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* UNI-DIRECTIONAL. NEW REVERSIBLE FLIPSOID PICKUP PATTERN

* ELIMINATES FEEDBACK

* IDEAL FOR BOTH DYNAMIC AND VELOCITY MICROPHONES

* FLAT RESPONSE FROM SHORT TO STEE. LISTED FOR GENEROSITY.

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RSHk: RBSk (200 ohms). Switch, cable connector, Acoustic Compensator.
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(Click Check)

I AM doing Radio work. I AM NOT doing Radio work.

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Address . Age .

City .

State .

14X1
Operating

The Servicing Troubles

RADIO

Lucrative Sideline for New

The Editorial:

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Copyright 1940 Radcraft Publications, Inc.
Dear Editor:  

As a precedent, by virtue of which, I'm not exactly a stranger in your columns, I refer you to my article in your Radio-Craft of October 1933—page 223.  

Well, that was way back in the "Dizzy '30s" and now as we are getting a good start into the "Boaring '40s", I feel the urge again. Unlike the last crack which was more on the technical side, I'm going to stick my neck out this time way over on the economic side.  

It has been my good fortune to become personally acquainted with more radio servicemen than the average. For example, in 1939 I barnstormed through 43 states, Canada and Mexico (of course such a swing included the Frisco and New York Fairs)—so my story need not be confined to the rather limited horizon of Vinegar Bend, Loudyville, Chittling Switch or even Main Street—not need it be excluded from Miami, Los Angeles, Denver or even The Cross Roads of the World at 42nd and Broadway!  

The schedule, herewith, of costs, entitled "Why It Costs the Average Serviceman $4.33 to Repair the Average 'Radio'" is self-explanatory, and we all know that we don't average that $4.33 receipts for the average job and we don't need any auditor to tell us how "unrigh" we are getting very fast at that speed!  

Somewhere along Main Street between Vinegar Bend and The Crossroads of the World, I must have skipped "That Man Who Knows"—so won't somebody please speak a piece for "That Little Man Who Wasn't There?"  

QUINCY GIBBON,  
Rolling Fork, Miss.  

See illustration, on page 324, of Mr. Gibbon's business-getting sales slip.  

2-BIT NEWSSTAND CUSTOMER  

Dear Editor:  

Can a 2-bit newsstand customer have your ear? Keep Radio-Craft for the Serviceman. QST, Radio News, and Radio cover the Amateur field to a satisfying fullness. Constructional articles for beginners likewise are covered well by Radio & Television. Keep, yes even expand, articles such as those by Sprachveri and Shaney. As for Operating Notes, each month's crop I enter in my Rider's Index. Re: Philco Warranty Station Plan placing more money in hands of Servicemen, well, maybe. At least they don't say yes nor do they say no. Philco always produced money for Servicemen but OH those headaches.  

JOHN E. HUSSER,  
Salem, Mass.  

DOESN'T AGREE WITH OUR BOSS  

Dear Editor:  

I have been in the Servicing business for the past 2 years. During the same period I have subscribed to Radio-Craft. I have always enjoyed your Editorials. In fact I practically always agreed with you. However, I cannot absolutely agree with the Editorial in the August number. Not that I would say you were afraid some Servicemens would) that you know nothing about the subject. Probably you know much more than I'll ever know about the business conditions of the average Serviceman all over our great country. However, I believe you will agree with me when I say that there are exceptions which prove the rule; Let me tell you about the conditions in this farming district in southwestern Iowa.  

In the first place Mr. Farmer just loves to save money. He will pay 50c for a tool 

MEISSNER—and F-M  

the only COMPLETE line for Listeners and Experimenters  

CONSOLE F-M RECEIVER  

For highest quality, noiseless, static-free reproduction of Frequency Modulated Broadcasts, this big console receiver is the finest obtainable! Its powerful, 13-tube chassis, with built-in super-sensitivity, together with a special high-fidelity F-M Dynamic speaker in the large bass-reflex tone chamber assure the discriminating listener of maximum satisfaction. Covers the complete F-M frequency range (42 to 50 MC) and is provided with a very flexible five-position "tone" control—exactly the right quality at your fingertips!  

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Model 9-1037  . . . . . . . List $135.00  

TABLE MODEL F-M RECEIVER  

This model is identical in all respects to the Console Model described above except for the size and shape of the cabinet. Uses the same 13-tube chassis and same high-quality F-M speaker. housed in a beautiful two-tone walnut cabinet, 12¼ high, 22¾ wide and 11½ inches deep it provides a convenient economy of space but at the same time, permits a quality of reproduction impossible with an ordinary type receiver.  

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01340  . . . . . . List $27.50  

4.3 MC 1-F TRANSFORMER  

Special, wide-acceptance band 1-F transformers designed for all stages between the mixer and limiter tubes. Double-tuned, set at 4.3 MC.  

01348  . . . . . . List $1.75  

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ADDRESS DEPT. C-12  

MAILBAG  

RADIO-CRAFT for DECEMBER, 1940  

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Mr. Quincy Gibbon of Rolling Fork, Miss., has developed the business getting sales ticket shown in the illustration at right. The adverse and reverse sides of this sales slip are shown. Mr. Gibbon's description of the service experience is given on pg. 323.

which would last a year much easier than he would pay 50c for a better tool which would last 5 years. All he can see is his immediate saving.

I grew up in this district and right here in Glenwood, I saw Servicemen working for only 50c of what they ought to get. I was of the opinion that if a man had the nerve to ask good prices he could get it. Provided of course that he had all the instruments necessary to do good work with and that he put in good quality parts.

When I became sufficiently interested in servicing to make it my career, I still held to this viewpoint. I prepared myself for servicing with a National Radio Institute course. I bought the best instruments and stacked high-quality parts.

I started out with an estimate charge of $1.00 and an hour charge of $1.50. None of my competitors charged for an estimate. I got very few sets. Lots of people inquired, but my! how their eyebrows lifted at the dollar estimate charge. I dropped this charge to 50c and got more business. Finally I dropped it altogether. Again I got more business. However I still was doing very well. Where my competitors would get $3 for a job I'd get $6. Mr. Farmer found that out soon enough. Neither of my competitors had a complete line of instruments, neither had as good a stock. But they got the business. I advertised 3 times as much as they. And what is more important I gave the advertising a chance by running it for more than a year. The direct results from the ads was so small as to cause me to finally cancel all my advertising.

Now I am charging not by the hour, but by the set, and trying not to let any set that comes into the shop for an estimate go out without my fixing it up. Since the best prices I get are only 50% of what I should be getting, the prices I sometimes get are downright pitiful.

However I am still in business and am getting more business all the time. I am working for the same prices as my competitors but since I have a better equipped shop I do better work and the work stands up better.

What I am now wondering is how will I keep my equipment at the standards I desire at the prices I am forced to work at?

The answer to this must lie in a union of Servicemen to set prices for all servicing at a fair level so that the Serviceman gives good value and also gets good wages for his work.

No, Mr. Gernsback, not all of us Servicemen are heading toward the poorhouse because of lazy, halfhearted methods. Some of us are forced to it by ignorant people who will not recognize good work, good equipment, good training, and good parts.

I think that the servicing situation is different in cities. Of course servicing costs are higher in a city, but their prices even then leave a bigger profit than in towns like Glenwood, where the chief source of revenue is the farmers. People in cities seem to have more ideas of the necessity of equipment. The farmer must be educated to this thought also. It will take a million years to do this however. Mr. Farmer is a very hard-headed individual.

ARTHUR BARNES, Glenwood, Iowa.

Re: Sept. "R.C."

Dear Editor:

Your article on F/M Revs. on page 148 is very interesting, and I suppose you fellows will give us some more articles as we go along, which is FB for us fellows.

Here is a diagram using type 30 tubes that a local Ham has had some trouble with, due to microphonics, etc., in the set. Can you publish some data on this? He has tried all kinds of "rigs" without getting results.

The circuit which troubled Mr. Sherwood and his friend.

RADIO-CRAFT FOR DECEMBER, 1940
that are anywhere near expectations. Perhaps an article on some such, would be of general interest to others, who have had "jumbles"!

The loop adapter write-up on page 169, by Leutz, is very FB & will meet with much interest, particularly when the days are with humidity around 90%!

Well that's about all from here, and I hope to be able to send some $ way, a little later for that 1941 year!

Thank you, & 73 for now. Your 1/4x8 ( ? — Ed.) & —.

Henry Sherwood,
Bridgeport, Conn.

The circuit mentioned by Mr. Sherwood is reproduced here. The original diagram shows the use of a Hammarlund R.F. choke and Baldwin type C magnetic headphones.

It is unfortunate that Mr. Sherwood did not supply sufficient details as to just what expectations the owner of this set had, and to what extent this receiver failed to meet these expectations.

Perhaps the complaint of microphonics was due to a lack of a grid-return in the A.F. amplifier or the loop returned this grid to a negative "C" voltage as indicated in dotted lines. If a condition of excessive microphonics is such, you have experienced it is possible that one or both of the tubes should be replaced with more sturdy ones of the same type number; transposing the present tubes will eliminate the trouble. It is also possible that the detector gridleak of 3 megs. may be open or at much higher than the rated value.

By proper adjustment of the gridleak value reproduction of fair quality may be obtained with 90 V. on the plate of the detector. However greater sensitivity will result if the plate-return lead is broken at X1 and the plate voltage reduced to about 22 1/2 V. The best value may be determined by experiment.

A third or tickler coil may be connected into the plate circuit by breaking the plate lead at X2. If this coil is brought into inductive relation with coil L2, regeneration may be obtained if the polarity of this coil is correct. Regeneration greatly increases the selectivity and sensitivity of a set of this type. Regeneration may be controlled by connecting a variable condenser, C, as shown dotted; if a commercial 3-coil assembly is used the correct capacity for this position ordinarily is specified in wiring instructions which accompany the coil kit.

THAT "READY FOR TELEVISION" BUSINESS

Dear Editor:

Maybe your readers will get a kick out of the *enclosed marked news clipping if they have not already seen it. It was taken from the Feb. 14, 1940, edition of The News-Sentinel, Ft. Wayne, Ind.

E. W. Miller
Ft. Wayne, Ind.

*Reproduced below.

Radio-Technology

RCA Institute offers an intensive course of study encompassing all phases of Radio and Television. Practical training with modern equipment at New York and Chicago schools. Also specialized courses in Aerial Communication, Broadcasting and Control Operating. Catalog Dept. RC-40.

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Ghirardi's Complete Experiments Make Course As Easy As A.B.C.

Radio physics is a subject that can be read as your daily newspaper. Every day you read about something that happens in the world of Radio and in the world of Nature. Every day you read about events that are happening at the moment. Every day you read about events that are happening in the past. Everything is explained in this book, from the very beginnings of the universe to the very latest developments in Radio and Television. The book is written in simple language, and each chapter deals with a specific subject. It is written in an easy-to-read format, and includes many diagrams and illustrations to help you understand the concepts. It is an excellent resource for anyone interested in radio and television, whether they are new to the field or have some experience. It is a valuable tool for anyone looking to improve their knowledge of radio and television technology.
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326
... random examples of radio's unusual applications suggest rich rewards

We have become so accustomed to the wonders of Radio, and are taking it so much for granted, that we do not give it much attention these days. Even the technical radio man, after a while, begins to think that the word "radio" stands only for broadcasting in one way or another.

There are, however, hundreds of different uses for radio and the list is constantly growing, so much so, that it becomes difficult, even for the research man to keep track of its widening scope.

When I speak of odd and unique radio applications, I wish to keep almost exclusively to radio transmitters, or receivers, or both, as we know them today. I purposely stay away from the field of electronics and other allied fields of radio where the applications are extremely large.

Most people probably know of some of the unusual uses of radio, such as for instance, the following:

Shortwave fever apparatus used in fighting various diseases. Then there are the many industrial uses, some of which are fairly well known, as for example cooking by radio, whereby shortwave radio apparatus causes food to be cooked from the inside out; in the case of frankfurters cooked in this manner the heat originates in the center and then spreads out to the skin. A parallel application is the high-frequency radio furnace, used in the preparation of chemicals, mixtures, alloys, etc. Experiments have been conducted for some time in an electric horticulture plant where a special, heat-producing radio transmitter is used to speed-up plant growth by ultra-shortwave radiation. This art is as yet in its infancy but shows promise for the future.

Not so well-known are the following, many of them made relatively recently:

The Chicago police are reported to be using a sort of radio detectivephone system. In this rather unique application of radio a miniature shortwave transmitter and a microphone are concealed on the body of a detective who thus can walk on the street, or indoors, without anyone knowing that he is a "walking radio station." Cruising along perhaps a few hundred feet away is a police automobile equipped with a radio receiver and sound recorder. Thus should the detective visit a dangerous dive, or abode tenanted by criminals, the operators in the police automobile are enabled to listen-in to anything that goes on in the immediate vicinity of the detective, and should he be attacked, he can summon help instantly. The important point of this use of radio is that no one knows that the detective is carrying a radio station around with him.

There is a radio-equipped, self-contained weather observation station which recently underwent tests at the United States Naval Air Station at Anacostia, D. C. This new radio weather robot automatically transmits signals to a remote point. Installed on top of a mountain, it automatically transmits to a distant receiving set, whenever desired, barometric pressure, air temperature, relative humidity, wind direction and velocity, rainfall and other meteorological factors.

Not so long ago there was a 16-year-old girl in Iowa confined to her home during a long illness. Again radio came to the rescue and enabled her to keep up her class work without going to school. A small set comprising loudspeakers, linked by telephone wires between her room at home and the class-room in the local school, enabled her to get her education without interruption.

For half-a-century geologists were unable to determine the path followed by a subterranean river, running for 3 miles underground, at Bellview, Ohio. Radio technicians solved the mystery by placing a shortwave transmitter inside an 8-in. rubber ball. This was floated down the river and during its underground journey the technicians, by means of direction-finding radio receivers, were enabled to accurately follow the course of the rubber ball and trace the twisting river.

Enemy airplanes, bombing planes, etc., can be detected when quite a distance away by the reflected radio waves—a radio echo, in other words. The British have great hopes that this system will enable them in due time to locate enemy planes when still a considerable distance off—that is, 25 to 50 miles and perhaps further. There is also in use a special submarine detector, somewhat similar to the airplane detector, which also works by ultra-short waves. The waves are reflected from the submarine and returned to a special receiver which accurately locates the submarine.

Aviation has been greatly benefited by the use of the radio altitude indicator, which is a device roughly similar to the echo devices. This is a special radio transmitter which sends an ultra-shortwave signal to the terrain below; the reflected wave is indicated on a panel meter calibrated in feet so that the aviator can read directly how high up he is at any given moment. The radio altitude indicator—an extremely accurate instrument—is of great value, particularly during fogs, heavy rains, nights, etc., when it is impossible to see the ground or water body over which the airplane is flying.

Another radio facility operating on the echo principle is the so-called metal or treasure locators whereby 2 special radio sets are used in a certain manner in order to locate underground pipes, buried treasures and the like.

In the exploration of the upper stratosphere and beyond, where it has been impossible so far for human beings to ascend, radio again has come to the rescue. We now have special sounding balloons which carry tiny ultra-shortwave transmitters and which give our meteorologists accurate information as to temperature, wind velocity, special radiations such as cosmic rays, and many other factors that we would not know of otherwise.

Where it is difficult to install wires, due to terrain difficulties or for other reasons, there is now a system whereby the height of water in a reservoir can be accurately relayed back to the power house by shortwave radio. A machine connected with a radio transmitter at the reservoir automatically registers the height of the prevailing water level and the engineer at the distant power station knows at all times exactly the amount of water contained in the reservoir.
PREPAREDNESS

UNCLE SAM'S Defense program is now advancing on the double-quick on all fronts. Radio went well forward in the vanguard, last month, when President Roosevelt issued an executive order that established a Defense Communications Board to coordinate all branches of communication—radio, wire and cable—with the national defense, and to prepare plans for operation "during any national emergency."... Air programs dedicated to the purpose of preparedness "just in case," reached a new high in number, last month. The National Association of Broadcasters not only aired the address, "Broadcasters Defend America," but also made it available in a pamphlet. ... N.B.C. completed plans to send a crew of announcers, engineers and production men on a grand tour of the nation's 13 training centers, to bring to the folks back home, in some measure, news of the young men called-up for training from, mainly, the "21 to 35" group.

The American Radio Relay League announced exceptional progress of its plan to boost the code receiving speed of a first contingent of 5,000 amateur radio operators to 20 words-per-minute. Listen-in nightly, except Fridays, to W1AW's tape transmissions at 10:15 P.M. on 1,261, 3,823, 7,280, 11,254, and 28,510 kc. ... Employees called to the colors from RCA, General Electric and other radio companies have been given official guarantees that their insurance and other benefits, the difference in salary, and their jobs, will be continued. ... Western Union... The American Tel. & Tel. Co., Long Lines dept., plans to extend its wired-radio (carrier telephone, telegraph and facsimile) system, as an element in the national defense plans, along lines dictated by 1st World War experience, but on a far larger scale. Coaxial lines will be installed between Boston-New York, New York-Florida, Oklahoma City-Los Angeles, Stevens Point (Wisl.)-Minneapolis, and Baltimore-Washington. ... Clifford E. Denton, Chairman, Radio Committee of the Advisory Board on Vocational Education, Board of Education, New York, last month announced that plans are being executed which will make available facilities for a radio in radio, that meets the requirements of the National Board of Education, the National Defense Committee, and the Armies, Navy and Air Corps. At present, this Defense Program will take men out of industry and further their training to improve their usefulness both to industry and to the nation.

SOUND

WENDELL WILLKIE, No. 1 presidential hope of the G.O.P., and the man who turned thumbs down on expenditures for sound trucks, last month addressed his supporters over a public address network in Elwood, Ind. This Western Electric P.A. system, perhaps the largest ever used for only a day, was set up and interlinked to address huge groups in 3 different sections of the town.

Vivid evidence of the dramatic revival of the musical reproduction business is seen by The Index, houseorgan of The New York Trust Co., in sales last year, of 370,000 radio-phonograph combinations, and 60,000-000 phonograph records; and points to recent technical improvements which will further stimulate business in this branch of the Sound business.

A Sunday edition of PM newspaper last month cooked-up the trick title "Wire Sex for Sound" in description of a new idea in wired music. It seems that a Hollywood operator has set up an "interphone" be-
tween a studio and 20 bars. Procedure: customer drops nickel in slot, swaps banter with girls with phonogenic voices who urge the purchase of a beer and request a music title, and then listens to the musical selection via wired sound.

Chinatown in New York City last month was treated to a visitation of sound trucks spouting warnings in the Chinese tongue, that all Chinese aliens must register before Dec. 30.

BROADCASTING

"CALLING car 47... proceed at once to Avon Street... investigate," and similar phrases foreign to its program interrupted studio rehearsals of a "Topics and Tunes" program by a WOR orchestra, last month. Engineer Dick Davis finally discovered that musician Ross Amelia's electric guitar was functioning as a crude detector, its magnetic pick-ups over the guitar strings acting, in conjunction with its associated amplifier, to pick up and amplify broadcasts from the Newark police radio transmitter a block away.

Last month station WGY was shifted from N.B.C. to the General Electric Co. WEA's field strength in Manhattan was boosted about 10 times through its move from Bellevue, L.I., to Port Washington, L.I., says N.B.C.'s radio facilities engineer Raymond F. Guv... Little Pea Island in L.I. Sound off New Rochelle, N.Y., will soon be the home of station WADC, 50-kw. key of C.B.S.'s net, and now at Wayne, N.J. ... C.B.S.'s shortwave station WCBL will be transplanted from Wayne, N.J., to 1,200 acres at Brentwood, Long Island, N.Y.

KDKA's new "Hear Yourself" air program holds the mirror to vocal Pittsburghers. This commercial by the makers of Breakfast Cheer coffee involves the use of a mobile recording van, and a master of ceremonies whose job it is to interview purchasers inside some grocery store. Recordings go on the air a few days later.

ENGINEERING

JAPAN is scheduled to get its first taste of wireless radio, come '41, reports Variety. Master receivers in the plant of the telephone or power company will feed remote loudspeakers via the respective system of supply wires. A "recorded service" (facsimile?) also is due to be worked into the scheme, with the equipment being an angle-on attachment to the regular receivers.

... To demonstrate how its new line of "Teledot Kooloam" resistors operate, Sprague Products Co. has prepared an ingenious mailing piece. If you follow instructions, which are to hold a match under the colored dots on printed resistors, heat from the match too slight to burn the card turns the red dots to brown—just as would an overload of an actual "Teledot" resistor.

... Add new radio term: "pertruded nickel"—a term coined by Baker & Co. to describe a metal mesh formed by pushing holes through sheeting, thus retaining all the metal, instead of cutting out the metal as in perforating. This construction is essential in certain types of radio tubes.

The Time Capsule, 800-lb. "letter" to the people of A.D. 6939 last month was sealed in its 50-ft. well in the grounds of the Westinghouse Exhibit at the New York World's Fair. The Time Capsule contains objects, illustrations and descriptions of not only radio items but also many others representative of the civilization of the 20th Century. Rods of Cupaloy have been imbedded in the plastic above the Capsule to aid "treasure"-finding devices to locate it, 5,000 years hence.

Dr. W. D. Coolidge, director of the G.E. Research Laboratory, has been named to the newly-organized National Inventors' Council, composed of 12 scientists and industrial leaders, a body created by Sec'y of Commerce Harry Hopkins to encourage civilian inventions as part of the program of the National Defense Research Committee.

The Writers' School, New York City, now has a seminar for radio script writers.

MY TIME IS YOUR TIME...

Here we see Rudy Vallee double-checking on the most exacting sound-disc "mirror" of his voice, an electrical transcription, preparatory to airing it over an N.B.C. network.
NEW CIRCUITS IN MODERN RADIO RECEIVERS

In this series, a well-known technician analyzes each new improvement in radio receiver circuits. A veritable compendium of modern radio engineering developments.

F. L. SPRAYBERRY

No. 39

[Fig. 1] CIRCUIT PROVISIONS FOR PHOTOELECTRIC PICKUP

PHILCO Models 41-608, and 41-609.—In this circuit the phono-radio changeover switch is in mechanical combination with the wave-band switch so that the pickup exciter lamp may be supplied with high-frequency voltage. Other circuit changes are made for phonograph operation.

From inspection of Fig. 1, the following circuit changes permit photoelectric phonograph reproduction: (1) The audio input at the volume control is shifted from the usual diode-return circuit to the output of a pickup preamplifier; (2) the cathode circuits of the 2 I.F. amplifiers are opened to prevent radio reception; (3) the mixer grid input circuit is opened to further prevent signal interference; (4) the oscillator plate and cathode circuits are switched for producing a fixed frequency of 1.8 mc.; (5) the oscillator, screen-grid and plate voltages are increased to raise the power output of the oscillator; and, (6) a pickup coil coupled to the oscillator tank circuit is connected to the pickup exciter lamp. Note that the photovoltaic cell is permanently coupled to the preamplifier input by means of an autotransformer for impedance transformation.

