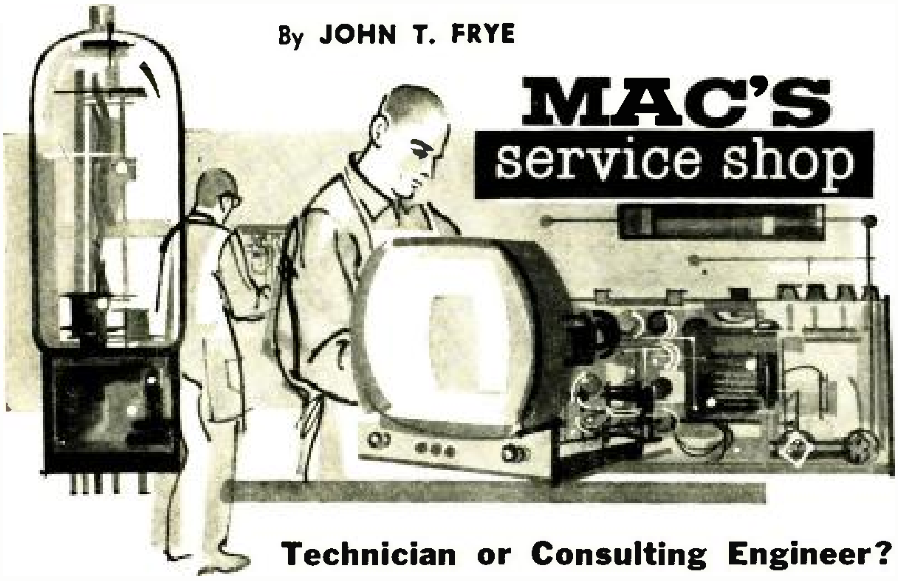
Ultimate success of the line is probably in the hands of equipment manufacturers, whose use of compactrons in less expensive, more efficient designs will be a key factor. —30—

Fig. 3. An engineer experiments with layout of prototype for two-compactron radio. Cabinet is to the right. A working model has since been demonstrated.



By **JOHN T. FRYE**

MAC'S service shop



Technician or Consulting Engineer?

BARNEY, returning to the service shop after his lunch hour, stepped aside just in time to keep from being run over by a vigorous middle-aged man dashing out the front door. Cautiously the young technician opened the door and stepped inside. As he entered the service department, his eyes swept the receiving bench quickly; then he turned to Mac, his employer, already busy at the bench.

"What did those last two jokers want?" he demanded. "I saw two guys come out of here while I was parking the truck. Neither one was carrying anything, and apparently neither one brought anything, either. That last one was a competitor. What was *he* doing? Spying?"

"Not exactly," Mac said with a chuckle; "so you can let your hackles down. I should warn you, though, you may have to start calling me 'mister.' I'm getting up in the world. Those two sought my services as a consulting engineer."

"OK, Mr. McGregor, don't stop there," Barney insisted.

"The first man who came out was Mr. Harkle, an engineer with the spring factory on the north side of town. Right after you left on that last service call before lunch, he telephoned to say he wanted to talk to me about a problem. I agreed, and he came right away with a bunch of blueprints under his arm.

"First he showed me a print of a large metal disc about seven feet in diameter with holes bored through it all around the rim. At the factory springs are loaded in these holes, and the rim of the big disc rotates slowly between two high-speed emery wheels that are properly spaced to grind both ends of each spring simultaneously. The rotating mechanism of the big disc is indexed so that at regular intervals it stops while finished springs are removed from a section or while unfinished springs are loaded into empty holes.

"The problem is that now and then a shaft breaks or a key shears on the shaft that rotates the big disc, and then the latter starts free-wheeling under the friction drive from the emery wheels. You can imagine the damage to the spring loading and unloading mechanism and the real danger to persons nearby which results when that big disc tries to turn as fast as those emery wheels. What was wanted was a device that would shut off the emery wheels the instant the big disc accelerated beyond its normal slow rotation. To be effective, the device had to detect acceleration that took place over a very small portion of a complete revolution."

"That rules out anything based on centrifugal force," Barney observed.

"Right. Mr. Harkle had a hazy notion the problem might be solved somehow by electronics, and I agreed it could. For example, a light could be arranged to shine through the holes in the centers of the springs onto a photocell. This cell could work into an amplifier designed to cut off at low frequencies such as those produced by the slow lighting and darkening of the cell as the disc rotated at normal speed. When the disc started to spin, this 'interruption' frequency would go up, pass through the amplifier, be rectified, and operate a relay to cut power off the grinding wheels. Another possible solution would be to mount little PM magnets around the rim of the disc so they passed close to the soft iron core of a coil. Voltage induced in this coil by the passage of each magnet would depend, among other things, on the speed of the magnet past the coil. Voltage thus produced could be amplified and used to operate a cut-off relay when it exceeded a certain value—such as that resulting when the disc started to rotate more rapidly.

"But I kept thinking of all the things that could go wrong with such arrangements: dirt could cut down the light received by the photocell; the exciting lamp could burn out; amplifier tubes could go bad; the magnets could weaken; the pickup coil could be jarred out of position; and so on. Suddenly I remembered the 'velocity trip' arrangement used on record changers that permits the tone arm to move in toward the spindle the diameter of one groove per revolution without tripping; but when the needle strikes the tripping groove and the tone arm swings in rapidly, the change mechanism is set in motion. In an instant I had what seemed to me a simple and nearly fool-proof solution.

"I suggested a small synchronous motor and cam arrangement be used to press the end of a rubber-tipped rod firmly against the rim of the wheel once every second. The rod would be mounted so its tip could be carried sideways a small amount by the normal motion of the disc during the fraction of a second the two were in contact; but when the rod pulled back each time, it would return to its original position. When the wheel started to spin, however, the end of the rod would be carried sideways much farther during the contact period. This increased lateral motion could easily be arranged to operate a micro-switch that would remove power from the grinding wheels. I pointed out to Mr. Harker that the arrangement would be very quick acting and positive; it used only a few parts; and it could be visually inspected at any time for proper operation. He gathered up his blueprints and took off in a happy frame of mind.

"Just before Mr. Harker left, Tony Klinck dropped in to report a solution I had worked out for one of his problems was a great success. Tony is a good TV service technician, but he got into the repair game since the advent of TV and lacks the broad background of general electronic experience that comes from growing up with the business since the early days of radio. He never hesitates to yell for help when he needs it, however; and a couple of weeks back he came to me with quite an interesting little problem.

"A drive-in eating place over on the west side has installed a whole new intercom system with speakers on posts in the parking area to relay orders to the kitchen. When a button on a parking lot speaker is pushed, this turns on a light above a switch in the kitchen. The order-taker throws this switch down, steps on a foot switch that operates a relay performing the push-to-talk function of the intercom system, and says, 'May I take your order?' Releasing the foot switch transfers the kitchen speaker transformer back to the output of the intercom amplifier and the post speaker transformer to the input of the amplifier so the customer can place his order.

"An added feature is the playing of music through post speakers not being used for talking. A tuner or record player working into a forty-watt amplifier accomplishes this. When all the switches in the kitchen are in the 'up' position, all post speaker transformer primaries are connected in parallel across the output of the music ampli-

(*Continued on page* 132)

Integrated Stereo Preamp-Amplifiers

By **WARREN DeMOTTE** / **By knowing what functions you require and referring to our chart, you can determine which model best fits your needs.**

IN this third year of the stereo disc, a very practical method of achieving high-fidelity stereo reproduction is still through the use of an integrated preamp-amplifier as the heart of the audio system. This versatile instrument has two distinct virtues that endear it to the experienced audiophile and the neophyte alike: it is convenient and it is inexpensive.

These terms must be understood in context and the context is "component high-fidelity." The integrated amplifier is easier to hook into a system than an equivalent preamplifier plus power amplifiers, and it also is inclined to be less expensive.

Cost has taken a curious turn in the high-fidelity field during these past years. While prices in other fields have been rising, prices in hi-fi have generally remained stable, and in some instances have even been reduced. More remarkably, the audiophile also gets more value for his dollar, as technical improvements have been made and passed on to the consumer.

Today, a high-fidelity stereo preamp-amplifier can be bought at prices ranging from $54.95 to $289.50, and these are not too far removed from prices that prevailed a few years ago for equivalent quality monophonic preamp-amplifiers. Considering the greater complexity of the stereo unit, with its doubling of parts and functions, it is evident that the audio industry has accomplished something in the nature of a minor economic miracle.

There are over fifty different integrated stereo amplifiers currently being marketed which can claim to be "high-fidelity." They all do a good job of amplifying the program material fed into them so that it comes out satisfactorily from the loudspeakers. Some of the amplifiers do a better job than others; some do a superlatively fine job. Some operate with more flexibility; some are more suited to specific conditions than others.

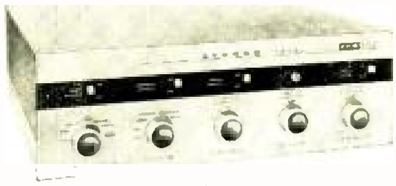
What makes one amplifier more desirable than another may be the subjective matter of sounding better with given associated equipment. The amplifier itself does not produce sound and, ideally, it should not color sound, but it is a reality that in combination with the same transducers (pickups or tape heads and speakers), one amplifier may give more pleasing results than another in an actual listening test. Yet, they both may check out equally well in the usual laboratory tests, and on paper, the second may even disclose superior electronic measurements.

It is axiomatic that a thirty-watt amplifier will drive an inefficient speaker more effectively than a fifteen-watt amplifier, and the difference will probably be readily apparent even to the relatively uneducated ear. But it may take much concentration and require special test material to establish the aural superiority of a forty-watt amplifier over a thirty, especially if both are operated at less than maximum ratings.

Bell Model 2420

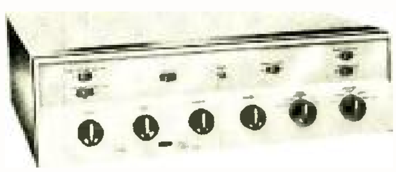
Bogen Model DB 212

DeWald N-1200B "Concerto"



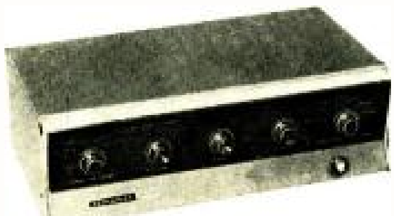
Eico Model ST40

Grommes Model 59PGA



Harman-Kardon A260 "Chorale"

Heath Model AA-100



In selecting a stereo amplifier, the speakers with which it will be used must be taken into consideration. If they are high-efficiency speakers, then any amplifier on the accompanying chart will drive them without difficulty. It is something to remark that the lowest power rating among these amplifiers is higher than the ten watts which were considered entirely adequate only a short while ago.

If you plan to use low-efficiency speakers, it is wiser to buy an amplifier with high wattage. It will not have to strain to drive the speakers and the latter will function under more favorable conditions. The result will be more pleasing sound at all volume levels.

Any amplifier you purchase should have enough input facilities for any program sources you will want to use with it. Generally considered necessary are inputs for magnetic stereo cartridge, stereo tuner, and stereo tape recorder. This last is for tape machines that have their own preamplifiers for play-back, as most do. However, if you plan to incorporate a tape deck in your audio system for playing back pre-recorded tapes, separate preamplifiers are not necessary if your preamp-amplifier has a tape-head input.

A word of caution: hooking tapeheads into an amplifier may set up hum if the leads are not well shielded and kept short, or if the hum level in the amplifier itself is not low. This is a qualitative factor that must be put to the test. If it is your intention to use the amplifier's tape-head input facility, it will be wise to have the salesman demonstrate the ability of the unit to handle tape without objectionable hum before buying it.

With adequate operating space, a record changer in addition to the turntable can be an appreciated convenience. If you want to use magnetic cartridges in both and hook both of them in permanently, the amplifier should have two stereo magnetic inputs. Otherwise, you may use a ceramic or crystal cartridge in the changer and a magnetic with the turntable.

More than one pair of speakers can be used in the system if you want to pipe stereo sound into another room or

(*Continued on page* 54)

Knight	KN-728B	79.95[1]	4¾h x 13¾w x 9¼d	13	14[3]	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	No	No	Yes	No	Yes	Yes
Knight	KN-740B	99.50[1]	4¼h x 15¾w x 12d	32	20[3]	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	No
Knight	KN-775	169.50[1]	4⅝h x 15¾w x 15⅛d	33	37½[3]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Knight	Y-933	59.95[1,2]	4¼h x 14¾w x 11¾d	20	16[5]	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	No	Yes	No	No	Yes	No	No	No
Knight	Y-774	79.50[1,2]	4⅛h x 15½w x 11¼d	21	20[5]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	No	Yes	No	Yes	Yes
Knight	Y-934	119.95[1,2]	4⅛h x 17½w x 13¼d	28	35[5]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Lafayette	LA-250A	99.50[1]	5½h x 14½w x 12¾d	23	25[5]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[6]	Yes	Yes[7]	Yes	Yes	Yes	No	Yes	No	No	No
Lafayette	KT-236A	59.50[1,2]	5⅜h x 14⅝w x 11½d	22	18[4]	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes[6]	No	Yes[7]	Yes	Yes	Yes	No	Yes	No	No	No
Lancer	LA20-20	139.95	4¾h x 13¾w x 12½d	20	20[5]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[6]	Yes	Yes[7]	Yes	Yes	Yes	No	Yes	No	Yes	No
Madison Fielding	360	180.00	5 3/16h x 14½w x 12d	23	20[3]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	No	Yes	Yes	No	Yes	Yes[16]	Yes	Yes
Olson	AM-147	69.95[1]	4½h x 14⅛w x 11⅛d	21	15[5]	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes[22]	Yes	Yes	No	Yes	Yes	No	Yes	No	No	No
Olson	AM-158	69.95[1]	4⅜h x 12¾w x 10⅝d	16	15[5]	No	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	No
Paco	SA40W	129.95[1,21]	5⅝h x 15⅜w x 11¾d	22	20[3]	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	No
Pilot	240	134.50[1]	5⅛h x 14⅝w x 11¾d	21	15[4]	Yes	No[10]	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No	No	No
Pilot	248	249.50[1]	5⅛h x 14⅝w x 12¾d	30	30[3]	Yes	No[10]	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes
Realistic	SAF-24	54.95[1]	4½h x 12w x 7¾d	15	12[5]	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes[6]	No	Yes[7]	No	No	No	No	No	No	No	No
Realistic	40/A	79.50[1]	4⅛h x 12w x 9 11/16d	20	20[5]	Yes	No[10]	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	No	No
Sargent-Rayment	SR2040	199.50[1]	5¾h x 14⅝w x 13⅝d	35	20[5]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Sargent-Rayment	SR-2051	263.70[1]	5¾h x 14⅝w x 13⅝d	45	50[5]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Scott	222B	144.95	5h x 15½w x 12½d	19	15[4]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	No	Yes	No	No	Yes
Scott	299B	209.95	5h x 15¼w x 12½d	25	25[4]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes
Scott	272	269.95	6h x 16w x 14¼d	47	44[4]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes
Shell	20-20P	129.95	4⅝h x 15w x 10½d	22	20[3]	Yes	No[10]	Yes	Yes	Yes	Yes	Yes	Yes	Yes[6]	Yes	Yes[7]	No	No	No	No	Yes	Yes[9]	Yes	No
Shell	30-30	159.95	5⅜h x 16⅜w x 10½d	26	30[3]	Yes	No[10]	Yes	Yes	Yes	Yes	Yes	Yes	Yes[6]	Yes	Yes[7]	No	No	No	No	Yes	Yes[9]	Yes	No
Sherwood	S-5000	189.50	4h x 14w x 13½d	26	20[3]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes
Stromberg-Carlson	ASR-2.20C	119.95	4⅝h x 13½w x 8½d	19	12[3]	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes[22]	Yes	Yes[7]	No	Yes	No	No	Yes	No	Yes	Yes
Stromberg-Carlson	ASR-6.60	159.95	4⅝h x 13½w x 13⅜d	23	18[3]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	No	Yes	No	No	Yes	No	Yes	Yes
Stromberg-Carlson	ASR-8.80	199.95	4⅝h x 13½w x 13⅜d	33	32[3]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	No	Yes	Yes	No	Yes	Yes[18]	Yes	Yes
Transistronics	TEC S-25[17]	289.50[1]	4⅜h x 14⅜w x 14d	32	34[4]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	No
Webster Electric	GL20-20	239.00[1]	5¾h x 13¼w x 13¼d	33	20[5]	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes[7]	No	No	No	No	Yes	No	No	No

Based on data and specifications supplied by the manufacturer.

NOTES: 1. Including enclosure. 2. Kit only. 3. Continuous-power rating. 4. Music-power rating. 5. Rating method unspecified. 6. Concentric individual-channel volume controls. 7. Individual-channel volume controls. 8. Contoured—actually loudness controls. 9. Induced 60-cycle hum plus cathode-ray tube. 10. Use auxiliary input. 11. Kit available $79.95. 12. Kit available $94.95. 13. Kit available $69.95. 14. Kit available $64.95. 15. Kit available KT-250A $74.50. 16. Null. 17. All transistor—no tubes. 18. Induced pulse. 19. Kit available SA-2 $54.95. 20. Kit available AA-50 $84.95. 21. Kit available SA-40 $79.95. 22. Completely contoured (loudness control).

Integrated Stereo Preamp-Amplifier Check List

Name	Model	Price (without case)	Size (inches)	Weight (pounds net)	Power Output Per Channel	Third Channel Output	Ceramic-Crystal Cartridge Input	Magnetic Cartridge Inputs	Stereo Tape Head Inputs	Stereo Auxiliary Inputs	Stereo Tuner Inputs	Individual Channel Tone Controls	Individual Channel Volume Controls	Master Volume Control	Loudness Control	Stereo Balance Control	Blend Control	Channel Reversing	Speaker Phasing	Extra Speakers Switch	Tape Recorder Output	Channel Balance Indicator	Rumble Filter	Scratch Filter
Altec Lansing	353A	$225.00[1]	5⅞h x 15w x 11¼d	35	25[3]	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	No	No	Yes	No	Yes	No
Arkay	CS-28	99.95[1-14]	5h x 16w x 9d	29	14[5]	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	No	No	Yes	No	Yes	No
Bell	2418	109.95	5 7/16h x 14¼w x 10⅝d	17	15[4]	No	No[10]	Yes	No	Yes	Yes	No	No	Yes	No	Yes	No	No	No	No	Yes	No	No	No
Bell	2420	129.95	5 7/16h x 17 3/16w x 10⅝d	20	17[4]	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	No	Yes	No	Yes	Yes
Bell	2440	179.95	5 7/16h x 17 3/16w x 10⅝d	26	22[4]	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	No	Yes	No	Yes	Yes
Bogen	DB-212	119.95	4¾h x 15w x 11⅝d	18	12[5]	No	Yes	Yes	No	Yes	Yes	No	No	Yes	No	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes
Bogen	AP-40	199.50	6h x 16w x 13½d	30	20[5]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[6]	Yes	Yes[7]	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Channel Master	6600	119.95	5h x 14⅜w x 11¼d	16	16[5]	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	No
De Wald	N-1200-B	99.95[1]	4½h x 14⅜w x 9d	19	15[5]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[8]	Yes	Yes	Yes[7]	No	Yes	Yes	No	Yes	No	Yes	No
EMI	555	267.50	4h x 14w x 13¾d	25	20[5]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	No	Yes	Yes	No	Yes	Yes[9]	Yes	Yes
Elco	HF-81	109.95[1-13]	4¾h x 15w x 10½d	24	14[3]	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	No	No	Yes	No	No	No
Elco	ST-40	124.95[1-11]	5h x 15⅞w x 14d	27	20[3]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[6]	Yes	Yes[7]	No	Yes	No	No	Yes	No	Yes	Yes
Elco	ST-70	144.95[1-12]	5h x 15⅞w x 16d	35	35[3]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[6]	Yes	Yes[7]	No	Yes	Yes	No	Yes	No	Yes	Yes
Eric	2160	103.75	4⅛h x 12¼w x 10½d	14	20[5]	No	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	No	No	No	No	No	No
Fisher	X-100	159.50	4 13/16h x 15⅛w x 11⅞d	21½	18[4]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	No	Yes	No	Yes	Yes
Fisher	X-202	229.50	4 13/16h x 15⅛w x 12½d	32	25[4]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
General Electric	G-7600	139.95[1]	5⅛h x 15w x 12d	27	20[4]	No	No[10]	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	No	Yes	No	Yes	No
General Electric	G-7700	189.95[1]	5⅛h x 15w x 12d	28	28[4]	No	No[10]	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes
Grommes	24LJ	99.95	4½h x 14w x 9d	20	12[4]	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	No	No	Yes	No	No	No
Grommes	36PG	169.95	4½h x 14w x 11d	22	20[4]	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	No	No	Yes	No	Yes	Yes
Grommes	50PGA	189.95	4½h x 14w x 11d	26	25[4]	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	No	No	Yes	No	Yes	Yes
Harman-Kardon	A230	109.95	4⅝h x 13 13/16w x 11½d	15	15[5]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No
Harman-Kardon	A260	199.95	4⅞h x 15¼w x 13⅞d	32	30[5]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Heath	WSA-2	99.95[1-19]	4½h x 15w x 8d	20	14[4]	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes[6]	No	Yes[7]	No	Yes	Yes	No	No	No	No	No
Heath	WAA-100	144.95[1-20]	5½h x 15¾w x 13½d	27	30[4]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	No	No

Lafayette Model 250

Madison Fielding Series 360

Olson Model AM-147

Webster Electric Model GL20-20

two. This can be done by wiring auxiliary speakers in parallel with the main speakers and adding a switch or two for selecting which speakers should operate. However, this extra wiring is obviated in the amplifier which makes provision for additional pairs of speakers.

The problem of the "hole in the middle," which plagued early stereophiles, has been pretty well eliminated at its source by improved techniques in recording. Where the condition exists due to speaker placement or listening room acoustics, two remedies are available. One is the employment of a third speaker, and several amplifiers have built-in center-channel facilities. The center channel is essentially a blend of the signals from both regular channels which is fed through the third speaker.

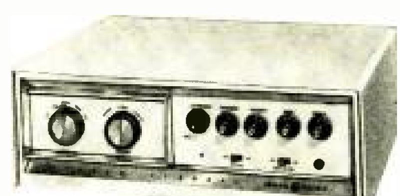
Other amplifiers have a blend or separation control which takes some of the signal from each of the two channels and adds it to the other. This has the effect of narrowing the spread of the stereo sound and, carried out fully, transforms it into monophonic sound.

Not every stereophile has identical speakers for both channels, and even with identical speakers, their placement may cause one to sound entirely different from its fellow. Also, one of the dual amplifiers in the unit may have slightly different characteristics than its mate. These possibilities make individual-channel tone controls desirable. To avoid clumsiness in operation, the tone control knobs are usually paired concentrically and employ a friction or clutch design. This gangs both treble knobs or both bass knobs at will. Thus, the treble and bass of each channel can be adjusted individually for most pleasing sound, and then further adjustments can be made of both channels simultaneously so that they remain in the original optimum relationship to each other.

The volume of sound that emanates from the two speakers must be kept in proper balance for proper fidelity. If the amplifier has individual-channel volume controls, this can be accomplished by increasing or decreasing the volume of one channel to match the other. If the two controls are on one shaft, they can also be turned together to raise or lower the volume of both channels simultaneously. Thus, they remain in proper aural relationship, and a friction or clutch design is convenient here.

An essentially simpler operating design is more commonly utilized. This consists of a permanently ganged volume control with a separate balance control. Once the latter is set, the former can usually be operated without fear of disturbing the balance.

As bass and treble have a tendency to vanish beyond the range of hearing when playing volume is lowered, provision is usually made to boost them when necessary without disturbing the normal tone settings. This is the function of the "loudness" control. When it is switched into the circuit, it adds bass and sometimes treble in accordance with certain formulas, thus re-establishing the proper balance of sound. However, leaving the loudness control on while playing at normal and high volume levels can make a high-fidelity system sound like a veritable juke box.

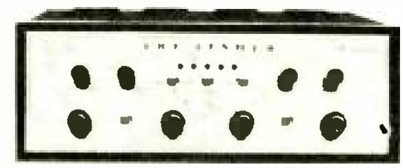


General Electric 7700 "Stereo Classic"

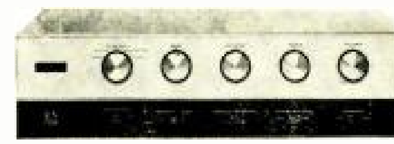
Paco Model SA-40

Pilot Model 248

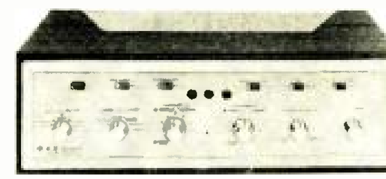
When instruments exhibit a tendency to wander between the speakers and the bass sounds thin and fluttery, a disparity in phasing of the speakers is indicated. This means that one speaker is pushing air while the other is pulling it. The effect is one of cancellation instead of support and this can be unpleasant, in addition to being unnatural. To correct this and put the speakers in phase with each other, the terminals of one speaker must be reversed. This is, of course, easily done, but some amplifiers simplify the task with a phase-reversing switch. A flip or two of this switch quickly establishes the proper phasing of the speakers.



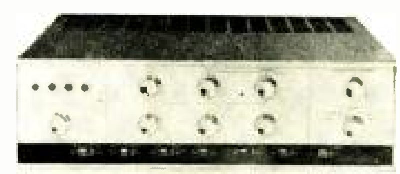
Fisher Model X-202



Knight Model 740B



Scott 299B "Stereomaster"

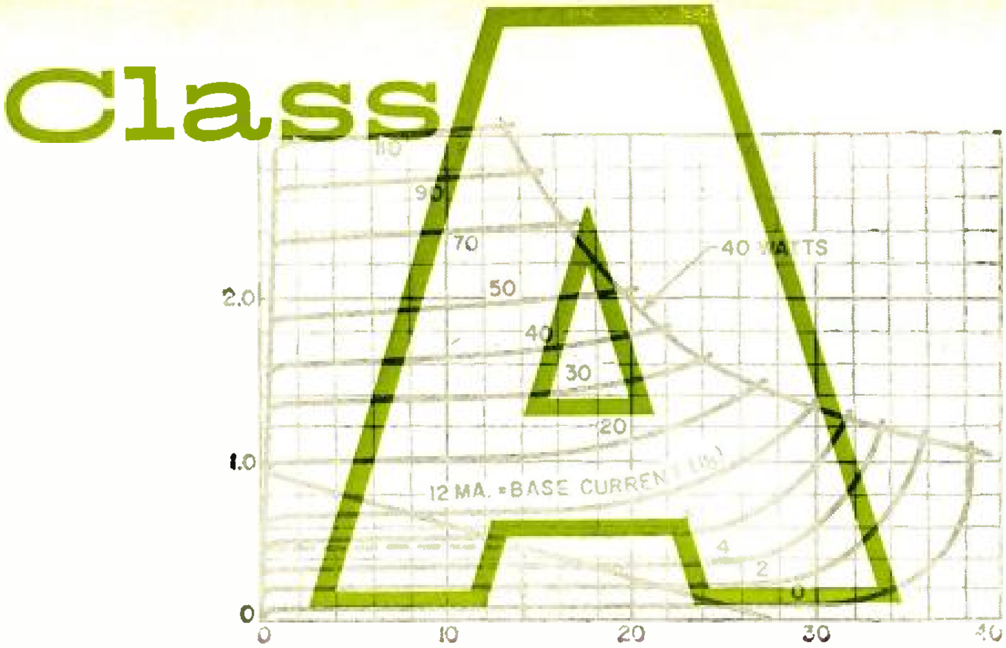


Stromberg-Carlson Model ASR-8-80

Transis-tronics Model S-25

Once channels are correctly determined with a stereo test record or a stereo record "with the violins on the left," they may be safely forgotten, until a record or a tape shows up "with the violins on the right." Then the "channel reverse" or "stereo reverse" or just plain "reverse" position of the mode switch must be turned to. This rarely happens, but switching from the normal stereo position to the reverse and back can aid in balancing the volume of the speakers. Utilize a mono

(*Continued on page 124*)



Class A Transistor Power-Output Circuits

By WALTER H. BUCHSBAUM / Industrial Consultant, ELECTRONICS WORLD

Some simple, as well as useful, basic circuit-design information that will help to understand class A transistor output circuits.

AMONG the many possible transistor power-amplifier circuits two basic types are certain to be included in any list of preferred or standard circuits. One is the class A single-stage output amplifier and the second is the class B push-pull circuit. These two circuits can be used with practically any power transistor on the market and can be designed for almost any amount of output power, linearity, frequency response, etc.

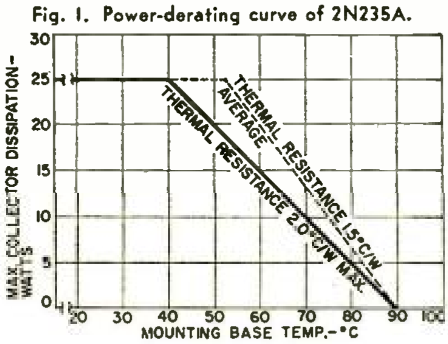
This article will consider the operation of class A transistor power amplifiers and will present sufficient engineering detail to permit the reader to design an amplifier, tailor-made to his own special requirements. Commercially available amplifiers are designed by the same process and an understanding of the technique will be of help in repairing such equipment.

Transistor Characteristics

Just as tube characteristics are important in the design or troubleshooting of vacuum-tube circuits, transistor characteristics must similarly be understood first. We assume that our readers are somewhat familiar with vacuum-tube characteristic curves and therefore we proceed to compare them to transistor characteristics.

The first factor which must be considered in selecting a transistor as a power amplifier is its power handling ability. Vacuum tubes are rated according to maximum plate dissipation, without any reference to operating temperatures. Transistors, however, are rated according to maximum collector dissipation at a certain temperature, usually 25°C, which corresponds to approximately 75°F or room temperature. If the maximum power is dissipated in the transistor, the temperature of the transistor itself will rise and this will limit its power handling ability. A transistor capable of handling 10 watts at 25°C sometimes can handle only 3 watts at 50°C. This brings us to the first important transistor characteristic which is different from its vacuum-tube counterpart. This is the power derating curve, a typical example of which is shown in Fig. 1. On the vertical axis we read the maximum collector dissipation in watts and on the horizontal axis the mounting base temperature is plotted. Fig. 1 applies to the type 2N235A which is a 25-watt transistor, similar to the 2N301 and a number of others. Note that up to 40°C of mounting base temperature the maximum collector dissipation of 25 watts is permissible, but as the mounting temperature goes up less power can be handled by the collector. At 90°C, with zero collector dissipation, the mounting temperature and the transistor junction temperature are the same. The solid line of Fig. 1 is based on the worst conditions, while the dotted line is representative of average transistor variations. To be on the safe side the designer should stay within the left portion of the solid line. More detail on temperature control is given in a later paragraph.

Fig. 1. Power-derating curve of 2N235A.



The other important transistor characteristics can be compared to their vacuum-tube equivalents. First comes the output characteristic which shows collector current *versus* collector voltage and, as apparent from the example of Fig. 2, this is equivalent to the plate characteristics of tubes. Instead of grid voltage, base current is used here as parameter but, the load line and other design features are obtained just as for vacuum-tube amplifiers. The constant dissipation contour shown in Fig. 2, is similar to maximum plate-dissipation curves supplied for power-output tubes.

Transistor input characteristics are comparable to the grid curves supplied for vacuum tubes, except that the base-current *versus* base-voltage curves are not usually as linear as grid curves. A third type of characteristic, which is usually supplied with transistor data, is the transfer characteristic which shows collector-current output *versus* base-current input at a fixed collector voltage. This curve is very useful in determining linearity and bias.

Having convinced ourselves that transistor characteristic curves are no more complex than those which we have used for vacuum-tube circuits, we can now examine the operation of a class A transistor output amplifier.

Operating Features

Class A operation means that the output waveform will be a facsimile of the input signal and this means that the transistor will conduct during the entire cycle. To obtain proper linearity, the collector voltage and current

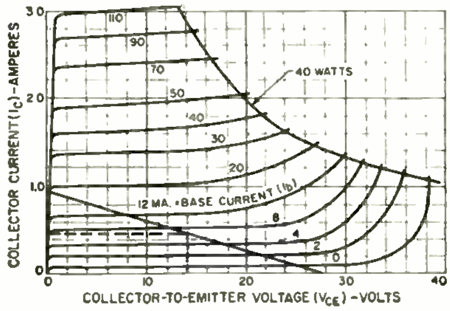


Fig. 2. Collector characteristics of 2N176.

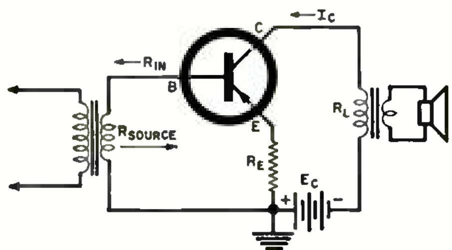


Fig. 3. Grounded-emitter output amplifier.

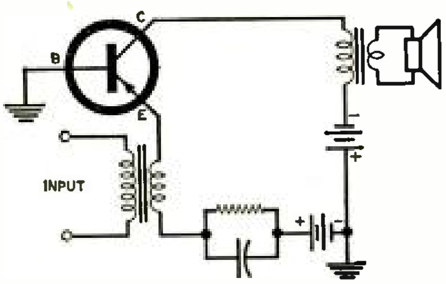


Fig. 4. A grounded base output amplifier.

must vary over a linear portion of the output characteristics. In transistor amplifier design it is possible to ground the base, the collector, or the emitter, with each connection having certain advantages and drawbacks. For audio power amplifiers the most frequently used connection is the one shown in Fig. 3 in which the emitter is effectively grounded. This provides the greatest amount of power gain while still giving reasonable linearity. Fig. 4 shows the connection for grounded-base amplifier, a circuit which gives excellent linearity but less power gain than the grounded-emitter scheme. The third connection has the collector grounded for a.c. and is called an emitter-follower. Like the cathode-follower this third circuit has high input and low output impedance, but is not really an amplifier. It is not usually used as class A single-stage and will therefore not be considered here.

One of the features of any class A power stage, tube or transistor, is the fact that considerable power is dissipated during zero-signal conditions. In a transistor this means that the quiescent point must be chosen well below the maximum collector dissipation and therefore the full power handling ability of the transistor cannot be used. The battery or power supply must deliver considerable power during zero-signal conditions. For these reasons class A amplifiers are not usually used for large power output stages, but are limited to applications below 5 watts. When two transistors are used in class A push-pull, the standby power requirement remains, but each transistor can be driven harder and all even-harmonic distortions are cancelled out. Considerable second- and third-harmonic distortion can be encountered in single-stage class A amplifiers, but careful design and certain precautions can keep distortion below 5%.

Class A Amplifier Design

Some texts treat transistor circuit design in great detail and involve the use of accurate mathematical expressions. In this article, however, only simple arithmetic is required to design certain basic amplifier circuits from manufacturers' data. Approximations, simplifications, and certain basic assumptions are made about the transformers and other parts, which are available from jobbers' shelves. The design procedures may not be accurate enough for servo amplifiers used in missile guidance systems, but they will do for practical audio amplifiers, that our technically minded readers can design, build, and work with.

A practical approach to the design of a typical class A power amplifier must start with the known requirements. How much audio power should be produced? What battery or power-supply voltage is available? In this example the desired output power might be 2 watts. Assuming that the output transformer efficiency is 75% we can see at once that the amplifier itself must deliver 2.67 watts in order to drive the speaker with 2 watts. Next we must provide for some overload capacity, say 25%, and this increases the power output capability of the transistor stage to 3.35 watts. Adding at least 3.35 watts for d.c. dissipation we can see that the collector dissipation must be at least 6.7 watts. If we choose a nominal battery voltage of 14 volts, the collector current can be calculated from Ohm's Law as:

$$I_c = \frac{6.7\ watts}{14\ volts} = 0.48\ amp.$$

Similarly, the load resistance is:

$$R_L = \frac{14\ volts}{0.48\ amp.} = 29\ ohms\ (approx.)$$

Now we can select a transistor by knowing that it must have a collector dissipation of over 6.7 watts and be able to stand a peak-inverse voltage swing of at least 2 times 14 or 28 volts. One such transistor is the 2N176, available from most jobbers and manufactured by *RCA*, *Sylvania*, *Motorola*, among others. The 2N176 collector can dissipate 10 watts and has a peak-inverse voltage rating of 40 volts, a safe margin for our requirements. The manufacturer's data for the type 2N176 transistor includes the collector characteristics which are shown in Fig. 2. We locate the intersection of 14 volts and 0.48 amp., which is then the quiescent point, just as in vacuum-tube circuits. The load line is drawn by connecting the quiescent point with the 28-volt point on the base line or the 0.96-amp. point on the vertical axis.

A look at the load-line drawing of Fig. 2 will indicate some of the reasons for non-linearity in the output signals. The quiescent point is here set for a base current of approximately 6 ma. A swing from 0 to 12 ma. would result in an output voltage swing from 25 to 8 volts, and this would produce a sine wave in which one portion is compressed as compared with the other. The base current is, of course, determined by the base voltage and by the signal source impedance. By making the source impedance much smaller than the base input impedance and by providing some bias on the base itself this non-linearity can be compensated for to some extent.

We see from Fig. 2 that the maximum base current will be approximately 20 ma. Next we refer to the input characteristic curve of Fig. 5 which shows that approximately 0.5 volt of base signal would be required to produce 20 ma. of base current. Multiplying these two figures we obtain the required maximum input power which is 10 mw. The input impedance can be approximated, using Ohm's Law:

$$\frac{0.5\ volt}{0.020\ amp.} = 25\ ohms$$

To reduce distortion we can choose a source impedance of 10 ohms.

The power gain of the stage can be calculated from the ratio of output power to input power, which, in this example, is 267. This corresponds to a power gain of approximately 24 db.

To get an approximate idea of the value of the emitter resistor, we must

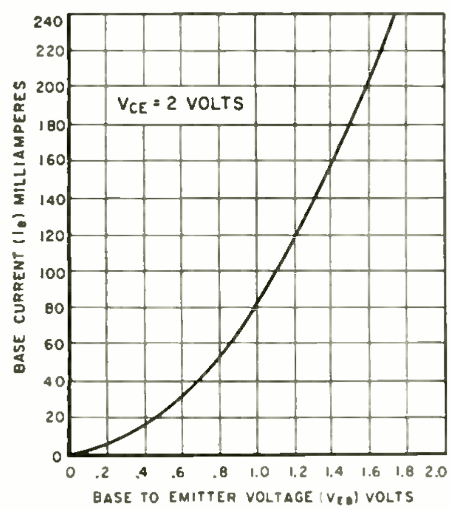
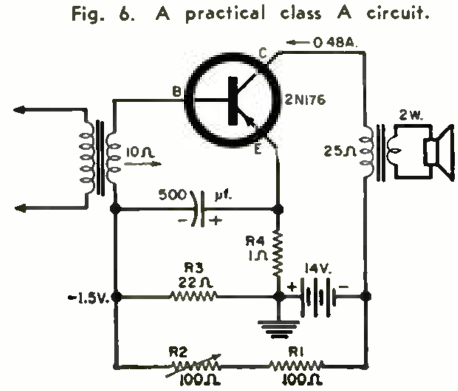


Fig. 5. Input characteristics of 2N176.

Fig. 6. A practical class A circuit.



determine the base voltage at the quiescent point which is approximately 0.25 volt. Using Ohm's Law again we know that the quiescent collector current of 0.48 amp. must pass through this emitter resistor and we then obtain a value for it as follows:

$$\frac{0.25\ volt}{0.48\ amp.} = \tfrac{1}{2}\ ohm$$

It is a safe assumption that a 1-ohm resistor in the emitter circuit will be approximately correct.

If we want to determine the circuit efficiency of our class A amplifier we divide the audio output power, 2.67 watts, by the total input power, 6.7 watts, and multiply the results by 100 to obtain approximately 40%.

We have now established all of the values for the circuit of Fig. 3 and from this we can go to the practical circuit which is shown in Fig. 6. Note that in this circuit we have added a forward bias of approximately 1.5 volts which is applied to the base through the voltage divider R_1, R_2 and R_3. Some circuits use a separate battery, usually located in the emitter lead, but for simplicity's sake a voltage divider has been used in Fig. 6. The adjustable resistor is set for best output linearity. A 500-μf. bypass capacitor is used between the emitter and the input transformer winding to keep a.c. out of the bias circuit. The 1-ohm emitter resistor limits the emitter current and therefore the base bias can effectively shift the quiescent point on the load line to obtain more linear output without causing excessive collector current to flow. It is possible to obtain 2 watts of audio power with a maximum of 3% distortion over a frequency range from 60 cps to 10 kc. with this circuit. Some of the loss at the higher frequencies is compensated by the increased efficiency of both transformers.

The circuit shown in Fig. 6 and the design procedure described above is applicable to other transistor types as well. In many instances manufacturing data includes some of the values calculated here and occasionally a complete circuit diagram for a class A audio amplifier is provided as part of the data sheets.

Controlling Temperature

As pointed out earlier, one of the limitations of any transistor is its sensitivity to changes in temperature. When the transistor gets warmer, more collector current can flow, which, in turn, tends to make it warmer still. This is often called "thermal runaway" and is the prime transistor killer in experimental work. Sometimes a circuit works perfectly until a hot day comes along and then things seem to go haywire.

There are several safeguards against thermal runaway and one of them has already been included in the design just discussed. This safeguard is the emitter resistor which at least limits the collector current and provides a back bias as the collector current increases. Another safeguard is the original circuit design which centers around a power range well below the maximum for that particular transistor. In Fig. 2 we can see that the load line chosen is well removed from the 40-watt maximum dissipation curve. Actually the collector temperature at the maximum design power level of 6.7 watts could go up beyond the room temperature of 25°C, but to play it safe we have designed for that temperature. If we were to operate this circuit at, say, 60°C, then we would have to provide some temperature compensation such as a thermistor, connected across the 22-ohm leg of the base-biasing circuit. As temperature increases, resistance of the thermistor drops and this also reduces the forward bias and therefore tends to limit collector current.

Aside from the problems introduced by thermal runaway and possible higher ambient temperatures, collector dissipation must be considered. All power transistors have the collector connected directly to the outside body and depend on dissipating collector power through the body. For this reason it is usually necessary to mount a power transistor on some kind of heat sink. In our previous example, over 3 watts of d.c. power is dissipated in the collector. If no heat sink is provided this power will quickly heat up the transistor body, raise the internal temperature, and thereby increase the collector current. Even with a suitable emitter resistor, the thermal runaway effect could take over. It is absolutely necessary that the collector power be dissipated into the surrounding air and, in most instances, the transistor case itself cannot radiate heat fast enough.

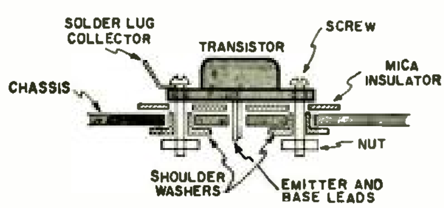


Fig. 7. Chassis mounting of transistor.

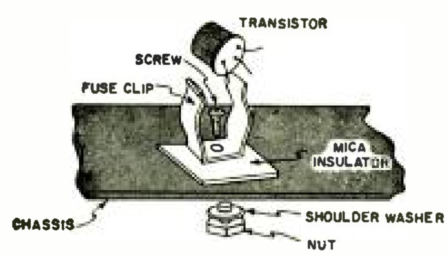


Fig. 8. The fuse-clip heat sink.

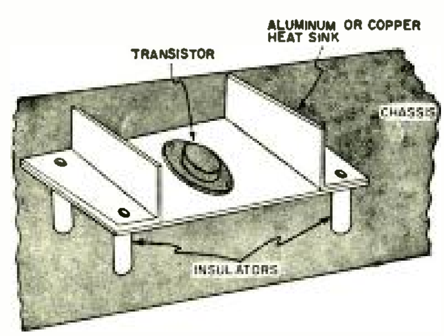


Fig. 9. Elaborate insulated heat sink.

There are many different ways of helping the transistor dissipate heat. Some power transistors are available with tight fitting copper radiating bodies and fins. Others can be mounted on specially designed heat sinks. Almost all power transistors are sold with a mica or alumina oxide mounting washer which permits mounting the transistor on the chassis for heat dissipation while obtaining electrical insulation. A typical arrangement is shown in Fig. 7. Ordinary insulators cannot be used since they do a poor job of transmitting heat.

