What About Radio in 1937? — March of Tubes — "Radio Kaleidochrome"

Make these: Midget Oscilloscope; Standard Tube Tester; 1-Tube Set

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HUGO GERNSBACK, Editor-in-Chief  
C. W. PALMER  
C. P. MASON  
Technical Editor  
R. D. WASHBURN, Managing Editor

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THE MAY PUBLIC-ADDRESS NUMBER—

—will contain information of importance not only to public-address specialists but also will prove to be an exceptionally interesting issue for the set builder, the Service Man, and the electronic technician.

"The Eternal Road"—the Max Reinhardt production that has set the theatre world agog—incorporates developments of prime importance to men in the sound field. The "whispering inter-phone" and other features in this production are described for Radio-Craft readers.

A 4-tube set, of simple design, that excels in tone quality is described for the set builder.

If it is scientific fiction you like, read "The Clairvoyant Dr. Fox."


Foreign Agents:

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RADIO-CRAFT is published monthly, on the first of the month preceding that of date; subscription price is $2.50 per year in U. S. and Canada. (In foreign countries, $3.00 a year to cover additional postage.) Entered at the post office at Springfield as second-class matter under the act of March 3, 1879.

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**I will train you at home for many good spare time and full time radio jobs.**

Do you want to make more money? Radio offers you many opportunities for well-paying spare time and full time jobs. And you don't have to give up your present job or leave home and spend a lot of money to become a Radio Expert!

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Radio broadcasting stations employ engineers, operators, station managers and pay up to $5,000 a year. Spare time Radio set servicing pays as much as $200 to $500 a year—full time jobs with Radio Repairers, manufacturers, and dealers as much as $30, $50, $75 a week. Many Radio Experts operate their own full time or part time Radio sales and service businesses. Radio manufacturers and jobbers employ testers, inspectors, foremen, engineers, servicemen, paying up to $6,000 a year. Radio operators on ships get good pay and see the world besides. Automobile, police, aviation, commercial Radio, and loud speaker systems are newer fields offering good opportunities now and for the future. Television promises to open many good jobs soon. Men I have trained are holding good jobs in these branches of Radio. Read their statements. Mail the coupon.

**There's a Real Future in Radio for Well Trained Men**

Radio already has 28,000 jobs to move more than 300,000 people. In 1936 over 300,000,000,000 words of sets, tubes and parts were sold—an increase of 20% over 1934! Over 1,100,000 auto Radios were sold in 1935, 25% more than in 1934! 22,000,000 homes are today equipped with Radio, and every million of these sets go up out of date and are replaced with newer models. Millions need servicing, new tubes, repairs, etc. Broadcasting stations pay their employees (exclusive of artists) more than $25,000,000 a year! And Radio is a new industry, still growing fast! A few hundred $30, $50, $75 a-week jobs have grown to thousands in less than 20 years!

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Act Today. Mail the coupon now for "Rich Rewards in Radio." It's free to any fellow over 16 years old. It describes Radio's spare time and full time opportunities and those coming in Television; tells about my training in Radio and Television; shows you actual letters from fellows I have trained, telling what they are doing and earning. Find out what Radio offers YOU! Use this COUPON in an envelope, or paste it on a postcard—NOW!

**J. E. SMITH, Pres., National Radio Institute**

Dept. 7DX

Washington, D. C.
VALUE...

that Stands Out

Like a Neon Sign on a dark street Rider Manuals stand out as the greatest manual value ever offered the radio serviceman. Complete information on radio receivers of over 350 different makers—7970 pages check-full of pertinent service data on the greatest number of models ever compiled in one work—and all presented in a way that makes it easy to find all of what you want when you want it. . . . Over a hundred and thirty thousand volumes of Rider Manuals, now in use, testify to the tremendous value of these outstanding books in saving time—increasing profits—and guaranteeing success for the work of the radio serviceman.

When you consider that your very next job may require the information contained in the very Rider manual you have “never gotten around to buying”—when you consider that your Rider Manuals can be kept up-to-date for the profit from one additional tube, take a week, you can see why we say, “You are taking unnecessary chances trying to ‘get by’ without a complete set of seven Rider Manuals”—the radio serviceman’s most inexpensive necessity.

Volume II—6.50—1931-32 Volume IV—7.50—1933-34 Volume VI—7.50—1935-36

VOLUME VII—1600 PAGES—$10.00 COVERING 1936-37.

Volume VII contains complete service information on radio receivers produced by these 105 Manufacturers.

Compare this list before buying any manuals.

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Autocrat Automatic Bosch Belmont Brunswick Radio Corp. Buckingham
Radio Corp. Cadillac Capemart Case Champion Climax Continental Coopera Crossley Detrola De Wald Eelectrad, Inc. Emerson Fada
Fairbanks Morse Federated Firestone Friedt
Gamblin Skorano Good
Gates Radio & Supply Co.
General Electric General Household Griffith Goodyear
Hallcrafters Halson Hammarlund Hetro
Horn Howard International
Intercity
Jackson Bell
Kenedy, Collin B.
Kodel Lafayette
Laurelhugh Mfg. Co.
Macy
Major
Midwest Mission Bell
Monarch
Montgomery Ward
Noblet Sparks
Oberadio
Pacific
Packard Bell
Patterson
Petersen
Pilot
RCA
R R Radio
Radio Laboratories, Inc.
Radio Circular
Radio MG.
Engineers, Inc.
Radio Products
Radio Corporation of America
Radio Corporation of America
Radio Corporation of America
Reading
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T.C.A.
Tatro
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Triangle
Truplett
Zealith
Zephyr

Turner Co.
United Motors
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Wilcox Gay
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Co., Rudolph
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Please Say That You Saw It in RADIO-CRAFT

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CELESTIAL ELECTRONICS

An Editorial by HUGO GERNSBACK

WHEN WE speak of the electronic art, we usually refer to electronics generated in various types of man-made vacuum tubes, which we use for exploiting various effects. Of such effects, scientists now know hundreds, and new uses for electronic tubes are found almost daily. Whether such tubes are used for television, whether they are used to open doors automatically as we approach them, whether we use them to assort beans or cigars, it is always the invisible electronic stream which is being used.

So when we contemplate these man-made electronic instruments, we realize the fact that there is nothing new about electronics. Indeed, it goes back for countless billions of years, since the first star was born.

But another and very curious point which I believe has never been described before is that the exact counterpart of an electronic tube actually exists not only in our own planetary system, but is probably duplicated myriads of times as well as in other universes throughout space.

Believe it or not, but the sun with the earth 93,000,000 miles distant is a remarkably close 3-element vacuum tube, similar to what we use in our radio sets. We have first the sun (the active cathode), far more efficient as an electron producer than anything we have ever produced on earth. As in the radio vacuum-tube filament, which is heated to incandescence, so the sun is also an incandescent body furnishing a steady yet invisible electronic stream which bombards the earth continuously, day in and day out, and has been doing so for countless millions of years. Scientists figure that the solar electronic stream takes about 26 hours to reach the earth from the sun. We know that this stream is not propagated at the speed of light, which is 186,000 miles an instant; therefore, reaches us in some 8 minutes from the sun. Whenever there is a solar disturbance of any magnitude, the solar electronic emission is increased or varies (fluctuates) and we know about it 26 hours hence.

The atmosphere of our earth may be taken as the exact counterpart of the grid in an electronic tube. Our atmosphere is made up of gases, and the molecules composing these gases are of such magnitude that during the solar bombardment various electrical phenomena are produced. Thus, before the solar electronic emission reaches the earth's surface the latter may be compared to the anode or "plate" of our celestial vacuum tube (the interposing atmosphere is the "grid" and acts similar to the grid in a man-made vacuum tube).

This is easily proved by several examples. The earth is electrified by the solar emissions, which set up electric currents in the earth's crust. This gives the earth its 2 magnetic poles; one the north magnetic pole, the other the south magnetic pole. When the highly charged solar electrons hit the upper layers of our atmosphere, certain electrical disturbances result and these disturbances make themselves known as the Northern Lights. Similar lights can be produced in any electronic tube under similar circumstances. When the tube is soft, that is, when it has too much gas content. If the earth had no atmosphere, or gas, it would then also not have its "grid" and consequently we would have no "northern lights" as we now have them.

While this discussion may be of interest from a purely theoretical viewpoint, I believe, it will also have its practical counterpart in the future, because here we have electronics on a large scale that can be investigated and important inferences drawn. Of course, there are many other electronic celestial phenomena which so far we have not made use of. Thus, for instance, we know that the tails of comets are only highly rarefied gases, much more rarefied than in our best electronic tubes. We also know that due to the electronic bombardment of the sun the tail of the comet always points away from the sun. Such phenomena we have duplicated in man-made tubes invented by Crookes and Nikola Tesla, but so far no practical application of these phenomena have been made.

When large sun spots appear, we have violent magnetic storms which cross through the earth's crust, interfering with telegraph and telephone communication and often putting both out of business for hours at a stretch. These disturbances are the aftermath of what happened on the sun and show the magnitude of the force.

We have produced large electronic tubes that due to the activity within them afford innumerable and varied results; however, we have not as yet succeeded in producing a "tube", or equivalent device, that permits us to achieve these results outside of the envelope. True, slight electronic activity may be obtained close to, and on the exterior of certain types of electronic tubes but, in a large sense, we have not yet mastered the secret of utilizing that electronic energy which is so abundant in our solar system and, in proportionate amount, on our earth. One practical consideration which such mastery of natural forces would involve would be to provide with our first electric stream so that this would open entirely new avenues of accomplishment which we, today, do not even suspect the existence.

But most important is the tremendous fact that science as yet has made no effort at all to tap this titanic electrical force which comes to us through solar electronic streams day in and day out.

There is no question that the electronic stream which we thus receive from the sun is of such magnitude that if captured, electrical energy would be immediately available at a rate undreamed of today. As the force continues in day and day out unabated, it will be only a question of harnessing the electronic stream by suitable means to give us such cheap electrical power as we of today can not even imagine.

When electricity first became known, all dynamos and generators of the day, without exception, were driven by coal. A little later on we took to gasoline, (which we still use,) and then we started to make use of our water power with which to run our generators. The next great step in technical advance will be the scrapping of all generators of every type in favor of electronic power, collected by huge electrical devices, then to be transformed into usable electric current which will be dispatched over the usual high-tension wires to factories and the individual consumer.

While we are still a long way from this electronic millennium, the time is drawing nearer and nearer when all of the world's machinery and electricity will be dependent upon celestial electronics.
P. A. IN THE AUTO STRIKE

ELECTRONIC devices played their part last month in the strike demonstrations at several plants of the General Motors Corp. In one of the demonstrations, which raged through an entire night, a CIO organizer in a sound truck roared directions to the strikers, in spite of police gas-bombs and missiles.

At plant No. 2 of the Chevrolet Co. another labor organizer gave instructions to "sit down" strikers inside the plant, from the outside, by means of a car having a P.A. installation. Since there was no way to communicate with strikers, the P.A. voice was the only means of carrying on official business between the labor representatives and the "sit downers."

Public Address, it seems, has other uses than the usual ones of electoneering and voice magnification in auditoriums!

H. F. MASSAGE HELPS POPE PIUS

THE latest development of Guglielmo Marconi—a system of micro-wave therapeutics—was used successfully last month in the treatment of Pope Pius's ailing legs.

The process consists of electric massage using currents of extremely high frequency (in the micro-wave range). This treatment was effective not only in relieving the neuritis from which he was suffering but also in healing the greater part of his varicose leg ulcers, especially in the left leg, it was reported.

The differences in Marconi's diathermy equipment and those available in the U.S. were not pointed out in the reports received, but it is estimated that very much higher frequencies than normal were used.

The effectiveness of such treatments in certain types of ailments, however, was amply proven by the improvement in the Pope's condition after application.
Radio is now such a vast and diversified art it becomes necessary to make a general survey of important monthly developments. RADIO-CRAFT analyzes these developments and presents a review of those items which interest all.

RADIO AS A FLOOD AID

THE unparalleled importance of radio, especially amateur radio, can be realized by the instructions issued by the F.C.C. last month, in connection with the devastating floods of the Ohio and Mississippi Rivers. The instructions read: "The F.C.C. has been advised that the only contact with many flooded areas is by amateur radio, and since it is of vital importance that communications with flooded areas be handled expeditiously, it is ordered that no transmissions except those relating to relief work or other emergencies be made within any of the authorized amateur bands below 4,000 kc. (75 meters) until the Commission determines that the present emergency no longer exists."

The broadcasting stations in the flooded areas have done their work in a commendable manner—especially at Louisville, Ky., where the authorities used the local stations WHAS and WAVE for communication with neighboring cities and towns for such calls as for police aid, vaccine, boats, fire fighting equipment and lights. Many of the stations in the affected area—notably WLW—placed their facilities at the disposal of the relief agencies.

A 4,000-CELL PRISON RADIO

IN MATES of Jackson Prison, at Jackson Mich., can now enjoy all the comforts of home—even radio—during their enforced residence at the institution. News was received, last month, that a new radio installation, the largest of its kind, has just been finished in the prison, to permit the inmates to enjoy radio broadcast programs. The equipment includes 3 channels which feed the 4,000 cells of the Michigan State Prison at headphone volume.

THE MAXIM AWARD FOR AMATEURS

IN memory of their father, the late Hiram Percy Maxim, the son and daughter of the founder of the A.R.R.L. established, last month, an annual award to be given to the amateur under 21 years of age who has made the greatest contribution during the year to amateur radio.

The award is in the form of a gift of $100 in cash and a miniature reproduction of the famous "Wouff Hong"—mythical implement of punishment for amateurs indulging in unsportsmanlike and unethical practices. Since the death of "The Old Man" the "Wouff Hong" has become a symbol of the principles and personality of the beloved patron of radio amateurs throughout the world.

SOS ROBOT THREATENS RADIO OPERATORS

AN automatic radio operator to intercept SOS signals from distressed ships sent the American Radio Telegraphists Association into a furor last month, when Hoyt S. Haddock, president of the association sent a scorching letter to the F.C.C.

Mr. Haddock said: "It is our belief that the public should be thoroughly familiar with any device upon which their lives may depend, especially since it has been shown in the past that the auto-alarm has not been perfected and its use has caused loss of lives at sea."

While considering ship radio, it is interesting to note that the U.S. Public Health Service decided, last month, to grant medical clearance—the new radio signal "radio pratique"—to passenger ships into New York harbor, on the approval of the ship’s doctor. This will expedite docking.

TELEVISION NEWS SHORTS

ACCORDING to a report received from Philco last month, "British television is highly unsatisfactory and primitive and the received images are so distorted at times that arms and legs look like bags of sand."

Farnsworth Television, Inc., started field tests with a 1,000-W. transmitter in Philadelphia at the beginning of February. The transmitter scans at 441 lines, following the recommendations of the television committee of the R.M.A. The British Broadcasting Corp. announced that they planned to build a "television van" to pick up images outside of Alexandra Palace. A coaxial cable will be stretched through the heart of London so that the images can be transferred to the transmitters.

The Federal Communications Commission, in its annual report to President Roosevelt, last month made the following statement: "While the technique of television has progressed during the past year, it seemed the general consensus of opinion that television is not yet ready for public service on a national scale.

"There are numerous obstacles to be overcome and much technical development is required before television can be established on a sound national scale. Nevertheless, the rate of progress is rapid and the energies of the laboratories of the country are being concentrated on the development of television."

Sports made a play for consideration as an important part of the television programs in England, last month, when a group of boxing matches were transmitted, much to the delight of sports fans who crowded to capacity the various demonstration "theatres" in London's large stores and railroad stations. There are now 8 manufacturers making television receiving sets in England, to receive the transmissions of Baird and the Marconi-E.M.I. systems. The sets sell for about $400.00.
SOME OF RADIO'S "400" TUBE TYPES
WHAT ABOUT RADIO IN 1937?

INDUSTRIAL LEADERS IN THE RADIO INDUSTRY ANSWER 6 PERTINENT QUESTIONS ASKED BY RADIO-CRAFT CONCERNING THE FUTURE OF RADIO AS A PROFESSION FOR TRAINED MEN.

(1) Will the Radio Industry benefit by a general improvement in business conditions throughout the country?
(2) Is it your opinion that the Radio Industry faces even greater growth ahead than it has experienced to date?
(3) Do you feel that the Radio Industry still offers opportunities to those who keep pace with its new developments and growth, as when the industry began?
(4) Would you consider radio and its many branches a desirable vocation for a young man to choose as a permanent career today?
(5) Do you believe that the Radio Industry will continue to need the services of competently-trained men?
(6) What is your personal advice to young men who wish to become identified with the Radio Industry today?

DAVID SARNOFF—
Pres., Radio Corp. of America

(1) Yes. (2) Yes. (3) Yes.
(4) Our knowledge in radio is far less than our ignorance. The greatness of the art lies ahead and I therefore consider it peculiarly a young man's business.
(5) Yes.
(6) I would suggest preparation in the technical field because that is the best possible equipment for advancement and success in a career in radio work.

COMM. EUGENE F. McDONALD—
Pres., Zenith Radio Corp.

(1) Naturally.
(2) Yes, if the major manufacturers do not themselves destroy it.
(3) Naturally not.
(4) Yes, if he is properly qualified.
(5) Yes.
(6) Be sure that radio is the vocation you are best qualified for and intend to stay with.

POWEL CROSLEY, JR.—
Pres., Crosley Radio Corp.

(1) It is inevitable that the radio industry, along with all other industries, will benefit with a general improvement in business conditions in the country. Sales of 7 and 8 million sets a year are distinct possibilities. The average price of sets sold has increased materially to about $55.00 for consoles and $42.00 for table models. It is estimated that the sales of auto-radio sets (Continued on page 614)

ISIDOR GOLDBERG—
Pres., Philco Radio Corp.

(1) Yes. More money will be spent for radio sets, and more money will be spent by sponsors for better programs.
(2) Yes. The average price of radio sets is increasing, new services will be provided by facsimile, calling for more transmitting and receiving equipment, and television development plans are being expanded.
(3) The number of salesmen, Service Men. (Continued on page 615)

L. E. GUBB—

(1) Yes. (2) Yes.
(3) Yes, if engineering and merchandising keep up to date.
(4) Yes. (5) Yes.
(6) (No comment.)

BENJAMIN ABRAMS—
Pres., Emerson Radio Corp.

(1) Judging by the attending increases during the past year, this may reasonably be expected.
(2) Yes. With the idea of several sets in a home gaining ground all the time—and with new technical developments, better broadcasting, etc.
(3) More so today than ever before.
(4) Decisively. As we learn more about the phenomena of radio the uses and opportunities they create will open up many new fields.
(5) More so than ever before.
(6) Take any sort of job, study the art and be prepared for the opportunities which are always arising.

RADIO-CRAFT for APRIL, 1937

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www.americanradiohistory.com
ELECTRONICS, that art of scientifically applying the forces and motions of electrons to do useful tasks, has had an astonishing history since the first evolution of the electron theory, a few decades ago. And perhaps the most astonishing of all is the rapid growth of the vacuum tube—that tiny glass or metal electronic relay—which is the very basis of the electronic art.

Every day, new uses are being found for these versatile "containers of nothing" and each new application calls for a vacuum tube of different design and construction than any previous type. It is only to be expected, therefore, that a large variety of tubes will be made to fill these varying needs—but few people realize the extent of these variations. A small idea of the number of tube types made can be gleaned from the fact that there are about 400 types of receiving tubes available in the U.S. alone, not counting the hundreds of experimental types which do not find ready application in sales to John Public!

Perhaps the outstanding happening in the field of electronic tubes this month is the announcement that the price of receiving tubes has been increased. For years, since the early tubes cost enthusiastic experimenters anywhere from $10.00 to $35.00 for a crude glass bulb having a somewhat haphazardly placed filament, plate and grid, the price of tubes has been consistently on the down grade. However, in spite of improved mass production methods and mounting sales, the price of tubes for receiving and amplifier uses has at last stopped its decline and an (average) increase of 11 per cent has been announced by the leading tube manufacturers.

From the standpoint of the dealer and Service Man, this announcement is an encouraging one, since it is the first step toward setting up a merchandising system which will allow a fair margin of profit in tube sales—which has not been the case for some time.

However, to leave the business end and look toward the technical side of the tube business, the engineers have not been twiddling their thumbs and sitting on past laurels—several new and useful tubes have been designed which will interest the radio fraternity.

Push-Pull High-Frequency Pentode. The Bell Telephone Labs. released a new tube to be used as an oscillator for ultra-high frequencies which is a step toward higher power on these "apex" frequencies. Because of the high-frequency possibilities of the tube it may have uses in television transmission.

The tube is made with 2 sets of elements inside a single thick glass envelope. These are connected to the external circuit to produce a balanced push-pull circuit having extremely short leads. Elaborate provisions have been made to shield the 2 pentode sections and very small spacing between the elements of each section is provided by careful manufacture. Long insulation paths permit using high plate voltages.

THE MARCH OF TUBES

The progress of the radio industry revolves around the vacuum tube. And every new radio innovation calls for new tubes—here are a few just added to radio's "400"!

C. W. PALMER

The result of this design increases the input resistance at 150 megacycles from about 1,000 ohms for the ordinary commercial tube to 30,000 for the new experimental tube. At 300 megacycles, the input resistance of the new tube is still 5,000 ohms while that of conventional tubes is so low as to make them inoperative.

When operated as a class A amplifier at 150 megacycles, an output of 1 W. is obtainable with the distortion 40 db. below the fundamental. Under these conditions the stage gain is 20 db. Outputs of 10 W. with a plate efficiency of 60 to 70 per cent at a gain of 20 db. are secured in class B operation.

The structural make-up of the new tube is shown in Fig. 1. The appearance can be seen in Fig. A. This tube is still in the experimental stages and has no official number or designation.

OZ4G Full-Wave Gas-Filled Rectifier (Ionic-Heated-Cathode Type). The OZ4G was developed primarily for use in vibrator-type "B" supply units for automobile receivers, according to the Raytheon Production Corp. from which the characteristics were obtained. This tube has the typical characteristics of all gaseous rectifiers (old-timers will remember the BH and BA rectifiers of this type) as regards a constant internal voltage drop and ability to handle peak currents. In common with the older types of ionic-heated gas-filled tubes, the OZ4G has a tendency to generate R.F. noise. This R.F. interference

Fig. 2. The socket connections of the tubes described. Notice the complicated grid structures of some of the multi-element types.
can be eliminated by proper filtering and by connecting the metal shell to the point giving the best shielding. The shielding and filtering commonly used to eliminate vibrator noise will usually be sufficient.

This tube is available both in glass and metal types, both having octal bases. In the metal type, the metal shell served chiefly as a container and electrostatic shield for the glass bulb which is required to insulate the contained gas from the grounded shell.

**6Z4G Characteristics**
- D.C. voltage output: 300 max. V.
- D.C. output current: 30 min. ma.
- Peak plate current: 75 max. ma.
- Starting voltage: 300 min. V. (peak)
- Voltage drop (dynamic): 24 avg. V.

**5U4G Rectifier Tube.** This rectifier, according to a bulletin from Raytheon Production Corp., has similar characteristics to the glass rectifier—type 523. It is equipped with an octal base though, instead of the older type.

**6A8, 6L7 and 6K7 Isolantite Grid Caps.** Also received from Raytheon, is news that the 3 types of tubes mentioned here are now fitted with isolantite insulation between the metal shell and the grid cap. This reduces R.F. losses at high frequencies, where the insulation resistance of most insulating materials falls off badly. The gain in short-wave and the high-frequency bands of all-wave receivers is definitely improved, according to the engineering report.