Note that the oscillator is a power amplifier tube (7B5) and uses a very unusual circuit having the control-grid at constant potential while the cathode and shunt-coupled plate are at P.F. The power output of the oscillator is thus increased to supply the pickup exciter lamp.

[Fig. 2] FREQUENCY MODULATION RECEIVER USES 2 LIMITERS IN CASCADE

SCOTT Model Custom-Built F.M.—To greatly expand the field strength range in which this receiver may satisfactorily operate and to eliminate any amplitude modulation arising from the selectivity characteristics of the I.F. amplifier, 2 limiter stages are used

As Fig. 2 illustrates, the 2 limiters are in cascade arrangement followed by the discriminator detector. The limiter input is sensitive down to a few microvolts and it is obtained from the coupling condenser and grid resistor values it may be observed that the limiter action is quite rapid. This serves to reduce the effects of impulse noise which might be great enough to affect the 2nd-detector adversely.

[Fig. 3] NEW METHOD OF AUDIO BIAS DERIVED FROM THE SIGNAL

EMERSON Model EQ-368.—A small I.F. signal is fed to the 1st audio grid causing rectification and thus builds up a bias on the grid very much like the action of a gridleak-condenser detector.

As shown in Fig. 3, the slider of the volume control is joined to the top of the volume control with a resistance-capacitance circuit, R11-C30. This circuit will pass no appreciable A.F. but about 90% of the I.F. supplied to it. Impressed on the 6SQ7GT grid, this produces a small rectified voltage which is applied as a bias. This action is carried down into the low volume settings of the volume control. With this method of bias a lower value of grid resistance may be used tending to give the amplifier more stability. Also we need not depend on the bias created by the cathode “work function” which rarely exceeds ½-volt.

[Fig. 4] WAVE-BAND SWITCH CONTROLS BASS COMPENSATOR

RCA Model V-170.—Since bass compensation is undesirable for intelligible short-wave reception and to avoid the necessity for 2 adjustments of the receiver controls, the bass compensator condenser is shorted by one section of the wave-band switch.

The circuit is shown in Fig. 4. It is conventional except for the mechanical grouping of the waveband and bass compensator switches. No further explanation is therefore needed.
... REPAILING OCTAL TUBES In servicing sets using the octal base tubes, it is often found that one that is dead or that will "motorboat." The cause is often traced to some of the tubes being in the wrong sockets. The owner often takes the tubes out for inspection or to be tested and gets them in the wrong sockets.

Always check the tubes with the service diagram to make sure the correct sockets are being used.

... P2H TUBE This tube is not directly interchangeable with type 2AS as specified in many charts. The 2AS is a 6-prong tube and the P2H has 7 prongs. In the suppressor the suppressor is brought out to a separate pin. This necessitates a change in the socket.

... WELLS-GARDNER 5E SERIES If this set is noisy, replace the 50-mmf condenser between the plate of the type 34 I.F. tube and the grid of the 2nd-detector. This is not a regular condenser but is a special capacity wire type that can be replaced with a 0.001-mf mica condenser.

... TRAVLER 51 Noisy operation frequently shows up, especially if the set is jarred. The shield on the control-grid lead of the type 75 tube may be shorting to the can of the electrolytic condenser. The can of the condenser is at negative potential with respect to chassis.

... PHILCO 57 This is a small 4-tube A.C. model. If this set becomes noisy, especially when the tuning condenser is rotated, look for some wax or tar between the plates of the variable. The jarred effect mentioned in this model occurs over the condensers and when hot will often cause some wax or tar to run out of it down between the condenser plates.

... GRUNOW 1937 A peculiar hum which develops on some of the Grunow 16-tube models, after the set has played a few minutes, can be eliminated by connecting the shell of the large speaker to ground.

... PUSHPUSH TUNING If you have trouble with the pushbuttons sticking in a pushbutton model, it's because the radio set is kept where there is too much sun or heat. The heat swells the buttons so that they stick on the sides. Often the springs will also lose their tension. Remember to keep the set and has the high spots down. Either stretch the springs for better tension or replace them.

If the buttons are replaced they should be of some material other than bone or rubber so they will not warp.

... PHILCO 40-125 A loose rattle when the voice coil of this set is not off-center may be due to a loose condenser connected from the center lug of the volume control to the G75G tube socket.

... SENTINEL-ERA MODEL 14A This set had fair volume but could not be peaked at 600 kc. A 50,000-ohm resistor, connected from the 540-1,730 kc. oscillator coil to ground, changed in value and caused the trouble.

... CROSLEY 726 Set "dead" and no screen-grid voltage on 6AS and 6KT I.F. tube. In this case, check the 50 -ohm section of positive bias resistor. This resistor is marked 57-Z on the factory diagram.

... CROSLEY 955 Set inoperative at times also gets very noisy. Check the 1,100-ohm bias resistor connected from the cathode of the 6C5 driver tube to ground. This is a flexible resistor and marked No. 46 on factory diagrams.

... ZENITH 95-262 If the complaint is "inoperative," and a check shows no plate voltage on the 6L7G 1st-detector and 6K7G I.F. tube, check for a shorted 0.05-mf condenser (marked C8 in factroy diagram).

... S.M. 58 HALLCRAFTERS In complaint of poor tone, check for a leaky 0.1-mf condenser from plate supply of the type 75 tube to ground.

... G.E. E72 Set "dead" and smoke comes out of the I.F. coil can, next to the dial. A shorted 0.02-mf condenser connected to the primary of this I.F. coil causes to burn up the 25,000-ohm resistor which is located inside of the I.F. coil can.

... THOS. R. DUESINGER, Chicago, Ill.

... PHILCO 71-01 Shadow meter does not work properly. If shadow-meter gradually widens out after set has been in use for a few minutes, install 2 No. 44 tubes in R.F. and I.F. socket. Condenser is caused by gassy tubes. Try several tubes, choosing the ones which give best results.

... PHILCO 39-17 These are frequent offenders, the usual complaint being "dead," due to the type of wiring used in nearly all '39 Philco models.

Examine output transformer leads. Wires will be found shorted to chassis due to the fact that the rubber insulation has become very soft causing voltage breakdown. The power transformer uses the same type of wire, and the writer suggests replacement of this unit, although repair can sometimes be made by using spaghetti on all leads.

... ISADORE HYMAN, Norfolk, Va.

... OPERATING NOTES...
LUCRATIVE SIDELINE FOR SERVICEMEN

— in Electroplating

The author tells how a successful Chicago service shop, by installing an electroplating outfit, frequently gets new customers who also want their radio sets repaired.

HARRY DODGE

WHERE can one go to have spoons, a door-knob, or a faucet replated? Answering this question opened for me an unexpected sideline to my radio business and a surprisingly remunerative source of income. I actually had tried to get a little plating work done and the difficulty I encountered set me thinking. The big plating shops wouldn't be bothered; the small shops did not always have the metal necessary—and if they did I was lucky to get the pieces in a week.

I POSE A QUESTION

I'm always on the lookout for "dodges" to better my income and my services to my customers. There isn't much to electroplating. Why couldn't I do it?, I wondered. Why not offer it as an extra service that would draw customers to my shop? Who would the customers be? I called on a few prospects to test my idea. The first was an antique dealer. Could I do silver and gold? I reckoned I could, though not yet having the haziest idea how it was actually done. He showed me more work than I could expect to do in a week! Next, I tried a real estate office that manages several apartments. Could I nickel-plate faucets and door knobs? How quickly could I get the work out? They didn't ask me how much it cost, but how quickly it could be done.

An auto repair shop wanted to know if I could resilver headlight reflectors. My dentist had a handful of instruments that needed a fresh surface of nickel. A restaurant wanted its soup spoons, ladles, and pickle forks tin plated. Some of my regular radio service customers had 25-piece sets of silver that needed replating—only they had never thought of having it done.

There wasn't any question about customers.

THE START

In making inquiries I learned of a chap who had a complete electroplating outfit in his basement and was doing part-time work with it. It was so profitable he was about to give up his job driving a truck and devote all his time to electroplating. I got him to install his whole outfit in my shop.

It didn't take up much space. The main part of it was an automatic mobile unit about the size of a small console receiver with a sloping panel. It contained a rectifier, automatic timing mechanism, voltmeter, and ammeter, and a time-delay reversing switch.

Also there were motor and buffering wheels mounted on a wood base, an electrically-heated cleaning tank and some smaller tanks for plating. A set of electrolytic anode brushes accompanied the outfit for brushing plating objects which couldn't conveniently be dipped in the regular plating tank. The chemicals came in powder form, and my new partner mixed these with distilled water for his cleaning and plating solutions.

Cleaning—I learned that the process was simple. First, he cleaned the object to be plated with the wire brush, then polished it with the cotton buffer. Next he hung the object in the heated cleaning solution and connected his machine. It passed current through in one direction for about 5 minutes, "making," he said, "bubbles of hydrogen surround the steel and cleaning it thoroughly." Then the machine automatically reversed the current for 2 seconds, causing oxygen bubbles (around the piece) which removed the film of hydrogen. Then a bell rang in the plating machine to notify him that the job was clean.

1st Rinse.—From here on he handled the clean metal with rubber gloves to avoid getting any grease on it from his fingers. He washed it thoroughly in running water to remove traces of the caustic cleaning solution, then attached wires which connected with an insulated strip over the plating bath.

Plating.—Making the proper connections to the plating machine, he set the timer and the current control according to a set of instructions. The plating bath required about 20 minutes, during which he examined the metal at intervals to see that it was taking a smooth plating.

2nd Rinse.—When the bell in the machine rang, indicating the prescribed time had elapsed, he removed the beautifully plated metal and washed it again to rid it of any of the plating solution.

Polishing.—After drying it with a cloth he went over it with a cloth buffer, and if I hadn't seen it done I would have sworn the piece had just come from a factory.

That is just the mechanical part. Simple, isn't it?

I'm getting $3 1/3% cut on the work; and from 8 to 10 new customers a day are bringing work into the shop. Some of them, of course, have radio sets to fix, too. Thus I've enlarged my income and my clientele, and I'm giving more service to my customers.

GENERALITIES

Although formulas and operating procedures for electroplating are generally available from the plating supply houses and in textbooks, the following additional comments may be of interest as some of them can be learned only as a result of considerable experience.

Speaking in general, the electroplating of iron or steel requires a current reversal for 3 seconds to remove the deposit of caustic soda that replaces the dirt and oxides on the surface of the work. The object must then be thoroughly cleansed of any trace of soda to prevent reaction of the soda with the acid and thus weaken the plating solution.

In plating copper in a sodium cyanide solution a 4-V. D.C. supply is ample but the current must be reduced through a heavy-duty rheostat to obtain the requisite degree of lightness and brightness of the copper deposit.

For copper plating in a blue vitriol (copper sulphate) solution 2-V. D.C. supply is ample.

Nickel plating requires the use of pure...
...A NEW Positive Pressure
BAND FOR ADJUSTABLE RESISTORS

No more broken or damaged resistance windings when you move the slider band on adjustable wire-wound resistors! No more oxidation or corrosion at point of contact.

No matter how much you tighten the new IRC Positive Pressure Contact Band itself, the pressure of the silver contact button on the windings remains safe, constant and positive. No matter how often the bands are readjusted, there is no danger to the windings. Moreover, the bands will not deteriorate under high operating temperatures or under constant use.

These new bands are available in 9/16", 3/4" and 1 1/2" diameters and are now supplied with all IRC Adjustable Wire-Wound Resistors from 25 to 200 watts, inclusive. Sold separately for use on your old resistors, too. Ask your jobber. Stop throwing adjustable resistors away because of broken wires and corroded contacts!

INTERNATIONAL RESISTANCE COMPANY
401 North Broad Street, Philadelphia, Pa.

sheet or cast nickel. Good work requires a base of copper; except in plating tableware in which case, to avoid the danger of taking too much copper into the system when using the tableware, the copper undercoating should be avoided.

In plating silver a pure silver anode must be used. Silver coins used as anodes will quickly ruin the plating solution because of the alloy in the coins.

Black iron plating for rust-proofing tools is really not a plating but an oxidizing process. The "solution" is pure distilled water—the drugstore variety rather than that obtained at filling stations—in a copper tank. The iron tool to be coated is made the negative terminal and is immersed in the water, brought almost to the boiling point, in the positive-terminal copper tank. Use 60 to 100 V., for 30 to 50 minutes. Higher voltage and longer periods of time are necessary if the temperature of the solution is less than 180° F., or if the area of the work is increased. An old "B" eliminator is a good source of voltage for small objects such as pliers.

A process for chromium plating is not given as the only good solutions are patented and restricted to licensed users. Besides the fumes thrown off in this process are very injurious when inhaled. Objects to be chromium plated should first be copper plated, then nickel plated, and then taken to a commercial plater for the final flash of chromium.

In all plating processes, the most important item in the procedure is to clean the surface to be plated and then avoid handling, unless rubber gloves are used, for fear of leaving finger marks of sweat or grease which will not take the plating. As the plating is usually very thin, do not expect it to fill up dents or scratches. The plated job will only be as smooth as the metal under it.

It is best to purchase plating compounds already prepared in dry form, ready to mix with water. Thus, there is less danger of poisoning or developing poisonous gases by mixing the wrong chemicals. Handle all cyanide compounds with rubber gloves and never mix an acid of any kind with cyanide compounds as a colorless and odorless gas is given off which is very toxic—one form of this cyanogen gas is used in Utah for the execution of criminals in a gas chamber.

"MICROPHONE TECHNIQUE"
Be sure to order your January issue of Radio-Craft today so as not to miss the first chapter of this up-to-date article on the proper use of modern microphones.
Radio Service Data Sheet

GALVIN "MOTOROLA" MODEL B-150 BICYCLE RADIO

3-Tube Superhet. [2 triple-purpose tubes and 1 power tube]; A.V.C.; Permeability Tuning of Antenna and Oscillator Circuits; 4-In. P.M. Dynamic Speaker, 1.4 V. Tubes; Lower Battery Drain.

Diagram of Motorola B-150 Bicycle Radio Set. Note permeability tuning unit. The market: 6,000,000 bike owners.

Chassis view. Note compactness; and fuser (arrow).

Placement of set and power unit on bicycle frame.

Alignment Chart

Output

Input

No.

Order

Output

Set At

Antenna

Connected To

Generator

Generator

Leak

Sensitivity and Stage Gain Measurements

Generator

Feeder

Antenna

Output

Meter

Voltage Chart

Tube

Set At

150 V.

I.F. Det.

51 V.

A.F.C.

50 V.

VOLUME CONTROL

3.5 MEAS.

DUAL RIB

HEX

SWITCH ON VOLUME CONTROL (UNIT) (CHASSIS)

BATTERY

CABLE

PLUG, BOTTOM (UNIT) (CHASSIS)

Oscillator Circuits;...
SERVICING TROUBLES

1. Anemostat a few of the troubles I have encountered and what I have done to remedy them.

(1) A resistor that will get hot enough to melt stick shellac when held against it, is either too small or not getting the proper ventilation.

(2) I have traced 3 cases of noisy reception when a person walks across the floor. The trouble was located in the basement where the gas and water pipes crossed each other, they were just close enough together that a slight jarring of the floor, caused them to make a minute connection. This was remedied by properly bonding with ground clamps and heavy wire. Another case was an ungrounded BX light cable lying across a water pipe. This was remedied by the same method as above. Another case where the doorbell wires had sagged and were lying across a hot-water pipe, the heat had melted the wax coating and general vibration caused a disturbance each time the unprotected wire touched the pipe. This was remedied by placing that section of the doorbell wire in a length ofloom.

(3) I have traced a very severe and troublesome case of intermittent reception, to a very poor soldering job on the top of the control-grid cap where the control-grid wire connects to the cap. Although the cap may have plenty of solder on it, there is always the chance that the wire was not properly tinned in manufacturing. Therefore reception is good when the tube is cool, and out of operation when heated. A hot soldering iron with a little flux will suffice in most cases. It is also well to resolder the tube prongs.

(4) Another case of intermittent reception was found in an inferior make of wax tubular condensers. Some of the condensers do not have a very solid weld between the lead wire and foil. These can be located at once by placing set in operation and slightly rotating the condenser with your finger. To avoid getting a severe, unexpected shock, I always wear a pair of rubber gloves. It is a very good idea when replacing these condensers, especially where there is heat, to use a good, reliable make of mica-molded condensers. This will avoid future troubles of this nature.

(5) I have found at least 3 cases of noisy or intermittent reception in car-radio sets where the male socket of the battery or antenna connections have been sprung so far apart that the female plug would make and break contact at intervals. In all cases this was remedied by squeezing the male socket back in shape. These sockets should fit so snug, that it takes a little effort to insert. Also see that each plug has a small mound of solder for connection, on the tip of each plug.

(6) Another case of noisy and intermittent reception, when the radio receiver was found to be OK and set still gave trouble, was due to the lightning arrester. It was found to have filled with dust and minute particles of metal which had seeped in or were blown-in between the contacts. A trouble of this kind can be readily located by placing the radio set in operation and tapping the arrester with the butt end of a screwdriver. The receiver will readily act-up if this should be the trouble.

(7) I have had many tubes in the shop that tested up OK, but in one case of intermittent reception, the set always played swell when in the shop but when taken to the customer's home the intermittent reception would start. I tested the tubes in my tester at the customer's house, and again at the shop, they always came up to standard. The set had me puzzled so I decided to get at the bottom of the trouble at any cost.

I put a complete new set of tubes in the customer's radio set and took the old tubes back to the shop. I tested them about 5 times each, with no result except to load off some of the tubes that tested OK, so I decided to try just once more. In changing the filament selector switch I accidentally left it on the 7.5-volt tap. Not knowing this, I proceeded to test the tubes. The third one I tested showed a short, and all the rest tested OK. It was then I noticed that I had the filament selector on the 7.5-volt tap.

Suddenly it dawned on me, why couldn't the customer's line voltage be abnormally higher than standard for his radio set? I wired directly to the customer's house, checked his line voltage, and found it to be 5 volts over the regular, specified line voltage. This increase in line voltage was 10 volts over the value recommended by the set manufacturer. Therefore the increase in voltage was just high enough to cause a cathode short by the increase of heater temperature, causing the cathode to expand further than normal. This was remedied by installing an autotransformer to reduce the voltage to the requisite amount.

(8) Intermittent reception was located in several multi-band receivers at the band changeover switch assembly. The small particles of metal that had worn away from contacts and had settled between the stationary contacts, and each time, the radio set would become noisy when the volume was raised; sometimes the set discontinued playing altogether. This was remedied by taking a toothbrush and thoroughly and cleaning-away the metal particles and then, by applying a small amount of vaseline to the wiper contacts, future trouble of this kind was eliminated.

L. C. JUENGENS,
Highland Radio Service, Mankato, Minn.
ALIGNING INFORMATION

Use a modulated signal generator with variable output voltage and a sensitive output meter across the voice coil. Align using the smallest possible input from the signal generator; volume control "full on".

IMPORTANT: Be sure metal plate is fastened in place on the bottom of the chassis before alignment is attempted.

ALIGNING PROCEDURE (follow this order exactly.)

I. Dial Pointer Adjustment.

With the plates of the gang tuning condenser fully engaged set the dial pointer in a vertical position directly on the calibration marks located at the top and bottom of the dial scale.

II. Intermediate Frequency Adjustments.

1. Tune the set to the extreme-low-frequency position. (Variable condenser plates all the way in)
2. Connect ground terminal of signal generator to chassis.
3. Introduce a modulated signal of 455 kc, using a 0.01-mf condenser in series with the lead from the signal generator to the oscillator adjusting condenser located on the front section of the variable condenser.
4. Adjust the I.F. aligners for maximum output in the following order:

III. Radio Frequency Adjustments.

1. Replace the 0.01-mf condenser in series with the output lead of the signal generator with a 200 mmf. condenser and connect them to the antenna terminal located on the back of the box assembly.
2. Set the signal generator's frequency and the receiver's tuning dial to 1.4 mc.
3. Adjust the oscillator and antenna adjusting condensers for maximum signal.
4. Set both the signal generator's frequency and the receiver's tuning dial to 0.6-nc. and check calibration.

NOTE: If the calibration is too far off at 0.6-nc., operations 2 and 3 may be repeated until the best results are obtained.

NORMAL VOLTAGE READINGS

Use a good, high-resistance voltmeter having a resistance of at least 1,000 ohms/volt.

Take all D.C. voltage readings on the 500-v. scale except where an asterisk (*) appears:

Take all readings with chassis operating and tuned to 1,000 kc.—no signal.

Use a line voltage of 120 v. or make allowance for the variation.

Read from indicated socket terminals to terminal No. 3 of the 12SK7 I.F. Amp. Socket ("F")

See Location Chart for position of terminals.

VOLTAGE TERMINALS OF SOCKETS

A.C. Voltages are indicated by boldface; when the receiver is operated from a D.C. power supply, D.C. voltages will be obtained in place of A.C. voltages shown.

CONTINUITY TEST

CAUTION: Remove all tubes, disconnect the receiver from the power supply and short terminals of the 35Z5GT rectifier, tune to the chassis base before making continuity test. Use a good meter capable of measuring accuracy up to several megohms.

Locations of main components and alignment trimmers.

Stromberg-Carlson model 500-H table model receiver.

Symbols used are as follows: \( r \) — open.  \( o \) — short.
THE ABC OF FREQUENCY MODULATION

The following article supplements with a detailed analysis and performance information the sketchy description of Frequency Modulation fundamentals by the authors in their preceding, 2-part article, "Frequency-Modulated Programs on Your Present Receiver!" in the December 1939 and January 1940 issues of Radio-Craft.

G. H. BROWNING and F. J. GAFFNEY

During the last year Frequency Modulation has received such a marked impetus that the Serviceman is beginning to recognize a real need for a detailed, fundamental knowledge of the new system particularly as it pertains to service and alignment of the new "F.M." receivers.

Perhaps a good starting place for an article to explain the details of F.M. receivers is a debunking of much of the mystery with which this new system has been clothed in the eyes of the Serviceman. Exactly the same principles of amplification, frequency conversion, etc., are employed in a frequency modulation superhet, receiver as with the more common or amplitude modulation receiver. Characteristics of the amplifiers themselves are, to be true, different. But the Serviceman has already dealt with many types of amplifying systems during the progress of the radio art to its present state and the new system should present no problems more complicated than those already present.

PROBLEMS IN BAND COVERAGE

One fact which appears to alarm the average Serviceman is the high-frequency band employed for the transmission of F.M. signals. The band of frequencies between 42 and 50 mc. has been assigned by the F.C.C. for this purpose. This means that

(a) the tuned antenna circuit, (b) the R.F. amplifier, and (c) the oscillator sections of the superhet. F.M. receiver must operate at these high frequencies. This of course results in certain design and stability problems which are not present to such a marked degree in allwave receivers. These problems, however, are ones which are of importance primarily to the manufacturer rather than to the Serviceman.