In locating power transistors on a chassis we must make certain that the heat they contribute does not injure other transistors and that the chassis is reasonably cool to begin with. In addition to radiating the heat on the chassis itself, some home-made auxiliary heat sinks can be used. A simple fuse clip or capacitor mounting clip can be used, especially on smaller power transistors, as shown in Fig. 8. The clip should make contact with the transistor body in as many places as possible to allow heat transfer to the clip. While the illustration shows the clip mounted against the chassis through a mica washer arrangement, in low-power applications the clip can be insulated by regular Bakelite or cardboard and then only the clip radiates the heat.

For larger power transistors the arrangement of Fig. 9 is quite useful. A rectangular sheet of aluminum, copper, or brass is used and, to add radiating surface, two angle pieces are bolted on each end. The entire structure can be mounted on Bakelite or ceramic standoffs which provide electrical insulation from the chassis. To further increase heat radiation, any of the heat sinks can be painted black, but care must be taken that the heat transfer points between the transistor and the heat sink are not covered with paint.

One frequent mistake made by people unfamiliar with transistors is that they forget to make an electrical connection to the body of the transistor which is the collector. Never solder to the transistor body since this is equivalent

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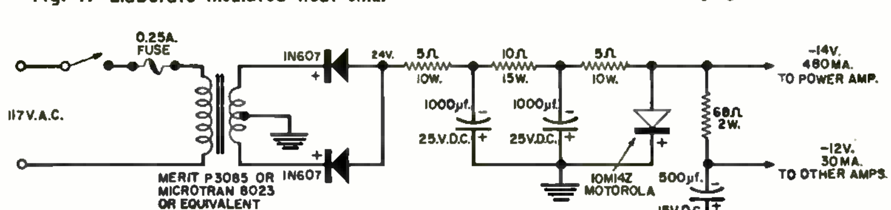

Fig. 10. Typical power-supply circuit.

By **ERNEST W. FAIR**

Keeping Step in Business

Technical ability alone is not enough to make up for everything else the competition may offer.

THAT wonderful day when a man could set up an electronics service business and keep it alive solely because he happened to be highly skilled has passed. In today's ever-changing business environment, technical capability alone is not enough.

Staying in business depends on many things. Many important ones come under the broad heading of keeping step with the changes going on around us—in the electronics business, in particular, and also in the general business atmosphere. There are many respects in which one must keep pace, and many ways of accomplishing this objective.

We can keep pace on the local level, and we must. To do this we must, first of all, look at our competitors. Are they offering any features or services that we do not provide? Does a competitor or his technician drive up to the set owner's house in a well-kept truck that advertises his business favorably and wear a neat uniform that also creates a good impression? Do we? The impressions made by such techniques are not always easily counteracted by the top-quality work we may offer. How does your promotion stack up against what competitors are doing?

We must also keep in step nationally. Even if the local competition, as a group, is so uninspired as to lag behind what is being done successfully in other areas, this is no reason for coasting. Take such an opportunity to pull ahead of the competition. If you don't, there is an element of risk: wherever local operators in one type of business in a given area tend to be similarly lax, some alert individual eventually spots the ripe situation. He can enter the field on an "impact" basis, providing what existing competition does not offer. At best, you have one more rival to buck. At worst, he can turn the whole situation upside down. On the other hand, where the local situation is considered "live," a shrewd outsider is likely to pass up such a locality for one that may be easier to crack.

Do you "skip read" the trade journals and other publications that cover electronics? Sometimes a small item tucked away in the corner of a page may give you an idea that you can exploit. If you read half-heartedly, out of a sense of obligation to get it over with, you will overlook much useful information altogether and miss the possible significance even of what you do look at.

Printed matter is your best way of keeping up with things that concern you which are not happening in your immediate locality. Surveys consistently show a high correlation between successful shops and those whose owners thoroughly read and study their technical and business periodicals.

Periodicals are not the only printed matter to keep up with. Get on the mailing list of every manufacturer who will list you, whether it be for service data, new products, or new information on old products—and give honest attention to every mailing piece you get. Many of us consider such material "junk mail" and automatically relegate a great part of it to the "round file." True, some of it may merit no better treatment than this, but make sure you screen it carefully first. Manufacturers invest impressive sums of money in preparing such literature, and they consider it important. If you pass it up too hastily, you may be sacrificing good business and promotion ideas along with worthwhile technical data.

Be active in local business groups. If there is a local service association with whose program you are in agreement, be active in it. Give it the strength it needs to solve those problems of the electronic service business that none of us can handle alone. If it isn't "your kind" of association, it may pay to get in and fight to make it your kind. From another viewpoint, this type of activity will give you a chance to meet others in the business and to exchange views and ideas to mutual advantage.

Take a good look at neighboring cities and communities. You may be surprised at what you can learn from other service shops in nearby areas, not your own, on only a two-day field trip. Although operators in these adjacent areas may not be direct competitors, anything they offer that is not available in your locality will eventually be picked up by someone to obtain an advantage. It might as well be you, first.

Listen to your customers. Since they do not know a great deal of what is involved in your business, or what is and is not possible to do, many customers may have suggestions or make demands that are impractical or even ridiculous. Nevertheless, it costs nothing to listen. The average customer gets around much more than any shop owner, who is generally restricted to his own business. In fact, whether you like to acknowledge the fact or not, your customers have probably seen much more of your competitors' shops than you have.

Above all, it is the customer and his expectations that you must satisfy to stay in business. He is the best source for his own viewpoint. Find out what he thinks other people are offering him that he would like to get from you. Find out what he wants that no one gives him.

Keep your eye on other lines of business, not just on radio-TV service dealers. The patterns that customers prefer in answering calls, establishing charges, or billing may show up in

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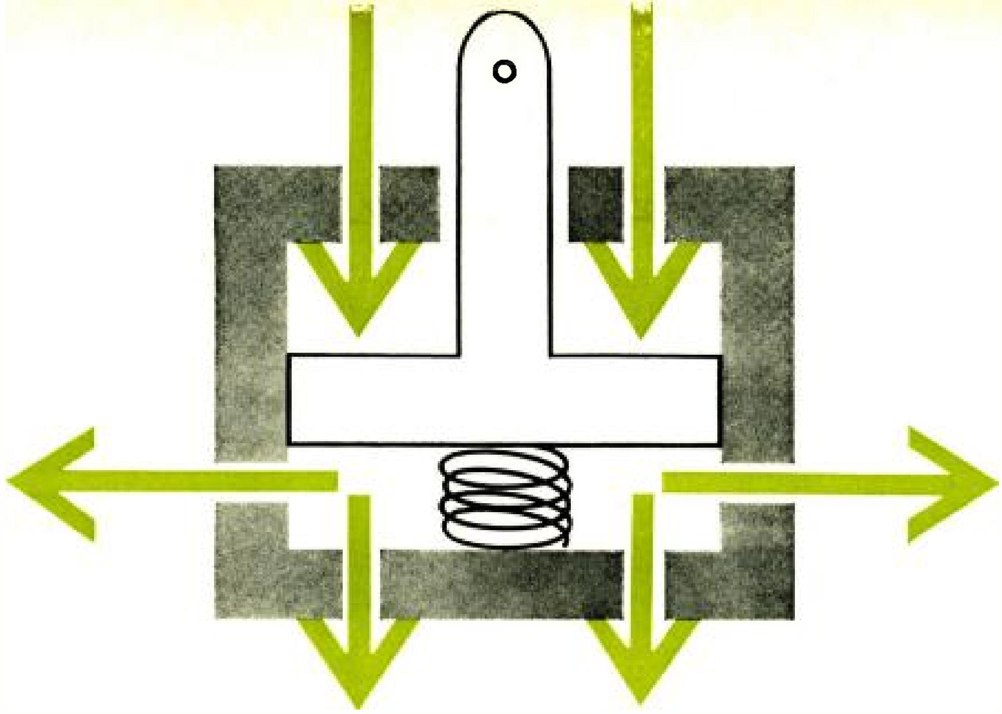


Technicians' Guide to Pneumatic Controls

By ROBERT GARY

Compressed air in valves and cylinders does work automatically at bidding of electrical controls.

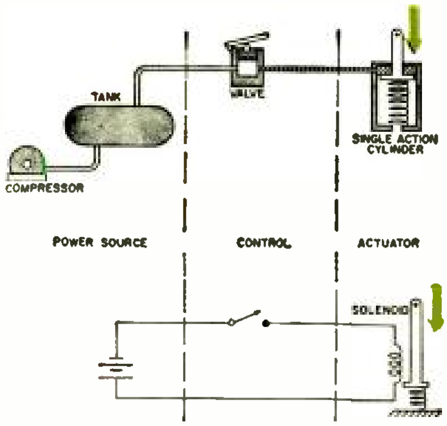


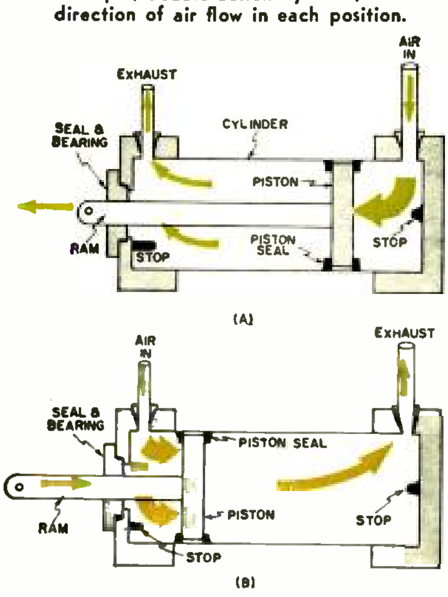
Fig. 1. The operation of a single-action, pneumatic cylinder (above) may be compared to that of solenoid below.

MANY discussions of automation tend to concentrate on the control mechanism and skip over the actuating device. Yet this part provides the muscle of the system: it carries out the decision of the automatic control and actually moves something. In a photoelectric conveyer-belt inspection system, the actuator pushes the rejected units to the side, just as in a simple, automatic door opener there must be some "muscle" to actually push the door open and hold it there. This power device, a vital part of the complete system, must be considered in any industrial servicing work.

As a rule the electronic technician will not be expected to service the mechanical, actuating portion of the system but, in order to troubleshoot the electronic portion accurately, he must know at least some of the fundamentals of such devices. This knowledge need not be too detailed, but he should be able to read diagrams and get a general grasp of the entire operation.

The three most frequently used "muscle" systems involve hydraulic, electric, and pneumatic power. Pneumatic systems, used very widely in connection with electronic controls, are especially adaptable to rapidly operating machines which do not require very great power. The reader will be familiar with the pneumatic hammer and riveter used in construction work and, if he has ever worked in a factory, with the air-powered drill and screwdriver. Compressed air is also used to blow chips or scraps out of the way and for spraying paint. All of these pneumatic tools are powered by compressed air stored in a tank and released by valves as needed.

Fig. 2. The two possible positions of a simple, double-action cylinder, with direction of air flow in each position.



One of the features of all of these tools is that the air is piped to the device in a single hose and, when it has done its work, is released into the surrounding atmosphere. There is no need for a return line to the compressor: air, of course, is free; one merely has to pay for compressing it. This is one of the great advantages which compressed air has over hydraulic systems. It has certain disadvantages too, but these are not important in many applications.

Pneumatic "Circuitry"

A familiarity with fundamental electric circuits can be used as a starting point in understanding pneumatic circuits, since analogies are possible. A simplified pneumatic system and its electrical counterparts are shown in Fig. 1. The compressor and tank are the "power source" that can be compared with the battery or power supply, while the similarity between the valve and the switch is obvious.

As actuator we show a cylinder to be roughly equivalent to a solenoid: in each case a piston or ram is pushed upward by a spring, unless power is applied to pull it down. The piston in the single-action cylinder is forced down when compressed air enters the chamber; and the armature is attracted to the solenoid when current sets up a magnetic field. Actually, each system shown is incomplete because, both in the pneumatic and in the electric system, there is no way for the energy stored in the coil or cylinder to

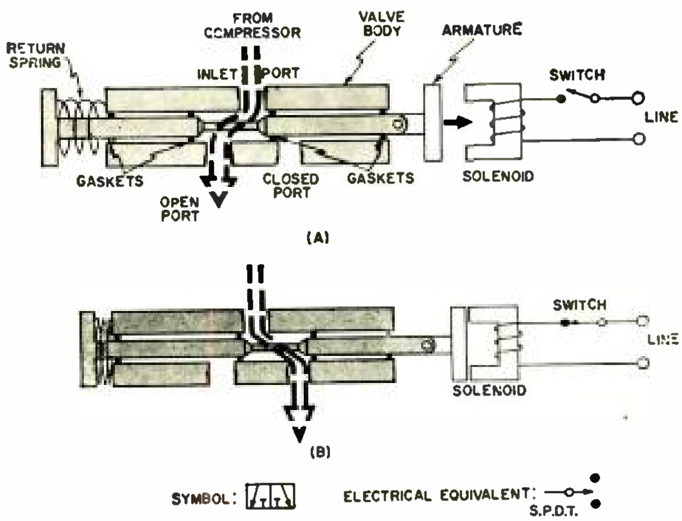


Fig. 3. The two positions of a 3-way, solenoid-operated valve. It is represented by the functional symbol below.

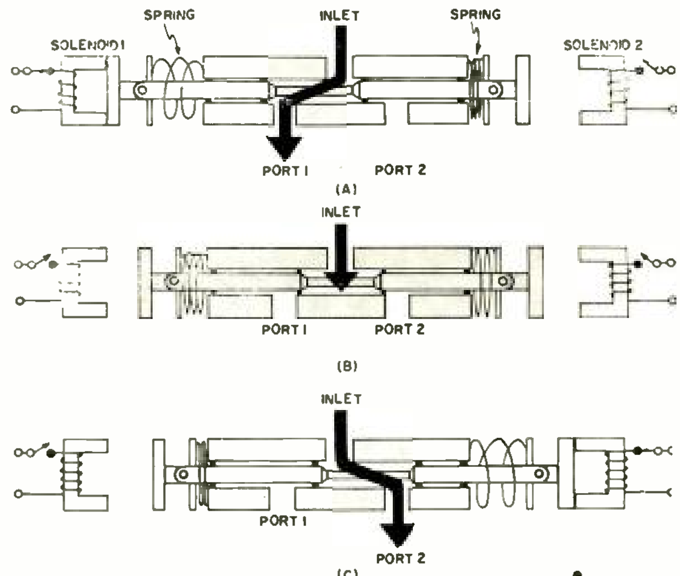


Fig. 4. The positions, including directions of air flow, for a 3-way, center-closed, 2-solenoid pneumatic valve.

dissipate when the switch is opened. However, experience teaches us that there will be an arc when the solenoid switch is opened; similarly, the valve or the cylinder will have an exhaust port to allow the spring to do its work.

To carry the analogy further, we learn that, in pneumatics, many other features of electrical systems also prevail. Comparable to meters and voltage regulators, there are special instruments—pressure gauges—which measure pressure and automatically regulate it at a fixed amount. Most pressure gauges are built into the air lines, usually near regulating valves or near the air tank. A typical air-pressure gauge may have a range from 0 to 20 or up to 120 psi in 5-lb. steps. Practically all ratings are given in psi (pounds-per-square-inch); and this means that such factors as the diameters or areas of the line, valve ports, and actuating surfaces must be known to determine the force at any given point.

A cylinder having a piston surface of 3 square inches can exert a force of 300 lbs. if a 100-psi power source is used. If the air-line diameter is small, it will take longer to push the piston out than if a lot of air can enter quickly. In a sense, we can compare the line diameter and the volume of air required to the wire diameter and the current through it in an electrical system. Losses due to leakage or high resistance due to air obstructions are also comparable troubles.

To avoid obstructions due to dirt and also to keep water away from the moving parts of valves and cylinders, special air filters are placed between the tank and the control portions of the pneumatic system. These filters must occasionally be cleaned out. Most of them use the action of the moving air itself to spin dust and dirt to the side and bottom of a bowl which also traps excess moisture. To clean out such a filter, merely open the drain cock—but keep well away from it, since the air will blow the dirt out with considerable force.

When a single air tank has to supply several, different, pneumatic devices, there may be times when all are demanding air at once, causing air pressure to drop. Conversely, back pressure may develop when none of these tools is in use. This situation is analogous to power-supply problems that occur when the load varies over a wide range.

A pneumatic regulator usually comes complete with a dial and valve which is set for the desired pressure. The valve then regulates the volume of air through the line. Some types of regulators also bleed off back pressure automatically. This regulator should not be confused with the pressure cut-off switch that turns the compressor on and off to maintain a certain pressure within the tank.

Other special-purpose devices used in air lines include lubricators to supply a thin film of oil to the valves and other wearing parts.

Some Pneumatic Components

Probably the most important type of actuator used in pneumatic systems is the cylinder. There are quite a few rotary air tools that use instead simple turbines, or paddle wheels, but in automation systems air is used mostly to provide linear motion. This is accomplished most efficiently by cylinders. The single-action cylinder shown as an example in Fig. 1 is used only for installations involving very low power. Practically all operations requiring a controlled stroke and return use the double-action cylinder of Fig. 2. This device does not rely on a spring: its motion in each direction is accurately controlled by the air entering and leaving, as shown in Figs. 2A and 2B.

Fig. 2 shows the basic elements found in any double-action cylinder, but leaves out many of the construction details. The seal and bearing which hold the moving ram, for example, is usually an elaborate combination of precision-machined parts and nylon, teflon, or special rubber gaskets. In some cases, cloth or rubber bellows extend from the bearing to the external end of the ram to prevent grit from collecting and wearing down the seal. The construction of the end stops varies greatly with cylinder design. There are also different means of connecting air lines to the cylinder, different adjustments, and different methods for lubricating the inner walls and the bearing.

One reason why double-action air cylinders are so widely used is that the length, the force, and even the speed of the stroke can be controlled carefully. In an automatic forming process, for example, it may be desired to move the ram rapidly for one inch; and then slowly, but with greater force, push it another half inch. The return stroke may have to be very rapid to start the next operation. This program can be achieved either by a combination of limit switches and solenoid-operated valves, or else by pneumatic time-controlled valves.

Pneumatic Valves

The cross-section of a simple three-way valve appears in Fig. 3. It consists of two main parts, both of which are round and usually machined of brass or a similar metal. The outer part is a cylinder which has three holes drilled in it, the inlet port (top) and the two outlet ports (at the bottom). These holes usually have threading so that the air-line fittings can be screwed in tight.

The inner part of the valve is a simple rod that has been turned down at one portion near its center. This permits air to pass from the inlet port to either of the two outlets, depending on the position of the rod. In a few special valves, the rod fits so tightly in the cylinder that gasket rings are not necessary, but usually such rubber or nylon rings are located as shown in the diagram to seal the valve against leakage.

A simple, single-action, solenoid-operated valve is shown in Fig. 3. When no power is applied to the solenoid, the return spring holds the inner rod in the position shown in Fig. 3A and allows air to pass from the compressor to the port on the left. As soon as the switch is closed (Fig. 3B), current passes through the solenoid. This attracts the armature, which moves the valve rod to the right, against the force of the spring. In this condition, air pressure is switched to the lower exhaust port on the right, while the lower left port is sealed off. In effect, the pneumatic power is switched much as the electrical power is switched in a single-pole, double-throw switch, the electrical equivalent of this type of valve. At the bottom of Fig. 3, we have also shown the standard pneumatic symbol for this valve. It consists of two sections, corresponding to the two possible valve positions. In each position, the arrow indicates the direction of air flow, while the "T" symbolizes a closed port.

An elaboration of the unit shown in Fig. 3 is a valve with three possible positions, as illustrated in Fig. 4. This type, actuated by two solenoids, can deliver air to either of two ports and can also close either of them or both simultaneously. Two springs are used here, to hold the inner rod in a center position when neither solenoid is actuated.

In Fig. 4A, we see the switch for solenoid 1 closed and the rod thus pulled to the left, allowing air to pass from the air line to port 1. In Fig. 4B, we show the condition where neither solenoid is actuated and the inlet opening as well as both ports are closed. In Fig. 4C, solenoid 2 is actuated and air flows from the inlet to port 2. The electrical equivalent of such a valve would be a single-pole, triple-throw switch. Its pneumatic symbol shows three sections, one for each possible position. The unit is a three-way, center-closed, two-solenoid valve.

A little reflection will show that the left and right solenoid switches should not both be closed at the same time but, by properly programming the closing and opening of the two switches, the flow of air can be arranged in a number of different sequences. All that is necessary is an electrical control circuit, possibly using a set of micro-switches, actuated by a timing motor.

In addition to three-way valves such as that shown in Fig. 4, a similar arrangement of valve body and a moving center rod can be used for 4- and 5-way valves providing all sorts of combinations of positions. It is merely necessary to turn down the inner rod in several places, locate the various ports accordingly, and fit gasket rings into the proper places.

To give just one more illustration, let us consider a four-way valve that could be used directly with the double-action cylinder of Fig. 2. In one position, the valve must connect the compressor to one end of the cylinder while allowing exhausted air to leave at the other end. For the return stroke of the cylinder, these connections must be reversed. These two conditions for the cylinder, the valve, and the solenoids that control them are symbolically represented in Figs. 5A and 5B.

Now let us look at the valve itself, which is shown in Fig. 6 without the actuating solenoids. Port 5 is connected to the air compressor. Ports 3 and 4 are attached to the two openings at the top of the cylinder of Fig. 2. When one solenoid pulls the valve rod to the left (Fig. 6A), air from the compressor passes through port 3 and on into the right-hand opening of the cylinder ("air in" in Fig. 2A). At the same time, air is forced out of the "exhaust" opening in Fig. 2A, and released through ports 4 and 2 of the valve (Fig. 6A).

When the other solenoid pulls the valve rod to the right (Fig. 6B), air from the compressor passes through port 4 and enters the cylinder as shown in Fig. 2B. Meanwhile the cylinder exhausts air through ports 3 and 1 of the valve.

The electrical equivalent of such a four-way valve is a double-pole, double-throw switch, and the electrical

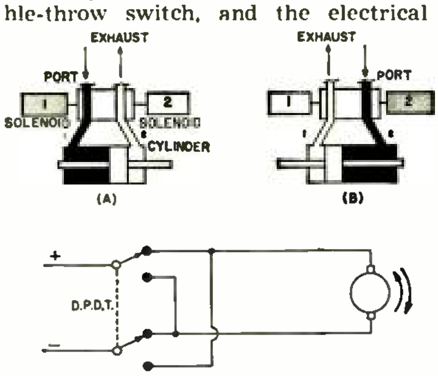
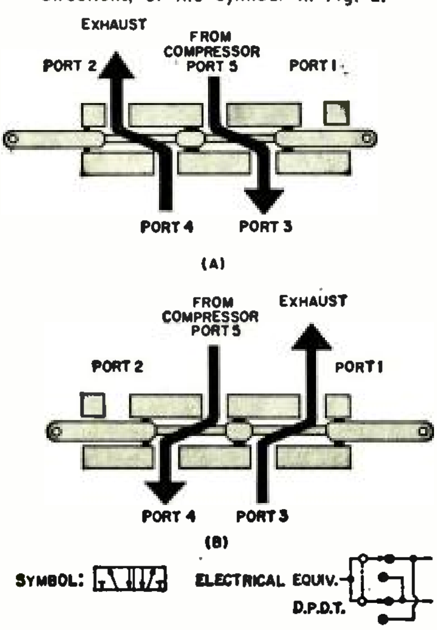


Fig 5. Four-way valve (A, B) used with cylinder of Fig. 2. Electrical equivalent (C) of function performed.

Fig. 6. Operation of 4-way valve of Fig. 5. It controls strokes, in both directions, of the cylinder in Fig. 2.



analogue of this entire pneumatic circuit, including the cylinder, can be represented as the polarity-reversing circuit for a d.c. motor, shown in Fig. 5C.

Although solenoids have been shown moving the rods of valves, the same principles of operation hold true when other means are used. This motion may be controlled by human beings, as by the hand or foot of an operator. The rod may also be moved by a small amount of air pressure.

The latter scheme is used in so-called "pilot valves." These resemble the valves already described except that, in place of the solenoids, another, small, air cylinder actuates the valve rod. This air cylinder, in turn, is controlled by still another valve, which is located remotely. Such a system may seem like an unnecessarily involved and indirect way of obtaining the action desired, but an electrical analogy again comes to the rescue by pointing up the logic involved. Often a small, manual switch is used to control current through a heavy-duty, power relay. The latter, in turn, controls power machinery. In each case, regulation of large amounts of power from a remote point is achieved by using relatively small wires (or air lines).

There are many specialized valves available, some of which use a rotary motion to perform the same actions as the cylinder-and-rod arrangement described above. Such configurations are sometimes used to allow a controlled amount of air leakage, which serves to slow down the valve action and thereby provide some time delay. Other special valves provide a controlled exhaust pressure, while still others combine pressure-regulating and indicating instruments with the regular valve elements.

Conclusion

Once the basic operation of pneumatic valves and cylinders is understood, the difficulty in tackling the more specialized types of pneumatic components is largely overcome. Compressed air furnishes muscle power for many automated installations, especially where controlled linear motion is required. Pneumatic cylinders are very useful, for example, in operations that involve hammering, riveting, or die punching, since these cylinders can be controlled closely by a variety of pneumatic valves.

Pneumatic circuitry has many features which are analogous to electrical circuitry. The electronic technician will therefore find that he may facilitate his understanding by analyzing the unknown in terms of the known. It helps to remember that valves generally correspond to switches or relays, and the variety of different valves is almost as great as that of switch combinations. Where solenoid-operated valves are concerned, the timing and sequencing of the pneumatic-circuit operation is usually determined by the electrical circuitry that controls the solenoid valves. —30—

By DELLROYE D. DARLING
Radio Electronic Television Schools

This device, which senses the presence of metals and other conductors, has many uses in automation.

Servicing R.F. Proximity Controls

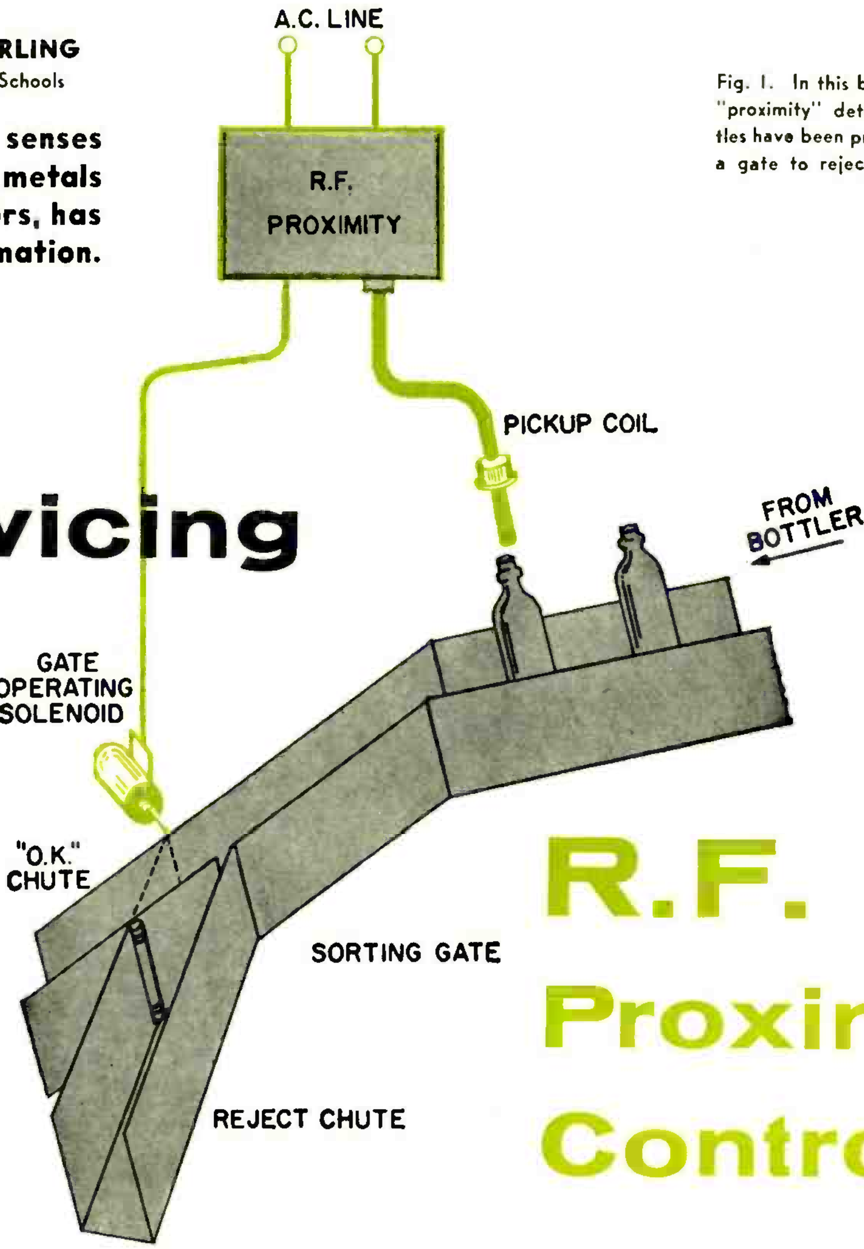


Fig. 1. In this bottling operation, the "proximity" determines whether bottles have been properly capped, opens a gate to reject those without caps.

AUTOMATION is the operation of machines without direct human control. A human operator has the wonderful ability to see, hear, or feel various parts of his machine or product; to tell when things are positioned right for the next operation; to know whether a new piece of work has been inserted. An automatic machine must have these senses built into it, in the form of limit switches, photocells—or proximity controls.

One very popular type of sensing device is the "r.f. proximity," which is capable of sensing the presence of almost any type of conducting material (such as metals and conductive liquids). Anyone going out to do industrial electronic servicing is bound to come across these units. A good understanding of their operation and possible troubles will be a big help.

Although there are several brands on the market, the basic principles of all are similar, so let's take as an example the Model 4905, made by *Electro Products Laboratories*. This unit (Fig. 3) is housed in a JIC (Joint Industrial Committee) approved steel case, about 6¼" x 8" x 3½" which can be sealed up tight against gas and liquid for protection.

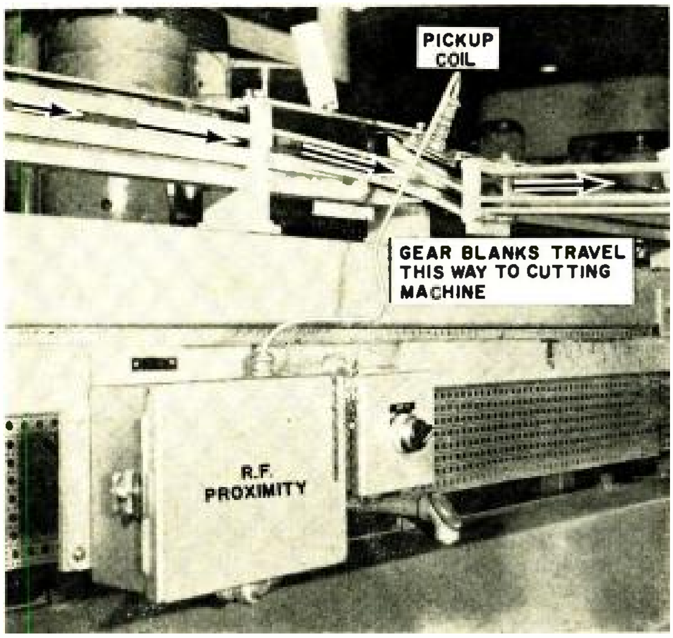
The case is opened by loosening one clamp bolt, and the entire chassis (Fig. 4) can be removed by taking out four corner screws. Although the chassis is fairly simple, you are impressed with the care that has gone into making it. All parts are first quality, and the wiring is neatly, carefully, and completely color-coded. (Industrial purchasers are more interested in quality and reliability than they are in price.)

Fig. 2. Various types of external sensing coils may be fitted to the control.

The only part of the control not housed in the box is the pickup coil, which is on a cable to allow it to be mounted in the best position for sensing. Various types that may be used, to suit the particular job, are shown in Fig. 2.

How It Works

Take a look at the schematic diagram (Fig. 5) or "print," as an industrial technician would call it. The pickup coil is the tank of a conventional, fairly simple r.f. oscillator, using one-half of a 6SN7 tube, V_{1A}. Sig-



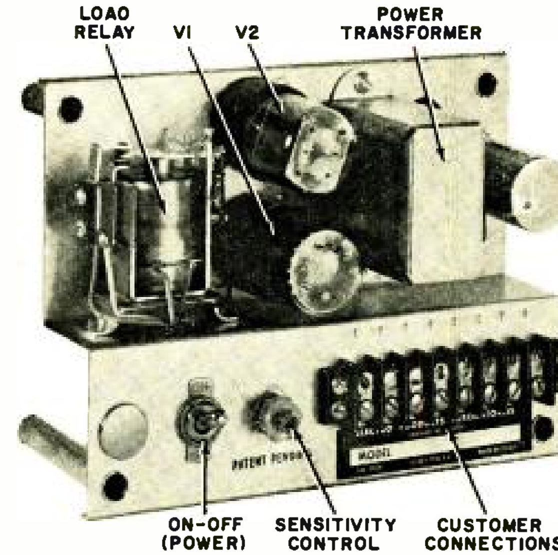


Fig. 4. The Electro Products Model 4905 with cover removed.

◀ Fig. 3. In a Ford Motor Co. plant, the Model 4905 checks gear blanks as they are being fed to a gear-cutting machine.

nal from this oscillator is fed from the cathode into the grid of V_{1B}, which operates as a resistance-coupled r.f. amplifier.

From V_{1B}, the r.f. signal is passed to V_{2A}, where it is amplified again and fed to a rectifier circuit (1N34A), which charges a .002-μf. capacitor to provide negative bias for the grid of V_{2B}. V_{2B} has a relay in its plate circuit, with contacts to switch the load on or off.

Normally, r.f. signal from the oscillator, amplified and rectified, keeps a negative bias on V_{2B} large enough to cut it off and leave the relay de-energized. When conducting material comes near the pickup coil, however, the latter absorbs enough energy from the coil to lower its "Q" to the degree that oscillation stops. When this happens, no r.f. will reach the 1N34A diode, and the cut-off bias will be removed from V_{2B}. This permits V_{2B} to conduct and operate the relay. This tube keeps on drawing current until the conducting material moves away from the pickup coil and permits the oscillator to come back into operation.

Sensitivity is controlled by varying the plate voltage on the oscillator tube with a 10,000-ohm pot, screwdriver-adjusted from the front of the chassis. (This adjustment has a lock-nut on it, which must be loosened and then retightened when an adjustment is made.)

Applications

There is almost no limit to the number of jobs that can be done by a unit of this type. With an external, electromechanical counter connected to the relay contacts, the proximity will count passing objects at rates up to 600 per minute. (With an all-electronic counter, using no relays, rates up to 1000 per *second* are possible!)

One or more r.f. proximities can be used to sense the position of a piece of work in an automatic machine, to control the sequence of machining operations. Tolerances in a setup like this are often small, and the pickup coils may have to be positioned to within thousandths of an inch for satisfactory operation.

An r.f. proximity control can be used to inspect packages or to check bottles, among other things. In the case of bottles, it could make sure that there is a cap on each or that there is *not* a metal object inside the bottle. After all, a nail in a bottle of beer doesn't exactly improve customer relations. A possible arrangement for a bottle-capping system is shown in Fig. 1. The control itself is mounted away from the moving line of bottles and the sensing coil, on an extension cable, is placed just above the moving line of bottles.

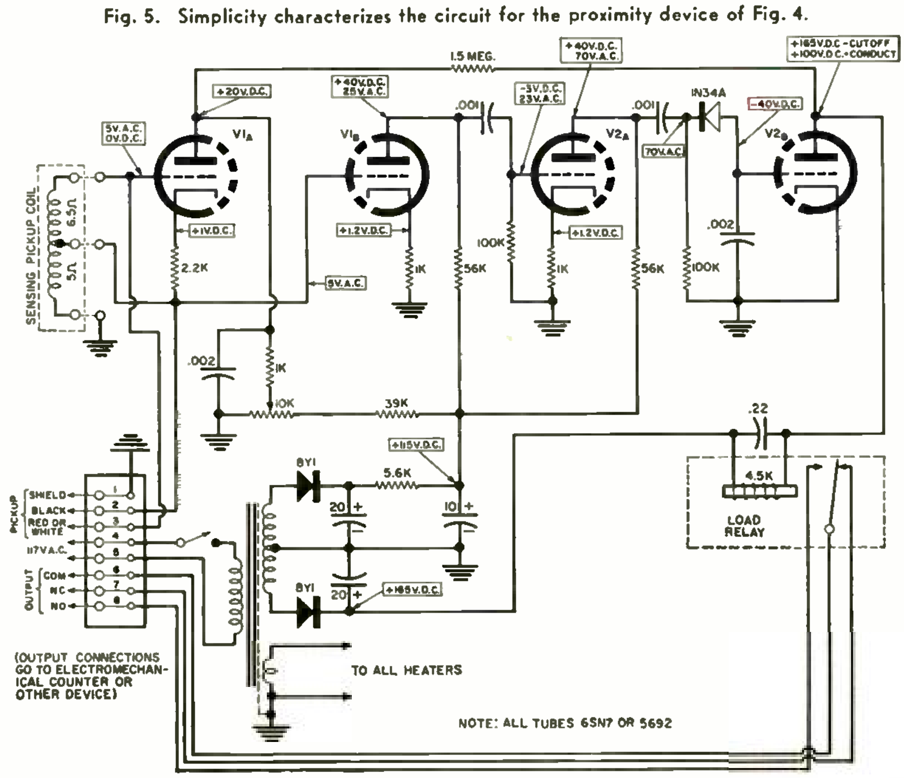
The load relay, instead of going to an external counter, is connected to a solenoid that operates the sorting gate, whose position determines into which of two chutes the moving bottles will be passed. When an uncapped bottle passes the pickup coil, the solenoid swings the gate to close off the "OK" chute, and the bottle is rejected.

A complete list of applications would fill volumes. Nevertheless, some are mentioned here because the job the proximity is doing often has a direct bearing on the troubles it can be expected to develop.

Troubleshooting

Although these controls are basically simple and very reliable, trouble, quite (*Continued on page* 129)

Fig. 5. Simplicity characterizes the circuit for the proximity device of Fig. 4.



STABLE TRANSISTOR V.F.O.

TRANSISTORS can be used to good advantage in almost every circuit—with the possible exception of high-power, high-frequency applications. Another exception is the transistor variable frequency oscillator. Until recently, it has been difficult to obtain stability with useful power output and at a usable frequency.

Several problems of v.f.o. design are peculiar to the transistor alone. As an example, it is somewhat easier to temperature-compensate a vacuum-tube v.f.o. since the tubes and associated equipment bring the components up to an elevated and reasonably steady temperature. Transistor circuitry operates at (or near) room temperature and is, therefore, affected by external conditions.

Another problem arises from the changes in junction temperature. When the transistor is energized, current passes through the junction resistance and generates heat. The junction heat changes the collector capacity which, in turn, shifts the oscillator frequency. This tiny amount of heat is not radiated to the tank circuit components and temperature-compensation tricks are not possible.

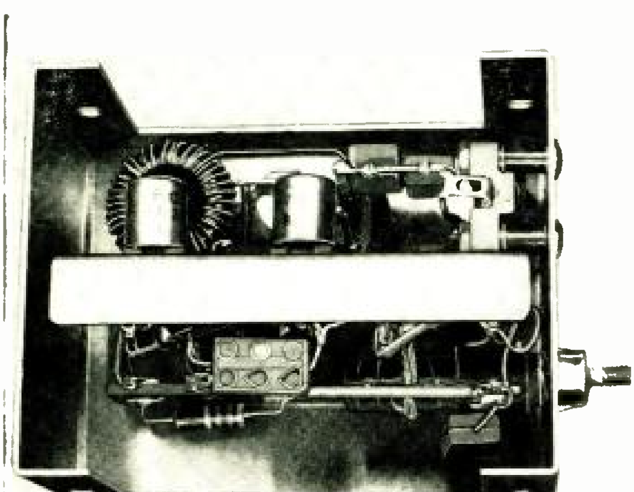
Still another problem rears its ugly head—this time one rather intriguing. Initial experiments (Fig. 3), using low-cost transistors, brought to light a rather startling effect. The transistor oscillator signal appeared to have modulation impressed on the carrier whenever it was compared to an equivalent vacuum-tube v.f.o. signal. The sound can only be described as a "gurgle." The level was low, to be sure, but was still very noticeable when the signal was detected with a selective receiver. Such a v.f.o. would be unsatisfactory for SSB or frequency-standard applications. The reason for this effect is still clouded but it would appear to result from the random arrival of carriers at the collector. This effect has not been noted with crystal-control transistor oscillators or when the v.f.o. is detected on a broad receiver. It is therefore assumed that the random nature of the carriers produces a frequency-modulation component due to rapid variations in collector capacity.

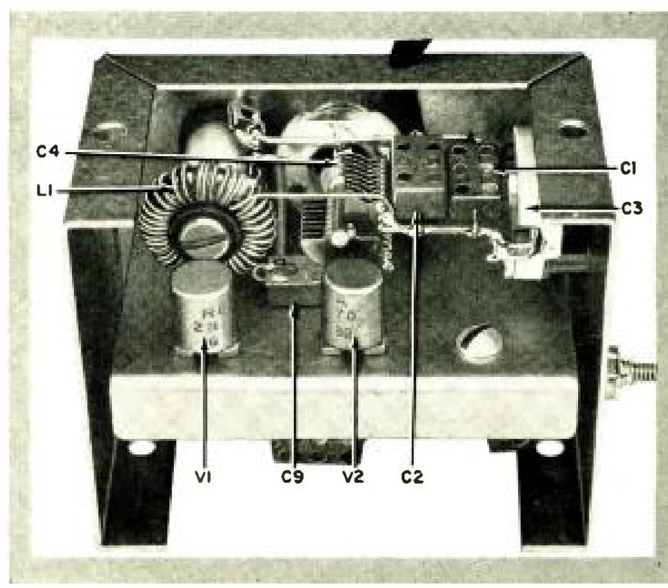
When compared to a vacuum tube, the transistor is a rather low-impedance device. The v.f.o. tank circuit, which should be high "Q" for best stability, is not exactly compatible. Unless the transistor elements are tapped down on the tank coil (to match impedances), the transistor will load the coil and reduce the stability. Buffer-amplifier circuits can also affect the oscillator since they have poor input-output isolation, much the same as a triode.

The author was about to "throw in the towel" when a circuit appeared in a West Coast publication (*Western Radio Amateur*, "Sidelights on Sideband" by Lester A. Earnshaw, ZL1AAX) covering a stable v.f.o.

Inside view of the v.f.o. showing mounting of the toroidal coil. ▶

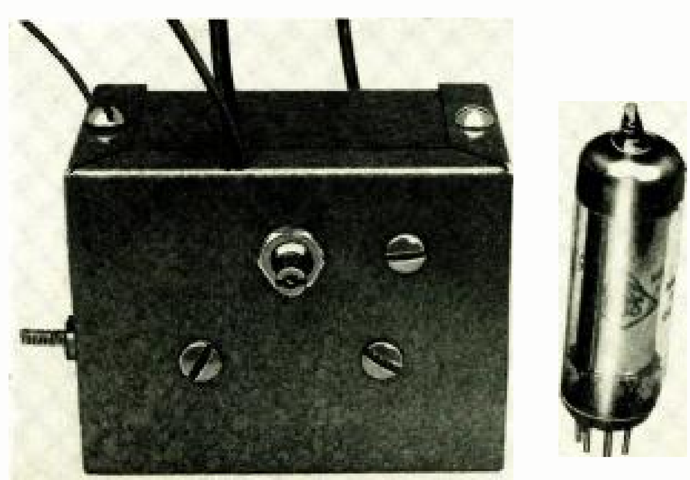
Another inside view showing output tuning coil (L_2) employed.