**6A6G Dynamic-Coupled Power Tube.** Since the type 6B5 tube was developed early in 1935, many manufacturers of auto-radio sets have selected this unique tube for their higher priced sets. The unique qualities of the “dynamic coupling” which provide a high power sensitivity, yet with lower harmonic distortion than equivalent pentode types, added to the remote cut-off characteristic, made it a popular one.

The new 6A6G was developed by Triad Mfg. Co. to provide the industry with a tube having the characteristics of the 6B5 (which was designed for use in A.C. sets) but having a lower battery consumption and utilizing less space.

The 6A6G heater requires 0.5-A. at 6.3 V. This represents a 37 per cent reduction in heater power compared with the 6B5.

The 6A6G is a strictly class A tube and as such, any of the high-resistance amplifiers may be used to supply the input signal; a grid resistor of 1 meg. is permissible under any operating conditions. When used in push-pull, the plate power can be reduced during periods of no-signal by connecting a self-bias resistor in the cathode lead (80 ohms) to introduce a 5 V. bias. This provides a semi-class AB operation in that plate current is reduced—but no driving power is required for this service.

The total resistance introduced into the grid circuit by the input coupling device should not exceed 1.0 meg.

**6AC8G Dynamic-Coupled Tube.** Like the 6A6G, the new 6AC6G, also developed by Triad, is a twin-triode tube, dynamically-coupled within the envelope of the tube itself. This tube is similar to the well-known 6B5, but is designed for those small A.C. sets which operate with a low plate voltage (less than 180 V.) in conjunction with a series speaker field.

It is expected that a field of 700 to 800 ohms will be used as the filter choke, which will give both ample plate supply filtering and ample field power. A single tube used in this way will provide 4 W. of audio power at 10 per cent over-all harmonic distortion.

There will be no difficulty in providing sufficient input signal to the grid of the 6AC6G if the type 75 or 6QT voltage amplifier is operated with a plate voltage of 180. The resistance of the grid circuit may be as high as 1 meg. which is of importance in resistance-coupled A.F. systems. In some cases, the over-all sensitivity will be greater than in systems using a more sensitive output tube which requires a (Continued on page 636)
**How to Make Standard**

A standard tester which will accommodate all the tubes now available is not a luxury but an absolute essential to a successful service business. It also provides for new tubes.

One ingenious idea that cut the cost of the tester is the use of a plain aluminum panel. This panel was carefully drilled as indicated in Fig. 1, with a series of bored ¼-in. holes, located at each indicator marking position of the selector switches. Four pieces of white cardboard 2½ ins. square with appropriate numbers and letters carefully drawn with India ink provided the scale markings for the various test positions. Transparent celluloid was used to cover the scales for protection from dust and damage.

Every part of the tester can be obtained from radio supply houses even to properly finished 2-color scales for the meter. If it is desired to make the scales for the meter in the lab, full details as shown in Fig. 2 can be followed.

**Assembly and Wiring**

The first step in constructing the tester is to lay out the panel very carefully for drilling. Cut the panel to the proper size and center-punch all holes as indicated in Fig. 2 especially those holes used as windows for the various identifying switch numbers and letters. Countersink these holes from the top of the panel so that a minimum of shadow will be cast on the letters by the side walls of the holes.

Wire-in the interconnections between the various switch taps before mounting the switches on the panel. This applies to the several sections of Sw.1, Sw.2 and Sw.3.

After the switch wiring is finished and checked start mounting all of the parts on the aluminum panel including the indicator scales. The proper placement of the parts can be checked from the bottom view photograph and the mechanical drawing. The electrical circuit drawing of Fig. 1 is so laid out that all of the parts are in their proper mechanical place as well as showing the electrical connections. Test for panel shorts between alive terminals and the insulated jacks with an ohmeter.

The 2 sections of the dual rheostat R1 are connected in parallel when the tester is used on 110 V. A.C. lines. Wire-in the 5 tube sockets as indicated to the selector switches. Check each lead at least twice.

Wire-in the leads from the power transformer to the

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**Fig. A. The front panel view of the unit in a portable case.**

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**Fig. 1. The schematic circuit of the tube tester, and resistance and capacity meter.**

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**Fig. II. Lab. and Standard Tube Tester.**
THE RADIO-CRAFT TUBE TESTER

This "standard" tester—developed by the staff of RADIO-CRAFT—is made in such a way that it can be incorporated in a portable case for servicing on the job; or in a counter cabinet for use in the service shop or radio store. The unit can accommodate future tube development.

filament and plate supply circuits following the directions furnished with the particular transformer used.

Check all wiring again so that no connections will be missed and if the final examination shows that the tester has been wired properly then proceed with the calibration which is very simple.

CALIBRATION

Take new tubes having different switch and shunt settings and adjust the position of the shunt knob on the 20-ohm rheostat, R5, so that the meter reads 40 on the numbered scale. This is in the GOOD area. Take a screwdriver and reset the bar knob on R5 so that when the meter pointer reads 40 on the scale the bar knob will be pointing to the proper number as given in the third or SHUNT SET. column of Table I.

A new type 27 tube is a good starting tube. Set the 2 selector switches to A (left-hand Selector Switch) and N (right-hand Selector Switch). Vary the Shunt Control until the meter pointer reads about 40. Note the position of the Shunt Control bar knob. If it is at 91 no further changes are necessary. If it is some place else on the scale carefully reset the bar knob without changing the position of the moving contact arm to 91. Check with other tubes known to be good of the same type and then check tubes having different Shunt and Selector settings. If the tubes are good they will give meter readings of approximately 40 with the proper shunt setting. Thus it will be noted that the hardest part of calibrating is the proper setting of the shunt control bar knob.

Note: After the calibration is set notice the relationship between the setting of the shunt rheostat control arm and the actual position of the bar knob pointer. Rotate the knob (slowly) to the left. Ordinarily, it is impossible to bring the bar knob pointer to "0." Do not try to force the "0" position as you will upset the calibration for tube testing. The instructions for resistor and capacity testing call for a "0" setting of the shunt control. This means a "0" setting of the contact arm and not a "0" set position of the bar knob. When making a "0" set adjustment simply turn the bar knob as far to the left as possible without forcing knob.

(Continued on page 628)

![Fig. B. This view shows the layout of parts and wiring of the unit.](image-url)
"ELECTRIC EYES"

Photoelectric or "PE." cells, by exhibiting capabilities in many fields of endeavor, are contributing materially to the business prosperity of these United States.

A LADDIN had everything pretty much his own way, so to speak, what with being able to rub an old lamp and thereby summon a jinnee to do his every bidding.

But Aladdin, were he able by some abracadabra of Mohammedan mythology to conjure himself into the year 1937, would hide his head in chagrin at the innumerable, and seemingly magical, results of which he never dreamed, but which with us have become almost commonplace—due to the versatility of the "electric eye."

In fact, it is not even necessary to move a hand—just a nod of the head and, flick, a bedridden invalid has caused a book's page to turn! Or, a bow before a white "altar"—a obeisance to the Prince of Magic, if you will—and lo, water gushes forth, in a fountain, for the thirsty!

But enough of this—Radio-Craft readers are familiar with these and many other tricks with the "electric eye" or light-sensitive photocell—it is the writer's desire to present in review a few of the more recent developments in the photoelectric field.

MOBILE APPLICATIONS OF PE. CELLS

The "Electric Eye" Auto-Speed Indicator. On the cover of this issue of Radio-Craft is depicted in colors an artist's conception of the new RCA roadside vehicle speed indicator recently demonstrated by its inventor, F. H. Shepard, Jr. (The circuit of a demonstration set-up is given in Fig. 1.)

It will register a car's speed, in miles-per-hour, within a space of 1 ft. or less. As soon as the hood of a car going in one direction breaks the second parallel beam of light the car's speed—a miles-per-hour calibration of the instrument's voltmeter scale—is indicated; if the car is traveling in the opposite direction the reading is obtained when the rear end of the car breaks the second beam of light.

This electronic robot makes it unnecessary for motorcycle policemen to keep constantly on the go, "pacing" cars over considerable distances in order to determine their speed. The use of a second unit of this type placed about a half-mile away and arranged to flash red if the car is exceeding predetermined speed limits would serve as warning to the motorist and at the same time afford the officer an opportunity to "get set" in case his double-check indicated that a chase was necessary. (Fig. A)

Photoelectric Car-Counters. Motorists passing a certain point on a road in southern Illinois seldom are aware that an unusually interesting type of electronic car-counter is operating. Unlike single-beam counters, that are actuated by any object—person or automobile—that breaks the ray's path to the photocell, this counter totals only when a car passes a given point.

This distinction between car and person is accomplished by using 2 beams instead of 1, focused on 2 photocells instead of the customary individual cell; only a car is long enough to simultaneously break both beams.

Push-Pull Photocells Detect Airplane. An American, A. Fitzgerald, has demonstrated that photoelectric equipment may be utilized to indicate, in an experimental set-up, the presence of an airplane 3,000 ft. high and 1,000 ft. distant.

To accomplish this, 2 lens systems focus the 'plane's image on 2 checkerboards having alternately transparent and opaque squares. The equivalent square on the opposite board is opposite in transparency; that is, if a given square on one checkerboard is transparent the equivalent square.

RADIO-CRAFT for APRIL, 1937
SEE ALL-DO ALL

This article discusses some interesting applications of photocells. These include the following: auto-speed indicator, car counter, and airplane detector. Coffee-bean, cigarette paper, lethal-gas, and razorblade tests. Camera aperture, shutter, exposure, and focus control. And miscellaneous applications.

WASHBURNED

on the other board will be opaque.

The light that each board permits to pass is focused by a second set of lenses onto 2 photocells that connect in bridge fashion to the input circuit of an A.F. amplifier; a relay is connected in the output circuit. This arrangement functions independently of cloud excursions across the field of vision.

A given point of light from an airplane falls, simultaneously, on an equivalent section of both checkerboards; but only 1 photocell is actuated since only board No. 1 can pass light through at that particular square. The point of light now moves along until the next pair of squares is reached; and only the square on board No. 2 will pass light through at this new position. And so the light darts through, actuating first one cell and then the other, alternately, with sufficient rapidity to produce an A.C. voltage at the input of the receiver. (Fig. B)

PHOTOELECTRIC TESTING UNITS

Coffee Bean Tests. Gourmets have traveled far for a real good cup of coffee. Today, though, extensive travel for the delight of a superlative brew of the bean is seldom necessary. Use of the importance of photoelectric equipment, used by Chase & Sanborn Coffee Co., for instance, to obtain a uniformly good product, in checking the exact roasting time of the coffee bean may be gained from the following interesting figures.

The particular flavor of coffee required in different localities or in different countries depends upon the proper treatment of the coffee bean, which must be roasted to a very definite color in order to obtain a particular flavor. Expert roasting operators are paid high wages for their ability to bring a load of coffee in the roaster to exactly the shade of a tested sample. But cloudy days or fatigue will result in errors. At best, a skilled operator cannot detect a variation of less than 15 seconds in roasting time as judged by the difference in color discernible to the naked eye. Photoelectric equipment, however, will easily detect roasting-time differences of 7½ seconds. The P.E. apparatus also may be used to determine how much additional time is required to roast the coffee to a given degree; and for checking the output of several roasting plants to maintain uniform grade throughout. (Fig. M)

“Electric Eye” Aids Milady’s Smoke. Photoelectric equipment is used by cigarette manufacturers to determine the opacity of cigarette paper. Chesterfield, for instance, uses the “electric eye” to determine, by variations in the amount of light reflected by the paper as it speeds along underneath an exciter lamp, the degree of uniformity and perfection of cigarette paper.

The Electric Nose. Mercury boilers, though efficient, occasionally leak and pollute the air with noxious mercury vapor. How to indicate the presence of the vapor was a problem until General Electric engineers conceived the idea of utilizing a sodium-type photocell to indicate the presence of a mercury vapor shadow formed when factory air, filtered out all but its burden of mercury vapor, is made to pass through a beam of ultra-violet light from a mercury-vapor type of exciter lamp, as here illustrated. The “nose” will “smell” a mercury-bottle stopper held near the air intake of the device. The circuit is no longer new but is reproduced here (Continued on page 631)

RADIO-CRAFT for APRIL, 1937

www.americanradiohistory.com
"WHITE"
IS A RAINBOW OF COLORS!

Details are given concerning a quantitative method of cataloging color by analyzing its primary components.

PART I
W. E. REYNOLDS AND A. R. HEXT

WHITE is simply "white" to most people, but to the colorimeter developed by the writers and here shown pictorially (Fig. A) and diagrammatically (Fig. 1), it is a veritable rainbow—a mixture of the proper percentages of the red, green and blue primary colors.

The slightest variation in these percentages allows a multitude of variations or shades of white. Similarly, slight admixtures of either of the two primary colors to the remaining, third primary color results in a change of shade. By interposing a color filter between a photoelectric cell and a beam of light reflected from a surface under test a means is thereby afforded for making precise color analyses.

Thus Sir Isaac Newton's experiment of optically, by means of a prism (3-sided glass) interposed in a beam of sunlight, causing the white light of sunlight to be splayed out in all its glory of rainbow colors is now duplicated by electronic means. The result, instead of being observed by the human eye as in the former instance, is "seen" by the "electronic eye", and indicated on a meter, when color filters are interposed in the path of the white-light beam that impinges on the photovoltaic cell.

(Continued on page 622)

PHOTOTUBES AND PHOTOCELLS—WHEN TO USE THEM

EARL D. WILSON

A PHOTOMISSIVE device is a light-sensitive unit which functions by virtue of the emission of electrons from a surface into free space. A photovoltaic device is a light-sensitive unit which functions by virtue of the displacement of electrons from a semi-conducting medium into a contiguous conducting medium.

Purely for the sake of brevity, we shall call a photoemissive device a "phototube" and a photovoltaic device a "photocell".

We choose also to define (in this article) "light" to include radiant energy in that portion of the spectrum commonly associated with photoelectric phenomena. (Inasmuch as the "electric eye" is susceptible to or otherwise will "see" what ordinarily would be referred to only as a "radiation".—Editor) Hence we may consistently refer to not only visible light, but also infrared "light", or ultraviolet "light." (Both the latter may be referred to as the so-called "black light"); but it is the latter that, in contrast with infrared radiations, due to its property of causing fluorescence in certain materials is commonly called "black light".—Editor)

A SKIN-LIKE SURFACE

Fundamentally, there is no difference in the functioning of phototubes and photocells. In both types the energy of a "light quantum" (given amount of light) is imparted to an electron which renders itself from its orbit with an excess of kinetic energy to escape in the one case into free space or, in the other case, into a conductive medium.

To use a crude physiological simile, the surface of a phototube cathode might be likened to the raw dermis of animal skin, the electron corpuscles bleeding (Continued on page 638)
QUESTIONS AND ANSWERS ABOUT ELECTRONIC MUSIC

The recent series of articles on electronic musical instruments omitted the synthesizing system of Eremeeff which is here analyzed.

Edward Kassel

The recent series of articles on the subject of electronic music which I wrote has aroused considerable interest, as letters from readers of Radio-Craft have indicated. The articles, covering as they did a very wide field of interest, were sketchy in parts, lacking somewhat in detail. This was necessary, because of the limited space available for the material.

Since there are probably many readers who have read the series of articles but have not taken advantage of my offer of supplying additional information on particular subjects where needed, some added data is presented here in answer to questions received. The letter, a representative one, is published, so that other readers will know just what questions were asked. The answers have been made as broad as possible, so that other readers will have their particular questions covered, as well.

The Question—

I am building an electrical organ, using the phonic wheel and pick-up coil method of frequency generation, and wish to know the necessary data for determining the number of turns, size of wire, etc., for the coils. Would 3/16-in. magnet bar steel 2½ ins. long be enough for the cores? The tone wheels are to be 3/32-in. thick, of soft sheet iron. Am using bevel gear drive; the generator frequency range is extensive.

The impedance of the coils I desire to be 4 ohms at the respective frequencies, and am using a 15-ohm resistor between the coil and the key bus bars, similar to the Hammond.

In your earlier articles you mentioned you were going to give a stop arrangement and synthesizing system for this type of electronic organ, and the October issue stated that it was the concluding article, so apparently you have finished the series without so doing. You further state that you will answer questions concerning various questions we experimenters may have relative thereto.

The organ I am building is to have 2 manuals and a pedal clavier of 2 octaves, and have obtained an old square grand piano for its enclosure, intending to put the speaker, amplifiers and generators all therein.

Paul J. Palmer

The Answer—

If you care to design magnet windings yourself, this problem can be solved as follows: Impedance matching for the experimenter is simplified by sending several permanent windings and phonic wheel assembly to a transformer manufacturer who will check the impedances of different windings, beginning with 10 turns of No. 28 wire, together with the primary of an output transformer, which you must have. It is practical to make the windings of the magnets with

(Continued on page 633)
AN ACOUSTIC CORRECTOR

REALIZING the difficulty of making a speaker cone or "piston" which will carry both very high and very low frequencies, a European engineer developed a diffuser to be placed in front of the speaker diaphragm to act as a tone corrector.

The tone corrector is mounted in front of the speaker (Fig. A) on a mounting which permits the distance between the corrector and the speaker diaphragm to be varied. The corrector consists of a flat metal "sound cell" of large diameter which is perforated and corrugated so that part of the sound passes directly to the hearer and part is reflected back to the speaker diaphragm. Thus by a combination of reflection and diffusion, which may be controlled by the listener, the tone range is extended. From La Nature (Paris).

A VARIABLE-SELECTIVITY SCHEME

AS A MEANS of achieving variable selectivity in an existing superhet receiver without the necessity of scrapping the I.F. transformers, an English experimenter devised the scheme shown in Fig. 1. This works on a system which differs to some extent from the other mechanical and electrical systems which have been previously developed. Instead of "loading" the coils in order to broaden their selectivity curve—or overcoupling them for the same purpose—they are detuned slightly so that their resonance curves do not exactly correspond. This produces the desired effect of widening the over-all selectivity curve for improving the fidelity of reception on local stations.

The 40-mmf. trimmers, C1 and C2, control the amount of detuning, while a split-stator variable condenser (having a capacity of about 50 mmf. for each section) provides the necessary control of sharp to broad selectivity.

(Continued on page 614)
MAKE THE RADIO-CRAFT MIDGET OSCILLOSCOPE

This "complete" oscilloscope brings visual alignment within the reach of every Service Man! It uses a type 913 Cathode-ray tube.

PART 1

WITH THE advent of the new type 913 tube described in Radio-Craft for January 1937 there can be no further excuse for a Service Man not to build and use his own oscilloscope, for this tube makes the cost of such an instrument a minor factor indeed. It will certainly be a poorly-stocked service shop which has not on hand every item to construct this instrument, save possibly the power transformer and tubes.

Even if the shop owner already has a standard-size oscilloscope, the little instrument to be described makes a very handy gadget to carry on service calls, and in addition it will take no "Sampson" to carry this oscilloscope since it is smaller in size than most service oscillators! The total weight is but 9 lbs., a considerable difference from the usual oscilloscope which, while admittedly of excellent design and construction, certainly was not made to be carried by the already overburdened Service Man on his daily rounds.

Our little instrument has every feature of the full-size instruments as well as several which are not found on most. It can be used for virtually every possible test the Service Man or experimenter wishes to make.

SWIVEL-MOUNTED C.R. TUBE

A very novel feature is the fact that the 913 tube may be mounted in either of 2 positions, inside the instrument, or in the "trench mortar" on top. The socket in the latter is connected by a cable to the inside 913 tube socket so that the change-over is quickly accomplished. For portable use, the inside mounting is to be preferred since the addition of the "mortar" or turret makes the apparatus a little more unwieldy and unhandy to carry. For shop or laboratory use, however, the external mount is much handier. It can be adjusted to any position whatsoever so that if the technician is standing at the bench he does not need to stoop over to view the screen. The mounting is simply turned so that the tube points directly at him. In this connection it is quite possible and very practical to use a small magnifying glass fastened on the end of the "mortar" casing. A glass of about 1½ in. dis. and of short focus, is excellent. In a pinch an ordinary reading glass will do very well but it must be held at from 4 to 6 inches from the screen of the 913 tube to give a worthwhile increase in image size.

DESIGN FEATURES

The frequency of the sawtooth sweep oscillator is controlled in 8 rough steps, and in addition a fine control is provided.

 Provision is made by proper switching, to use the hori-

(Continued on page 618)
HOW TO MAKE THE TELEVISION

In this, Part IV, the concluding data for making the RADIO-CRAFT Television Receiver, built under the direction of C. W. Palmer, are given. Review the complete series of articles before starting the actual construction of the receiver.

PART IV

A TELEVISION receiver in its construction embraces several factors which vary widely from those encountered in building the usual sound radio receiver. One of these variations is in the detector or demodulator. On this detail of the receiver design, more than any other, depends the definition of the images received. The flat characteristic, covering the frequency range passed by the I.F. amplifier, is one of the most essential elements of the receiver.

For this reason, since the original half-wave diode circuit was printed, in Fig. 1, some experimental work has been done by the Radio-Craft laboratory and several improved circuits are shown in Fig. 7, which may be used to replace the original one, providing improved image definition. The first, shown at A, is a change from half-wave to full-wave diode rectification. This change necessitates center-tapping the secondary of I.F.T.3, which may at first thought be a difficult task, but actually it is not very hard. The coil is removed from the set and the shield can be taken off. This exposes the 2 coils on their "iron" core with the air-trimmers at the upper end. The number of layers of wire on the secondary is then counted (it will be found to be 9 layers) and the "end" wire of the center layer is pulled out a little from the winding. This permits the insulation to be scraped off and the enamel to be removed with alcohol. A wire is then carefully soldered to the exposed tap and a lead carried out through the fibre centering strip. (While this wire may not be at the exact center of the winding, it has been found experimentally that the difference in I.F. voltage is so slight it may be entirely neglected.)

Now, as for the difference between the circuits in Fig. 7A and B, that at A gives much better definition than the original half-wave circuit, and the reduction in rectified voltage compared to the circuit in Fig. 7B is not so pronounced. The circuit of Fig. 7B, however, gives much better definition than either of the other two detectors, though the signals are attenuated more.

For those builders who are but a few miles from the television station which is to be picked up, the circuit of Fig. 7B is best. The 30-V. positive tap can be obtained by shutting a variable voltage divider of about 50,000 ohms across the "B" supply and connecting the tap to the detector. For those builders who do not pick up a very strong carrier from the television station, the circuit of Fig. 7A is preferred, while with a very weak carrier, the original half-wave circuit is best, since it provides a stronger rectified signal than the other two.

SOUND CHANNEL ALIGNMENT

A question has arisen by several builders of the set regarding the alignment of the sound channel, described in Part III of this series. Unfortunately, some descriptive matter concerning this I.F. amplifier was inadvertently omitted, which has caused the questions. The I.F. transformers used in the sound channel do not tune to a frequency of 5,350 kc. and since they provide a much higher gain than the air-core type, they were used, but instead of tuning them to 5,350 kc. they were tuned to the 2nd-harmonic of this frequency or 2,675 kc. This does not make use of the coils at their peak efficiency, but plenty of gain was obtained in the experimental model and because of certain desirable characteristics of these "iron-core" transformers, they were decided upon.