Once the design for a high-frequency R.F. tuner has been correctly worked out, it can be expected to perform satisfactorily with little attention. Due to the fact that only a few turns of heavy wire are used for winding the coils, there is little if any possibility of shorted or open turn in the R.F. system. One precaution might be pointed out, however. If it becomes necessary to replace an open or shorted resistor or condenser located in the high-frequency tuner, the exact position of the component to be replaced should be carefully noted by the Serviceman and the replacement made so that the new component occupies exactly the same position as did the original. This precaution is necessary at these high frequencies because of the regeneration difficulties which can be caused by even a very short lead incorrectly located. Even more care would have to be exercised were it necessary to replace a coil, but as previously pointed out, this is seldom if ever required.

In the design of a high-frequency tuner for the F.M. band, stability is the most important consideration. This is particularly true as regards the frequency stability of the high-frequency oscillator since a change in its frequency will result in a marked detuning of the receiver with consequent increase in noise level. If the detuning is severe enough, marked distortion will also occur.

Even after all of the precautions as regards component stability have been considered, a certain amount of drift is still present due to the oscillator or mixer tube itself. This can be minimized by using an oscillator circuit of high capacity; and, if required, by using a certain amount of compensation in the form of a negative temperature coefficient condenser suitably located in the oscillator circuit. The detuning effect due to the tube is, of course, present only during the warm-up period which is ordinarily for about the first half-hour during which the set is in operation. It might be pointed out here that any F.M. receiver should be retained after about 15 minutes to insure best quality reception.

THE F.M. INTERMEDIATE FREQUENCY STAGES

The requirements of the I.F. amplifier are perhaps the next logical subject of discussion. Under present standards of transmission, the frequency swing of the carrier for 100% modulation is 75 kc. either side of the center frequency. In order to transmit the signal faithfully, a transmission system which is capable of passing a band of frequencies 150 kc. wide is required. As will be pointed out in connection with limiter action, however, it is not necessary for the I.F. amplifier itself to have this extreme bandwidth in order to faithfully reproduce F.M. signals. It has, in fact, been found that for the usual signal strengths available at the input to the receiver, the response of the I.F. amplifier may be "tuned 10 times" 100 kc. away from the center frequency without impairment of the recovered audio signals.

A certain amount of selectivity is required in the I.F. amplifier to achieve good adjacent-channel separation. This is particularly important when it is desired to receive a weak signal in the presence of a very strong signal on an adjacent channel. The design of the I.F. system is somewhat of a compromise, then, between the bandwidth required for faithful reproduction and the selectivity required for adjacent-channel separation.

During the past year, stations have been operating on an experimental basis on carriers spaced only 200 kc. apart. This has resulted in a rather severe selectivity requirement. Starting in 1942, however, the new channel assignments will go into effect and these are made in such a manner that no 2 stations serving the same locality will be separated by less than 500 kc. With this channel spacing the design problem is not particularly severe. The curve of Fig. 1 illustrates a satisfactory characteristic.

I.F. SELECTIVITY

One erroneous idea in the minds of many Servicemen is that too-sharp an I.F. channel will result in a loss of the higher audio frequencies as is the case with present amplitude modulation receivers. With F.M. receivers this is definitely not the case, since the required bandwidth is a function of frequency swing and is largely independent of the audio frequencies with which the transmitter is modulated. As will be pointed out in the discussion of the detection (demodulator) circuit, the actual result of too-sharp an I.F. system is to produce distortion on the loud signal passages.

Fig. 2. The in and out of Frequency Modulation will be easier to learn during its developmental stage. Diagrammed at left is the "heart" of F.M. circuits.
The broad band characteristic required in the I.F. amplifier is obtained by over-coupling the coils of the I.F. transformers and by resistance loading. The effect of resistance loading, which is accomplished by placing proper value resistors across one or both of the transformer windings, is to effectively lower the Q of the I.F. coils. In addition to broadening the response characteristic, resistance loading also results in the elimination of fuzz frequencies in the recovered audio signal which would otherwise be present due to transients in the system as the frequency is varied.

To obtain the required reception characteristic, it is necessary to employ a reasonably flat frequency I.F. system. Frequency of about 3 mc has been found optimum for this use. Higher frequencies than this result in decreased gain and increased stability problems while lower frequency systems it is difficult to obtain the required bandwidth. There has been no attempt at standardization as yet, however, and receivers at present on the market may be found to employ intermediate frequencies anywhere in the range from 2 to 5 mc.

THE LIMITER

One device present in an F.M. receiver which is somewhat new to the service man is the limiter. This device is nothing more than a tube employing a resonant circuit and condenser bias whose plate and screen-grid voltages are sufficiently low so that the tube saturates. A typical limiter circuit is shown in Fig. 2.

The device depends for its operation on the fact that the output I.F. voltage can not exceed the result of the applied D.C. plate voltage. Consequently if a curve of I.F. output voltage vs. an I.F. input voltage is plotted, it has the form shown in Fig. 3, curve 1. The ideal response curve for a limiter would of course be a characteristic as shown in curve 2.

For such a characteristic, a very weak signal would result in full output from the limiter and further increase in signal would result in no change in output voltage. This curve is not capable of practical accomplishment, however, because the signal can not be obtained. From curve 1 it can be seen that a certain input voltage is required to produce saturation. The value required is that indicated by the dotted line S in the diagram. For values of input greater than this, the output voltage is constant until a second point on the curve is reached, after which greater values of input may result in an actual decrease in output. To prevent this, a form of bias whose value depends on the I.F. voltage feed to the input of the tube is employed. Such bias is most conveniently obtained by means of a resistor and condenser, and when suitable values are used the curve may be made to have a flat characteristic out to point B, a point of sufficiently high input to result in adequate operation for all practical values of signal actually obtained. Figure 4 shows a curve of audio voltage developed at the detection transformer plotted against volts input to the limiter grid. It can be seen from this curve that the input voltages of greater than about 3 volts result in no further increase in audio output when the frequency swing is maintained at some constant value.

NOISELESS OPERATION

In order to accomplish noise-free operation, however, the use of input the input to the limiter must be what greater than this is required. The curve of noise reduction is shown in Fig. 5. From this it can be seen that about 10 volts of I.F. are required at the grid of the limiter for most complete noise suppression. A material amount of noise reduction however, occurs for signal levels of 7 or 8 volts, as indicated in Fig. 5.

These high values of signal required at the limiter grid for noise-free reception explain the requirement of a high-gain I.F. system. It is for this reason that intermediate frequency stages are usually employed. The gain of a 3-stage I.F. amplifier at 3 mc is about 10,000 if one 1852 and one GSX7 tube are used as the I.F. amplifiers. If two 1852 tubes are employed the gain is about 15,000. The total gain of the system is to produce 3 V at the limiter grid with an input signal of 10 microvolts is 300,000. It can thus be seen that the R.F. system should have a gain of at least 30 not counting the conversion gain in the mixer tube. For noise-free operation with such weak signals, the R.F. system should have a gain of about 20 if two 1852 tubes are used in the I.F. system.

The voltage developed across the limiter load serves as an excellent indication of signal strength. The voltage is nearly directly proportional to signal strength for values up to several hundred microvolts. The curve of limiter voltage vs. signal strength is shown in Fig. 6. Bending of the curve which begins at point X is due to overloading of the I.F. amplifier tubes. Strangely enough, overloading the I.F. amplifiers does not result in distortion in the frequency modulation receiver but merely serves as a prelimiter device to keep the output more nearly constant. The voltage across the limiter load is an excellent alignment indicator as will presently be explained.

CHECKING THE LIMITER

From the above curves and explanation, it can be appreciated that the limiter in an F.M. receiver acts not only as a means of "ironing out" amplitude variations in the carrier but also as an automatic volume control. It has been pointed out that a certain minimum signal strength is required to saturate the limiter so that noise-free reception will be obtained. For this reason it is not desirable to incorporate in an F.M. receiver any A.V.C. of the conventional sort, for it may cause loss of signal strength at the limiter grid as high as possible. Provided that the limiter grid voltage does not drop below 3 volts in the system being discussed, extremely wide variations in field strength at the antenna may occur with absolutely no change in recovered audio level.

The operation of the limiter may be checked in several ways. Perhaps the most convenient method is to connect a vacuum-tube voltmeter between the plate of the limiter tube and ground. A signal from a single generator is then fed to the control grid of the converter tube at the intermediate frequency and the level of this signal is increased gradually starting from about 100 microvolts. The output voltage should begin to flatten off as the 200 and 400 microvolts input and should be constant for all higher values of input level.

Another method of checking the limiter action is to connect a high-impedance D.C. meter or vacuum-tube voltmeter between the ungrounded 6H6 cathode and ground. A signal put into the converter grid at the exact I.F. intermediate frequency should result in zero voltage on the meter. If the signal frequency is now changed by approximately 50 kc, a reading should be obtained. The reading may now be varied from 100 microvolts up, whereupon the meter reading should increase to the point where the signal level is somewhere between 200 and 400 microvolts and should thereafter remain constant.
THE DEMODULATOR (2nd-Detector)

The final point of difference between an F.M. and A.M. receiver is in the detection system. An F.M. detection system is entirely different both in its construction and theory of operation from the conventional diode detector used with A.M. receivers.

Referring to Fig. 2 it will be seen that the "detection transformer" which feeds the audio amplifier or 2nd-detector has, in addition to the magnetic coupling between its coils, a capacity coupling between the top of one secondary and the center-tap of the secondary. This results in 2 voltages being developed between the plate of each diode and the center-tap of the transformer. If the frequency of the impressed signal is exactly that to which both primary and secondary are tuned, the voltage developed by magnetic induction will be almost exactly 90° out-of-phase with the voltage developed by means of the capacity coupling.

These voltages are shown in Fig. 7. The subscripts m, c, and r, refer respectively to the upper and lower diodes respectively. It can be seen from the figure that Er1 and Er2 are equal in magnitude under these conditions. These voltages are rectified in the diodes and produce equal and opposite voltages between the two cathodes and point 0. The voltage AG is thus zero.

If, now, the frequency is made to depart from the frequency to which the system is tuned, the capacity voltage fed to each plate will be the same, but that due to the magnetic induction will shift in phase as shown in Fig. 8. The result is that the voltages Er1 and Er2 are no longer equal so that the difference between these rectified values appears between point A and ground. An increase in frequency results in point A becoming negative with respect to ground, while a decrease in frequency results in point A becoming positive with respect to ground.

A plot of the D.C. voltage is shown in Fig. 9 for plus and minus departures from the center frequency. If the input frequency is varied at an audio rate, an audio voltage will be developed across this output network. (NOTE: In Fig. 9, D.C. voltages +5 and +8 should be divided by 1000, or 50, an error due to the scale in the drawing. — Ed.)

To insure faithful reproduction, it is essential that the portion of this curve be used (between 75 kc. and 85 kc.) that is linear. In the case of very strong signals being fed to the detection transformer, the point at which the curve bends over, points A and B, can be determined exactly, and the design of the transformer itself. If the incoming signal is too weak, however, the overall detection characteristic may appear as shown in the dotted curve, the point of bending occurring for smaller frequency departures due to lack of voltage at frequencies closer to the frequency than was previously the case. This can result in distortion on loud passages since the frequency swing is greater with greater amplitudes of audio voltage fed to the microphone at the transmitter. Note that this effect can occur only on weak signals where the operation of the limiter is not sufficient to maintain the input voltage constant over the range of frequency excursions encountered. Again it must be emphasized that the sharp I.F. system is in loss of high audio frequencies but rather in distortion with large volumes.

An interesting point in connection with the detection transformer is that it is possible to compensate with resultant audio signals at 3 points on the curve. These are point 0, the correct one, and points m and n on the tails of the characteristic. Point 0, the only one at which good noise reduction and high fidelity will be obtained. At this point also the greatest audio signal is obtained.

ALIGNMENT

The alignment of an F.M. receiver is similar in many respects to that of a high-frequency amplitude receiver. The intermediate frequency system may be aligned by simply adjusting primaries and secondaries of the I.F. transformers for maximum response at the correct I.F. If the design of the transformers is such as to give a single peak response, if the transformers are designed for double peaks, the alignment is considerably more difficult and the use of a frequency wobbler is indicated. The alignment of the R.F. and antenna systems is identical with that of an A.M. receiver. The antenna circuit should be aligned whenever possible with the antenna which is to be used with the receiver.

The alignment of the detection transformer which is the only real point of difference is made as follows:

1. Connect a high-impedance voltmeter or vacuum-tube voltmeter between point A of Fig. 2 and ground.

2. Put in an I.F. signal to the grid of the converter tube and, making sure that the frequency is exactly the correct I.F., adjust the primary trimmer, C2, of the detection transformer to give exactly zero voltage.

3. Change the input frequency to 75 kc. lower than the I.F. Note the reading of the meter.

4. Change the input frequency to a frequency 75 kc. higher than the I.F. To observe the reading of the meter it will now be necessary to reverse the terminals unless a center-scale meter is employed. Note the second reading of the meter. If the system is correctly aligned, the readings for plus and minus 75 kc. deviation will be exactly equal in value and opposite in polarity. If this is not the case, adjust the secondary trimmer, C3, of the detection transformer slightly and repeat the procedure until exactly equal voltages are obtained.

5. Adjust the input frequency to the exact I.F. and readjust, if necessary, the primary to give exactly zero voltage. The alignment is now complete.

In replacing components in the I.F. amplifier the same precautions should be taken as with the R.F. system. All replacements should be connected as nearly as possible in the same location and in the case of condensers the lengths of leads should be as near as possible like those of the removed condenser.

This article has been prepared from data supplied by courtesy of Browning Laboratories, Inc.

ENGINEERING

The Delaware River Joint Commission has asked the F.C.C. for permission to set up a 2-way radio system to facilitate bridge traffic control.

A large glass jar, in C.E.'s plastic research lab, at Pittsfield, Mass., for keeping a constant-temperature bath for measuring viscosity in plastic materials, had a tendency to collect scum, making the glass opaque. Cleaning the jar twice a week being a tedious job for chemist Samuel Johnson, he finally hit upon the use of 3 goldfish to eat the scum, upon which they seem to thrive.
Build this Practical

VIBRATOR TESTER

ROGER DICKERY

The past 2 years I have been using an oscilloscope to test vibrators. This method, although quite accurate, is very slow. Also, since the vibrator must be in the set to make the test, it has become a real problem with what the customers bring in just the vibrator to be tested (as they are accustomed to do with tubes).

Many good vibrator testers are available, but due to their complicated circuits, cost a little too much money for the average Serviceman to own.

After carefully studying the different types, styles and circuits used on all vibrators I worked out the circuit for the Practical Vibrator Tester here described. It has proved very successful. I do not claim it to be better than other testers, but it will do anything any other vibrator tester will do and is much less complicated.

The main features are:
(1) Sockets for all "plug-in" type vibrators.
(2) Tip-jacks to allow for special types—not "plug-in."
(3) Tests vibrator for its ability to start on low voltage.
(4) Meter indication of voltage at which vibrator starts.
(5) Tests vibrator for steadiness of output.
(6) Tests all vibrators under actual operating conditions.
(7) English reading Red (bad) and Green (good) scale for test.
(8) Tester has a single circuit-selector switch that makes proper circuit changes for various vibrators.
(9) A type switch changes circuit for interruptor- or synchronous-type vibrators.
(10) A minimum number of controls for making a quick and accurate test.
(11) Easy to construct.
(12) Inexpensive to build.

CIRCUIT

The unusual feature is the wiring of the sockets and the manner in which they connect to the rotating contacts of the 6-gang, 11-position switch. About 75% of all vibrators can be tested without even moving the circuit selector switch from the No. 1 position. This simplifies the switching necessary for making most tests.

In order to conserve space on my service bench the tester was combined with an A.C. power control panel which I remodeled at the time of building the vibrator tester. It would be a simple matter to build it to fit in a portable case.

The diagram and parts list are self explanatory. The 1½-ohm rheostat was placed in the "A-" lead to avoid insulating the shaft. Switch Sw.4 is a single-pole double-throw spring switch that remains in Position No. 1 until the button is pressed to make the test and then connections are as in Position No. 2.

The meter used was a 0-10 ma. instrument taken from an old tube tester. A 0-1 ma. meter may be used by changing the values of resistors R3, R4 and R5. Resistor R2 (5,000 ohms) places a load of 40 ma. on the vibrator at 200 volts which is approx. the same as when the vibrator is in actual operation in a receiver.

The only adjustment necessary on the tester is to use a new vibrator and adjust R1 until the meter reads 6V. Then press down test button Sw.4 and adjust R4 until meter reads exactly to the center of the green scale. The tester needs no further adjusting.

The proper test procedure is quite simple:
(1) Set selector switch and type switch to positions as given on chart.
(2) Place vibrator in socket shown on chart.
(3) Turn tester on and wait about ½ minute for the type 84 tube to heat up.
(4) Turn R1 gradually increasing voltage...
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- 3 Decibel Ranges: From -2 to +36 D.B., based on .006 watt in 500 ohms.

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until vibrator starts. A good vibrator will start at 5.2 volts or less.

(3) Set R1 until voltage is 6 volts, then push test button.

A good vibrator will read to center of green scale and the meter hand will remain perfectly still. If the meter hand fluctuates, or reads in the red sector the vibrator is "no good."

In compiling a test chart for the Practical Vibrator Tester it was found that there are 265 different part or type numbers used by 3 manufactures. Each one has a different number for the same type of vibrator.

There is no reason why the manufacturers could not agree on a standard numbering system. This list is presented here.

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Schematic circuit of the Practical Vibrator Tester which Servicemen and experimenters may wish to duplicate.
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SUPERIOR INSTRUMENTS CO. 136 Liberty St., Dept. RC-12 NEW YORK, N. Y.

BOOK REVIEW

TELEVISION BROADCASTING, by Lenox R. Lohr, President of the National Broadcasting Co., with a foreword by David Sarnoff (President of RCA), size 6¼x9¼, 274 pages: illustrated with diagrams and photos of actual television broadcasting, published by McGraw Hill Book Co., Inc. New York, 1940.

This is a very valuable book to the general student of television and it covers such interesting and vital subjects as the legal aspects of television service, the history of the pioneer in television, basic economic factors, the problem of network broadcasting for television, specific tests of aspects of outdoor television pickups, etc. Other topics discussed at length, in an authoritative, manner, are motion picture film television, diagrams showing how the images from the films are picked up by the iconoscope, etc. and a valuable section covers the production of studio programs, while the last appendix contains a typical television script, with production directions. To round out the book the author has included a chapter on the technical elements of television systems, with diagrams and photos.

THE NEW MODEL 1280 SET-TESTER

Complete A.C. and D.C. Voltage and Current Ranges.
- A.C. Voltage: 0-15, 0-150, 0-750 Volts.
- A.C. Voltage: 0-15, 0-150, 0-750 Volts.
- A.C. Current: 0-1, 0-15, 0-150, 0-735 ma.
- A.C. Current: 0-15, 0-150, 0-750 ma.

2 Resistance Ranges: 0-500 ohms, 500-5 megohms.

High and Low Capacity Scales: .0005 to 1 mfd. and .05 to 50 mfd.

3 Decibel Ranges.

-10 to +10.

-10 to +38, -10 to +57.

Inductance: 1 to 700 Henries.

Watts: Based on 6 MW, at 0 D.B. in 500 ohms .006000 MW to 600 watts.

ONLY $19.95

A NEW SUBSCRIPTION OFFER! See Page 362

FREE!
HAMMARLUND NEW '40' RADIO CATALOG

The latest Hammarlund catalog with complete data, illustrations, drawings and curves on the entire Hammarlund line. Address Department RC-124 for your free copy.
NEW Combination Tester

Combining simplicity of operation with absolute flexibility, Triplet’s new lever switching permits individual control for each tube element—yet test procedure is simple and quick. The switch setting shown above will permit tests of 45 commonly used different type tubes without change of position of the levers. Many tubes require only two lever switch settings—more than half, only three settings. Model 1183 is truly a Non-Obsolescent Tube Tester, combined with a Volt-Ohm-Miliamp-meter and Free Point Tester. Three fundamental testers that you can use for many years. Volt-Ohm-Miliamp-meter Ranges: 0—10-50-250—1000 AC and DC Volts; DC at 10,000 Ohms per volt; AC at 2,000 Ohms per volt. DC Milliamperes 0—1—10—50—25; Resistance 0—500 low ohms; 0—15000 Ohms; 0—1.5 and 0—15 Megohms. Complete Free Point Tester with sockets for all tubes, including new Midgets. Tube Tester has new lever type switch. Speedes Roll Chart, removable from panel as separate unit. Dealer’s Net Price $49.84

MANUFACTURERS’ TUBE REPLACEMENT CODES AND POLICIES

When servicing radio sets requiring tube replacements Service- men should be conversant with manufacturers’ guarantees.

All radio tubes used in Stewart-Warner (and other manufacturers’) receivers are guaranteed by their respective manufacturers and all adjustments made through the manufacturers on the basis of each maker’s replacement policy. Therefore, all returns of defective tubes must be made directly to the tube factories in accordance with their routines.

When returning defective tubes to the manufacturer, be sure to attach a tag or label describing the defect and stating the length of time the tube was in service.

The tube manufacturers code-mark the tubes to indicate the date of shipment and their warranty extends for a definite length of time after the code date. All tubes used in current model Stewart-Warner (and some other manufacturers’) receivers are guaranteed for 12 months after the code date. In addition, tubes sold to set manufacturers usually are coded ahead so that the warranty periods actually begins several months after the date of manufacture, thus allowing sufficient time for the set to go from factory to distributor to dealer to customer. For example, a tube shipped to us in July might be code marked August or September, and the warranty would then extend 6 months after the code date.

It is a good time for the set to move from the factory to consumer and still be in the code date warranty during the 90-day guarantee on the receiver.

Details of the Ken-Rad, Sylvania and Raytheon tube adjustment policies are exactly as shown in these policies are considered obsolete and free replacement will ordinarily be refused.

STEWART-WARNER CORP., Service Department.

KEN-RAD TUBE ADJUSTMENT POLICY

Ken-Rad Radio Tubes are guaranteed to be free from mechanical and electrical defects due to either workmanship or materials. All tubes not coming within this guarantee will be replaced provided return is made to the factory within replacement period. (See chart)

If adjustment is claimed on tubes out of replacement period they should be submitted to the factory for decision and must be accompanied by stickers (supplied on request), showing the user’s name and address, length of service and reason for claiming adjustment. Broken tubes or physically abused tubes (example, elements distorted due to rough handling, tubes with broken or missing base pins, etc.) are not subject to adjustment.

All Ken-Rad Tubes are code marked to indicate date of shipment from the factory. Tubes not coded, tubes coded with a single letter, and tubes coded AT to L7, M6 to Z8 and A9 to G9, are obsolete and are not subject to adjustment. Tubes which will operate but have given average life in service and tubes within reasonable limits should not be returned.