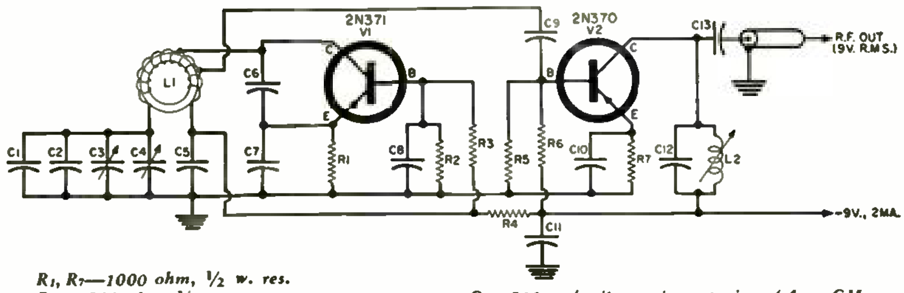


By **DONALD L. STONER,** W6TNS

Construction of compact oscillator for ham who wants to experiment with very stable unit that will drive most SSB exciters and frequency standards.



Over-all view of transistorized unit compared to miniature tube. ▶



R_1, R_7—1000 ohm, ½ w. res.
R_2—3900 ohm, ½ w. res.
R_3, R_6—47,000 ohm, ½ w. res.
R_4—470 ohm, ½ w. res.
R_5—3300 ohm, ½ w. res.
C_1—100 μμf. silver mica capacitor (Arco CM-15-J-100)
C_2—50 μμf. silver mica capacitor (Arco CM-15-J-50)
C_3—4.5–25 μμf. rotary trimmer (Centralab 822-CN)
C_4—20 μμf. var. capacitor (E. F. Johnson 30M8, modified per text)
C_5, C_8, C_{10}, C_{11}—.005 μf. disc ceramic capacitor
C_6, C_{12}—24 μμf. silver mica capacitor (Arco CM-15-J-24)
C_7—510 μμf. silver mica capacitor (Arco CM-15-J-511)
C_9—30 μμf. silver mica capacitor (Arco CM-15-J-30)
C_{13}—470 μμf. disc ceramic capacitor
L_1—Toroid coil, 41 t. #24 en., closewound on 0.68" powdered iron toroid form. Tap at 16 t. for V_1 and at 10 t. from "cold" end for V_2. (Miller No. 7501 may be used, see text)
L_2—36 t. #36 en. scramble-wound on 5/16" slug-tuned form (Miller No. 7502 may be used, see text)
1—Aluminum chassis box 2⅝" x 2⅛" x 1⅝"
V_1—"p-n-p" drift transistor (RCA 2N371)
V_2—"p-n-p" drift transistor (RCA 2N370)

Fig. 1. The highly stable transistorized v.f.o. employed by the author.

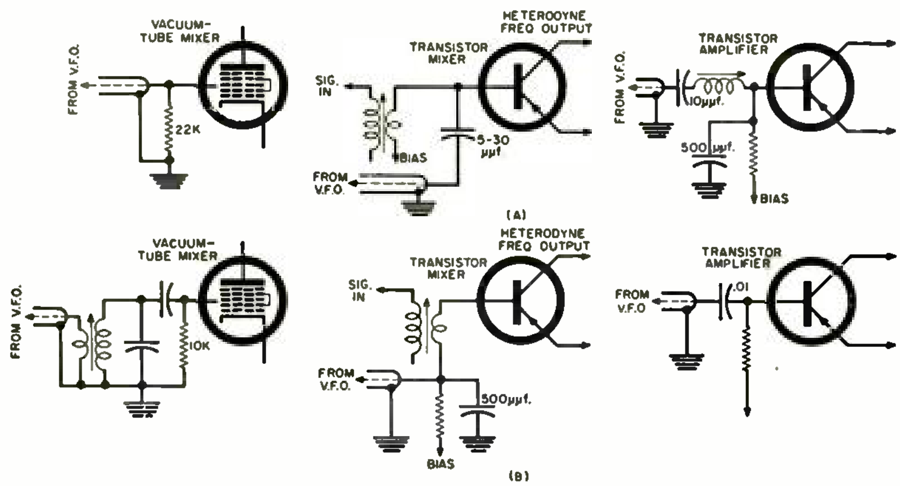


Fig. 2. Coupling circuits for use with v.f.o. (A) Circuits using short, high-impedance lines; (B) circuits using long lines along with link-coupling arrangement.

The circuit shown in Fig. 1 is a variation of Mr. Earnshaw's circuit and has been optimized for American components. In addition, the volume of the v.f.o. has been reduced by about 400% with the miniature components available in this country. In every respect, the performance of this v.f.o. exceeds its vacuum-tube counterpart, except for power output.

Junction heating was found to be in direct proportion to the oscillator current and, therefore, the amplitude of the oscillation. Since the junction heating problem could not be overcome, it was necessary to "live with it" and minimize its effect. For this reason, the design concept of using a very low power oscillator in conjunction with a class A amplifier/buffer would seem to be the most logical. A tank circuit of higher-than-normal "Q" was used and the collector was tapped near the cold end of the coil. Less than 50 cycles of drift can be attributed to junction capacity change.

The collector-capacity modulation described earlier exists but is not audible since the collector (and its capacity changes) are tapped at a low impedance point on the coil. It would appear that the excellent high-frequency characteristics of the "drift" type of transistor contribute to the over-all stability.

Circuit Details

Coil L_1 is wound on a ferrite toroid and the unloaded "Q" is in the vicinity of 400. The highest tap is at the 16th turn out of a total of 41 turns. The use of a toroid (which has little or no external field) allows the v.f.o. to be physically compact, since the coil is less than one inch in diameter and can be mounted within ⅛" of the metal chassis. If this were attempted with a customary coil, the metal in proximity would reduce the "Q" and cause drift due to heating of the chassis.

Capacitors C_1 and C_2 are silver micas, while C_3 is the calibration trimmer and C_4 the tuning capacitor. The ratio between C_4 and the other capacitors determines the bandspread.

Feedback occurs between collector and emitter through capacitor C_6. A low emitter impedance is established by C_7. The d.c. stabilization is provided by the large emitter resistor, R_1. Forward bias for the oscillator is obtained from the voltage divider R_2-R_3.

Drive for the class A amplifier, V_2, is taken from a low-impedance point on the oscillator coil and is coupled through capacitor C_9. The low-impedance tap and the small-size coupling capacitor (30 μμf.) effectively isolate the buffer output from the oscillator tank. Additional isolation is gained by using a decoupling resistor, R_4, in the "B−" circuit. Forward bias for the amplifier/buffer is obtained through another voltage divider made up of R_5-R_6. Resistor R_7 is used for d.c. degeneration of the output stage. The output tank circuit consists of coil L_2, capacitors C_{12} and C_{13}, plus the capacity of the coaxial cable. Approximately 9 volts of r.f. (r.m.s.) is available, which is more than adequate for vacuum-tube or transistor amplifiers and mixers.

Each transistor draws approximately 1 ma., making the v.f.o. suitable for battery operation, even when used in conjunction with non-portable equipment.

The voltage stability is quite amazing. A variation in the source voltage between 7 and 11 volts will cause a frequency shift of 700 cycles. A zener voltage regulator should be unnecessary, even in mobile installations. A battery lead can be keyed and no "chirp" or drift occurs.

The mechanical stability, which is a function of the construction style, is excellent. A 5G shock produces no noticeable frequency shift. The unit was demonstrated at a radio club recently. The frequency was zero-beat with WWV, then held by the wire leads and banged on the table. Not so much as a warble was heard and the frequency never came out of zero-beat! Thus, the v.f.o. should be ideal for mobile operation and could be mounted on the steer-

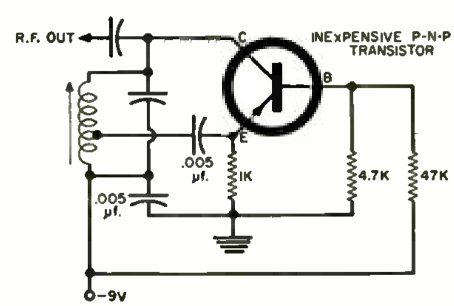


Fig. 3. Simple transistor v.f.o. which has all the faults mentioned in the text.

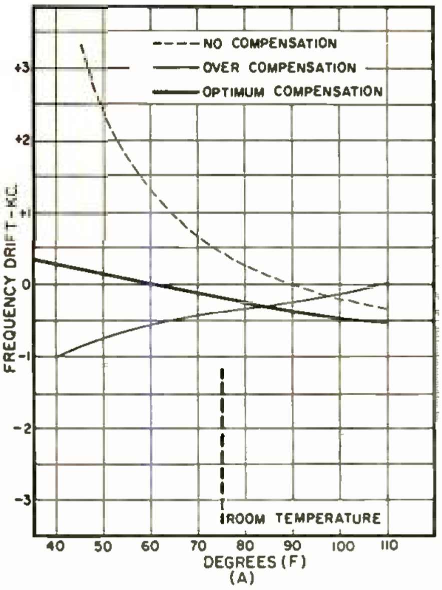
Fig. 4. R.f. detector probe employed.

Table 1. Voltage chart. Upper figures are probe-measured r.f. voltages. Lower figures are —d.c. with a 9-volt battery.

	C	B	E
V_1 (Osc.)	3.5*	0	.03
	8.7	.64	.53
V_2 (Amp.)	9.4	.12	0
	9.0	.54	.48

Coil L_1: Top end—4.5 volts* r.f.; V_2 tap—2.2 volts* r.f.

* Actually higher, but reduced due to probe loading.



ing column (for remote frequency control) without ill effects.

This little v.f.o. is currently being used in conjunction with a single-sideband exciter on the 75 and 20 meter bands. It provides adequate drive and yet occupies less than 1/25 the volume of the BC-458 v.f.o. that it replaces. Future applications include an all-band transistor exciter and transceiver.

Construction & Testing

As can be seen from the photographs, the v.f.o. is extremely compact and is certainly no project for a beginner. The exact layout dimensions are not given since one usually winds up "playing checkers" with the components anyway. Elaborate circuit details are given and between these and the photographs, the constructor should have no trouble duplicating the unit.

The v.f.o. is constructed in a 2⅝" x 2⅛" x 1⅝" aluminum chassis box. The size is approximately the same as two packs of regular cigarettes. A small aluminum chassis measuring 2⅜" x 1⅝" (exclusive of the ¼" lips) is mounted on the center line of the chassis box and is secured with two 6/32 screws. This divider serves as a shield to isolate the oscillator and buffer tuned circuits. The toroid sets on a ¾" porcelain standoff insulator, mounted to the right of the tuning capacitor. The coil is positioned so that the oscillator tap lines up with a hole in the divider below V_1, for the collector lead. This also lines up the tap for C_9 so its lead passes through a hole below the buffer V_2. The trimmer capacitor, C_3, is mounted on the side apron. A common ground wire runs from a ground lug under the porcelain insulator, to the rotor of C_1, on to the rotor of C_3. Disc capacitor C_5 is connected between this ground lug and the cold end of L_1, with very short leads. Another common wire runs from the hot end of L_1, to the stator of C_4, and onto the stator of C_3. Fixed capacitors C_1 and C_2 are connected between these two common wires. Sockets for V_1 and V_2 are mounted on the divider, directly above the tank circuit components.

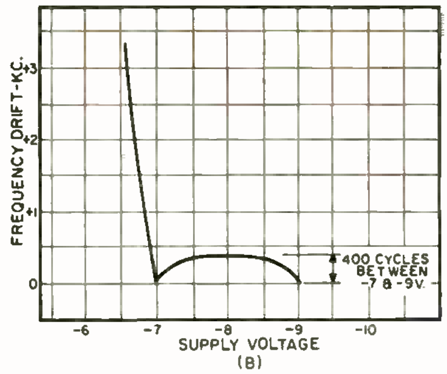
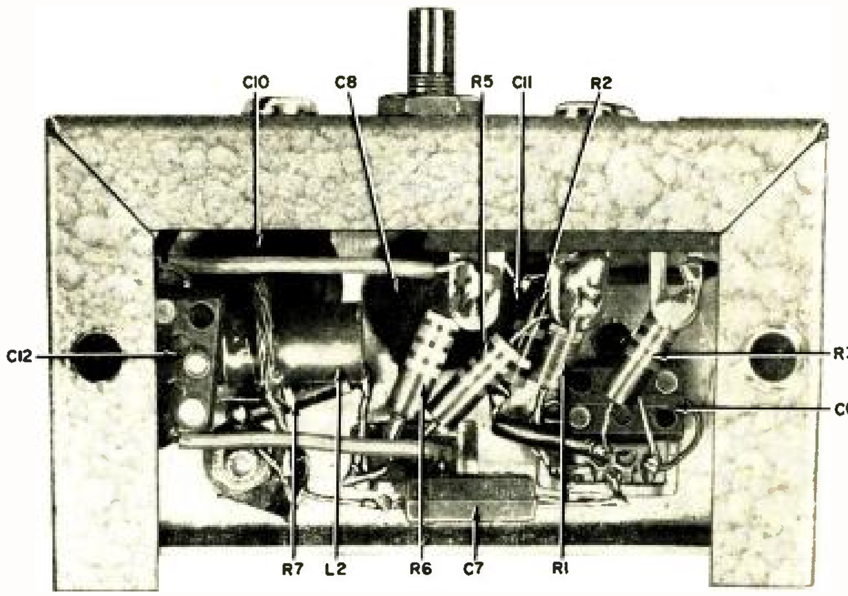


Fig. 5. Graphs showing the measured frequency stability versus temperature and supply voltage. The compensation methods used are described in the text. By the addition of the proper amount of negative temperature coefficient capacitors, the frequency shift that exists can be almost completely neutralized.

box lip. These two holes are just big enough to accept the leads, preventing them from flopping around and disturbing the oscillator circuit. The "B+" return is to the metal case.

The coaxial cable is worthy of special mention since it is part of the output tuned circuit. A 10" length of *Amphenol* #21-598 "Subminax" was used in the model. If substitutions are made, remember that the impedance (50 ohms) is not as important as the capacity-per-foot figure. If more than 20 inches of cable is required, a link should be used on output coil L_2. Coupling the cable to various circuits is shown in Fig. 2. In all cases, coil L_2 should resonate at the operating frequency.

An r.f. probe will be very useful for testing the operation of this v.f.o. The circuit shown in Fig. 4 was used by the author in conjunction with a *Heath* V7-A vacuum-tube voltmeter. The meter will indicate r.m.s. radio-frequency



Amplifier-buffer side of chassis box. Most parts are soldered to 3-lug strip.

Looking at the amplifier side of the divider, you will see the majority of the capacitors and resistors. A three-lug terminal strip (center lug ground) is secured under the left 6/32 nut. Resistor R_1 is soldered in the eyelets, between the end terminals. The left lug secures resistors R_3, R_4, and the wire through the divider to the junction of C_5 and L_1. Tied to the center terminal (ground) you will find R_1, R_2, R_5, C_8, and C_{11}. The right terminal is used to secure R_6, C_{11}, and the lead to L_2. Capacitor C_6 is connected between the emitter and collector pins of the transistor socket. Capacitor C_7 connects to the emitter pin and the solder lug adjacent to V_2. R_7 and C_{10} are connected between the emitter of V_2 and the adjacent ground lug, which also terminates the coaxial cable shield. Capacitor C_{12} is secured to the coil terminals. Capacitor C_{13} connects to the coax center lead with a "space tie point". The coax and the "B−" lead pass through a hole in the divider and another hole in the chassis

voltage due to circuit losses. The frequency response is fairly good up to about 60 mc. The voltage chart, Table 1, gives both the r.f. (upper) and d.c. (lower) voltages that should be found in the v.f.o.

With the values shown in the parts list, the v.f.o. should cover any 0.3 mc. between 4.5 and 5.5 mc. Plates were removed from C_3 (originally 30 μμf.) to limit the v.f.o. to this range. Lower frequency ranges can be covered by adding more turns to L_1 and L_2 and moving the taps up a turn or two. If more or less frequency coverage is desired, you can increase or decrease the size of C_4. Capacitors C_1 and C_2 should be decreased or increased also (if a great change is made in the size of C_4) to keep the total circuit capacity at 200 μμf. It is recommended that a minimum of component substitutions be made. As it often happens, the temperature coefficient of one component may compensate for the drift in an-

(*Continued on page* 107)

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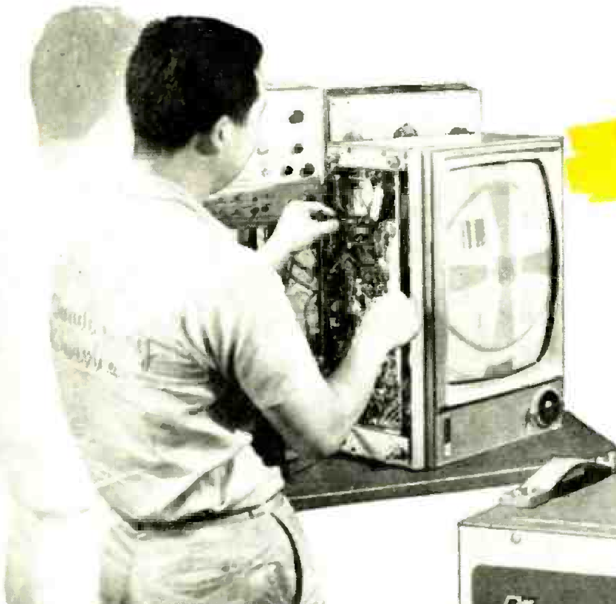

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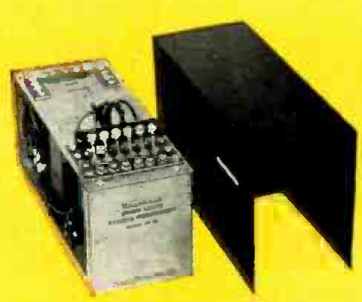
$8.00 dn., $8.00 mo.



MIXED LOWS
STEREO CROSSOVER KIT (AN-10)

Permits using one bass woofer and more economical "wing" speakers for stereo. Delivers non-directional bass of both channels below 250 cps to one woofer; passes higher frequencies to wing speaker. Takes 25 watts per channel; 8, 16 ohm woofers; 8 ohm high freq. speakers. 10 lbs.

AN-10 $19.95

Player Kit by Heath—
Mechanism by Garrard

MANUAL
STEREO RECORD PLAYER KIT (AD-10)

Rubber matted heavy turntable is shock mounted, and idler wheels retract to prevent flat spots. 4-pole motor; 16, 33⅓, 45 and 78 RPM; Sonatone 8TA 4-SD ceramic stereo turnover cartridge with diamond and sapphire styli; preassembled mechanism and base. 10 lbs.

AD-10 $33.95

Quality Stereo at Minimum Cost

ECONOMY STEREO PREAMPLIFIER KIT (AA-20)

A low-cost, versatile stereo preamp-control center. Four inputs each channel accept magnetic cartridge, crystal or ceramic cartridge, and tuner, tape, TV, etc. Six position function switch gives flexible stereo or monophonic use. Features cathode follower outputs plus hi-level outputs for tape recorder drive, calibrated Baxandall-type tone controls for each channel, clutch-type volume controls, filament balance controls, and accessory AC sockets. Self-powered. Styled in black and gold. 8 lbs.

AA-20 $34.95

PROFESSIONAL RATED 35/35 WATT BASIC AMPLIFIER KIT (AA-40)

Doubles as a superb dual 35 watt stereo amplifier or a full-fledged 70 watt monophonic amplifier. Features a mixed-channels center speaker output for fill-in sound, and individual level controls for stereo. "Stereo-Mono" switch ties both amplifiers to one level control for monophonic use. Dual outputs for 4, 8, 16, and 32 ohm speakers. Paralleling outputs for 70 watt monophonic use matches 2, 4, 8, and 16 ohm speakers. 41 lbs.

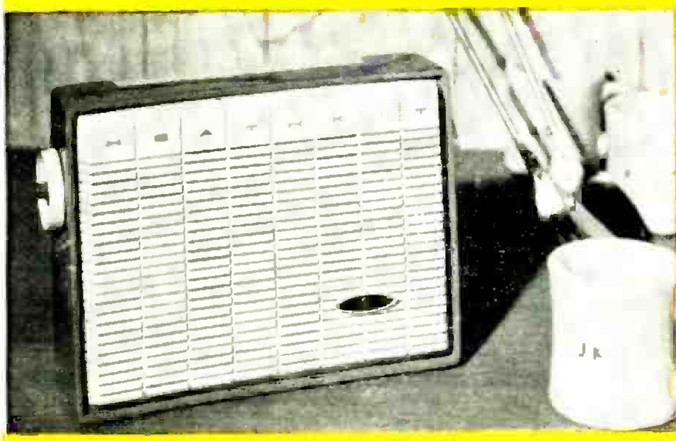
AA-40 $79.95

$8.00 dn., $8.00 mo.

HI-FI RATED 14/14 WATT BASIC STEREO AMPLIFIER KIT (AA-30) (not illustrated)

14 watts per channel, separate level controls, local/remote power switch, circuit board. Styled like AA-40 above. 21 lbs.

AA-30 $45.95



Perfect for Summer Sun and Fun!

6-TRANSISTOR PORTABLE RADIO KITS (XR-2 Series)

Assembled in only a few hours, both of these models incorporate superior design features that will give you portable-listening enjoyment day after day. Vernier tuning control gives smooth, easily-separated station tuning. Large 4" x 6" PM speaker with heavy magnet provides "big set" richness of tone. Operates on standard size "D" flashlight batteries. Six Texas Instrument transistors.

XR-2P (plastic) 6 lbs. **$29.95**

XR-2L (simulated leather) 7 lbs. **$34.95**

MOBILE PA SOUND EQUIPMENT

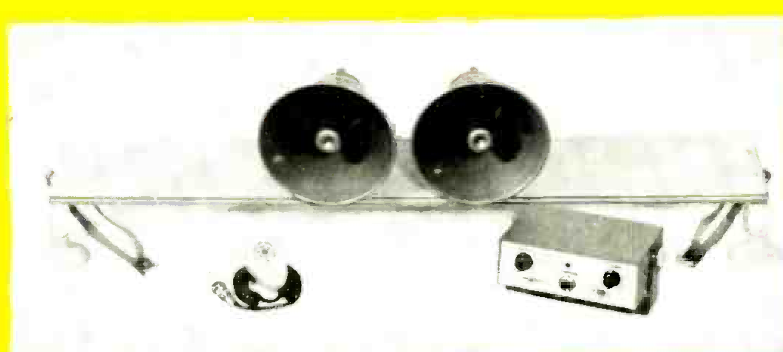
Perfect for political campaigns, advertising, sporting events . . . hundreds of PA applications. The 10 watt amplifier operates from any 12 to 15 volt battery. Features an all-transistor circuit for rugged, dependable performance and long life. No warm-up time required. Mounts easily under auto dash. Inputs for microphone and music source. Two channel mixing circuit "fades" auxiliary input when used with microphone supplied . . . lets you override music with voice without changing control settings. Outputs for 8 and 16 ohm speakers.

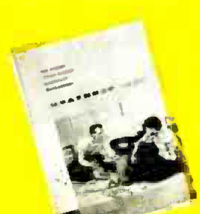
MOBILE PA AMPLIFIER KIT (AA-80) 7 lbs. **$39.95**

COMMERCIAL SOUND SYSTEM (CSS-1) consists of AA-80 Amplifier; microphone; car-top carrier; one 16 ohm, 15 watt outdoor speaker. 19 lbs. **$84.95**

COMMERCIAL SOUND SYSTEM (CSS-2) same as above except with 2 speakers. 25 lbs. **$99.95**

EXTRA HORN SPEAKERS (401-38): As described above. 6 lbs. **$19.95**





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GW-10A or GW-10D **$62.95** each

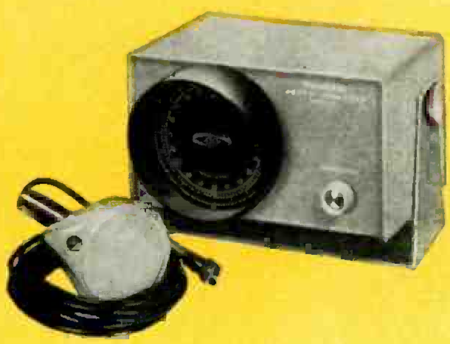
$6.30 dn., $6.00 mo.

3 band "Mariner"
TRANSISTOR DIRECTION FINDER KIT (DF-3)

Features nine-transistor circuit, flashlight battery power supply, pre-assembled, pre-aligned tuning section, three bands (beacon-aeronautical, broadcast and marine-telephone), and a new "sense" antenna system that eliminates 180° ambiguity in bearings. Splash resistant. 13 lbs.

DF-3 **$99.95**

$10.00 dn., $9.00 mo.



For Boating, Fishing, Skindiving
TRANSISTOR DEPTH SOUNDER KIT (DS-1)

Completely transistorized. Indicates depth, type of bottom, and submerged objects, from 0 to 100 feet. Powered by 6 flashlight batteries for complete portability. Transducer included may be mounted through hull, or temporarily outboard. Rugged, splash-resistant cabinet. Adjustable mounting bracket. 10 lbs.

DS-1 **$69.95**

$7.00 dn., $7.00 mo.

Ten-transistor "Mohican"
GENERAL COVERAGE RECEIVER KIT (GC-1)

First kit of its kind to use ceramic IF "Transfilters." Covers 550 to 30 mc on 5 bands, with 5 separately calibrated bands to cover amateur frequencies (including 11 meter citizens band). Powered by 8 flashlight batteries. Built-in 54" whip antenna, tuning meter, headphone jack. 20 lbs.

GC-1 **$109.95**

(Less Batteries)

$11.00 dn., $10.00 mo.

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EDUCATIONAL KIT (EK-1)

Teaches, as you build, the basic "yardsticks" of electronics . . . opens up fascinating areas of study for youngsters and adults alike. The combination kit and text-workbook gives you a practical demonstration of the principles of voltage, current and resistance, the theory and construction of direct current series and parallel circuits, voltmeter, ammeter and ohmmeter circuits and the application of ohms law to these circuits. The completed meter is used to verify ohms law and the maximum power transfer theorem, one of the most important theorems in electronics. The finished kit, a practical volt-ohm-milliammeter, may be used in a variety of applications. Procedures for checking home appliances and automobile circuits included with the kit. The EK-1 will serve as a prerequisite to following Heathkit Educational kits; get started NOW in this "learn-by-doing" series. 4 lbs.

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An impressive list of electronic and mechanical features make this tube tester one of the finest values in the electronics industry. Test Gm (amplifiers) from 0 to 24,000 micromhos, Emission, Leakage, Grid Current (¼ microampere sensitivity), Voltage Regulators (built-in variable DC power supply), low power Thyratron and Eye tubes. Features 300, 450 and 600 ma constant current heater supplies, Life test, Hybrid tube test, built-in switch-operated calibration circuit. Large, easy-to-read meter. Constant tension, free rolling illuminated chart. Kit includes 7 wiring harnesses. Assembly skill of technician or higher recommended; assembly time, 40 hours average. Black leatherette case with white trim, nylon feet, removable top. A specialized tool of unusual value that will pay for itself many times over. 27 lbs.

TT-1 $134.95

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TRANSISTOR MOBILE POWER SUPPLY (HP-10)

All transistor circuit! Operates from 11 to 15VDC input; at 12VDC provides 600 VDC @ 200ma. or 600VDC @ 150ma & 300VDC @ 100ma simultaneously, at 120 watts. Negative 125V @ 30 ma also provided. Max. ambient temp. 150° @ 120 watts ICAS. Input required: 2 amps idling; 13 amps full output. Includes heavy filtering, remote relay primary control, silicon rectifiers, aluminum heat sinks. 10 lbs.

HP-10 $44.95

NEW Six and Ten Meter
TRANSCEIVER KITS (HW-19 and HW-29)

Combination crystal controlled transmitters and variable tuned receivers operating fixed or mobile on the 6 and 10 meter amateur bands (50-54 mc for HW-29 and 28-29.7 mc for HW-19). Superregenerative receiver pulls in signals of 1 microvolt; transmitter input approximately 5 watts. Built-in 117 VAC power supply, metering jack, press-to-talk switch. 10 lbs.

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HW-29 (6 meters) $39.95 ea.

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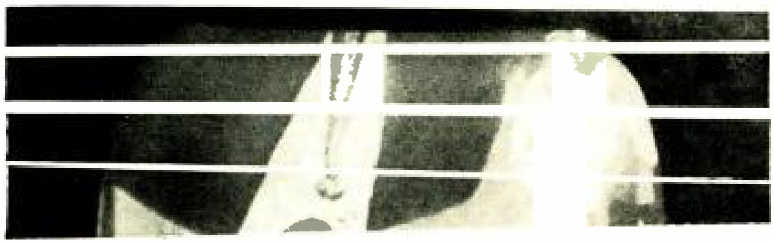
Intermittent Vertical Sync Problems



By **SOL HELLER**

Erratic behavior, always hard to pin down, is doubly complicated with vertical-sync symptoms.

THE CAUSE of an intermittent defect is particularly difficult to determine in any case and, when vertical synchronization in a TV receiver is involved, the difficulty is increased. The reason for this lies in the fact that almost any section of the receiver may be responsible for a vertical-sync problem—not to mention such elements outside the TV set as the antenna system, the power line, and external interference.

The possibilities are so numerous that they cannot all be dealt with in an article of reasonable length. Accordingly we will consider only those defects in the vertical system itself that may produce intermittent synchronization problems. Even within this limitation, faults that result in jitter or impairment of interlace will not be covered.

When the technician is confronted with a fault that suggests vertical-circuit involvement, he immediately faces two questions. The first one is, do the symptoms actually represent a loss of vertical synchronization? The second one is, if they do, how can it be ascertained that their cause is in the vertical section itself? In most cases, the second question will be the important one, with the answer to the first being obvious. However, there are cases that will be hard to recognize.

Occasional frame slipping, roll, or picture lock-in at the wrong phase in the vertical direction unmistakably represent a loss in vertical synchronization. However, there may be a problem when the frequency of the vertical oscillator has become higher than normal. In this type of defect, one field of receiver scanning takes place before one field of transmitted information has come and gone.

Assume, for instance, that the defect has produced a range of possible oscillator operation between 70 and 140 cps, and the technician has succeeded in adjusting the vertical hold control to keep the picture steady by synchronizing at 120 cps. When the electron beam in the CRT has completed one sequence of vertical scan, the picture is actually at the midpoint of the true, transmitted field, and has reproduced alternate scanning lines representing the top half of the transmitted picture only. The receiver beam now retraces back to the top of the screen. However, a small amount of picture information, which is still being applied to the CRT, is reproduced in reverse (upside-down) during this retrace period. The electron beam then starts a second cycle of vertical scan, reproducing what remains of the transmitted field, which is essentially the alternate lines for the bottom half of the transmitted field.

The result of the action just described is that the top and bottom halves of the picture are superimposed over each other on the receiver screen. Total vertical deflection is also reduced by about 50 per-cent, due to the higher frequency at which the vertical oscillator operates: since the saw-tooth-forming capacitor does not charge as much, sweep-signal output is reduced.

An inspection of the screen will reveal the two (top and bottom) superimposed halves of the picture. Picture information scanned in reverse during retrace will comprise a third, faint, superimposed layer. A further aid to identification of the condition is the loss in vertical deflection that is associated with the other symptoms.

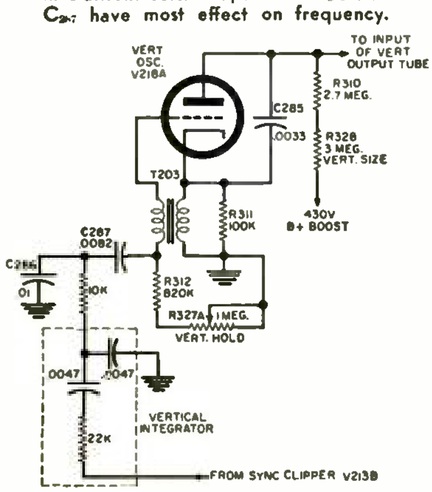
When the vertical hold setting is not near 120 cps, the symptoms will not be as recognizable; however, adjustment of the control to the setting where the most recognizable picture is seen will bring the oscillator to 120 cps, facilitating the diagnosis.

If the defect causes the vertical oscillator to rise to a much higher frequency of operation—say, 400 cps—an unrecognizable, chaotic mass of picture information will be seen that suggests a total loss of horizontal synchronization. One clue to the real nature of the condition in this case, is the severe loss of vertical deflection present. Another is the greater-than-normal, uneven spacing of the horizontal scanning lines; this is the result of the vertically faster, non-linear travel of the scanning beam. A frequency check of the vertical oscillator will confirm a diagnosis of the above-normal frequency. A representative frequency range, when the hold control is rotated, is 40 to 80 cps if oscillator operation is normal.

We now come to the second question: How can we tell if the cause of the intermittent vertical synchronization lies in the vertical section?

Trouble in the vertical section is indicated if, assuming roll is the com-

Fig. 1. Vertical blocking oscillator used in DuMont sets. Capacitors C_{286} and C_{287} have most effect on frequency.



plaint, adjustment of the vertical hold control is unable to lock in a single picture even momentarily during the time roll is present. To make the test more conclusive, remove a sync stage tube (or open the coupling capacitor between the sync section and the vertical oscillator) before performing it.

Even if a single picture can be momentarily locked in, it doesn't necessarily mean the vertical section is OK; if lock-in is obtained too close to one end of the vertical hold control range, inadequate range may be present when sync signals are coming in. Therefore the test definitely clears the vertical section only if lock-in is obtained at or near the center of the control's range.

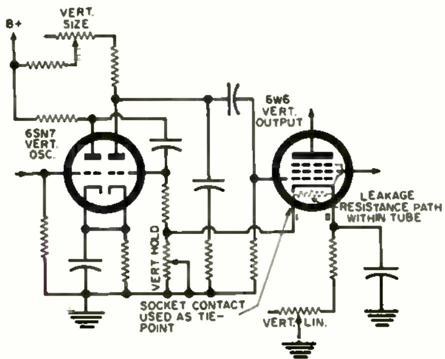


Fig. 2. Leakage between output-tube pins affected oscillator's stability.

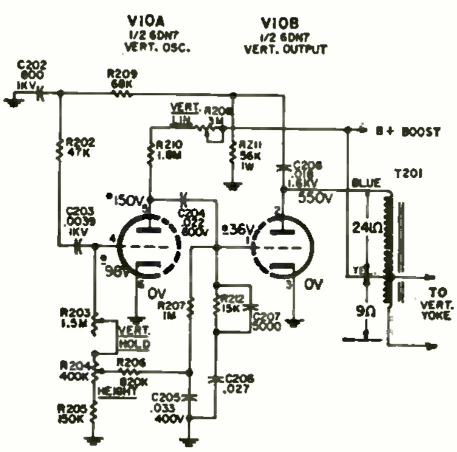


Fig. 3. Vertical circuit in G-E M5 chassis. H-v capacitors break down.

Trouble in the vertical section is indicated if—assuming occasional frame-slipping is the complaint—a scope check of the sync pulse at the input to the vertical oscillator shows no change in the amplitude or shape of the sync signal during an interval of time long enough for the symptoms to develop. The vertical oscillator tube should be removed or disabled during this test to prevent the oscillator "kickback" signal from being superimposed over the sync signal. It is assumed the receiver is tuned to a station and control settings are normal.

When occasional loss of vertical synchronization is the complaint, and symptoms have not manifested themselves, a preliminary check for insufficient vertical hold control range may prove helpful. To make the test, rotate the vertical hold control from one extreme setting to the opposite one. If the action of the control is correct, the picture should roll upward at one extreme and downward at the other during this rotation. If roll in one direction only can be obtained, insufficient control range is present, and may be a cause, or at least a contributing cause, of the trouble.

Oscillator Defects

Tube Defects. When occasional roll or critical vertical hold is the complaint, and a 6BL7 is used as the vertical oscillator, the tube itself is a logical suspect. This is particularly true if the tube is one that was manufactured several years ago. An estimate by a manufacturing source is that about 50% of early 6BL7 tubes may cause vertical instability. A tendency to grid emission is present in the tubes. The grid emission causes bias to decrease progressively, and the frequency of oscillator operation changes in step with the decrease, causing vertical drift or roll. Tapping the tube is likely to bring on the instability symptoms, if the tube is to blame, and may be used as a test.

A number of new tubes, including several different makes of tubes, may have to be tried in some cases when a 6BL7 is being checked by substitution as the possible cause of vertical instability. A 6BL7 may be replaced by the more stable 6SN7GT in many instances; sometimes, particularly when the line voltage is relatively low, the substitution will not provide proper height, linearity, or both. A 6SN7GTA can dissipate more power than a 6SN7GT, and may be more stable; thus it is more desirable as a substitute. (Overheating of an oscillator promotes instability.)

Dirty tube pins are a possible source of intermittent instability and should be checked.

A noisy oscillator tube may be responsible for intermittent vertical synchronization losses. If gently tapping the tube brings on (or eliminates) symptoms, the tube should be replaced and results noted.

Grid Capacitor. The grid coupling capacitor is a common cause of vertical drift trouble, particularly drift during warm-up. Heat-caused changes in capacitance are responsible. Other capacitors in the frequency-determining circuit may also be the cause of the symptoms. Holding a soldering iron near suspect capacitors, in turn, and noting whether symptoms develop is one way to test for the condition.

Capacitor substitution offers the best check when suspicion has fallen on one particular unit. The best capacitor to use as a test replacement (or a permanent replacement) is a silver mica unit. This type undergoes a very small change in capacitance in the presence of heat, and recommends itself for this reason.

Sometimes undue heating of a grid capacitor is due to the presence of a hot resistor nearby. Physical relocation of the capacitor or resistor in question will serve as a test, as well as a remedy for the condition.

When a grid or frequency-determining capacitor is located in warm surroundings and nothing else can be done about the matter, use of a silver mica capacitor with a voltage rating that is considerably higher than required will minimize the heating effects on the capacitor.

Intermittent vertical instability may be due to a leaky or intermittently open capacitor in the frequency-determining circuit. In a typical blocking oscillator like that of Fig. 1, capacitors C_{246} and C_{247} have the greatest effect on frequency. One way to test for such trouble is to scope-check the amplitude of the voltage waveform present at either side of suspect capacitors first, when the set is performing normally, and again later, when it isn't. The defective capacitor will show a considerable change in the relative amplitudes of the waveform voltages between its terminals and ground.

Grid Resistor. Heat-caused changes in the value of a resistor in series with the vertical hold control may be the cause of vertical instability. Checking the resistance of the suspect unit before and immediately after symptoms have manifested themselves will serve as a test for such trouble. Use of

(*Continued on page 80*)

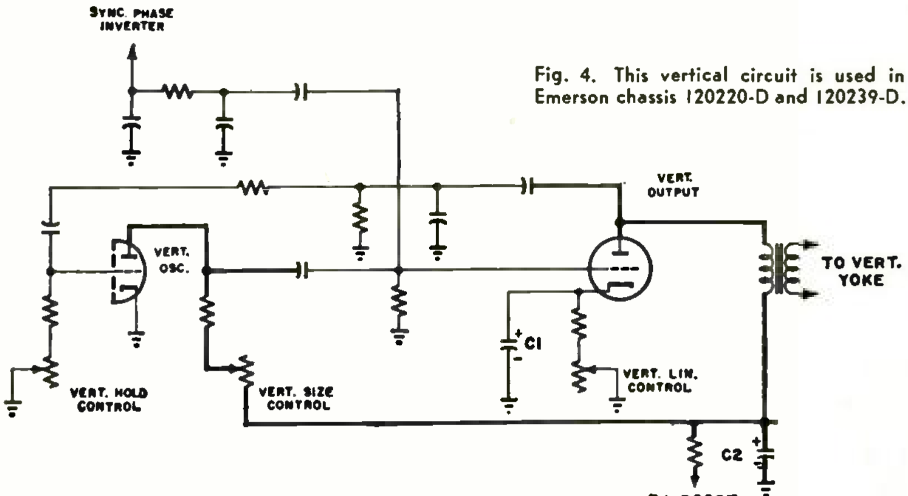
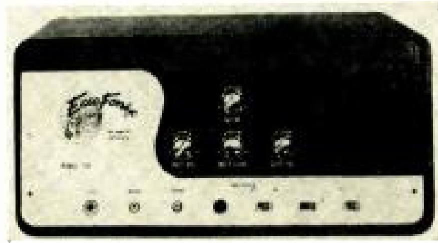


Fig. 4. This vertical circuit is used in Emerson chassis 120220-D and 120239-D.

Hi-Fi-Audio Product Review

RECORDING ECHO AID

Ecco-Fonic, Inc., 905 S. Vermont St., Los Angeles, Calif. has introduced a device that provides pre-set amounts of echo, sound delay, and reverberation during a recording session. The "Accompanist" is an amplifying and rever-



beration unit which may be used to enhance certain acoustic effects in one's own recording, as well as to overcome problems of poor room acoustics.

A portable model is designed for use by musicians and singers. Additionally, it can be used with existing stereo or mono reproducing equipment. The console model includes a built-in 15-ips tape recorder with a repeating "memory" tape cartridge.

SONY TAPE RECORDERS

Superscope, Inc., Audio Electronics Div., 8150 Vineland Ave., Sun Valley, Calif., has introduced three new "economy priced" tape recorders. The *Sony* 101 is an a.c.-operated, bantam, transistorized dual-track monophonic recorder. It comes complete with carry case, built-in speaker, and dynamic microphone.

The *Sony* 262-SL is a 4-track monophonic recorder with 4- and 2-track stereo playback. It includes a built-in monophonic preamplifier, recording amplifier, and monitor power amplifier. A second-channel playback preamplifier is also provided. It features sound-with-sound recording, and is supplied

with portable case, earphone, monitor speaker, dynamic microphone, and connecting leads for stereo playback.

The *Sony* 262-D incorporates the transport mechanism of the model 262-SL, without electronics, but with a 4-track stereo erase head and 4-track stereo record/playback head. The heads are wired to six output and input facilities for connecting to external electronics.

P.A. AMPLIFIER

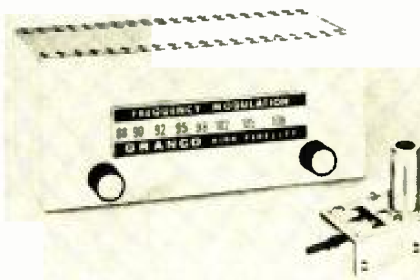
Fanon Electronic Industries, Inc., 98 Berriman St., Brooklyn 8, N. Y. has added the Model 3310 public-address amplifier to its line of audio equipment.

Power output is 10 watts at less than 5% distortion with peak power output (music waveform rating) of 14 watts. Frequency response is 30 to 20,000 cps ±2 db. The circuit provides one microphone input and two phono inputs with fader control. Gain is 120 db on microphone and 85 db on phono. The amplifier is especially designed to accommodate a phono top which is offered as an accessory, the Model 3604.

A data sheet providing complete electrical and physical specifications on this unit is available on request.

FM CAR RADIO

Granco Products, Inc., 83-30 Kew Gardens Road, Kew Gardens. N. Y. has announced a low-cost FM receiver, to be produced for 1961 car models. Ac-



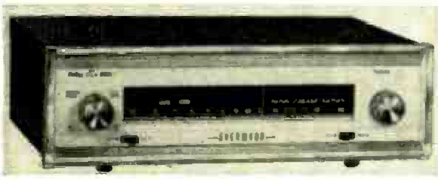
cording to the manufacturer, the front end of this 8-stage set will utilize transistors and an a.f.c. device that eliminates the need for fine tuning. Reportedly, the set will lock the FM station into perfect tune as soon as sound is picked up.

Designed for installation in cars using a 12-volt ignition system, the set is supplied less antenna and loudspeaker.

SHERWOOD FM TUNER

Sherwood Electronic Laboratories, Inc., 4300 N. California Ave., Chicago 18, Ill. has introduced its Model S-3000 III FM tuner. This unit is a basic FM tuner, with space internally to plug in the same manufacturer's Model AMX multiplex adapter, which then makes it possible to receive stereo *via* FM multiplex.

The tuner itself uses a "corrective" inverse feedback circuit for improved response and lower distortion. In the S-3000 III, 3 db of inverse feedback is applied from the discriminator to the a.f.c. tube. Its effect is to increase the discriminator equivalent to 1100 kc. and the i.f. equivalent bandwidth to 290 kc., without sacrificing selectivity.



This technique also is said to improve long distance reception.