Since the description, last month, the manufacturer of these coils has introduced a new type of I.F. transformer (having the iron cores and air-trimmers) which tunes to 5,350 kc. Those who prefer to obtain these transformers will find that the sound channel will have more gain than with the type previously specified. There are no changes required, other than inserting the new coils in place of those specified in the circuit, Fig. 4. *(Footnote, at end of article.)

Another "loose end" in the previous parts of this constructive series is the matter of loading the I.F. transformers of the video channel to provide the necessary wide band for television reception. In Part I, we mentioned that later data would be given to permit this loading to be successfully accomplished.

The actual values of resistors R in Fig. 1, depend on the strength of the carrier received at the location of the receiver. And since this depends on several factors other than the actual distance from the transmitter, it has been left until the signals are actually received. Such things as the aerial used, the type of detection scheme decided upon, and the care with which the set is built and aligned, are all considerations which have to be accounted for.

The best way to ascertain the optimum value of these

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Fig. J. Here is the cathode-ray receiver in its complete form—in operation.

Fig. K. Here we see the receiver with the cabinet removed. The lens system is used to enlarge the images from 2½ ins. to about 8 ins.
RADIO-CRAFT—1937
RECEIVER

Lenox R. Lohr, President of RCA, said, last month, upon
resumption of transmissions of the Empire State television
transmitter using 441 lines: "Pictures of 441-line definition
are much clearer than those of 343 lines—the definition
employed in previous tests from the Empire State. Another
significant advance has been made in our work of tele-
vision development. As we proceed in this fascinating
adventure of bringing radio sight to distant eyes, it is
courageous to be able to report this substantial progress."

resistors is to actually get the set working and then try
different values across the coils until the best all around
results are obtained. A value of 50,000 ohms is a good one
to start with—working down until the gain of the set is
too low to give good definition. A certain value will be found
at which the deflection—determined by band width and
amplifier gain—is best.

There is another point (which will be of interest to ex-
perimenters) about the I.F. adjustment. The I.F. coils are
supplied with optimum coupling between primary and sec-
ondary—for the reception of "sound" broadcasting. Now,
if the spacing between the windings is reduced to introduce
"over coupling" the selectivity of the I.F. amplifier will be
lowered, without introducing loading resistors (Rx) across
the windings. By this method, the resistance value of
the loading resistors can be increased so that the actual gain
of the I.F. amplifier will be higher at the required I.F. band
width. By experimenting with the coupling, the correct rela-
tion of coupling and loading can be determined. An oscil-
loscope and wide-frequency wobbler will be helpful in this
work. Remember that it will be necessary to re-tune the I.F.
coils if the coupling is varied—and this should be done with-
out the loading resistors, Rx, in place.

THE AERIAL

The next point to consider is the subject of aerials. The
strength of the carrier signal picked up on micro-waves
depends greatly on the type of aerial—its location and the
care with which it is erected.

In Fig. 7, several types of tuned aerials are shown. See
details C to F. The units shown in Fig. 7C, D, and E, con-
sist of single rods of copper or other suitable low-resistance
material which should be arranged to "telescope" so that
the actual length can be varied to suit the frequency of
the transmitter being received. The unit at C has 2 wires sol-
dered to the central portion of the rod, about 28 ins. apart.
These wires are carried down with ceramic spacers to keep
them about 2 ins. apart and a coupling coil of about 2 or 3
turns of heavy wire wound to a diameter of about 3/8-in.
is connected to these two wires and coupled to the grid coil
of the 1st-detector, V1. The rod is mounted vertically and
must be well-insulated from all conducting bodies.

The next aerial, Fig. 7D, consists of the same type of
telescoping rod, but a single lead-in wire is fastened to the
top end of the rod and run down to the receiver at an angle
as near to 45 deg. as possible. This aerial is a favorite with
many "hams" and was found to supply the best "wham" in
the original set-up. The rod is adjusted to resonance with
the station as a half-wave resonator.

Next is the vertical "dipole" (Fig. 7E) with the rod split
to 2 parts, each tuned to 45-wave. This is made with 2
lead-in wires spaced about 2 ins. apart in the same way as
that shown for detail C. The last aerial shown is the hori-
zontal dipole which is like the vertical unit, though the

(Continued on page 624)

Fig. 7. Detector changes and aerials.
Fig. 8. Details for making the cabinet and "viewing funnel" if a lens is not used.

RADIO-CRAFT for APRIL, 1937
MODERN SHORT-WAVE DIATHERMY

Experienced radio men can build this modern 250-W. (R.F. output), 16-meter diathermy machine—designed for the use of doctors. Interference problems are discussed.

LEON C. BUNKIN

The necessary requirements for the design of a short-wave diathermy machine can be realized from the preceding instalments of this article. Preparatory to the actual construction of a machine that will function satisfactorily we must bear in mind the following basic essentials:

1. The circuit used must have the ability to perform in a stable manner, and should display no tendency to go out of oscillation under varying load conditions.

2. Full-wave rectification with the addition of some ripple filter must be incorporated.

3. The design of the circuit must be such that complete protection is afforded both the physician and the patient against possible electrical burns and shocks (even a slight shock might prove fatal to a person whose heart is weak).

With these factors as a basis, the author, W2GF, in collaboration with Leon I. Sprung, W2ACG, "set to work."

CIRCUIT CONSIDERATIONS

Considerable experimentation with different oscillator circuits finally led to the choice of the Hartley oscillator in a push-pull version of the circuit. It acted most stably, maintaining constant oscillation regardless of load.

The choice of tubes is an important consideration. They must be of rugged design, and have an output capability of at least 250 W. For this reason a pair as specified in the List of Parts was chosen.

It would have been "penny wise and pound foolish" to use low-grade parts; hence, to ensure perfect performance and requisite durability, only the best of standard parts were tolerated.

Reference to the circuit diagram will show clearly the salient points to be discussed.

For ordinary S.W. diathermy the regular control-grid bias of 10,000 ohms, R1, is used. For high-frequency cutting, etc., however, this bias was increased to 35,000 ohms by the addition of a 25,000-ohm resistor, R2, with a switch, Sw.1, across it to cut R1 in or out of the circuit. The power supply delivers about 1,500 V.; tubes V1, V2, therefore (so as not to exceed the dissipation rating of the tubes when the bias is 10,000 ohms), should not be run at more than 250 ma.

An examination of the diagram will show the power switching arrangement employed. The plate voltage can not be applied until the filament voltage has first been switched on. The precaution of allowing the filaments to heat up about 15 seconds before throwing on the plate voltage should be observed to protect the life of the tubes. (If desired a 15-sec. time-delay switch may be utilized to accomplish this result.)

The prospective builder may follow (Continued on page 620)
THE LATEST RADIO EQUIPMENT

PHONO-P.A. UNIT (1310) (Radiolte Company)
PUBLIC-ADDRESS specialists have long wanted a compact unit with the capabilities of the 20 W. device here illustrated. It operates on either 6 V. D.C. (12 A.), or 110 V. A.C. Has gain sufficient for crystal microphone unit; tone control; removable remote control head equipped with 2 volume controls; adjustable mounting legs.

SMALL VOLT-OHM-MILI-AMMETER (1311) (The Readrite Meter Works)
THE feature of this instrument is its range—in a metal cabinet that measures only 5 1/4 x 1 7/8 x 4 1/2 ins. deep. Ranges: 0-100-250-500-1,000 A.C. and D.C. volts at 1,000 ohms per-volt (D.C. accuracy 2 per cent; A.C., 6 per cent); 1-10-50-250 D.C. ma.; 0-500 low ohms; high ohms to 0.25-meg. at 1/4 V. (and higher, if external battery is used).

MULTIPLE CONDENSER (1312)
ONLY individual sections of this condenser unit need be replaced in the event of failure.

TEST EQUIPMENT GOES RACK AND PANEL (1313) (Clough-Brengle Co.)
THE workbench overflowing with test equipment is the earmark of an outmoded service shop. One modern service lab, design incorporates its test equipment in a bay of rack-and-panel type. Several panel combinations are available, and the entire equipment is available on a time payment basis.

PORTABLE 20-W. AMPLIFIER (1314) (Supreme Instruments Corp.)
THE input arrangement of this compact, light-weight amplifier permits using 2 microphones, 1 microphone and phonograph, or 2 phonographs. Output is tapped at 3.6-350-500 ohms.

DOUBIE-ENDO SOLEDING IRON (1315) (Triumph Manufacturing Co.)
VERSATILE SERVICE OSCILLATOR (1319) (Triumph Manufacturing Co.)
MORST unfortunately space limitations preclude listing here (Continued on page 625)

Tips, extendable to 4 ins., are available in several shapes; tilt-angle is adjustable over wide range.

MANTEL SET WITH FINGER TUNING (1316) (The Tripllett Electrical Instrument Co.)
THIS new instrument tests all tubes under actual operating voltages. It includes a test of rectifier tubes and separate diodes; neon test for shorts and leakage.

SMALLER ELECTROLYTIC (1318) (Cornell-Dubilier Corp.)
COLOQUIAL but apt is the trade name "dwarf midget" used to designate this new dry electrolytic. Compare the triple 8 mf. for instance with preceding types of 450 V. D.C. (working) dry electrolytic condensers. Note individual leads.

RADIO-CRAFT for APRIL, 1937

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www.americanradiohistory.com
SHORT-WAVE COILS IN A JIFFY
—IF YOU USE THIS CHART!

If you make short-wave sets or converters, this chart will greatly simplify your coil problems. How do you like it?

RAYMOND P. ADAMS

The USEFUL chart shown in Fig. 1 at the left has been prepared for radio men interested in building the "Simplified Converter for Short-Wave Beginners," described in the January and February 1937 issues of Radio-Craft. It can also be used for almost any desired short-wave coil calculations in receiver and converter construction. Its utility range is confined, therefore, to the frequencies covered in practical short-wave receiver service. Using the chart, the designer may directly and easily find an inductance, with 2 known factors, providing, of course, the 2 knowns may be found on the chart scales, and the unknown lies in the straight-line-relation range.

With the 2 knowns spotted, a straight line is drawn between them and the unknown found where the line crosses the 3rd scale, either in traveling between the points or in extension.

For example, suppose we have a coil of known 5 microhenries inductance and we wish to know the frequency to which this coil will tune with a capacity of 50 mmf. (or .00005-mf.). We check these 2 figures on the capacity and inductance scales, draw a straight line between them, and find that we cross the frequency scale at 10 megacycles (10,000 kc. or 30 meters). Or, if we have a variable condenser which we wish to use in a tuned circuit and which at a value of 50 mmf. is to "hit" 30 meters; we draw a straight line between the known frequency and capacity scales, from known point to known point, and extend it to cross the 3rd scale for inductance at 5 microhenries. The coil required should have this inductance; to be found by trial and error, and the application of the simple formula found in the text of the Short-Wave Converter article.

Inductance figures are in microhenries and the capacity figures, for the sake of simplicity, are given in terms of megacycles; the capacity figures in terms of microfarads. These same terms are used in the inductance formula.

The chart may be used to give readings below or above the scale ranges by dividing or multiplying straight-edge figures by 10, or multiples of 10. If we wish to know the inductance required to tune to 500 meters or 600 kc., for instance, with a capacity of 400 mmf., we simply draw a straight line between the 50-meter and 40-mmf. points, and extend the line to cross the inductance scale. We find the inductance reading to be approximately 16. As we divided both capacity and wavelength figures by 10 (in order to use our limited-range chart), we must now multiply 16 by 10 in order to get the true required inductance.

The chart is fairly accurate and for almost all practical purposes may be relied upon where 2 factors are known—one desired, one measured. Where one "known" factor (particularly capacity) must be estimated, the result must of necessity be considered a near or approximate reading only.

Approximations, however, will be acceptable in designing coils for the converter, accuracy of alignment to cover desired frequencies being a matter of adjustment, and check-up against the carriers of stations known to be crystal-controlled, with coils built and wired into the circuit.

Fig. 1. A straight-edge is placed across the scales.
DIRECT-COUPLING IN A 30-W. BEAM-TUBE AMPLIFIER!

This Part continues the consideration of the unusual power supply in the amplifier and covers the phase-inverting scheme.

A. C. SHANEY

To continue the discussion of the rectifier system used in the direct-coupled amplifier, where we left off in Part I, last month, we find that if a uniform load resistance is applied across the rectifier output, the potential difference between the center of the load and the center-tap of the coil is zero. If these two points be joined and the circuit redrawn, it will appear as in Fig. 2-A.

The insertion of a choke in each leg of the rectifier output and appropriate filter condenser produces the stabilized 2-phase bridge rectifier as utilized in Fig. 2-B and hitherto unused in P.A. amplifiers.

The advantages of this rectifier system are manifold. In the first place, the pivot of the circuit (the voltage at the mid-point of the load) is always kept at a constant potential and detrimental trigger action is avoided. Secondly, 600 V. output is available from a 650-V. center-tapped transformer. (Another glance at Fig. 2A will disclose the presence of a full-wave voltage doubler in our synthesized rectifier.) Thirdly, hum potentials are almost completely cancelled out by virtue of identical choke coils and bypass condensers in each of the output legs of the rectifier, so that all hum potentials picked off each leg are equal but opposite in phase and are cancelled when fed to the zero-potential mid-point of the bridge rectifier.

Because of the fact that mercury-vapor tubes (type 83) are not available with isolated filaments for each half of the tube, 2 tubes must be used for rectifying one of the voltage phases while the 3rd rectifier is used in the conventional manner. In order to keep the regulation of each side perfectly balanced, only one plate of V1 and V2 (Continued on page 622)

HOW TO USE V.-T. VOLTMETERS IN RADIO AND P.A. SERVICING

The measurement of non-sinusoidal voltages necessitates a "peak voltage" meter.

PART II—PEAK MEASUREMENTS

KENDALL CLOUGH

The lower scale of the instrument illustrated in Part I is calibrated directly in peak volts over 2 scales—0-10 and 0-100 V., with an automatically-operated multiplier device.

The sinusoidal voltage graphed in Fig. 3A has a peak voltage of value E, but an effective or root-mean-square (r.m.s.) value of e. In this, since it is a pure sine wave under consideration, the value of E is equal to 1.41 times e. The ordinary voltmeter reads r.m.s., and when the voltage is known to be sinusoidal in shape, the peak value may be calculated.

However, in circuits employed for radio sets and amplifiers, the voltage wave frequency is other than sinusoidal, and an instrument capable of measuring the actual peak value is needed if one is to know the actual circuit conditions in determining needed ratings of condensers, etc. A typical measurement of this type is described in the following paragraphs.

Figure 3C shows the manner in which the instrument might be set up for measuring the peak A.C. voltage across the first filter condenser in a power supply circuit. A blocking condenser of 0.1-mf capacity and voltage rating sufficient to withstand the potential, and a 1-meg. resistor are connected across the instrument binding posts marked "PEAK." In this manner the voltage reading obtained will be the value of the peak A.C. potential or ripple coming through the rectifier tube of the power supply.

Inasmuch as this ripple voltage may have unequal positive and negative peaks, the test leads should be reversed and the highest voltage reading of the two trials be used for calculations. By adding this peak A.C. voltage to the D.C. potential being developed in the circuit, it is possible to determine the peak voltage to which the condensers in the power supply are called upon to withstand.

A similar measurement may be made at the output of the power supply, reversing the test leads to secure the value of both positive and negative peaks. The percentage of ripple can then be computed by dividing the average value of these two peaks with the D.C. voltage output. It may be desirable to repeat these tests under various conditions of power load (Continued on page 613)
BUILD THIS "2-IN-1" EMERGENCY RADIO SET

Floods, hurricanes, earthquakes, fires—these uncontrollable forces of Nature often disable established methods of communication, and, therein lies the merit of this construction article. A 1-tube battery-operated set for receiving emergency radio broadcasts is described.

N. H. LESSEM

Fig. A. A battery-operated radio set for emergency operation.

Fig. 1. Pictorial and schematic circuits of the broadcast-band receiver. A twin-pentode battery tube is used.

FEW people realize the important role the innocent-looking home broadcast set can be made to play in times of stress. Since radio is usually the last medium of communication to be affected by such unfortunate catastrophes as floods, earthquakes, blizzards, and the like, it is being depended upon, more and more, to coordinate the work of rescue and relief agencies. At this very writing, as unprecedented flood waters rage through the Ohio and Mississippi Valleys, local broadcast stations (operating with emergency heavy-duty batteries) are cooperating with boat crews equipped with portable battery sets in directing rescue work and acting in general as a clearing house for all important messages. In the stricken areas people fortunate enough to own battery-operated sets are in a position to be immediately warned of new impending dangers.

The set described here is an "emergency" set to be used at just such times. It is a simple affair, the entire thing, batteries and set, being contained in a small portable carrying case measuring but 10½ ins. long by 8 ins. wide by 4 ins. deep. All the components of the set are mounted on a single, ¼-in. 3-ply wood panel covered with a leatherette material. The panel measures 4½ x 7½ ins. long. The set operates from 2 No. 6 dry cells; if greater volume is required, a "B" battery may be added. It may be made from spare parts lying around the house or laboratory; or since all the parts used are standard, they can be readily obtainable.

Figures A and B show the layout of parts. The tuning condenser is mounted at the bottom, the 5-to-1 ratio A.F. transformer on top, the regeneration-control potentiometer in the center and the tube halfway up the panel on the left. To increase the sensitivity and selectivity of the set one of the new type iron-core antenna coils is used. The primary winding, however, in this particular circuit, is used as a tickler (regenerator) coil while the secondary winding is used in the conventional manner as a control-grid circuit coil. The tube is the type 1E76, a 2-volt double pentode. Although designed primarily as a twin-pentode power tube it lends itself quite nicely to our purpose. One section is used as a regenerative detector and the other as a 1st A.F. To obtain as much gain as possible from this circuit a 5-to-1 ratio A.F. transformer is utilized.

The 10-ohm rheostat is used to drop the "A" supply voltage to the requisite 2 V. for the tube. This unit has a short, slotted shaft for screwdriver control since it requires only occasional adjustment to compensate for the wear of the dry cells. The filament "on-off" switch is combined with the potentiometer.

The parts have been so laid out as to make for shortest possible leads. Best results will be obtained by following this layout, illustrated in Fig. B. The set draws a total of 250 milliamperes so that the batteries will last a long while.

Figure 1 shows the circuit of this emergency set. It is the well-known, sensitive regenerative type using screen-grid control of regeneration. The small (mica-dielectric) variable condenser in the antenna circuit is used to compensate for...
"HURRICANE" STATIC!

Station WRUF in Florida is devoting much time to the location of hurricanes and storms by means of a novel recording scheme.

JOSEPH WEIL

Hurricanes cause much worry to many inhabitants of various parts of the world. Every geographical location on the earth carries with it serious and frequently difficult problems which require study, observation, synthesis, and analysis. Problems which will have to be solved by those who have the talents, and who love their country and are determined to preserve and use its great natural resources.

The location of tropical storms by means of associated static is probably the first scientific attack upon this problem by Florida men. (The University of Florida has published a booklet that details work on this subject.)

The static crashes associated with a hurricane passing over Florida in 1928 were observed by experimenters at Houlton, Maine. Even 5 years prior to this, other observers at the National Physical Laboratories in England had been able to secure good correlation between readings obtained by an oscillograph (oscilloscope and camera) and the azimuth of lightning flashes near enough to be visible. Since 1928 other workers in Canada, Australia and the United States have made improvements on the apparatus used in the early experimental work. However, insofar as is known, none of the developments have produced apparatus that has proved satisfactory for quick, accurate weather forecasting, particularly with reference to hurricanes.

It was toward this end and with the idea of further

(Continued on page 640)

Fig. A. The recording set-up from tuners to the oscilloscope. This equipment is shown in block form in Fig. 1.

Fig. 1. Block diagram of the equipment shown in Fig. A, plus the loops shown in Fig. 8.

IMPROVEMENTS IN THE "12-TUBE HI-FI BROADCAST RECEIVER"

Changes in the A.F. amplifier and bass booster improve the operation on weaker stations, which is important in rural locations.

M. H. GERNSBACK

Since this receiver was originally described (in Radio-Craft for February and March 1936) it has been found desirable to revamp the audio system of the receiver to secure improved performance. The new audio system makes use of 3 stages instead of the former 2. The bass-booster action has been greatly improved by this change and in addition the volume of the set on the less powerful local stations has been increased. The bass booster is no longer in series which greatly simplifies it.

It has also been found desirable to eliminate the A.V.C. action on the control-grid of the bass-booster tube. Careful listening tests on the receiver with automatic and manual control available at the flip of a switch established the fact that the automatic control caused a peculiar effect on the reproduction of certain types of music.

The diode detector of the receiver was changed slightly to allow the single grid of the 1st A.F. stage to be fed from it in place of the push-pull arrangement formerly used and to allow the distortionless detection of high-percentage modulation carriers.

The advent of the 6L6 "beam power tube" for the output stage of audio systems has made it possible to secure much greater undistorted output from the set with low overall distortion at all volumes.

Reverse feed-back is employed in the power stage. The use of this arrangement reduces the power sensitivity or gain of the 6L6 tubes (which is normally as great as the power sensitivity of a power pentode) to approximately that of a power triode tube such as a 45. However, in doing this the odd-harmonics generated in the power stage, together with any hum or tube noise, is reduced to a negligible amount. (The push-pull action cancels even-harmonics.) Under the conditions obtaining in this set, without reverse feed-back, the pair of 6L6 tubes in push-pull would deliver about 25 W. of signal with about 2 per cent total harmonic

(Continued on page 653)
HE RADIO Kaleidochrome is a novel and useful add-on unit which can be connected to almost any receiver and which performs two functions—(1) it serves as a tuning indicator and (2) as a translator of sound frequencies into a vari-colored array of lights; a sort of radio "color organ."

The portion comprising the tuning indicator (red glow—off-tune; green—in-tune, as used in the new 1937 General Electric receivers) is entirely separate from the color organ and may be omitted at the discretion of the builder. However, in late-model receivers which have automatic volume control but do not have any tuning indicator built-in, it is certainly worth while to install the indicator in the Kaleidochrome, as a means of indicating the "point of best reception" of a station. The color tuning indicator has been previously available as an integral part of a radio receiver, and various types of color tone indicators have been described in the radio press, but the combination of both in a single unit, adaptable to any radio receiver, is believed to be an entirely new development.

THE "COLOR ORGAN"

An auxiliary audio frequency amplifier in the unit is used to pick up audio voltage from the radio receiver and convert the amplified voltage to light, in various color combinations, by means of 4 special argon lamps (similar to the tiny neon lamps in appearance). These lamps are connected to resonant filters in the output of the auxiliary amplifier. The 4 lamps and their filters respond to 4 different bands of frequencies in the audio spectrum, and are colored as follows: Red, 400 cycles; Green, 800 cycles; Orange, 1,500 cycles; and Blue, 2,500 cycles. (The test oscillator used by the writer in resonating these several A.F. circuits, in order to determine the

(Continued on page 623)

MAKING THE RADIO KALEIDOCHROME COLOR-TUNER—TONE-COLOR ADAPTER

The radio experimenter and builder will find this add-on unit both an attractive and useful addition to a radio receiver having A.V.C.