Description of Code Marking and Replacement Periods—Tubes claimed defective in warranty in accordance with the above policy will be replaced if returned during or prior to the months shown below.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Month to Replace</th>
</tr>
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<tbody>
<tr>
<td>J9</td>
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<tr>
<td>K9</td>
<td>July 1940</td>
<td>Oct. 1940</td>
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<tr>
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<td>Nov. 1940</td>
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<tr>
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<td>Sept. 1940</td>
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<td>Oct. 1940</td>
<td>Jan. 1941</td>
</tr>
<tr>
<td>P9</td>
<td>Nov. 1940</td>
<td>Feb. 1941</td>
</tr>
<tr>
<td>R9</td>
<td>Dec. 1940</td>
<td>Mar. 1941</td>
</tr>
<tr>
<td>S9</td>
<td>Jan. 1941</td>
<td>Apr. 1941</td>
</tr>
<tr>
<td>T9</td>
<td>Feb. 1941</td>
<td>May 1941</td>
</tr>
<tr>
<td>U9</td>
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<td>July 1941</td>
<td>Oct. 1941</td>
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<tr>
<td>Z9</td>
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<td>Nov. 1941</td>
</tr>
<tr>
<td>A1</td>
<td>Sept. 1941</td>
<td>Dec. 1941</td>
</tr>
</tbody>
</table>

SYLVANIA TUBE ADJUSTMENT GUIDE

Guarantee—Sylvania radio tubes are guaranteed to the consumer for 6 months from date of purchase, which is accomplished by a guarantee enclosed in every Sylvania sealed carton, and which, to be effective, must be properly filled out by the retailer at the time of sale.

Sylvania retailers are authorized to accept adjustment of any alleged defective Sylvania tube presented by a consumer, if it is accompanied by the identical guarantee form indicating purchase less than six months prior. Tubes not accompanied by proper guarantee are subject to adjustment as provided for by the code date etching as described under “Obsolescence Schedule.”

Instructions—Sylvania tubes may be submitted for adjustment only by authorized Sylvania jobbers. If it shows any defective tubes for adjustment once each month. All return shipments must bear Sylvania return authorization labels, available on request. Tubes received from retailers will be returned without inspection to the retailer, transportation charges collect. Transportation charges on all return shipments must be prepaid. We, in turn, will make the proper adjustment with the Sylvania’s return. All tubes proven subject to adjustment, in accordance with our guarantee and this guide, will be replaced type for type. The option to issue a merchandise credit memorandum to the value of the tubes found subject to adjustment, computed at current prices, is reserved.

It is suggested that full details regarding unusual defects be supplied when tubes are returned for adjustment, to avoid improper handling and delay.

Obsolescence Schedule—Sylvania radio tubes automatically become obsolete and not subject to adjustment, depending on code dates, as outlined in the following schedule:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Month to Replace</th>
</tr>
</thead>
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<td>Z-19</td>
<td>Jul. 1, 1941, 1, 9</td>
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<tr>
<td>20</td>
<td>Z-20</td>
<td>Oct. 1, 1941, 1, 9</td>
</tr>
<tr>
<td>21</td>
<td>Z-21</td>
<td>Jan. 1, 1942, 1, 9</td>
</tr>
</tbody>
</table>

Tubes Not Subject to Adjustment

The new model 1183 Triplet combination tester is manufactured in accordance with this guide.

RADIO-CRAFT for DECEMBER, 1940
BUY DIRECT FROM THE MANUFACTURER AND SAVE

THE NEW DYNAROMETER

Features New Giant 8½" Double Jewelled Meter

This amazing versatile instrument is our answer to the demands of radiotechnicians for a combination instrument which, in addition to making the usual V.O.M. measurements, will also permit DYNAMIC D.C. VOLTAGE MEASUREMENTS without interfering with or affecting delicately balanced circuits, such as tuned circuits, electronic apparatus, control voltages, etc. Actually, as you will note from the specifications listed below, the DYNAROMETER is a combination Vacuum-Tube Voltmeter and V.O.M. besides permitting additional measurements such as Capacity, Decibels, Inductance, etc. All calibrations printed in large, easy reading type on the giant 8½" double jewelled meter. The Input Impedance for the V.O.M. is 10,000,000 ohms with 2,000,000 ohms per volt on the lowest range. The 4 V.T.V.M. ranges are 3, 25, 100 and 500 Volts, and because of the zero center no attention need be paid to polarity since the meter will read either in the plus or minus direction, depending on the position of the probes.

HAYE YOU EVER—

Tried to measure Control Voltages such as A.V.C., A.F.C., oscillator, etc. Impossible with the ordinary V.O.M. due to leading of the circuit? But the 11 megohm input impedance of the DYNAROMETER enables measurements without distortion at any point in the receiver.

Tried to locate distortion in the audio section of a receiver? A long tedious job with the ordinary V.O.M. but almost instantaneous with this new DYNAMIC method of testing.

Tired to isolate the cause of trouble in an intermittent job? A cinch with the DYNAROMETER. Extreme sensitivity and flexibility enable speedy measurements at points usually impractical when using a standard MULTIMETER.

SPECIFICATIONS:

D.C. VOLTS RANGES AT 11 MEGOHMS INPUT:

D.C. CURRENT MEASUREMENTS IN 4 RANGES:

RESISTANCE MEASUREMENTS IN 3 RANGES:

The DYNAROMETER operates on 90-120 Volts 60 cycles A.C. Comes complete with test leads and all necessary instructions. Shipping weight 29 lbs. Size 13½"x8½"x2½". Our net price

SUPERIOR INSTRUMENTS CO.

136 Liberty St., Dept. RC-12
NEW YORK, N. Y.

BOOK REVIEW

The Best Book on Sound!

See Page 356


Latest addition to the Radio-Craft Library is book No. 24 which is a complete treatise on the subject of auto-radio covering all phases from installing and servicing to maintenance. We quote from the author's preface: "... this is a practical treatise based on practical experience by practical radio people for the practical radio technician, who is sometimes a novice and sometimes a dozen years in the engineering but is primarily interested in the practical end of the art."

Chapter headings: Introduction—The Auto-Radio Art; Features of the Modern Automobile Receiver; Installation of Automobile Radios and Antenna; The Automobile High- and Low-Tension Electrical Systems; Automobile Electrical Disturbances; Vibrator Converters and Motor Generators; Service Hints, Classified Automobile Installation Notes, and Conclusion.
**25-RANGE TEST METER**

This article tells Servicemen and experimenters how to make an efficient multi-range meter. The design is so simple the average beginner will have little difficulty duplicating this comparatively inexpensive A.C.-D.C. instrument.

MILTON REINER

The meter unit described here is one which combines wide utility with good engineering design, economy and simplicity of construction. It is an instrument which will prove decidedly useful to the most experienced Serviceman or experimenter, and yet is so simple to build that it is well within the ability of even the beginner.

Because there has been an insistent demand for a simple instrument in kit form, especially from beginners who are after the utmost economy, and the experience of “rolling their own,” this model has been made available either as a complete kit, or in the form of a foundation D.C. kit to which the necessary parts to convert it to A.C. measurements can later be added.

The completed unit provides a wide variety of measurements as follows:

- **D.C. voltage:** 0-5/50/250/500/2,500
- **D.C. milliamperes:** 0-1/10/100/1,000
- **A.C. voltage:** 0-10/100/500/1,000
- **Resistance:** 500 ohms/0.1-10 meg.

Output ranges: Same as A.C. voltage ranges.

**UNIVERSAL MULTIPLIERS**

Where A.C. and D.C. measurements are to be made with the same meter, complications are introduced by the fact that when an instrument rectifier is inserted in the meter circuit for A.C. measurements it has the effect of changing the inherent sensitivity and resistance value of the meter. It is therefore necessary either to use different sets of multiplier resistors for the A.C. and D.C. voltage ranges, or to provide some form of correction.

With the copper-oxide type of rectifier, meter sensitivity is reduced nearly 60% and actually becomes about 420 ohms-per-volt for A.C. measurements, as compared with 1,000 ohms/volt for D.C. In spite of this, the same multipliers can be used for both.

This is accomplished by reducing the effective sensitivity of the meter circuit during D.C. voltage measurements by shunting it with the proper resistance value. It need not be brought down to a sensitivity of 420 ohms/volt, but only to twice this value, or 840 ohms/volt. Obviously this reduction from 1,000 to 840 results in somewhat greater loading of circuits under measurement but the slight difference is of no great importance. If a circuit under measurement has a resistance value of 10,000 ohms, for instance, and its voltage is to be measured on the 100-volt range of the meter, the loading effect of the meter will be only 1.6% greater if its resistance is 84,000 ohms than would be the case were its resistance 100,000 ohms (0.1-meg).

With a shunt value selected to reduce meter sensitivity to 840 ohms/volt, and using the same multipliers for both A.C. and D.C. measurements, the A.C. range of a given multiplier will be double that of the
D.C. range. Thus the multiplier in the 5-volt D.C. range will provide a 10-volt A.C. range, etc. The same multipliers, terminals and even meter scale therefore serve for both A.C. and D.C. voltage measurements. The only requirement is that when going from one to the other is to insert (by switching) the rectifier for A.C., and the shunt for D.C.

D.C. CIRCUIT

An interesting arrangement is that employed for direct current measurements. In analyzing this, the circuit of Fig. 1 with all parts eliminated which do not pertain to this type of measurement.

Here we have all the current shunts joined together to form, with the 100-ohm meter, a closed circuit with resistance of 620.3 ohms. From this any desired current range can be obtained by simply inserting one test probe in the "Common" jack and the other in the jack representing the desired range. No switching is required in changing ranges. Thus, when the probe is inserted in the "10 Amp." position, the current under measurement will divide between 2 paths, one including only R1, the other including all other resistors and the meter. The meter path will have a resistance of 620.26 ohms while the shunt path (R1) is only 0.006 ohm. This is a ratio of very close to 10,000 to 1, therefore the original meter range of 1 ma. is multiplied 10,000 times, giving readings up to 10 amperes. (Actually a shunt multiplies the original meter range by the ratio of the resistances plus.)

When the probe is inserted in other ranges, the shunt branch increases in value while the meter branch decreases, thus reducing the ratio and decreasing the current range.

The total value of resistance in Fig. 2 is not important so long as the proper ratios are maintained. A figure of 626.3 was selected in this case because this is the correct shunt value to provide the 50-ohm/volt sensitivity discussed earlier. This shunt network is therefore left in the circuit not only for all current measurements but also for D.C. voltage measurements, and switching operations are therefore greatly simplified. In addition, construction is considerably simplified by avoiding separate shunts for each current range, and separate multipliers for A.C. and D.C.

Because many beginners are likely to be interested in this instrument it is felt that a study of the foregoing discussion will help to provide a better basic understanding of meter circuits, etc.

Figure 3 shows the arrangement employed for D.C. voltages. The 5 tip-jacks provide 5 ranges. Multiplier values are determined on the basis of 840 ohms/volt sensitivity as discussed earlier. Thus at the 5-volt jack the resistance is 1,417 ohms, plus that of the meter (and its shunt which reduces the meter resistance from 100 to 83 ohms), or a total of 2,200 ohms. At the 50-volt jack the resistance is 42,000 ohms, etc.

A.C. CIRCUIT

In Fig. 4 is shown the A.C. voltage circuit. This is similar to Fig. 3 except that the shunt network is switched out automatically and the rectifier cut-in when the selector switch is set for A.C. measurements. The rectifier is of the copper-oxide half-wave type with provision, for bypassing the reverse peaks to avoid the development of unsafe voltages across the rectifier during use of the higher voltage ranges.

Figure 5 is the circuit arrangement when the selector switch is set for "Lo" ohms measurements. The meter is shunted to provide a 10-ma. range and the variable resistor adjusted until the meter reads full-scale. Any resistance connected between the "Common" and "Lo" terminals will set the meter to a value where and reduce its reading accordingly. Readings down to 0.2-ohm are obtainable with this arrangement and are read directly on the special "Lo" ohms scale on the meter.

The circuits employed for the 0.1-meg. and 1 megohm ranges are shown in Figs. 6 and 7. These are the conventional set of circuits and are similar except that in the lower one the 10-ma. shunt is used and the limit resistors are lower in value. The kit's engraved and punched panel greatly facilitates the correct assembly of the parts. Because the 14 tip-jacks are supplied with self-locking mounts, the entire assembly of panel parts can be completed in perhaps 15 minutes. All resistors are mounted directly on the terminals to which they connect. The meter rectifier is supplied with a bracket which is mounted on one of the meter terminals.

List of Parts

One Radio City milliammeter, model 446.
One 0-1 ma., 100 ohms. 5-in.-sq. bakelite case.
One Radio City panel, 8 x 4½ ins., etched, engraved and punched.
One Radio City 2-gang, 10-point rotary switch.
One Radio City instrument rectifier for No. 446 model.
One Radio City special-taper rheostat, small type, 2,500 ohms.
Twelve Amphenol insulated tip-jacks with self-blocking mounts, red.
Two Amphenol insulated tip-jacks with self-blocking mounts, black.
One Radio City wood instrument case, polished hardwood, to take above panel; has built-in compartment for 3 flashlight cells.
Three 1/4 V. large-unit flashlight cells.
One pair test probes, insulated handles (not supplied nor essential to kit).

RESISTORS

One RCP shunt, 0.063-ohm (bare Mangano wire);
One Radio City, 0.563 ohms, flexible;
One Radio City, 5.63 ohms, flexible;
One Radio City, 56.37 ohms, flexible;
One Radio City, 335 ohms, flexible;
One Radio City, 463.7 ohms, flexible;
One Radio City, 1,117 ohms, flexible;
One Radio City, 4,117 ohms, carbon;
One Radio City, 3,350 ohms, carbon;
One Radio City, 840 ohms, carbon;
One Radio City, 0.168-meg., carbon;
One Radio City, 0.21-meg., carbon;
Two Radio City, 0.84-meg., carbon.

As of unanswerable questions.

This article has been prepared from data supplied by courtesy of Radio City Products Co.
NO. 12

A 6V6G INVERSE-FEEDBACK AMPLIFIER

**The Question . . .**

I have use for several amplifiers having the following qualities: high fidelity, inverse feedback, adaptability to phonograph and radio tuner, no tone control, and a single 6V6G in the output stage, for 115 Volts A.C. operation.

I would greatly appreciate a diagram on the construction of such amplifiers.

**Arnold Klein,**

Bronx, New York

**The Answer . . .**

A circuit diagram of the type amplifier you desire, is indicated in Fig. 1. This circuit follows conventional design throughout the amplifier proper. A resistance-isolated mixing circuit is employed for extreme simplicity. Independent controls are provided for both your radio and input.

The inverse feedback is looped from the voice coil winding of the output transformer to the cathode of the 1st stage. This particular arrangement is most effective when properly employed. It may be necessary for you to reverse the primary or the secondary of the output transformer in order to obtain correct phase relationship for inverse feedback. The value of Rx will be dependent upon the amount of feedback you desire, as well as the impedance of the voice coil winding. You could start with a value of approximately 10,000 ohms. The amount of feedback will be controlled in the series cathode circuit of the first stage. The exact amount of feedback incorporated into the circuit can easily be measured by connecting a high-resistance output meter across the voice coil winding, and feeding 1,000 cycles into either the phono or radio input. As the 1,000-ohm control is turned up, the output level should drop. The amount of drop in db, is equal to the feedback in db. incorporated into the circuit. At least 8 or 10 db. of feedback should be incorporated in order to provide any degree of compensation for frequency discrimination of the output transformer, speaker, and output stage.

All resistors, excepting those otherwise marked, are of the 1/4-watt type. Chokes Ch.1 and Ch.2 could be identical units capable of handling 75 ma., each having an inductance of approximately 10 henries. The output transformer should be of a reasonably good quality in order to handle the desired power without introducing excessive distortion.

No particular precautions are necessary in the construction of this amplifier. Reasonable care should be exercised in the placement of the 1st stage and its associated input controls and components, so as to avoid hum pick-up.

3-CHANNEL PREAMPLIFIER—CRYSTAL MICROPHONES IN PARALLEL

**The Question . . .**

I would appreciate it very much if you could supply me with a crystal microphone preamplifier circuit having 3 microphone inputs. Each input should have a separate volume and tone control. Also please include a method of connecting this preamplifier to the phonograph input of an 85 to 150 watt amplifier. The unit should be self-powered from a 110-volt 60-cycle line. Hum should be kept as low as possible.

What loss, besides decreasing the volume in half, occurs when 2 crystal microphones are connected in parallel?

**Robert Mitchell,**

Chicago, Ill.

**The Answer . . .**

A schematic circuit of a 3-channel crystal microphone preamplifier with independent volume and tone controls for each channel is indicated in Fig. 2.

As you did not mention the exact type of tone control you desire, I have taken
it for granted the popular high-frequency attenuator type is desired. If additional high-frequency attenuation is desired, the 0.001-mf. condenser in the tone control circuits may be increased to 0.001-mf. On the other hand, if excessive H.F. attenuation is prevalent, these condensers may be reduced to 100 mmf. The isolating 1/4-meg. resistor, in series with the center arm of each volume control, provides 2 desirable functions: (1) It prevents interaction of tone control, so that should one channel be set for maximum high-frequency attenuation, the other channels will not be affected; (2) It prevents appreciable interaction of volume control circuits. Adjusting one control from maximum to minimum attenuation will change the input signal at the 6SF5 tube by less than 2 db.

As you did not include a circuit diagram of your 65-150 watt amplifier, it is impossible to give you a specific output circuit adapted to your phono input. It is assumed however, that your amplifier input is of the high-impedance type. If such is the case you can couple the high-impedance output of the preamplifier directly into the high-impedance amplifier input.

Chokes Ch1, Ch2 and Ch3 should be capable of carrying 10 milliamperes and be capable of developing an inductance of approx. 30 henries. All resistors are of the 1/2-watt carbon type unless otherwise marked. The power supply should be capable of delivering 250 volts at approximately 5 ma. In constructing this unit, care should be exercised in keeping the chokes away from any of the preamplifier tubes so as to avoid inductive hum pick-up. It will also be necessary to carefully place all components of the 1st stage circuit away from any hum-producing source. All leads should be kept as short as possible. Shielding should be employed at the input grid circuits.

When 2 microphones are connected in parallel, a number of unusual conditions, other than a decrease in volume, may become apparent under actual working conditions. If both microphones are not in-phase, the outputs of the microphones will cancel each other. This is particularly noticeable when the sound wave is equidistant from each microphone. If the microphones are in-phase, but at unequal distances from the sound sources, a peculiar type of frequency discrimination may become apparent. Assuming that the speed of sound is 1140 feet per second, it is apparent that a 1,000-cycle tone will have a wavelength of 1.14 feet. This means that the distance between the maximum possible sound pressure and the minimum sound pressure would be separated by a distance of 1.14 feet. If a microphone is placed, let us say, 3 feet from a sound source, and another one (in-phase) 4.14 feet from the same sound source, it is obvious that one microphone would be producing its maximum positive voltage, while the other would be producing its maximum negative voltage, the combined output of which may approach 0. This condition would be prevalent at discrete frequencies only, and can easily be detected when sound measurements are made in an open area where reflections do not tend to balance these antiphase conditions.

There are a number of other undesirable conditions, brought about by paralleling crystal microphones, which are too involved for adequate discussion in this department.

NEWS SHORT

U.S. Patent No. 2,009,971 describes the use of a variety of sound pattern of opaque metal (an electroplating?), on a transparent material, for grainless reproduction by means of a photocell and amplifier.

SOUND

IT'S RCA FOR UNMATCHED QUALITY...UNBEATABLE LOW PRICES!

Your BEST Bridge Between Amplifier and SOUND!

RCA QUALITY SPEAKERS

YOUNOW...and we know...

that sound reproduction quality is more often marred by the speaker than by any other element in the system! That's why good speakers are your best Sound Investment!

Who makes the best speakers—RCA. Why—Because the extensive research of the greatest name in radio has found the best answers to problems of speaker design and manufacture. When you buy a modern RCA Speaker, you buy low distortion—for extra clarity in speech and music. You buy uniform, extended frequency-response—for higher fidelity. You buy higher audio-to-sound conversion efficiency—for greater coverage with smaller amplifiers...for more actual Decibels from your Watts!

And because of the tremendous mass-production facilities of RCA, prices are pleasingly low! Believe your ears—hear RCA Speakers at your RCA Distributor's this week!

SLIPS THAT PASS IN THE MIKE

Mel Allen: "It's Snipe Poking Time, Gentlemen!"

P. D. Floyd (off-air): "This is the Musical Broadcasting System. (Neale announces all of WOR-Mutual's many important concert programs.)"

An unidentified N.B.C. Chicago mikeman: "This is the National Biscuit Company."

Art Whiteside (presenting the Crown Prize of Norway): "Today it is our extreme pleasure to introduce the Brown Quince of Norway."

And then there's the story they tell about a veteran radio editor and crackerjack radio interviewer, who began one of his interviews with the question: "Tell me, Miss So-and-So, what was the dirt of your birth?"
A New A.F.-Drift Correcting, Signal-Balancing, Direct-Coupled
F.M. AUDIO AMPLIFIER

This circuit achieves remarkable results (Frequency Response—13 to 30,000 cycles ±1db.; Noise Level—at least 75 db. below rated power output; Distortion—1% total harmonics at average working level). It includes a novel D.C. balancing arrangement, A.C. balancing circuit and push-pull balanced feedback, all of which provide marked reduction in tube noise and hiss, and a wide range response, as well as sufficient clean power output to provide distortionless high- and low-frequency amplification beyond requirements set for F.M. transmitters.

A. C. SHANEY

PART I

A Letter from the Author

Dear Editor:
The development of this stabilized push-pull Direct-Coupled Frequency Modulation Amplifier has convinced all technicians who have studied, and checked the performance of the circuit, that we have finally removed the last obstacle for universal application of Direct-Coupled Amplifiers. In fact, our development (patent applied for) has over-shot our desire to make the stability of this model at least equal to standard resistance-coupled circuits. In a conventional push-pull resistance-coupled amplifier, signal imbalance between each side of the circuit is carried through and finally cancelled in the output transformer. This condition introduces an unbalanced push-pull action and is usually encountered to a varying degree, in all standard resistance-coupled amplifiers. In our attempt to balance the amplifier for variations of plate current in push-pull tubes, we found that we had also developed a circuit which would stabilize for variations in tube gain. The revolutionary circuit arrangement provides for balancing of the signal circuit in the preamplifier stages long before it reaches the output transformer. Aside from the advantages gained by an extended frequency response range, and very low noise and hum levels, this A.C. balancing circuit makes this general type of amplifier far superior to any standard resistance-coupled unit.

A. C. SHANEY

P.S.—Although this particular amplifier was designed for F.M. applications, your readers should not construe this as limiting the application of the unit for this purpose only. Its exceptionally fast response, low noise level, and no effective distortion, makes it admirably adapted for any other application which would normally require a high-quality laboratory amplifier.

P.P.S.—My associates have named this unusual balancing circuit “The A. C. Shaney Balancer.”

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the largest manufacturers of transmitters guarantees the following audio characteristics:

(1) Frequency Response—Flat ±1 db. from 30 to 15,000 cycles.
(2) Noise Level—70 db. below full modulation.
(3) Distortion—Less than 2%, total harmonics.

It was therefore decided to anticipate a reasonable amount of improvement and design this F.M. amplifier so as to prevent obsolescence. The following tentative specifications were set:

(1) Frequency Response—±1 db. from 13 to 30,000 cycles.
(2) Noise Level—At least 75 db. below rated power output.
(3) Distortion—1% (at average working level), total harmonics.