Other features include an FM interchannel muting control; tuning eye; 7-inch expanded slide-rule tuning scale; a.f.c., and local-distant switch. Sensitivity is stated as 0.95 microvolt for 20 db quieting, and 1.8 mv. for the IHFM standard of 30 db noise and distortion below 100% modulation. IM with corrective feedback is given as ¼% at 100% modulation. Hum and noise are specified at −60 db; frequency response, 20 to 20,000 cps ±½ db.

FAIRCHILD TURNTABLE

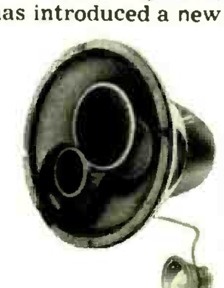
Fairchild Recording Equipment Corporation, 10-40 45th Avenue, Long Island City 1, N. Y. has announced the availability of a high-fidelity turntable, the Model 440.

The new turntable provides two-speed operation (33⅓ and 45 rpm), single-belt drive, a "Speed Sentinel" control that varies turntable speed by ±1½%, and a precision turntable platter. The entire assembly is supplied on a channel for easy mounting. Rotational speed is controlled by applying d.c. to the motor windings. This is controlled from the top of the unit. A strobe disc is supplied with each turntable as is a graph of the unit showing performance over a 24-hour testing period.

The mounting board and base (in walnut or unfinished) are available as accessories.

THREE-WAY SPEAKER

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y. has introduced a new 10-inch, 3-way loudspeaker designed expressly for bookshelf enclosures.

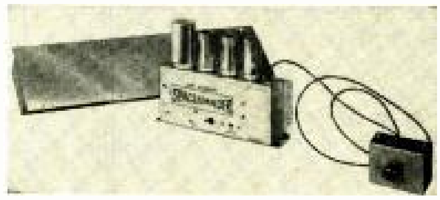


Known as the "Trihelix," the new speaker utilizes three mechanically and electrically independent speakers mounted within a 10-inch frame. A built-in electrical network provides crossover from woofer to mid-range at 1500 cps, and from mid-range to tweeter at 5000 cps. Over-all response is said to be 20 to 20,000 cps ±3 db. To minimize interaction among the three speaker cones, the mid-range and tweeter units are mounted eccentrically off center in relation to the woofer. Additionally, mid-range and tweeter are completely enclosed by specially designed baffles.

The woofer employs a "conical stiffener" at its apex to improve piston action. Designated by stock number SK-180, the "Trihelix" has an impedance of 8 ohms, and free air resonance of 35-55 cps. Power rating is 20 watts for average program material.

REVERBERATION DEVICE

Fisher Radio Corp., 21-21 44th Drive, Long Island City 1, N. Y. has announced a new device for enhancing the reverberation characteristic in reproduced sound. Designated as Model K-10, and called the "Dynamic Spacexpander," the new unit is said to enhance both stereo and mono playback by providing the reverberation that is heard in the concert hall, but which is usually absent in recording studios and the average listening room.



The Model K-10 can be used with virtually all *Fisher* units, both components and consoles, now being manufactured. Additionally, it can be used with high-fidelity systems using separate preamplifiers or having tape monitoring facilities.

LOW-COST CARTRIDGE

Shure Bros, Inc., 222 Hartrey Ave., Evanston, Ill. has brought out a new low-cost magnetic stereo cartridge. Especially designed for use with record changers, the new pickup, model M8D, is known as the "Stereo Standard Dynetic." Claimed response is 30 to 15,000 cps; channel separation is given as more than 20 db at 1000 cps. Tracking force is 5 to 8 grams.

The M8D uses the moving magnet principle. Compliance is listed as 3 x 10^{-6} cm./dyne. Output voltage is 5 mv. per channel at 1000 cps. Recommended load impedance is 47,000 ohms. The cartridge has four terminals but is adaptable to three-terminal arms.

ORGAN TUNING KIT

Schober Organ Corp., 43 West 61 St., New York 23, N. Y., has introduced its "Autotuner" which permits fine-tuning of electronic organs in a matter of minutes without the need for technical skill or musical knowledge.

The "Autotuner" is a strobe device that provides accurate pitch to within 1/100 semitone, said to be finer than the human ear can hear. Small enough to be carried in the pocket, it is available fully assembled or in assemble-it-yourself kit form.

V-M STEREO RECORDERS

V-M Corporation, Benton Harbor, Mich. has added a new stereo recorder to its 1960-61 line. The new portable is Model 722 and records stereophonically on 4 tracks. It offers monophonic as well as 2-track and 4-track stereo playback. Included are two microphones and a dual tuning eye. Model 722 also incorporates the "Add-A-Track" feature which permits recording on one track, rewinding the tape, and recording again on a second track while listening to the first. Then, on playback, both tracks can be heard together.

To complete the stereo playback mode, using the 722, the company also offers its Model 168 auxiliary amplifier-speaker as a separate unit. Other models in the new line include stereo and mono equipment in table models and consolettes.

STEREO MATRIXING XFORMER

Microtran Company, Inc., 145 E. Mineola Ave., Valley Stream, N. Y. is in production on a new stereo matrixing transformer which permits the audiophile to convert his monophonic system to stereo or enlarge and modify his existing stereo setup.

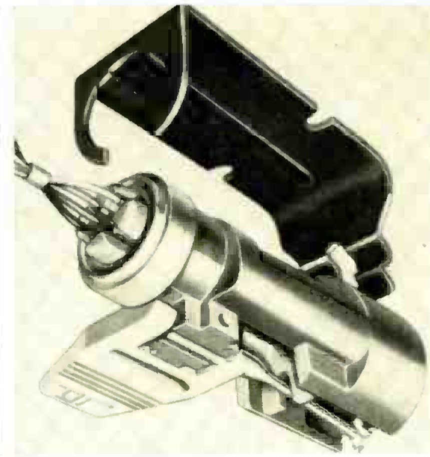
The new transformer provides for the use of "left" and "right" amplifiers to provide "sum and difference" speaker outputs. Two of these units (one for each channel) used with "left" and "right" amplifiers enables virtually any kind of stereo system to be built with simple components.

Specifications include a 30-watt power rating, 100 watts peak; frequency response from 40 to 20,000 cps; and impedance range of +16, +8, +4, 0, −4, −8, and −16 ohms. The transformers measure 3¾" x 2½" x 2$\frac{5}{16}$" with 3⅛" mounting centers.

CRYSTAL STEREO CARTRIDGES

Sonotone Corp., Elmsford, N. Y. is offering a new Series "12" line of crystal stereo cartridges. These low cost pickups feature high output, easily replaced stylus, and simple installation. Model 12TH has an output of 2.5 volts; Model 12TL, an output of 1 volt.

Both models use 0.7-mil and 3-mil sapphire stylus tips. Both are of the turnover type. Tracking pressure for



the 12TH is recommended at 9 to 11 grams; for the 12TL, 6 to 8 grams. Recommended load for either type is 1 megohm. Channel isolation is said to be 15 db. Each is supplied with a mounting bracket.

PROFESSIONAL RECORDERS

Crown International, So. 17 St. & Mishawaka Rd., Elkhart, Indiana, has announced its new "Supra professional" 800 series of tape equipment. Featured are: all-electric controls; a third head monitor with *A-B* and echo switch; "advance micro cueing;" photocell automatic stop. The 800 uses three motors with a synchronous capstan motor. It is a three-speed unit, accepts 10-inch reels, with 14-inch reel capacity available.

Performance claims are: at 15 ips, ±2 db, 30 to 30,000 cps, with flutter and wow 0.06%, and noise ratio 58 db; at 7½ ips, ±2 db, 20 to 22,000 cps, with flutter and wow 0.09%, and noise ratio 55 db; at 3¾ ips, ±3 db, 30 to 15,000 cps, with flutter and wow 0.18%, and noise ratio 51 db. Harmonic distortion is stated as below 3%, measured by NAB standards.

TAPE CUEING TABS

W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis., has introduced "Quik-Cue Contact Tabs," thin aluminum-foil tabs which are applied to recording tape for automatic stop-start-repeat operation with tape equipment that incorporates automatic switching. Tabs are applied to the tape wherever switching or cueing is desired. When the tab reaches the contact points on the machine, it actuates the mechanism.

Tabs are furnished 42 to a dispenser card. When applied to a section of tape, the tab effectively becomes a part of the tape. For further information, write direct to the manufacturer, Dept. 173.

AUDIO CATALOGUES
PHONO STYLI

Astatic Corp., Conneaut, Ohio, has published a 40-page catalogue giving detailed information on the company's complete line. Included is a needle replacement and a cross-reference guide.

Illustrations and the use of two-tone printing facilitate the use of the catalogue. Also included are listing of the company's phono accessories, cartridges, and microphones.

* * *

REPLACEMENT DRIVES

Robins Industries, Flushing 54, N.Y. has issued a new 16-page reference guide designed to help distributors and service technicians select the right replacement drives for nearly 95% of phono and tape recorders.

The guide lists manufacturers, model numbers, and the *Robins* replacement drive for servicing each unit. A supply of new guides will be given free with the company's new phono and recorder parts deal DD-10RP. The guide carries a list price of 50 cents.

* * *

BOGEN-PRESTO BOOKLETS

Bogen-Presto Company, Box 500, Paramus, N. J. has issued three new booklets of interest to audiophiles.

The first publication, #520, describes three stereo receivers and the five tuners and amplifier which the company is offering in a new gold panel cabinet as well as in grey. Performance data, photographs, and prices are shown for each model.

Publication #521 covers the company's line of turntables for home hi-fi systems while the third publication is an 8-page catalogue of the "*Presto* 800 Series Professional Tape Recorders." This publication, #910, covers models for a full range of recording applications.

* * *

EICO "STEREO GUIDE"

Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, N. Y. is now offering free a four-page booklet entitled "Stereo and High Fidelity."

The booklet covers a definition of stereo sound, discusses stereo sound sources, and provides data on various stereo and mono sound systems, complete with diagrams.

* * *

NEEDLE DISPLAYS

Jensen Industries, Forest Park, Ill. has announced a new catalogue of attractive counter card displays plus a full listing of its phono needle kits for dealers.

Divided into separate sections for dealers, distributors, and service technicians, the new booklet provides detailed data and illustrations of four different kinds of needle kits, and ten different types of point-of-sales display cards.

* * *

FM ANTENNA INFORMATION

Apparatus Development Company, Inc., Wethersfield 9, Conn., has published a 38-page booklet dealing with the installation and operation of FM antennas.

Titled "Theme and Variation," the booklet discusses in non-technical language the function of an antenna and the basic types for FM reception.

Neatly printed and bound, and amply illustrated, the publication will be mailed by the manufacturer upon receipt of 30 cents in coin. -30-

Intermittent Vertical Sync

(*Continued from page 73*)

a resistor of the same value as the original one, but of a higher wattage rating, will generally remedy the trouble.

Oscillator Transformer. In some instances, a blocking oscillator transformer with too high a "Q" may be responsible for vertical instability. A white, horizontal area at the top of the picture is likely to be an associated symptom. The abnormally large "Q" tends to cause ringing from time to time, and the ringing voltages may trigger the vertical oscillator at the wrong times. A test as well as a remedy for the condition, in many cases, is to connect a 1-megohm resistor across the grid winding, or a 10,000-ohm resistor across the plate (or cathode) winding, and note results.

Removing the capacitor connected across the primary or secondary of the vertical blocking oscillator transformer, or reducing its value 50%, will eliminate a tendency to vertical sync instability in some receivers. The procedure is worth a try when troubleshooting has revealed no clear defect.

Hold Control. When insufficient vertical hold control range is associated with vertical instability, check in which direction roll occurs. If the picture rolls up, the vertical oscillator frequency is too far below 60 cps; an increase in grid circuit resistance is indicated. If the picture rolls down, the frequency of the oscillator is above 60 cps; look for a decrease in grid resistance (or capacitance) in this case.

When the vertical hold control has to be turned very slowly to reach a setting at which lock-in is obtained, an increase in the resistance of the control itself may have developed. Try shunting a 1-megohm resistor across the control when symptoms manifest themselves. If lock-in is now much more easily obtained, a defect in the control probably exists. A resistance check of the control may or may not indicate such a defect; substitution of a new control is often necessary as a test.

Miscellaneous Oscillator Stage Troubles. An unusual trouble that some service technicians have found hard to locate is leakage between binding posts to which an oscillator grid component is connected. See Fig. 2, in which a tube pin that normally has no internal connection is used as such a tie point. The leakage may be due to heat. A resistance measurement may or may not indicate the leakage. Disconnecting the grid components from binding posts and noting results will serve as a test for such trouble.

In a plate-coupled multivibrator circuit in which one tube serves as both output stage and part of the multivibrator, leakage in a feedback capacitor (see Fig. 3) can be responsible for intermittent vertical instability. Vertical linearity and size will often be affected by such trouble. Vertical deflection may even momentarily disappear altogether. A resistance check (preferably on the 1000-megohm range of a v.t.v.m.) will often reveal the capacitor defect. The high pulse voltage developed across the capacitor is responsible for its tendency to break down. In Fig. 3, C_{204}, C_{202}, and C_{203} are particularly subject to this trouble. Note their voltage ratings.

Amplifier Stage Defects

Vertical instability may be due to parasitic oscillation in the vertical amplifier stage. The trouble is particularly likely when a triode is being used as the output tube. A check for the presence of such oscillation is to remove the vertical oscillator tube or disable it. If some vertical deflection is still present, parasitic oscillation is probably causing it. The placement of components in the vertical output stage is sometimes responsible for the condition. Make sure the ground returns of components are as close to the cathode ground of the stage as possible. Insertion of a 68- or 100-ohm antiparasitic resistor in series with the grid of the output tube is often an effective remedy.

An unsuspected but possible source of trouble is a loss of capacitance in the decoupling capacitor of the vertical output stage (C_2, Fig. 4). The defect may cause a 60-cycle deflection signal ripple to get into the "B" supply and appear in the sync stages. The ripple signal output of the sync stages will at some times be strong enough to fire the vertical oscillator. Since the phase of the ripple signal is shifted during its travels, it may be out-of-phase with the vertical sync signal, and will trigger the vertical oscillator at the wrong times.

To check for the defect, try bridging the suspected capacitor with another one of the same value and note results. Another way to test for the condition is to make a scope check on high side of the decoupling capacitor. Very little or no vertical sweep signal should be seen here.

In the plate-coupled multivibrator circuit shown in Fig. 3, certain slight defects in the vertical output transformer may cause intermittent vertical instability. (The "Q" of the transformer determines, in part, the size of the feedback signal; any defect that changes the transformer "Q" may therefore affect vertical stability.) Replacement of the transformer will serve as a test as well as a remedy for the condition. The original transformer may work normally in some other receiver, and need not be discarded.

The cathode bypass capacitor of the vertical output stage is normally not a logical suspect when intermittent vertical instability exists, but in some circuits it can cause such trouble. In Fig. 4, for instance, degeneration produced by an intermittent reduction in the capacitance of the cathode capacitor (C_1) can attenuate the vertical sync pulse and cause vertical instability. —30—

Handy Dust Remover

By

RICHARD E. SHAFER

Vacuum-cleaner extension uses suction for cleaning.

HIGH-VOLTAGE arcing, overheating, and general malfunctioning of TV sets, radios, electric clocks, fans, and other small appliances can be caused by dust and lint. Microscopic dust is plentiful, even in apparently "clean" air.

Since most appliances operate at temperatures above ambient, this causes an increase in convection air circulation, with additional dust deposited. The dust adheres to oily surfaces and is also strongly attracted by high-voltage charges found in TV sets.

It is essential to remove such dust from inside these appliances. Before beginning such a periodic cleaning operation the unit must be disconnected and the high voltages of the type found in TV sets must be discharged.

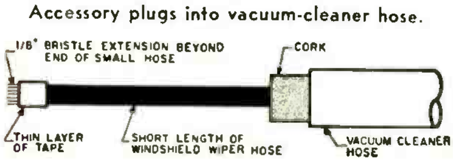
Cloths or brushes may sometimes be used for dust removal from parts but this generally stirs up the dust which may fog into more critical areas. This method also tends to force dust into small holes or gaps where it may cause trouble. A cloth and window cleaning compound can usually be used to clean the face of the picture tube and the safety glass.

Ordinary vacuum-cleaner hoses are too large to fit into such congested areas as TV chassis. A good solution to the problem is to use a short length of windshield wiper hose, as shown in the diagram. It is desirable to use the shortest practical length of hose since the suction loss is directly proportional to the length of the hose. It is also advisable to use the largest practical diameter because the pressure loss is directly proportional to the square of the velocity.

The arrangement shown has proven satisfactory and does not abrade parts or wiring. After removal of the dust, high-voltage insulators, tube supports, and other critical parts can be wiped with a cloth.

The bristles shown in the diagram can be cut from an old toothbrush or from plastic strands. A thin layer of bristles is installed *around* the tube, none should be placed in front of the tube opening. —30—

Accessory plugs into vacuum-cleaner hose.



Electronic Metronome

(*Continued from page 39*)

transformers and transistor. C_2 should be varied from about 100 to 150 $\mu\mu$f. until the optimum value is found. The brilliance of the lamp does not affect operation of the metronome and need not be adjusted unless maximum light output is desired. Several transistors were tried in the circuit with no change in C_2 being required.

Battery drain is low and varies from about 200 μa. to 1 ma. at the higher rates. Battery life is in excess of several hundred hours.

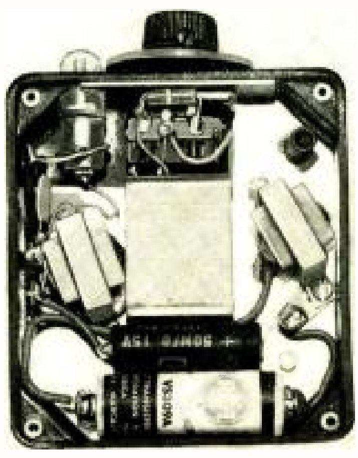
Before beginning calibration, check the range of ticks to make sure it exceeds 40 to 208 counts per minute. If this range is not covered, a slight variation in R_1 will change the upper limit as described earlier. However, during the design of the circuit, it was noted that some capacitors used for C_1 showed a leakage resistance which prevented the metronome from approaching the 40-beat lower limit. If you experience this difficulty, try different capacitors of the same value.

The extremely wide range covered by the rate potentiometer, R_2, is reduced by shunting the control with a 1-megohm resistance, R_3. Depending on the condition of capacitor C_1 and the actual value of R_2, some variation in R_3 may be necessary to cover the slower rate adequately. Once you determine this resistance, the metronome is ready to calibrate.

Calibration

Calibrate the metronome by counting the number of ticks over a given period of time. For the slower rates, better accuracy can be obtained if the ticks are counted for several minutes. One easy method of calibration consists of temporarily mounting a card on the metronome and marking off the beats-per-minute for various settings of the control. Calibrations can be transferred to a disc which is then glued to the bottom side of the control knob, as shown in the photo. —30—

View showing how chassis plate is mounted within the speaker case.



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G	Audio-Hi Fidelity*	V-3 or equivalent	Eve. 3 mos.
H	Video Tape*	V-3 or equivalent	Eve. 3 mos.
I	Technical Writing (V-10)	V-3 or equivalent	Eve. 3-18 mos.
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K	Radio Code (V-4)*	8th Grade	Eve. as desired
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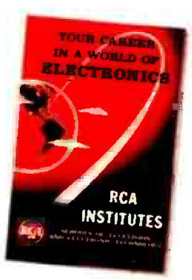

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"Reverse" GDO

By JOHN POTTER SHIELDS

HERE'S a little trick that has proved handy for calibrating various receivers, r.f. oscillators, etc. All that is required is a fairly accurate signal generator and a v.t.v.m. or high-impedance v.o.m. The calibration accuracy is limited only by the accuracy of the signal generator or other calibrating source, and the procedure is simplicity itself.

Fig. 1. shows the basic idea. A coil, consisting of a few turns of hookup wire, is connected to the output of the signal generator and placed over the oscillator coil of the oscillator to be calibrated. The v.t.v.m. or high-impedance v.o.m. is used to measure the oscillator's grid voltage by connecting it across the oscillator's grid resistor.

In operation, power is applied only to the oscillator and its grid voltage is noted. Next, the signal generator is turned on and adjusted for maximum output. Slowly vary the signal generator's output frequency over the expected range of the oscillator under calibration. At some point, the oscillator's grid voltage will "jump," indicating resonance with the signal generator's output frequency. The signal generator should now be carefully adjusted for maximum oscillator grid voltage; at which point, the oscillator's operating frequency can be read on the signal generator's dial. It's that simple.

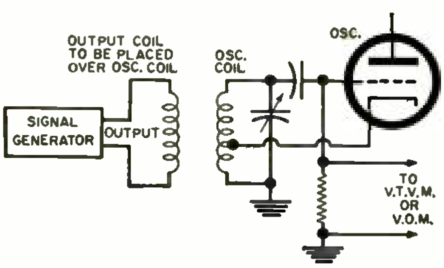
The whole idea is based on the fact that the coil placed over the oscillator coil absorbs energy from the oscillating circuit; lowering its grid voltage when its frequency is not the same as that of the signal generator. When the signal generator and oscillator are operating at the same frequency, the coil no longer absorbs energy from the oscillating circuit and the oscillator's grid voltage rises.

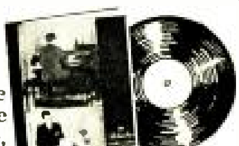
As in the case of a standard grid-dip oscillator setup, the coupling between the oscillator coil and pickup coil should be as loose as possible in order to obtain the sharpest reading. Also, any source of r.f. of a known frequency can be used in place of the signal generator with equally good results.

Well, that's the story on the "reverse" grid-dip oscillator. The author recommends it as a simple, inexpensive, and accurate means of r.f. calibration.

—30—

Fig. 1. Handy calibrator for receivers.

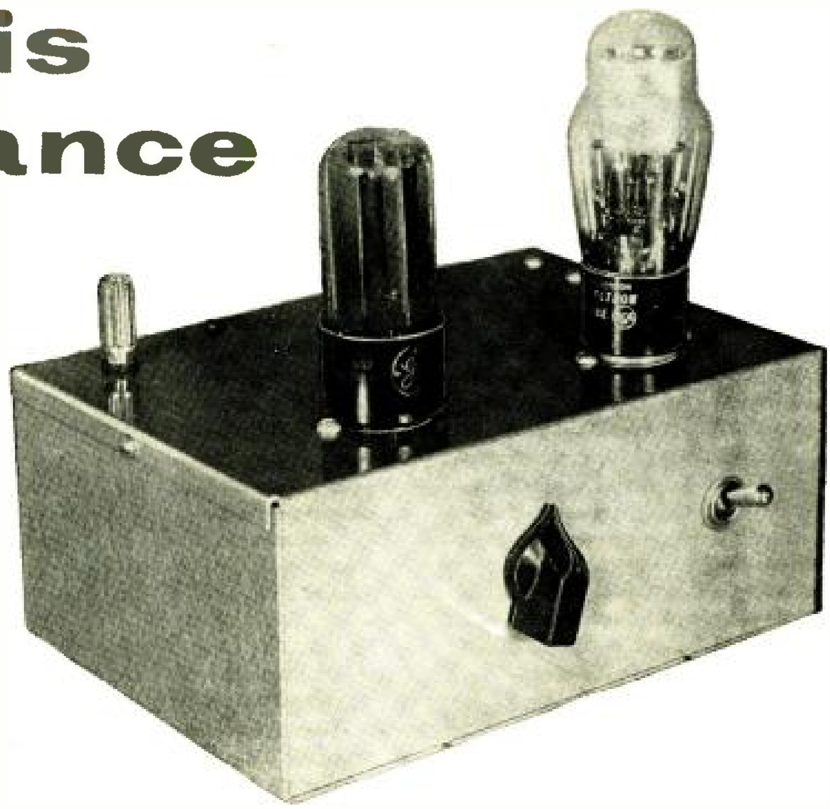




Build This Capacitance Relay

By
RUFUS P. TURNER

Construction details and operating theory for a simple two-tube capacity operated relay circuit. Standard components are employed throughout.



Front view of the capacitance-operated relay. Unit is built on a 7" x 5" x 3" chassis. The 117N7 tube is on the left, the 2050 is on the right. The antenna terminal is at the left rear corner atop the chassis. The knob is for pot R_2.

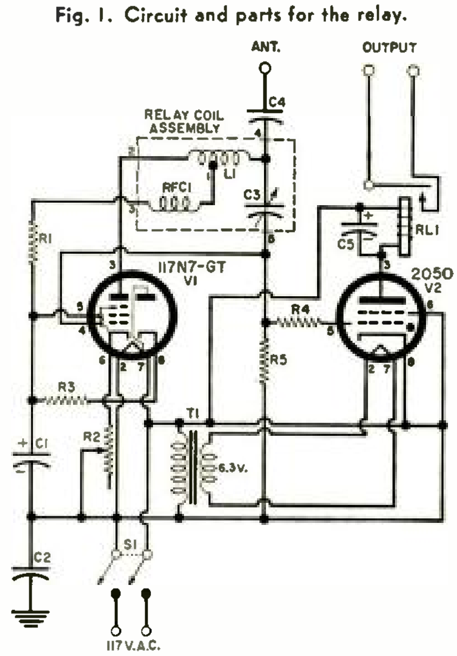
A CAPACITANCE-OPERATED relay is both useful and entertaining. It can be used to turn electrical devices on and off and it has the interesting ability to go into action whenever the human body, hand, or some metallic object comes near its antenna. It makes a reliable intrusion alarm when its antenna wire is concealed around a door frame or window frame or hidden under a rug. It is an interesting crowd-stopper when used to activate exhibits in a store window when the window is touched by passers-by!

The basis of the capacitance-operated relay circuit is a simple r. f. oscillator connected to a short wire or metal plate as an antenna. Oscillator tube current is made to actuate a relay, either directly or through a second tube. The circuit is so adjusted that the current normally is insufficient to operate the relay. But the presence of a hand or body near the antenna will introduce enough extra capacitance to detune the oscillator, change the current, and operate the relay.

Rugged Circuit

The oscillator in the capacitance-operated relay shown here is built around an inexpensive, commercial capacity relay coil—*Miller* No. 695. This manufactured coil unit is complete and well-built and will save the experimenter a great deal of time and bother in making his own. The coil unit includes in one assembly the oscillator coil L_1 (see Fig. 1), radio-frequency choke RFC_1, and screwdriver-adjusted trimmer capacitor C_3. Five terminal lugs (numbered in Fig. 1) permit simple connections to other components in the oscillator circuit.

Fig. 1. Circuit and parts for the relay.



R_1—3300 ohm, 1 w. carbon res.
R_2—1000 ohm wirewound pot.
R_3—150 ohm, ½ w. carbon res.
R_4—2.2 megohm, ½ w. carbon res.
R_5—680,000 ohm, ½ w. carbon res.
C_1—30 μf., 150 v. elec. capacitor
C_2, C_4—.1 μf., 600 v. capacitor
C_3—Mica trimmer (part of L_1)
C_5—8 μf., 150 v. elec. capacitor
L_1—Oscillator coil (Miller No. 695 capacity relay coil, see text)
RFC_1—R.f. choke (Part of L_1)
RL_1—110 or 115 volt a.c. relay (Leach Type 1157 or equiv.)
S_1—D.p.s.t. toggle switch
T_1—Fil. trans. 6.3 v. @ 1 amp. (Merit P-2944 or equiv.)
V_1—117N7-GT tube
V_2—2050 tube

Fig. 1 shows the complete circuit which has been adapted from the hookup recommended by the coil manufacturer. The oscillator includes a 117N7-GT tube. The pentode section of this tube is the oscillator, and the rectifier section furnishes d.c. to the pentode.

The relay is a 110-volt a.c. unit. The *Leach* Type 1157 relay shown here was available surplus, however, any other available 110- or 115-volt a.c. relay will work in the circuit. The *Leach* unit has two pairs of contacts which can be connected in parallel to control heavy loads. The relay is actuated by a 2050 gaseous tube. The control grid of this tube is actuated by oscillator grid current changes in resistor R_5. The 2050 filament is operated from the 6.3-volt output winding of filament transformer T_1.

The capacitance-operated relay circuit has two controls which do not often need re-adjustment in permanent installations; they are potentiometer R_2 and trimmer capacitor C_3. The latter is part of the coil assembly. The potentiometer is adjusted by means of a front-panel knob (see photo), while C_3 is adjusted with a long screwdriver blade inserted through a hole in the rear of the chassis.

The antenna may be 3 feet or more of insulated wire connected to the "Ant." terminal. The free end of this wire may be connected to a metal plate (2 inches square, or larger) when increased "pickup" is desired. The device to be controlled and its power source are connected to the "Output" terminals.

Construction

The circuit is not critical and the reader can suit himself pretty much regarding the layout of parts. However, the arrangement shown in the photographs seems the most compact obtainable with the parts used. A 7" x 5" x 3" enamelled aluminum chassis box was used for the assembly shown in the photographs.

Each of the tubes requires an 8-contact octal socket, and these are mounted in 1⅛" holes cut with a socket punch or fly-cutter.

The oscillator coil, potentiometer R_2, and switch S_1 are mounted along the front lip of the chassis. The potentiometer requires a ⅜" hole, and the switch a ½" hole. The coil has two mounting feet which are held with 6–32 screws. Transformer T_1 and relay RL_1 are "slung" under the top of the box. The "Ant." and "Output" binding posts are mounted with insulating washers to prevent their making contact with the metal box, and the "Output" posts are placed close to the relay. The "Ant." post is mounted through the top of the box, and the "Output" posts on the rear lip.

Be careful to observe the correct polarity of the electrolytic capacitors (C_1 and C_5), as shown in Fig. 1.

The screwdriver clearance hole on the rear lip of the box should be at least ⅝" in diameter and should be directly in line with the coil (mounted on the front lip). The hole for the power cord (center of rear lip) should be lined with a rubber grommet to prevent cutting of the cord.

Operation

After checking to be sure the wiring is correct, connect about 3 feet of insulated hookup wire to the "Ant." terminal, set potentiometer R_2 to its maximum-resistance setting, insert the power plug into a 117-volt a.c. outlet and throw switch S_1 "on."

Now allow about 3 minutes for warm-up; then bring your hand within 1 inch of the antenna wire. If the relay does not close—you should hear it click—advance the setting of the potentiometer R_2 carefully while continuing to hold your hand near the antenna. Also adjust trimmer C_3 with a long-bladed screwdriver (preferably insulated) through the hole in the back of the chassis. A point will be found in the adjustment of C_3 and R_2 where the relay clicks-in readily when your hand is brought near the antenna wire and clicks-out when it is withdrawn.

The correct adjustment with any particular antenna is the point at which the unit is sensitive to approach at the distance you wish, but is not so unstable as to set itself into operation when no object is nearby. Make the adjustments so that the relay operates under the influence of objects at the distance you wish.

Better sensitivity and stability will be obtained with the power plug inserted into the a.c. outlet one way than the other. Experiment to find which way is best. The unit must be re-adjusted whenever changing to a different type of antenna. In general, keep the antenna as short as possible to reduce radio interference.

After adjustment, connect an electric bell and battery in series with the "Output" terminals. Bring your hand near the antenna or walk by, and the bell will signal your approach. Withdraw, and the bell will stop ringing. A lamp and power source likewise can be connected in series and to the "Output" terminals as an alarm device. So can a motor be operated.

How It Works

The oscillator frequency is approximately 2 megacycles. In the simple, self-excited circuit, there is no tank capacitor other than the distributed capacitance of the coil plus stray and tube input capacitances. This, of course, makes it easy for external capacitances to affect the circuit. Despite the low-C tank, the frequency stability is good enough for this application.

The trimmer capacitor, C_3, which is part of the manufactured coil assembly, controls r. f. excitation to the oscillator tube grid, maximum feedback and excitation voltage occurring when this capacitor is set for maximum capacitance (screwed tightly). Rheostat R_2 being the cathode resistor of the oscillator tube, sets the static d.c. grid-bias level. At maximum resistance of R_2, negative bias is highest, and C_3 must be set for high capacitance in order to obtain enough r.f. grid voltage for oscillation. The circuit appears to have least capacitance-sensitivity in this condition. Capacitor C_4 is an isolating unit which prevents plate voltage from reaching the antenna and thus protects against shock and particularly short-circuit.

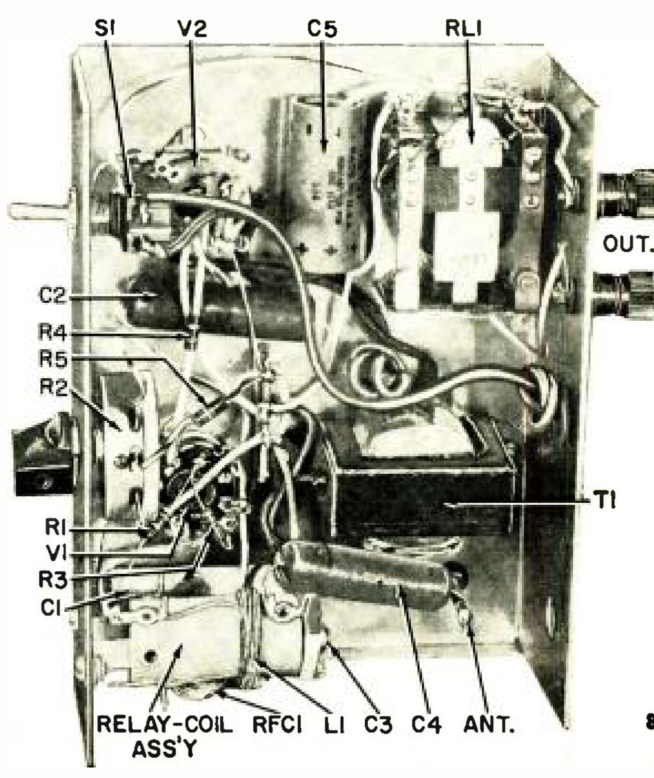
When the unit is placed in operation, trimmer capacitor C_3 and bias rheostat R_2 are adjusted for oscillation. (Actually, the circuit is most sensitive when adjusted just to the threshold of oscillation.) An object brought near the antenna then will add capacitance to ground, thereby reducing the excitation applied through the capacitance of C_3. This causes oscillation to cease. You might say that the nearby object robs the grid of the excitation necessary for oscillation.

Oscillator grid current is high during oscillation and low in the absence of oscillation. Grid current flows through resistor R_5, producing a comparatively high voltage drop across this resistor during oscillation and a low voltage drop when there is no oscillation.

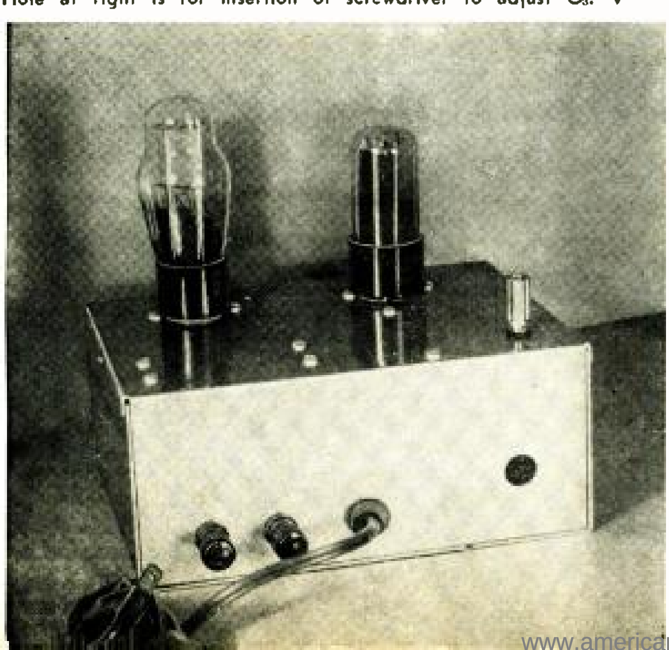
Since the top of R_5 is connected

(Continued on page 148)

Inside view of the capacitance-operated relay showing location of parts. Tuned circuit used is a pre-assembled, available unit.



Rear view of the relay. The two output terminals are at left. Hole at right is for insertion of screwdriver to adjust C_3.



By
BERT WHYTE

CERTIFIED RECORD REVUE

As I write this column, Labor Day is still in the offing and the record industry is still in the throes of its mid-summer slump. Sales are far lower than those of past summers and I think that continuing public confusion regarding stereo is one of the prime factors contributing to this situation. Perhaps the story I am about to relate will offer a little insight into this very serious problem confronting the record industry.

I have been traveling a great deal in the past few months, so a few weeks ago when I was home to roost for a while, I threw a little party for some friends I hadn't seen in some time. There were eight people besides my wife and myself, all of widely varying backgrounds. Only one was connected with the electronics field—and his connection with audio was no more than casual.

The others were in the construction game, insurance, and stock brokerage. Only one was a real "music lover," the rest professing to "enjoy music," especially, as they said, "when we hear your system." In other words, they could be properly classified as the "lay public" in terms of their knowledge of music and audio.

Now keep in mind that I had not seen these people in some time and their exposure to stereo had followed the normal pattern. They had read the propaganda barrages touting stereo as being "all things to all men," that music had "broken through the sound barrier," and that "concert hall sound was now a reality," etc., etc. They had visited the establishments selling this new miracle—the department and appliance stores. All of them felt that they had been grossly oversold since the demonstrations they had heard didn't live up to the glowing claims of the advertisements.

All of them, having visited my home in past years, felt that my "hi-fi" sounded much better than this newfangled stereo thing. And all of them confessed that they were given such incredible gobbledegook as an explanation and sales talk that, coupled with the sound they heard, they were just plain confused about the whole thing.

Having thus elicited this information from my friends *via* the relaxation of some tall, cool glasses with interesting contents. . . . I proceeded to play some stereo discs for them. I ranged from jazz and other "pop" fare to some of the more familiar classics. In doing so I came up with some very interesting comments and perhaps a few clues as to why John Q. Public reacts as he does to the "commercial demonstration."

I hardly need tell you that my friends "flipped" when they heard my stereo system. Their enthusiasm was boundless and, at the same time, was alloyed with indignation at what had been represented to them as stereo. I hastened to point out that, in all fairness, they must remember that in hearing my stereo they were listening to an "all-out," very expensive *component* system, very precisely positioned for maximum stereo effect, in a room that had been given special acoustic treatment for still further enhancement.

Sobered somewhat by this, I then pointed out to them that a selection of very modest *components*, set up with reasonable regard for the rules governing good stereo reproduction, could be quite satisfactory and would enable them to enjoy the musical treasures in the ever-growing stereo catalogue. At this point, as you might expect, one of the women present said, "I can see your point, Bert, but what about the problems of decor . . . you know our home is furnished in period style and I don't think I could fit components into our setup. Why can't we get the same sort of stereo sound from the consoles you see advertised? There is a lovely Queen Anne unit in X's window that would just fit perfectly in my living room."

Somewhat wearily and I confess a bit peevishly, I said to her, "You will have to make up your mind which is more important to you . . . good sound or decor." And she threw the ball right back to me and surprised me a little by proclaiming that *both* were important to her and wasn't there any way in which her desires could be fulfilled?

So there is clue No. 1. The "woman of the house," always a formidable factor in purchases which involve decor, is not wholly intractable and is pliable to the extent that *once having heard what good stereo is really like*, wants to have it in her home but wants it housed in something that will be in reasonable harmony with her furnishings.

For our lady friend and the others assembled I went into the anatomy of a stereo sound system and pointed out that no matter where or in what the other components of a stereo sound system were housed, it was desirable, in fact almost mandatory, that the speakers be housed each in its own separate enclosure. I showed the lady some pictures of currently available speaker enclosures or systems of the smallish "bookcase" size and she came out with the not-unexpected comment that they were not far removed in looks from packing cases and that while their simple lines might fit into modern decor, they certainly would be out of the question in her period living room.

Pressed a bit further, she admitted that she would make the concession of using two separate speaker systems in order to obtain good stereo but was adamant on the point that it surely must be possible to get these speaker enclosures in some reasonable approximation of the style she desired. Are you listening manufacturers?

Now to the startling part of this evening! As I played various types of music I gave everybody a chance to sit in "the best seat in the house." I think my system has as good "off-axis" stereo perception as any I have heard, but I freely admit that until we have three-channel stereo and its enhancement of off-axis effects, the choice listening in stereo is at an optimum position between the speakers. Thus seated, my guests made some observations which should lift a few eyebrows. When "big band" type of "pop" ballad material was being played, they commented on the clarity of the instrumentation and, as with most newcomers to stereo, got quite a kick out of the directional changes in the orchestra, especially in the more "ping-pong" type of recording.

They commented that in the "appliance-store" demonstrations they had heard, directionality was talked about, but they failed to perceive it altogether or only on a very marginal basis. I played various classical pieces for my friends and was quite surprised when the consensus (by now they were all stereo experts) was that something must have gone wrong with my system and that it wasn't balanced! Needless to say, I very quickly checked and, as I suspected, nothing was wrong with the balance but my friends were manifesting a condition which never fails to astonish me.

Now, these people were all fairly well-to-do, certainly above average in intelligence and, while not all avid concert-goers, had nonetheless been to more than a few concerts. Thus you would think they had some familiarity with the way a symphony orchestra is set up and the way it sounds. Despite this, my friends were complaining that the sound was erratic . . . it was too much on either the left or the right and the two speakers were not playing together *as they were supposed to do!*

They all pointed out that in the store demonstrations, the two speakers were always working together. This is the fallacy and lack of understanding that is confusing more people and losing more stereo sales than anything else! Very patiently I played certain classical recordings for them and showed them that far from being out of balance, the system was operating at maximum efficiency and that what they were hearing was the true essence of stereo. I explained that according to the way the orchestra is disposed for stereo recording, the manner in which the engineers handle their microphones and, above all, the way in which the music is scored, will vary the effect and amount of directionality and depth in a recording. Thus I played a passage for them in which the scoring called for trumpets and trombones alone . . . explained that these instruments were positioned to the right and hence in a good system in the proper room the sound would appear to come mainly from the right speaker, although if they went right up to the left speaker they would hear the same instruments at a much lower level.

I explained this was an example of directional effects due to sound intensity differences. I then played a passage from another recording in which the first and second violins were positioned to the left and in which the score called for them alone; thus, again, apparently only the left speaker was responding. I then played a work in which a solo flute appears to come right between the two speakers and went on to describe the operation of a ghost channel in an original three-channel recording.

To press home the point, I played full ensemble passages in which both speakers re-sp[illegible]tily, then played M/S (mid-side) type European recordings for them. (Refer to "Stereo Microphone Techniques" by Herman Burstein in our March 1960 issue—Ed.) Having now become indoctrinated to the American style of stereo, the M/S seemed flat to them. I also pointed out and played for them various recordings on different labels, showing that some companies carried out directional effects to unrealistic extremes, some went too far the other way, and how a few achieved the ideal of directivity that was definite and present, but not too obtrusive and blended with the right amount of depth and instrumental density. This was the clincher with the ladies . . . who now realized why separate speaker enclosures, placed the proper distance apart, was a prime necessity if they were to enjoy true stereo sound.

The message for the manufacturer and retailer is implicit. If they are going to sell stereo to Mr. Average Man, they will have to return to the concepts of separate enclosures. But, in addition, they are going to have to dress up those separate enclosures, in styles and periods as acceptable as those used in the consoles, and then spend some of that advertising dollar to impress the idea on the public. They will also have to spend some more money on the sales personnel at the retail level so that when Mr. Average Man comes in, an *educated* sales person can give an honest and informative demonstration that can only result in increased sales.

WAGNER
DIE MEISTERSINGER OVERTURE
FLYING DUTCHMAN OVERTURE
PRELUDE AND GOOD FRIDAY SPELL (Parsifal)
Columbia Symphony Orchestra conducted by Bruno Walter. Columbia Mono ML5482. Price $4.98.

These are vintage Wagnerian works done to a turn by Bruno Walter. His readings are vital and purposeful and, fortunately, not too heavy-handed. Lovely string sound here and excellent brass of great weight.

In the "Parsifal" excerpts, Dr. Walter creates a wonderfully reverent mood, but doesn't quite match the passionate fervor that distinguishes the manner of Stokowski with this work. Superb playing of the orchestra must be noted here, and a nod of the head to the exceptional monophonic balance and good acoustic employment.

DANCES BY BRAHMS AND DVORAK
Berlin Philharmonic Orchestra conducted by Herbert von Karajan. Deutsche Grammophon Stereo 138080. Price $5.98.