CHARLES SICURANZA

LIST OF PARTS

One Allied Radio Corp. drilled chassis, size 11 1/2 x 8 x 3 in.;
Four Radiotron, National Union, Triad or Tung-Sol tubes, 1—80, 1—42, 1—C6, 1—76;
One Kenyon power transformer, T1;
One Audion filament transformer, No. 197-16, T2;
One General Electric reector No. RL310, T3;
One Assy output transformer, type 400, Ch, Cl;
One Kenyon filter choke, 20 by. Ch, C2;
*Four iron-core R.F. chokes, 10 mhy., L1, L2, L3, L4;
One A.C. switch;
Four Allied or Wholesale waver sockets, one 4-prong, one 5-prong, two 6-prong;
Four Svalkite tinted argon lamps, 1/4-W.
Seven Allied Radio or Wholesale Radio Service pilot lamps, No. 46, 1 V., 0.15-A;
Four Allied Radio Corp. or Wholesale Radio Service Co. enclosed-base sockets;
Seven Allied Radio Corp. or Wholesale Radio Service Co. pilot light sockets;
One Cornell-Dubilier electrolytic condenser, No. 4.08803, 8.3 mf.;
One Cornell-Dubilier electrolytic condenser, 10 mf., 25 V., C1;
Three Cornell-Dubilier tubular condensers, 0.1-mf., 400 V., C7, C8, C9;
One Cornell-Dubilier tubular condenser, 0.01-mf., 400 V., C5;
One Cornell-Dubilier tubular condenser, 0.05-mf., 400 V., C6;
One Cornell-Dubilier mica cond., 0.001-mf., C7;
One Cornell-Dubilier cond., 4 mf., 400 V., C8;
One Cornell-Dubilier cond., 2 mf., 400 V., C9;
Two Cornell-Dubilier paper condensers, 0.0-mf., 200 to 400 V., C10, C11;
One Electrolyte C.T. wire resistor, 20 ohms, R1;
One resistor, 500 ohms, 2 W., R2;
One resistor, 1,000 ohms, 1 W., R3;
One resistor, 1,000 ohms, 1 W., R4;
One resistor, 0.1-meg., 1 W., R6;
One resistor, 0.2-meg., 1/4-W., R7.

*Names of manufacturers will be supplied upon receipt of a stamped, self-addressed envelope.

Fig. 8. Here is the unit in operation, on a set.

Fig. 1. The schematic circuit of the tuning indicator and the "color organ" unit. The device is easy to construct.

RADIO-CRAFT for APRIL, 1937

www.americanradiohistory.com
MAKE THIS 1-TUBE "HOME BROADCASTER"
A useful device to convert any radio set into a P.A. system. It should find ready sale!

D. L. WARNER

EVERY OWNER of a radio set has, at some time or another, wished that he might be able to hook a microphone to said set. The desire is usually prompted by an idea that it might be a lot of fun to imitate some particularly well liked radio program for purposes of amusing friends or guests at a party, or just to "play around" with a "mike" to see what it feels like to be an "announcer."

Sometimes the set owner feels that the set might be pressed into service as a small Public Address System for some neighborhood or school activity. Since the average radio set is capable of producing a fair amount of volume, it stands to reason, argues the set owner, that there is or ought to be, some means of making it do other things than just bring in a few programs during the week. And if a small P.A. system is needed for only a short length of time, and since the radio receiver originally cost quite a bit of money, well, why not, and how can it be done?

The answer isn't nearly as difficult or as expensive as a lot of people have been led to believe.

First, and simplest is by means of one of the very cheap microphones readily obtainable at most every radio store or supply house. These "mikes" are usually fitted with a small wafer-type adapter that fits under one of the tubes

(Continued on page 627)

HERE IS A GENERAL-PURPOSE HI-FI P.A. AMPLIFIER
A modern amplifier which, because of its high efficiency and economy, should interest P.A. men.

McMURDO SILVER

IT IS FELT that the A.F. amplifier illustrated and described herewith, and known as the Masterpiece 3-A Power Amplifier, will interest an unusually large group of readers, so flexible is it and so manifold its uses. It has been designed primarily for Public Address use in line with the modern school of engineering thought which is rapidly realizing the efficiency and economy of separating low-level, high-gain voltage amplifying equipment from power amplifying apparatus. Thus it may serve as the complete power amplification unit of a P.A. system large enough to cover a 20,000-person audience while the addition of one or two more of these units with suitable speakers would quite easily cover a half-million people.

In order that it may be quite flexible, and be capable of being driven by preamplifiers having little or no actual audio power output, it must require no driving power, and have sufficient gain in itself to require no excessive preamplifier gain. A suitable order of gain is such that it may be driven directly by a crystal or good magnetic phonograph pickup. Thus it may also serve, not only as the fundamental power amplifier of a P.A. system, but as a booster amplifier for

(Continued on page 619)
Fig. 1. Detail circuits discussed.
MAKE THIS POCKET-SIZE METER RECTIFIER

This is an add-on unit, for the pocket-size multimeter described last month, to permit measurement of A.C.

MILTON REINER

THE POCKET Multimeter described by the writer in last month's Radio-Craft was designed for D.C. measurements only. Of course the great majority of trouble shooting and radio servicing requires only D.C. measurements but there are a number of instances when A.C. voltage measurements are decidedly helpful. In fact there are some occasions when they are absolutely necessary.

PROS AND CONS

The meter should respond with reasonable accuracy to all frequencies within the audio range. The iron-vane type of meter, has a low sensitivity and is exceedingly inaccurate for this purpose, although it is included in some commercial testers now on the market. Electro-dynamometer instruments are fairly low in sensitivity as well as expensive and have limitations at the upper end of the audio range. The hot-wire type of meter is not able to stand much overload and is not adaptable for rough usage and multi-range design. The thermocouple type is of course expensive and delicate, and is somewhat sluggish; although, it is highly accurate at all frequencies. The electrostatic type of meter is also impractical for service (Continued on page 635)

PRACTICAL RESISTANCE AND CAPACITY DECade BOXES

By a clever application of switching facilities, these two useful devices are brought within reach of all Service Men.

WILLIAM H. FRITZ

IMAGINE having two boxes on your work-bench—one containing 9,989 resistors and the other containing 10,000 condensers—with any one of the values in either box available at your finger's tips on a moment's notice! Decade resistance and condenser units that are the equivalent of these mythical boxes will be described in this article.

DECADE RESISTANCE UNIT

The decade-type resistance box contains 4 selector switches, each connected to 4 resistors. This makes a total of 16 resistors to yield the amazing number of resistance values named. It is the function of the selector switches to connect the resistors in series in the proper order to accomplish this result. By (Continued on page 617)
The chassis is constructed in 3 basic assembly units (see small diagram below): R.F., center, has R.F. amplifier V1, oscillator—1st-det. V2; I.F. unit (right of chassis) has I.F. amplifier V3, 2nd-det.—A.V.C. V4; output-power pack, at left, includes V5, power tube and rectifier V6. Tone control Sw.2 is ganged with power switch Sw.1 on this last unit. (Compensator locations in separate diagram.)

Philco "foreign tuning" system incorporates a multiple switch, the numerous connections of which are detailed at the upper right of the large schematic diagram. The antenna terminals 1 and 2 are intended for connection across a dual transmission line, with jumper across 3 and 4; but a single leadin may be used on 1, with jumper across 2 and 3 and the latter connected to a good ground.

While circuit was unchanged in this model, in later assemblies input filter condensers (110-V. line) were removed from front to rear of the chassis; and 0.05-mf. condenser in plate circuit of V5 mounted in their place. It is a bakelite, not tubular, condenser, in the second run.

When replacing any part of the speaker, be careful to connect hum-back coil terminals with the polarity for minimum hum.

**Philco 420CS (Chair-Side Cabinet)**

Adjustment is begun by centering the glowing beam of indicator on first line of the dial scale, with tuning condenser at maximum setting. The I.F. amplifier is then peaked at 470 kc., adjusting CQ, CF, CO and CN, in that order. Trimming R.F. compensators is done first on 18 mc. (To overcome detuning effect on the oscillator circuit, a 350-mmf. vernier condenser is connected across CB and tuned till 2nd-harmonic of the oscillator beats against signal.) Set units CF and GI for maximum output; external condenser is removed; and CM turned clockwise to maximum capacitance, then backed off to second peak, to avoid image frequency (first peak). With range switch at middle (police band) setting, and input frequency and dial setting of 7 mc., CL is adjusted for maximum setting; then, at 6 mc. CH and CE are adjusted for maximum readings. For broadcast adjustment, signal input at 900 kc., and dial setting at 1,600 kc., receiving the 2nd-harmonic; CJ, CG and CD are then adjusted for maximum. Then, at 600 kc., CE is adjusted—rolling tuning condenser for maximum output (that is, varying first CK, then tuning condenser, till a maximum is found near 600 kc.). Readjustment is made at 1,600 kc., as before; and then, at 1,500 kc., CD and CG are finally adjusted.
EMERSON MODELS L117, L122, L133, L135, L141, L150 (Chassis Model L)

Five-tube A.C. Super, 2-range (540-1,750 kc., 2,000-7,500 kc.), A.V.C.

Note 1: Data apply to receivers with serial numbers above 995,002. In those below No. 991,000, primaries of antenna coil are in parallel, and a 5-meg. condenser in series with antenna lead and S.W. primary. C17 is 0.0018-mf. Speaker, L135, 10 in.; others, 6½ in.

Note 2: In Model L150, C28 is 8 mf. 450 V.; C29 mf. 450 V., both dry electrolytics. In other models, both are 10 mf. wet types.

Color coding is (generally): Plate, blue; ▲, red; screen, brown; cathode, white or yellow; grid, green; filament and ground, black. I.F. transformers are coded accordingly. Power transformer is coded: Prt., black; high-voltage sec. red, with center-tap red and yellow; V5 sec. green, 6.3 V. sec. yellow.

Voltage readings, with 1,000-ohm voltmeter, at 117.5 V. line, are as follows (to chassis):

<table>
<thead>
<tr>
<th>Plate Screen-grid Cathode</th>
<th>V1</th>
<th>V2</th>
<th>V3</th>
<th>V4</th>
</tr>
</thead>
<tbody>
<tr>
<td>255</td>
<td>90</td>
<td>3.5</td>
<td>120</td>
<td>255</td>
</tr>
</tbody>
</table>

On oscillator plate (G2 of V1) 170 V.; at filament of V5, 325 V.; field (5-6) 70 V.

In adjusting the receiver, I.F. transformers are found above chassis, with trimmers reached through holes in cans. I.F.T.2 is behind tuning condenser. At 456 kc., trimmers are adjusted for maximum response, and C6 (wave-trap, between V1 and I.F.T.) for minimum.

On the S.W. band, signal is fed in at 6 moms., with a 400-ohm dummy antenna. Adjust C7 (beside C2-C3, nearest front) and C1 (left side chassis top, nearest front). Be careful to find minimum capacity peak on oscillator (maximum on anlging trimmer). Puffling condenser C7 is fixed micro type; if it is replaced, this capacity (within 2 per cent) must be duplicated, or S.W. tuning will not track.

Adjust B.C. band pad at 600 kc. C16 (near 6A7 tube) is set at minimum-capacity peak of response. Adjust B.C. band trimmers C8 (beside C2-C3, rear) and C5 (left side rear) at 1,600 kc., rocking tuning condenser. Always tighten trimmer with last motion—do not loosen it. If outside plate is so loose there is no tension on screw, bend up plate or remove screw.

EMERSON MODELS A130, A132 and A148 (Chassis Model A)

5-tube A.C.-D.C. Superhet, 2-range (540-1,700 kc.), A.V.C. in later sets.

In sets below Serial No. 799,001, Circuit No. 1 was used, with V3 a 78 triode. Up to No. 819,000, Circuit No. 2 (dotted parts in X-ed connections out). From No. 819,001, Circuit No. 3 (dotted parts removed, RI4 and RI7 inserted shown). Voltage Readings (at 117.5 V., A.C.): Plate Screen-grid Cathode grid Circuits Circuit No. 1.

<table>
<thead>
<tr>
<th>V1</th>
<th>V2</th>
<th>V3</th>
<th>V4</th>
</tr>
</thead>
<tbody>
<tr>
<td>112</td>
<td>60</td>
<td>1.5</td>
<td>2.5</td>
</tr>
<tr>
<td>112</td>
<td>112</td>
<td>4.6</td>
<td>6.6</td>
</tr>
<tr>
<td>760</td>
<td>6</td>
<td>0.5</td>
<td>15.0</td>
</tr>
</tbody>
</table>

*In Circuit No. 1, 50 V. on V3 plate.

Oscillator plate voltage (G1 of V1) 112 V. Across field coil, 125 V.; across Ch.1, 12 V. Across R10 (ballast tube) 45 V., A.C. across pilot light, 4 V., A.C.

I.F.T. 1 is oblong can, behind C2-C3; I.F.T. 2 round can at right of speaker, and has a single trimmer. R.F. trimmers (not diagrammed) are on variable condenser top—C2 front, C3 rear.

Receiver is adjusted at 456 and 1,500 kc. I.F.T. 1 is plug-in type; unsolder leads and lift out. (Color code is as for Model L, above.)

CAUTION: power line is grounded to chassis base!

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**Radio Service Data Sheet**

**Radio Craft** for **April, 1937**

609

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www.americanradiohistory.com
P.S.:  
"HE MADE THE SALE!"

Breaking into P.A. work does not necessitate a large investment if you tackle the job right!

H. M. BAYER

highlighted his heavy head on the storage battery and proceeded to enlighten us.

"I'm rich!" he informed us after a deep drag on our cigarette, "I've just finished a P.A. installation in our church, and signed a contract for another in the Elk's Club. Want to borrow any money?"

We rendered the looked-for gasp of awe at the first part (Continued on page 634)

IN ANOTHER PAGE

The complete amplifier and speakers fit into a split case.

JOHN STEFAN is a bright, young radio technician who possesses his own modest establishment and an inordinate capacity for griping. Because of our soft nature which includes a work phobia acquired as a childhood disease, we often drop into his shop to discuss this and that and to serve as a convenient target for his multitudinous gripes. For one thing, we are a member of the slide-rule fraternity, and Johnny places slide-rules and spinach side by side.

However, his pet pecuvis make another story—a long one. Something, other than the battle between theory and practice, was on his mind as he guided us into his be-metered sanctum sanctorum this bright and cheery afternoon.

"Here, sit down," he invited, waving to a storage battery and reaching his other hand into our cigarette pocket. We thanked him, swept a high-fidelity midget receiver (!) and an oscilloscope from the bench to the floor and sat ourselves on the clearing thus made. He didn't bat an eye—that gave us plenty to wonder about. In turn, he collapsed gently on a 12-volume set of "Magnetic Personality—Yours For The Asking" that was spread, divan fashion, over the floor.

A department devoted to members and those interested in the Official Radio Service Men's Association. For mutual benefit, contribute your kinks, gossip and notes of interest to Service Men, or others interested in servicing.
AWARDS IN THE CONTEST
FIRST PRIZE $10.00
SECOND PRIZE 5.00
THIRD PRIZE 5.00
HONORABLE MENTION

USEFUL RADIO CIRCUITS

Experimenters: Here is your Opportunity to win a prize for your pet circuit idea, if it is new, novel, and useful.

FIRST PRIZE—$10.00

Line-Booster Transformer. In locations where ac line voltage drops 10 or more volts during the hours of peak load, radio receivers and some other appliances do not function properly. A booster transformer can be added to the line circuit, feeding the individual appliance and thus stepping up the voltage. Such a scheme is shown in Fig. 1. The transformer T should have a rating in watts equal to, or greater than, the appliance to which it is connected. The transformer should have a 110-V. primary and a secondary tapped in 5-V. steps. The secondary is connected in series with the line and the transformer of the appliance. The secondary must be connected "series anode" in other words in phase with the transformer. Switch Sw.1 is the on-off control for the booster. When turned to the left it cuts in the transformer in the right-hand position it removes the booster from the line circuit. When the booster is being used the A.C. voltmeter M should always be in the circuit to prevent accidental voltage to sensitive apparatus. If the switch is left in position and the booster is not being used, the voltmeter will indicate the amount of booster voltage added to the primary circuit of the radio set transformer.

SECOND PRIZE—$5.00

Full-Wave Rectification Without A Power Transformer. Here is a full-wave rectifier for supplying "H" current to A.C.-D.C. sets, energizing speaker fields, and for supplying high voltage to test apparatus, etc. See Fig. 2. Because of the full-wave action, loss filtering is required than with half-wave circuits. Also, the voltage is slightly higher and the maximum current drain is much greater than with equivalent half-wave circuits. If the 35V. metal tubes are used it can be made very compact.

THIRD PRIZE—$5.00

A Bridge-Type Tester. This unit which operates on the principle of a simplified Wheatstone bridge is very useful for Service Men and experimenters in testing for resistance, capacity, plate resistance of vacuum tubes, ratio of transformer windings and a comparison of inductive reactance.

The unit consists of a type 68 or 27 triode tube and a 3621 A.F. transformer connected as an audio oscillator, feeding a potentiometer which is equipped with a scale calibrated in equal parts (of the resistance of the pot). See Fig. 3. In operation, for resistances, condensers, and inductances, the unknown unit is connected to one side of the bridge and a corresponding unit of known value is connected in the other branch. Then the potentiometer is shifted for minimum tone from the oscillator and the ratio of unknown to scale of the potentiometer will give the ratio of unknown to known. In the example shown in Fig. 3, the unknown capacity is 9/2 times the known capacity which equals 1/2 mfl.; and, in the instance of checking an unknown resistance, when compared to a 10-ohm resistor it is 15 ohms.

LOWELL SLACK

HONORABLE MENTION

A "Short" Tube Tester for the Supreme Tube Tester. A tester for testing every element of a tube can be very easily added to a Supreme type S1 tester. This tester originally does not have a short indicator that detects small leakages. The neon lamp added to the unit indicates much smaller leakage or shorts between elements. In Fig. 4, showing the tube tester, the simple changes and additional parts are evident. The short-circuit or test switch must be a toggle double-pole double-throw type, to close a circuit at either throw of the toggle. The tester originally has an extra toggle switch which is removed and replaced by a new one of the correct type. The 2-W. neon lamp can be mounted in a compartment. In testing tubes for shorts, after having heated them to operating temperature, the toggle switch is thrown to the test position and each element button pressed. If no short exists, a flash or no flash of the neon tube results. But if a short is present, the neon tube will glow continuously.

HOMER SCHULZ

HONORABLE MENTION

MAGNETO-TYPE POWER UNIT

A 120-V. and 32-V. D.C. Generator. The scheme shown in Fig. 5 is a unit for supplying 120 or 32-V. D.C. for testing radio sets of the D.C. type. A 120-V., 1/2-H.P. compound wound motor (speed 1,725 r.m.p. G.E. type SD) is driven at a speed of about 3,000 r.m.p. Generator—producing an output of 11 V. with a load of 100 W. A 1/2-H.P. A.C. motor is used to drive it. Any D.C. motor will work for this purpose, but the compound type is best. It should be driven at about 45 r.p.m. and a speed of 250 r.p.m. to develop 120 V. output. A 4- or 6-mfd. 300-V. paper condenser is connected directly across the D.C. output from the generator and a 0.1-mfd. to R.A.F. 300-V. condenser is connected to each brush and back to the frame.

When using the unit for 115 V. sets, place a fuse in socket No. 1 or No. 2, and a 19- to 25-W., 115-V. lamp in socket No. 3. The radio set (Continued on page 629)

Fig. 1. A line-voltage booster which permits the radio set to work in spite of low voltage.

Fig. 2. A full-wave power supply system for small sets, speaker field supply and other uses.

Fig. 3. A simplified A.C. bridge unit.

Fig. 4. Neon test for Supreme 35.

Fig. 5. 120-V. and 32-V. D.C. supply.

Fig. 6. Phono. pickup coupling unit.

Fig. 7. An improved volume control.

Fig. 8. Increasing the sensitivity.

Fig. 9. Capacity coupling scheme.

Fig. 10. Magneto-type power unit.

Fig. 11. Wind power for 2-V sets.

www.americanradiohistory.com
RCA VICTOR MODELS B8T, B8T6, 88K, AND B8K6

8-tube, battery powered superhet, continuous 3-range (530-1,780 kc., 1,780-6,300 kc., 6,3-22 mc., phonograph connections, "B" battery or vibrator unit.

Table models B8T, B8T6, have 8-in. speaker; console models 88K, 88K6, 12-in. speaker, permanent-magnet types. (The "G" indicates use of 6-V. storage battery, operating 155-V. vibrator-type power unit; shown in diagram below.) The 6-V. models have a pilot-lamp switch, to turn off lamps and save current. Current drain, 580-630 ma. on 2-V. battery; 1.3A. on 6-V. battery; 19 ma. plate current at 155 V. Tuning dial has 2 ratings: 10:1 and 60:1. Four bias cells, used for the R.F. and I.F. amplifiers, should never be tested with a voltmeter; but a 4-V. battery may be substituted, and comparative plate current readings made. A 40 per cent increase in plate current indicates a drop of 25 per cent in bias, and bias cells should be replaced.

The range selector switch functions by shorting out unused portion of the inductances in the antenna and oscillator circuits; 1st-det. V1 feeds a 2-stage I.F. amplifier in which magnetite-cored transformers are used, as well as in the 460 kc. wavetrap. The I.F. adjustment is so made that 2 kc. up or down in the 460-kc. test input signal makes little difference; the R.F. adjustments are sharply peaked. A cathode-ray oscilloscope is recommended for alignment; lacking it, a neon-pilot indicator across the voice coil. The photo of one model, shown, will aid identification.

Adjustments of I.F. transformers are made by screws attached to the cover; begin with C14 and C15; then C12 and C11; then C10 and C9. With the oscilloscope, a perfectly symmetrical curve is developed, with maximum amplitude; with glow-lamp or meter, maximum output on 460 kc. R.F. circuits are first compensated at 20 mc., by C6 at minimum capacity peak (plunger near out) and C3 at maximum capacity peak (plunger near in); checking image-frequency at 19.08 mc.; then at 6 mc., by C7 and C4. Wavetrap is then set for minimum signal with 460 kc. test input. Broadcast band settings are made first at 600 kc., adjusting screw L in top of oscillator coil for maximum; then trim C3 and C5 for maximum. Then at 600 kc., screw L is readjusted while rocking tuning condenser through signal, and finally C8 and C7 again. Lock-nuts are to be tightened after each trimmer setting is found.

In vibrator models, red and blue 4-V. leads should not touch; or vibrator buzz may be heard.
NEW STREAMLINED "MIKE!"

RCA "Aerodynamic" Microphone combines small size with fine performance!

![Image of a microphone]

SPECIFICATIONS:
Type...Pressure Operated.
Frequency Range...100 to 6000 cycles.
Impedance...250 ohms.
Average Operating Level...68 db (10 bar signal across open circuit).
Dimensions...2¼" wide, 3½" high, 3¾" deep.
Net weight...1½ pounds.
Finish...polished chromium.
Cable...6 feet shielded cable.
Stand Fitting Size...½" pipe thread.
RCA's new Aerodynamic Microphone, MI-6226—the pressure operated dynamic type—is small enough to fit the hand, light enough to carry easily, and offers outstanding performance! It is ideal for normal public address work and particularly suited for close talking. This new "mike", handsomely streamlined, gives excellent frequency response, insuring truly natural tone reproduction and clarity of speech. Its new Alnico permanent metal magnet provides maximum sensitivity and extra long magnet life. In addition, it makes the use of external excitation or power unnecessary.

Besides these features, the RCA Aerodynamic Microphone also offers many others, listed below for your convenience. Look them over. They'll convince you that there's plenty of microphone quality packed beneath the attractive chrome covering!