With an amplifier of this type, it was felt that an ultimate consumer would ever have to worry about having the “bottle neck” of an F.M. program in his audio amplifier equipment.

Furthermore, reasonable improvements in F.M. transmitters (based on similar improvements which have taken place in A.M. work) will provide direct benefits to the listener.

SELECTING THE FEATURES

The Equalizer

Oftentimes, it would appear that an F.M. amplifier should be built to meet ideal requirements and have unvarying characteristics. In other words, the amplifier should be devoid of high-frequency or low-frequency controls. Referring to the requirements set by the F.C.C., it will be noted that provision must be made in every F.M. transmitter to pre-emphasize high frequencies. This means that high frequencies will be accentuated during transmission. The purpose of this pre-emphasis is to attenuate residual atmospheres.

As disturbing effects of atmospheres are predominant in the higher audio frequencies, it is logically assumed that accentuation at the transmitter and attenuation at the receiver will ultimately result in a flat overall response and at the same time, materially attenuate atmospheres. This is graphically illustrated in Fig. 1.

If we assume that a high-frequency program signal has a level of +20 VU and it is pre-emphasized to a level of +23, this signal will be received along with an atmospheric disturbance of say +20. Hence, without pre-emphasis, the original program signal and the atmospheric will be of equal intensity.

On the other hand, pre-emphasis has already made the program signal appreciably higher than the atmospheric. By attenuation in the receiver, the program signal is brought back to its original level of +20 VU, and the atmospheric is reduced 3 VU. The degree of attenuation of disturbances is a function of the pre-emphasis at the transmitter.

From a casual study of this operating procedure, it would appear that a high-frequency attenuator is the only required control of the receiver. A study of existing deficiencies in present receivers, however, will
clearly indicate that both the high and low frequencies should be independently controlled, and the control range should provide for both attenuation and accentuation. Another very desirable characteristic in the equalizer circuit is to have it exactly complement the equalizer used at the transmitter or in the recording studio (for recording programs). The equalizer should not introduce harmonics, hum, or resonant peaks in any portion of the spectrum.

The VU Meter

It was also considered desirable to have a visual monitoring arrangement so as to indicate normal, average, and peak levels of the program. This auxiliary feature is high and low overload protection. The limit is required to avoid overload of either the amplifier or the loudspeaker. Low-frequency speaker overload is usually judged from a distortion viewpoint; because the intensity of the signal cannot be accurately judged in view of the fact that the ear is comparatively insensitive to low frequency critical lines, therefore, will detect overload at low frequencies. The use of the meter, however, makes it possible for any average in-dielectric to adjust the sensitivity of the program level so as to definitely prevent overload at any frequency. Furthermore, it becomes relatively simple to determine just what actual effect the various settings of the equalizer controls have upon the overall program level.

Dual-Channel Input and Electronic Mixer

In order to extend the usefulness of this Direct-Coupled F.M. Amplifier, it was considered desirable to incorporate an additional input circuit so that photograph recorders, in addition to F.M. transmissions, may also be enjoyed.

A dual circuit input could most economically be employed by the use of a change-over switch, but inasmuch as the average volume level of the radio program and the recorded program may be different (and therefore necessitate a continual change), it is more desirable to incorporate an electronic mixer. This provides 2 entirely independent input channels with independent gain control so that each channel may be set for ideal results. Furthermore, the use of the electronic mixer insures complete isolation of both controls, so that they do not affect each other. The various frequency response characteristics of its associated channel.

Details covering the design of these 3 features will be described in Part II of this article. A block diagram which shows the relative position of the various features is given in Fig. 2.

THE AMPLIFIER

In order to more fully understand the advanced design principles incorporated in this unusual Direct-Coupled F.M. Amplifier, it is suggested that the reader refer to the previously-published data.*

As all of the several 10-, 20- and 30-Watt Direct-Coupled Amplifiers previously described in this magazine have been designed around an effective drift-correcting circuit, no immediate improvement in stability seemed apparent. Subsequent investigation disclosed that unusual differences in plate resistances of the input tubes affected the performance of direct-coupled amplifiers more than resistance differences in plate-coupled units. This difference in effect was

*See the July, 1939, issue of Radio-Craft, pg 14, for the elementary principles involved in the design of direct-coupled amplifiers.

SUPREME 504

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As a tube tester, merely rotate the smooth acting roller chart to the type desired and "follow the row." Leakage tests are equally simple. With the same set-up just press one button after another on the right hand side of the panel.

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**SOUND**

*See the October, 1939, issue of Radio-Craft.

augment the bias of the output tubes, so as to compensate for variations in output plate current.

In Fig. 4, as the elements of a revised single-ended direct-coupled amplifier, Rp is the plate resistance of the voltage amplifier and Rk is the partial cathode resistor of the grid-dropping resistor.

Figure 5 shows the basic balancing circuit originally conceived to automatically compensate for both variations in plate resistance of the input tube V1 and output tube V2. It will be noted that V3 is used as a plate load resistor for V1. The bias for V1 is set on the plate current flowing through its cathode resistor R2. The time-delay constant of R1, C1, prevents signal frequencies from affecting a change in the plate resistance of V3, and limits automatic adjustments only for "steady state" or average conditions; V4 was to be used as a shunt across Rk, so as to keep the bias against Rk constant.

This circuit is likewise made responsive only to steady state or average unbalance, by inserting a time delay through the resistor-condenser network R2-C2.

Inasmuch as the final amplifier was to be push-pull throughout, 4 additional tubes would be required for the balancing action. The added expense and complexity of this circuit inspired additional research to produce a simpler and more economical circuit to achieve the desired result.

A side project was started to adapt the use of the twin indicator (6AF6G) through a twin-triode amplifier (68CT7), so arranged as to measure the voltage drop across the balanced primary winding of the output transformer. A special transformer was wound so that both sides of the primary were of equal D.C. resistance (and equal A.C. impedance). The idea behind this development was to provide a partially automatic check on the visual check on the visual appearance of the output tubes so that should greatly unbalanced tubes be used, it would become immediately visible, and the tube would provide for readjustment. It was found, however, that the indicator with its associated amplifier was too insensitive for the average user to adjust within a 10-ma. balance. The circuit was the simplest possible, as it is given in Fig. 6 for the benefit of some readers who may have other applications in mind than this particular one. The condenser-resistor network R1-C1 provides a time delay to prevent A.C. potentials from having any effect upon the twin-eye indicator. A novel part of the circuit is the fact that raw A.C. is applied to the plates of the indicator. The flicker is not observed because of the persistence of vision of the eye which will tolerate interrupted images down to about 16 cycles before flicker becomes visible.

The easiest way to understand the action of the final D.C. balancer is to substitute a resistor (rl) for the plate load and another (rp) for the plate resistance of the voltage amplifier (as in Fig. 7). This D.C. voltage (E) is applied across the network, which provides a fixed D.C. voltage to the plate of the tube and is dependent upon the voltage drop across rp. If rp is varied from zero to infinity, the voltage will vary proportionately. The ratio of voltage change will depend upon the ratio of rl to rp.

If rl is made large in comparison to rp, the ratio of change will be small. If an additional resistor (rc) is inserted in series with both rl and rp, as indicated in Fig. 8, then the effective voltage E'dc would be equal to

\[ E = \frac{rl + rp}{rc + rl + rp} \]

The push-pull version of this circuit is indicated in
Fig. 9. If we neglect \( r_k \) (which is very small) the voltage which appears across \( r_1' + r_p' \), is equal to \( Bdc \) which can be calculated from

\[
Bdc = \frac{(r_1' + r_p') (r_2' + r_p')}{r_c + \frac{r_1' + r_p'}{r_1') + \frac{r_1' + r_p'}{r_1}}
\]

If \( r_1' \) is 100,000, \( r_c \) is 500,000, and \( r_1' \) varies from 800,000 to 120,000 (which represents a \( \pm 2 \) variation of approx. \( 20\% \)), it will be found that the percentage of change at \( Bdc \) is 1.9% as compared to a 4% change which would take place under conditions of Fig. 7. In other words, a 50% correction is affected. If the same type of network is applied to the screen grids of the driver tubes, as indicated in Fig. 10, still more correction is affected.

The practical value of this self-balancing circuit can best be indicated by referring to laboratory data compiled during its development. A total of 100 average B817 tubes were checked for the maximum deviation they produced in the output plate circuit of the 6L6G's. Two sets of the worst combination produced the following results:

<table>
<thead>
<tr>
<th>Unbalanced Tube Numbers</th>
<th>Unbalance in dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 and 2</td>
<td>61 ma</td>
</tr>
<tr>
<td>1 and 3</td>
<td>68 ma</td>
</tr>
</tbody>
</table>

When these same tubes were inserted into the balancing circuit, the following results were noted:

<table>
<thead>
<tr>
<th>Unbalanced Tube Numbers</th>
<th>Unbalance in dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 and 2</td>
<td>8 ma</td>
</tr>
<tr>
<td>1 and 3</td>
<td>8 ma</td>
</tr>
</tbody>
</table>

As the D.C. balancer becomes an integral part of the A.C. balancer circuit as well, it was necessary to select optimum resistor values which would provide a minimum D.C. unbalance and minimum A.C. unbalance. The design of the A.C. balancer circuit will not be covered here because of lack of space but will be discussed in Part II.

**CASE HISTORIES OF P.A. SALES**

**No. 12—Funeral Parlour Sound System**

Few sound Servicemen, I believe, have taken advantage of a very profitable outlet for their sound systems. This use—rental to funeral directors to accommodate overcrowd situations—has brought in several extra dollars and much valuable advertising in the way of satisfied customers and interested attendants; often a worthwhile sale may be made. I have had 2 of this type of rental in the last 2 months. Of course every funeral has not an overflow attendance. I will refer to an installation I made some time ago.

A very prominent physician in my town was killed in an auto accident. On the evening before the funeral, the minister and undertaker came to me and asked to have the outside lawn and sidewalk covered with a public address system. I set up at 10:00 A.M. in order to be out of the way of the early visitors. The church is small and holds 250; a conservative estimate of the number outside the church was about 200. Everyone outside heard perfectly and persons standing in the vestibule told me they noticed no cut-off or dead spots between the minister and loudspeakers. An outside listener remarked that a soprano soloist sounded as beautiful outside as she ordinarily did inside. The family, minister, friends and undertaker are thoroughly pleased; the undertaker has promised me his future business in this line.

A very vital technical problem on an installation of this type is the monitoring and placement of the microphones. A loud blast of a loud-voiced minister or singer would immediately ruin the service and also the sound man's reputation.

To solve this problem, only 1 dynamic microphone was used. This mike was placed about 5 ft. from the pulpit and 8 ft. from the choir and singers. Thus I eliminated the possibility of blasts into the microphone and also enabled the use of but 1 microphone and 1 long line.

It was decided that the best place to monitor was at the loudspeakers. A table was set up on the lawn, next to the building and at a moderate distance from the speakers, and the amplifier placed there.

As the end of each solo or talk, I lowered the decibel gain to a low value for a moment in order to obtain the new volume level and avoid a disagreeable blast.

Very little adjustment of the controls was found necessary. In tests, no feedback was encountered with gain off full. The church is located on a corner; I set the loudspeakers at right angles (see illustration), and secured perfect coverage at a very moderate level—about 4 watts on each speaker. The speaker cables were suspended 10 feet above the walk and laid along the curb in the street in order to eliminate hazards of tripping. Large, infinite-baffle speakers were used for the sake of portability, appearance and high-fidelity reproduction.

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A Resume of the Contents of the AMPLIFIER HANDBOOK
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Effect of mismatching speakers to amplifier output
A typical P.A. installation (in a skating rink)
SECTION V—USEFUL PUBLIC ADDRESS DATA AND INFORMATION
Speak matching technique
The ABC of DB, VU, Mu, Gm and Sm
Charts and formulas useful to the practical P.A. sound man
Handy index to important articles on public address and sound

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RADIA^-CRAtT for DECEMBER, 1940
chuch or mortuary before and after the service, but if music is desired, an extra mike may be used to pick-up soft organ music; or recordings may be played. It is important to have a correct, not-too-loud volume level.

If organ, singer or minister is located too far from the microphones, severe audience noise may occur. If these 3 sound sources are not in a radius of 8 or 9 feet, several microphones should be used; semi-directional mikes work best.

Here's hoping that other sound men will find this unusual use for their equipment as worthwhile as I. I charge $6 to $12 for this service, depending upon the equipment used, the size of the funeral and the time spent. Of course, contacts must be made through the funeral directors.

The parts list and the specifications of the public address system, and a rough sketch of the set-up, are given here.

I have found that a supply of several dozen screw-hooks and eyes are very handy to use to hang power and speaker cables to keep them in a neat position when on a portable job.

My amplifier I consider quite unique as well as original. It has 2 mike channels, a phone input and a combination phone or all-wave Tube Tuner. The radio receiver may be tuned-in with earphones and electron eye independently of the amplifier, i.e., with the amplifier public address system in operation. I use this feature to tune-in favorite dance bands while playing recordings for dances.

The amplifier consists of 10 tubes; the receiver has 8. Two separate power supplies are used, one for the output tube plates only. The hum cannot be heard at a distance of 10 ft. in the living room of my home. It has 5 inputs, adjustable line and voice coil outputs and adjustable 500-ohm line permanent-magnet speakers. The output uses two 6BSs at 425 V. for 20 W high-fidelity output. Provisions are made for decibel meter and headphone monitoring. The mixer is a 4-channel electronic circuit. High- and low-pass filters are to be added very soon.

Approximate net cost of equipment less labor, $220; retail value, not less than $360. All parts are the highest quality of standard grade.

A complete set of extra tubes for the amplifier is carried at all times as a safety factor.

Parts List

<table>
<thead>
<tr>
<th>Parts List</th>
<th>list price</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Dynamic mike, model D-5-T</td>
<td>$32.50</td>
</tr>
<tr>
<td>Astatic Tru-Tan phone pickup, model B-10</td>
<td>17.50</td>
</tr>
<tr>
<td>Green Flyer motor, model A</td>
<td>13.25</td>
</tr>
<tr>
<td>Shure mike stand, model S-51</td>
<td>12.50</td>
</tr>
<tr>
<td>Two Wright-DeCoste P.M. speakers, 15-watts, @ $22.50</td>
<td>45.00</td>
</tr>
<tr>
<td>One Jensen 12 inch Electro-dynamic</td>
<td>15.00</td>
</tr>
<tr>
<td>Two infinite-baffle enclosures, similar to Cinaudograph units, 36 x 36 x 15 ins. deep (home built), value . . .</td>
<td>30.00</td>
</tr>
<tr>
<td>Lentz and Belden cables, total 375 ft.</td>
<td>15.00</td>
</tr>
<tr>
<td>Amplifier (approx.)</td>
<td>100.00</td>
</tr>
<tr>
<td>Inca transformers and chokes</td>
<td></td>
</tr>
<tr>
<td>RCA and Sylvania Tubes</td>
<td></td>
</tr>
<tr>
<td>IRC and CRL resistors and controls</td>
<td></td>
</tr>
<tr>
<td>Sprague and Aerovox condensers</td>
<td></td>
</tr>
<tr>
<td>Tobe All-Wave Tuner</td>
<td></td>
</tr>
<tr>
<td>Miller I.F. coils and tie points</td>
<td></td>
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<tr>
<td>Amphenol connectors and sockets</td>
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</tbody>
</table>

Gray metal crakle cabinet 18 x 13 x 12 ins. deep
Radio Television Supply Co., Los Angeles

$340.55
plus many hours' labor
RAY W. WINTER,
Serviceman for Deck's Electric, La Habra, Calif.

The 2nd prize in the 2nd Edition of "R-C's" $2,000 P.A. contest. Last year went to Mr. Winter for his contribution.

BOOK REVIEW

MOST POPULAR 1940 RADIO DIAGRAMS

This book will be found very useful to the student, the Serviceman and electricians who now and then service radio sets. All necessary checking data, such as intermediate frequencies, etc., are given in the diagrams, together with the values of the various condensers, resistors, etc. The diagrams are printed in excellent, legible form, practically a diagram to a page, and the selection of the diagrams covers all of the more popular receivers now in use by the public. Even the student Serviceman will have no trouble in checking up a receiver circuit from these clear diagrams, and instead of having to hunt through hundreds of circuits the selection of the most popular ones has all been done by the editor of this book.

SERVICEMEN

Keep posted on P.M. Read the feature articles on this subject in the January, 1941, issue of Radio-Craft.
CIRCUIT APPLICATIONS FOR THE MINIATURE TUBES

This Article presents applicational information on the miniature tubes IR5, IS4, IS5, and IT4, which operate from a 1.5-volt "B" battery and a 1⅛-volt "A" cell. Only one-fifth the cubic size of the 1.4-volt GT tubes, these new tubes are well suited for use in wearable hearing-aids, meteorological balloons, pocket-size receivers, other portable receivers, or any radio equipment where small size and light weight are important.

This article is concerned principally with the use of the types IR5, IS4, IS5 and IT4 miniature tubes in receivers and especially with the operation of the IR5 pentagrid converter.

In addition to their small size—compact structure makes it possible to mount a full-size 1.4-V. filament in a tube only 2½ ins. long—and low "B" voltage requirement, the miniature tubes have other important advantages. The IR5 pentagrid converter employs an oscillator circuit which inherently gives high oscillator transconductance. Both the IR5 converter and IT4 I.F. amplifiers have a remote cut-off characteristic which enables them to handle a wide range of signal strengths without modulation distortion. The IR5 detector and A.F. amplifier tube has a pentode amplifier section which can provide an audio gain of 30 when "B" supply is 45 volts, and adequate signal gain in output when the "B" battery is at the end of its life. The IS4 output tube has a maximum-signal power output of 65 milliwatts when plate and screen-grid voltage are 45 volts, and 190 milliwatts when plate and S.G. voltage are 67.5 volts. All the miniature types have a single-ended construction which eliminates flexible grid leads and top-cap connectors.

CIRCUITS—IR5 PENTAGRID CONVERTER

The IR5 is a pentagrid converter similar to the 6SA7 in that the IR5 has no separate oscillator anode. Typical circuits for the IR5 are shown in Fig. 1. In Circuit I, oscillator feedback is obtained by connecting the filament to a tap on the oscillator tank coil. This 2nd circuit is similar to the cathode feedback circuit used with the 6SA7.

In both circuits, the IR5 has 2 important advantages in addition to the fact that the "B" supply can be as low as 45 volts. One advantage is that, in both circuits, almost all the electron current emitted by the filament is effective in providing feedback. As a result, the oscillator transconductance of the IR5 in the circuits of Fig. 1 is higher than that of other battery-operated converter types in the conventional circuit where the feedback current (the oscillator-anode current) is only about 50% of the total emission current. The high oscillator transconductance of the IR5 makes it possible to obtain wider tuning ranges with this tube.

A 2nd advantage of the IR5 is due to the fact that the arrangement of grid side-rods in the IR5 is similar to that in the 6SA7. Because of this arrangement, most of the electrons turned back toward the filament by the negative signal grid are prevented from reaching the space charge near the filament. This action of the side-rods, together with the electrostatic shielding of the signal-grid, practically eliminates the filament space charge from the signal-grid. As a result, changes in signal-grid bias produce very little change in oscillator transconductance. Changes in A.V.C. bias, therefore, produce very little change in oscillator frequency. This feature of the IR5 is important in shortwave operation.

COMPARING CIRCUITS I AND II

In a receiver which is to use the IR5, the choice between Circuits I and II depends on the frequency range of the receiver. If a set tuning not higher than about 6 megacycles, Circuit I is generally preferable. In a set which is to tune higher than this frequency, Circuit II may be preferable. At the high frequencies, the choice between the 2 circuits depends on the following considerations.

Circuit I has the advantage that it is somewhat easier to provide adequate grid excitation in a tickler-feedback oscillator than in a cathode feedback oscillator. When Circuit I is operated at frequencies higher than about 6 megacycles, a neutralizing condenser Cx should be connected in the circuit, as discussed in the next paragraph. Circuit II has the advantage that it does not require this neutralization. Also, band-switching in Circuit II may be simpler than in Circuit I. The relative importance of these advantages will determine the choice between the 2 circuits for use in a particular receiver operating at high frequencies.

NEUTRALIZATION OF CIRCUIT I

In operation of Circuit I at frequencies above 6 megacycles, the oscillator voltage on the screen-grid may cause considerable oscillation voltage on the signal-grid. The reason is that, at these frequencies, there is only a small percentage difference between the signal and oscillator frequencies. The impedance of the signal-grid circuit at oscillator frequency is therefore appreciable compared with that of the screen-grid-to-signal-grid capacity. To minimize the oscillator voltage on the signal-grid, a small condenser should be connected between the signal-grid and the No. 1 grid, indicated in dotted lines in Fig. 1, when Circuit I is to be tuned higher than 6 megacycles. Because the oscillator voltage on the No. 1 grid is in phase opposition to that on the screen-grid, the oscillator voltage on the signal-grid can be practically cancelled by use of the proper capacity for Cx.

The effect on receiver sensitivity of varia-
tion in the capacity of $C_s$ is indicated by Fig. 2. This curve was plotted for a typical receiver operating at 16 megacycles. The values on this curve are not necessarily correct for other receivers, but the curve shape is approximately correct for other receivers.

The explanation of this curve shape is briefly as follows: There are 2 components of oscillator voltage on the signal-grid, one applied from the No. 1 grid, the other applied from the grid-screen. The 2 components are in phase opposition. In the receiver for which the curve of Fig. 2 was plotted, when $C_s$ is approximately equal to 4.5 mmf, the 2 components are equal, and cancel each other. When $C_s$ is smaller than 4.5 mmf, the net resultant oscillator voltage on the signal-grid is in-phase with the signal-grid voltage and out-of-phase with the No. 1 grid voltage. It may be desirable to use a negative oscillator voltage on the signal-grid reduces the modulation of the electron stream by the No. 1 grid, and, therefore, reduces conversion for a receiver. When $C_s$ is larger than 4.5 mmf, the net resultant oscillator voltage on the signal-grid is in phase with the No. 1 grid voltage. This in-phase voltage on the signal-grid increases the plate current above the value giving maximum conversion transconductance, and causes the D.C. to the oscillator to fall. This reduction in capacity is large. This grid current loads the signal-grid tuned circuit and increases the A.V.C. bias voltage on the I.F. tube. From this explanation it can be understood why there is a value of $C_s$ giving maximum sensitivity. However, the value of $C_s$ is not critical; it can be seen from Fig. 2 that variations of ± 10% in $C_s$ do not cause excessive variation in the sensitivity of the receiver measured. In other receivers, it has been found that capacity variations of ± 3%, or even more, can be tolerated.

Consideration of Circuit I shows that the value of $C_s$ providing best neutralization depends on the ratio of the amplitude of oscillator voltage on the screen to that on the No. 1 grid. This ratio is determined by the turns ratio between the tickler coil and the No. 1 grid coils. The optimum value of $C_s$, therefore, depends on the number of tickler turns. A good method for adjusting $C_s$ and the number of tickler turns for the frequency band is to use approximately 6 and 18 megacycles as follows.