That is the way the title reads on this recording. Actually famed Maestro von Karajan has excerpted eight of the Brahms "Hungarian Dances" and five of the Dvorak "Slavonic Dances" and teams up with the Berlin Philharmonic to give us a recording which cannot be called definitive, but which is a very pleasant and personal view of these staples.

His tempi, in general, are on the fast side but this is of small moment. He elicits some wondrous playing from the Berliners and gives us a recording which can find support from those who do not wish to bother with all the Brahms and Dvorak "Dances."

This is an M/S stereo recording, miked much closer than is usual, with better directivity and more orchestral detail. A very lovely clean sound, with the strings positively luscious.

GRIEG
CONCERTO FOR PIANO AND ORCHESTRA
SCHUMANN
CONCERTO FOR PIANO AND ORCHESTRA
Leon Fleischer, pianist, with Cleveland Orchestra conducted by George Szell. Epic Mono LC3689. Price $4.98.

A pair of summery warhorses, this is a curiously lightweight version, especially with Szell at the helm. Fleischer is an excellent technician and many of his readings have had considerable warmth. Here is the lyricism and warmth but not in the degree which lifts the record above many competing versions. As noted, the Szell accompaniment is entirely sympathetic, but seems oddly devoid of any large sonority. The sound is clean and open but it, too, is on the thin side and could be considerably more robust.

WIENERWALZER PAPRIKA
Philharmonia Hungarica conducted by Antal Dorati. Mercury Stereo SR90190. Price $5.98.

Some more beergarten schmaltz, but when served up so tastily by Dorati and company, is quite a good item for dancing und quaffing. Dorati follows more of a strong balletic impulse with an excellent rhythmic sense, rather than the usual "oompah-umph" treatment.

The orchestra, formed of Hungarian refugees, is playing far better than when we first heard them and turns in a spirited performance. Dorati has chosen such items as the well-known "Merry Widow Waltz," "The Gypsy Princess Waltz," and the "Village Swallows Waltz," along with the lesser known Dohnanyi "Wedding Waltz" and "Die Schonbrunner Waltz." The stereo sound has plenty of power and superb clarity, with depth treatment very effective as it was recorded in the great Grosse Saal with its wonderful reverb characteristics.

BALLET FOR BAND
Eastman Rochester Wind Ensemble conducted by Frederick Fennell. Mercury Stereo SR90256. Price $5.98.

Versatile Fred Fennell departs from the usual thing he has been recording for *Mercury* these past eight years and leaves the field of original works as Rossini's "La Boutique Fantasque," Gounod's ballet music from "Faust," and Arthur Sullivan's "Pineapple Poll." They seem a mite strange at first in their new orchestral garb, but the orchestra plays with such verve and spirit, that one soon is caught up in the swirling stereo sound and begins to enjoy this new experience.

To those to whom the Fennell recordings have always been the signal for a new onslaught of brass and percussion, this may seem a little tame . . . nonetheless this is stereo sound of equally surpassing quality as in others of this series. Good directivity and depth effects throughout.

RACHMANINOFF
CONCERTO #2 FOR PIANO AND ORCHESTRA
PRELUDES FOR PIANO (#3, #6, #2)
Philippe Entremont, pianist, with New York Philharmonic Orchestra conducted by Leonard Bernstein. Columbia Mono ML5481. Price $4.98.

It never fails . . . one company decides that it is time for a new version of this Rachmaninoff staple and all the other companies seem to get the same idea at the same time.

This is the second Entremont record of this work in the *Schwann* catalogue. He did this some years ago for *Concert Hall* and the recording was subsequently sold to *Urania*. By no means can any comparison be made between this and his older recording. The artist has matured in every department and this reading is miles ahead.

In the sound department it is simply "no contest" as this far surpasses what was not a particularly good recording even in its day. Entremont's most endearing quality is his rich expressive warmth. But he fails to match several other versions in the delineation of this work's power and the tone of his piano is not as big as one could want.

Bernstein gives a knowing accompaniment, but I feel he is almost trying to urge the pianist to a little faster tempo. The sound is clean and the piano transients particularly so but, as noted, more sonority would have been welcome. I say let us wait for the other entries in this concerto sweepstakes. There are some giants yet to be heard from! —30—

Sound on Tape

By **BERT WHYTE**

WHAT'S new in the tape world? That is a good question. The 4-track tapes continue to gain ground and, as might be expected, the cartridge boys are playing things real cool since *RCA* gave up on its entry. But no further word is forthcoming on the status of the *CBS* tape and if any marketing plans are afoot, it won't be this fall nor possibly next, either.

I ran across a funny analogy the other day . . . I was in the market for a new movie camera and, if you know anything about this field, you are aware that automation has really taken hold. There are electric-eye automatic jobs and 'lectric zooms and drives and gosh knows what else. The fancier jobs just about think for you. Well, in my innocence I asked the salesman about magazine loading in several models. He looked at me like I must have been in the Mongolian desert for the past ten years. "Don't you know, Mac, that the magazine jobs are all passé?"

This rather surprised me, for at their introduction some years ago, this was supposed to rid the amateur movie man of the odious task of threading up his camera, and was supposed to be the gimmick that would boom movie sales to new heights. Well, it didn't and it hasn't. For some time there has been a slow retreat back to the plain old fashioned roll film, and in today's streamlined cameras, the magazine loader is dead as the dodo.

What caused the demise of such a promising gimmick? From what I was able to learn, the principal reason was that the darn thing would develop mechanical troubles . . . they wouldn't seal properly, or failed to engage the sprocket gears, etc. And the cost was higher than that of the plain and unglamorous roll of movie film. Add these two together plus other reasons and poof!, no more magazines.

Similarly the cartridge for tape held a promise of great things and was supposed to be a tremendous spur to business. Thus far it has led a pretty chequered career. Perhaps the *CBS* or some other scheme will prove workable. Only time will tell and all I can say is that movie magazine bit hit awfully and uncomfortably close to home.

The promised re-entry of *RCA* and *Capitol* has thus far failed to result in my finding any of their tapes, reel-to-reel style, in my mailbox. In the meanwhile other tapes are coming in if not in droves, in at least enough quantity to keep the pot boiling.

BEETHOVEN
PIANO CONCERTOS #3, #4
Wilhelm Backhaus, pianist, with Vienna Philharmonic Orchestra conducted by Hans Schmidt-Isserstedt. London 4-track "twin-pak" LCK80007. Price $11.95.

This is a new idea that *Ampexes' UST* division has come up with. It is called "twin-pak" and what it means is that whenever tape length and time permits, you get an extra-long playing tape, which contains two works instead of one. Thus here we have the Beethoven 3rd and 4th piano concertos, and there are other similar couplings such as "Le Sacre du Printemps" and "Petrouchka". You get a lot of music and you save money to boot.

Needless to say this package is for the dyed-in-the-wool Beethoven enthusiast. As noted in the review of the disc, this is Beethoven in the grand manner, with one of our pianistic giants fully in charge. He thunders his way through these works in the most supremely confident fashion, aided by the redoubtable Schmidt-Isserstedt and the Vienna Philharmonic.

The stereo is gorgeous—big, sonorous, and full blown. The piano was recorded close-up and yet its transients betray no harsh ringing and the spacious acoustics softens the contours. The sound was recorded at quite a high level and so this tape is at full comfortable listening levels, very quiet and free from hiss. All the stereo virtues are offered in profusion and, this is one of the prime 4-track stereo tapes on today's market.

BASIE
The Count Basie Orchestra. Roulette 4-track RTC502. Price $7.95.

I have been a Basie fan from way back and therefore it pains me to give this tape a bad mark. The arrangements are clever . . . by that ole master Neal Hefti, but the material is rather sparse and not overly distinguished. The playing of the orchestra is good, but I have heard them better, but most of all, whatever musical worth the tape contained is drowned in a sea of distortion. The tape is noisy and full of hiss and darn near every other phrase, and especially in the higher dynamics, is atrociously overloaded. I may have gotten a badly dubbed copy, but I rather suspect it is just a poor recording job. Too bad!

ALL AMERICAN SHOWCASE
Mantovani and his Orchestra. London 4-track LPK70004. Price $7.95.

Well, one thing is for sure about this tape . . . you will either love it or hate it, depending on whether or not you are a Mantovani fan. I profess no mad passion for him, but don't mind if he flits quietly around my head at cocktail time.

On this tape he gives his unique treatment to the works of Rudolph Friml, Victor Herbert, Irving Berlin, and Sigmund Romberg. You name it . . . it is sure to be here . . . "Lover Come Back to Me", "The Girl That I Marry", "Kiss Me Again", "Donkey Serenade", etc., etc.

Highly artificial recording of course but expertly done, and this is what it is supposed to be . . . very much overblown and larger than life. All is very clean and the sugary string sound will delight the avid Mantovani fan. —30—

CALENDAR of EVENTS

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			2	3	4	5
						12
						19
						26

SEPTEMBER 26-30

Fifteenth Annual Meeting and Conference. Sponsored by Instrument Society of America. The Coliseum, New York City. Further information from ISA Headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

SEPTEMBER 27-30

Space Power Systems Conference. Sponsored by National Aeronautics and Space Administration, Air Force, AEC, Advanced Research Projects Agency with IRE and AIEE. Miramar Hotel, Santa Monica, Calif. Additional information on program from J. L. Bogdanoff or F. Kozin, Div. of Engr. Science, Purdue University, Lafayette, Ind.

OCTOBER 10-12

National Electronics Conference. Sponsored by IRE, AIEE, EIA, SMPTE. Hotel Sherman, Chicago. Details from NEC, 228 N. LaSalle St., Chicago.

OCTOBER 13-14

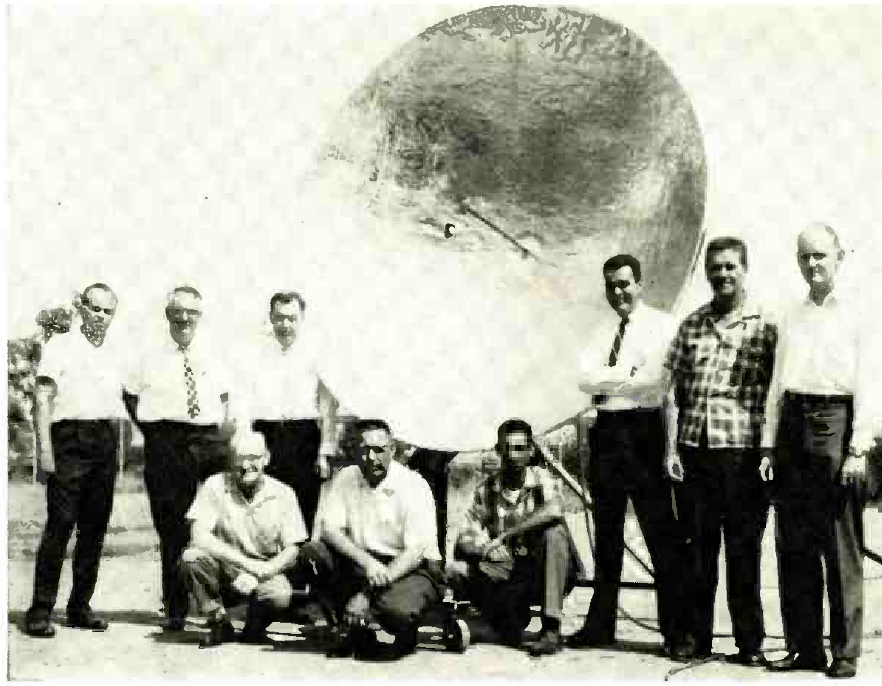
Symposium on Engineering Writing & Speech. Sponsored by PGEWS & Chicago Section. Bismark Hotel, Chicago. Program information from Melvin Whitmer, Admiral Corp., 3800 W. Cortland St., Chicago.

OCTOBER 11-14

1960 Convention. Sponsored by the Audio Engineering Society. Hotel New Yorker, New York City. Program details from AES, P. O. Box 12, Old Chelsea Station, New York 11, N. Y.

OCTOBER 15

HARC Convention. Sponsored by Hudson Amateur Radio Council, Inc. Statler-Hilton Hotel, New York. Tickets for event from HARC Convention, Box 971, New Rochelle, N. Y.



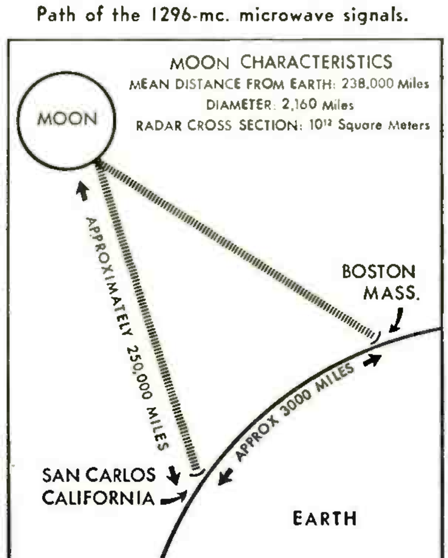
Some members of the Eimac Radio Club in San Carlos, California, who participated in the moon-bounce circuit are shown here with their make-shift parabolic dish.

Ham Radio Earth-Moon-Earth Contact

Details on the first amateur radio moon-bounce two-way microwave contact between California and Massachusetts.

THE FIRST amateur radio moon-bounce two-way microwave communication took place on Sunday, July 17 between two distant points. This contact marks an important milestone in the development of amateur radio. The historic contact was between the members of the *Eimac* Radio Club in San Carlos, California and Mr. Sam Harris, Rhododendron Swamp VHF Society in Medfield, Mass.

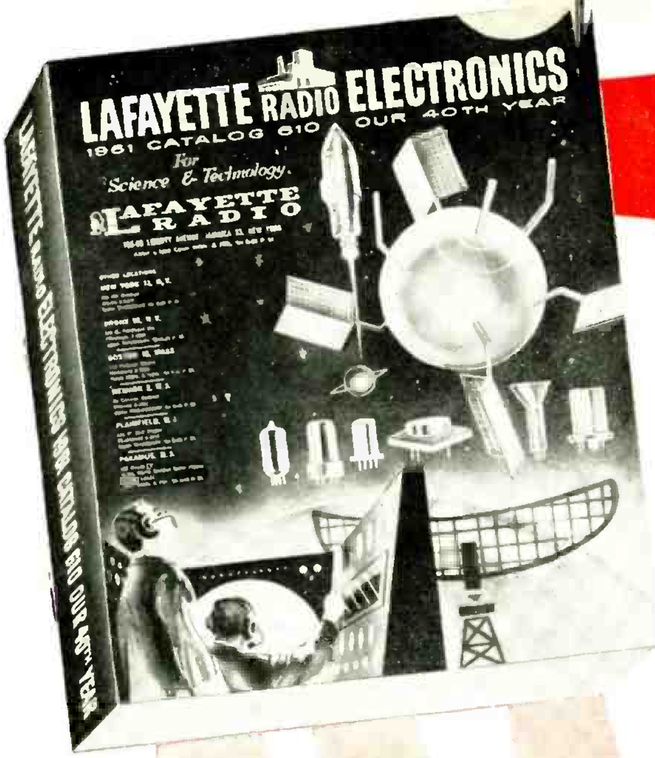
Path of the 1296-mc. microwave signals.



After months of personal effort by the radio amateurs concerned with this project, signals were transmitted in both directions on 1296 mc. The equipment was then refined and the first successful two-way communication was made. The first transmission was from West (W6HB) to East (W1-BU). The pattern was then reversed and the first amateur coast-to-coast communication *via* the moon completed. At each end of the circuit, a 1000-watt klystron was used in the transmitter and a very sensitive parametric amplifier in the receiver.

This successful reception and transmission using the moon as a signal reflector will stimulate efforts to improve amateur-built equipment for further moon-bounce communications. The only other moon-bounce communications equipment in existence is military or experimental in nature; the principal installation is the Naval link between Washington and Hawaii.

Members of the *Eimac* Radio Club who participated in the moon-bounce circuit are: Bill Orr, W6SAI; Hank Brown, W6HB; Bill Eitel, W6UF; Ray Rinaudo, W6KEV; Bob Morwood, K6-GJF; Bob Sutherland, W6UOV; Hugh MacDonald, W6CDT; George Badger, W6RXW; Allan Beer, K6GSO; Al Clark, W6MUC; Mike Krivohlavek, K6AXN, and Charlie Anderson, W6-IVZ. —30—



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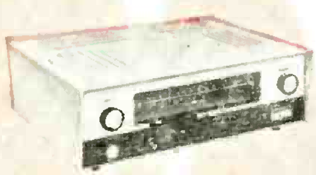

KT-650 FM Tuner Kit
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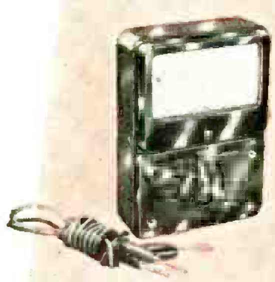

RW-60 20,000 Ohms Per Volt Multitester
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RK-400 2-Speed Portable Tape Recorder
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ELECTRONIC TERMINOLOGY CROSSWORD PUZZLE

By JOHN J. GILL

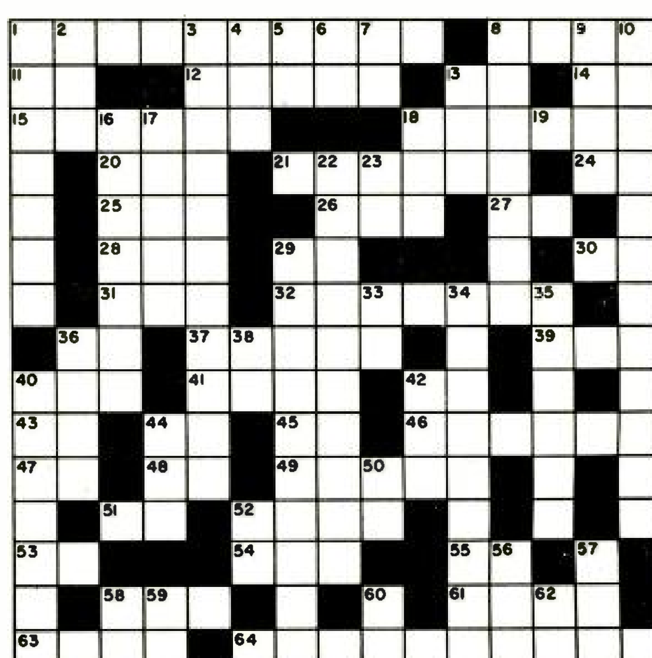
(*Answer on page* 148)

ACROSS

1. Reciprocal of impedance.
8. Protective device.
11. Greek "N".
12. Used in house wiring.
13. Chemical element (symbol).
14. Pilot light (abbr.).
15. Doughnut-shaped coil.
18. Amount of force that causes rotation.
20. Measurements.
21. One who goes forth.
24. Type of circuit.
25. A "collector" of electromagnetic waves (abbr.).
26. Vase.
27. Frequency used in superhets (abbr.).
28. 102 (Roman numeral).
29. A news service (abbr.).
30. E = —.
31. Scotch hat.
32. Equipment used in servicing electronic devices.
36. Relay type (abbr.).
37. ——high frequency.
39. Tool for making holes.
40. "For each".
41. Falsehoods.
42. Tonnage (abbr.).
43. Type of modulation.
44. Amplification factor.
45. Negative reply.
46. Useful energy delivered.
47. Number (abbr.).
48. Part of "to be".
49. Beneath.
51. Inductive reactance (symbol).
52. Ratio of output to input.
53. Plate current (symbol).
54. And so on.
55. College degree (abbr.).
58. Network (abbr.).
61. Whip.
63. TV blanking pulse.
64. Memory tube used in computers.

DOWN

1. Radiator of r.f. energy.
2. —— diode.
3. Values used in matching colors.
4. An English unit of weight.
5. Broadcast radio (abbr.).
6. Pilot light symbol (abbr.).
7. Capacitor of unknown value (schematic symbol).
8. Iron compound used in transformer construction.
9. Goad.
10. Type of capacitor.
13. Pedal digit.
16. Coil.
17. All (Latin).
18. Cask.
19. Quality rating of a coil.
22. Above the range of human hearing.
23. Power supply component (abbr.).
29. Network for introducing a variable transmission loss.
33. Neighboring continent (abbr.).
34. Type of reactor.
35. Transformers and coils are sometimes ———.
36. Remote TV or radio broadcast.
38. Lithium (abbr.).
40. Moving a TV camera to scan a field of view.
42. Sorrow.
44. Unit of wire size.
50. Dental corpsman (USN, abbr.).
52. Mother of Uranus.
56. Our "aerial umbrella" (abbr.).
57. Unit of 1 Across.
58. By.
59. Exist.
60. Not down.
62. Quiet!



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Another reason why CREI men are respected and eagerly sought by industry and Government agencies alike is the accreditation and enthusiastic approval accorded the CREI home study program in advanced electronics. We co-founded the National Council of Technical Schools, and we were among the first three technical institutes whose curricula were accredited by the Engineers' Council for Professional Development. Further, the U.S. Office of Education lists CREI as "an institution of higher education."

Of equal importance, we believe, is the appreciation expressed by industry and government for the CREI programs. Dozens of major electronics organizations, ranging from industrial giants to the Government's Voice of America, have agreements with CREI for enrollment of students under company sponsorship. U.S. Navy electronic personnel in the number of 5,240 are enrolled in CREI extension programs. The British Royal Air Force, Army and Navy have approved CREI courses under their tuition assistance plan. The following companies comprise only a partial list of the organizations which not only recommend CREI study but actually, in many cases, pay all or part of the tuition for employees taking CREI courses:

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Radio Corporation of America
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Federal Electric Corporation
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Voice of America
Canadian Broadcasting Corporation
Northwest Telephone Company
Commercial Cable, Incorporated
Canadair Limited
Columbia Broadcasting System
All America Cable and Radio
Canadian Marconi
Mackay Radio
United Air Lines
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If you have a high school diploma or equivalent, basic electronic training and practical experience in electronics, you meet the minimum requirements for enrollment. Tuition is reasonable and may be paid monthly, if you wish. Veterans qualify for this program under the GI bill.

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You can pursue the CREI program while you continue your regular full-time job. You study at home during hours chosen by you. You are not rushed and you have plenty of time to do your best.

The courses are prepared in easy-to-understand format, and the CREI staff of experienced instructors guides your progress all along the way. These instructors stand ready to assist you whenever you need help. You will find our personal assistance and guidance efficient and helpful, because 33 years of experience in home study teaching enables us to anticipate questions in our lesson material.

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CREI students are electronic engineers and technicians engaged in every phase of electronics. They are in research laboratories and manufacturing plants. They work on the design, development and production of the latest computers; on the latest military and civilian aircraft; on the electronic equipment associated with the Nation's missiles and space exploration efforts; on communications equipment of all kinds; they maintain electronic equipment for the air lines, the Government and private corporations. You will find CREI students in all 50 States and in most foreign countries of the free world.

To the serious-minded and ambitious CREI student our home study program offers a series of important benefits:

1. You gain a solid college-level education in advanced electronic engineering technology; you keep abreast of continuous new developments in the field.
2. You can gain higher status and enjoy the increased respect of your associates.
3. You facilitate more rapid professional advancement with corresponding significant increases in pay.
4. You gain the personal satisfaction that comes from working and communicating intelligently with your technical colleagues and superiors.

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Service Industry News

A SIGNIFICANT example of cooperation between service and another, related segment of the broad electronics industry is a matter of record in Iowa. During station breaks, WOI-TV (channel 5) of Ames, Iowa has begun to display the official emblem of the state association along with prepared material suggesting that viewers who need service call on member shops for reliable work.

This can scarcely be claimed as a "first." Over the years, there have been other stations in various parts of the nation that have undertaken similar projects. However, the scale on which this activity is being carried out in Iowa is impressive. WOI-TV is the first broadcaster to adopt this policy in the central portion of the state, but makes a total of five Hawkeye stations engaged in such activity. This is the sort of broad coverage that can give members of TESA of Iowa the type of identification with the public that many associations have sought, but few have been able to achieve.

The principals involved report that the program helps everyone. Viewers benefit in that they have some assurance of reliable service and of maintaining their sets in working condition. The broadcasters feel that this service to their viewing public assists them in maintaining their audience. As for member service shops, they report definite improvement in business.

The state group has adopted the NATESA emblem officially and is using it in this broadcast campaign. Members feel that this will provide residual benefits for NATESA members outside the state whose potential customers receive Hawkeye stations. Along with the adoption of the emblem, the state group, formerly TSA of Iowa, has officially become TESA of Iowa. A recent issue of "NATESA Scope," commenting on this effort, urges other associations everywhere to try to put over similar programs. At that, blanketing the nation with this sort of promotion would be quite a boost to the service industry.

Impact of "Tube Jockeys"

Although most of us like to be masters of our own fate, much of what we do is inevitably influenced by the behavior of others. If such influence constitutes an undesirable infringement, we consider that we have some rights in restricting the behavior of those responsible for the infringement.

An editorial in "TSA DV News" (Television Service Association of the Delaware Valley) deals with the manner in which an "outside" influence is bringing about a basic change in the nature of established, full-scale service businesses. For many years, it has been the practice in service shops everywhere to avoid large bills on difficult repairs although the work involved may justify such high fees. The technician thus avoids antagonizing his customers and expects to compensate for these "dogs" with the greater number of routine jobs on which he can average out a reasonable profit margin.

However, the editorial takes note of a change in the ratio between routine and difficult cases that may upset this line of reasoning. "Have you given some thought to the kind of jobs you are getting?" asks the editor. "Have you noticed the absence of the gravy jobs? Where are the repairs we used to sail right through? Are we losing our touch? No, of course not. The run-of-the-mill, easy jobs are skimmed off by the incompetent shysters who are not equipped in their shops or in their heads to handle the harder jobs. These are the characters your customers and mine call in to repair their TV sets at cut prices. Then when they fail to do so, we get called in to pick the chestnuts out of the fire."

The writer proceeds to the case of a competent dealer who had to make extensive, costly repairs on a damaged set."What can I tell my customer?" muses the dealer. "He will think *I'm* trying to fleece him. All of this was made necessary because the set owner had called a neighborhood tube jockey in to repair his set and this idiot had put some tubes in the wrong sockets in his endeavor to repair the set for a couple of fast bucks. Why must I be on the defensive to justify a *bona fide* repair bill?"

The editorial goes on to propound licensing as a solution because it will weed out the incompetents. Without becoming embroiled in the oft-repeated pros and cons on legislative supervision, we think this instance is worth attention simply because it highlights one of the many ways in which all members of the industry affect one another whether they wish to or not. Another point: licensing could never be the *complete* solution to this problem. The unrealistic notions held by the public relative to service fees—in part encouraged by dealers—must change: charge enough and don't apologize!

Answer to a Customer

Speaking of positive action in consumer education, the "Guild News" (Radio and Television Guild of Long Island, New York) suggests an answer to a common problem in public relations. The problem arises when the customer says, "You just fixed the set; why should it stop working again? Didn't you check everything?"

While we would suggest a more moderate tone to avoid antagonizing clients, the essence of the recommended reply is useful: "How much did this set cost you when new? The manufacturer guaranteed the parts for only ninety days. Do you expect me to give a better guarantee when the set is old than the manufacturer did when the set was new, for a repair price that is one fourth (or fifth, or whatever the case may be) of the original cost?"

The Guild also suggests an antidote for customer moaning about the cost of repairs: "Do you use your telephone as many hours as your TV set?" (The viewer is a safe bet to answer in the negative, unless he's a bookie.) How much does your phone cost per year? Must be at least $100. (Use your own figure, if that doesn't suit you.) Do you spend $100 a year on your TV set? And you *do* own your TV set but you *don't* own your telephone!"

Are Shops Merging?

"TESA Miami News" reports that the local *Bell Radio & TV Service* has combined forces with *Radio Doctors* of South Miami, once more raising the point as to whether the pattern of the next few years will not be one of fewer, larger shops, many of them growing out of such business marriages. While there have been other cases of mergers here and there recently, we think it is too early to identify a trend.

Actually the optimum, efficient size of any business varies greatly depending on the type of activity. Even with such giant corporations as the larger automobile manufacturers, economists tell us there is a point beyond which increased growth actually results in reduced efficiency and economy. In short, there is such a thing as growing too big in any field.

Experience suggests that most types of service and repair operations are at their best when relatively small. The notion of large service establishments or chains is not new, but most of those that have been attempted on an independent basis, not supported by other activities, have not survived. The neighborhood service shops today far outnumber the giant ones and account for most of the repair business.

Manufacturer Jottings

Both *CBS-Electronics* and *Raytheon* have been recent recipients of NATESA "Friends of Service" Awards for "outstanding service in creating better customer relations" . . . *Philco* is offering "Trace," which consists of plastic circuit panels to be placed over parts of their transistor radios. These indicate where and how tests should be made and pinpoint possible defects. The notion has merit. —30—

Engineering Schools Spend $71-Million for R & D

Extent of research and development expenditure that has been reported by 129 schools for the 1958 fiscal year.

ENGINEERING schools in the United States reported that they spent $71-million for "earmarked," or sponsored, research and development in fiscal year 1958, according to information released by the National Science Foundation.

Engineering schools received $48.6-million of this total from the Federal Government and $10.3-million from industrial sources. Direct support of R & D from their own funds was $10.5-million, plus an additional $3.5-million to cover the indirect costs of outside-sponsored grants and contracts.

The 129 engineering schools, either independent institutions or affiliated with colleges and universities, were part of a comprehensive survey of expenditures and manpower for research and development in colleges and universities. In analyzing trends of R & D expenditures in engineering schools, it should be pointed out that there has been a decreasing trend in the enrollment of undergraduate students and a rapidly increasing enrollment of graduate students in engineering schools. These factors may tend to increase both the faculty time available to conduct research and development because of reduced teaching loads and the number of graduate students available to conduct research and development under faculty supervision.

Twenty schools reported expenditures of $1-million or above for research and development, eighty-five reported between $25,000 and $1-million, and twenty-four reported expenditures of less than $25,000.

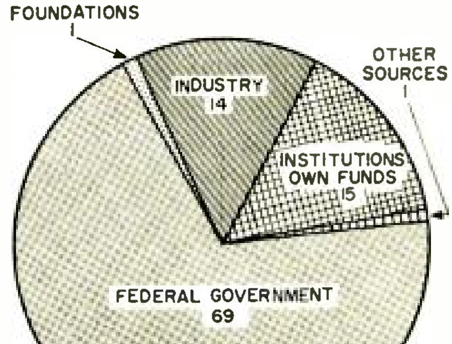

Fig. 1. Per-cent distribution of expenditures for separately budgeted research and development in engineering schools, by the source of support, for the fiscal year 1958.

Of the $71-million total, 57 per-cent was reported as going for basic research, in contrast to the 45 per-cent reported in a comparable previous study covering fiscal year 1954.

Fig. 1 shows the percentage of support borne by each major source. Fig. 2 shows each Government agency's percentage of total Federal funds. The specific sources and amounts of support for separately budgeted research and development for fiscal year 1958 are shown below:

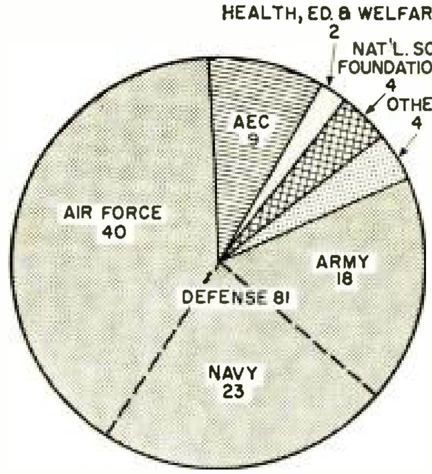

Fig. 2. Per-cent distribution of Federal expenditures for separately budgeted research and development in engineering schools, by agency involved, for the fiscal year 1958.

	(thousands of dollars)
GRAND TOTAL	$70,882
Total, Federal Government	48,626
Dept. of Defense	39,438
Dept. of the Army	8,882
Dept. of the Navy	11,193
Dept. of the Air Force	19,256
All Other	107
Dept. of Health, Education, and Welfare	929
Atomic Energy Commission	4,239
National Science Foundation	1,937
Other Agencies	2,080
Total, Other Sources	22,256
Institutions' Own Funds	10,540
Foundations	957
Industry	10,363
Other Sources	396

These and other preliminary data from the Foundation survey were issued in "Reviews of Data on Research & Development," No. 21 ("Funds for Research and Development in Engineering Schools, Fiscal Year 1958"). This publication is available for 10 cents from the Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C. —30—

Stable Transistor V.F.O.

(*Continued from page* 66)

other component used in the circuit.

Oscillator Coil Notes

There is really nothing magic about the toroid coil (L_1). The fact that the lines of force are more contained in the core will allow you to build a more compact unit. However, if you do not care about the size, it is possible to use more "standard" components. A coil was constructed for 5.0-5.2 mc. by winding 18 turns of #22 enamel closewound on a 1" diamter solid polystyrene rod, with the tap at 7 turns. Using this coil, it was possible to connect the oscillator collector and the amplifier capacitor (C_6) to the same tap. The v.f.o., using this coil, was contained in a 4" x 5" x 6" aluminum box, with the oscillator coil as near the center of the box as possible.

The oscillator can also be used on 3.8-4.0 mc. Another coil was constructed with 28 turns of #22 enamel, closewound on the same form, but with the tap located at the 10th turn from the bypassed end. It was necessary to connect a 100 $\mu\mu$f. capacitor across L_2 to pad it down to 4 mc.

The constructor may have difficulty locating the powdered iron toroid form. It must be purchased in large quantities and would be considered a "non-standard" item. Anticipating this difficulty, the author had planned to make pre-wound and properly tapped toroid coils available directly. However, this proved to be unnecessary as the *J. W. Miller Co.* is making the coil available at their local distributors as part No. 7501. The *Miller* version of coil L_2 is also readily available as part No. 7502.

You may have noticed that there are no temperature-compensating components in this v.f.o The performance graphs of Fig. 5 show that the drift can be reduced with the proper choice of compensating capacitors.

As the v.f.o. warms up, it will drift lower in frequency. By adding the proper amount of negative-temperature-coefficient capacitors, the frequency shift can be almost completely counteracted.

Tests were made by placing the v.f.o. in the frozen food compartment of the refrigerator and then letting it come up to room temperature. The uncompensated curve was obtained with the values shown in Fig. 1. The compensated curve was the result when a silver mica 82-$\mu\mu$f. capacitor was substituted for C_1 and a 68-$\mu\mu$f. N750 compensating capacitor was used in place of C_2. By using the N750, 82-$\mu\mu$f. capacitor and the 68-$\mu\mu$f. silver mica, the v.f.o. was "overcompensated." Somewhere between these two values it will be possible to compensate the v.f.o. perfectly to cover the range from 32 to 100 degrees. —30—

Music-Power Rating

(Continued from page 37)

take in 10 electrical watts and deliver 1 acoustic watt—maximum. But it is called a 10-watt speaker.

That's not all. Few loudspeakers, rated at 10 watts, will handle this much input power at a single sinusoidal frequency, through the range for which they are designed—which most good amplifiers do with ease. But the same loudspeakers are quite happy handling the maximum musical power a 10-watt amplifier can deliver, which is a mixture of many frequencies, with a low waveform factor.

Taken in conjunction with this fact, and other inconsistencies we haven't space to explain here, it is not so illogical to rate amplifiers according to the new IHFM music power definition. So let's take another look at that question, "Does the new Music Power Rating help tell the quality of an amplifier?"

What Good is MPR?

If you want to use all the figures you can get hold of about every available amplifier, you will probably try to make some deductions for which the published information was never intended. In introducing music power rating, the intention is to bring into use a figure for comparison that is more realistic than the one now used.

During a transitional period, progressive manufacturers will have to use both ratings, not to provide more information about their own product, but so that comparison can still be made with other products that do not yet use the new rating. It is hoped that all firms will ultimately use music power rating—at least as the main figure.

For simplicity, most people do not want to digest a whole catalogue of specifications about each product. From this standpoint, music power rating is a more informative single figure than continuous power rating. If you are sufficiently interested, continuous power rating, *as a second figure*, will convey an additional measure of merit.

We should not compare amplifiers with the same continuous power ratings and different music power ratings. When both figures are given, we would compare amplifiers first by music power rating; if two amplifiers have the same music power, we may then compare continuous power ratings.

This is important. Viewing music power rating as the secondary figure, we are tempted to conclude that a bigger difference between the two numbers represents a better amplifier. Our intuition favors the amplifier with better power-supply regulation, so we suspect the whole notion of music power rating.

But starting on the other foot, with music power rating as the primary figure and continuous power rating secondary, our intuition supports the rating inference. It is legitimate, to get reasonable quality at low cost, to put music power ahead of continuous power, by using an inexpensive power supply. But using a better power supply results in an amplifier with "more solid" quality.

We would not say music power rating completely solves the problem of providing a relative evaluation of an amplifier, though. Properly used, it is a good step forward but there are still many things the present method of specifying performance doesn't tell. Let's put it this way:

Provided the amplifier does not handle musical transients in some peculiar fashion the specification does not show, and provided you always work it so musical peaks never exceed twice the rated music power output, this rating does give a relative indication of how much power amplifiers will deliver.

We can still have amplifiers that do strange things on certain kinds of musical sound. None of the figures currently published shows what is likely to happen if a momentary peak overshoots the peak music power (twice the music power rating). One amplifier may handle these things without "batting an eyelid," while another has electronic convulsions. That the specs do not tell us even now. This difference can often account for one amplifier *seeming* to give a lot more undistorted power than another of the same or similar rating, even when both the ratings are fully supported by tests.

We still have the effect that loudspeaker loads can have on an amplifier, as compared with the "dummy" resistance load, used for testing. The low distortion figures are always obtained with the dummy load. Nobody publishes, even if he measures, distortion with a loudspeaker load, because this depends, in an amplifier, on how much reactance the loudspeaker has—and no two loudspeakers are alike.

A good amplifier may give up to twice the test distortion when a loudspeaker is connected. A poor one may give many times as much distortion as soon as a little reactance enters the picture.

It should be possible, for the benefit of those who really care, to find a standard means of evaluating these various differences. It would be good to see the manufacturers make a move, possibly through the IHFM, in this direction. Meanwhile, it remains true that the specifications are a good starting point in judging an amplifier: but the real test is how it performs in your system.

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—30—

Keeping Step

(*Continued from page* 58)

other types of service businesses. The people who repair washing machines, air conditioners, or refrigerators may be more favorably regarded in your particular locality than TV service technicians. It might pay to find out why. For all you know, the local bake shop may be using an idea that can help you. Most of the ways of doing business that are characteristic of our era and distinct from the methods of an earlier day originated in one, single field. After they won acceptance, they spread to other fields by change and adaptation. The idea of self-service may have started with the cafeteria. Eventually the modern supermarket replaced the small grocery with the same basic notion. Today a do-it-yourself trend that has affected nearly every type of endeavor may be traced to the same principle.

Be prepared to pay the price, literally, for keeping up with the times. Of course, it is never wise to squander money without knowing why, but nickel-nursing, as distinguished from thrift or good management, never built a solid business. A study was made not so long ago of firms that had once been well-established, but were found to be losing out to competition gradually over the years. The most obvious pattern of similarity among these was found to be the fact that the owners were standing pat financially. "Creeping death" was due to the fact that these people had no arrangement for allocating a regular percentage of funds out of profits for making necessary changes to keep up with the world around them.

Look for new sources of revenue. Don't just speculate about new items to sell or to service. Take action. The chances are that you are letting opportunities go by right now, some of which you may even recognize to some extent, because they do not fit into your present operation conveniently. There is a close relationship between rigidity and rigor mortis. There are shops that will let a ripe local market for service of non-entertainment receivers go to someone else by default, for want of the addition of just one more piece of test equipment.

Don't forget advertising. The word-of-mouth type is fine. It doesn't make any difference which of the many other possible types—phone-book, mailing pieces, door-to-door leaflets—do or do not work best for you, as long as you keep up the ones that have proved themselves. Advertising is just as important in keeping old customers as it is in getting new ones.

Finally, stay profitable. You must make a certain minimum profit on every dollar you turn over. This too is part of keeping step. —30—

Superior's New Model 85—*a DYNAMIC type*

TRANS-CONDUCTANCE

TUBE TESTER

Model 85—Trans-Conductance Tube Tester. Total Price—$52.50. Terms: $12.50 after 10 day trial, then $8.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

● Employs latest improved TRANS-CONDUCTANCE circuit. Tests tubes under "dynamic" (simulated) operating conditions. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured as a function of tube quality. This provides the most suitable method of simulating the manner in which tubes actually operate in radio, TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.

● **SYMBOL REFERENCES:** For the first time ever in a trans-conductance tube tester, Model 85 employs time-saving symbols (★, +, ●, ▲, ■;) in place of difficult-to-remember letters previously used. Repeated time studies proved to us that use of these scientifically selected symbols speeded up the element switching step. As the tube manufacturers increase the release of new tube types, this time-saving feature becomes more necessary and advantageous.

● **THE "FREE-POINT" LEVER TYPE ELEMENT SWITCH ASSEMBLY** marked according to RETMA basing, permits application of test voltages to any of the elements of a tube. The addition of an extra switch position permits the application of the necessary grid voltage needed for dynamic testing and insures against possible obsolescence due to changes in basing design.

● **NEW IMPROVED TYPE METER** with *sealed air-damping chamber* provides accurate, *vibrationless* readings.

● **FREE FIVE (5) YEAR CHART DATA SERVICE.** The chart provided with Model 85 includes easy-to-read listings for *over 1,000 modern tube types.* Revised up-to-date subsequent charts will be mailed to all Model 85 purchasers *at no charge* for a period of five years after date of purchase

● **SPRING RETURN SAFETY SWITCH** guards Model 85 against burn-out if tube under test is "shorted."

● **7 AND 9 PIN TUBE STRAIGHTENERS** have been included on the front panel to eliminate possibility of damaging tubes with bent or out-of-line pins.

● **AN ULTRA-SENSITIVE CIRCUIT** is used to test for shorts and leakages up to 5 megohms between *all* tube elements.

Model 85 comes complete, housed in a handsome portable cabinet with slip-on cover. Only......

$52.50

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Model 77—VACUUM TUBE VOLTMETER ...Total Price $42.50—Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price

- ✓ Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
- ✓ Model 77 employs a sensitive six inch meter. Extra large meter scale enables us to print all calibrations in large easy-to-read type.
- ✓ Model 77 uses new improved SICO printed circuitry.
- ✓ Model 77 employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

- ✓ Model 77 uses a selenium-rectified power supply resulting in less heat and thus reducing possibility of damage or value changes of delicate components.
- ✓ Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.
- ✓ Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

SPECIFICATIONS

● **DC VOLTS**—0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. ● **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1,500 volts. ● **AC VOLTS** (Peak to Peak)—0 to 8/40/200/400/800/2,000 volts. ● **ELECTRONIC OHMMETER**—0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms ● **DECIBELS** —10 db to + 18 db, + 10 db to + 38 db + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). ● **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads. Use it on the bench—use it on calls. A streamlined carrying case, included at no extra charge, accommodates the tester, instruction book, probe and leads. Operates on 110-120 volt 60 cycle. Only....................

$42.50 NET

GENOMETER

7 Signal Generators in One!

Model TV-50A—Genometer
Total Price $47.50
Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary.

- ✓ *R.F. Signal Generator for A.M.*
- ✓ *R.F. Signal Generator for F.M.*
- ✓ *Audio Frequency Generator*
- ✓ *Bar Generator*
- ✓ *Cross Hatch Generator*
- ✓ *Color Dot Pattern Generator*
- ✓ *Marker Generator*

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peak wave audio signal.

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV): Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency)

THE MODEL TV-50A comes absolutely complete with shielded leads and operating instructions.

$47.50 NET

EXAMINE BEFORE YOU BUY!

USE APPROVAL FORM ON NEXT PAGE

Hand-Held CB Transceiver

(Continued from page 44)

sistent with stable oscillator performance. Then adjust coil L_3 for maximum r.f. output as indicated by a grid-dip meter coupled near coil L_4. All adjustments should be made with someone holding the case to represent a ground-plane for the antenna. The whip should be clear of all metal objects. Tuned in this manner, the transceiver should be well within the specified frequency tolerance of 0.005% (1.3 kc.). However, the actual frequency should be checked accurately. (See "What's Your Citizens Band Frequency?" in the August, 1960 issue of this magazine.)