NOTE THESE FEATURES!
- Small size
- Light Weight
- High Sensitivity
- No external excitation of power supply required
- Rugged construction—insensitive to mechanical vibration.
- Unsullied by changes in temperature, humidity or barometric pressure
- May be operated at distances up to 1000 feet from amplifier.
- Excellent for close talking.
- Practically non-directional when faced vertically.
- Minimum response to wind.
- New Alnico metal magnet—retains magnetism indefinitely.

List Price...$826.50

ACR-155...New, Low-Cost General Purpose Communications Receiver
Amateur's Net...$74.50 f.o.b. factory

2 RCA Amateur Receivers
Answer Price and Performance Problems!

This receiver brings superior performance under modern operating conditions—yet sells at exceptionally modest cost! A number of its features are not to be found in other receivers costing so little. The outstanding features include continuous frequency coverage from 520 to 22,000 kcs...9 Metal RCA Radiotrons for improved high-frequency performance...improved, large tuning knob with crank handle for easy tuning...100 to 1 bandspread tuning drive...improved, adjustable, air-dielectric trimming capacitors...magnetite-cored transformers...calibration spread-dial for accurate logging...electrically stabilized oscillators...

ACR-175...New, Multi-Feature Communications Receiver...
An Outstanding Value!

Amateur's Net...$119.50 f.o.b. factory

This excellent instrument presents a combination of advanced features not even found in receivers selling at much higher prices! Its keen selectivity, plus a specially designed crystal filter, makes separation of interfering stations easy—even in the most crowded amateur bands.

Among its 32 performance features is an unusual tuning range—500 to 6000 kcs—giving coverage of many services unachieved by other communications receivers. Has 11 tubes, two stages of high-gain if amplification and a smooth-handling, single control bandspread system for easy tuning and accurate logging without use of reference points!

Conversion Your Radio Into Phonograph-Radio at Low Cost!

You can do it with the smart RCA Victor Record Player illustrated here! This fine instrument easily and quickly attaches to any electrically operated radio and in a jiffy turns it into an electric phonograph-radio combination! With it, you can hear all your favorite radio programs PLUS recorded music!

LATE NEWS FLASH!
1936 RCA Metal Tubes Sales Double Those of 1935!

Extra quality of RCA Tubes boosted 1936 sales to double the millions sold in 1935.

Please Say That You Saw It in RADIO-CRAFT
I'LL PROVE IT!...

...JUST 17¢ A DAY CAN PREPARE YOU FOR A GOOD-PAYING JOB IN RADIO!

Sprayberry Training does much more than teach you the basics of Radio, Television, Electronics, Sound, etc. It teaches you modern business methods—helps you make more money—gives you actual working experience—ready to help you get a job.

A.F.C. IMPROVEMENT

A SERIOUS limitation of the automatic-frequency-control systems now in use is the fact that they are not equally effective over all wavelengths, since the control tubes directly affect the oscillator frequency and the amount of correction thus varies at different points of the frequency band.

A means of removing this drawback was recently described in Wireless World (London). The ordinary superhet. frequency converter is replaced by a circuit containing two frequency changers so that for all wavelengths within the tuning range the second intermediate frequency remains constant. As shown in Fig. 3, the first converter, V1, feeds a second converter, V2, the output of the latter being fed to the double-tube, V3. The two circuits are tuned one above and the other below the second intermediate frequency. Any initial mistuning thus produces an E.M.F. across the 3 balanced load resistances R1 and R2. This potential is applied to a control tube, V4, which is shunted across the tuning condenser of the oscillator circuit of the second converter. The resulting change in the effective grid-cathode capacity of V4 provides the correcting factor which brings the act accurately in tune.

NEW LABORATORY TUBES

TWO ELECTRONIC tubes which have interesting applications in laboratory development and experimental work are shown in Fig. C. The first (at A) is a diode-type vacuum-tube voltmeter tube which was designed by Manfred von Ardenne, in Germany, for measurements in the decimeter (extremely high) range of frequencies. Measurements with ordinary tubes at these high frequencies are prevented by the great "electronic-transit-time" which is due to the spacing between the cathode and plate of these tubes.

The new tube is equipped with a cathode support at the plate end of the glass tube which has 3 glass bulbs sealed in. These glass bulbs (called "glass springs") allow the cathode to be moved closer than it is by normal spacing from the plate by means of a micrometer screw in the tube support, which compresses the glass bulbs. From Radio-Centrum, Berlin.

The second laboratory tube is a composite type, combining the tube types triode and tube, which was described some time ago, with a standard photocell and having an internal grid-cathode resistor.

F. L. Sprayberry

PE. ESCALATOR CONTROL

A NEAT and useful combination of laboratory oscillograph and recording motion-picture camera was described in Fig. 3 of the recent issue of Siemens Zeitachrift (Berlin). The oscillograph is equipped with a "fast" tube and the circuit is arranged in such a way that any motion applied to the horizontal plates is varied in synchronization with the shutter of the motion picture camera.

How do you like this department? Let us know, please, whether this effort on our part to acquaint you with the outstanding many European radio developments meets with your approval.

Editor

WHAT ABOUT RADIO IN 1937?

(Continued from page 555)

POWEL CROSLEY, JR.—

for 1936 will have reached 1,600,000 to 1,750,000 units compared with 1,200,000 auto-radio receivers sold in 1935. Radio, itself, has been one of the most important factors in business recovery. Aside from being a $400,000,000-a-year industry, radio broadcasting is $100,000,000 an industry in itself, has been a vital factor in business recovery in two ways: one, as a most effective advertising medium and the other as the quickest means of business, financial, and news reporting.

(2) Unquestionably the radio industry as well as industry in general faces a great growth in the future. Greater purchasing power of the people, together with the fact that there is an increasing appreciation of better radio sets, assures that.

(3) The radio industry may be compared with other industries in the opportunities it presents to those who can adapt themselves to new development and growth. In fact, it is necessary for any business to keep pace with progress if it is to endure. The opportunities in radio today are no doubt greater than they have ever been. Of course, keep in mind the different conditions that prevail in a pioneering era and one more fully developed.

(4) I would say that radio and broadcasting have many branches offer a young man as many good opportunities as any other business.

(5) This is an age of trained men and with specialization becoming more and more the rule, competently-trained men will be required more than ever before.

(6) This is a question that would require much space to answer. As a general suggestion, a young man desiring to enter the radio business, or any other, should prepare himself with a good fundamental education. Then, depending on where he lives, endeavor to secure a position with a dealer, distributor, or manufacturer of radio receivers or parts, or by passing through a radio broadcasting station. In this the young man's own ambition and industry will be of great value. There is no magic formula.
WHAT ABOUT RADIO IN 1937?

Isidor Goldberg—

Factory workers, broadcast station personnel, and engineers is increasing and will continue to increase. There are opportunities for many new men of various kinds of training.

(4) Yes. There is every reason for a young man to look forward to a permanent future in the branch of the industry to which his talents are suited.

(5) Radio is a technical product, and performs technical functions which will always require the services of technically-trained men.

(6) Try to find out which branch of the industry appeals to your individual ability. Then get the best training possible for that kind of work.

WESLEY M. ANGLE——


(1) Most certainly the radio industry is the branch where factory workers, broadcast station personnel, and engineers are suited.

(2) I am doubtful that the industry faces greater growth ahead than has been experienced to date. I do not at all feel that the saturation point has been reached because there will be many more kinds of homes, equipped with one set, which will be equipped with 2 or 3, and there are still persons who have no sets who will have them, to say nothing of the general growth in population. But, to a large extent, radio has not reached the condition where sets are sold to replace sets already in use, and modern sets should not need replacements as quickly as did sets in the days when a major improvement was being introduced every year.

(3) Most certainly I feel the radio industry still offers opportunity to those who keep pace with its new developments and growth.

(4) I feel the industry offers a good opportunity for young men as a permanent career. Of course we manufacturers had to reduce our forces tremendously during the depression years. Ours was cut to one-sixth or one-seventh of its former size, the persons laid off being released from all departments (manufacturing, engineering, selling and accounting). And for sometime after the up-grade began, it was a question of bringing back persons already laid off and not of hiring young men who had never worked for us before. This past year our manufacturers and dealers have been hiring a considerable number of young men who were not previously employed by us. And this year there will continue to be openings for young men from time to time in all lines of the industry.

(5) If there are going to be openings for young men of all types, there will certainly be openings for those who are competent and trained.

(6) I can only answer question No. 6 in very general terms because the answer depends so much on the ability, previous training and inclinations of the young man in whose behalf you were asking the question. Every young man who wishes to enter the industry should acquire as much education as he can along the lines of the particular branch of industry in which he is most interested, with due regard to his own native ability, and yet with the realization that some cultural education as well as technical education is desirable.

How to Use V-T. Voltmeters in Radio and P.A. Servicing

(Continued from page 681)

PART III

In June Radio-Craft, will conclude this series of articles on the V-T. voltmeter, with a consideration of D.C. voltage measurements.

The descriptions of measurements of r.m.s. and peak A.C. voltages will give the Service Man an idea of the flexibility and usefulness of vacuum-tube type meters for service work. The high sensitivity (in other words, low current drain in the meter) permits many measurements which cannot be made by the usual D'Arsonval, moving vane, and thermocouple or hot-wire instruments.

This article has been prepared from data supplied by courtesy of Clough-Brengle Co.
A special arrangement between RADIO-CRAFT magazine and the publishers of this literature, which permits bulk mailings to interested RADIO AGE readers, eliminates the trouble and expense of writing to each individual organization represented in this department.

1. THE 1930 ELECTRA-CATALOG. Contains complete specifications, illustrations and prices of the entire Electra line of variable and adjustable condensers; intermediate frequency transformers, coils and coil forms; sockets; shields; chokes and miscellaneous parts for broadcast, short wave and ultra-short wave reception and transmission. Also contains description and prices of the Electra line of "Comet Pro" and "Super Pro" receivers.

2. ELECTRAT 1936 VOLUME CONTROL AND REGISTER CATALOG. Contains complete descriptions and prices of all ELETRAT standard and replacement volume controls. Tru-voit adjustable resistors, variable wire-wound fixed and adjustable resistors and voltage dividers, precision wire-wound non-inductive resistors, center-tapped filament resistors, high-quality attenuators, power (50- and 150-watt) rheostats and other Electra resistor specialties.

3. THE KEY TO SUCCESSFUL SERVICING. Four different types of combinations of courses on Radio Servicing, Public Address Work, and Television, developed by the Radio Service Institute, are described in this 24-page booklet. Complete information, including outlines of the courses and costs, is given. Two of the courses are designed for the more advanced and more ambitious Service Men who are anxious to get to the top of their profession. The other two courses are for less-experienced Service Men who want to advance more rapidly in the Radio Servicing Field. Please do not ask for this booklet unless you are interested in taking a course in these subjects.

4. POLYCON Coil Data Sheet 536. This folder contains complete catalog descriptions, specifications, prices, performance curves and circuits showing applications of the complete line of Polycon radio components made by the Alladin Radio Industries, Inc.

5. RIBON MICROPHONES AND HOW TO USE THEM. Describes the principles and operating characteristics of the Amperite velocity microphones. Also given is a diagram of an excellent home-built microphone and battery-operated preamplifier.

6. THE 1937 LINE OF SUPREME TESTING INSTRUMENTS. This 24-page catalog gives complete specifications on the entire Supreme line of testing instruments, including the Model 555 Diagnotester, the Model 540 and 555 Radio Testers; the Model 500 Automatic, the Model 555 Tube Tester; the Model 555 Diagnoscopence and other Supreme oscilloscopes and telemetry, signal generators and multimeters. Complete details of the Supreme Easy Payment Plan for purchasing testing equipment on the installment plan are also given.

7. SUPREME DESIGN MANUAL "A" OF TUBE AND RADIO TESTING CIRCUITS. This interesting and useful 60-page handbook covers the fundamental principles of meters, measuring instruments and test circuits and illustrates, with detailed explanations, the basic circuits used in Supreme Testing Instruments. Every Service Man who is interested in the "why" of testing circuits should have a copy of this handbook in his kit.

8. HOW TO ELIMINATE RADIO INTERFERENCE. A handy folder which gives very complete information on how to determine and locate the sources of radio noise by means of the Sprague Interference Analyzer. A description of the analyzer and method of using it is included, together with data on how to eliminate interference of various kinds once the source is located.

9. ELECTROLYTIC AND PAPER CONDENSER CATALOG. Lists specifications, with list and net prices on a complete line of wet and dry condensers made by the Sprague Products Co. for radio servicing, set builders, experimenters and engineers. Information on the Sprague Capacitor, for making capacity tests on condensers and in servicing receivers, is included.

10. SPRAGUE TECH-11 HOW CONDENSERS GUIDE. A valuable chart, compiled by the Sprague Products Co. which tells the proper types, capacity values and voltages of condensers required in the various circuits of radio receivers and amplifiers, and also to locate radio troubles due to defective condensers. Includes data on condenser calculations.

11. Facts You Should Know About Condensers. A folder, prepared by the Sprague Products Co., which explains the importance of various characteristics of condensers, such as power-factor, leakage, capacity and voltage in determining the efficiency or suitability of a given condenser to provide maximum filtering and safety in operation.

OPERATING NOTES (Continued from page 606)

section in these models has been removed by making a direct connection from the ground side of the amplifier to the ground of the power converter. Sharper tuning has also resulted from this alteration. (Fig. 11.)

The original ground connection between the sections of this and other Spartan models, consists of a piece of tin which lies on the chassis board with the tuner, R.F. amplifier and power converter sections merely resting on it, there being no soldered connections made. See Fig. 11.

Note caused by poor contact at one of these points can be eliminated by providing a wire connection between the chassis for tuner and power supply. The position of this can be left under the two chassis, if desired. The wire should be soldered to lugs, fastened under screws on the chassis.

A. F. PATHCHECK

Please Say That You Saw It in RADIO-CRAFT
choosing 16 resistors between 100 ohms and 600,000 ohms (0.6-meg.) and grouping them with each of the 4 switches, values can be read between 100 and 999,990 ohms (0.9999-meg.) in steps of 100 ohms.

Each section of the resistance decade box consists of a 2-gang, 10-position selector switch and 4 resistors. Fly one method of wiring a single-decade section could be assembled as shown in Fig. 1A. This employs a conventional 2-gang, 2-pole, 10-position switch. This method requires much external wiring, entailing additional labor and a possibility for poor connections, so a better plan was figured out.

Special switch sections were designed. These are shown, in Fig. 1B, with the resistors numbered and connected to the proper terminals. Note the absence of external connections. By using specially-designed contact clips and rotors all of the connections are automatically made as the switch is rotated. The resistance is measured between points A and B. A completely-assembled decade switch section is shown in Fig. A, the heading photograph.

To go from 100 ohms to 999,990 ohms in steps of 100 ohms, use the following resistance groupings:

<table>
<thead>
<tr>
<th>Resistor</th>
<th>Number of Ohms</th>
<th>Ohms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>1,000,000</td>
</tr>
<tr>
<td>2</td>
<td>200</td>
<td>2,000,000</td>
</tr>
<tr>
<td>3</td>
<td>300</td>
<td>3,000,000</td>
</tr>
<tr>
<td>4</td>
<td>400</td>
<td>4,000,000</td>
</tr>
<tr>
<td>5</td>
<td>500</td>
<td>5,000,000</td>
</tr>
<tr>
<td>6</td>
<td>600</td>
<td>6,000,000</td>
</tr>
<tr>
<td>7</td>
<td>700</td>
<td>7,000,000</td>
</tr>
<tr>
<td>8</td>
<td>800</td>
<td>8,000,000</td>
</tr>
<tr>
<td>9</td>
<td>900</td>
<td>9,000,000</td>
</tr>
<tr>
<td>10</td>
<td>1,000</td>
<td>10,000,000</td>
</tr>
<tr>
<td>11</td>
<td>2,000</td>
<td>20,000,000</td>
</tr>
<tr>
<td>12</td>
<td>3,000</td>
<td>30,000,000</td>
</tr>
<tr>
<td>13</td>
<td>4,000</td>
<td>40,000,000</td>
</tr>
<tr>
<td>14</td>
<td>5,000</td>
<td>50,000,000</td>
</tr>
<tr>
<td>15</td>
<td>6,000</td>
<td>60,000,000</td>
</tr>
<tr>
<td>16</td>
<td>7,000</td>
<td>70,000,000</td>
</tr>
<tr>
<td>17</td>
<td>8,000</td>
<td>80,000,000</td>
</tr>
<tr>
<td>18</td>
<td>9,000</td>
<td>90,000,000</td>
</tr>
<tr>
<td>19</td>
<td>10,000</td>
<td>100,000,000</td>
</tr>
</tbody>
</table>

Since resistance is being considered, it is only necessary to wire these 4 sections individually and then place the 4 separate units in series. If higher ranges are required, add switches in parallel. The range is only limited by the commercial values of available resistors.

DECADE CONDENSER UNIT

Just as for the resistance decade, the condenser decade box consists of 4 individual units, each made up of 1, 2, and 4 condensers.

The problem is slightly different, however, since condensers must be placed in parallel to add two or more values together. One circuit to accomplish this is shown in Fig. 2A. Here a 4-gang, 4-pole, 11-position switch is used. It is possible how the condensers are connected in parallel but, due to the unused terminals on 3 of the sections, could hardly be called economical.

By proper design, a special 1-section switch is available that accomplishes all that the 4-gang switch shown in Fig. 2A can do. All external connections except the actual connection of condensers are eliminated. This switch, viewed from the rear, is shown at Fig. 2B. The capacity is measured from A to B. Just as for the resistance decade switch, the condenser numbers when multiplied or divided by 10,000, 1,000, etc., indicate the range that a given switch will cover. This tabulation illustrates the range of a typical 4-section condenser decade box:

<table>
<thead>
<tr>
<th>Condenser</th>
<th>Sw 1</th>
<th>Sw 2</th>
<th>Sw 3</th>
<th>Sw 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>mf.</td>
<td>mf.</td>
<td>mf.</td>
<td>mf.</td>
<td>mf.</td>
</tr>
<tr>
<td>1</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>2</td>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td>3</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
</tr>
<tr>
<td>4</td>
<td>0.004</td>
<td>0.004</td>
<td>0.004</td>
<td>0.004</td>
</tr>
<tr>
<td>(0.0001-0.001)</td>
<td>(0.001-0.01)</td>
<td>(0.01-0.1)</td>
<td>(0.1-1)</td>
<td></td>
</tr>
</tbody>
</table>

This assortment gives an available range of 0.0001-mf. (100 mmf.) to 1 mf. in steps of 0.0001-mf. (100 mmf.). In 10,000 distinct capacity values! In increasing the range of condenser decade boxes, be sure to add additional sections in parallel—not in series, as is the case for resistors. This, of course, is a fundamental difference between condensers and resistors.

This switch, described above, are available in knocked-down form.

LIST OF PARTS

Resistor decade switch
One Centralab K-121 Index assembly
One Centralab Type 7P switch section
One Centralab Type 7Q switch section
Condenser decade switch
One Centralab K-121 Index
One Centralab Type 7P switch section
Two Centralab K-127 dial plates

This article has been prepared from data supplied by courtesy of Centralab.

THE WESTON CHECKMASTER

$45.00 TO DEALERS IN U. S. A.

It's the experienced servcemen who have gone for the Model 771 Checkmaster in a big way. This was to be expected... for we built Model 771 to give the serviceman everything he needs for trouble shooting and estimating in one compact, easy-to-carry case. He has all this in the Checkmaster... providing it does for a thorough check of tubes, as well as for checking continuity, resistances and voltages. In addition, it has a spare compartment for tubes or tools. This means time saved in answering emergency calls... for he need carry only this one, compact and complete Checkmaster for quickly getting at the root of the trouble.

But to make the Checkmaster even more useful, it has been strikingly designed and finished for counter use as well... making it the handiest, most versatile tool any serviceman can own. Inexpensive, too. And the name it bears is the best guarantee of instrument dependability and long life. Be sure to see the Checkmaster at your jobber's, or return the coupon for complete information.

FEATURES:

INGENIOUS WESTON SWITCHING CIRCUIT
ACCOMMODATES TESTING OF TUBES WITH WANDERING FILAMENTS

Wired for testing latest tubes.
Neon short check while tubes are hot.
Cathode leakage test of CORRECT DESIGN.
Individual tests on elements of diodes.
Voltage ranges for point-to-point testing.
High and low resistance ranges for continuity testing with built-in filtered power supply.
Actual condenser leakage measurements—all types of high and low voltage condensers—read in ohms on meter scales.
All readings on one legible, open-scale meter.

The famous WESTON 301 in modern rectangular form.

Positive line voltage control.

Weston Electrical Instrument Corp., 599 Frelinghuysen Ave., Newark, N. J.
Rush me bulletin on the Checkmaster and other Radio Instruments.

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CITY ________________________________ STATE _______________________

Please Say That You Saw It in RADIO-CRAFT
MAKE THE RADIO-CRAFT MIDGET OSCILLOSCOPE

(Continued from page 395)

LIST OF PARTS

Skeletal amplifier for either 60-cycle or sawtooth sweep, or it may be used to amplify any external input to the horizontal plates. Either amplifier may be cut in on the parameter and amplitude controls for vertical or horizontal plates are available for voltage control whether the amplifiers are in use or not.

An additional control is provided through the use of a single-pole double-throw switch on the potentiometer which controls vertical amplitude. This switch cuts out the potentiometer entirely when the instrument is to be used for transmitter R.F. measurements. The R.F. is no respector of potentiometers as many hams have found to their sorrow! Even if the control is "on" fully, a great deal of heating occurs and the control is usually ruined; so the best we can do is to cut it out. When the potentiometer is turned fully counterclockwise the switch operates to cut it out. A slight operation must be performed on the resistance element as it is 60-ohm that the contact arm be entirely open-circuited when the switchoff is applied. It is a simple matter to sense sufficient curbing from the element so that this is accomplished. The "off" position is noted on the diagram.

SYNCHRONIZING CONTROL

Through the medium of a switch and a potentiometer full synchronization of patterns is possible in the instrument. The switch allows for (1) internal, (2) 60-cycle, or (3) external synchronization. In the latter position a "wobbler" may be connected for use when tuning-up sets or for observing R.F. transformer and amplifiers response curves.

It should be noted that this synchronization input circuit is of high impedance, rather than low, Impedance, as found on commercial oscilloscopes. If it is imperative to have low-impedance synchronization connections, this may easily be accomplished by use of a transformer with the high-impedance winding connected to the binding posts. A microphone transformer will give a very low-impedance input if this is needed.

DESCRIPTION OF COMPONENTS

A short description of some of the parts may be in order. While the power transformer is the only really "special" part, the builder is urged to follow the List of Parts as closely as possible, as the units have been selected for special elements of quality and compactness. The transformer, while not made for exactly this circuit, is designed for use with the 912 tube. In our circuit it is slightly overloaded, but, probably due to careful design, there seems to be no overheating, even when the apparatus is used for a considerable length of time. The 2 rectifiers and the heaters of the 912's are run from the "winding market" 0.3 V. Y. Y. This is a load of 1.2 A, but as noted it does not seem excessive. The other 6.3 V. winding is rated at 0.6 A. A 60-ohm resistive coupling connects only to the 912 tube. When hooking up the heater circuit, that pin No. 2 goes to the junction of the 2 potential resistors. If pin No. 7 is connected in this position all sorts of weird patterns will result. The 2.5 V. winding supplies the type 885 oscillator, and in addition, is a 60-ma.