First, tune to the low-frequency end of the band and adjust the tickler turns to give 20 microamperes No. 1-grid current. Then, tune to the high-frequency end of the band and adjust the capacity of $C_s$ to give maximum receiver sensitivity. In receiver production, it is suggested that we use a value of $C_s$ somewhat smaller than the value giving maximum sensitivity so that manufacturing variations will not make $C_s$ much larger than the optimum sensitivity value. If $C_s$ becomes much larger than this value, circuit instability is likely to result because of interaction between the oscillator and signal-grid circuits. In the receiver for which the curve of Fig. 2 was plotted, a value of 4 mmf for $C_s$ gave practically no interaction, 5 mmf caused some interaction, and 7 mmf made the circuit inoperative. The value of $C_s$ selected for use in the 6-18 megacycle band can also be used in the middle and low-frequency bands.

In the middle-frequency band, the optimum value of $C_s$ is not at all critical, while in the low-frequency bands, the presence of $C_s$ in the circuit has very little effect on circuit performance.

In the high-frequency band, the effect of variation in $C_s$ on receiver sensitivity and stability depends on the amplitude of oscillation. When this amplitude increases, the value of $C_s$ becomes more critical. Hence, this capacity is generally most critical at the high-frequency end of the band. When it is desired to reduce the effect of variation in $C_s$ on receiver sensitivity, this reduction can be made by limiting the amplitude of oscillation at the high-frequency end of the band. A simple method for limiting this amplitude is to connect a resistor in series with the oscillator and with the test condenser.

The method used to vary $C_s$ in our laboratory tests consisted of connecting in the circuit a variable condenser. Each fixed condenser was made by winding a length of bare copper wire tightly on a length of rubber-covered wire. The capacities of these condensers were measured on a Q-meter.

**R.F. CHOKE FOR CIRCUIT II**

An R.F. choke for Circuit II should meet the following requirements which are not difficult to satisfy. The resistance of the choke should not be so large as to cause excessive drop in the filament voltage supplied to the I.R.A. A resistance of 1 ohm, or less, is satisfactory. The inductance of the choke should be large enough to provide effective choking at the lowest frequency to which the oscillator tunes. For operation in the domestic broadcast band, an inductance of 30 to 40 microhy. is generally satisfactory. The distributed capacity of the choke should be small enough so that the resonant frequency of the choke is higher than the highest frequency to which the oscillator tunes.

**FEEDBACK—CIRCUITS I AND II**

In Circuit I, the number of tickler turns should be large enough so that strong oscillation is maintained throughout the tuning range and throughout battery life. However, the number of tickler turns should not be much larger than necessary because an excessive number of tickler turns causes a reduction in conversion transconductance. The reason is that an increase in tickler turns causes an increase in the amplitude of oscillator voltage on the screen-grid. When Circuit I is in normal operation, cathode current flows only during the positive half-cycles of No. 1 grid voltage. During these half-cycles, the oscillator voltage on the screen-grid is negative. Hence, an increase in the amplitude of oscillator voltage on the screen decreases the effective D.C. screen voltage. As a result, an increase
in tickler turns above a certain number reduces conversion transconductance.

Similar statements are true of Circuit II. The filament tap on the oscillator tank coil should be far enough up the coil for strong oscillation. However, the tap should not be too far up the coil because the oscillator voltage on the filament makes the filament positive with respect to the signal-grid during positive half-cycles of No. 1-grid voltage. Hence, the oscillator voltage on the filament has the effect of increasing the negative bias on the signal-grid and thus reduces transconductance.

These statements are illustrated by the curves of Figs. 3 and 4 which show the effect on conversion transconductance of the oscillator on the screen-grid in Circuit I, and of the oscillator voltage on the filament in Circuit II. These curves can be used as a guide when a 1R5 oscillator coil is to be adjusted to give best sensitivity over a tuning band. The curves are convenient to use.

A simple vacuum-tube voltmeter adequate for measuring oscillator voltage on the 1R5 screen-grid or filament consists of a diode in series with a 0.1-meg. resistor and a microammeter. In the domestic broadcast band, best sensitivity is usually obtained when oscillator-grid current ranges between 50 and 150 microamperes.

MODIFYING CIRCUIT I FOR 90-V.

Modification of Circuit I may be desirable when the "B" supply voltage is used in a receiver where it is desired to obtain more power output than can be provided by a 1S4. For such a receiver, a good tube line-up is a 3Q5-GT operated at 90 volts plate and screen-grid voltage, a 1S5 operated at the 90-volt conditions given below under "Resistance-Coupled Operating Conditions for 1S5 Pentode," a 1T4, and a 1R5. Because the maximum rated screen-grid voltage of the 1R5 and 1T4 is 67.5 volts, a series screen-grid resistor is necessary for these tubes unless a 67.5-volt battery tap is employed.

Figure 5 shows 3 methods of supplying screen-grid voltage to a 1R5 and 1T4 from a 90-volt battery in a receiver where the 1R5 stage employs tickler feedback.

Circuit A.—In circuit A, the 1R5 plate current does not flow through the tickler coil; the tickler feedback current is the screen-grid current alone. With this arrangement, the feedback current, and hence the oscillator transconductance, changes with A.V.C. bias. This change may be objectionable in the shortwave bands but is unimportant in the domestic-broadcast and longwave bands.

Circuit B.—In circuit B, the voltage on the 1R5 plate is lower than in circuit A. As a result, the conversion gain obtainable from circuit B is somewhat less than that from circuit A. However, in circuit B, both the plate current and screen-grid current of the 1R5 contribute to the tickler-feedback current. Because the sum of plate current and screen-grid current changes very little with A.V.C. bias, oscillator transconductance in circuit B is less affected by A.V.C. bias than in circuit A. As a result, circuit B gives better oscillator performance in the shortwave bands than circuit A.

Circuit C.—The diagram of circuit C gives somewhat more conversion gain than circuit B because the 1R5 plate voltage is higher in circuit C. Also, the oscillator performance of circuit C is good in all bands because the tickler coil carries both the plate current and the screen-grid current of the 1R5. However, circuit C employs an additional screen-grid resistor for the 1T4.
REMOTE CUT-OFF—18S AND 1T4

Both the 18S converter and 1T4 I.F. amplifier have remote cut-off. As a result, a receiver using these tubes can have a better A.V.C. characteristic than a receiver using sharp cut-off types. This statement is illustrated by Fig. 6 which shows A.V.C. curves for a typical battery-operated receiver before and after conversion to the miniature tubes.

In this figure the curve for the sharp cut-off tubes bends upward at an antenna input of about 30,000 microvolts. At this value of input, the A.V.C. bias on the converter and I.F. tubes is a large percentage of their cut-off bias. As a result, there is some clipping of negative signal peaks on the I.F. amplifier grid. This clipping produces an increase in the percentage modulation of the I.F. amplifier output, and thus causes the upward bend in the curve for measured audio output. In other words, the upward bend in the curve indicates the signal strength at which modulation distortion starts. The curves show that the range of signal strengths amplified without appreciable modulation distortion is about 5 times larger for the miniature tubes than for the sharp cut-off types.

CURVES FOR MINIATURE TYPES (67.5 V. ON S.G.)

The maximum rated screen-grid voltage of the 18S, 1T4, and 1S4 has recently been raised from 40 to 67.5 volts. The maximum rated plate and S.-G. voltages of the 18S had been previously set at 90 volts. Curves for all 4 types at a screen-grid voltage of 67.5 volts are given in Figs. 7-14. Figure 9 also shows power output and distortion curves for the 1S4 operated at 45 volts plate and screen-grid voltage. It should be noted that, in a receiver where part of the "B" supply voltage is used to bias the output tube, the values of transconductance and power output will be somewhat less than those shown in the curves.

RESISTANCE-COUPLED OPERATING CONDITIONS—15S PENTODE

Plate supply voltage 45 67.5 90 volts
Screen-grid supply voltage 45 67.5 90 volts
Control-grid voltage 0 0 0 volts
Load resistor 1 1 1 megohm
Series screen-grid resistor 3 3 3 megohms
Control-grid resistor 10 10 10 megohms
Control-grid resistor for following stage 2 2 2 megohms
Voltage gain* (approx.) 30 40 50
* Obtained when the grid of the pentode unit is fed from a source having an impedance of 1.0 megohm.

SHIELDING AND SOCKETS

Shielding caps are not usually required for the miniature tubes. The 1T4 I.F. amplifier tube has a shielding electrode which surrounds the plate and is internally connected to the filament. The socket for a 1T4 should have a central metal insert shielding the grid base pin from the plate base pin, which is opposite the grid pin. The socket for a 1S5 should be cushioned as a precaution against microphonics. Suitable cushioning can be provided by soft rubber grommets between the socket and chassis. Similar cushioning for the 1T4 may be desirable. It may be necessary to mount a baffle plate or other shielding between the 18S and output tube to prevent audio feedback. Also, in a receiver tuning to the longwave band where signal frequencies are close to the intermediate frequency, it may be necessary to shield the 1S5 and 1T4 from the loop and the R.F. input leads.

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Premium No. 4 (5 Pts.) Val. 25c.

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All metal chassis punched for 1 tube, 1 meter, and 50 points. Ideal for use as remote control or battery charger, or in experimental circuits. Ship weight 1 lb. 6 oz.

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LOUDSPEAKER UNIT

Kobex magnetic loudspeaker unit, with built-in speaker and transformer. May be used as loudspeaker for remote control or battery charger, or in experimental circuits. Thru-throw 15/8" dia.

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Unusually well insulated, 5 wire set with nuts, washers, terminal blocks, and terminal nuts. Ship weight 2 lbs.

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RADIO-CRAFT for December, 1940
its socket, the tube should be pulled straight away from the socket without a rocking motion. Rocking the tube in its socket produces a transverse pressure on the base pins which may crack the glass base. Likewise, wiring to the socket should not pull socket terminals out of position because this pull applies transverse pressure to the base pins. Socket contacts should grip the base pins not less than 1/4-inch below the base so that the base pins can bend slightly to make up for misalignment of socket holes or contacts.

This article has been prepared from data supplied by courtesy of RCA Manufacturing Co., Inc.

**BOOSTER TYPE TONE CONTROL**

Here is a diagram of an unusual tone control circuit. In the "Treble" position, the low frequencies are completely cut off, resulting in exceptional clarity for speech and C.W. In the "Bass" position, the high frequencies are attenuated, giving the control, in this case a 21-Watt, unusual tone quality due to the boosting effect on both high and low frequencies. This control, because of its wide range, should be useful for short waves.

Condenser and resistor sizes are not critical but different values may be tried for C3, C4, C5, C6.

**COLOR-CODED WRENCHES**

- T0 put a step to picking 5 wrong out of a possible 6 socket wrenches I hit upon the scheme I recommend to Servicemen of marking them according to the R.M.A. color code; smallest, black, etc.

**MORER RADIO SERVICE, Malone, Ill.**

**STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933.**

Of RADIO-CRAFT, published monthly at Springfield, Mass., for October 1, 1940.

State of New York
County of Hampden.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared H. Gernsback, who, having been duly sworn according to law, deposed and says that he is the editor of Radio-Craft and that the following is a true statement of the ownership, management and circulation, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912 and as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Radercraft Publications, Inc., 29 Vesy St., New York, N. Y.; Editor, H. Gernsback, 29 Vesy St., New York, N. Y.; Managing Editor, H. D. Washburne, 29 Vesy St., New York, N. Y.; Business Managers, none.

2. That the owner is: iff owned by a corporation, the name and address must be stated and also immediately thereunder the names and addresses of the officers of the corporation holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. Radercraft Publications, Inc., 29 Vesy St., New York, N. Y.; H. Gernsback, 29 Vesy St., New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (if there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner: and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as to stated above.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the twelve months preceding the date shown above is...

H. Gernsback, Publisher.

Sworn to and subscribed before me this 26th day of December, 1940.

MAURICE COYNE, Notary Public.

Notary Public, N. Y. Co. No. 104
(My commission expires March 30, 1942.)
BUILDING A MODERN MINIATURE-TUBE METAL-TREASURE LOCATOR

The author of this article tells how economy in operation, weight and bulk may be achieved in a sensitive metal locator by utilizing the new miniature-type battery tubes. Complete construction details are included.

G. M. BETTIS

Metal locators—so-called “treasure” finders—have been built and experimented with often but the one described here is of the radio balance type and is extremely flexible as there are several variable controls that make it possible for one to get the most from the instrument without rebuilding for a few small changes. These variable controls are not gadgets but are useful for proper and precise adjustment which is necessary for successful operation.

FEATURES
The features of this locator are:
- Use of the well-proven radio balance;
- Practical use of the RCA Miniature tubes that are designed to operate on a 1.5 volt "A" cell and maximum of 45 volts "B" battery, and thereby achieving greater efficiency in a portable instrument;
- Use, in the Receiver, of a 1T4 tuned-radio-frequency stage, 1S5 diode detector and pentode A.F. voltage amplifier, 1S4 pentode power amplifier, and 1T4 vacuum-tube meter indicator;
- Use of a sensitive 100-microampere meter in the visual indicator;
- Amplitude modulation of the transmitter inasmuch as the more common self-modulated oscillator cuts down the output of the transmitted radio-frequency signal;
- Use of portable lightweight batteries that give good results and reasonable length of service;

Use of standard, reliable radio parts that can be purchased from most jobbers.

OPERATION
The Transmitter is attached to the 2 handles in the vertical position and the Receiver in the horizontal position with the operator wearing the phones and watching the meter.

The Receiver is tuned to the neutral part of the transmitter field, which is approximately at right-angles, by adjusting the frequency stage, of the Transmitter by means of the turn-buckle. This is easy to do when the instrument has been properly built. The presence of metal in the Transmitter field will cause the receiver to be out-of-balance and a loud signal will be heard in the phones; at the same time a deflection will be noticed in the meter.

When making tests it should be well to know that pipe lines buried for some time will give a better indication than new lines on top of the ground. The actual surface area of an object, and not the weight, is what governs the sensitivity.

The closer together are the Transmitter and Receiver, the less power can be used in the Transmitter because no balance can be obtained, but the instrument then will detect smaller objects at a shallow depth; on the other hand increasing the power, and the distance between Receiver and Transmitter, will make it possible to locate larger objects at greater depths.

Increasing the frequency at which the instrument operates, beyond that specified in the following description, increases the sensitivity of the unit but at the same time reduces its depth of penetration; also the harder and more critical is the instrument to construct and operate satisfactorily.

CONSTRUCTION
You cannot take a pair of pliers, screwdriver, soldering iron, and pocket knife, to build an instrument of this sort, and expect it to work when you turn the switch on. The following detailed steps may seem amateurish but it will be well worth your time to follow most of them.

First consideration is the construction of the Transmitter and Receiver chassis and locate the details of which are shown in Figs. 1 to 7. The loop frame is made of white pine and glued together with blocks. A and B (also glued in place). Two coats of orange shellac are applied and allowed to thoroughly dry between coats. The chassis shown in Figs. 5, 6, and 7 are made of tempered Masonite and held in place with small brass screws.

The detail drawings of Figs. 8 and 9 show the Transmitter and Receiver cases which are made of white pine with front panels and sliding doors of tempered Masonite. The inside of the Receiver's front panel is covered with a piece of aluminum foil glued-on for shielding purposes and ground- ed to "A—"
Two strips of Masonite ½ x 14 ins. are also made to fasten to blocks B to hold the batteries in place. A few white pine blocks are glued to the front panels at top and sides of the batteries to keep the batteries firmly in place.

The Transmitter and Receiver chassis loops, fit snugly inside the cases as shown, and are held there by brass screws which extend through the center portion of the loop frame. The holes shown are for the standard parts specified in the accompanying List of Parts.

The handles and positions of the Transmitter and Receiver are shown in Fig. 11, as well as the small turnbuckle that will be used to tune to a perfect balance, and to keep the apparatus anchored firmly when in use. The detail of the 3/16- x 2-in. bolts held in place with nuts for attaching to handles is shown in Fig. 8. The hole centers are shown in Figs. 8 and 10 for other bolts. Additional holes every 6 ins. can be made in handles for bringing the Receiver closer to the Transmitter for operation on lower power. The Locator will operate much more efficiently when held as close to the ground as possible. Therefore it is suggested that in some cases it may be desirable to sling the Locator from the shoulders by straps or cords with shoulder pads or hand grips.

The woodwork can be done in a home workshop or by a local cabinet shop. The work shown was built in the writer's workshop while waiting for the components he had to get by mail order.

The loops are wound with 22 turns of No. 21 enamel wire in each groove, on the outside of the loop frame, making a total of 44 turns per loop. The loop frame was first covered with a layer of No. 912B ribbon. The loops are all wound in the same direction and soldered to the sockets that are mounted in C as shown in Fig. 5.

**TRANSMITTER**

Now start construction of the Transmitter by mounting switch 11 in a 7 16-in. hole in the panel; switch 10 in its ¾-in. hole; next, control 8; then, condenser 4 so it can be adjusted through the ¾-in. hole; and finally, the sockets and condenser 5.

The Transmitter is wired, as shown in Fig. 12, by connecting the dotted line at X and omitting the connections to the modulator. The batteries are then wired-up and the unit turned on with control 8 advanced most of the way. Place the Transmitter close to a broadcast receiver set on 700 kc., then adjust condensers 4 and 5 as well as control 8 so a signal will be heard over the radio set.

Remove the tube from the Transmitter and wire-up the modulator, as in Fig. 13, and disconnect the wire at X. Put a pair of headphones in series with the "B+" lead to the A.F. transformer and, with tube and batteries in place, a good signal should be heard in the phones. If it may be necessary to reverse the grid and grid-return leads of the A.F. transformer to obtain a signal in the phones. Now remove the phones from the "B+" lead and substitute for the phones a 0-15 ma., D.C. milliammeter, and with the tube replaced in the transmitter and modulator control 8 properly adjusted, that should be from 2.5 to 4 ma. drain, using a 90-V. "B" supply, a good signal on about 700 kc. is fed to the broadcast receiver. With all the bugs out of the Transmitter proceed to the Receiver.

**RECEIVER**

Mount the phone-tips (being careful to see they do not short to the aluminum foil inside the panel), control 10, control 25, condenser 4 so it can be adjusted through the ¾-in. hole, switch 18, and switch 19 (on front panel of Receiver case). Then mount the sockets and transformers, and wire-up all but the meter and control 23 as shown in Fig. 14. In place of resistor 11 put a 100,000-ohm resistor with the positive meter connection to "F-" and the negative meter connection to a 100,000-ohm resistor as shown in Fig. 15.

With the IT4 tube removed, that connects to the meter shown in Fig. 14, turn-on the Receiver after all connections to the Miniature tubes have been carefully checked as the connections vary and serious damage will result to tubes not properly connected or in their right sockets. There should be no reading on the meter until the Transmitter is brought close to the Receiver. When the Receiver is properly lined up with Transmitter readings should be obtained as given in Table 1. Condensers 4 and 4A, and transformers 16-5081 and 16-5730, are to be adjusted for maximum meter reading. In Table 1 are shown not only 4 series of tests, but also several others that may be made, and it is well worth while to make them and record the results for future reference while the Receiver is connected in this manner.

### Table 1

<table>
<thead>
<tr>
<th>Transmitter</th>
<th>Receiver</th>
<th>Cont. Meter</th>
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<tbody>
<tr>
<td>&quot;B&quot;</td>
<td>&quot;B&quot;</td>
<td>22</td>
</tr>
<tr>
<td>Sw. 10 Cont. &amp; Ma.</td>
<td>Sw. 18 10 22</td>
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<td>Series 1</td>
<td>22.5</td>
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<td>45</td>
<td>3.8</td>
<td>1.5</td>
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</tbody>
</table>
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Two Mallory type TP 403, 500 mmf., 6, 7;
MALLORY
One Mallory dual control, type DRP 292, 3 meg., 8;
One Mallory dial plate, No. 397;
One Mallory knob, No. 365;
One Mallory S.P.S.T. midget switch, No. 10, 11;
One RCA type 16G2 tube;
One Amphenol "Super-Mic" socket, No. 64-8;
Two Burgess portable batteries, No. 230NX, 45 V;
One Burgess portable drycell, No. 44, 1.5 V;

MODULATOR
One Mallory condenser, type TP 410, 0.01-mf., 1;
One I.R.C., type BT1/2, 15,000 ohms 1;
One audio-frequency transistor for type 30 to 19 tube (class-B driver);
One I.R.C., type 16G2 tube;
One Amphenol type R8S socket;

RECEIVER
One Amphenol No. 78-1M socket 70-1M plug, T. 2;
One Amphenol No. 78-1M socket 70-1M plug, green, 3;

CONDENSERS
One Meissner "Alignaire" No. 22-5200, 40-100 mmf., 4;
One Meissner dual No. 22-5293, 100-300 mmf., 5;

SERVICEMEN
One Mallory dual control, type DRP 292, 3 meg., 8;
One Mallory dial plate, No. 397;
One Mallory knob, No. 365;
One Mallory S.P.S.T. midget switch, No. 10, 11;
One RCA type 16G2 tube;
One Amphenol "Super-Mic" socket, No. 64-8;
Two Burgess portable batteries, No. 230NX, 45 V;
One Burgess portable drycell, No. 44, 1.5 V;

CONFUSIONS
One Meissner dual No. 22-5293, 100-300 mmf., 5;
Two Mallory type TP 403, 500 mmf., 6, 7;

RESISTORS
One I.R.C., type BT1/2, 0.05-mf., 11;
One I.R.C., type BT1/2, 10 meg., 12;
Two I.R.C., type BT1/2, 1 meg, 13, 15;
Two I.R.C., type BT1/2, 3 meg., 14, 21;
One I.R.C., type BT1/2, 0.1-meg., 16;

MISCELLANEOUS
One Mallory-Yaxcel control, type Y-1000-M-P, T meg., 10;
One Mallory dial plate, No. 397;
One Mallory knob, No. 365;
One Mallory type GB14 holder, 4 bias cells, 17;
Two Mallory cells, T. 1;
Two Mallory cells, 1 1/2 V;
One Mallory S.P.D.T. midget jack switch, No. 11, 18;
One Mallory S.P.S.T. midget jack switch, No. 10, 19;
Two Mallory tip-jacks, No. 521, 20;
Three Hickok 0-100 microamperes D.C., meter, No. 46, 22;
One Mallory-Yaxcel 200-ohm control, No. C200P, 23;
One Mallory dial plate, No. 393;
One Mallory knob, No. 365;
Three RCA type TF4 miniature tubes;
One RCA type 185 miniature tube;
One RCA type 184 miniature tube;
Three Amphenol sockets, No. 54-TP;
Two Amphenol sockets, No. 78-TP;
One Amphenol ribbon, No. 66-001 912B;
One Amphenol bottle liquid, No. 912, 55-4;
One lb. No. 21 enamelled copper wire;
One Meissner ferrocart I.F., interstage, No. 16-6981, 175 kc.
One Meissner ferrocart I.F., output, No. 16-6792, 175 kc.
One Burgess portable battery, type 230NX, 45 V;
One Burgess portable drycell, No. 44, 1.5 V;

RADIO-CRAFT for DECEMBER, 1940

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RADIO DEVELOPMENTS

Above, Major Edwin H. Armstrong at the control panel of W2XOR, atop 444 Madison Ave., during the 1/2-hour dedicatory air-premiere program of this wide-band Frequency Modulation station. At left, J. R. Poppele, WOR's chief engineer; and right, Alfred J. McCosker, WOR's president. The photo at right shows engineers monitoring an F.M. broadcast in WOR's "Studio One" at 1440 Broadway.