You can observe the modulation waveform by constructing the test set-up shown in Fig. 2. If you talk loudly, you may note a flattening at the top and bottom of the speech waveform as seen on the oscilloscope. However, speaking in a normal voice about 12 inches from the microphone should produce clear, crisp audio at approximately 85% modulation. You cannot overmodulate the device, but you can distort the audio by speaking too loudly or working too close to the microphone.

"No License" Operation

Special provision is made in Part 15 of the Commission Rules relating to low-power transmitters. No license is required for this unit if the following requirements are met:

1. The power input to the final amplifier must not exceed 100 mw. (11 ma. at 9 volts). This transceiver cannot be overpowered when wired as shown.

2. An antenna no longer than 60 inches, attached to the case, may be used. The antenna on this unit is 36 inches.

3. The carrier must be maintained within the band 26.97-27.27 mc. For class D operation, a frequency tolerance of 0.005% (about 1.3 kc.) must be observed. This circuit uses a 0.005% crystal and the circuit will maintain this stability. The manufacturer of the transmitter subassembly has certified the unit at the factory.

4. Spurious radiation is at least 20 db below the fundamental frequency. The second harmonic of this transceiver is 38 db below the fundamental. Other spurious signals are too weak to be measured.

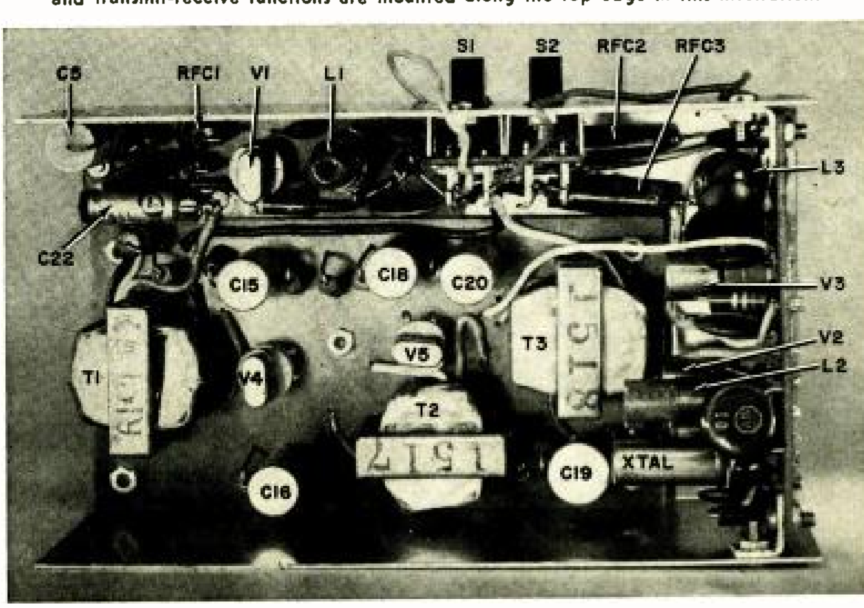
It is suggested that a typewritten sheet containing the following information be attached to the back of the case: "This device is intended for low power, short range, two-way voice communication in compliance with Part 15.205 of Commission Rules and shall be used only with the single wire antenna supplied. Said antenna does not exceed 36 inches. Frequency control is by means of quartz crystal and is certified to 0.005% specifications."

Whenever the transceiver is used in conjunction with the usual 5-watt class D Citizens Band station, or is used with an outside antenna, it assumes the call numbers and becomes a unit of the station. A card giving the call numbers, owner, and frequency should be attached to the unit in compliance with FCC Citizens Band Rules (Part 19).

Conclusion

This Citizens Band portable has proven invaluable on numerous occasions. Even though it is used and loaned quite often, it is still on the first battery—indicating long life. The dependable range is in excess of 2000 yards on a line-of-sight basis. The power is so low it cannot possibly "skip out" and interfere with other stations. Since the unit is completely portable and interference in eliminated, the transistor transceiver is useful in many places where the "high power" 5-watt units would not be applicable. —30—

Inside view of the completed transceiver. Audio board with its three transformers occupies most of the space. Receiver board is at the top left in this photo; the transmitter board is at the right side. Two slide switches, employed for on-off and transmit-receive functions are mounted along the top edge in this illustration.



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Up to 75% OFF on BRAND NEW TUBES

GUARANTEED ONE FULL YEAR! You Can Rely On Rad-Tel's Speedy One Day Service!

Not Used — Not Pulled Out Of Old Sets • Each Tube Individually and Attractively Boxed!

Qty.	Type	Price
	0Z4M	.79
	1AX2	.62
	1B3GT	.79
	1DN5	.55
	1G3	.73
	1J3	.73
	1K3	.73
	1L6	1.05
	1LN5	.59
	1R5	.62
	1S5	.51
	1T4	.58
	1U4	.57
	1U5	.50
	1X2B	.82
	2AF4	.96
	3AL5	.42
	3AU6	.51
	3AV6	.41
	3BA6	.51
	3BC5	.54
	3BE6	.52
	3BN6	.76
	3BU8	.78
	3BY6	.55
	3BZ6	.55
	3CB6	.54
	3CF6	.60
	3CS6	.52
	3CY5	.71
	3DK6	.60

Qty.	Type	Price
	3DT6	.50
	3Q5	.80
	3S4	.61
	3V4	.58
	4BC5	.56
	4BC8	.96
	4BN6	.75
	4BQ7	.96
	4BS8	.98
	4BU8	.71
	4BZ6	.58
	4BZ7	.96
	4CS6	.61
	4DE6	.62
	4DK6	.60
	4DT6	.55
	5AM8	.79
	5AN8	.86
	5AQ5	.52
	5AT8	.80
	5BK7A	.82
	5BQ7	.97
	5BR8	.79
	5CG8	.76
	5CL8	.76
	5EA8	.80
	5EU8	.80
	5J6	.68
	5T8	.81
	5U4	.60
	5U8	.81
	5V6	.56
	5X8	.78
	5Y3	.46

Qty.	Type	Price
	6AB4	.46
	6AC7	.96
	6AF3	.73
	6AF4	.97
	6AG5	.65
	6AH6	.99
	6AK5	.95
	6AL5	.47
	6AM8	.78
	6AN4	.95
	6AN8	.85
	6AQ5	.50
	6AR5	.55
	6AS5	.60
	6AT6	.43
	6AT8	.79
	6AU4	.82
	6AU6	.50
	6AU7	.61
	6AU8	.87
	6AV6	.40
	6AW8	.89
	6AX4	.65
	6AX7	.64
	6BA6	.49
	6BC5	.54
	6BC7	.94
	6BC8	.97
	6BD6	.58
	6BE6	.55
	6BF6	.44
	6BG6	1.66
	6BH6	.65
	6BH8	.87

Qty.	Type	Price
	6BJ6	.62
	6BK7	.85
	6BL7	1.00
	6BN4	.57
	6BN6	.74
	6BQ5	.65
	6BQ6GT	1.05
	6BQ7	.95
	6BR8	.78
	6BU8	.70
	6BY6	.54
	6BZ6	.54
	6BZ7	.97
	6C4	.43
	6CB6	.54
	6CD6	1.42
	6CF6	.64
	6CG7	.60
	6CG8	.77
	6CM7	.66
	6CN7	.65
	6CR6	.51
	6CS6	.57
	6CU5	.58
	6CU6	1.08
	6CY5	.70
	6CY7	.71
	6DA4	.68
	6DB5	.69
	6DE6	.58
	6DG6	.59
	6DQ6	1.10
	6DT5	.66
	6DT6	.53

Qty.	Type	Price
	6EU8	.79
	6EA8	.79
	6H6GT	.58
	6J5GT	.51
	6J6	.67
	6K6	.63
	6S4	.48
	6SA7GT	.76
	6SK7	.74
	6SL7	.80
	6SN7	.65
	6SQ7	.73
	6T4	.99
	6U8	.78
	6V6GT	.54
	6W4	.57
	6W6	.69
	6X4	.39
	6X5GT	.53
	6X8	.77
	7AU7	.61
	7A8	.68
	7B6	.69
	7Y4	.69
	8AU8	.83
	8AW8	.93
	8BQ5	.60
	8CG7	.62
	8CM7	.68
	8CN7	.97
	8CX8	.93
	8EB8	.94
	10DA7	.71
	11CY7	.75

Qty.	Type	Price
	12A4	.60
	12AB5	.55
	12AC6	.49
	12AD6	.57
	12AE6	.43
	12AF3	.73
	12AF6	.49
	12AJ6	.46
	12AL5	.45
	12AL8	.95
	12AQ5	.52
	12AT6	.43
	12AT7	.76
	12AU6	.50
	12AU7	.60
	12AV5	.97
	12AV6	.41
	12AV7	.75
	12AX4	.67
	12AX7	.63
	12AZ7	.86
	12B4	.63
	12BA6	.50

Qty.	Type	Price
	12BD6	.50
	12BE6	.53
	12BF6	.44
	12BH7	.73
	12BL6	.56
	12BQ6	1.06
	12BY7	.74
	12BZ7	.75
	12C5	.56
	12CA5	.59
	12CN5	.56
	12CR6	.54
	12CU5	.58
	12CU6	1.06
	12CX6	.54
	12DB5	.69
	12DE8	.75
	12DL8	.85
	12DM7	.67
	12DQ6	1.04
	12DS7	.79
	12DZ6	.56
	12EL6	.50

Qty.	Type	Price
	12EG6	.54
	12EZ6	.53
	12F5	.66
	12F8	.66
	12FM6	.45
	12K5	.65
	12SA7M	.86
	12SK7GT	.74
	12SN7	.67
	12SQ7M	.73
	12U7	.62
	12V6GT	.53
	12W6	.69
	12X4	.38
	17AX4	.67
	17BQ6	1.09
	17C5	.58
	17CA5	.62
	17D4	.69
	17DQ6	1.06
	17L6	.58
	17W6	.70
	19AU4	.83

Qty.	Type	Price
	19BG6	1.39
	19T8	.80
	21EX6	1.49
	25BQ6	1.11
	25C5	.53
	25CA5	.59
	25CD6	1.44
	25CU6	1.11
	25DN6	1.42
	25EH5	.55
	25L6	.57
	25W4	.68
	25Z6	.66
	35C5	.51
	35L6	.57
	35W4	.52
	35Z5GT	.60
	50B5	.60
	50C5	.53
	50DC4	.37
	50EH5	.55
	50L6	.61
	117Z3	.61

Not a Kit, but Completely Wired

STEREO AMPLIFIER CHASSIS $4.95

lots of 3 ea.

☐ Single, $5.95 ea.

☐ Set of tubes: 2-35C5; 1-12AX7; 1-35W4 $1.15

☐ Set of 3 grey ½" knobs 30c

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EW 1060

Within the Industry

(Continued from page 32)

search division in Philadelphia. Dr. Ghandhi is chairman of the AIEE-IRE semiconductor devices subcommittee, and was staff member of the *G-E* electronics laboratories for nine years before joining *Philco.* He is a graduate of the Benares Hindu University of Benares, India, where he earned his Ph.D. in electronics in 1951 . . . **DONALD E. GARRETT** has been named manager of advanced development engineering for *General Electric's* television receiver department. He has been with the company since 1950 . . . **THOMAS C. PRIDMORE** is the new chief engineer for *Bradley Semiconductor Corp.* . . . **CYRIL J. STATT** has been appointed manager of *General Electric's* Schenectady tube plant. He joined the company in 1940, originally in testing work . . . **IRA S. FRENCH** has been named director of public relations for the Instrument Society of America. He was previously in PR work as well as the newspaper field . . . **ARTHUR S. DAVIS** has been appointed customer relations manager of *Elgin Micronics,* a division of *Elgin National Watch Co.* Prior to joining the firm, Mr. Davis was sales manager, Gearing division of *Westinghouse* . . . **HERMAN FIALKOV,** president of *General Transistor Corp.,* is the new chairman of the Long Island, N. Y. chapter of the Young Presidents Organization . . . **EDWARD S. MAURY** has been appointed vice-president in charge of engineering for *Marion Instrument Division* of *Minneapolis-Honeywell.* Since 1955 he had been the division's sales vice-president . . . **BERNARD B. MASKET** has been named vice-president and controller of *BSR (USA) Limited* . . . **BOYD B. BARRICK** has been promoted to general sales manager for *Raytheon's* distributor products division. He was formerly central zone manager for the division . . . **GEORGE D. BUTLER** has been elected a vice-president of *International Resistance Co.* For the past two years he had been director of marketing for the company . . . **JOHN D. VICKREY** has been named sales manager for the selenium products division of *International Rectifier Corp.* He was formerly sales manager of the distributor division . . . **C. DONALD PRICE** has been appointed advertising and sales promotion manager of *Sylvania Home Electronics Corp.* Since 1958, he had been district advertising manager of the Hotpoint Appliance Division of *General Electric* . . . **JOHN C. SCHMIDT** has been named customer liaison engineer for the military products division of *Tempo Instrument Inc.* Before joining the company he was a sales engineer for *Airborne Instruments Laboratory* . . . **EUGENE JOHN FREEMAN** has been appointed vice-president and general manager of *Roberts Electronics.* He was formerly general manager of *Pacific Mercury's* marketing division . . . **WILLIAM S. AIKEN** has been named director of engineering at the *Thompson-Ramo-Wooldridge Products Co.* He was formerly manager of the computer firm's product engineering department.

* * *

EDWARD E. BAUER is the new vice-president and general manager of the New Bedford Division of *Aerovox Corporation.*

He comes to the job from the *General Electric Company* where he was general manager of the Irmo, South Carolina capacitor plant, manufacturing tantalum, Mylar, and electrolytic capacitors. Previously, he was employed in various capacities with other divisions of *G-E.*

Mr. Bauer received his B.S. in Mechanical Engineering from the University of Wisconsin and his Master's Degree from the University of Pennsylvania. He holds an LLB. from LaSalle University in Chicago.

* * *

BRITISH BROADCASTING CORPORATION has opened the first of its new White City studios in Britain. According to **ENGLISH ELECTRIC VALVE COMPANY, LTD.,** whose image orthicon tube will be used by *BBC,* the new studios are expected to give Britain the lead over any other European country enjoying TV services . . . **PAM ASSOCIATES, INC.,** specialist in noise control and acoustic and vibration equipment, has moved to larger quarters in Baltimore . . . **ULTRASONIC INDUSTRIES, INC.** is building a new plant at Engineers Hill, Plainview, N. Y. . . . **CHICAGO AERIAL INDUSTRIES, INC.,** Melrose Park, Ill., has moved its executive offices and industries division to new facilities in Barrington, Ill. The kintronic and aerial survey divisions will maintain their own quarters in Franklin Park, Ill. . . . **COOKE ENGINEERING CO.** has announced the opening of new offices at 735 N. St. Asaph St., Alexandria, Va. The organization specializes in telecommunications from a systems design viewpoint and is also active in radar air traffic control . . . **KENTUCKY ELECTRONICS, INC.** is the new name of the firm previously known as **ERSKINE PRECISION WIRE CORP.** Its entire facilities and offices have been moved from Emporium, Pa. to Owensboro, Ky. . . . **ATLEE CORP.** is constructing a new manufacturing plant in Rockland, Mass. —30—

JAY CARVER, advertising and merchandising manager of *University Loudspeakers,* was killed in an automobile accident while returning home from his company's stereo demonstration at Grossinger's. He was associated with a number of well-known firms in the industry, most recently with *Electro-Voice.* He was a contributor of numerous audio articles to this and other publications in the electronics field. —30—

FAMOUS BC-645 TRANSCEIVER

15 Tubes 435 to 500 MC

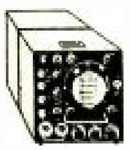
Can be modified for 2-way communication, voice or code, on ham band 420-450 mc, citizens radio 460-470 mc, fixed and mobile 450-460 mc, television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!) 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE 316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton. **$19.50**

Shipping weight 25 lbs. **SPECIAL!**

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**

BC-929 3-INCH SCOPE

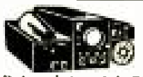


Low cost station monitor and or bench scope. Has Horiz., focus, sweep, intensity controls. Tubes: 2—6SN7, 2—6H6, 1—6X5, 1—6G6, 1—2X2, 3BP1 CR Tube. Voltage req. 115V 400 cy. and 24 VDC. Complete with tubes, exc. used **$9.95**
BRAND NEW ... $12.95
Conversion instructions for 110V 60 cyc. AC ... 65c

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.
Value $1200.00.
Our Price **$79.50**
Used, less tubes, crystal and visor, but with 3BP1 C.R. tube ... $29.50
12 Volt Inverter Power Supply for above. BRAND NEW ... $32.50
28 Volt Inverter Power Supply, exc. cond ... $49.50
Shock Mount for above ... $2.95
Circuit diagram and connecting plugs available.

LORAN APN-4

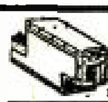


FINE QUALITY NAVIGATIONAL EQUIPMENT

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 **$49.50**
Receiver-Indicator as above, BRAND NEW **$88.50**

12V Inverter Power Supply. BRAND NEW ... $32.50
28V Inverter Power Supply, exc. cond. ... $49.50
Shock Mount for above ... $2.95

ARC-5/R28 RECEIVER



2-meter Superhet. 100 to 156 Mc in 4 crystal channels. Complete with 10 Tubes. BRAND NEW **$24.45**
110V AC Power Sup. Kit for above $9.75

ARC-5/T-23 TRANSMITTER

100-150 Mc Includes 2—832A, 2—1625 Tubes. BRAND NEW ... **$21.50**
SPECIAL OFFER! Limited quantity ARC-5/T23 xmitters. Excellent Used, less tubes ... $5.95
MD-7 MODULATOR for T-23, complete with 4 tubes. LIKE NEW ... **$9.95**

ARC-5 MARINE RECEIVER-TRANSMITTER

Navy Type Comm. Receiver 1.5 to 3 Mc BRAND NEW with 6 tubes ... **$16.95**
Navy Type Comm. Transmitter 2.1-3 Mc BRAND NEW with 4 tubes and Xtal **$12.45**
MODULATOR for above, new with tubes ... $5.95

SCR-274 COMMAND EQUIPMENT

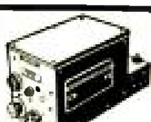
ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$12.95	$14.95
BC-454	Receiver 3-6 Mc	9.45	12.45
BC-455	Receiver 6-9 Mc	11.50	13.95
BC-450	3-Receiver Control Box	1.29	1.75

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case, instructions ... **$7.95**
Factory wired, tested, ready to operate ... $11.50
SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only ... **49c**

BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal. BRAND NEW ... **$8.95**
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal. BRAND NEW ... **$9.75**
BC-459 TRANSMITTER—7-9.1 Mc. complete with all tubes and crystal ... **$13.95**
BC-456 Modulator ... USED 3.45 NEW 5.95
BC-451 Transmitter Control Box ... 1.25 NEW 1.49
ALL ACCESSORIES AVAILABLE FOR COMMAND EQUIPMENT.

234-258 MC RECEIVER



AN/ARR-2

BRAND NEW 11-tube UHF Tunable Receiver with schematic. Only a few at this low price!
Complete with tubes **$8.88**

Send Name, Address on Post Card for FREE CATALOG of Wonderful Surplus Buys!

ARC-3 RECEIVER!

Crystal controlled 17-tube superhet, tunes 100 to 156 Mc AM; on any 8 pre-selected channels. 28V DC Power input. Complete with all tubes. Exc. used. Only ... **$16.95**

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. Exc. Used ... only **$16.95**

5-TUBE AMPLIFIER

Made by Pioneer Instrument Co. Uses 2—6SN7, 1—6X5, 2—6H6 tubes
BRAND NEW ... VERY SPECIAL **$2.95**

AN/ART-13 100-WATT XMTR

11 CHANNELS
200-1500 Kc
2 to 18.1 Mc
$48.50

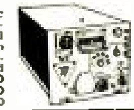
Complete with Tubes
Famous Collins Autotune Aircraft Transmitter, AM, CW, MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier/clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP811s modulate 813 in final up to 90%, class "B." A Real "HOT" Ham buy at our low price! Orig. cost $1800. Exc. Used ... **$48.50**
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

POWER SUPPLY for BC-620, 659, available for 6, 12 or 24 Volts DC. Specify ... $8.95

BC-659 TRANSMITTER & RECEIVER

27 to 38.9 Mc. F.M. Two preselected channels crystal controlled. 5 watts. Complete with speaker, tubes. Used ... **$10.95**
Less tubes, used ... $5.95
Antenna for BC-659. Telescoping 20" to 8-Ft. ... $2.95

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 ... $34.50
Like New ... $26.50
Power Supply 110 V. AC. Wired $8.50

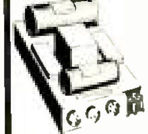
BC-906 FREQ. METER—SPECIAL

Cavity type, 145 to 235 Mc. BRAND NEW, complete with antenna. Manual included.
OUR LOW PRICE ... **$10.88**

SCR-625 MINE DETECTOR

Complete portable outfit in original packing, with all accessories. Brand New ... $22.50

DYNAMOTOR ASSEMBLY



Very fine unit, made by Collins Radio. Consists of TWO Dynamotors mounted on filter base.

Dynamotor #1—
INPUT 12VDC @ 3.8A — OUTPUT 220VDC @ 100 Ma.

Dynamotor #2—
INPUT 12VDC @ 9.9A — OUTPUT 400VDC @ 180 Ma.

BRAND NEW, in original packing. shpg wt 29 lbs.
OUR LOW PRICE ... **$10.95**

MOBILE-MARINE DYNAMOTOR

Model DM35
Input 12V DC. Output: 625 V DC @ 225 Ma, for press-to-talk intermittent operation. Shpg. wt. 14 lbs. OUR LOW PRICE, BRAND NEW ... $8.45

OTHER DYNAMOTOR VALUES:

Type	Input	Output	Excellent Used	BRAND NEW
DM-25	12V 2.2A	250V .050A		$4.50
DA-1A	28V 1.6A	230V .100A		3.25
DM-28	28V	224V .07A	2.75	4.75
DM-32A	28V 1.1A	250V .05A	2.45	4.45
DM-33A	28V 5A 28V 7A	575V .16A 540V .25A	1.95	3.75
DM-34D	12V 2A	220V .080A	4.15	5.50
DM-53A	28V 1.4A	220V .080A	3.75	5.45
DM-64A	12V 5.1A	275V .150A		7.95
PE-73C	28V 20A	1000V .350A	7.95	P.U.R.
PE-86	28V 1.25A	250V .050A	2.75	3.85

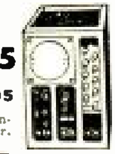
BD-77 DYNAMOTOR Input 14V @ 39A. Output 1000V @ .350A with starting solenoid. Filter Box and Mounting Base ... Like New $14.95

SCHEMATIC DIAGRAMS For any 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
51 Vesey St., New York 7, N. Y.

BC-603 FM RECEIVER



20 TO 27.9 MC.
Excellent Used ... **$14.95**
BRAND NEW ... $17.95

10 Channel, pushbutton tuning or continuous tuning. Complete with speaker, tubes, squelch.
12 or 24V Dynamotor for Above. Exc. Used $4.25 ... Brand New **$5.50**
BC-604 TRANSMITTER—Companion unit for BC-603 Rcvr above. With all tubes. BRAND NEW ... $10.95
With Tubes, Used ... $4.95

SPECIAL! BC-603 FM RCVR CONVERTED FOR ANY FREQUENCY FROM 30 TO 50 MEGACYCLES!

BRAND NEW! Checked out, perfect working condition, ready for operation. Specify Frequency desired (between 30-50 Mc) when ordering. **$27.50**

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 ... $10.49
Complete 240-page Technical Manual for BC-603, 604 ... $3.15

BC-605 INTERPHONE AMPLIFIER

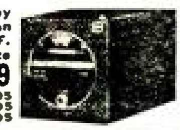
BRAND NEW ... Special, each $4.95

AN/APR-4 RECEIVER only. 38 to 4000 Mc in 5 tuning unit ranges. High precision laboratory instrument used to monitor or indicate frequency of any signals within its range. Includes wide and narrow band IF strip selected from panel. Outputs provided for attachments to pulse analyzer, panadapter, etc. Input 115 V 60 cy. LIKE NEW ... **$69.50**
Tuning Units: TU16, TU17, TU18 ... each $39.50
TU19 ... each $89.50

RECEIVER SPECIALS!

BC-312 MOBILE RECEIVER 6 Bands. 1500 Kc to 18 Mc. With Tubes and 14V Dynamotor. Exc. Used ... **$59.50**
BC-342 RECEIVER 1.5 to 18 Mc. AC only. Exc. Used ... $69.50
BC-348 SUPERHET Receiver 200 to 500 Kc and 1.5 to 1800 Mc. Voice, tone, CW. Self-contained dynamotor for 24 VDC. Like NEW ... $69.50

BC1206-C BEACON RECEIVER



195 to 420 Kc. made by Setchel - Carlson. Works on 24-28 volts DC. 135 Kc. IF. Complete with 5 tubes. Size 4" x 4" x 6". Wt. 4 lbs. BRAND NEW **$9.99**
Brand New, less tubes ... $5.95
USED, with tubes ... 5.95
USED, less tubes ... 2.95

SCR-522 2-METER RIG!

Terrific buy! VHF Transmitter-receiver. 100-156 Mc 4 channels. Xtal-controlled. Amplitude modulated voice. They're going fast! Excellent condition.
SCR-522 Transmitter-Receiver, complete with all 18 tubes, top rack and metal case.
COMBINATION. Exc. Used ... **$29.50**

MICROPHONES

Model	Description	Excellent Used	BRAND NEW
T-17	Carbon Hand Mike		$5.45
T-30	Carbon Throat Mike	$ .34	.74
T-45	Army and Navy Lip Mike		1.25
TS-9	Handset		3.88
TS-11	Handset		3.95
TS-13	Handset		4.25
RS-38	Navy Type		4.75

HEADPHONES

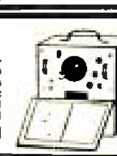
Model	Description	Excellent Used	BRAND NEW
HS-23	High Impedance	$2.19	$4.65
HS-33	Low Impedance	2.69	4.65
HS-30	Low Imp. (featherwt.)	.90	1.65
H-16/U	High Imp. (2 units)	3.75	7.95

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

TG-34A CODE KEYER

Self-contained automatic unit, reproduces code practice signals recorded on paper tape. By use of built-in speaker, provides code-practice signals to one or more persons at speeds from 5 to 25 WPM. Checked out, exc. used ... $16.95
Signal Reels of Tape, Each ... $1.85
BRAND NEW **$22.50**

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 ... **$59.50**

STANDARD TUBES

Removed from Brand New Gov't Equipment

RECEIVING					
6AG5	.35	12SG7	.75	807	.95
12AT7	.45	6J5	.65	813	6.95
6AK5	.40	6H6	.55	814	2.25
6C4	.25	6SL7	.85	815	2.15
6AL5	.38	12A6	.45	826	.44
6AC7	.55	SPECIAL PURP.		1625	.29
6J6	.32	2C39	3.50	4X-150	5.95
6V6	.65	3E29	4.25	6072	2.50
				1P25A	7.95

WILLARD 6-VOLT MIDGET STORAGE BATTERY

3 Amp. Hour, BRAND NEW, 3⅝" x 1-13/16" x 2⅝". Uses Standard Electrolyte ... Only $2.95

2 VOLT BATTERY "PACKAGE"

1—2V. 20 Amp. Hr. Willard Storage Battery. Model #20-2. 3" x 4" x 3½" 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**

IF

If you're in a weak signal area where all channels are not sharp and clear, or in a big city where buildings interfere with reception ■ If your TV set is growing old and doesn't perform the way it used to ■ If you're operating 2, 3 or more TV sets from a single antenna, and reception is not quite up to par ■ If your FM radio is not bringing in all stations in your area

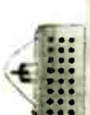
ADD

NEW BLONDER-TONGUE TV/FM POWER BOOSTER* MODEL BTA...ONLY $18.95

TV PICTURES WILL SPARKLE

and FM will come through crisp and static-free

*

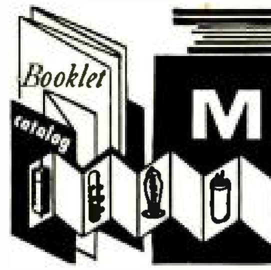


All of the engineering know-how responsible for the nation's finest TV products has been incorporated in the remarkable new Blonder-Tongue BTA. The result – a product that: ■ offers more gain than ever before possible, at such a low price . . . $18.95 ■ improves TV (black & white or color) and FM reception by boosting signal strength. (7 to 9 db, channels 2-13; 4-8 db, FM) ■ installs in seconds with only a screwdriver ■ features stripless 300 ohm terminals and "on/off" switch ■ employs latest low-noise, frame-grid tube ■ works with indoor or outdoor antennas ■ improves 2, 3 & 4 set installations.

engineered and manufactured by

BLONDER-TONGUE, 9 Alling Street, Newark 2, N. J.

Export: Morhan Export Corporation, New York 3, New York



Manufacturers' Literature

RCA TUBE MANUAL

Radio Corporation of America, Electron Tube Division has published a new edition of its Receiving Tube Manual, RC-20.

The new edition contains 432 pages and maintains its traditional format. Contents have been up-dated, revised, and augmented. More than 760 tubes are covered, including types for TV, series-string applications, a.c.-d.c. equipment, 12-volt car radio receivers, and stereo and mono hi-fi. Data is also provided for more than 173 picture tubes, including color types.

Basic tube theory and application information are covered in the same style as used in previous editions. The circuits section features new diagrams for hi-fi circuits. The Manual may be obtained from distributors or by sending $1.00 to Commercial Engineering, Electron Tube Division, Harrison, N. J.

SAMS INDUSTRIAL BROCHURE

Howard W. Sams & Co., Inc., Indianapolis 6, Ind., has issued a brochure titled "Special Services and Products."

Intended as an aid for the industry, the new booklet describes *Sams'* services in testing, marketing help, product analysis, compilation, technical writing and editing, drafting, technical art and photography, printing and direct mail services.

ANTENNA CATALOGUES

Hy-Gain Antenna Products, 1135 North 22 St., Lincoln, Nebraska has issued two new antenna catalogues. One covers a complete line of beams, verticals, tri-banders, halos, monobanders, ground planes, doublets, mobile and portable types, and the rotobrake for ham use.

The other includes antennas for Citizens Band use.

Catalogues are available from distributors or by writing direct to the manufacturer.

LAFAYETTE 1961 CATALOGUE

Lafayette Radio Electronics Corp., 165-08 Liberty Ave., Jamaica 33, N. Y. announces its 1961 catalogue. Containing over 320 pages, this volume is the largest and most comprehensive yet issued by the firm. Items offered include the company's own lines of kit and ready-made equipment, as well as the latest equipment offered by major manufacturers.

Among the equipment described are stereo and mono hi-fi components, radio and TV components and accessories, Citizens Band gear, tools, books, optical units, cameras, p.a. systems and parts, and a host of products of interest to hobbyists, students, hams, experimenters, and industrial personnel.

Listed as Catalogue No. 610, the new volume is available free on request to the company.

KNOB REPLACEMENT GUIDE

GC Electronics Co., Division of *Textron Electronics, Inc.*, 400 South Wyman St., Rockford, Ill., has announced a comprehensive, fully illustrated wall chart on exact replacement TV knobs.

The new chart pictures 235 knobs that are claimed to take care of 98 percent of all replacements.

Charts are free at distributors or by writing direct to the manufacturer at the above address.

BRITISH TUBE BULLETINS

English Electric Valve Co. Ltd., Chelmsford, England has issued three booklets describing some of its new tubes.

The contents of each are self-explanatory from the respective titles: "Voltage Stabilisers and Reference Tubes," "V.H.F. Transmitting Tetrode for FM and Television Service," and "Valve Replacement Index." The first two booklets contain tube data, illustrations and dimensional drawings.

G-E RECTIFIER MANUAL

A new design manual for applying silicon controlled rectifiers in electronic and electrical equipment has been published by the Semiconductor Products Department, *General Electric Company*, Charles Building, Liverpool, New York.

The 13-chapter, 255-page "Controlled Rectifier Manual" was prepared by five members of the Department's application engineering organization. It contains information on voltage transients in SCR circuits, test circuits, turn-off characteristics of the device and methods, firing characteristics and firing circuits, and series and parallel operation of SCR's. Charts, nomographs, oscilloscope traces, and 224 circuit diagrams are also included.

Copies are priced at $1.00 each, obtainable from the firm's authorized semiconductor distributors, or from the department direct.

TOROIDAL INDUCTORS

Burnell & Co., Inc., 10 Pelham Parkway, Pelham Manor, N. Y. has published a unique and comprehensive ready-reference wall chart on toroidal and variable inductors which it is offering to design engineers.

The three-color chart measures 24"x 36" and has a metal edging top and bottom to insure its hanging flat against the wall. Twenty graphs provide "Q" *versus* frequency curves for several ranges of voltage or inductance. Also shown is a table of the electrical characteristics and physical dimensions of 25 toroidal inductors with diagrams and sizes of a number of commonly used hermetic and epoxy-potted metal cases.

The reference chart is available on letterhead request addressed to Mr. Leo Schwartz, vice-president, sales.

PERMANENT MAGNET ALLOY

Hoskins Mfg. Co., 4445 Lawton Ave., Detroit 8, Mich. has published a new illustrated brochure describing the properties and applications of a new copper-nickel-iron ductile permanent magnet alloy of the generic "Cunife" type.

Properties listed include high coercive force and energy product values, plus excellent ductility, malleability, and machinability. The material can be stamped, machined, or otherwise fabricated in a wide variety of shapes and sizes.

Full details on this new product are included in the brochure which is available without charge upon request.

TV ANTENNA REPLACEMENTS

JFD Electronics Corp., 6101 Sixteenth Ave., Brooklyn 4, N. Y. has just issued a second edition of its "Exact Replacement Antenna Guide," covering portable and "Tote-Able" TV sets marketed since 1947.

The 16-page guide lists the manufacturer, receiver model number, year manufactured, picture tube size, manufacturer's antenna part number, and *JFD* replacement antenna number.

Copies of this guide are available without charge to service technicians and dealers who write on their company's letterhead.

NEW A.S.A. STANDARD

The American Standards Association, 10 East 40 St., N. Y. 16, N. Y. has issued "American Standard, Preferred Frequencies for Acoustical Measurements, S1.6-1959."

This standard has been approved by the Association in order to reduce to a minimum the number of frequencies at which acoustical measurements need to be tabulated. It refers all frequency-series to a single reference frequency, and selects others in such a way as to afford a maximum number of frequencies common to the various series.

Copies of the new Standard are available at 35 cents each from Dept. PR 140, care of the Association.

PRECISION METER DATA

Greibach Instruments Corp., 315 North Ave., New Rochelle, N. Y. has issued a single-page, two-color data sheet covering its patented "Bifilar" meter movement which is applicable to a wide range of single and multi-range current, voltage, and resistance meters in bench, panel, and portable models.

Exploded views illustrate how the "Bifilar" design is applied in the construction of measuring equipment for transistors, semiconductors, amplifiers, and ionization.

Copies of this bulletin, as well as the company's complete 20-page catalogue, are available on request.

"COMPUTERESE"

The Industrial Division, *Minneapolis-Honeywell Regulator Co.*, Philadelphia, Pa. has issued a new booklet entitled "Do You Talk 'Computerese'?"

This pocket-sized 22-page glossary is intended to make computer language more intelligible to the layman by defining some 82 terms which crop up in both professional and consumer publications.

"EICO" DEALER AID

Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, N. Y. has announced two attractive red-white-and-black neon and clock-neon signs for window and interior display by dealers. Each sign calls attention to the *Eico* line of stereo and mono hi-fi test instruments, ham gear, and receivers in both kit and wired form.

The clock neon sign is 14 inches high by 37 inches wide; the standard neon sign, 10 inches by 25 inches. For further information, dealers and distributors should contact their local *Eico* representative.

METER-RELAY BULLETIN

Assembly Products, Inc., 75 Wilson Mills Rd., Chesterland, Ohio has issued a 4-page bulletin which describes a new kind of meter-relay which combines continuous signal indication with reliable control action and instantaneous reset.

Entitled "The Picture Story of the CRMR," Bulletin S-2-1 features diagrams showing how various circuit components are affected during operation.

ULTRASONIC APPLICATIONS

Acoustica Associates, Inc., 10400 Aviation Blvd., Los Angeles 45, California is offering actual case history reports describing twelve standardized ultrasonic cleaning applications in everyday industrial use.

How such equipment is used by firms like *Bell Labs, Texas Instruments, Fairchild Controls, Reeves Instrument*, etc. is presented along with process data for cleaning an additional 48 specialized items.

DIRECT-WIRE TV

Argus Cameras, Inc., 405 Fourth St., Ann Arbor, Mich. has published a brochure that describes how a business may use direct-wire (or closed-circuit) television with a minimum investment of $595.

The new booklet, titled "How to Use Direct-Wire TV as a Tool of Business and Industry," presents ideas for the use of this form of TV by many organizations.

To obtain a copy, write to the A-V Systems Dept. at the company address.

CB EQUIPMENT CATALOGUE

GC Electronics Co., 400 S. Wyman Street, Rockford, Ill. is now offering a new illustrated 8-page catalogue covering its line of Citizens Band equipment.

Included in the listing are specially designed antennas for fixed station and mobile applications; antenna mounting devices for mobile installations; wall, chimney, and tower mounts; adapters, capacitors, and suppressors.

Copies of catalogue No. AN-61 are available without charge upon request.

INSULATED CABLES

Sequoia Wire & Cable Co., 2201 Bay Road, Redwood City, Calif. has issued a four-page brochure giving specification details on Teflon-insulated hook-up wire for the internal wiring of meters, panels, electrical and electronic equipment, and data on Teflon cables for high-frequency equipment and r.f. transmission lines of the type employed in radar and communications. —30—

ADDING BASS RESPONSE TO A.C.-D.C. RECEIVERS

By MARSHALL HARRY

SOME of the methods for improving the bass response of small a.c.-d.c. radio receivers involve adding a few parts or changing the output transformer. The output transformers of these little sets are usually small, not only because of the lack of space on the chassis but for reasons of cost.

Fig. 1 shows one method of connecting a small push-pull output transformer in place of the single-ended type usually found in all a.c.-d.c. receivers. As most such radios have a little extra space, either back of the speaker or on the speaker itself for mounting this new transformer, this is no problem.

A 10-watt output will work wonders with these little sets since most of them have an ouput of 2 watts or less—even the better varieties.

Fig. 2 shows how by adding an RC network across the primary of the output transformer, an increase in effective bass response can be obtained without too much loss of volume. If the bass isn't low enough after the network has been installed, try a somewhat larger resistor, that is, add 5000 ohms or so, making the resistor 20,000 ohms.

Fig. 3 is a variation of Fig. 2 but with a control provided. Here, again, one can do a little juggling of resistor and capacitor values to provide optimum results. —30—

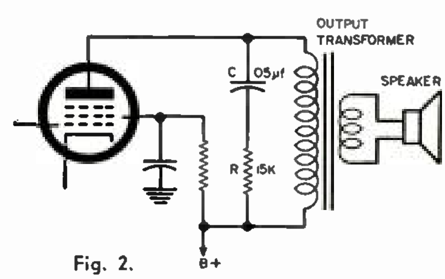


Fig. 2.

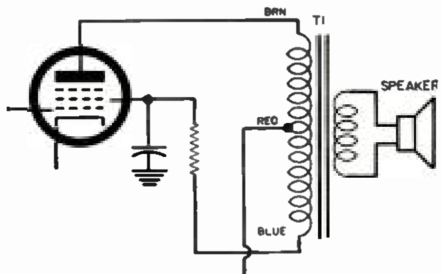


Fig. 1.

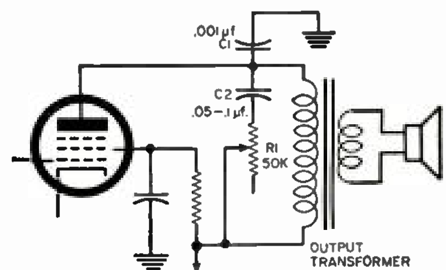


Fig. 3.

Transistor Output Circuits

(Continued from page 57)

to heating the entire unit. A solder lug should be screwed on to the unpainted mounting flange and the wire should, preferably, be soldered to the lug beforehand.

Power Supply or Battery

Our readers may justly wonder about a suitable source of 14 volts at half an ampere. Batteries that can deliver such power are rather large, and smaller units don't last very long. The ordinary laboratory type power supplies can deliver the power but not at the voltage and current required. For this reason special power supplies are usually designed to work with transistor circuits. While there is not enough space in this article for a complete description of such supplies, we do want to give the reader some idea of what is required.

The circuit shown in Fig. 10 is typical of those used with transistor audio amplifiers and has certain features which make it somewhat different from vacuum-tube type supplies. The power transformer is available from jobber's stock and is widely used for selenium-rectifier, low-voltage supplies. Although two 1N607 rectifiers are shown, any unit capable of 500-ma., 50-volt peak inverse operation will do. The reason for not using a choke is that chokes having low enough d.c. resistance are not always available. Capacitors of the values shown are readily available and the power resistors are also carried in jobber's stock.

One luxury accessory in the power supply of Fig. 10 is the zener diode, type 10M14Z. It is not absolutely necessary but will help to reduce a.c. ripple, voltage variations with load changes, and will also present a low output impedance for the power supply. The author has found that the addition of a zener diode greatly improves over-all amplifier performance and is well worth the extra expense.

Conclusion

The basic method for designing a class A transistor power amplifier has been explained and a typical design has been illustrated. Class A operation, especially with transistors, is not very efficient for larger power ranges, and a number of precautions must be observed. Distortion can be reduced by proper circuit design and selection of a very low signal-source impedance. The heat generated by the collector current must be dissipated to avoid overheating of the transistor. To supply the low voltage and relatively high current, a fairly simple power supply can be constructed and a circuit for such a unit is shown here. Despite some of the disadvantages of using a class A power output amplifier, the circuit simplicity and reliable operation make this circuit useful in many low-power applications. —30—

New Audio Test Report

ELECTRONICS WORLD LAB TESTED

Heath Model AA-50 Integrated Stereo Amplifier Kit
Shure Model M232 Stereo Tone Arm

Heath Stereo Amplifier Kit

THE first impression one gets of *Heath's* Model AA-50 integrated stereo amplifier is that it is compact, reasonably priced, neat in appearance, and that it incorporates all the necessary functional controls. Actually, it is more than this in that their engineers have utilized a circuit design that provides hi-fi performance with exceptionally low distortion for an integrated system. If we were to judge by the performance characteristics at its maximum power output (25 watts per channel), we would have to say that it is the best unit of its type that we have tested to date. The reason is that *Heath* has underrated the power output of the unit. If they followed standard industry procedures, they could have rated the amplifier at approximately 33 watts per channel, which would be 66 watts for monophonic operation.

The harmonic-distortion figures that we obtained are as follows: At 1000 cps: .36% at 25 w., .41% at 30 w., .49% at 32 w., and 2% at 33.2 w. At 30 cps and 15,000 cps: the power output for 2% harmonic distortion was slightly less. These figures were taken with one channel in operation. When we loaded both channels equally, we were able to obtain 28.5 watts at 1000 cps with 2% harmonic distortion.

The IM distortion (60 and 7000 cps, 4:1 ratio) was .08% at 2 watts, .24% at 10 watts, .67% at 20 watts, and .81% at 25 watts. Again, this is for single-channel operation. When both channels were loaded equally, the IM distortion per channel was 1.1% at 25 watts. We had to change our method of taking IM distortion measurements since the 4-ohm output tap in this design is grounded. We loaded the amplifier and took our power-output measurements in the normal manner across the 8-ohm tap. The IM tests were made at the 4-ohm tap.

The number of operating controls was held to a minimum, and only the essential ones have been incorporated. They are as follows: 4-position "function switch" (stereo, reverse stereo, and either channel *A* or *B* through both speakers); an input selector switch (tuner, 2 auxiliaries, tape head, and separate magnetic phono inputs for stereo and mono); balance, channel separation, level, and individual bass and treble controls; and a separate power switch. In addition, an output phasing switch is incorporated on the rear apron.

The tone controls provide normal (approximately 18 db) boost and attenuation at 30 and 15,000 cps.

The RIAA magnetic equalization curve proved to be within ±1.2 db of the standard curve over the entire range.

Frequency response at a 2-watt level was within ±.85 db from 30 to 15,000 cps.

Damping factor at 1000 cps with 2-watt output was slightly over 11.