2-V. pilot lamp is connected to this winding. A series resistor of 10 ohms provides the necessary voltage drop. Do not use any other type of pilot light, as the current drain will be too high.

The high-voltage windings deliver about 450 V. and 200 V., and supply the 913 and amplifier circuits respectively. A tap on the high-voltage winding allows the use of about 325 V. on the 913; this gives increased sensitivity but reduced brilliance and sharpness of focus. The patterns are still very usable, however, and a double-throw switch might be incorporated to change the voltage.

A very desirable feature of the transformer is its apparent complete lack of external field. The 913 almost touches the transformer, yet the latter causes no change of pattern shape! A small replacement transformer tried in a previous model had so much field that it could not be used at all.

The bleeder for the low voltage is made partly by a fixed resistor of 2 W. size and partly by a small, wire-wound unit with 5 sliders on it, one for the screen-grid voltage of the amplifiers, and the other for control-grid bias of the 885. The transformer is set at 50 V. the latter at about 7 V.

The List of Parts will permit the constructor to proceed with the detailed point of assembling the components. Part II in a forthcoming issue will contain constructional instructions.

Please Say That You Saw It in Radio-Craft

Audio-Video and Electronic Circuits

XMR Manual

The Kenyon Transformer Co. Inc. has just released a new booklet, entitled "Ranger," bearing the title "Amateur Transmitter Manual" consisting of 64 pages of circuits, data, graphs and informative reading matter which is of interest not only to "hams" but also to radio technicians in general. The 14 pages of graphs alone, provide a vast source of reference in solving technical problems. This booklet is priced at 25c. (Booklet No. 1324.)

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existing systems, or as the complete amplifying system for a manually powerful and fine electrophonic phone.

It may further be used as a standard audio system in a laboratory, developing radio, records, or for the experimenter may serve not only as the audio system for his radio receiver, but it is also the complete "A" "B" and "C" power supply for the entire radio set as well.

Providing 55 db, voltage gain, so that it requires only 1 V of A to produce the full 32 W, power output at not over 2 per cent total harmonic distortion, it has a frequency characteristic of 30 to over 20,000 cycles—or over a far greater audio range than will ever be needed outside a laboratory!”

Deriving all of its operating power from any 110-V. 50- to 60-cycles A.C., light socket, it not only provides 32 W. of excitation to the field of its own special speaker, but has a power socket from which can be drawn 4.5 A. at 6.3 V. A.C. to drive condenser- or tube-in-a-bottle amplifier.

This extra power can be used to power a preamplifier, to power a multi-tube radio tuner, or to do many of the things that additional speaker fields yet this giant of flexibility and power is only 5½ x 7½ x 11 ins. long.

The circuit design of the amplifier lies not only in its thorough and up-to-the-minute design, but in the superior-18-in. loudspeaker which is a fundamental part of it. Not only does this speaker cover with exceptional fidelity the full audio tone range of 30 to 90,000 cycles, but its 35 per cent 7 times customer efficiency results in an acoustic or sound power output equal to 224 W. fed into any ordinary 5 ohm efficient speakers, i.e., 32 W. into an 8 ohm per cent efficient transducer (loudspeaker) gives 11.2 acoustic watts, and 224 W. fed to a 5 per cent efficient transducer likewise gives 11.2 acoustic watts output. This is sufficient power to handle comfortably heard by 50,000 people or by several times this number if more than one speaker is used for wide-angle sound distribution.

Fundamentally, the circuit consists of a 6N7 dual-triode voltage amplifier and phase-inverter driven by a pair of 6L6 tubes in power-pull. Power is had through a choke-input filter, with an effective 3/4-mf. of input capacity used only 1 K ohm the, at 360 volts hum customary to unbypassed filter input chokes. Since a choke input filter inherently possesses excellent and very flat voltage regulation, the alternating current exchange of an 83Y for the single 5Z3 rectifier allows the extra 33 W. of power for preamplifier, extra amplification, and power output to be had, without upsetting operating voltages. Since input voltage is fed in less than 1 db. in more than is ordinarily needed in a P.A. power amplifier, a 1/2-meg. gain control is included, so that gain may be adjusted for exactly balance with preceding input equipment.

Coupéndensers and resistors are so chosen as to give input current to less than 1 db. above 20,000 cycles, as are bypass condenser values. The order of plate filtration required by the 6L6 power stage being less than that needed by the 6N7 voltage amplifier, the needed additional filtration for the 6L6 is had by a resistance-capacitor filter of 5,000 ohms and 8 mf., a compact and economical means of filtering and isolating the 2 stages.

Since no additional voltage is needed, and only 1 V. input for full output, and since input impedances are far from critical, almost any number of inputs can be driven by a single small preamplifier—but unless daydreaming is indulged in there will never be need for more than 2 or 3 such in the largest installations.

For radio or phone operation no preamplifica-
tion is needed, while for crystal or similar "full- down" microphones, a single 637 audio pentode with 1/4-meg. plate resistor and 0.1 mf. coupling capacitor will yield gain of over 90 db., which is plenty, and add only a cost of a dollar to two since it gets from the P.A. and thence to the P.A. amplifiers, to give a complete, distortionless and ultra-powerful P.A. system. This whole equipment will gloriously stand up to a $69 for its extraordinary fine performance.

This article has been prepared from data supplied by courtesy of McMurdo Sound Corp.
his own ingenuity in mounting the parts to suit individual cabinet requirements; in the instrument here depicted the components were distributed and shown in the photographs.

The baffle disc seen in the 8-390 meter, variable condenser, electrode jacks, pilot light, and all the switches. The oscillator tube, front, and filter condenser, are mounted on the lower deck at the bottom of the cabinet.

All high-voltage leads are made with very heavy cable. An extra outlet, S2, placed on the side of the cabinet to permit the use of a foot switch when cutting is used. Provisions must be made for cool ventilation as the tubes radiate considerable heat. To this end, grilles are placed at the top, bottom, and across the back of the cabinet, to provide for the proper circulation of air currents.

The high-voltage side condenser, C2, of about 0.002 mfd., should be used so that the patient's circuit will be isolated from the tank circuit, should the tank circuit be broken by a chance touch to either.

Correction: In Fig. 1, Switch SW-2 is shown incorrectly connected: It should be wired in series, into the short lead that connects CS. R.F.C.1 to primary of P.T.1, and the former lead from this side of the primary to the pilot light permanently connected (just as would be with SW-2 in the old position and "on").

The next step is to tune-up the instrument for either (1) straight-forward diathermy or (2) special applications.

ADJUSTMENT

(1) In tuning up the completed machine, with resistor R1 employed for straight diathermy, it will be found that the plate current will vary with the different positions of the electrode pads on the body. Plate current will be restored to the correct value by readjustment of the output circuit including the pads is brought back to its resonant frequency by readjustment of the variable condenser, C1. Should less heat be desired, the plate current can be reduced by a further adjustment of C1. Under normal conditions the plate current for both tubes will read from about 150 to 250 milliamperes.

(2) When the machine is to be used for special applications—(a) cutting, (b) cautery, (c) desiccation, or (d) coagulation—resistor R2 is connected in series with the output circuit with a resultant drop in plate current.

This particular machine was designed to be operated on 16 meters. Therefore, when the electrode pads (flexible metal plates imbedded in soft rubber) are connected, the soft-rubber-covered connecting cords should be short enough so that the electrode unit will resonate at this wavelength. All connecting cords and pads be bought instead of attempting to make them at home. They are stocked as standard equipment at many surgical supply houses, but one applies to any other accessories used with the machine for other functions.

DIATHERMY INTERFERENCE

A very great problem encountered in the use of diathermy equipment is that of radio communications interference. A great stride towards the solution of this problem can be taken in the inherent design of the circuit. Note in the diagram the use of a 4 mfd. filter condenser, C6, across the output of the power supply. This is essential to prevent oscillator instability, and the resultant set-upting of spurious frequencies which cause interference.

The inside of the cabinet is lined with copper sheet, whenever possible to act as shielding, and so reduce high-frequency radiation into surrounding house wiring and other metal materials.

This method, however, is very effective and widely used and may be recommended. Another filter system, of an array of R.F. chokes and bypass condensers placed directly at the power transformer, will do this. This precaution is more care of all that can be done at the machine proper.

Upon installation of the equipment, however, it may be found that these measures alone might prove inadequate. Therefore, another filter arrangement, similar to that in the input circuit, will be placed at the particular current outlet (wall plate, etc.) that feeds the machine. It should be borne in mind that success with any filtering method is entirely dependent on a very good ground being used in conjunction with it. Although it is quite possible that they will not always be practicable, there are other measures that can be employed to eliminate interference. The foregoing treatments for radio interference elimination will be found very effective in most cases. In some instances the cure will be under the technician who makes the installation. He may find that one method will do the trick, or perhaps a combination of several. Through this the orderer may not be interested in the construction of the machine, the doctor, or the patient. (See Note at end of article—Editor)

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**HERE'S THE WAY YOU CAN OWN A NEW C-B OSCILLOGRAPH FREE!**

Linear Sweep Circuit  Synchronizing Circuit  Dual Amplifiers  Beam Centering Control

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Don't miss this chance to own a fine new oscillograph, Act quickly! Until March 31st you deposit only $29.90 and agree to buy less than 8 National Union tubes per week for two years. You get the instrument immediately. After you purchase the required number of tubes YOUR DEPOSIT IS REFUNDED as a merchandise credit. After March 31st the deposit goes up to $39.90, so SAVE $9.00, ACT TODAY! Here's an instrument you need... let National Union give it to you.

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National Union means MORE service business BETTER service business.... AT A PROFIT!

---

**LIST OF PARTS**

- One diathermy-type tuning condenser, 90 mmf. (max.), 5,000 V., type XP-96-KS, C1;
- Two Cornell-Dubilier fixed condensers, 0.002-mf., 5,000 V., C2, C5;
- Two Aerovox mica fixed condensers, 0.006-mf., C7, C8;
- One Electrodi (or, as illustrated) power-type resistor, 50 W., 2 sections—10,000 ohms, R1 and 50,000 ohms, R2;
- Two Hammarlund R.F. chokes, 25 my., 100 ma., R.F.C.1, R.F.C.2;
- Two Hammarlund short-wave (line) chokes, 5A., R.F.C.3, R.F.C.4;
- One Weston square-fuse meter, 300 ma., D.C., MA.:
  - One filament transformer (6L, sec.): V1-V2, 6/5 A. at 10 V.; V3-V4, 10 A. at 2.5 V.; 3,500 V., insulation), P.T.1;
  - One power transformer (H.V. sec.: 300 ma. at 1,550 V., each side of center-tap), type 611, P.T.2;
- One coil (13 T. No. 10 enam. wire, wound 2½ ins. dia. and spaced 1 turn. Top 4 T. each side of center). L1;
- One coil (5 T. No. 10 enam. wire, wound 1½ ins. dia. spaced between turns, about 1 in.), L2;
- Two diathermy tubes, type 100-7S, V1, V2;
- Two Sylvania, Raytheon, National Union or RCA Radiotron rectifier tubes, types 886, V3, V4;
- One Eveready pilot light, 110 V., 7 W., candelabra base, V5;
- *Four ceramic, high-voltage sockets, for V1, V2, V3, V4;
- Two flush-mounting sockets (female sections for separable plug-in connectors), S1, S2;
- One Wholesale Radio Service Co. socket and bulb bases for V5;
- One tuning-control knob for C1;
- Two fuses (one for each side of the power line; not shown in schematic, but recommended), and fuse holders;
- Three snap switches, Sw.1, Sw.2, Sw.3;
- Two insulated, base-mounting tip-jacks (for electrodes);
- *One diathermy cabinet (it may be built in accordance with the directions given in Fig. 5; ventilate rear panel).

*The names and addresses of manufacturers will be supplied upon receipt of a stamped and self-addressed envelope.

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Please Say That You Saw It in RADIO-CRAFT

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**Fig. 1.** The special shielded "diathermy booth" which prevents radiation of R.F. interference currents.

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HAMMARLUND 15th YEAR RADIO CATALOG

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**FREE!**

**DIRECT-COUPLING IN A 30-W. BEAM-TEE AMPLIFIER**

(Continued from page 601)

should be used (Fig. 2B).

The analysis of the stabilizing action of the entire system can best be illustrated by redraw-

ing the relative amounts and costs of the output

tube circuits (V3) as indicated in Fig. 2C. For purposes of simplicity, the rectifier has been drawn as a D.C. generator only.

In this circuit, One of the EL6 tubes is connected through 1/2 of the output transformer to the high-voltage terminal.

It will be noted that although 200 V. is applied to the cathodes, the voltage across the 25 V. less negative (175 V. is applied to the control-

grid), while the plate is 400 V. above cathode (600 V. above ground) and the gate divider and

tube at 500 V. potential (300 V. above cathode). Under these conditions the no-signal current is 50 ma. for plate and gate and 40 ma. for screen-grid. Approximately a 2,700-ohm bias will be required.

At full-signal conditions an increase of 10 ma. (combined increase of plate and screen-grid cur-

current) flows through R2 so that the cathode volt-

age would be raised 51.3 V. This degenerative effect not only lowers the available power out-

put but also discriminates against the low fre-

quencies, as the voltage drop is not constant at all

values of plate and screen-grid current.

The reason for this is that an external bridge circuit is formed across the cathode of the output

tube. As such circuit is divided equally, half flowing through resistor R1, while the other half flows through R2. Voltage

voltage is therefore directly proportional to the current, so that a constant cathode potential is maintained above ground

of the plate and screen-grid circuits of the amplifier are of the bridge-circuit self-neutralizing type.

THE NON-REACTIVE PHASE INVERTER

Up to the development of the circuit shown in

Fig. 2A and B, all existing methods of phase-inversion utilized a superfluous coupling

system whereby a voltage opposite in phase but equal in amplitude to the signal voltage was picked off a plate circuit and

directly fed into the input circuit of some tube or tubes ar-

ranged to operate in push-pull fashion. The original intention of the phase-inverter was to elimin-

ate the input push-pull transformer. Naturally, all the objectives to resistance and transformer coupling mentioned before also

hold for phase-inversion circuits.

The ideal phase inverter will equally divide

the amplitude of a signal and separate their phases by 180 deg. Naturally, this action must take place equally well at all frequencies and ampli-

tudes within limitations set by the tube itself. Any circuit utilizing a condenser cannot accom-

plish this because the capacitative reactance presented by the condenser to the varying

frequency Transforms are likewise limited in their phase-inversion action because of the

varying inductive reactance of both of the pri-

mary and secondary windings. In the face of

these handicaps, circuits utilizing conventional phase inverters may be adjusted for true inver-

sion at one frequency only. As the frequency decreases, inversion is retarded and conversely as the frequency increases, phase inver-

sion is accelerated.

Therefore, one that will vary inversely with very narrow frequency limits will be the inverter shown in 180 deg. outlet with phase of the original signal. Phase

Amplitude distortion is of course considerably

in transformer inverters unless unusual care is exerted in the design and construction of the transformer.

The phase-inverter circuit shown in Fig. 2E and 2F utilizes simple voltage stability and an

capable of theoretically and practically equal

division of a signal into 2 equal amplitudes and

at the same time, inverting one of the signals 180 deg. out of phase with the other.

The plate load of the tube is divided into 2 equal, non-reactive parts and one section (pure resistance) is inverted in the cathode circuit forming 2 signals in phase opposition. In the positive cycle of the input signal, the plate cur-

cent increases with a subsequent drop in plate voltage because of the increased voltage drop in the plate resistor (Pi). The increase in cathode current raises the cathode voltage be-

cause of the increased current addition to the cathode resistor (Ki). Therefore, the poten-

tials appearing across the plate and cathode of the tube are opposite in phase. As Pi and Ki are equal in value the amplitudes of the voltages developed across them are exactly alike.

**VOLTAGE DISTRIBUTION IN THE AMPLIFIER**

A casual study of the simplified amplifier schematic circuit Fig. 2 shows the haphazard distribution of voltages ranging from 600 V. on the plate of one EL6 to 65 V. on the cathode of the other. A careful analysis is made however, it will be found that the relative voltages from cathode to grid remain constant and in accordance with accepted tube ratings.

Of course, when the plate of one tube is connected directly into the grid of the next tube both the grid and plate have the same applied potential as measured from ground. It then becomes necessary to adjust the cathode and plate voltages of each tube so that, in relation to its grid, they are equal.

In a 3-stage direct-coupled amplifier of this type, all voltages are additive. This accounts for the high plate voltage of the plate of one of the EL6 power output tubes.

Part III of this article, in July Radio-Craft, will describe the complete circuit of the amplifier with some hints on its use.

This article has been prepared from data supplied by courtesy of Amplifier Company of America.

Please Say That You Saw It in Radio-Craft
Fig. C. The positions of the argon lamps can be seen.

MAKING THE RADIO KALEIDOCROME
(Continued from page 601)

constants specified in the List of Parts, is shown at right in Fig. A. It is a magnetio radio set, rebuilt slightly as a beat-type A.F. oscillator.)

The bulbs are tiny, argon-filled G.E. glow lamps similar in appearance to the noon lamps used iri many tubc testers and continuity indicators. The lamps must be coated with a special fluorescent paint (available either transparent or translucent) which glows when the argon gas inside the lamp is ionized. These unusual fluorescent coatings produce a diffused light, of any desired color, which is very attractive. A sheet of ground glass further diffuses the light and produces a continually varying band of color which changes as the music is received. (The lamps may be obtained ready-colored as specified in the List of Parts.) Each of the 4 lamps lights on a band of frequencies above and below the frequency mentioned above. The lamps are grouped in a V-shaped reflector made of polished aluminum to further mix the light as it is seen on the ground-glass panel.

The construction of the device is simple and any radio builder or experimenter can make one by following the schematic circuit, List of Parts and photographs.

The Kaleidochrome may be attached to any receiver without changing the wiring of the set or altering it in any way. Also, either the "color organ" or the "color tuner" may be built.

THE "COLOR TUNER"

The tuning-light portion is entirely independent of the color organ and operates as follows:

As per Fig. 1, the 16 outputs from the A.V.C. voltage developed in the receiver to which it is connected. With no bias applied to its grid, the tube is essentially a valve, and its glow increases as the plate current rises to a value great enough to saturate the core of the special "tuning reactor." This, in turn, lowers the impedance of the secondary winding to a point sufficiently low to pass 300 ma. or more. This is sufficient to light the series-parallel pilot lamps (back of the slot in the chassis as shown in the photos) to full brilliance. These 4 lamps are coated with ordinary red-water-color paint, while the remaining 3 lamps are coated green by the same process.

The condition of brilliant light on the red lamps applies only when no signal is tuned in on the receiver. As the A.V.C. voltage increases with a signal the bias on the tube control-grid increases and the plate current (Continued on page 624)
Sweep Adjustment

In Part III, the value of the vertical sweep-frequency condenser C10 was given as 0.001-mf. and it was stated that the sweep-frequency condenser C18 as 0.5-mf. These values are correct for 43-line interlace systems used in the experimental transmissions of R.C.A. in New York and Philo and Parnsworth in Philadelphia. However, for television systems on the Pacific Coast, where one may wish to pick up the transmissions of the Don Lee system, the value of C18 may have to be changed to a 0.5-mf. condenser in parallel with a 0.05-mf. unit (both 400 V. D.C.) in order to reach the frequency of 24 cycles required for the low-frequency sweep. The high-frequency sweep for this system is 7,200 cycles which can be reached with the specified condenser.

The Lens System

In the photographs accompanying this concluding Part of the series, it will be noticed that a lens system increases the size of the images from 2½ ins. (on the end of the 3-in. C.R. tube set about 1½ ins. This is the lens system which contains 2 lenses having a very short focal length which was taken off an old scanning-line television receiver tube by the Bally Corp. Jenkins Television Corp. Quite a number of these lenses are available from "second-hand" radio dealers but if the experimenter cannot obtain one, a suitable lens may be obtained from any reliable optical glass manufacturer (such as those who supply lenses to amateur telescope makers) to enlarge the image as much as possible without introducing any distortion in the form of spherical aberration, etc.

As a last resort, quite presentable images can be seen directly on the face of the tube and the following procedure is used in order to intensify the apparent brilliance of these images. Cut a funnel, of the size shown in Fig. 8, should be provided with a flat-bottom and with flat-black (or "lamp black") paint on the inside. The image when viewed through this funnel appears very clear—though rather small.

The cabinet in which the set is housed should have been designed and fitted in any desired manner. The 9 controls on the side of the sweep and C.R. tube chassis should pass through holes in the right-hand side of the cabinet, so that they can be adjusted when necessary. The actual tuning control and the volume control for vertical channels are located on the front panel, below the image lens.

Adjustments

Although explicit instructions are not given for adjusting the receiver for the reception of images, the various adjustments are needed for this particular receiver to get started. After this, it is a matter of cut and try in order to get the various parts of the set adjusted to the location at which the receiver is used.

The various adjustments have been made to line-up the circuits and sound and controls. When the television signals are received (on headphones connected to the output of the video channel) on the screen of the chassis with the grid current of the "hum" to the horizontal sweep, the next problem is to adjust the C.R. equipment to synchronize with the transmitter signal. When the two chassis are tied together by connections A, B and C, the various potentiometers on the chassis must be turned until the image should turn to the mid-position as a starting point. Without any carrier tuned in, the sweep amplitude control should be varied until a clean-out rectangle of light is seen on the end of the C.R. tube. The intensity control R35, should be turned until the brilliance is about medium. If this control is turned too far to the left, the receiver will go out, while if it is too far to the right, brilliance will be too great for satisfactory definition in the receiver.

With no signal being received, there should be no "hum" on the screen, the intensity of the light. Any variations which move up and down the rectangle of light indicate the presence of the "hum." The grid current of the C.R. tube with sheet iron. A piece of stove pipe or sheet iron should be formed into a cylinder and placed around the neck of the chassis and carefully grounded to the chassis. It will be noticed that reversing the connections to the heater of the C.R. tube will sometimes reduce the "hum" since the cathode connects to the side of the filament and correctly polarizing this filament is important.

Next, the television station should be tuned in and the "hum" automatically tuned in the sound accompanying (if one is being transmitted). The remainder of the procedure consists of changing the oscillator frequency, the mid-frequency controls, the gain controls of the sweep circuit and the gain of the amplifier in the C.R. chassis until satisfactory images are seen. If a large number of black and white dots are seen on the screen, the low-frequency scanning circuit is too high or too low in frequency. As the images move up or down, the low-frequency sweep is off. If more than two or three of these spots—seen in groups—are seen in the low-frequency oscillator is at too high a frequency and should be adjusted. In some locations, where the signal is very weak, it is not possible to swing the image from brilliance to dark, it may be necessary to add one or more additional stages of I.F. amplification to the video channel in closed, let us once more point out that a cathode-ray television receiver operates on high voltages and a severe shock can be encountered at many places of the receiver and C-R chassis of the set as described, with great care. Radio-Craft incurs no liability in connection with any accidents due directly or indirectly to the information given in this article. It is hoped that an experienced person has anything to fear from the set—if it is carefully built. (Any more than a person should ask anyone at a high-power amateur phone or code transmitter, thousands of which are in daily operation.) But—ALWAYS turn off the current before touching any exposed or metallic parts of the set or power supply.