STATION WOR GETS F.M. VOICE

NEW YORK CITY got its first full-time wide-band Frequency Modulation radio transmitting station last month when WOR started regular daily program service over W2XOR from the 42nd floor of 444 Madison Ave. At this elevation (about 630 ft. above sea level) the radius-range is about 48 miles.

The new super-fidelity, statistic transmitting station, the first of its kind in the city, was officially dedicated when Major Edwin H. Armstrong, inventor of the wide-band system of F.M. broadcasting employed in this station, threw the key that put the station on the air.

W2XOR will operate on a daily schedule from 9 A.M. to midnight with programs originating from WOR's New York studios at 1440 Broadway, from Newark (N.J.), and from the Mutual Playhouse in N.Y.C. Operating on a frequency of 43.4 megacycles (43,400 kc.) the station will originate 2 hours of programs of its own part from those of its mother station, WOR.

The 1,000-watt synchronized transmitter of the station is the latest product of Western Electric laboratories and incorporates several innovations in frequency modulation design that result in less distortion, less dial drift and easier tuning for F.M. listeners; a new type of circuit and temperature-controlled crystals give it the unusually efficient frequency stability of 0.0025%. The transmitter and studio equipment is designed for a fidelity range of 30 to 15,000 cycles.

A unique feature of the new F.M. station, is that it is equipped for frequency modulation all the way, with special equipment including a new "egg" microphone in the studio (see photo at upper-left); also, high-fidelity broadcast lines that connect studio and transmitter are corrected for a frequency range of 20 to 20,000 cycles.

The vertical coaxial antenna on the roof stands 75 ft. above the roof. Two auxiliary 40-ft. antennas on the roof are for emergency use with the F.M. transmitter, for facsimile, and high-frequency shortwave relay broadcasting.

The transmitter room at 444, Madison Avenue is also a research laboratory and will be equipped with a workshop and measuring apparatus, so that research and experimentation can be carried on at all times.

Application is pending for permission to operate a 100-watt RCA auxiliary F.M. transmitter.

Present Status of F.M. Broadcasting

DICK DORRANCE

The progress of Frequency Modulation ("F.M."), as with anything that is new and not fully understood—has given rise to a number of common fallacies, widely spread by omnipresent pseudo-experts who do not grasp the picture quite so fully as they believe they do.

Many of these fallacies deal with the capabilities and limitations of F.M.; others seek to anticipate public reaction. Most of them are sheer conversation pieces. All of them bear refutation, in light of the remarkable growth that has attended the new noise-free, full-fidelity method of radio broadcasting during recent months.

Here, for example, are a few representative misconceptions about F.M. that have gained erratic circulation.

(1) F.M. stations can't be heard more than 50 miles from the transmitter. Therefore they can't begin to service as great an area as the regular amplitude stations. It will take many, many more stations to cover as great a territory as that reached by the major standard stations today.

This is a common example of misinformation. The coverage area of an F.M. station is based on a combination of 3 factors:

(a) The height of the antenna above the surrounding countryside;

(b) The power used at the transmitter; and,

(c) The type of antenna employed.

Service ranges of 100 to 125 miles from the transmitter are quite possible, and many of the applications now pending before the Federal Communications Commission will be for such service areas. The range of an F.M. station is the same by day and night—an unvarying, unfading signal of remarkable clarity. Very few 50,000-watt stations of the ordinary type reach a greater area with consistency during daytime hours. The night-time coverage is greater, of course, but marred by fading, static and cross-interference beyond the primary coverage area.

(2) F.M. networks are impossible with the use of telephone wires because these wires won't carry the high-fidelity notes that F.M. demands for full-natural quality. Therefore the use of radio-relay—small transmitters placed at intervals across the country to carry programs from network station to network station—is the only answer. This would be very expensive and there is no proof that it might be satisfactory for a coast-to-coast hook-up.

Wrong again. Telephone wires can carry the 30- to 15,000 cycle range of tone demanded by F.M. stations. They can carry even much higher ranges. Such telephone lines do not exist widely at present because there is no great demand for them. But the phone companies stand ready to supply this superior service when the demand is strong enough to warrant the installation of such new facilities.

The development of F.M. networks on a nationwide scale, co-operatively run, is expected to start within another year or two. By that time the telephone companies will probably have the new, full-range wires ready for use.

(3) The public has a "tin ear." The public can't tell a high note from a medium one. Furthermore, the average hearing doesn't register above 10,000 cycles, so why bother with a lot of fancy equipment to bring in notes as high as
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See Page 382

15,000 cycles! "High fidelity" doesn't mean anything, because the average A.M. set reproduces notes above 5,000 cycles anyway.

This let-well-enough-alone attitude is a poor argument. The public has a so-called "tin ear" and has never known what natural, full-fidelity radio can sound like. Experience shows that average listeners, after hearing F.M. for a period of a few days, are acutely aware of a flatness in standard broadcast reception when they return from F.M. to A.M.

The fact that the average listener does not go absolutely mad the first time a) that the ear does not catch and appreciate the many overtones created in this airy region of the sound spectrum. It is here that the public's illusions of "natural-ness" are created. It is further heightened by the fact that F.M. has no "carrier noise."

There is no rushing, and when voices or music are not present on the wave, as in standard broadcasting. F.M. is completely silent. The faintest innuendoes of tone are not muffled in this everpresent background rush.

(4) It's proof, say the F.M. scoffers, that the public doesn't want or appreciate higher quality. These shows are so many listeners leave their tone controls on the "bass" position. This cuts out the treble notes that occur up around 7,000 cycles.

Actually it proves nothing of the kind. It merely shows that the average listener is instinctively aware of the background rush in any A.M. or "A.M." broadcasting which becomes definitely prominent with the tone control at "treme." By reducing the tone control to "bass" all the highs, badly distorted by the background, are eliminated and the listener has a nearer (albeit lopsided) approximiation of the real, natural thing. Low radio listening does not place any emphasis on either bass or treble. High-fidelity reproduces precisely what the microphone hears, with the same proportion of highs and lows.

(5) Why buy a new F.M. receiver when all the best programs are still on the regular stations? How can anyone who is a listener have 2 complete receivers in his living room? There are 45,000,000 receivers in this country. Why should they become obsolete?

Nobody wants them. There are now 14 manufacturers offering the new F.M. receivers for marketing during the next few months, and in every case the new F.M. sets also have a band-switch that can turn instantly to standard broadcasts, thus giving you a choice of the old or the new.

In addition, a number of manufacturers are making "adaptors" or "translators" that may be used in conjunction with a standard set to receive F.M. programs. Their use, however, is only recommended with sets that have superior tone—since the F.M. wavelength may be easily destroyed by a poor loudspeaker.

America's 45,000,000 radio sets will not be obseolusted overnight. As the public buys new sets, it will be urged to purchase combination A.M.-F.M. receivers. The process therefore will be one of normal absorption over a period of years.

(6) F.M. is quite beyond the range of the average pocketbook. F.M. sets will always be much more expensive than the regular type.

F.M. sets are not produced in mass quantities. Consequently their "per unit" cost is greater. Basically there is no important difference between the components used in an F.M. receiver and those of a standard receiver, except that F.M. de-
FUSE HOLDER
Alden Products Co.
Brockton, Mass.

MOUNTS by means of rivets or screws to the panel and therefore cannot work loose. The contacts at the far end of the holder have an internal spring which ejects the fuse even though the glass may have been broken. Slotted-top type (illustrated) is removable with screwdriver; knurled-top, with fingers.—Radio-Craft

POWER LINE FILTER
Belden Mfg. Co.
4689 W. Van Buren St., Chicago, Ill.

KNOWN as No. 8100 this new unit is designed to eliminate power line interference. Contains 2 dual condenser sections and 2 dual high-Q choke coils, which it is claimed eliminates man-made static in the power lines for both broadcast and shortwave bands.—Radio-Craft

BLOWER SYSTEM FOR RECORDINGS
Presto Recording Corp.
242 West 55 St., New York, N. Y.

MODEL 400-A blower system eliminates 1 of the commonest hazards of instantaneous recording. It directs a tiny blast of air across the surface of the disc just behind the cutting head, throwing the waste thread to the center of the disc. The intense airstream removes lint or grit from the surface of the disc just before it passes under the cutting needle. Blower operates quietly and can be used in the same room as the microphone if necessary.—Radio-Craft

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6 - 110 V. MOBILE AMPLIFIER
Erwood Sound Equipment Co.
224 W. Huron St., Chicago, Ill.

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Belden Mfg. Co.
4689 W. Van Buren St., Chicago, Ill.

THE handles of these irons are separated from the elements and tips by a series of baffle plates designed to keep the handles...
cool. The iron will not roll on a flat surface since the baffle plates are polygonal in shape. Available in 90, 100 and 150 W. sizes.—Radio-Craft

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Bud Radio, Inc.
5205 Cedar Ave., Cleveland, Ohio

These small, compact neutralizing condensers are tubular in design and have a single hole for mounting. Capacities are adjusted by means of a screwdriver and may be locked at any desired setting. Available in capacities of 0.25-mmf to 4 mmf, at 1,000 V.; 0.25-mmf to 5 mmf, at 2,000 V.; and 1 mmf to 9.5 mmf, at 3,000 V.—Radio-Craft

PREAMPLIFIER

Montgomery Ward & Co.
Chicago, Ill.

The 6 channels of this exceptionally quiet, "Professional Airport" preamplifier permit the use of 4 additional microphones at one time with 2 extra phones. The unit can be operated up to a mile distant from the amplifier itself. The controls include 2 tone boosters, to emphasize either the low bass or high treble notes, or both; and 4 microphone input controls for regulating volume in each individual mike. There are also 1 master phone volume control and 1 master gain control. The unit consumes 60 W. of power and operates on 105-125 V., 50-60 cycles A.C.—Radio-Craft

MOBILE AMPLIFIER

John Meck Industries
1313 W. Randolph St., Chicago, Ill.

Model AMR-15C is a 15-W. mobile amplifier timed for election sales. Has built-on phone top which operates from both 6 V. battery and 110 V. A.C. Optional equipment includes 2-piece leatherette carrying case, housing 2 P.M.-type speakers and all accessories.—Radio-Craft

NEW CONTACT BAND FOR ADJUSTABLE RESISTORS

International Resistance Co.
401 N. Broad St., Philadelphia, Pa.

The new band for adjustable resistors, designed so it cannot be adjusted too tightly, can be used at temperatures above those ordinarily met in resistor operation. This eliminates the danger of wire breakage and other damage due to making the band too tight.—Radio-Craft

PORTABLE P.A. SYSTEM

Commercial Sound Division
RCA Mfg. Co., Inc., Camden, N. J.

Type PG-180 is a compact 15-W. portable P.A. unit in a single carrying case. Its basic unit is the RCA amplifier type MI-12202. The 2 loudspeakers are 10"-in. P.M. types while the microphone is a Junior Velocity type mounted on a table stand. Provisions are made for 2 separate high-impedance input circuits with individual volume controls. Suitable for indoor audi-
VANE-TYPE CERAMIC TRIMMER CONDENSER

Centrik

900 E. Keefe Ave., Milwaukee, Wis.

Fixed plate bonded to the ceramic base, eliminating the usual variable air film. Variable plate rotates on a ground ceramic surface. Equally stable at all capacity adjustments. Provides negative temperature compensation of 0.0006 mmf./mmf.°C. Power factor less than 0.1%. Capacity change with humidity or temperature cycling minimum. Available capacitance ranges: 2 to 6 mmf., 3 to 12 mmf., 7 to 30 mmf., and 60 to 75 mmf. Unit measures about 1/2 x 1/2-in. thick.—Radio-Craft

RECORDING-PLAYBACK UNIT

Mellaphone Corp., Rochester, N. Y.

The model TT recording-playback unit here illustrated is interchangeable with present recording mechanisms already on the market. Powered by heavy-duty recording motor with weighted turntable. Magnetic-type cutting head. Playback pickup optional in either crystal or magnetic type. Top plate measures 10 x 15 ins. and is made of 1/16-in. steel.—Radio-Craft

COMPLETE HOME RECORDER—PLAYBACK—P.A. SYSTEM

1219 W. Van Buren, Chicago, Ill.

Three units in one, viz., (1) easily-operated recorder, (2) record player, and (3) complete P.A. system, including amplifier, crystal microphone and 6%-in. dynamic speaker. Plays-play the recordings it makes, or plays any standard 10- and 15-ins. records with cabinet lid closed. Develops 5 W. of power output as P.A. system. Amplifier is a 5-tube job, including rectifier and visual tuning indicator. The entire unit is housed in a single carrying case measuring 16 x 16 x 14 ins. high. Weight, approx. 45 lbs.—Radio-Craft

“ROLINDEX” CHART

Radio City Products Corp.
88 Park Pl., New York, N. Y.

The “Rolindex” chart when mounted on old tube testers greatly increases their business-like appearance in addition to speeding tube testing and avoiding the use of separate charts. “Rolindex,” when mounted behind a transparent plastic window with a hairline engraved across its center for easy reading of the control settings. It is supplied in 2 models, viz., one with internal illumination (model 102) and one without (model 101).—Radio-Craft

POWER LEVEL RECORDER

Sound Apparatus Co.
150 W. 46 St., New York, N. Y.

Automatically makes a continuous and permanent record of the transmission characteristics of any electroacoustic apparatus. The instrument can be equipped with input potentiometer of different kinds, as for instance, dB. potentiometer in steps of 1/4, 1/2, and 1 db., linear potentiometer and also phase potentiometer for making any loudness measurement. Unit is popularly priced. The instrument is designed for 110 V., 60 cycles. Size, 10% x 12 x 8 inches wide; weight, 22 lbs.—Radio-Craft

SOCKET SHIELD

James Millen Mfg. Co., Inc.
Malden, Mass.

As illustrated this aluminum socket shield electrostatically isolates the grid and plate terminals of single-ended metal tubes, thus permitting their use in high-gain circuits. Shield is made of aluminum.

MODERNIZER KIT FOR TUBE TESTERS

Allied Radio Corp.
833 W. Jackson Blvd., Chicago, Ill.

This kit, known as model B1680, permits testing new tubes in old tube testers. It provides filament voltages of 25-30-35-50-70-85 and 117 V. for the new high-voltage filament tubes. Voltages are selected by a rotary tapped switch mounted on its panel or in a spare socket hole of the tube tester. Installation is very simple, requiring only 2 connections with the tube checker.—Radio-Craft

RADIO-RECORD-PHONO ATTACHMENT

Rock-Ola Mfg. Corp.
800 N. Kedzie Ave., Chicago, Ill.

This company, best known for its coin phonographs, has entered a new field with the announcement of a line of com-
T HIS Microphone and telephone headset
outfit was built especially for the U.S.
Navy Aviation Corps for Plane-to-Plane and
Plane-to-Ground communication.

The Holter-Cabot Electric Company con-
structed the outfit to Government specifi-
cations and under rigid Navy Department su-
 pervision.

The outfit consists of a low-impedance car-
bon microphone (transmitter), securely fas-
tened to a metal breast-plate, and a set of
heavy, low-impedance earphones. A
special twin construction switch on the back of
the breast-plate controls the microphone
circuit. The earphones are U.S.N. Utah type,
attached to adjustable headbands. Twenty-
eight feet of very heavy weather and
waterproof conductor cable, terminating in a
special brass plug, is furnished with this com-
plete outfit. Current of not more than 10
volts should be used. A storage battery is
the most satisfactory current supply. Talk
in a natural tone of voice, when using the
outfit, with the lips close to the mouthpiece.
Shouting and loud talking should be avoided.

We understand that the U.S. Government
paid more than $40.00 for each of these out-
fits. We have bought the whole lot at a low
price and are offering them, as long as the
supply lasts, at $4.96 each, complete as
shown in illustration. The shipping weight is
9 lbs.

All merchandise in original packages—
ever used. Money-back guarantee.

All shipments will be forwarded by Express
Collect if not sufficient postage included.

WELLWORTH TRADING CO.
1915 So. State St., Dept. RC-1240, Chicago, Ill.

A NEW BOOK ON
AUTO RADIO: See Page 333

FLIGHT MAGAZINE
20-2 Vesey St., New York, N. Y.

FLIGHT MAGAZINE
20-2 Vesey St., New York, N. Y.

MODEL FM-13 is a 3-way instrument incorporat-
ing F.M. and A.M. radio reception, and phone record
recording. A 9-tube dual tuner provides a tuning
range of 560 to 1,600 kc. for standard A.M.
broadcasts and 40 to 50 mc. for P.M. broad-
casts. The audio system, rated at 20 W. out-
put, is claimed to be substantially flat from
30 to 15 c.p.s. Other features include bal-
danced dual speakers, automatic base com-

bination home recorders with radio and
phonograph attachments. The units have
5 to 11 tubes and are said to be the only
ones on the market which in addition to
the radio and phonograph are capable of
automatically playing 20 records.—Radio-
Craft

DISPLAY-SIZE TUBE CHECKER
The Hickok Electrical Instrument Co.
10302 Dupont Ave., Cleveland, Ohio

OPPORTUNITY AD-LETS

Advertisements in this section cost 15 cents a
word for each insertion. Name, address and initials
must be included at the above rate. Cash should accom-
pany all classified advertisements unless placed by an
authorized advertising service for less than ten words accepted. Ten percent dis-
count on six issues, twenty percent for ten issues.

Objetionable or misleading advertisements not ac-
ccepted. Advertisements for Janitorial Service must
reach us not later than November 1st.

Radio-Craft 29 Vesey St. New York, N. Y.

BOOKS AND MAGAZINES

ASSURE YOURSELF OF GREATER PROFITS BY
doing your service job efficiently. The Automatic service
guide shows you how to locate and correct troubles in
Manuals show you how to complete more repair jobs in
less time. In each paragraph helpful. R.C. Manufacturing
Hodgkraft Publications, 29 Vesey St., New York City.

MANY A FEW HUNDRED
pedestals, by S. Gemma, second edition, originally paid
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most comprehensive flexible binding. Send
$1.49 in stamps, cash or money order and book will be
forwarded express collect. Technikraft 1915 So. State
Street, Chicago, Illinois.

WHAT DO YOU KNOW ABOUT AMPLIFIERS AND
Sound Systems? The Amplifier Handbook and Public
Address Guide covers P.A. from A to Z. Must complete
and authentic book published on the subject. Contains
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Art work and explanatory diagrams, and only 25c. See
pages 320.

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DIATHERMY, SHORT-WAVE THERAPY, AND ULTRA
short-wave therapy methods custom built by
diathermy machines at considerable saving over commercial machines; 6 months,
15 months, or any other payment plan may be
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patient safety factor, 120-200-watt output, professional
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RESISTANCE, INDUCTANCE, and Capacitance in
radio circuits explained. F. H. Mather.

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available, custom construction only. Allan Stuart, F. 0. Box 50,
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USED CORRESPONDENCE COURSES AND EDUCA-
tional Books Bought, Sold or Hired. Catalog Free.
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books and periodicals of all kinds. Satisfaction guar-
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receiver for electric detector, Woods or good
fine tone-quality. Also want airplaned-cinch speaker.
Amiron-Morgan wood-cased variable condenser, over variable
loosener, deForest Audion control box, or what old
speaker has you? B. Bernard, 46 Manning Ave., N.
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have all the hard-to-get. We do not want no
one thing. Send no money—write first giving fullest
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We have helped many Servicemen, servicemen and
girls. We may help you. Allan Stuart, P. O. Box 66,
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RADIO KITS—$3.50 UP, SINGLE BAND; ALL WAVE
tubes. Pleasure and hobby. Save 50%. Modern

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THREE SCARCE BET, NOW OBSOLETE, 25c, with

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DRAFTING SCHEMATIC DIAGRAMS SEND US A
rough sketch of your circuit. We'll return it by return mail.

We use the most up-to-date instruments—up to
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New York, N. Y.

RADIO-CRAFT FOR DECEMBER, '40
penetration and separate manual controls for bass and treble equalization. The phonograph is of the automatic record changing type. Handles up to ten 10- and 12-inch records, mixed. Pickup, of tangent-arm type, reduces record wear.—Radio-Craft

REMOTE CONTROL RADIO TELEPHONE
Jefferson-Travis Radio Mfg. Corp. 136 W. 52 St., New York, N. Y.

A 50-W. completely remote-controlled radio telephone instrument. It is possible with this instrument to place the main unit in some inconsiderable spot below deck while up to 3 remote control units may be placed at convenient locations in various parts of the vessel. These control units consist of telephones, speakers and operating controls. An automatic voice control feature eliminates the need for a press-to-talk, button arrangement. Further, a remotely-controlled "gate" is designed to suppress static. All components of the instrument are completely corrosion-proofed to stand up against moist salt atmospheric conditions.—Radio-Craft

360° TRUMPET
University Laboratories 195 Chrystie St., New York, N. Y.

MODEL RSH Radial is not a cone speaker but an exponential driver unit speaker of the high-power public address type. Acoustically it is claimed to be equivalent to a 3-ft. exponential horn. Provides 360° radiation. Overall height, 20" bell dia., 15 ins. It is claimed to give uniform distribution without "hot" spots and is especially useful where one speaker must cover large areas and still overcome high background noise.—Radio-Craft

75-CHANNEL ULTRA-H.F. SMITTER-RECEIVER
Westinghouse Electric & Mfg. Co. Radio Division, Baltimore, Md.

The type HR ultra-H.F. transmitter-receiver battery-powered has 75 calibrated frequency channels in the band from 28 to 65 mc. Ideal for communication between scattered field groups as in traffic, fire, large-scale construction, or rescue control work. Weight, complete with batteries, amber in this instrument to suit telephones and has an approved 30 lbs. Receives on one channel, sends on another, crystal-controlled. Tube complement: 8608 triodes, 1-659 pentode. 1-1572 twin-pentode. Output, 0-5-W. min. Av. receiver sensitivity, 5 microvolts.—Radio-Craft

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Your chance to get exact re-print of original $25.00 Radio Technical Institute course for only $1.95, the full price. This is the latest Radiotelevision Course, complete in every way, and exactly the same as the much higher pricedorige lesson. You will receive full satisfaction.

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The training is remarkably complete. You quickly learn radio servicing from simple circuits to signal tracing. From the very start you are introduced to real radio methods and equipment. After finishing this course you will be able to expertly service every radio set. Take advantage of this unusual bargain in radio education.

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Back your course to us today. May take ten additional lessons and every bit the same as the course you have already started. Each lesson will save enough to pay the special $1.95 price for the complete course.

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Ship the complete Radio Course at the special reduced price. We will examine your work. You will receive a diploma of completion and a certificate of achievement.

\[ I \] I am enclosing $1.95, the full price, sent postpaid.
\[ II \] I ship C.O.D. I will pay postman $1.95 and a few cents for postage.