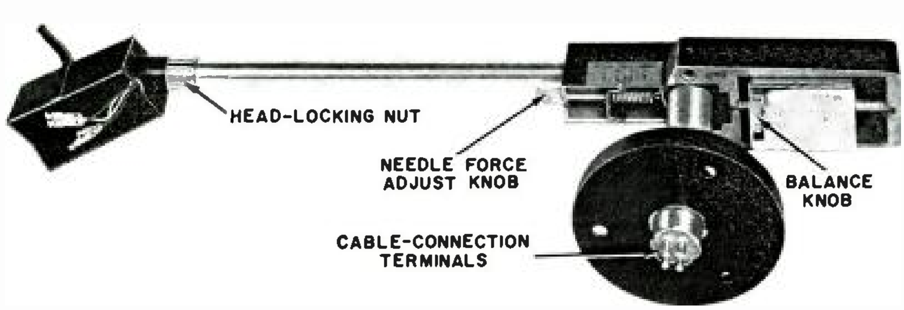
Sensitivity of the amplifier at 1000 cps was .178 v. on all high-level inputs, and .0016 v. for low-level inputs for 25-watt output.

Hum and noise was measured at −55 db on magnetic phono input (volume control adjusted for 2-watt output with 6 mv. input) and −70 db on auxiliary input at the same volume setting with respect to 2 watts output. The inputs were shorted for this test.

The channel separation control, which is sometimes referred to as a blend control, permits adjustment of the channel separation from its maximum of 39.1 db at 1000 cps to 0. The purpose of this control is to eliminate the so-called "hole-in-the-middle" effect. If your speakers are too far apart or are not placed ideally in your room, it is possible to adjust the control to blend the two channels together so that the sound emanates from a broad front and not just from the left and right. We personally dislike this approach, and feel that every attempt should be made to place the speakers properly or, if necessary, to add a third, center speaker. This amplifier has separate output connections for such a center speaker.

One additional feature, which we find quite convenient, is that the amplifier incorporates individual level controls on all inputs, with the exception of tape. These controls can be adjusted so that, for example, when switching from tuner to phono, re-adjustment of the front-panel master level control will not be necessary. Additional level controls are connected at the inputs to the power amplifier sections of both channels. With these two controls it is possible to adjust the individual gains of the two channels to correct for differences in speaker efficiency.

The construction of the unit is such that any novice could assemble the amplifier. It is time-consuming, as for all integrated stereo systems, but two printed circuit boards do help in reducing the time required. If one follows the instruction manual exactly, the amplifier should operate as intended. In performance, all of its characteristics come extremely close to the manufacturer's published specifications. In our opinion, this integrated stereo amplifier (available in kit form at a price of $79.95) is an exceptionally good unit, and can be classed among many of the best available, even some of those at a much higher price. —30—



Shure Stereo Tone Arm

THE essential characteristics of a tone arm are mainly mechanical. The arm must permit the convenient mounting of any one of a large number of phono cartridges with ease. It must allow perfectly free vertical and lateral motion so that the cartridge is able to track any record with a minimum of tracking pressure. Any resonance it has must either be completely damped out or well outside of the audible range. It would also be convenient to be able to adjust the stylus force to the correct value, and it would be helpful to be able to read the value of the force directly on a scale on the tone arm without recourse to a stylus-pressure gauge (except for occasional checking). And finally, the arm should be convenient to use, easy to mount, and attractive in appearance. We are glad to report that the *Shure* Model M232 stereo tone arm meets all these requirements admirably.

Complete instructions, along with all the necessary hardware and mounting plates, are supplied to mount just about any available cartridge. Conveniently, the arm is designed so that it may be completely installed from the top of the motorboard. After mounting has been completed, the adjustable counterweight is moved by means of a thumbscrew until the arm is perfectly balanced. Then, the stylus-force spring thumbscrew is put in place and adjusted for the proper stylus force, as indicated by the 0 to 8-gram scale printed directly on the side of the arm near the pivot. Precision ball bearings are used throughout on all pivot surfaces so that the arm moves perfectly free. The plug-in type black plastic shell that mounts the cartridge is offset from the tubular metal arm to provide minimum tracking error over the entire record.

The pivot post, which fits in the mounting base, has a four-pin plug at its end for the connecting leads. A four-foot cable, supplied with the arm, has a matching receptacle to fit this plug and phono plugs at the other end of the prefabricated cable make it unnecessary to take your soldering iron out of your tool box when installing this arm. The four-foot cable uses special low-capacity shielded cable—an important consideration when working into high-impedance inputs of preamps. These may have input impedances of up to 100,000 ohms when they are to be used with some phono cartridges.

Along these lines, we recently had occasion to measure the capacity of some plastic-covered shielded cable that we wanted to use between our phono cartridge and our preamp. We were dismayed to find that the cable we planned to use had a capacity of 65 $\mu\mu$f. per foot, making it quite unsuitable for this use. Low-capacitance shielded cable or even coax is a must.

The Model M232, designed to play records up to 12 inches in diameter, can be adjusted up to 2¼ inches above the level of the motorboard. The tone arm, complete with plug-in shell, mounting base, and 4-foot cable, is available for $29.95. The manufacturer also has the longer Model M236 available for records up to 16 inches in diameter. —30—

Stereo Preamp-Amplifiers

(Continued from page 54)

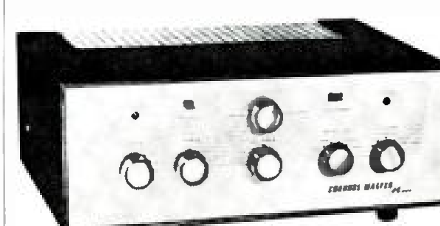
record with all controls set for stereo operation. Adjust the balance control until the volume is the same in either speaker when the switch is flipped back and forth from "stereo" to "reverse."

A few amplifiers make balancing even more simple. They provide methods of balancing that range from induced a.c. hum to a cathode ray tube on the front panel. The latter shows visually that the system is in balance—up to the speakers. If these are not matched or their individual acoustic environments differ, more balancing has to be done. The sound's the thing, not the electronic patterns.

If you plan to use a good turntable,

Altec Model 353-A

Arkay Model CS-28

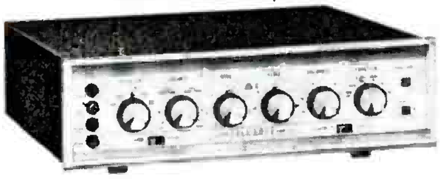


Channel Master Model 6600

Eric Model 2160

Sargent-Rayment SR-2051

Shell Stereo Amplifier



Sherwood Model S-5000

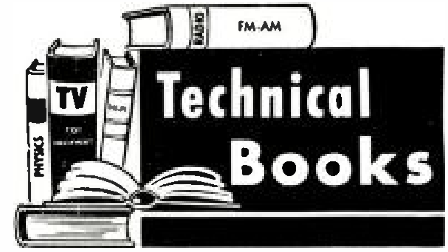
EMI 555 "Stereoscope"

you will have no need for a rumble filter. However, if you use a turntable that is somewhat the worse for wear or a record changer that is not specifically designed for high-fidelity stereo operation, you will have to use a rumble filter or suffer the annoyance of a continuous low-pitched growl in your system.

A scratch filter is not nearly as necessary. Most modern records have pretty decent surfaces, and even when they don't, a little surface noise is usually preferable to the loss of the high frequencies and consequent dulling of sound that ensue from employing the scratch filter.

All in all, there is such a great variety of integrated stereo preamp-amplifiers on the market today, and from a large number of reputable manufacturers, that it should not be too difficult to make a choice that will please your ear, your eye, as well as your pocketbook. These manufacturers have done their best to please you, so that it is up to you to choose a product that will make stereo convenient and enjoyable, with all the features you could possibly want.

Unless you are an audio technician, you cannot delve into the electronic and electrical characteristics of an amplifier. However, by knowing what functions you require of an amplifier and referring to the accompanying chart, you are well on your way to determining which model will best suit your needs. Add to this a few minutes of physical inspection and listening, and you will know if the workmanship employed in the manufacture of the amplifier is of good quality and if its sound is the type you prefer. When you reach the last point, you are one-up on the experts, for it is your taste that the amplifier—and almost every other piece of audio equipment—has to please. —30—



"MATHEMATICS FOR ENGINEERS" by W. N. Rose. Published by *John F. Rider Publisher, Inc.*, N.Y. 2 vols. Vol. 1, 548 pages; Vol. 2, 420 pages. Price per vol. $6.60.

Each volume in this set is devoted to certain areas of engineering mathematics, going from fundamental rules and processes through calculus and its applications. More than a thousand examples are given and worked out.

"ELECTROMAGNETIC ENERGY TRANSMISSION AND RADIATION" by Richard B. Adler, Lan Jen Chu, and Robert M. Fano. Published by *John Wiley & Sons, Inc.*, N.Y. 621 pages. Price $14.50.

In this volume, the three M.I.T. professors treat electromagnetic waves and oscillations in one, two, and three space dimensions, using time-domain, complex-frequency domain, and energy points of view.

"MATHEMATICAL METHODS FOR DIGITAL COMPUTERS" by Anthony Ralston and Herbert S. Wilf. Published by *John Wiley & Sons, Inc.*, N.Y. 293 pages. Price $9.00.

This book deals with the interrelation among problem analysis, computer capabilities and limitations, and coding procedures. It offers mathematical analyses and derivations of commonly used techniques of digital computation, and detailed, step-by-step discussion of the processing of problems.

"ELECTRONIC CIRCUIT THEORY" by Henry J. Zimmerman and Samuel J. Mason. Published by *John Wiley & Sons, Inc.*, N.Y. 564 pages. Price $10.75.

This book deals primarily with methods of analysis of electronic circuits, stressing the "model concept". Basic circuit functions are classified as: rectification and detection, waveshaping and amplification, and waveform generation.

"DIRECT CONVERSION OF HEAT TO ELECTRICITY" edited by Joseph Kaye and John A. Welsh. Published by *John Wiley & Sons, Inc.*, N.Y. 369 pages. Price $8.75.

Recent developments in efforts to convert thermal energy directly into electrical energy are here discussed in a number of edited papers contributed by various researchers in this field.

"THE DYNAMIC BEHAVIOR OF THERMOELECTRIC DEVICES" by Paul E. Gray. Published by *John Wiley & Sons, Inc.*, N.Y. 136 pages. Price $3.50.

This is a report that investigates the small-signal dynamic behavior of thermoelectric devices, such as heat pumps and generators. The text is based on mathematical analyses of linear models.

"ELECTRONIC CIRCUITS, SIGNALS, AND SYSTEMS" by Samuel J. Mason and Henry J. Zimmerman. Published by *John Wiley & Sons, Inc.*, N.Y. 616 pages. Price $12.50.

This book presents matrix, topological, and signal-flow graph methods of circuit and system analyses. In each case the formulation and solution of electronic circuit problems is stressed, but the methods used are applicable to many other fields.

"PHOTOCONDUCTIVITY OF SOLIDS" by Richard H. Bube. Published by *John Wiley & Sons, Inc.*, N.Y. 461 pages. Price $14.75.

A unified physical description and interpretation of photoconductivity is provided in this volume, with examples drawn from different kinds of material. Additionally, the correlation between photoconductivity and related phenomena in insulators and conductors is given.

"ELECTRONIC SWITCHING, TIMING, AND PULSE CIRCUITS" by Joseph M. Pettit. Published by *McGraw-Hill Book Co., Inc.*, N.Y. 267 pages. Price $7.50.

This book integrates the numerous circuits devised during the 1940's in connection with radar, nuclear instrumentation, and TV into a unified analytical framework for understanding the use of tubes and transistors as switching devices.

"INTRODUCTION TO MODERN NETWORK SYNTHESIS" by M. E. Van Valkenburg. Published by *John Wiley & Sons, Inc.*, N.Y. 498 pages. Price $11.75.

For readers already familiar with network analysis, here is an intensive study of network synthesis, which attempts to provide a scientific and mathematical basis for circuit design. This subject is regarded with increasing importance in modern electronics, along with information theory, automatic control theory, and automatic computation.

"TUBE SUBSTITUTION HANDBOOK" by the Sams Staff. Published by *Howard W. Sams & Co., Inc.*, Indianapolis, Ind. 96 pages. Price $1.50. Soft cover.

To facilitate the work of the technician who comes across different tube types, this volume serves as a reference work on tube substitutions. Included is a cross-reference of American receiving tubes; a list of industrial substitutes for receiving tubes; European substitutes for American types; American substitutes for European types; and a section on picture-tube substitutes.

"TRANSISTORS" by Saedi Staff. Published by *Saedi Unlimited*, 626 S. Federal St., Chicago 5, Ill. 30 pages. Price $1.25. Soft cover.

This is an elementary treatment of the subject, presented in the form of

five "Lessons", which are equally adaptable to home-study or classroom use. The text is well enough illustrated and clear enough in its presentation so that those without prior semiconductor experience should have no trouble handling the material. The fifth lesson covers servicing procedures, the balance is theoretical.

"STEREO HIGH FIDELITY HANDBOOK" by Norman H. Crowhurst. Published by *Crown Publishers, Inc.*, New York. 183 pages. Price $5.95.

This is another in the growing roster of popularly written books on this subject that have appeared in the past three years. Written in non-technical language and profusely illustrated with photos and drawings, the book attempts an explanation of stereo, how it relates to high-fidelity, and offers advice on equipment for new and converted-from-mono systems.

"PRACTICAL TRANSISTOR SERVICING" by William C. Caldwell. Published by *Howard W. Sams & Co., Inc.*, Indianapolis, Ind. 191 pages. Price $2.95. Soft cover.

Avoiding some of the more complex theory of transistors, the author here devotes much of this book to showing how the transistor works, to explaining circuit components, and mostly to isolating and curing troubles in equipment using transistors. One whole chapter contains "case histories" of troubleshooting auto and portable transistor receivers.

"TELEVISION EXPLAINED" by W. E. Miller, revised by E. A. W. Spreadbury. Published by *Iliffe & Sons, Ltd.*, London, England. 192 pages. Price 12s. 6d., plus postage.

Written simply, and in non-mathematical language, this book explains the technical fundamentals of television, with emphasis on receivers. As the seventh edition of a work originally published in 1947, the present volume has been generally revised and updated to keep pace with new developments. A new chapter deals with combined TV and FM receivers. The book assumes no previous knowledge of TV circuits by the reader, but it does assume an acquaintance with ordinary radio receivers.

"RADIO SERVICING" by Abraham Marcus. Published by *Prentice-Hall, Inc.*, Englewood Cliffs, N. J. 649 pages. Price $7.95.

This is the third edition of a reputable staple in the technical library that first appeared back in 1948. Its purpose, briefly, is to teach the theory of the radio receiver and how to service it. It presumes some previous technical training, at least in electronic fundamentals, and then builds on that to delve into tubes and their uses, typical circuits, test and servicing instruments, and servicing procedures. Serious students will find the book valuable; older hands may welcome it as a general refresher course. —30—

R. F. Proximity Controls

(*Continued from page* 63)

naturally, is always possible. When it does occur, it must be found in a hurry. A machine out of operation may cost thousands of dollars per hour in lost production.

Since almost no current flows in the pickup coil, about the only thing that can go wrong with the latter is physical damage. A quick check with an ohmmeter at the control end of the cable will usually tell whether the coil is still in good condition.

Unlike most radio and TV oscillator circuits, the d.c. bias on the grid will *not* tell if the oscillator is working, since no grid resistor or capacitor is used. However, an ordinary multimeter, switched to the output function, can be used to trace the oscillator signal right through the control.

Naturally, if you find the r.f. signal present at the plate of V_{1B} but not at the grid of V_{2A}, you would suspect that the .001-μf. coupling capacitor between these triodes is open. As you can see, there is nothing mysterious about fault-detection methods. The exact signal voltages will vary with the adjustment of the sensitivity control, and also according to the presence of conducting material near the pickup coil: but signal tracing should still show an increase in signal strength at each amplifier.

If r.f. is present right up to the cathode of the 1N34A diode, a simple d.c. voltage check between grid and cathode of V_{2B} will show whether the diode circuit is working or not.

Tube changing hasn't been mentioned here, because any electronic service technician who doesn't change tubes first is not a realist!

Because of the quality construction, the chance of serious trouble other than tubes in the control chassis is very small. Most cases of faulty operation can be traced to external causes, such as the following:

A careless installation may have resulted in location of the pickup coil too near masses of metal or metal objects other than the ones that are supposed to be sensed. Small pieces of metal (or other conducting material) may have become stuck on the pickup coil or are near it. The coil itself may have become physically damaged.

Erratic operation can also sometimes be traced to the manner in which the control box is mounted, without regard to the nearness of conducting matter. It may be that the box is subjected to considerable vibration. This can shorten tube life. It can also sometimes cause the load relay to make momentary contact when it should be open.

A system using an r.f. proximity control is actually a simple one. The only "special equipment" a technician really needs when breakdown occurs is an understanding of how this device works. —30—

Bulk Eraser for Magnetic Tape

By **WILLIAM QUITMAN WOLFSON, M.D.**

Make this high-performance eraser for tape in 15 minutes at a cost of only a few dollars.

FEW scientific fields remain a stranger to magnetic recording tape. In medicine, for example, its uses are countless and varied, including such different applications as data recording in physiologic laboratory experiments, continuous monitoring of the vocal behavior of psychiatric patients, the registration of heart sounds illustrated on the cover of the November 1957 issue of this magazine and even, for the past few years, a complex system of recorded tape summaries for practicing physicians which permits them to absorb the well-abstracted meat of the newest developments in medical science while they are driving from call to call.

For at least some of these applications, such as the accurate recording of heart sounds, it is desirable to have as low a level of background as possible. With most inexpensive recorders, even when the instrument is new, it is difficult to erase completely earlier recordings from previously recorded tape, yet it is essential to do so for optimum results in certain problems. Even very slight background will markedly impair a recording of heart sounds. If the recording apparatus has been used much, the erase efficiency is generally not maximal because of worn pressure pads or inexact alignment of the head horizontally or with respect to azimuth, defects not so obvious as if they had occurred with the record or playback head. However, even if these factors are carefully controlled, poor erase may ruin a critically important tape if the line voltage happens to be low when the recording is made or if the tape happens to be from a lot which is intrinsically difficult to erase. During 1954, the writer purchased some 1-mil Mylar tape which was not notably reduced in intensity by one passage across the erase heads of any of a half-dozen different American and European home-type recorders.

The solution to these problems is the use of a so-called "bulk eraser" before the recording is made. A properly designed bulk eraser will, in a matter of seconds, completely remove previous recordings from a reel of tape and leave it with a background level less than that which it had when new. Unfortunately, many commercially available erasers are expensive enough to discourage their wide use by amateur home recordists. Fortunately, however, home construction of an adequate bulk eraser is almost ridiculously simple and inexpensive, providing the right starting material is used. The unit to be described is not the first "do-it-yourself" bulk eraser to be suggested but it is far simpler even than the eraser suggested by Driscoll[1] which is made by a somewhat tedious process from surplus power transformers.

Construction

Purchase a receiver or transmitter power supply filter choke of the commonly used 5 to 25 henrys inductance, rated at 75 to 200 ma. capacity. If bought surplus, such chokes may cost as little as 70 cents and, in any case, should not cost more than a few dollars. Remove the case of the choke. Examine the laminations. These will be found to consist of two groups: (a) a series of E-shaped laminations with a coil wound on the center bar of the E and (b) a series of straight laminations which close the open parts of the E. The latter are generally held against the E only by varnish. Using a screwdriver to direct the force properly, knock off the straight laminations and discard them. There now remains the coil wound on the center bar of the E-shaped laminations. Fasten these E-shaped laminations together tightly with two nuts and bolts; most chokes already have holes which permit this to be done without drilling. Tape the coil down securely with electrical insulating tape and attach its two leads to an ordinary line cord and 117-volt male plug. A convenient additional feature is to mount a press-to-make switch on the unit. It is connected in one side of the 117-volt line and permits the unit to remain plugged in continuously with current flowing only when the switch is pushed.

Erasing Technique

The effective erasing field is located at the open ends of the E and, like any electromagnetic field, it falls off in intensity in proportion to the square of the distance from this region. This means that, while being used, the unit should be closely applied to the reel of tape being erased. In practice, the eraser is plugged into the 117-volt socket and passed slowly over the reel so that every area on the reel passes directly under one of the two open gaps in the E. A simple extra precaution against failure to erase some small area is to pass the eraser successively over both faces of the tape reel, although this is unnecessary if the first face is covered carefully. After this process is completed, slowly withdraw the eraser to about two feet from the reel before turning it off; this is a precaution against recording the self-induction current surge which occurs after the current is turned off. The coil is carrying considerably more current than its rated continuous capacity and therefore the unit should be operated only intermittently. With the prototypes, up to ten reels were erased without excessive heating. Ample warning against excessively prolonged use is given by the obvious rise in coil temperature if the unit is used for a long period.

The only parts needed are the choke, two nuts and bolts, one 117-volt male plug and cord and some insulating tape; all at a cost of only a few dollars. The only tools needed are a hammer and screwdriver. Any interested person with no mechanical experience or special electrical training can make this unit in less than 15 minutes. It has been found, in the case of the prototypes, that all tapes studied have been completely erased by passing the unit over one surface of the tape reel in the manner described. Samples of tape studied have included the 1954 material which is virtually unaffected by the erasing fields of the erase heads of a number of representative U.S. and foreign recorders. This performance is comparable to that of the commercially available bulk erasers and is obtained at a cost much less than that of the commercial units.

REFERENCE

1. Driscoll, R. M.: Hi-Fi Tape Recording, November 1957.

—30—

M. C. Anderson of Arlington, Va., suggests that plastic cabinet repairs are easier to make than most people suspect. Most plastics can be readily repaired with plastic cement (available at radio supply houses and dime stores). Since the cement will mark finished surfaces, use it sparingly to avoid smears. Even a badly broken cabinet can be repaired if cloth reinforcing patches are used on the inside. Soak patches in cement and smooth them over the break. Allow 24 hours for "setting."

Mac's Service Shop

(*Continued from page* 50)

fier. Throwing any one switch down removes the attendant speaker transformer from the music bus and connects it to the intercom circuit. The rub was that music was heard through post and kitchen speakers, even when they were switched to the intercom circuit, interfering with orders.

"A couple of things complicated the situation: first, I could not make my own tests. It was Tony's job; so it simply would not do for me to go nosing around. I had to depend on him to do the testing. Second, the system had been struck by lightning shortly after being installed, and the owner could not be sure if the trouble had been present before then or not.

"Tony had checked over all the wiring carefully to make sure it was correct and that there were no short-circuits feeding the music into the intercom circuits. I suggested several tests aimed at isolating the part of the circuit where this transfer was taking place, and he soon reported that it was happening somewhere in the banks of switches that transferred each post speaker from the music bus to the intercom circuit, and *vice versa*. Remembering the lightning, I thought possibly an arc had carbonized a path across the insulation of one or more switches; so I suggested the switch banks be disconnected and individually checked for leakage with an ohmmeter. This test revealed no degradation of switch insulation, and that left just one possibility: the music was being transferred across open switch contacts through the capacity between them. Capacity between contacts on one switch would be quite small; but when dozens of switches were wired in parallel, the total would be high.

"I could think of no practicable way of reducing this capacity appreciably; so I decided to try to 'buck out' the music in the same way a transmitting tube is neutralized; that is, supply a bucking signal equal in amplitude but 180° out-of-phase with the signal being transferred through the switch capacities. I worked out a circuit to do this and tested it here on the bench. I let the audio generator represent the music amplifier. One half the primary of a small output transformer was connected across the output of the generator, the center-tap being grounded. The output of the generator was fed through a 20-$\mu\mu$f. capacitor to the a.c. v.t.v.m.; and the output of the generator, operating at 1000 cycles, was adjusted for a 10 millivolt reading. A 35-$\mu\mu$f. variable capacitor was connected between the loose end of the transformer primary winding and the hot terminal of the v.t.v.m. The 20-$\mu\mu$f. capacitor represented the capacity between switch contacts through which the unwanted signal—10 millivolts in this case—was feeding. I knew any signal appearing at the hot end of the portion of the transformer winding across the signal generator would produce another signal equal in amplitude but 180° out-of-phase at the other end of the winding. This phase-shifted signal would be transferred through the variable capacitor to the v.t.v.m., representing the intercom bus in our test setup. When the variable capacitor was adjusted to 20 $\mu\mu$f., the two signals should cancel—and they did! With the capacitor adjusted for maximum attenuation, the reading could be dropped 35 or 40 db; and since the two signal paths were identical, this attenuation would hold all the way from 50 to 5000 cycles.

"All Tony had to do was connect one end of a center-tapped output transformer winding to the music bus, ground the center-tap, and connect the other end of the winding through a small variable capacitor to the intercom bus. He stopped by to tell me that when he set the variable capacitor equal to the capacity between switch contacts, the music dropped out of the intercom as if by magic, and stayed out."

"How about pay, Mr. Consulting Engineer?" Barney inquired.

"In Tony's case, when he asked for my bill I suggested he could pay me by doing some antenna tower work out at the house. He is a crackerjack at this and well equipped. As for the spring company, I'll send them a bill for consultation and advice. The point I want to make, though, is that the radio and TV service technician has acquired a wealth of knowledge, not necessarily restricted to repairing ailing radio and TV sets, that others are willing and eager to buy—*if* he is alert to this fact.

"On the other hand, the technician must be careful not to get in over his head. For example, yesterday I had a long distance call from the director of the hospital over in Carlston. He wanted to install a two-way radio system at the hospital and in ambulances so that the emergency ward and doctors could be alerted and ready to handle accident patients when they arrived. He had received some quotations from people manufacturing and selling this type of equipment, but he did not like the prices. He had heard of the fabulous 'bargains' to be had in surplus electronic equipment, and he wanted me to go with him to a war surplus depot, pick out suitable equipment, convert it, and install it in the hospital at a big fat saving to the hospital. I politely declined after pointing out several of the many pitfalls involved in converting war surplus, getting the equipment licensed, maintaining it, etc."

"I don't blame you," Barney remarked. "Dependability would be very important in such a setup. He had better wait until he can afford commercial equipment. That's a case where you probably gave away advice worth several hundred dollars to the hospital director."

"Oh well, it's a good cause," Mac said with a grin. -30-

Audio Pickup Circuit

(*Continued from page* 38)

For this service a 0-1 ma. meter, in series with a 10,000-ohm resistor, can be connected in the collector circuit of transistor V_2 in place of the relay. A phono-cartridge coil probe works fine for this purpose.

Many other applications will undoubtedly occur to the experimenter—such as picking up the field from a tape recorder bias oscillator coil to operate an indicator light or to control the a.c. power to the tape transport mechanism to prevent recording without proper bias current should the oscillator fail.

Satisfactory tests were also made with a simple crystal-diode power supply in place of the 22½-volt battery.

Since there is nothing critical about wiring or assembly, layout and construction into a compact unit can be arranged to suit the builder and according to the application for which the circuit is to be used. —30—

GROMMET GADGETRY

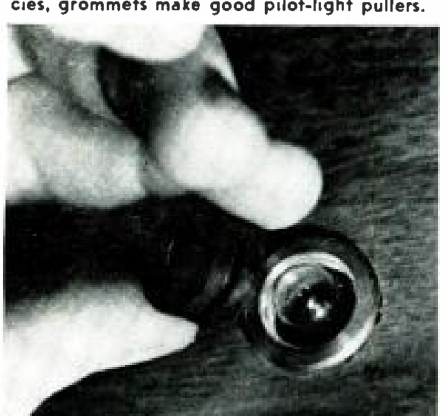
By JOHN A. COMSTOCK

IF YOU have extra pilot lamps lying around in your spare-parts box, you might try slipping a rubber grommet over the envelope of each one to eliminate the chance of breakage.

It doesn't take much of a jar to loosen the inside filament mountings, either, and the rubber grommet "bumpers" serve as all-around protection for the lamps.

Another handy use for grommets is as pilot-lamp pullers whenever your regular rubber pilot lamp remover happens to turn up missing. An ordinary rubber grommet, pressed firmly against the lamp's envelope, does a neat job of removal and can also be used in installing the new lamp as well. —30—

(Above) Using grommets as "bumpers" to protect pilot lights. (Below) In emergencies, grommets make good pilot-light pullers.



Wayward Capacitor Woes

By **ALLAN F. KINCKINER**

Look out for "perfectly good" capacitors that pass all tests but produce strange and confusing faults.

EVERY technician is confronted at one time or another by tubes that pass every test on the very best tube checkers but simply will not work properly in certain circuits, although a substituted tube will. After a number of such experiences, the technician adopts the following credo: If a tube is suspected, don't rely on a check—substitute.

Another electronic component that often presents the same baffling condition of causing circuit malfunction while passing every test is our friend the capacitor. A look at what tests these components are subjected to in the better capacitor analyzers reveals the following: capacitance measurement (generally quite accurate) and leakage (the amount of direct current the component will pass). In the latter check, a substantial d.c. voltage is fed into one terminal of the component, which is in series with a voltage-reading meter. Some analyzers use eye tubes or neon bulbs in place of the meter.

A more efficient leakage test is to use a source of several hundred volts (depending on the component's rating) applied to one terminal of the capacitor, which is series-connected to a v.t.v.m., as in Fig. 1. Leakage resistance may then be determined from the following relationship: $R_c/R_m = E_c/E_m$; where R_c is the leakage resistance of the capacitor, R_m the input d.c. resistance of the v.t.v.m. (usually 11 megohms), E_c is the voltage across the capacitor, and E_m is the voltage read on the meter.

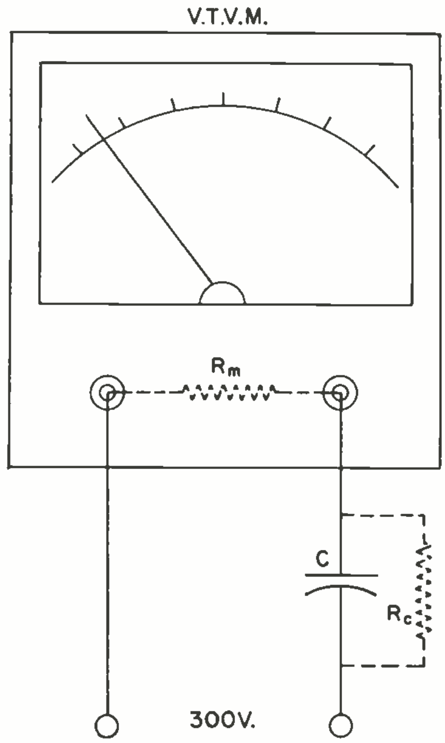


Fig. 1. Sensitive leakage measurement.

In the example shown, the meter reading (E_m) is .1 volt, which leaves 299.9 volts as E_c. Solving for R_c, we we have a leakage resistance of almost 33,000 megohms. The leakage current, determined by Ohm's Law, would come to less than a hundredth of a microampere. Insignificant as these leakage figures seem, there are circuits in which capacitor replacement would be warranted.

The advantages of checking leakage in this way are twofold. First, the sensitivity is greater than in the test provided by most analyzers. In the second place, leakage is more easily read. A man could get eyestrain trying to judge the opening or closing of an eye tube or the lighting of a neon lamp. However, just as the tube checker should be neither condemned nor scrapped because it doesn't bat one thousand, the capacitor analyzer should not be demoted for its less-than-perfect score on the leakage test.

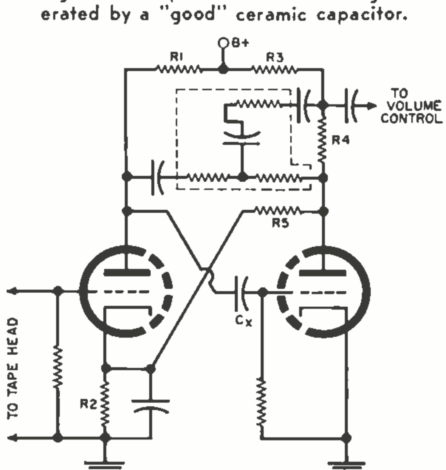
It is true that the substitution of a suspected capacitor is not so easily accomplished as that of a tube. Yet this will often be the quickest path to a repair. However, the substitution should only be considered after thorough circuit testing has left the capacitor as the prime suspect, although on circumstantial evidence. The capacitor fault may be so elusive that it will not always be possible to determine exactly what defect has occurred, although malfunction disappears when a substitution is made. Following are several accounts of skirmishes with capacitors, to prove the points made.

Before going into the case histories, we should like to point out another parallel between tubes and capacitors. The baffling defects are most likely to occur in more critical electronic circuits, such as low-level amplifiers, discriminating or limiting networks (such as the sync stages), sine and other waveform generators (such as TV deflection generators), and in other pulse-handling or pulse-forming circuits.

The Sizzling Ceramic

A *V-M* model 711 tape recorder came in for service with the complaint of being noisy. Inspection revealed that, with no tape threaded on and with the "play" button depressed, a constant sizzling noise could be heard. The latter could be attenuated by adjusting the volume control, indicating that the trouble was in a preceding stage (or perhaps in a later stage, but was being detected by the sensitive preamplifier). A scope check quickly eliminated the alternate possibility in this instance.

Fig. 2. Preamp in which noise was generated by a "good" ceramic capacitor.



The preamplifier consisted of a 12AX7 with the triodes in cascade (see Fig. 2.) Further troubleshooting revealed that grounding the second grid killed the noise, but grounding the first grid had no effect. The sizzling noise sounded precisely like a noisy resistor, so the resistors were substituted after resistance and voltage checks in the order numbered, but without any result.

Capacitor C_x was disconnected at the second grid and checked with an analyzer, which passed it as being faultless. C_x was also checked as per the technique discussed in connection with Fig. 1; not the slightest leakage was indicated. Since every other component in the circuit had been substituted, C_x was now temporarily replaced with a tacked-in unit, and dawg-gone if that didn't cure the trouble.

This capacitor, a black .01-µf. disc ceramic, subjected to all types of further testing on our brand *X* capacitor analyzer, was also checked on a fellow service technician's brand *Y* analyzer. It passed without even the slightest indication of fault.

Shifting Height

A TV set came in with the complaint that raster height was insufficient, with the compression occurring on the bottom. The condition occurred only after the receiver had been operating an hour or more, and would get progressively worse. After the saw-tooth forming capacitor in the vertical circuit had been replaced, the bottom of the raster was easily stretched out to fill the bottom of the CRT screen with normal linearity. Furthermore, the raster remained constant in vertical size, without needing later re-adjustment.

The capacitors that produce the not uncommon defect noted here are generally of the waxed paper type. Their capacitance may tend to increase as their temperature goes up. While a capacitor analyzer is quite capable of indicating an increase in capacitance, it can do so only if the suspected component is heated to the temperature at which it works in the receiver. Thus, tacking in a replacement is the quickest way to make a satisfactory check.

Sneaky Plastics

The horizonal Synchroguide circuit is one of those where capacitors can really raise havoc. For example:

The fellow service technician previously referred to as the owner of the brand *Y* analyzer sought help on a tough dog. It was an *RCA* KCS34B that would not hold horizontal sync for more than twenty minutes. In answer to questioning, he insisted that he had disconnected and tested all the capacitors in the circuit and that all read up to par on his analyzer. Knowing him to be a thorough technician who normally makes the necessary resistance, voltage, and scope checks when he has trouble, we advised him to tack-solder capacitor substitutions.

About one hour later he phoned with the information that, "after replacing the .002 μf. that feeds the sync and sampling pulses to the grid of the a.f.c. triode (C_1 in Fig. 5), the trouble was corrected." While he was happy that he had repaired the set, he was also extremely unhappy because his expensive analyzer would not indicate anything wrong with the replaced unit. The .002-μf. unit was one of those black, plastic-encased capacitors.

In line with this experience involving Synchroguides, one set, an *RCA* KCS-84F, operated relatively normally except that the horizontal sync was critical. It was noticed during trouble-shooting that the frequency slug of the oscillator transformer adjusted at an extremely withdrawn position. Component and voltage-checking tests revealed nothing, so the various frequency-determining capacitors were temporarily replaced. When C_2 in Fig. 5 was replaced, not only did the frequency slug adjust to a more orthodox position, but the horizontal saw-tooth waveform increased from 130 to over 160 volts, peak-to-peak, as a scope check showed. As a result other improvements occurred; the width increased, as did the high voltage, with improved focusing.

C_2 was also a black, plastic-encased tubular; it too passed all tests, including leakage, and its measured capacitance was within ten per-cent of nominal value although it was only rated at twenty per-cent. We are not exactly sure what the elusive fault is that occurs in units of this type, but suspect that the pulsed nature of the voltage to which they are subjected causes them to react erratically in a way that does not show up on static tests.

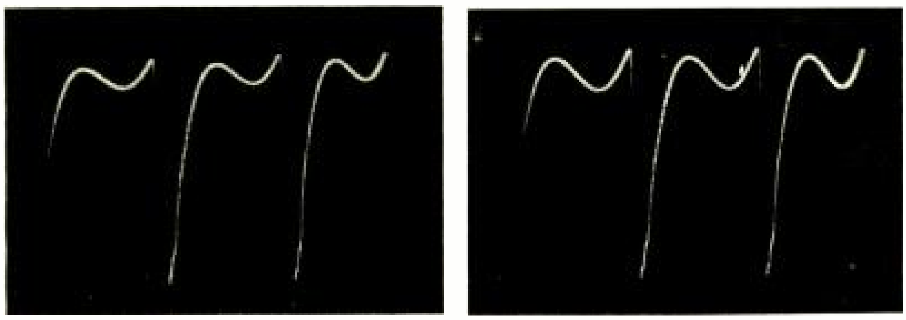


Fig. 3. Low (A, left) and proper (B) sine-wave height in Synchroguide waveform.

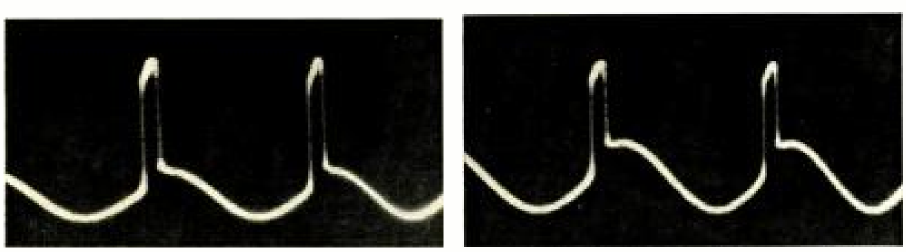


Fig. 4. Low (A, left) and proper (B) sine-wave height in multivibrator waveform.

Watch That "Q"

On to case 4: The stabilizing network in the Synchroguide circuit is a tank that generates a sine wave at approximately the horizontal sync frequency. This plays an important role in maintaining synchronization in the presence of random pulses that might otherwise trigger the oscillator falsely. The network consists of an adjustable coil shunted by a capacitor.

In Fig. 5, this network consists of C_3 shunted by L_p, with the latter being known as the phasing coil. Stabilizing efficiency is affected by the over-all *"Q"* of the tank, which is affected by the *"Q"* of C_3 specifically. This factor may decrease over a period of time, reducing sine-wave amplitude.

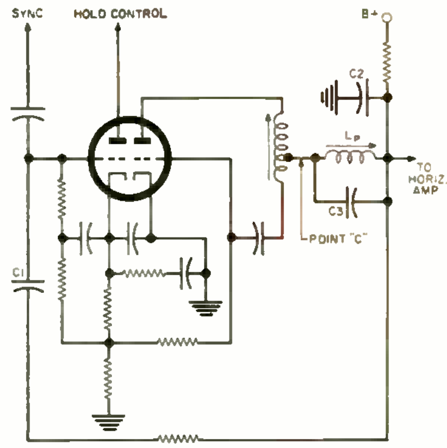
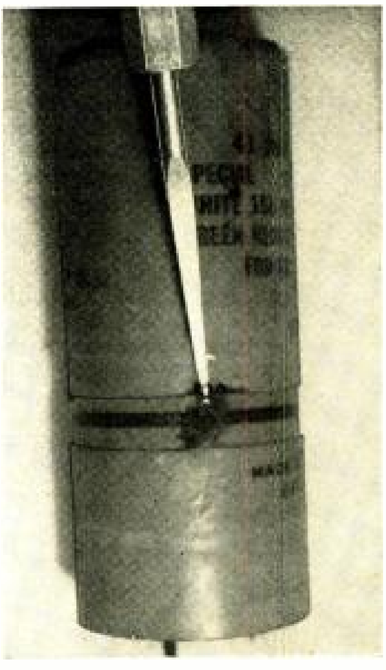


Fig. 5. Synchroguide oscillator with sine-wave generating tank (L_p and C_3).

Analyzers will not indicate this lowered *"Q"* factor, but it can be determined with the scope. The waveform of Fig. 3A was noted at point *C* of a Synchroguide used in a '53 *Philco*. Note that, while the phasing coil is adjusted properly, the sine-wave amplitude is about 15 per-cent of the composite waveform's total amplitude. The waveform of Fig. 3B was noted at the same point after C_3 was changed. Note now that the sine-wave amplitude is nearly 25 per-cent of the composite amplitude. This change improved horizontal synchronization in this particular receiver considerably.

In multivibrator-type horizontal oscillators, the stabilizing tank again consists of an adjustable coil (usually called the ringing coil) shunted by a

Fig. 6. The pointer indicates stain on capacitor case from electrolyte leakage.



capacitor. The coil's action parallels that of the phasing coil in that it generates a sine wave each time the oscillator plate switches on to draw current. The tank is invariably in series with a resistor in the plate lead of the multivibrator's controlling (first) triode. The stabilizing efficiency of this network is similar to that of the one in Fig. 5, and similar problems may occur.

The relative *"Q"* factor of the tank in these circuits can also be determined with the scope. Fig. 4A was taken at the plate of the first triode of a horizontal multivibrator in a *Motorola.* Note that the amplitude of the sine wave is about 30 per-cent of the composite waveform's amplitude. Fig. 4B was taken at the same point after the tank's capacitor was changed. Now the sine wave scopes better than 50 per-cent of the total waveform height. The replacement cleared up a complaint that setting of the horizontal hold control was too critical.

The ratios given here for sine-wave amplitude to over-all waveform height are those most often used in original design for Synchroguide and multivibrator circuits, although they are not universal. In general, where marginal horizontal-hold is the problem and no other defects exist, approximating these ratios will produce enough improvement to satisfy an unhappy customer.

The change in the capacitor, over a period of time, that produces this reduction in sine-wave amplitude sheds light on the tendency of older sets to develop more critical sync.

Capacitor or Rectifier?

A *Philco* TV about nine years old was benched for drifting vertical lock. The hold control had to be re-adjusted every ten minutes until it reached the end of its rotation, after which rolling could not be stopped. Trouble of this nature is due to gradual changes in such frequency-determining oscillator components as resistors (including the control), the blocking oscillator transformer, and, of course, the coupling and timing capacitors. In this case, replacing a capacitor corrected the trouble.

Suspected of leakage, the capacitor had been checked on an analyzer but no leakage had been found. When it was checked again after the replacement had worked, there was considerable leakage. Further checking showed that, when the capacitor was connected to the tester in one way, there was still no leakage. However, when the capacitor leads were reversed, leakage was clearly indicated! Evidently the component had begun to act like a semiconductor, passing current in one direction only. It was weird but it happened. The unit was a .01-μf. capacitor encased in plastic.

An Eccentric Electrolytic

The villain in case 6, unlike the smaller units involved with the other histories noted so far, was the big brother of the capacitor family, an electrolytic. A *Sylvania* TV (Model 540) came in with the complaint that it was erratically blowing a 2.5-ampere fuse. One fuse might last several days; but the next might only survive for one hour.

In a bench check, line current was metered at about 1.5 amperes. Receiver operation was entirely normal, with good picture and sound. Instrument checks revealed no unusual conditions. However a visual check showed a suspicious chemical staining at the metal band used to mount a 150-μf., 200-volt electrolytic filter to the chassis. Unfastening the metal band by removing the self-tapping screw that held it to the chassis caused the line current to fall to about 1 ampere.

Fig. 6 shows the staining on the cardboard case of this unit, with the metal band removed to render the symptom more visible. This type of electrolyte leak-through on cardboard-cased units was more common in pre-war radios, where it often led to puzzling hum problems. Service technicians can be grateful that the difficulty doesn't arise so often these days, but they should keep in mind the fact that it can occur. One end of this capacitor was connected directly to one side of the a.c. line in a voltage doubler using two selenium rectifiers, which is why the leakage blew fuses. However, an analyzer would not have indicated abnormal leakage.