Radio-Craft incurs no liability in connection with any accidents due directly or indirectly to the information given in this article. It is hoped that an experienced person has anything to fear from the set—if it is carefully built. (Any more than a person should ask anyone at a high-power amateur phone or code transmitter, thousands of which are in daily operation.) But—ALWAYS turn off the current before touching any exposed or metallic parts of the set or power supply.

Making the Radio-Kaleidochrome

(Continued from page 623)

is reduced. The saturation of the core of the "heating reactor" diminishes and the impedance of the secondary becomes so great that little current can flow through it. In this case, therefore, the current flowing in the "heating reactor" will be light up brightly but because they are series-connected with the power supply of only 150 ma. is required for full-brilliance. The same current will show as dots or red lamps, but they will light very dimly because of the lower resistance of the series-parallel circuit. It should be the responsibility of the manufacturer to show the wiring and the actions explained above can be understood more readily by examining the photographs which illustrate various parts as indicated in the photographs does not necessarily have to be followed exactly. The equipment or the manufacturer's, the layout in which the actions of tuning and color variations are presented. It will be found best, though, to follow the general principles of the circuit carefully. The circuit is designed so as to diffuse the light as much as possible and prevent the formation of "spots of light" on the ground glass screen.

Please Say That You Saw It in Radio-Craft
THE LATEST RADIO EQUIPMENT
(Continued from page 509)

the 30 outstanding features of this newest in
signal generators for the progressive Service
Man. Following are a few of its more outstand-
ing attributes. Will measure receiver sensitivity,
stage gain, translation gain and selectivity; fre-
quency range: 100 kc. to 75 mc. (30 per cent,
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switches.

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HERE is a 20-W. deluxe portable unit especially
designed for boats. Used for paging, crew
radio, musical entertainment, etc.; speaker horn
is suitable for hailing passing vessels or in
giving docking instructions from the bridge (a la
past issue of Radio-Craft).

POCKET-SIZE MULTITESTER (1321)
(Radio City Products Co.)

A RAKLITE case, d'Arsonval meter with
knife-edge pointer, and 2 per cent accuracy
are constructional features of this instrument.
The outstanding merit, though, is its scope in
such compact form: ranges: 0-550 microA.;
0-5-50-500 milliA.; 0-5: 0-5-50-500-1,000 V.;
0-500-50,000 ohms and 1 meg. Virtually 12 meters
in one!

I hope that I will get many particulars from
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A. F. L. de QUANT,
De Quant’s Radio Service,
Larabian 85.
De Haan, Holland.

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original arrangement. Certainly, our “Hol-
landaise” could not appear in perfection hie
“English” and as to technical ability, well, hav-
ing regularly received several Holland radio
magazines over a period of years we have ac-
quired a wholesome respect for their grasp of
the art’s finer points.

NEW YORK: HELP AN ORSMA
MEMBER

Radio-Craft, Orsma Dept.: I am a Service Man of ORSMA but have been
in this hospital for 2 years and am attempting
to do whatever service work I can but am lack-
ing testing equipment. I can’t afford the modern equipment at present but thought perhaps you would know where I could purchase an old model that perhaps I could alter to suit my needs until such time as
I could purchase a modern analyzer; even an
ohmmeter would stand me in stead. Hoping you can be of help to me, I remain

CHAS. F. HOSCHEK,
C/o Sea View Hospital,
Ast. Staten Island, N. Y.

How about it, Members? Maybe you have a
piece of test apparatus, that you don’t need, which you could pass on to a game fellow who is trying hard to face life with a smile?

WEST VIRGINIA:
A TIP FOR SERVICE SHOPS

Radio-Craft, Orsma Dept.: We are sending a photo of our service bench
which we would like to see in the Orsma Forum.
We are members of the ORSMA.
Our bench is much too long to show in its
entirety, but the photo gives some idea of its
appearance. The equipment includes the follow-
ing: Supreme model 85 counter tube tester, model
19 tube tester, model 935 automatic analyzer,
model 90 analyzer; signal generator; high-voltage
condenser tester; substitute condenser tester,
and several other small units which are
home-made. Suspending desk lamps slide on a
tight-wire. (See view on page 610.)
The shop testing equipment is mounted in a
sliding panel of wood which places the instru-
ments at the most convenient angle for observa-
tion. The units are held in place by gravity
and thus are easy to remove.

W. B. DAVIS,
Davis Radio Service,
Weston, W. Va.

PUBLIC ADDRESS NUMBER

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er-and-tweeter H-L infinite-baffle speaker sys-
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a deluxe inter-office phone and radio set, and
many other items.

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* 5 D.C. voltage ranges: 0-10; 0-100; 0-250;
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* 4 D.C. current ranges: 0-1 ma; 0-10 ma; 0-100 ma;
0-250 ma.

* 2 resistance ranges: Low ohms shunt method,
0-600 ohms. As low as 1/2 of an ohm. High
ohms reading, 0-300,000 ohms.

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D’Arsonval type; 2% accuracy. Employs top
and bottom bridges; highly grained jewels;
rounded pivots; specially designed pole pieces
for equalized flux distribution; reinforced
needle pointer. Will withstand rough usage.

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* Selector controlled throughout; only two polar-
ized pin jacks on panel.

* Wire wound shunts of 1% accuracy used.

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* Compact size; 4½ x 7 x 2½.

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* Zero adjust compensator for accurate resis-
tance readings.

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shipment... include name and address of your parts jobber.

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Name

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Please Say That You Saw It in RADIO-CRAFT
MAKE THIS 1-TUBE "HOME BROADCASTER"

(Continued from page 605)

in the radio set. Such gadgets can be obtained for less than a dollar, and surprising as it may seem, they usually work quite well.

The drawback to these "home microphones" as they are called, is their inability to really make use of the gain and volume of which the radio set is actually capable. It is for this reason that they will always remain more or less of a toy, and not reach any great degree of popularity as a means to satisfying the public demand for a really efficient microphone attachment for the average radio set.

During the past 3 or 4 years the set manufacturers have had a tendency to keep increasing the output volume of their sets in order to get better tonal reproduction at low volume levels. Most of the present-day sets have the ability to turn out volume ranging from about 3 W. in the smaller sets, up to 30 W. in some of the larger multi-tube sets.

Here is an adapter unit that will permit using a microphone of the double-button carbon type with any radio set. The more powerful the set, the better the results will be.

This unit is easy to build, simple to operate, and most important—the parts necessary for its construction cost very little. All plate and heater voltages are taken from the set with which it is used. To put it into operation insert power cable adapter (see Fig. 2 for hook-up) under the output tube in the receiver, connect the antenna lead from the unit to the receiver antenna terminal, and turn the set on. The signal from the unit is tuned in exactly as you would tune in a regular broadcast program.

Fundamentally the unit consists of a modulated oscillator of low power output, or, in other words, a miniature broadcast station. A pentagrid oscillator tube, either a type 6A7 or a 6AT is used. The pentode section being used for the modulator to plate, and the output of the oscillator, thus enabling you to hear whatever voice or music is put into the unit to be heard in the radio receiver. The whole radio, from the 1st R.F. stage through to the audio output stage is used, resulting in extremely powerful results.

Early designs of equipment of this type, in which such an R.F. unit feeds into the standard radio set, have been described in the April 1934, and subsequent issues of Radio-Craft—Editor's Notes. The diagram, Fig. 1, is almost self-explanatory and indicates the extreme simplicity of the unit. The total cost, including mike, is under $10.

The only point in constructing the unit which might require special mention here is the output coupling between the unit and the receiver. This takes the form of a very small capacity, as shown in the circuit diagram. The capacity effect is brought about by taking a short piece of stiff insulated hook-up wire, attaching it to the oscillator plate terminal, and winding 3 or 4 turns of similar wire tightly around it. The other end of this latter wire is connected to the antenna post on the set. Care must be taken to see that the two wires do not make electrical contact with one another. The capacity thus formed is sufficient to couple a strong signal into the set, without radiating to other sets nearby. If too much capacity is introduced, the oscillator will not oscillate.

The tuning range of the oscillator is approximately 900 to 1,760 kc., allowing it to be set to be received at some point on the receiver dial where no other regular broadcast program would normally be received.

LIST OF PARTS

One small aluminum or electrolytic chassis base, 4 x 3 x 2 in.
One carbon resistor, 300 ohms, 1/2-W.; One carbon resistor, 20,000 ohms, 1/2-W.; One carbon resistor, 30,000 ohms, 1/2-W.; One carbon resistor, 50,000 ohms, 1/2-W.; One volume control and switch, 1 mfd.; Two tubular condensers, 0.1-mfd., 400 V.; One tubular condenser, 0.05-mfd., 400 V.; One mica condenser, 0.25 mfd.; One double-button microphone transformer; One bar knob; One grid clip; One triple tip jack; One 1/2-ft. tube socket; One trimmer condenser, 220 mfd.; One pentagrid oscillator coil; One tube shield; One hardware kit; consisting of Eight 9/16 x 6/32-in. machine screws Six 6/32-in. hexagon nuts Four 1/4-in. rubber grommets One 1/8-in. length spaghetti tubing Three collar clamps Five ft. solid push-back hook-up wire; Two ft. 4-conductor cable; One ft. 2-conductor cable; One Knight 2A7 or 6AT tube; One power tube adapter (4, 5, 6, 7M, or 8 prong); One pair tip jacks.

Accessories
One double button carbon microphone; One microphone desklamp; One "O" bat., 4½ V.; Twenty-five ft. 3-conductor microphone cable.

This article has been prepared from data supplied by courtesy of Allied Radio Corporation.


HOW TO MAKE THE RADIO-CRAFT STANDARD TUBE TESTER

(Continued from page 509)

OPERATING THE TESTER

It is very important that the following instructions be memorized and that the same procedure be carried out every time a tube is tested.

First, turn all 4 selector switches to the blank (off) position at the bottom of the scales. Connect the line cord to the A.C. circuit and the tester is ready to work.

Short and Leakage Tests. When making short and leakage tests be sure that the tube selector switches are at the OFF position. Turn the short test switch through the various test positions at 23, 34, C-2, etc. The neon will glow brightly when a short occurs at any position of the switch. High-resistance leaks will be indicated by a dim glow of the neon.

Always make the short test first. If the short test is made after the tube has been heated there may be a glow from the neon for a short period of time, even though there is no leakage in the tube. This false glow will quickly disappear if the tube is not leaky.

Hot-cathode leakage tests can be made as follows. Set the tube selector switches to the proper positions as indicated in the Reference Chart. Set the Short Test Switch to KL. There should be no indications on the test meter if there is no leakage. Any readings indicate leakage between heater and cathode.

Tube Testing. After the short tests have been made and the tube tests OK proceed to test the tube in the following manner. Note: allow ample time for the Set Line Voltage Control so that the pointer on the A.C. meter is at the arrow.

1. Turn the Short-Test Switch (Sw.3) to the "off" position.
2. Adjust the Filament Selector Switch (Sw.4) as indicated in the chart.
3. Reset the Line-Voltage Control so that the pointer is properly set at the arrow.
4. Adjust the Shunt Control, R5, to the numerical setting indicated on the chart.

(5) Permit the tube to heat and note reading GOOD, OR POOR.

Combination types of tubes with 2 sets of elements are tested individually as indicated in the Reference Chart. The 2 sets of elements are listed as A and B.

Rectifier Tubes are listed as (HW) half-wave, (FW) full-wave. Diode sections are listed as (D). A reading beyond the line marked "DIODES OK" indicates a good diode section.

In some cases one setting of the tube selector switches is indicated. When this occurs the second selector switch can be in any position without affecting the test. However, it is best to set the unused selector switch at the "blank" position for such tests. This will help to avoid confusion.

When making Shunt settings be careful not to force the knob as this will upset the calibration of the instrument.

Resistor Measurement. A type 84 tube is used for resistance and capacity measurements. This tube should be tested before it is used and the meter reading should be 40 when the shunt is set at 50. The Filament Selector Switch setting for this tube is 7. Do not use a tube that will not give a reading of 40. Do not touch the live ends of the test probes as the voltage across them is more than 100 V.

Set the Short Test Switch to the "off" position and adjust the line voltage meter pointer to the arrow on the dial scale.

Connect the test leads to the tip-jacks and short the opposite ends. Adjust the shunt until the meter reads full-scale (40). If the meter will not adjust to full-scale by varying the Shunt, reset the Line Voltage Control until it does.

When the test leads to the resistor or circuit to be measured and note the meter reading. Refer to Fig. 3 and note the value of resistance. A reading of 40 on curve "A" indicates a resistance value of 13,000 ohms.

Resistors having a value greater than 50,000 ohms can be checked by setting the Shunt to

Fig. 2. Panel drilling and marking layout and meter scale markings.

Fig. 3. Charts for using the tester for resistance and capacity measurements.

Please Say That You Saw It in RADIO-CRAFT.
“O” ; read meter and refer to curve “B” to
determine the resistance. Remember, “O” setting
of the Shunt will be the “O” setting of the
contact arm. Do not force the knob as it will
upset the calibration of the instrument.

Circuits having a resistance greater than 1
meg. and up to 10 meg. can be checked for
continuity by setting the Short Test Switch on
“O”, and watching the neon tube. A faint glow
will be seen even though the resistance of the
circuit under test is 3 megs. or more.

Capacitor with A.C. and D.C. connections
will cause the neon type tube in the socket and the Short Testing Switch to
“O”. The Filament Switch will be set at 7, and the
Shunt Switch at “N”.

Adjust the Line Voltage Control so that the
pointer is set at the arrow on the scale. Set the
Short Switch at “O” and connect the test leads
to the capacity under test. Electrolytic condensers
can be measured but be sure that the red lead
or tip-jack connects to the positive side of the
condenser.

Read meter and note capacity by referring to
the Capacity Chart. Use scale “A” if the value is
less than 0.25 mf. Capacities greater than 0.25 mf.
will cause the meter pointer to go off scale.
To test the Shunt Control to 90 and check meter reading
with the “B” scale on the chart.

Very small values of capacity can be noted by
watching the neon lamp. A faint glow around
one of the lamp sections indicates a good con-
denser. An open condenser will give no glow at all
and a shorted condenser will cause a bright
flash and the meter pointer will go off scale.

Circuit improvements for the radio set
will be published in Radio-Craft so that the tester
will be always up-to-date.

USEFUL RADIO CIRCUITS
(Continued from page 611)

C-D ENGINEERS
announce
DYKANOL IMPREGNATED
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The type TL series of high voltage
filter condensers were designed for
power supplies, high power ampli-
fiers, TV and Hi-Fi receiving sets,
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civers, etc. Hermetically sealed in
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to those employed in the construc-
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terminal is insulated, the other
grounded. Can be conveniently
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plugs into socket No. 4.

When using the unit with a 32-V. set having a
600 plate meter, place a 30-W., 115-V.
lamp in socket No. 1 after having removed the
fuses. Then place a 10-W., 32-V. lamp in
socket No. 3, and a 32-V. D.C. set in socket
No. 4. Then start the generator and when the
15-W. lamp lights, start the radio set working.
This will dim the lamp very greatly but if a
75-W., 115-V. lamp is inserted into socket No. 2,
the voltage will be normal for the radio set.
This procedure for 32-V. sets is necessary as
the residual magnetism of the generator will
not be sufficient to light the lamp and if it did,
there would be a heavy voltage surge which
might injure the set.

HONORABLE MENTION

HONORABLE MENTION

A Phono Pickup Coupling Unit. The circuit
has the advantage of a constant coupling tone
which can be varied to suit the characteristics of pickup and amplifier. The
coupling unit can also be used effectively as a
scratch filter, cutting off the high-frequency
response at the correct point for the most
good response. The variable condenser should
be a micro-ohm unit of the type used for
trimming and padding R.F. circuits. See Fig. 6.

Dimitris V. Takacs
Athens, Greece

HONORABLE MENTION

Improved Volume Control. In Stewart-Warner
type A, using the system of a variable volume control shown at A in Fig. 7, there
is a tendency to overload or choke at full volume, with accompanying difficulty in
tuning local stations.

By removing the control from the aerial and
substituting in its place a variable resistor of
0.1-meg., resistance and a uniform taper (con-
nected in the screen-grid circuit as shown in
Fig. 6) the above difficulties are removed. If
circuit oscillates at 1,500 kc., change R2 to
30,000 ohms; and place the 0.002-mf. detector plate bypass condenser with
one of 0.01-mf. capacity.

EX-STATION SERVICE BENCH

HONORABLE MENTION

Small Set Improvement. Radio owners who
have small sets of the table and A.C.-D.C.
variety which are lacking in selectivity and
sensitivity can improve them by connecting a
feeder coil in the aerial circuit, as shown in
Fig. 8. Make a coil which fits inside of the
aerial coil of the set, containing about 18 turns
of any convenient size of wire. One end of this
coil is connected to the plate of the first tube
and the other end to the grid of that tube.
This coil, smooth operation can be obtained. Be
to check the alignment of the set after the
feedback coil has been inserted in parallel.

Arthur Petru

HONORABLE MENTION

Capacity Coupling. The use of a condenser as
shown in Fig. 9, permits close coupling and
good gain at low frequencies, with good selec-
tivity and fair gain on high frequencies in an
R.F. coupling circuit.

Further advantages are that a single-winding
coil is used, resulting in lower losses and better
matching of tuned circuits both at high-
and low-frequency ends of the tuning band.

Cal Brainsard

HONORABLE MENTION

A Novel “B” Power Supply for Ford T Car
Sets. Those who still own model T Ford cars
can utilize this novel way of obtaining “B”
power for a car radio set. A charging trans-
current from an old battery charger which has a
20-W., secondary and a 110-V., primary is con-
nected between the magnetic plug and the frame of
the car, as shown in Fig. 10. The
110-V. winding is connected to the power plug of a
“B” power unit of the type using a BI or other
rectifier which has no filament.

D. C. DePuy

HONORABLE MENTION

A Fool-Proof Switch for “Wind” Power
Supplies. Radio set owners who employ the use of
a 6-V. storage battery and wind-driven gen-
erator to power a 2-V. receiver will welcome the
switching arrangement shown in Fig. 11.
A study of the diagram shows that the 8-pole
double-throw switch is used as a double-throw
switch in the case of a double-throw unit.
Be sure to use a switch of the correct type
as shown in Fig. 11.

The switch automatically

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der filter all requirements of service stations, dealers, experimenters and set builders, retaining the flexibility of CARRON COILS.

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1936 OFFICIAL RADIO SERVICE MANUAL
Just packed with service data of sets manufactured during 1936. Contains schematic diagrams and service notes for many older receivers. The volume is printed on a special “Bible Stock” and comes out of the press as a thousand pages, still only 1 1/8 in. thick. Conveniently rolls to fit into your pocket. Contains a vast amount of information on all-wave receivers, P. A. equipment, midget sets, auto-radio receivers, and test equipment.

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OVER 90,000 GERNSBACK
OFFICIAL RADIO SERVICE MANUALS
AND HANDBOOKS
IN USE TODAY!
"ELECTRIC EYES"
(Continued from page 501)

SEE ALL—DO ALL

Built-on Electronic Exposure Meter
Photographs are familiar with the currently available light-intensity meters which utilize a photoelectric cell to indicate relative values of lightning. Few, however, are aware that an exposure meter of this type is now being incorporated along one side of new-type Zeiss-Ikon cameras just announced in France; and atop the Zeiss-Contax III (illustrated) in America. (Fig. G)

MISCELLANEOUS APPLICATIONS
"Electric Eyes" Police Uncle Sam's New "Free Port" Against Smugglers. At Stapleton, Staten Island, is located the recently-announced "free port"—a zone wherein commodities from abroad may be received, handled, packed, graded, assorted, assembled and repacked without becom- ing subject to duty—first of its kind in the United States. Photo-electric equipment scheduled to be an essential policing agency in preventing misuse of the international trade experience this New York port affords. Only the cross-cutting lightbeams overcome the War Department's objections to previously-suggested methods which were vetoed as being menace to navigation. Contracts for the PE installation have been let.

The lightbeams will skim the surface of the water from a control station at the extremity of the central dock to phototrons in boxes fixed to the ends of the dock at either extremity. These boxes are to be protected against ice and debris by crashwork; and will rise and fall with the tide. A signal system will flash warning to ship headquarters of the free zone if the beam is broken. Even a swimmer crossing the rays will break them. (Fig. H)

Photocells Establish Brightness of 100,000 Stars. "Twinkle, twinkle, little star—" reads the nursery rhyme; but savants at Columbia University, New York, are prepared to tell you just how much the stars—25,000 of them—really do twinkle. (Soon, 75,000 more stars will be similarly cataloged.)

Photographic plates, exposed and developed at Yale University, are now available which carry dots of varying density from grey to practically black, which represent various intensities from 4th-magnitude (visible by the naked eye) brightness to 9th-magnitude intensity. The trick is to intercept these dots with a beam of light trained on a photocell; the amount of light each dot intercepts is indicated by a reduction in the photocell's meter reading and this reduction may be taken as an "index of intensity" (of the star). (Fig. E)

Having thus established for the first time a quantitative figure for a star's brightness, and knowing its type (spectrotypes have been made by Harvard) and movement (angular-displacement data have been obtained by Yale), astromomers can now obtain a comprehension of a star's magnitude.

"Electric Hand" for Telescopes. A control more delicate than a woman's little finger and as powerful and positive in its action as a drawbridge mechanism is the new photoelectric-type automatic guide for telescopes. Star selecting, and especially time-exposure photography, usually demands continual readjust- ment. But at Mt. Wilson Observatory, for instance, electronic means have been found for automatically keeping the tens-weight, 60-in., reflecting telescope trained on a particular star. (Continued on page 632)

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- 10-50-250, 500-1000 Volts D.C.
- 7.5 Megohms
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BUILD THIS "2-IN-1" EMERGENCY RADIO SET

(Continued from page 632)

Fig. 2. Battery connections for "emergency" and "normal" operation. Fig. B, upper-right. Panel rear-view.

"ELECTRIC EYES" SEE ALL—DO ALL

(Continued from page 631)

This photocell, be it noted, is a patented type, designed by the writers, of exceptional sensitivity over the entire range. The photocell used is a 0-200 microampere instrument with the scale marked 0-750 for easy determination of the percentage (by leaving all zeros in to left and thus obtain the divisions easily); the readings are sensitive to less than 2 microamps of an ampere without amplification (which would introduce errors greater than the sample being tested), and in addition has available 10 scale readings as afforded by the multiplier switch that connects into the circuit, in series, resistors of requisite value which extend the readings to 7,500 points.

If dull materials (blotting paper, liquids, dark materials, etc.) are the ones encountered with greatest frequency in utilizing the color meter a single exciter lamp is used, as shown in Fig. 1A. If glossy materials (alloys, ceramics, glass, etc.) are to be accurately checked the 2-lamp design shown in Fig. 1B is to be preferred in order that only true color and diffuse reflection will be indicated.

In either event the beam of light from the exciter lamp does not shine directly on the photocell but reaches it only after being reflected, at an angle of 90 deg. from the surface under test and then color-filtered. The sample of material to be color-tested unless special provisions are made should be about 3 ins. in dia. Since the sample is completely covered by the instrument daylight cannot enter and cause erroneous readings.

Part II will continue this interesting explanation, giving a number of applications of the reflection-type color meter.

Our Information Bureau will gladly supply the names and addresses of any manufacturers whose products are mentioned in Radio-Craft,
IMPROVEMENTS IN THE "12-TUBE HI-FI BROADCAST RECEIVER"

(Continued from page 593)

distortion. With reverse feedback the tubes will deliver 25 W, with only a small fraction of this distortion!