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TESLA-OUDIN COILS
10c En. in order for 10 
(Data and Drawings only)
36" Sp'k Tesla Coil (1 K.W. Exc. Trf. Data incl.)
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3 Tesla Works on Ford Coil 40c
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5 Meter Superhet.
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New you can have an expensive noise-free antenna system for a com- plete Kit consists of unique components: Generator, control box, switch; one which is attached to the a-c power line. The receiver or earphones and the antenna are connected in place of radio. Installation simple as ABC. Anyone can do it. For use with broadcast and short-wave receivers. Built-in transformer is shielded in aluminum case. Weather resistant; can't be encroached on, or rusted. Complete kits included. Packed in original box. Shp. Wt. 1 1/2 lbs.

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**SUPRE SPECIAL**
3 5/8" R.P.M. SYNCHRONOUS MOTOR
This high-torque, low-speed universal motor making only 3 5/8" R.P.M. for use in variable-speed drives. Particularly well adapted for crowbar-electric window-drive, store-window display, small fan motor, etc. Also ideal for cutting tables, as an electric winch on an overhead crane, derrick motor in erecter sets, etc. Built-in high-speed step-down gears and ball-bearing frame to minimize loss of power. Made by Dayton Mfg. Co. of Dayton, Ohio. Diameter 3 1/2". 3 1/8" thick overall. Shp. Wt. 2 lbs.

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This attractive light gathers its own illumination from an ordinary electric hand. Gives strong light; water-proof, weather-resistant. Costs nothing to main- tain. A leading tool for service, tool box, or any other purpose. Fully satisfy your needs. Packed in original box. Shp. Wt. 1 lb.

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In your package, a 3 1/2" looking glass, complete with 2% discount. Send money order, certified check, new U. S. stamps, or C.O.D. to foreign countries.

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**RADIO-CRAFT for DECEMBER, 1940**

CONTACT SERVICE KIT
General Cement Mfg. Co. 919 Taylor Ave., Rockford, Ill.

MODEL 777 service kit is designed for cleaning noisy attenuators, tuners, all-wave switches, variable contacts, etc. Consists of special contact cleaner and corrosion-resistant lubricant.—Radio-Craft

NEW GLASS FUSSE
Littellus, Inc. 4757 Ravenswood Ave., Chicago, Ill.

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"DETERMOMH" DECADE RESISTANCE BOX
Ohmite Mfg. Co. 4835 Flourny St., Chicago, Ill.

This instrument makes it simple as A-B-C to determine the proper replacement re- sistors for burn-out in circuits. It is available in 2 ranges, viz., 1 to 9,999, and the other 10 to 99,999 ohms. These sizes are in addition to the 100 to 900 ohms resistor kits already available. The resistance element is made up of wire-wound resistors connected to tap-switches. May be connected directly in any radio or electrical circuit which does not cause the instrument to dissipate more than 1 W. for each tap in the circuit. Measures 6-3/16 x 8 3/8 x 3 3/4 in. deep.—Radio-Craft

MINIATURE RADIO
DeWald Radio Mfg. Corp. 436 Lafayette St., New York, N. Y.

WEIGHING only 4 lbs., this model 410 receiver is a miniature personal radio set. Features of its circuit include automatic volume control, built-in loop antenna, tuning range of 170 to 240 kc. and a dynamic speaker. The receiver is housed in a compact, radio-tight, cast aluminum simulated-o-whyde case which measures but 8 x 4 1/2 x 8 3/4 in. deep.—Radio-Craft
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Permanent . . . . P

Belden MF'G, CO., 4647 W. Van Buren St., Chicago, Ill.

CRUCIBLE STEEL CO. OF AMERICA, 405 Lexington Ave., New York, N.Y.

General Electric CO., Schenectady, N.Y.


Racz Electric CO., INC., 52 E. 19th St., New York, N.Y.


METAL FOR RADIO

Aluminum . . . . A

Brass . . . . B

Chassis . . . . C

Core materials . . . CM

Dissolved . . . . DC

Foils . . . . F

Laminations . . . L

Molybdenum . . . M

Nickel . . . . N

Permanent magnets . . . PM

Racks . . . . R

Speaker housings . . . SH

Staplings . . . . S

Tantulum . . . . T

Transformer housings . . . TH

Tungsten . . . . T

Special chemicals and metals . . . SCM

Spring contact metals . . . SM

Graphite . . . . G

Tube parts . . . . TP

Copper wire . . . . CW

Electrical sheet . . . . ES

Cold-rolled steel . . . . CS

Stainless steel . . . . SS

Zinc . . . . Z

Pullies . . . . PS

Bracket . . . . B

Perforated nickel . . . . PN


Airplane & Marine Direction Finder Corp., Cleveland, Ohio.


American Radio Hardware Co., Inc., 590 S. Broadway, New York, N.Y.

Radio Craft for December, 1940.
MICROPHONES

Airplane & Marine Direction Finder Corp., Clearedfield, Pa.
Allied Products Co., 715 Center St., Brockton, Mass.
Allied Dns Co., 108 Madison Ave., Toledo, Ohio-Dyn, VEL, ACC
Allied Engineering Institute, 85 Warren Ave., Newton, N. Y.
Allied Radio Corp., 813 W. Jackson Blvd., Chicago, Ill.
American Condenser Corp., 2508 S. Michigan Ave., Chicago, Ill.
American Microphone Co., Inc., 1915 Western Ave., Chicago, Ill.
American Phonologic Corp., 1520 Van Buren St., Chicago, Ill.
Americophone—ACC, TEL, VEL
Amperite Company, 561 Broadway, New York, N. Y.
*Amphenol, American Phonic Art Corporation, Specialty, New York, N. Y.
Audiograph Sound Systems, 1313 W. Randolph St., Chicago, Ill.
Bell & Howell, Inc., 501 W. Winthrop Ave., Chicago, Ill.-Dyn, VEL
Barker & Williamson , Ardmore, Pa. —PA
Bell Sound Systems, Inc., 1183 Eves Ave., Columbus, Ohio—Bell, Cry, Dyn.
Benson Radio Co., Inc., 145 Hudson St., New York, N. Y—ACC, TEL
Bell Radio, Inc., 661 W. Randolph St., Chicago, Ill.
Buhl, Inc., 205 Cedar St., Cleveland, Ohio—Dyn, VEL
Bullen, Transducer Laboratories
Cannon Electronic Development Co., 420 West Ave., 33 Los Angeles, Calif. —ACC
Carhart Microphone Co., 479 So. La Brea Ave., Inglewood, Calif.—CON, Dyn
Clos Circuit Engineering Co., 1505 S. Verdugo Ave., Burbank, Calif.—CON, Dyn
Crumpacker Distributing Co., 1801 Fannin St., Houston, Texas—ACC, Dyn
Dynebrite Corporation, 1435 Amittle Ave., Chicago, Ill.—Dyn, VEL
Electro-Metal. Afco., 54 Crystal St., Brooklyn, N. Y. —Eastern—ACC, CON, Dyn
Electrical Industries Mfg. Co., Red Bank
Electro-Voice Mfg. Co., 1279 South Bend Ave., Chicago, Ill., Electro-Vite—Cry, Dyn
ERWOOD Sound Equipment Co., 224 W. Huron St., Chicago, Ill.—CON, Cry, Dyn, ACC
Fischer Dyeing Corp., 222 Fulton St., New York, N. Y—CAR, CON, Cry, Dyn, HB, VEL, ACC, CR, ACC, STD, VEL
Galvin Mfg. Corp., 454 Augusta Blvd., Chicago, Ill.—Motorola
General CEMENT MFG. CO., 919 Taylor Ave., Racine, III.—ACC, VEL, STD, Dyn, HUNTER PRESSED STEEL CO., 8th St., & Maple Ave., Lansdale, Pa.
H.C, Satalyst Co., Inc., of America INSULINE CO., OF AMERICA, 3030 Northern Blvd., Lawn, N. Y., TCA—CAR, HOWARD B. JONES, 2306 Wabansia Ave., Chicago, III—CT
Kelllogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Il.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.—Kar—Cry
The Haloid Co., 4500 Ravenworth Ave., Chicago, Ill,—STD
Hunter Pressed Steel Co., 8th St. & Maple Ave., Lansdale, Pa.
H.C, Satalyst Co., Inc., of America INSULINE CO., OF AMERICA, 3030 Northern Blvd., Lawn, N. Y., TCA—CAR, HOWARD B. JONES, 2306 Wabansia Ave., Chicago, III—CT
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.—CAR, CON, CR, DYN, HB, VEL, ACC, STD, CR
Montgomery Ward & Co., 619 W. Chicago Ave., Chicago, Ill.—CON, Dyn, VEL, ACC, CR, STD
Motorola, General Mfg. Corp.
“Mystic Mikes” 200 W. Chicago Ave., Chicago, Ill.
Olson Mfg. Co., 362 Wooster Ave., Akron, Ohio—Mystic Mike—CAR, HB
Operadio Mfg. Co., St. Charles, Ill.—Cry, Dyn, VEL, STD
Paraphone Hearing Aid, Inc., 400 Euclid Ave., Cleveland, Ohio—CAR
Permanic, Quin-Nichols Co., 110 6th Ave., New York, N. Y.—“Amperite”—Cry, TEI, VEL, STD
Permaphone, American Phonic Art Corporation, Specialty, New York, N. Y.
Philo Mfg. Co., 113 University Place, New York, N. Y.
“Phonolophone” Laboratories, Inc., 5, E. 55th St., New York, N. Y.
“Phonolophone” Laboratories, Inc., 125 Piltchorage Ground Ave., Chicago, Ill.—Phonolophonic—Dyn
Racon Electronics Inc., 610 W. New York, N. Y.
Radio Receiver Inc., 251 W. 17th St., New York, N. Y.
Radiotone, Incorporated, 7336 Melrose Ave., Hollywood, Calif.—Cry, Dyn
Radokey Company, 601 W. Randolph St., Chicago, III.—CAR, CAR, Dyn, HB, VEL, ACC, STD, CR, STD
Remler Co., Ltd., 2401 Bryant St., San Francisco, Calif.
Rowe Industries, Inc., 1200 Monroe Street, Toledo, Ohio—Dyn
Maurice J. Katz & Son, 715-718 Broadway, Schenectady, N. Y.—CAR, CON, CR, Dyn, HB, VEL, ACC, STD, TEL
Selectar Mfg. Co., 30 W. 15th St., New York, N. Y.
Setchell, Inc., 2233 University Ave.
Shure Brothers, 225 W. Huron St., Chicago, Ill.
Smith-Bird Co., 861 S. 4th St., St. Paul, Minn.
Mark Simpson Dist. Co., Inc., 16 Hudson St., New York, N. Y.
Sound Equipment Co., 150 W. 45th St., New York, N. Y.—“Spectophone”—Cry, Dyn, VEL
Stromberg-Carlson Telephone Mfg. Co., 1525 Anderson Ave., Sun River Dr., New York, N. Y.
Sun Ray, Inc., 122 1st St., New York, N. Y.—CAR, CON, Dyn, HB, VEL, ACC, CR, STD
Sunnit Engineering Company, 4717 Ravenswood Ave.
Timbrell Laboratories, Camden, Me.
Transducer Laboratories, 42 W. 48th St., New York, N. Y.—Dyn
Turner Corp., 990 17th Ave., Cedar Rapids, Iowa—CON, Dyn, HB, ACC, STD, Universal Microphone Co., Inglewood, Calif.—CAR, CON, Cry, Dyn, VEL, ACC, STD, VEL
Veboltron, Bruno Laboratories, Inc.
The Webster-Chicago Corp., 5622 W. Bloom.- ingdale Ave., Chicago, Ill.—Cry, Dyn, VEL, ACC, STD
“Western-Chicago” 1917 West Chicago Electric Co., 300 Central Ave., Keeney, N. J.—CAR, CON, Dyn, ACC, CR, STD
NOISE ELIMINATION EQUIPMENT

Interference analyzers... IA
Interference locators... P
Power filters... S
Radio set filters... S
Industrial noise analyzers... INA

Aerovox Corporation, 740 Belleview Ave., Cleveland, Ohio
American Communications Corp., 123 Liberty St., New York, N. Y.—IA
Astitc Electric Mfg. Co., 729 S. Front St., Manchester, Minn.
Belden Engineering Company, 4647 W. Van Buren St., Chicago, Ill.
Bendix Radio Corp., 920 E. Fort Ave., Baltimore, Md.
Bendix Radio Corp., 5005 Cedar Ave., Cleveland, Ohio—“Bud”—P
Consolidated Wire & Assoc., Perio
Continental Carbon, Inc., 1390 Lorain Ave., Cleveland, Ohio, “Continental”—“Filternoy”
Cornell-Dubilier Elec. Corp., South Plainfield, N. J—“Quinton”—P
Electric Products Laboratories, 549 Rand.,olph St., Chicago, Ill.—S
Ferris Instrument Corp., Boonerton Ave., Boonton, N. J.—“Ferrit”—IA
Filternoy, Continental Carbon, Inc
General Electric, General Electric—P
General Winding Corp., 254 W. 31st St., New York, N. Y.
Gen. Win. General Winding Corp., 1390 Lorain Ave., Cleveland, Ohio—“Continental”—“Filternoy”
Haddorff & Co., 1473 23rd Ave., Oakland, Calif.
Haraldorff, 4500 Ravenswood Ave., Chicago, Ill.
“Insinine” of Continental Corp.
J. C. Howard, 30-30 Northern Blvd., Long Island City, N. Y.—“J. C. Howard”—P
International Transformer Co., 17, 20th St., New York, N. Y.—P
Meissner Mfg. Co., 7th & Belmont, Mt. Carmel, Ill.—S
Middle Atlantic Products Co., 9517 S. Main St., Los Angeles, Calif.
*Miller—IA, 1, P.
Omniite Mfg. Co., 4035 S. Flournoy St., Chicago, Ill.—P
Philco Radio & Television Corp., Torre & C.
*Philosophical Mfg. Co., 113 University Place, New York, N. Y.
Pioneer Radio Company, 1239 Cornell Ave., Chicago, Ill.
Quieten, Cornell-Dubilier Elec. Corp.
*Snyder, Incorporated, 813-23 Noble St., Philadelphia, Pa—P
Sprague Products Co., No. Adams, Mass. 1, S
*Taco, Technical Appliance Corp.
Technical Appliance Corp., 17 E. 16th St., New York, N. Y.
*Tefft Radio Co., Plymouth, Calif.—“Tefft”
Television Co., 314 N. Pulaski Rd., Chicago, Ill.—IA
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111爱好 New York, N. Y.
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F.C.C.'S MAIL BAG

With reference to reallocation of frequencies under the North American Regional Broadcast Agreement, the Commission is unable to advise about prospective individual changes pending working out of the reallocation plan in its entirety. Full publicity will be given when frequency shifts at that time. Meanwhile, it is not necessary for a station to make application for such change in frequency.

The Commission is likewise without authority to take remedial action with respect to the following complaints:

A Brooklyn, N.Y., man is irked because a network substituted an address given by Winston Churchill for the usual baseball program.

A Washington, D.C., man alleges failure of the network to advise the listening audience concerning the reconvening of the Republican National Convention.

A San Francisco listener takes issue with the "man in the street" type of programs.

A Bronx, N.Y., individual would bar the radio to minority groups.

A W.T. Vm. reads condenser voltage as the drop across a resistor on a scale calibrated in w.p.m.

The Board of Directors of the National Assoc. of Broadcasters has urged all stations carrying foreign-language programs to exercise extreme precautions against the use of their facilities, wittingly or unwittingly, to promote propaganda inimical to the interests of the United States." (Program censorship? Main plan is to prevent deviations—ad libbing, for example—from script; and to institute a reference file of all foreign-language program script.

The "Adam Hats" fight broadcasts instituted 3 years ago are credited with boosting the number of the company's stores from 275 in the Metropolitan N.Y. area to over 2,000 extending coast-to-coast.

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Mr. Serviceman: Do you know how to construct, sell install and service Fluorescent Light-Up Radio-Craft, in which will appear Part I of an informative article on this popular, money-making subject.

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SUN MACHINE & TOOL CO., 197 S. Michigan Ave., Chicago, Ill.-RL, WP
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TOKO MFH. CO., 1795 N. Magnolia Ave., Chicago, Ill.
TRANSFORMER CORP. OF AMERICA, 47 Wooster St., New York, N.Y.-ARC, EL, RR, RP, TR, TT, WP
TROY RADIO & TELEVISION CO., 1144 S. Olive St., Los Angeles, Calif.-EL, RP, WP
TUNN'S RADIO, 723-4 Lake St., Oak Park, Ill.-R, S
UNITED CINEMA CO., Sound Equip. Div., 60-73 33rd St., Long Island City, N.Y., N.-CL, PP, RP, TT
UNITED STATES RECORD CORP., 727 Broadway, New York, N.Y.-RP, TR, WP
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VOCALION—Columbia Recording—Chicago, Ill.-EL, WP
WEBSTER-CHICAGO CORP., 3422 Bloomingdale Ave., Chicago, Ill.-ARC, EL, M, PM, RP, TR
WEBSTER-CHICAGO CORP., The Webster-Chicago Corp. WEBSTER ELECTRIC CO., Racine, Wis., W.-"Webster" ELECTRIC CO., PM, P, H
WESTERN ELECTRIC CO., 300 Central Ave., Keeney, N.M.
WESTERN SOUND & ELECTRIC LABS, INC., 33 1/2 Kilbourne Ave., Milwaukee, Wis.-N
WILLiam ELECTRIC CO., INC., 4041 State Line, Kansas City, Kans.-RC
WILCOX & GAMPP CORP., Charlotte, N.C.-N, R, RA, WP
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ZENITH RADIO CORP., 6001 Dickens Ave., Chicago, Ill.--ZEPHYR—Shure Bros

(Part IV next month.)

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HOWARD Model 490 has sensitivity that never knows "crowding" and selectivity that may be varied at will from the hi-fi linear sharp position required for CW to the wide band requirements of high fidelity reproduction. Contains 14 tubes. Tuning covers 540 Kc to 48.5 Mc in 5 bands. Incorporates 2 RF stages, calibrated band switch, air tuned IF's, temperature compensated oscillator, split stator tuning condenser, 9 position variable IF selectivity, variable audio fidelity, automatic noise limiter and dozens of other spectacular features. Comes complete with 10" matching speaker and crystal filter.

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satisfaction of the stage may be raised or lowered. Ex-
ample: if R is normally 20,000 ohms, change to
15,000 ohms and add a 10,000-ohm vari-
ble resistor in series, as shown in circuit R. Decreasing the amount of resistance
increases the gain while increasing the
amount of resistance lowers the gain. Un-
less the value of C is over 1 mf, it may be
advantageous to increase it when making the
change.

E. H. DISNEY,
Lowery City, Mo.

NOVEL TUNING INDICATOR

A FORM of zero-center vacuum-tube vol-
meter is shown in the diagram, where a
6ES is biased to cut-off. If positive voltage is
applied to the control-grid, the shadow will
open, since the net grid bias will then be
decreased by the amount of grid voltage
applied. When the grid bias is negative, the
shadow will overlap as it closes. With no

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If no bleeder resistor is used a part of the
screen-grid dropping resistor R may be
made variable, in which case the effect
is reversed. I.e., increasing the resistance
duces the gain and decreasing the resis-
tance reduces the gain. In either ar-
rangement the maximum sensitivity want-
ed for a certain condition is established.
The sensitivity control is set for that level
and thereafter the regular volume control
is used as usual. This trick is done only over
a portion of the screen-grid voltage range
and that portion must be found by experi-
menting.

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RADIO-CRAFT for DECEMBER, 1940
bias applied, except that through the cathode resistor, the shadow is adjusted so it just about closes in the "tuning eye".

The same circuit finds application in the new Scott custom-built receivers, but may also be used for F.M. alignment in place of an expensive microammeter or V.T. voltmeter.

WILLARD MOODY,
New York, N. Y.

SHOP LAMP

THE sketch shows a tool which is extremely useful and simple to make. An inexpensive line cord (mine came from a 2c. soldering iron that had burned out) is soldered directly to the contacts of a 7-watt, 110-volt light bulb, and then bound with tape. A short length of number 14 enamelled wire is wound over the tape and then bent to form a hook. Another layer of tape is added to hold the wire in place. The unit can be hung from the hook-up wire under any chassis, and gives ample light without bothering your eyes. The heat of the bulb will not damage tubular condensers. You can use the gadget on sets in any position, and you can't do without it for final adjustments on trimmers, and minor wiring jobs when the chassis is mounted in a console. The unit is just as useful in the daytime as it is at night.

JOHN M. KENNEDY,
New York, N. Y.

"INTERMITTENT" INDICATOR

RECENTLY, I had occasion to service a 7-tube A.C.-D.C. midget, which would intermittently cut out, sometimes after playing satisfactorily for as much as 2 hours. The trouble was found to be caused by an intermittent open in the heater circuit. A careful inspection showed the wiring to be intact, thus localizing the trouble in one of the tubes. Since it would obviously be impossible to test each tube separately in a tube checker, due to the long periods of time involved, I devised the scheme shown here to locate the offending tube under actual operating conditions.

A 115 volt, 71/2-watt bulb was clipped into the circuit across the suspected tube, and glowed faintly until the tube's heater opened; then burned with nearly normal brilliance. It was only necessary for me to turn on the set, and glance at the light bulb when I heard the set stop playing.

THOMAS FREDWITT,
Plainfield, Ill.

FOOT VOLUME CONTROL

THE expensiveness of foot volume controls often prohibits their incorporation in circuits in which they might otherwise be useful. To meet the need for an inex-

In addition to presenting detailed instructions on service work, this book includes chapters on special alignment and adjustment problems. For example, in the servicing of F.M. receivers, etc. The section on operating servicing illustrates the use of a loudspeaker, a signal generator, and signal generator in making practically any required test in repairing receiver faults. This book is based on the use of a commercial signal generator.


Revised. "Radio Operating Questions and Answers," now in its 20th year as a standard technical radio review book, represents a reprint in a new, pocket-size format. It contains practically all questions and answers, and home study schools specializing in radio communication courses, and to available text-books. A new section in this edition is "Radio of the Scene," and wireless operators and answerers cover the scope of commercial radio operation license examinations (Elements 1 to VI of the F.C.C. requirements). The book is recommended to students and operators about to take a government examination for a radio operator's license.

Chapter: Basic Radio Laws: Basic Theory and Practice; Radiotelephone: General Radio Operation; how to use Radio. Appendix I: Operating Abbreviations, etc.; Appendix II: Rules Governing Commercial Radio Operation; and Extracts from Radio Laws: Index of Subjects; Index of Diagrams and Illustrations.


This little booklet should be the property of every radio Serviceman. It discusses the following installations in accordance with the scope of the American Standards Association: Antennas and Construction; Protective Devices; Protective Devices; Protective Wiring; Grounds; Power Line Connections; and, Batteries.


This new manual on home wiring practices is a guide for checking and writing specifications, and the material specifications for home wiring, as well as suggested ways of checking the completed installation. A series of tables useful to radio installers concludes the booklet.


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