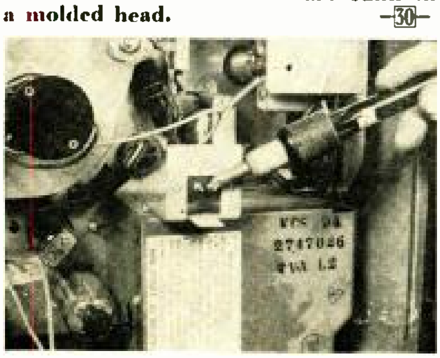
Thus we close the file on wayward capacitors. In each of the cases described here, the defects were of the kind that would escape detection with capacitor analyzers or other direct instrument checks. In each, secondary evidence was the only indication that the capacitor might be at fault. In closing, a few words of commendation might be said for that old stand-by, the oscilloscope. As in several instances recounted here its role in revealing the secondary conditions that lead to apprehension of guilty capacitors with off-beat defects is important. —30—

TIGHTENING INTERLOCKS

By ROBERT HERTZBERG

INTERMITTENT operation of a TV set was traced to poor contacts in the interlock line connector on the back of the chassis. This was fixed in a jiffy by the addition of a rough layer of solder on each of the male pins.

It is difficult to fix the female connectors, to which the cord is attached, because the contacts here are sunk in a molded head. —30—



Troubleshoot with Theory

(*Continued from page* 45)

comes open, the alternate path just mentioned still exists. Similarly, a shorted or open C_3 will not affect d.c. voltage or the signal path appreciably. Picture *quality* might be seriously affected, but the picture would not be lost altogether. Thus—still without measurements — reason has removed two components from serious consideration. Similar reasoning eliminates L_1 and L_2, making the total four.

Assume that the first reading, at the plate of V_{1A}, indicates noticeably low "B+" voltage here although a check shows that the power supply is operating normally. The schematic reveals eight components that still might be involved with this condition: V_{1A}, R_1, R_2, R_3, R_4, R_6, C_1, and C_2. But we can eliminate two of these from suspicion.

Low plate voltage may be present because R_1 has increased in value or because the tube is drawing too much current. If the latter is true, then the grid is too positive or the cathode resistor is shorted. However, the grid components, R_2 and C_1, do not seem to be involved. If R_2 were open, the charge on C_1, caused by grid-current flow, could not leak off. Thus, the negative voltage on the grid would increase, tube current would decrease, and plate voltage might rise somewhat, but would not drop. But what if R_2 were shorted? We would still have the cathode bias resistor, R_3, which would keep plate current down and plate voltage up. So much for R_2.

As for C_1, it would have little effect on the operating bias if it were open, so it would have little effect on plate voltage. Suppose that C_1 is shorted or leaking. If this component was intended to block d.c., some positive voltage would now pass through it to affect operating bias of V_{1A}, and plate voltage would go down. However, there is no positive voltage available at the output of the detector to do this. C_1 may now join R_2 as being exonerated.

With a single measurement and the application of theory, the defect has not only been narrowed down to a single stage, but six of the twelve possibly defective components in Fig. 1 have been set aside. The few minutes spent in studying the schematic to make these conclusions involve less time than it would take to make checks on the several parts that are not likely to be involved.

Even with components that may be involved, it is not necessary to perform all checks on each. The various ways in which a component may become defective, and the effect of these various abnormalities on the circuit, may also be taken into account. For example, resistors may become open, change in value, or possibly (though not usually) short. Capacitors may short, open, leak, or change capacitance. Coils may have shorted turns, which will change inductance, or they may develop an open winding. Tubes are subject to open filaments, shorted elements, open elements, and changes in characteristics.

Each *type* of defect for any given component will affect the circuit in which it is used in a specific way. Therefore, a suspected component need only be checked for the type of defect that could cause the complaint being serviced. For example, it would be unnecessary to disconnect one end of a capacitor for a leakage test if the symptom observed could not be caused by leakage. Conversely, with low plate voltage on V_{14}, of Fig. 1, C_2 would be checked for leakage or shorting, but it would not be necessary to place this capacitor on a bridge to find out whether it had lost capacitance or was effectively open.

The samples chosen here illustrate the method but certainly do not exhaust all possibilities. In any event, they indicate that the systematic application of theoretical analysis does more than provide mental exercise. It can save much valuable time. —30—

SIMPLE CRYSTAL CALIBRATOR

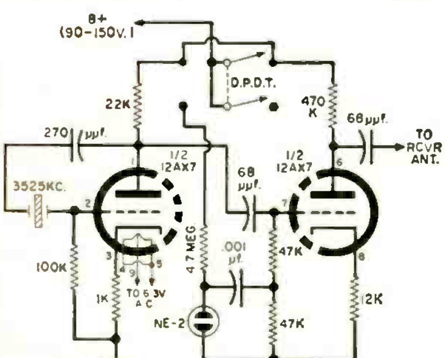
By STEPHEN MAYBAR, K2IBQ

A CRYSTAL calibrator is a necessary item for all ham shacks. Many an amateur has shied away from building a calibrator because of the numerous parts which had to be purchased. With this deterrent in mind, the following circuit was dreamed up. It uses no r.f. chokes, coils, or variable capacitors. None of the parts is critical and most, if not all, of the parts can be found in the average spare-parts box.

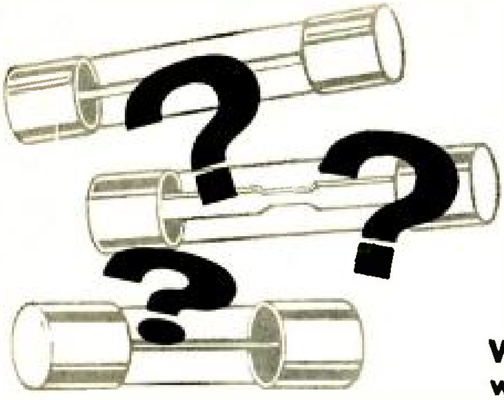
The circuit has been in use at the author's station for a while now and results have been very satisfactory. Any crystal can be used but at this station we use a 3525-kc. crystal which gives us spots on all amateur bands with which to line up the receiver.

A relaxation oscillator was used to modulate the buffer stage so that the signal could be spotted easily on a crowded band. A d.p.d.t switch with a center "off" position was used. This turns on the "B+" to the oscillator and cuts the modulation in or out.

The circuit functions quite well with voltages of from 90 to more than 150. In our receiver, the power is taken from the VR tube. Since the unit draws about 0.8 ma. in operation, it is not necessary to worry about the drain on the receiver supply. With this circuit strong signals are provided on all amateur bands up to 31 mc., which is as high as the receiver goes. —30—



ALL RESISTORS ARE 1/2 WATT



Fuses Are Not for Confusion

By **GEORGE D. PHILPOTT**

Wrong replacements cause annoyance—or harm. Know which types to use, when, and how to identify them.

IN RECENT years, manufacturers of TV receivers and of fuses as well have done much to alleviate a set of common complaints made by set owners and service technicians. "It's that fuse again," is heard less often than in the past. So is the wail of woe over a burned-out part that was not adequately protected. Special requirements have been analyzed and met. New fuses and fuse holders have been developed. However, one ominous factor remains to becloud an otherwise clearing fuse picture—correct fuse replacement.

An undo-it-yourself set owner—sometime even a service technician—doesn't happen to have a satisfactory replacement for a blown fuse or cannot identify it properly because the brand he happens to have on hand uses a method of coding that differs from that of the original. The replacement used is one thought to be a reasonably acceptable equivalent. The result may be annoying and unnecessary repeated fuse failure or the burn-out of an expensive component while the fuse remains intact. Sometimes, on the other hand, a replacement with slightly different characteristics is desirable. In any case, the operator should know what he is doing. This means he must know something about fuses and their applications.

Blowing Speed

The speed with which a fuse blows is important. Broadly, there are three general categories, the quick-acting, medium-lag, and slow-acting (or "Slo-Blo," as *Littelfuse* calls these types). Actually there are more shades of difference than these three types would indicate. High-speed instrument fuses, like those used to protect meter movements, generally act faster than the more commonly encountered fast-acting types. They are used because some types of instantaneous overloads could damage a meter.

Medium-lag fuses are the most popular, being widely used in aircraft applications, amplifiers, car radios, TV receivers, and other equipment. According to brand, these are found in the AGC types (*Bussmann*) and the 3AG or 5AG types (*Littelfuse*).

Slow-blowing fuses are most useful where harmless transient currents or voltage surges are likely to occur that would ordinarily cause quicker acting fuses to blow unnecessarily. Most fuses, whatever delay they may show under partial overload, will blow rather quickly under heavy overload.

Slow-blowing types often find specific applications in TV receivers. The transient surges caused by the action of certain *LC* networks in the horizontal section of a TV set might cause even a medium-lag fuse to open unnecessarily. The inductances used in many TV circuits (yokes, flyback transformers, peaking coils, others) often create reverse e.m.f.'s for short periods during set warm-up that may double the current drain in a circuit.

A common example of apparent fuse unreliability occurs in the horizontal output stage. Low drive voltage from the horizontal oscillator to the grid of the output tube, especially during warm-up, may permit the latter tube to overload.

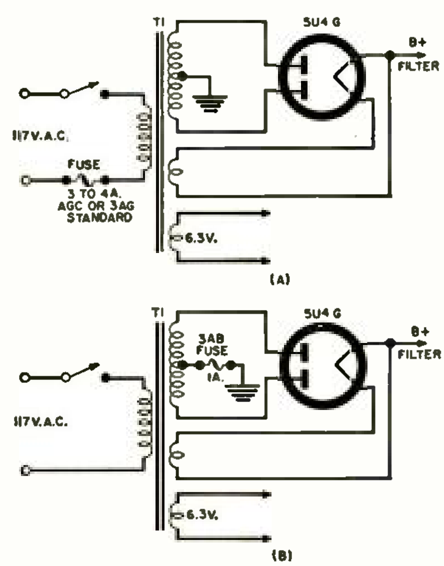


Fig. 1. Fuse in xformer primary (A) protects more than (B) in secondary.

Voltage Ratings

A frequently asked question is, "What does the fuse's voltage rating mean?" Some sets come from the factory with 125-volt fuses installed. Others may use fuses with a maximum rating of 250 volts. Furthermore, the latter may appear in 500-volt circuits. Does the excess voltage make the fuse blow?

Essentially, fuses respond to changes in current without respect to the applied voltage, within certain limits. The maximum voltage rating, according to *Littelfuse,* is that voltage up to which a fuse, when subjected to a current overload (defined as a 10,000-ampere d.c. short circuit), will interrupt safely, without shattering or burning up. The most severe short likely to occur, say, in a TV receiver will produce a current that is only a small fraction of this test rating. Thus fuses rated at 125 or 250 volts can safely be used at much higher voltages. However current ratings must be considered very carefully, taking into account the normal current range likely to be found in the protected circuit and

Table 1. Common TV and other fuses in the lines of two leading manufacturers. Note that code designations assigned to various fuse types relate to such differences as physical size and blowing characteristics, but not to current rating.

BLOWING CHARACTERISTICS	FUSE TYPE (Bussmann)	FUSE TYPE (Littelfuse)	SIZE	RATING (Amps.)	MAXIMUM VOLTAGE RATINGS*
High Speed		8AG	1" x 1/4"	1/500-5	32,125,250
	AGX		1" x 1/4"	1/500-2	125,250
Medium Lag		3AG	1 1/4" x 1/4"	1/16-20	32,125,250
		5AG	1 1/2" x 13/32"	1-50	32,250
	AGC		1 1/4" x 1/4"	3-30	32,250
	MTH		1 1/4" x 1/4"	4-6	250
	GLH		1 1/4" x 1/4"	8 or 10	125
	AGU		1 1/2" x 13/32"	1 to 60	32,250
Slow Acting		3AG	1 1/4" x 1/4"	1/100-5	32,125
		5AG	1 1/2" x 13/32"	1-30	32,125
	MDL		1 1/4" x 1/4"	1/100-30	32,125,250
	MDX		1 1/4" x 1/4"	1 1/4 to 7	125,250
	AGU		1 1/2" x 13/32"	1 to 60	32,250

Types N and C, especially suited to television receiver protection, irrespective of voltage rating or manufacturer, are directly interchangeable.

* The ampere rating applying to individual voltage ratings may be determined from manufacturer's literature.

Cat. #	DESCRIPTION
311005	5 amp. 3AG fuse, 32 v.
311010	10 amp. 3AG fuse, 32 v.
311015	15 amp. 3AG fuse, 32 v.
311020	20 amp. 3AG fuse, 32 v.
311030	30 amp. 3AG fuse, 32 v.
307009	9 amp. SFE fuse
307014	14 amp. SFE fuse
307020	20 amp. SFE fuse
312001	1 amp. 3AG fuse, 250 v.
312002	2 amp. 3AG fuse, 250 v.
312003	3 amp. 3AG fuse, 250 v.
312005	5 amp. 3AG fuse, 250 v.
31201.5	1½ amp. 3AG fuse, 250 v.
312.250	¼ amp. 3AG fuse, 250 v.
312.500	½ amp. 3AG fuse, 250 v.
313001	1 amp. 3AG "Slo-Blo" fuse
313.250	¼ amp. 3AG "Slo-Blo" fuse
313.500	½ amp. 3AG "Slo-Blo" fuse
361.010	1/100 8AG instrument fuse
361.031	1/32 8AG instrument fuse
361.250	¼ amp. 8AG instrument fuse
318.250	¼ amp. 3AG pigtail fuse
342001	3AG fuse extractor post
341001	3AG fuse extractor post
357001	1 pole 3AG m'nt'g (Type S)
357002	2 pole 3AG m'nt'g (Type S)
383002	8AG mounting
150027	Fuse retainer; 19" lead, 14 amp.
150028	Fuse retainer; 19" lead, 9 amp.

Table 2. Contents of service-maintenance fuse kit recommended by Littelfuse.

the possible magnitude of harmful overloads.

Fatigue

Occasionally a technician wonders why a fuse of any type may, for no reason that can be found, fail during operation. He may say facetiously that the fuse just got tired. He may also be correct. In circuits where a constantly interrupted current is flowing through the fuse (vibrator applications, TV horizontal sections, frequency choppers, high-current multivibrators, and the like), such cycling may produce constant expansion and contraction of the fuse element, eventually wearing out this slender, metal strand. This "cyclic fatigue" is just one of many problems confronting a fuse manufacturer endeavoring to supply a reliable product to users. The slow-blowing fuses usually stand up better under cyclic fatigue.

Interchangeability

One of the problems likely to confuse a technician attempting replacement is the fact that different manufacturers do not code identical or similar fuses in the same way. Table 1 is a handy cross-listing of fuses manufactured by *Littelfuse* and *Bussmann*. The boxes in which fuses by the latter manufacturer are packed usually carry cross-identification, although the fuses themselves are not so marked. For example, a pack of *Bussmann* AGC fuses may carry such information as "formerly called 3AG." For some similar types, there may be slight differences in certain characteristics between one manufacturer and another. While these do not usually affect use much, it is a good idea to learn what they are and what effect they might have in specific applications.

Some TV Applications

The problem of fuse failure and replacement are of above-average concern in the case of TV receivers, where more than one fuse is likely to be used, where there may be conflicts between over-all and single-section protection, and where the fuses used on a single set may be quite different from each other. A brief examination of common configurations will help show how and where fusing is provided and help in choosing replacements to meet special problems.

The partial schematic of Fig. 1A is of a commonly encountered full-wave rectifier circuit. The fuse, in the primary lead of the transformer, gives over-all protection. A disadvantage, if no other fusing is used, lies in the fact that it takes a rather healthy overload to pop the unit. Thus, if no other protection is used, excess current due to a short in a particular circuit may be enough to cause circuit damage but under the amount required to blow the fuse. An advantage is that the expensive power transformer is fully safeguarded.

Suppose that the envelope on a rectifier tube should crack. When it does —and every technician has probably seen this happen several times—the filament of a heavy-duty rectifier like the 5U4 may, in the process of melting as it is exposed to air, form a dead short across the 5-volt winding. This could cook a transformer to death. Standard cartridge fuses, rated at a few amperes, are used here.

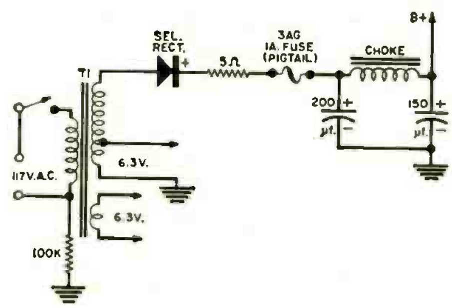


Fig. 2. Half-wave rectifier supply, fused in d.c. line going to filter.

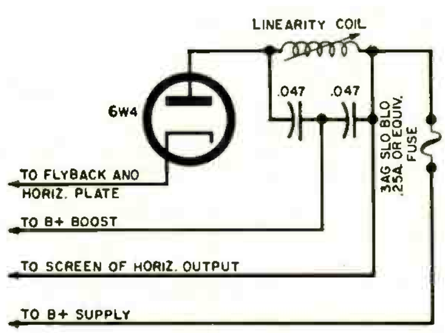


Fig. 3. Separate fusing for "B+" supply in TV's horizontal-sweep section.

An alternate method of fusing the low-voltage section is shown in Fig. 1B. Here the center-tap on the transformer's high-voltage secondary is fused to ground or "B−." The transformer is protected except in the case of filament-circuit overloads. Since the receiver's many tubes consume quite a bit of filament power in relation to total drain, and current for the filaments does not pass through the fused winding, the current rating of the fuse is substantially reduced. The type 3AB shown is a special, arc-quenching variety often found here. It prevents element flashing, a condition related to the inductance of the transformer. The fuse is a medium-lag type.

Fig. 2 shows a common half-wave rectifier using a semiconductor. Sometimes a voltage doubler is used without the transformer. Here a standard pigtail fuse is likely to be found wired into the circuit, but it will be the slow-blowing type too. A surge resistor is necessary to protect the rectifier from the heavy initial surges that would otherwise charge the filter capacitors. Because of these surges, a faster acting fuse might open needlessly.

Fig. 3 shows the damper portion of a horizontal-output and high-voltage circuit. Again a slow-acting fuse, but at a reduced current rating, is used. Although the location of the fuse in the horizontal-output circuit may vary, the fuse characteristics are likely to remain the same.

Many recently made TV receivers use other protective devices, such as resettable, thermal-overload cut-outs, fusible resistors, and thermistors, instead of fuses. These do not act rapidly, as a rule. Where fuses are used instead, they correspondingly tend to be slow-blowing. Radios and amplifiers usually have medium-acting fuses. Instruments and aircraft equipment tend to use fast-acting fuses, although many aircraft applications call for medium-speed types.

Bayonet-type fuses, becoming increasingly popular, were originally designed for the TV industry. These are made in different sizes depending on current rating, as are the corresponding fuse holders. Thus only the right fuse can be inserted and locked into the fuse holder. These type *C* and *N* fuses are made by both leading manufacturers, but the two brands may be interchanged.

If your fuse kit happens to be short of some types when you need them, you might check your supply against the list of most frequently used types for service dealers and maintenance engineers in Table 2. Some common holders and mountings are listed as well. Also helpful is Table 3, which is a short list of fuse sizes generally used to protect insulated copper wiring of various sizes.

Just one more thought before closing. Fuses are used for good reasons—protection and safety, both to equipment and personnel. This good purpose should not be thrown away with a thoughtless or indifferent replacement.

—30—

Table 3. Ratings of fuses generally used with popular sizes of copper wire.

WIRE SIZE (B & S)	FUSE RATING (Amps.)
No. 16	10
No. 14	15
No. 12	20-30
No. 10	40
No. 8	50

What's New in Radio

SPRAGUE ASSORTMENT

Sprague Products Co., North Adams, Mass. is offering a specially selected assortment of its "Littl-Lytic" capacitors for transistorized equipment.

Known as the EK-4 assortment, the package consists of 15 miniature metal-

encased capacitors (one each of the 15 most frequently used ratings), boxed in a case. Individually identified compartments keep each capacitor in place and permit easy selection.

PORTABLE DF RECEIVER

ALCO Electronics, 3 Wolcott Ave., Lawrence, Mass., has introduced a portable, transistorized superheterodyne radio direction finder. Designed for marine craft or personal use, the set uses four standard flashlight batteries for its power source. The printed circuit uses seven transistors plus a diode and thermistor for low power consumption. Other features include: a high-gain ferrite-rod antenna, aluminum case, convenient illuminated dial, and sensitivity control. Also included is a built-in marine compass that works simultaneously with marine radio signals.

The direction finder measures 7" x 5" x 5½" and is light enough to be worn from the shoulder with the strap furnished. The company invites further inquiries.

TRANSISTOR CHECKER

Dynatron Laboratories, 71 Glenn Drive, Camarillo, Calif. has introduced its Model 1003 transistor checker, for checking all important transistor d.c. parameters, including those in the inverted condition. A remote connector permits checking a transistor while it is in an environmental chamber.

The meter's 50 microampere movement enhances its capability to read I_{co} and I_{eo}. Because the *beta* of many transistors exceeds 100, a *beta* times ten scale has been provided for accurate indications up to 1000.

The Model 1003 is said to be accurate to ± 3 per-cent on all scales. Its dimensions are 5⅝ inches wide, 6⅞ inches long, and 3 inches high.

SSB POWER SUPPLY

The Amateur Division of *Tel-Instruments Electronics Corp.,* 728 Garden St., Carlstadt, N. J. is now offering a compact high-voltage power supply which has been expressly designed for SSB ham use.

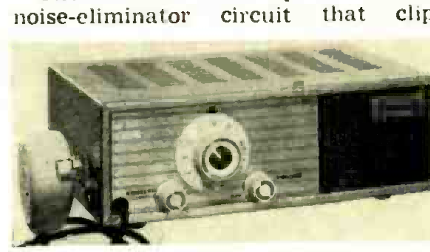
The entire unit measures 17"x17½" x10" and is capable of delivering 4200 volts d.c. at 500 ma., continuous duty. The power supply is currently available in two models, the 65A, rated at 4.2 kv. at 500 ma. and the 65B providing 3.5 kv. at 500 ma. Both models provide, simultaneously, any screen voltage (in 350-volt steps) up to 1050 volts. Overload trip relays and remote control operation is provided in both models.

Dept. U-2 will supply complete descriptive literature, including prices, on request.

CB TRANSCEIVER

Utica Communications Corp., 1834 W. Foster Ave., Chicago 40, Ill. has brought out its Model MC 27 "Town and Country" radiotelephone for Citizens Band operation.

The transceiver incorporates a new noise-eliminator circuit that clips



peaks without distorting the audio portion of the incoming signal. Equipped for six-channel operation, the MC 27 will operate on 6, 12, or 117 volts.

REGULATED POWER SUPPLY

Freed Transformer Co., Inc., 1718 Weirfield St., Brooklyn 27, N. Y. has introduced a regulated supply containing a reactor and a hermetically sealed constant-voltage transformer.

This tubeless power supply is said to eliminate the periodic replacement of tubes as well as the maintenance problems of supplies that use tubes.

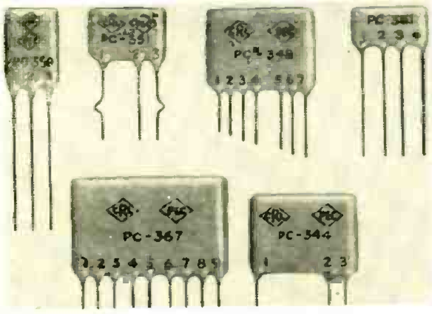
Input of the unit is 95 to 130 volts a.c. at 60 cps; output is 155 volts d.c. at 150 milliamperes, regulated to ± 1 per-cent. Ripple is less than 10 mv.

Also built in is a 6.3 volt a.c., 60 cps supply, regulated to ± 1 per-cent against line variations of 95 to 130 volts. For further information, write to the manufacturer.

CENTRALAB PEC's

Centralab, Division of *Globe-Union, Inc.*, 900 E. Keefe Ave., Milwaukee 1, Wis., has added 27 new packaged electronic circuits to its line of replacement PEC's.

In addition to replacements in TV sets, part of this new group is for use in high-fidelity equipment. The new group, numbered from PC-344 to PC-370, includes loudness contour networks, a diode-triode "Couplate," a



balanced dual capacitor, a horizontal oscillator and phase detector, and other specialized units.

POCKET-SIZE RECEIVER

Tokyo Shibaura Electric Company of Japan has introduced a new transistor receiver, of shirt-pocket dimensions, and covering the 1.6-4.50 mc. marine band as well as the 540-1600 kc. broadcast band. The set features two antennas: a 10-section telescoping type for marine reception and a ferrite core type for standard broadcasts.

Seven transistors are used. Included with the set is a leather case, an earphone, and a mounting bracket. For additional information, contact the American distributor, *Transistor World Corp.*, 52 Broadway, New York 4, N. Y.

CAPACITOR KIT

Cornell-Dubilier Electric Corp., South Plainfield, N. J. is offering a compact kit of molded Mylar capacitors. Called the "Hit Kit," the package reportedly is the company's answer to distributor and technician requests for a smaller sized version of an earlier larger service-shop size kit.

The new kit contains 35 popular "PM" capacitors, in seven widely used values, packed in a plastic box. As part of this "Hit Kit" promotion, the company is conducting a contest for jobber salesmen and professional technicians. Details and entry card are included in the kit.

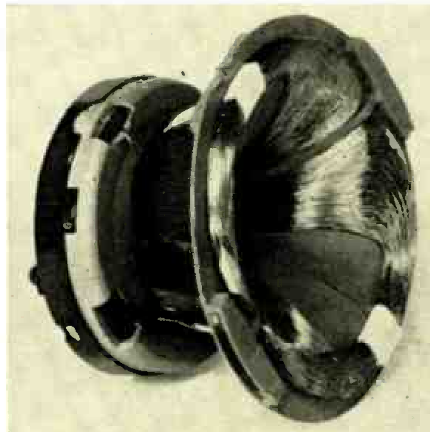
NEW TV YOKE

F. W. Sickles Division of *General Instrument Corp.*, Chicopee, Mass., has announced a new type of "super-sensitive" yoke for controlling the beam in a TV picture tube. The new yoke is

(*Continued on page* 144)

said to reduce the power requirements for the deflection circuit in a battery-powered, transistorized TV receiver, thereby adding to battery life.

In non-transistorized sets, the company states, the lower power requirements of the new yoke will mean



smaller and less expensive associated components, thus providing a cost saving to set manufacturers.

The new yokes feature a special form of toroidal vertical winding. Vertical sensitivity is said to be 30 to 40 per-cent greater than conventional units.

NEW RECTIFIER

Sarkes Tarzian, Inc., 415 North College, Bloomington, Ind., has announced the S-5347 silicon rectifier tube to replace types 12BW4 and 6BW4 vacuum tube rectifiers.

The new model may be utilized in rectifier applications requiring 1600 peak inverse volts at 500 ma. d.c. The tube has a 9-pin miniature base and requires no filament power.

ANTENNA TOWER

Rohn Manufacturing Co., 6718 West Plank Rd., Peoria, Ill. announces its No. 55 heavy-duty communication tower.

This tower provides rigidity and strength in heights up to 450 feet in a 30-pounds-per-square-foot windload. When properly guyed, the tower is said to be capable of holding about 12 square feet of antenna at its maximum height.

TWO-WATT POTS

Continental-Wirt Electronic Corporation, 26 W. Queen Lane, Philadelphia 44, Pa. has introduced a new series of wirewound, metal-housed potentiometers and rheostats.

The new series F-888 control is designed for wide use in the electrical and electronics field, in radio, TV, instrument, computer, and test equipment applications. Resistance range is from ½ ohm to 25,000 ohms ± 10%. A 2-watt power rating and 3% linearity are standard. A wider range of resistance values, higher power dissipation characteristics, and closer linearity tolerances are available on special order.

The controls measure 1.125 inches in diameter by 0.560 inch deep. Full specifications are contained in a special potentiometer and rheostat bulletin which the company will supply on request.

TWO-ELEMENT ANTENNA

Herb Kreckman Co., Cresco, Pa., is now offering its two-element co-plane "Kreco" communication antenna in an all-aluminum construction.

The new Model CP-105A weighs only 2 pounds at 150 megacycles. A gain of 3 db is guaranteed. This antenna can be ordered cut to any frequency from 108 to 470 megacycles. The all brass Model CP-150B is still available.

The same type antenna is made for the 25-50, and the 72-76 mc. bands in both the all-brass and all-aluminum constructions.

INDUSTRIAL THYRATRON

National Electronics, Inc., Geneva, Ill. has introduced its type NL-710A inert-gas and mercury vapor high-voltage thyratron.

The tube, designed especially for the higher voltages encountered in the new spike welding applications, is rated at 2.5 amps., 2500 peak inverse and forward voltage. According to the manufacturer, this rating enables the new thyratron to be used as an ignitor firing tube in the new welding operations as well as in many other applications requiring such high voltages. For additional data, contact the manufacturer.

CB-BC POCKET PORTABLE

American Japan Trading Co., Inc., No. 2, 3-Chrome Ginza, Chuo-Ku, Tokyo, Japan is now offering a pocket-sized combination CB transceiver and broadcast-band receiver.

The "Dauphin Model CB-1" is transistorized and weighs less than a pound, including battery. It measures 3 1/16" wide, 5 3/4" high, and 1 1/2" deep and is powered by a single 9-volt battery.

The CB transceiver is a single-channel, fixed-tuned crystal-controlled superhet using nine transistors, one diode, one thermistor, and two crystal oscillators. The broadcast band is covered by a seven-transistor superhet. Since the transmitter output power is 50 mw., no license is needed to operate this equipment. Communication range is said to be 1 to 1 1/2 miles between similar units. There is a built-in ferrite bar antenna in addition to a base-loaded telescopic whip which extends to 59".

The unit comes complete with cowhide carrying case, whip antenna, magnetic earphone, and battery.

"TWINWELD" EPOXY

Fybrglas Industries, 3010 W. Montrose Ave., Chicago 18, Ill. has recently introduced a new "TwinWeld" epoxy adhesive which has been engineered for permanent adhesive use for metal, glass, ceramic, concrete, hard rubber, wood, fiber glass, and other materials for the aircraft, electronics, tooling, etc. industries.

The new material is said not to expand or contract and is resistant to acids, alkalies, grease, and solvents. In order that prospective users can test this new product the company is offering a free sampling kit that contains equal 50/50 quantities of epoxy resin and hardener.

The test kit and additional information on the product are available direct from the manufacturer.

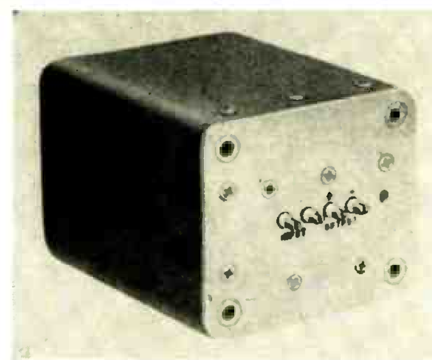
MIKE FOR MOBILE USE

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y. has introduced a new high-impedance dynamic microphone designed expressly for mobile and industrial applications (CB and ham radio, police, ship-to-shore, public address, and aircraft).

Designated as Model PA-77, the unit features a slide switch which operates microphone and relay circuits for "transmit" and "receive" switching. Frequency response is said to be 100 to 9000 cps. Impedance is 50,000 ohms. The PA-77 comes with mounting bracket and a 5-foot single-conductor shielded cable plus two color-coded switching conductors in one plastic jacket. Size is 3" x 1¾" x 1".

D.C. POWER SUPPLY

Sorensen & Co., South Norwalk, Conn. (a subsidiary of *Raytheon*), is offering seven new, completely transistorized d.c. power supplies, ranging in output from 6.3 to 36 volts. These units are component-type supplies, completely contained in a military-type can.



Supplementing the 36 existing models in the company's "QM" series, the new units have a maximum output rating of 30 watts with voltage regulated to ± 0.05 per-cent against line and load variations. —30—

HAM AFFAIRS SCHEDULED FOR OCTOBER

THE SSB Amateur Radio Assn. is joining forces with the Quarter Century Wireless Assn. to honor Dr. George W. Bailey, W2KH, secretary of the IRE and former president of the ARRL, with a testimonial dinner October 14th. The affair will be the opening event of the Hudson Division ARRL Convention which will be held at the Statler-Hilton in New York.

An SSB Forum will be held from 2 to 5 p.m. on the 15th with Ed Piller, W2KPQ, president of the SSB Amateur Radio Assn. presiding. —30—

INVITATION TO AUTHORS

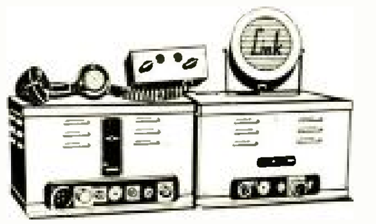
Just as a reminder, the Editors of ELECTRONICS WORLD are always interested in obtaining outstanding manuscripts, for publication in this magazine, covering the fields of audio and high-fidelity and radio-TV-industrial servicing. Articles in manuscript form may be submitted for immediate decision or projected articles can be outlined in a letter in which case the writer will be advised promptly as to the suitability of the topic. We can also use short "filler" items outlining worthwhile shortcuts that have made your servicing chores easier. This magazine pays for articles on acceptance. Send all manuscripts or your letters of suggestion to the Editor, ELECTRONICS WORLD, One Park Avenue, New York City 16, New York.

SAVE! CHECK THESE *PLATT* BARGAINS...

EVERY ONE IS A SPECIAL!

***** SENSATIONAL SAVINGS ON MOBILE RADIO EQUIPMENT! *****

Platt Electronics has available a complete inventory of all LINK past and present equipment. Its technical staff, with considerable experience in the 2-way FM Communications field, is in a position to give Link product users excellent service. Inquiries are invited.



2-PIECE MODEL FMTR 30-50 MC ED. 7 FM MOBILE TRANS. & REC.—6 OR 12 VOLTS

Unit complete with Peak Modulation control head, mike, antenna, cables & crystals ground to your specific frequency. Modified.

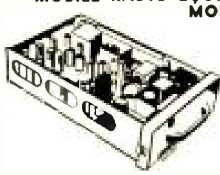
6 Volt—$109.95 **12 Volt—$149.95**

2-PIECE MODEL FMTR 152-174 MC ED. 7, 25 W. FM MOBILE TRANS. & REC. —6 or 12 VOLTS

Supplied as illustrated above.

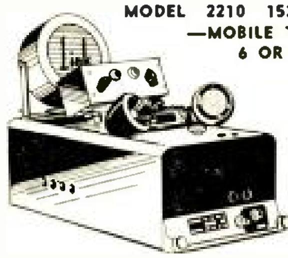
6 Volt—$134.95 **12 Volt—$174.95**

MOBILE RADIO EQUIPT. 450-470 MCS MODEL 2975-15VR-D2b



For 450-460 mcs. 6/12 volts. Single unit construction. Power output 15 to 20 watts. Featuring noise-free, trouble-free operation, peak modulation control, excellent split-channel selectivity. Unit complete with accessories. NEW... **$395.00**

MODEL 2210 152-162 MC FM —MOBILE TRANS. & REC. 6 OR 12 VOLTS



Antenna, cables, control head, mike, crystals. Complete for immediate installation. Specially priced.

6 Volt $139.50

12 Volt $162.50

MODEL 2365 25-40 OR 30-50 MC FM MOBILE TRANS. & REC.—6 OR 12 VOLTS

Supplied as illustrated above. Complete for immediate installation.

6 Volt—$119.50 **12 Volt—$149.50**

FEDERAL PORTABLE MOBILE SIGNAL GENERATOR 110 V AC POWER—TYPE 104A

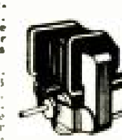
Designed to facilitate alignment of FM mobile and land station receivers in the field. Provides a continuous source of frequency modulated carrier, the frequency of which is determined by the multiplier-type crystal that is used in the unit. It will, by the proper selection of crystals, provide a signal suitable for the alignment of FM mobile receivers in both the 25-50 MC band and the 148-174 MC band. In addition to these frequencies, the type 104A Mobile Signal Generator provides a 1000 cycle signal that may be used to check audio circuits. Unit has external power facilities **$49.50**

AC MOTOR

1/4 H.P., RPM 2100, Amps .8, WD Series, 50/60 cycle.

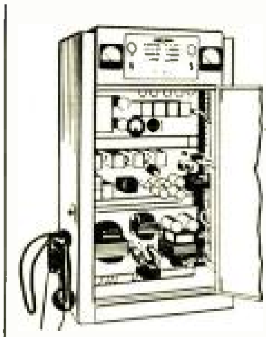
New **$7.95**
Excellent **$5.25**

115 V 60 CYCLE BARBER-COLEMAN. Shaded Pole MOTORS for continuous duty.



Full load ratings are 16 amps, 10.5 W., 2400 RPM's, .0015 horse power. Exc. for chassis cooling. NEW ... **99c**

MODEL 50 UFS 60 WATT 30-50 MC BASE STATION



Housed in a 34" upright cabinet. Operates on 110 AC. Reconditioned, checked out, complete with accessories **$249.50**

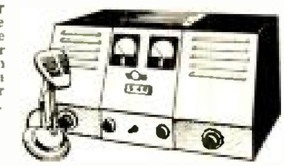
MODEL 1907 60 WATT FOR HIGH FREQ. OPERATION 152-174 MC—110 V.

Reconditioned, ch'ked out, complete with all accessories **$299.50**

REMOTE CONTROL UNITS

Model 1890 for operation in the 25-54 megacycle band. Used for Link Base Station operation & can be adapted for any other type. Brand New

$169.50



7 TUBE FM TRANSMITTER

- 6 Volt Dynamotor Power Supply.
- Instructions for connecting and for converting to 10 or 6 meters.

A 7C7 is used in a resistance coupled crystal controlled oscillator circuit. The output freq. is between 30 & 40 MC. The crystal freq. is between 937.5 KC and 1250 KC. Two 7A8's are used as balanced modulators. Two 7C7's are used as freq. quadruplers, and a 7C5 as a freq. doubler. An 807 is used as a power amplifier. Also included are a schematic diagram of the transmitter, a hook-up diagram and instructions for converting to 6 or 10 meters. Transmitter housed in louvered grey enamel case 8"x8"x16" W. Link Radio Mobile FM Transmitter Model 35-UMF as described. Reg. $325.00.
Less tubes—SPECIAL.................. **$11.95**

SPECIAL!

Current Westinghouse 832-A Tube, boxed. Sensationally priced at only............ **$4.95**

Take Advantage of this Tremendous Saving!

BRAND NEW CARTER GENEMOTOR

Input 26.4 VDC @ 7 amps. Output 405 VDC @ .270 amps. **$7.95**

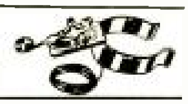
TS-9 HANDSET HAS BUTTERFLY-TYPE PRESS-TO-TALK SWITCH

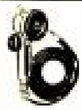
Standard Signal Corps handset has 50/75 ohm carbon button, 135/600 ohm @ 1 kc magnetic revr capsule, press-to-talk switch and 3-conductor cord.
NEW **$3.95**

Terrific Buy!

TRANSMITTING KEY

J-45 with metal knee-band. BRAND NEW... **$2.45**





While They Last!

T-17 HAND-HELD CARBON MIKE

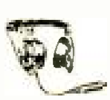
For use in voice communication. Effectively covers the audio frequency range from 300 to 2600 cps. 200 ohms, with press-to-talk switch, 5 ft. rubber cord & plug.
NEW **$3.95**

HEADSET H-16/U

8000 ohms. Rubber inserts similar to headset HS-30, with ear cups to exclude noise. Cord 11" terminating into PL-54 short phone plug. (CD-307 extension cord used with this item.)

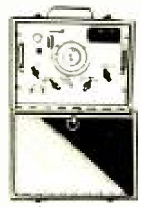
BRAND NEW — ONLY $2.95
CD-307 CORD — $1.25

HEADSETS



HS-23 high impedance, brand-new **$4.55**
HS-33 low impedance, brand new with cord and PL-54 plug **$4.65**
Navy-type H 63-U 600 ohm impedance **$6.95**

6 ft. Extension Cord with jack & plug for above headsets **$1.19**
High Impedance Matching Transformer from low to high **79c**



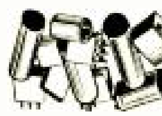
FREQUENCY METERS

For the maintenance shop and field service. BC-221 Frequency Meters complete with original calibration book. Available in modulated and unmodulated types as well as a-c operated models. Factory tested, checked for frequency alignment and GUARANTEED.

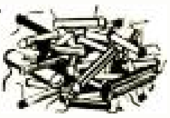
Unmodulated Type	**$119.50**
Modulated Type	**$139.50**
Modulated Type with AC Power Supply	**$159.50**

NEW! Our own version of the famous BC-221 with built-in magic eye zero-beat indicator. **Add $25.00 to any model.**

SPECIAL!
17 LBS. of ASSORTED RADIO PARTS
Now at give-away price of only.... **$1.59**



AMAZING KIT SALE!



Kit of 25 Assorted 10 & 20 watt RESISTORS. Popular Sizes **$1.97**
Kit of 25 CONDENSERS—Bathtubs, Electrolytics & high voltage Mica **$1.89**
Kit of 15 Assorted Popular WAFER SWITCHES. **$1.89**
Kit of 20 AIR PADDER VARIABLE CONDENSERS, popular sizes.................................. **$1.89**

NEW CHICAGO PLATE TRANSFORMER TR-1040

115 VAC Primary. 2500 VDC @ 250 MA DC Secondary. 9" high, 8 1/2" wide, 7" deep. Weight 60 lbs. **$39.95**

MINIMUM ORDER $5.00

Immediate Delivery. Include 20% deposit with order—balance C.O.D. All shipments F.O.B. our warehouse, N. Y. C. (N. Y. C. residents add sales tax to your remittance.)

RADIO SET SCR-694

We maintain a complete replacement stock for this type equipment. We invite all inquiries and offer free technical assistance. Platt Electronics participated in the original design and manufacture of this equipt.

BC-1306 TRANSMITTER-RECEIVER for MARS application. 3800 to 6500 KC, MO or Crystal Control. Includes Crystal Calibration and Net Controls. NEW UNITS, with all tubes.
Each ... **$29.50**

PE-237 POWER SUPPLY for BC-1306. Supplies all necessary voltages and current for both transmitter & receiver sections. Operates from 6, 12 or 24 Volts DC. NEW UNITS
Each **$24.95**

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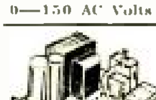

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Telephone: COrtlandt 7-2575

Capacitance Relay

(*Continued from page* 87)

(through current-limiting resistor R_4) to the 2050 grid, this grid is quite negative during oscillation of the 117N7-GT and somewhat less negative when oscillation ceases (object near antenna). The positive-going swing fires the 2050 and energizes the relay. If the 2050 anode were supplied from d.c., the tube would then remain fired indefinitely. But since it is a.c.-supplied, the tube is self-restoring (that is, it is extinguished each time the a.c. supply cycle goes through zero). Relay chatter due to this action is prevented both by using an a.c. relay and by including the large shunting capacitor, C_5. When the object withdraws from the vicinity of the antenna, grid current and the voltage drop across R_3 increase, the 2050 is extinguished, and the relay opens.

Sensitivity of the circuit is such that the operator's fingertip 1 inch from a 2-foot length of insulated wire connected to the antenna terminal will actuate the relay. Good action is obtained from the *whole* body when walking past a 5-foot vertical antenna 1 foot away. A 4-inch metal disc connected to the antenna terminal allows the relay to be operated by the fingertip 6 inches away, or the palm of the hand about 8 inches away. —30—

Answer to Puzzle
Appearing on page 98

A	D	M	I	T	T	A	N	C	E		F	U	S	E
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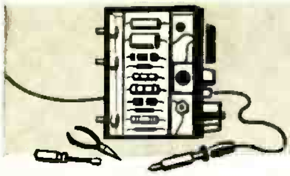

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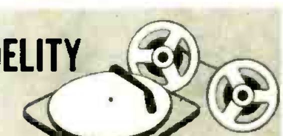

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OCTOBER 1960

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4. RCA "KNOW-HOW". RCA's continuous product research and advanced design engineering have resulted in RCA Silverama picture tubes being steps ahead of all other brands.

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