The output transformer for the 6L6 tubes has a primary plate-to-plate impedance of 6,000 ohms, and the voltage divider in the set in order to permit the 6L6's to be operated with 480 V, on their plates.

It is necessary to use a power transformer with a high-voltage secondary of 500-0-500 V, instead of the 375-60-375 V, winding in the old transformer, in order to be capable of full voltage output at 220 ma. drain (D.C.).

The A.F. transformers used are precision high-grade equipment with a frequency response flat within 1/2 db, from 30 to 16,000 cycles.

LIST OF PARTS
(Additional material: for original List of Parts, see RADIO-CRAFT, Feb. and Mar. 1936.)
One Cornell-Dubilier paper cond., 4 mf., 600 V., C1;
One Cornell-Dubilier paper cond., 2 mf., 400 V.;
Two Cornell-Dubilier paper cond., 0.5-mf., 600 V.;
Four Cornell-Dubilier electrolytic condensers, 30 mf., 50 V.;
Four Cornell-Dubilier electrolytic cond., 4 mf., 425 V.;
One Cornell-Dubilier electrolytic cond., 8 mf., 425-V.;
One Cornell-Dubilier paper cond., 2 mf., 400 V.;
One insulated resistor, 0.25-meg., 1 W.;
One wire-wound resistor with 2 adjustable slides, 20,000 ohms, 25 W.;
One wire-wound resistor with 2 adjustable slides, 20,000 ohms, 25 W.;
One wire-wound resistor with 2 adjustable slides, 15,000 ohms, 25 W.;
Assortment of insulated metallized fixed resistors, 1/2-W. (see diagram for values);
One audio transformer, precision type, single plate to push-pull grid, T1;
One deluxe output transformer, push-pull 6L6 tubes to loudspeaker, type D-100B;
One choke, 60 hy., 15 ma., type HC-117, Ch. 5;
Two RCA Radiotron 6L6 beam power tubes.

Names and addresses of manufacturers will be sent upon receipt of a stamped, self-addressed envelope.

The amplifier circuit changed according to the details given above.

QUESTIONS AND ANSWERS ABOUT ELECTRONIC MUSIC
(Continued from page 593)

Several tapes so that the transformer manufacturer will mark them for different impedances.

You need to have only 8 impedances for 8 windings: one winding for the first octave; one winding for the second octave, etc. Impedance must be checked while the shaft carries phonic wheels of all As, so that the fourth A must have 440 cycles, and all magnets must deliver the same amount of energy, while the number of turns is more for low As and less for high As.

It is advisable to make one shaft with 7 or 8 phonic wheels on it in consecutively doubling numbers of teeth, the same number of the magnets must be 5 1/4 in. to 5 1/2 in. dis., and not less than 2 1/4 in. long. The tone wheels must be 311/2 in. long.

I do not think much of a bevel gear drive, especially when the ratios contain errors. There is no use in using a Thomas gear drive, patent No. 1,156,329, "invented" by Hammond. I suggest you use a gear train made of composition similar to bakelite or fibre, consisting of 24, 14-in. face, pitch 48, these gears placed on 12 shafts, with a 196-tooth gear meshed with a 118-tooth gear, and on the same shaft as the 186-tooth gear, the 196-tooth gear meshed with a 186-tooth gear on another shaft and so on.

By this arrangement, frequencies have no error, since the speed of the shafts progresses geometrically at a ratio of 12V:1. However, for your purpose, I believe that pulleys and belts are best.

Dozens of flexible joints are unnecessary, as you probably find the necessity for electrical filters to eliminate parasitic frequencies of the revolving shafts. (Hammond uses 45 filters.)

A diagram of one type of synthesizer, which can be altered to suit individual needs, is shown in Fig. 1. This type of synthesizer is used by Mr. Eremeeff. Be sure that the windings of the magnets are always open, so that you do not get trouble from Foucault. Shield the magnets.

For synthesizing

First key
C# fundamental 32.79
C#2 fundamental 34.64
C#2 second 68.40
G#3 second 69.29
G#3 third 97.99
G#4 third 103.82
C#4 fourth 130.81
C#4 fourth 139.30
F# fifth 164.18
F# fifth 174.16
G# sixth 196.77
G# sixth 207.65
C#8 eighth 361.62
C#8 eighth 377.18

Second key
C#2 fundamental 32.79
C#2 fundamental 34.64
C#2 second 68.40
G#3 second 69.29
G#3 third 97.99
G#4 third 103.82
C#4 fourth 130.81
C#4 fourth 139.30
F# fifth 164.18
F# fifth 174.16
G# sixth 196.77
G# sixth 207.65
C#8 eighth 361.62
C#8 eighth 377.18

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of his statement, softly reminded him in answer to his latter question, to get out his books, and then went about getting the whole story from him. Like the Scotchman after winning his first bet, Johnny, who had developed, had sold him first a P.A. job, and was asking: "How long has this been going on?" 

Up to the time he was called along with his radio trade, a victim of inertia. Public Address, to him, was something that involved an enormous amount of work, large investments and excessive labor—he just couldn't get excited about it. One day, however, as he sat down, it came to him as in a dream (but, among other things). He really hit on an idea. He would make it his business to see that someone used a conventional receiver or phone-radio combination for dancing or entertainment. As a move to enter the P.A. field, it amounted to nothing more than first trying the water with your large toe. But it worked. 

A church after he attended produced the first prospect. Music for the dances was supplied by a radio receiver of average power. Needless to add, it possessed shortcomings for the role for which it had been drafted. It was so terrible it was ideal—for Johnny. His next move was not bad at all; he instructed a fair-sized amplifier, obtained a pair of better-quality speakers, microphone and stand, turntable and pickup in a carrying case and the usual wire and cabling. 

The amplifier put 15 W. into a 500-ohm line, had 3 inputs—1 high-end 2-low gain—mixer-fader controls and two handleable output impedances. The tube line-up comprised a 6CG, 6AK, 6200a and an 83V rectifier. Field current was fed 16 W. above which, an unusually high gain, 140 db. at 5 mcs, permitted the direct use of crystal or velocity microphone. 

Choosing the microphone was quite a problem; maximum portability was desired, money for pure sales promotion was scarce, but it was darning important to the complete satisfaction of a prospect. A pair of good radio-set speakers answered all three factors very nearly, but the radio company sold them in a swoop by offering a conventional carrying case which split the package and also pruned space for the amplifier and speaker cable. It looked mighty clean and impressive. 

The phono-motor, turntable and pickup like-wise were selected. But the microphone presented no problem whatsoever—it was simply a matter of buying one, regardless of the pain involved. Then he had to the extent of a crystal sound cell. 

Then came the big day. Empty bottles, hairpins and old Batteries Peels were swept ruthlessly from the back of the car and the system slowly stowed away. Off he went feeling like a Pantages in heading for the gold fields—and just as broke. 

His church was the first objective. Upon arriving there, he went briskly about setting up the outfit in the social room. That much credit must be given him—for nerve; if he had first referred to demonstrate, he, doubtless, would have been hemmed and haunted out of it, but his way certainly stole a march on that of debbie "Sales Resistance." When the set-up was packing to his satisfaction, he called in the minister and did his stuff. He pulled all the mike-phono fusing out of the mixing section and organd machine. He brought along a few organ recordings, and taught the minister microphone technique of which Johnny knew nothing.

That clinched it. The church board was called at once and came running. (Here is where the Elks come in.) The Elks sale begins. The performance was repeated with each member taking his turn at the mike, and, boy, oh boy, there's nothing like learning to speak a church hour long to satisfy to his satisfaction, he called in the minister and did his stuff. He pulled out all the mike-phono fusing out of the mixing section and орган machine (he had brought along a few organ recordings), and taught the minister microphone technique of which Johnny knew nothing.

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MAKING THIS POCKET-SIZE METER RECTIFIER (Continued from page 607)

in handling the rectifier as carelessness may easily damage it permanently. All solder-
ing to the rectifiers lugs must be quickly and properly done, as, high temperatures can easily alter the characteristics of the copper-oxide film. The rectifier will not stand any severe physical shock and the initial pressure on the discs must not be changed. This necessitates caution in mounting. The tip-

jacks on the converter unit are used for A.C. measurements. One jack is common for all measurements and the various range jacks are designated on the panel.

LIST OF PARTS
One Radio City engraved panel:
One Radio City case:
Two flexible leads, PJ, P2.
One Dependable resistor, 650 ohms. R1.
One Dependable resistor, 1,000 ohms. R2.
One Dependable resistor, 6,000 ohms. R3.
Two Dependable resistors, 0.7-meg., R4, R5.
Two tip-jacks, 21 to 26.
One Dependable full-wave-copper-oxide rectifier, FWR.

This article has been prepared from data supplied by courtesy of Radio City Products Co.

Fig. 1. A typical calibration curve.

Fig. 2. The rectifier chassis is 3 in. long.

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THE MARCH OF TUBES
(Continued from page 587)
lower value of grid resistance, and thus reduces the gain of the preceding stage.
When used in push-pull the 6AC6G will pro-
duce 3.5 W. of audio power at a total harmonic
distortion of 10 per cent. When necessary to
minimize plate current, a bias of 50 ohms which
totals the plate current to 70 ma. at
no-signal, may be used.
6H8 Tuning Transformer. The GHS differs from
the G6G and G6S tuning indicator tubes in
the addition of a current-limiting grid around
that portion of the cathode which furnishes
emission for the target current, according to
data from National Union Tube Co. This addi-
tional grid is connected internally to the cathode
and acts solely to prevent the target current from
taking over all of the plate current.
The A.C. voltage required to change the
shadow from 90 deg. to 0 deg. is 22 V. Where the
A.C. voltage in the receiver reaches higher
values than 22 V., a voltage dividing system is
necessary to limit the bias applied to the GHS.
The GHS section operated with a plate voltage of
250 V. and a plate load resistor of 0.1 to 0.25-
meg., should have a negative bias of 2.5 V. for the
grid.
6V6 Beam-Power Amplifier. The 6V6 is a beam-power amplifier similar in design fea-
tures to the G6G, but having a high positive
sensitivity, high power output, and low per-
centage of third and higher order harmonics.
The 6V6 should prove very desirable where heater
and plate current must be maintained at a
minimum. The horizontal current of 0.4 ma
rather low for a power tube having the power
capabilities of the type 6V6.

6V6G2 Characteristics
Class ABI amplifier (push-pull) Values are for 2 tubes
Heater voltage... 6.3 V.
Plate voltage 250 300 V.
Screen-grid voltage 250 300 V.
Total plate and screen-
grid dissipation (per
tube) ... 125 W. max.
Control-grid voltage -15 -20 V.
Peak input signal (grid
to grid) 21.2 28.2 V. approx.
Plate current (zero
signal) 75 78 ma.
Plate current (max.
signal) 79 90 ma.
Screen-grid current (zero
signal) 5 5 ma.
Screen-grid current (max.
signal) 12 15.5 ma.
Load resistance (plate
to plate) 10,000 8,000 ohms
Total harmonic distortion 4 per cent
3rd harmonic 3.5 3.5 per cent
Power output 0.5 3.5 W.
"Maximum. "1" used in conjunction with the
term class A and class AB indicates that no grid
current flows during the time that the input circuit is
d ischemic. *Transformer and impedance coupling devices
are recommended and the resistance introduced in the
central transformer circuit should be kept as
low as possible. For fixed bias this resistance should not
exceed 50,000 ohms. The maximum control
grid resistance when self-bias is employed may be
0.5-meg.
**The self-bias resistor should be shunted with a
suitable filter network to prevent degeneration.
25AT7 Pentode-Rectifier Tube. This tube
combines the functions of power amplifica-
tion and rectification within one envelope
of a pentode-power-output section similar to the type
48 and a half-wave rectifier somewhat similar to
the 2Z25A comprise the internal elements.
Designed for small A.C.-D.C. receivers where
space at a plate connection is at a premium. The connection tube
will produce a power output of 0.77-W. with
about 9 per cent distortion and will supply a
voltage for the speaker field and the plate supply at a
maximum current of 75 ma.
25AT7 Characteristics
Heater voltage 25.0 V.
Heater current 0.3 A.
Operating Conditions Pentode Section
Plate 100 V.
Screen-grid (grid No. 2) 100 V.
Control-grid (grid No. 1) -18 V.
(Grd No. 3, 5, and 7 only eough
within tube)
Plate current 20.5 ma.

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TYPE RT-1—Three sections (18-18-18) all 150 volts; six units give any needed combination of these capacitances. List Price $1.50, Net $1.10.

See them at your Jobbers... Write for Catalog:


Screen-grid current 4 ma. Amplification factor 90 Plate resistance 50,000 ohms Mutual conductance 1,800 mhos Low resistance 4,500 ohms Total harmonic distortion 9 per cent Power output 770 milliwatts (approx.) Receiver Section A.C. plate voltage (r.m.s.) 125 max. V. D.C. output current 75 ma.

Metal-Grid Power Amplifier. The design of the 25L6 is similar to that of the 6L6 with the difference that the 25L6 is intended for use in the output stage of transformers receiving a voltage from a 115 V. power line, either A.C. or D.C. According to the data received from RCA, this tube has high sensitivity, high efficiency and high power output. With 110 V. on the plate and screen-grid, the 25L6 is capable of giving an output of 2.2 W. with a maximum signal input of only 3.3 V. r.m.s.

25L6 Characteristics

Heater voltage 25.9 V. Plate voltage 110 max. V. Screen-grid voltage 110 max. V. Control-grid voltage -8 V. Zero-signal plate cur. 45 ma. Max.-signal plate cur. 48 ma. Zero-signal screen-grid cur. 3.5 ma. Max.-signal screen-grid cur. 10.5 ma. Signal input voltage 5.55 V. r.m.s. Plate resist. (Approx.) 10,000 ohms Load resistance 2,000 ohms Distortion: Total harmonic 11.0 per cent Power output 2.2 W.

25L5 Improved Rectifier. One radio tube company* has just released an improved type of dual beam rectifier tube which reduces to a minimum the possibility of flash-overs, open cathode tabs, slow heating, shorts and filament burns. These improvements should remove the possibility of injuries to the heads which dealers and Service Men have encountered with this type of tube.

920 Twin Photo Tube. This new tube announced by the RCA Manufacturing Co. is a new type photoelectric cell containing 2 separate photocells in one glass envelope. It is designed primarily for use with double-sound-track film in a system of sound reproduction having a high signal-to-noise ratio. In this system the light on one unit of the 920 varies from zero to maximum in accordance with the positive half-cycles of the signal recorded on one sound track. The light on the other unit varies from zero to maximum with the negative half-cycles recorded on the other sound track. The outputs of the 2 photoelectric cells are combined to give a full-wave signal current.

1603 Triple-Grid Detector-Amplifier. This tube is designed for preamplifier equipment which is critical as to noise and microphones. As a pen-toe, the 1603 is capable of delivering a large A.F. output voltage, with relatively low input voltage. As a triode (that is, with the grids tied together) the tube has a high mutual conductance with a comparatively high amplification factor. The tube is constructed with an internal shield connected to the cathode.

1603 Characteristics

Heater voltage (A.C. or D.C.) 6.3 V. Heater current 0.3 A.

As class A Amplifier Type Plate voltage 100 250 max. V. Screen-grid voltage (grid No. 2) 100 100 max. V. D.C. grid voltage (grid No. 1)** -3 -3 V.

Suppressor (grid No. 3)** tied to cathode at socket

Amplification factor 1,185 greater than 1,500 Plate resistance 1,000 1,225 mhos Plate current 2 max. ma.

Screen-grid current 0.5- 0.5 ma.

As class A Amplifier triode Plate voltage 180 250 max. V. D.C. grid voltage -6.3 -6.3 V. Amplification factor (approx.) 20 20

Plate resistance 11,000- 10,000 mhos Mutual conductance 1,800- 1,900 mhos Plate current 0.5- 6.5 ma.

D.C. grid voltage is -7 V. for cathode current cutoff.

This concludes the tube descriptions for this month. Because of a relatively large number of tubes released the descriptions are necessarily short in some cases, and therefore curves, available from the manufacturers, have been omitted.

"Names of manufacturers will be sent on receipt of a stamped and self-addressed envelope.

Please Say That You Saw It in RADIO-CRAFT.
Phototube, Photocells—When to Use Them

(Continued from page 50b)

out into the open; while the surface of a dry powder photocell may be likened to the skin of a dry potato.

As a matter of fact, a phototube will develop an electromotive force on an open circuit when exposed to light, and will not develop any electromotive force on the circuit at all, both with or without aid of an external battery. On the other hand, a photocell may be used in an external circuit, its characteristics corresponding to that of a phototube shunted by a non-conductive resistance.

Light Valve and Light Generator

The phototube may be regarded as a light-activated current valve used for the control of an amount directly proportional to the incident light flux. The current, small as it may be, can be driven full-strength through any resistive, the maximum value of which is limited only by the available e.m.f. in the external circuit.

The photocell may be regarded as a light-activated generator, the output of which is a direct value of the incident light flux. If a photocell is connected to a low-resistance device, and its own internal series resistance is very small, the photocell may be considered to behave linearly proportional to the light intensity.

Current Sensitivity

The useful characteristics of the photocell are its low-resistance current sensitivity expressed in microamperes per foot-candle. A better, better, and better is perhaps the only measure that can be applied to it. For example, a photocell may be capable of converting a low radiant flux of light, say 1 foot-candle, into a measurable amount of electrical power. These values are important for the design and construction of light-sensing devices and systems. Formerly, it was necessary to use photographic or photoelectric cells, which were not capable of converting the light energy into electrical energy in a useful way.

For example, in Fig. 1A are shown spectral curves for some experimental cesium-oxide photocells made by Texas. It appears that these curves illustrate the greatest infrared sensitivity that has been reported to date for phototubes. In the region from 0.7 to 1.4 micron such tubes can be very conveniently used to measure or to be actuated by infrared light. A cesium-oxide tube, together with a tungsten filament, and a certain band-pass filter such as Corning Glass No. 254 or Jenoptik Glaspal No. 9, will be found to be well suited for use in such applications.

There is no photoelectric device which has an appreciable sensitivity at wavelengths longer than 3 or 4 microns. In practice, one never expects to detect any useful response beyond 1.2 micron in cesium-oxide photocells.

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There is no photoelectric device which has an appreciable sensitivity at wavelengths longer than 3 or 4 microns. In practice, one never expects to detect any useful response beyond 1.2 micron in cesium-oxide photocells.
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Enlarged View of Imprint

In general, copper-oxide cells tend to be somewhat shy in red response, while selenium cells have excess sensitivity in both red and violet. However, by use of a suitable filter, at the expense of some sensitivity, the selenium cell can always be made equivalent to the copper-oxide cell. In devices such as color matchers or color analyzers in which it is necessary to obtain comparable responses in all parts of the visible spectrum, one should have a light-sensitive unit at least as responsive to violet as it is to other colors. In fact, since the tungsten lamps, which serve as sources, are notoriously weak in violet radiation compared to red, it is highly desirable to use a light-sensitive unit more sensitive to violet and blue than to red. In Fig. 1C it may be seen that the normal copper-oxide tube is relatively weak for blue light. Fortunately it is possible to modify the manufacturing schedule so as to obtain a "blue-sensitive" tube which is almost ideal for the application. Superbly infrared-sensitive response is conveniently removed by means of an infrared absorbing filter such as Corning A10 Glass.

"ULTRA-VIOLET" TUBES

Doubtless a more elegant method for measuring isolated regions in the ultra-violet is provided through the use of "photo" or special ultra-violet phototubes developed by Rentschler, Henry and Smith* of the company with which the writer is connected. These tubes consist of pure sputtered film of cesium-oxide enclosed in envelopes of Correx glass or quartz. Although their current sensitivity is relatively low, they have the distinct advantage of having their total response confined to quite narrow spectral regions of the ultra-violet, being entirely insensitive to any other light. The long-wave limit is defined by the threshold frequency of the particular metal involved while the short-wave limit is fixed by the absorption characteristic of the envelope.

Typical spectral curves for such tubes are given in Fig. 1E. It is apparent that practically any desired region may be isolated by suitable choice of metal and envelope. It is feasible to amplify the current from these tubes, many suitable circuits having been published. (This concludes the discussion of light-sensitive cells, and the respective colors to which the several types of cells are particularly responsive. It is hoped that the data contained in this article will be of assistance to experimenters in every field of science who are looking for the type of light-sensitive set-up best adapted to an individual need. The material in this article is an abstract from a comprehensive article in Cleveland, last year, before the Electrochemical Society.—Editor.)

The captions for the graphs in Fig. 1 are briefly as follows:

Fig. 1A—Spectral curves for several experimental condensers showing extent of exclusion into the infrared. (After Teves)

Fig. 1B—Spectral curves for cesium-oxide tube in line glass and Correx glass envelopes. The dotted curve illustrates the differential response as a method of measuring intensity in an isolated spectral region.

Fig. 1C—Spectral curves for "red-sensitive" and "blue-sensitive" cesium-oxide phototubes. Additional curves show how to design envelope on ultra-violet response of the "red-sensitive" type.

Fig. 1D—Spectral curves (typical) for selenium and copper-oxide cells as compared to the range of sensitivily curves for the human eye.

Fig. 1E—Spectral curves showing change in threshold of frequency in the ultra-violet for various metallic cathodes. (After Rentschler, Henry, and Smith, by courtesy of R.S.I.)

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improving apparatus and devising a suitable technique of observation that stations were set up during the past year at the University of Florida and the University of Puerto Rico. Whether all stations send out such radiation is not definitely known. Certainly, from visible lightning, there will emanate an aperiodic (unmodulated) discharge. Whether similar discharges are produced in connection with all tropical disturbances remains to be determined. Nor can it be said that visible lightning is the sole source of atmospherics which can be detected by the radio continuum or direction finder. Therefore, it seemed advisable to determine whether such discharges, which could be detected, were associated with tropical disturbances. The following data indicate that from directions corresponding to the location of a hurricane such discharges are obtained.

1. Knowing the approximate position of the storm with reference to the observing station, it should be possible to select directions coming apparently from that general direction. 2. From similar observations made at other stations, the probable position of the storm might then be obtained by the method of triangulation.

The procedure described in Fig. A, used in these experiments is based primarily on that developed by Watson-Watt in 1926, and much of it was built under the direction of the U.S. Navy. It consists essentially of 2 vertical loops, placed in planes mutually perpendicular. Each loop, Fig. B, is connected to an amplifier. The output of each amplifier is then impressed across the deflecting plates of a cathode ray oscilloscope, resulting in a fluorescent line, or deflection, appearing on the screen of the tube when the loops are oriented in the vertical plane. The deflecting action on the screen is then taken by means of a specially constructed camera. These are studied for correlations between the azimuths of the deflections observed and the probable positions of the disturbance. A block diagram, Fig. 1, shows the general arrangement of the apparatus.

The general procedure used in analyzing the photographs was to determine whether or not any ray could be found in the approximate direction in which the hurricane was known to be. In some cases, apparently such a ray (or spot, in fact) B) could be readily discerned because of its predominance.

In conclusion, although this method has not yet been developed to the point where successful and accurate forecasting is always possible, it looks promising, and, as improvements are made, it is probable that the Weather Bureau may secure data from this apparatus which will greatly augment that which received from other sources.

Combines in one instrument a standard Kelvin Bridge and a standard Wheatstone Bridge for measuring resistances from .00001 ohm to 11 megohms.

**Fig. B. The two perpendicular vertical loops.**

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