RADIO and TELEVISION maintenance

AUDIO EQUIPMENT ISSUE

SQUARE-WAVE ANALYSIS OF AUDIO EQUIPMENT

—Page 6

SERVICING THE AVC SYSTEM

—Page 9

FM ALIGNMENT AND EQUIPMENT

—Page 10

● New devices for audio installation—

see 'Products for the Trade' ....

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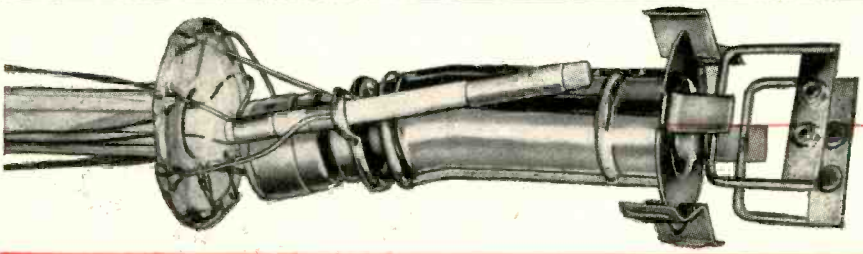

- In big-picture tubes, more than ever, fine-line focus — clear across the screen — is an important function of the electron gun.
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RADIO INDUSTRY NEWSLETTER

FREEZE TO END BY SEPT.—COY

Prediction of an end to the freeze on construction of new television stations by September was made, with conditions, by FCC Chairman Wayne Coy recently. The chairman said the freeze, which is now more than two years old, would end in late summer unless the nation's defense mobilizaton requirements are so strong that materials for new stations are unavailable. He also said, however, that he had made so many predictions of the resumption of station construction, that later proved to be incorrect, that "no matter what I suggest . . . the date will be wrong."

SIMPLE COLOR VIDEO SYSTEM DEMONSTRATED

A new system of color television has come into the controversial TV scene. Invented by C. A. Birch-Field, and developed by Audicon Corporation, the new arrangement is extremely simple. Utilizing a filter made up of narrow strips of colored plastic in front of the camera tube, and a corresponding filter in front of the picture tube, the system is compatible, requires no moving parts, and should be extremely inexpensive. In experiments, sheets of colored plastic were cemented together, and slices cut off the edge of the resulting block of plastic. The slices were then used as filters. In commercial practice, the filters could be made integral with the tubes, it was reported.

CITY REQUIRES $2 TV LICENSE

In an area of suburban Philadelphia, residents will soon be required to pay a fee of $2 for each home television installation. Reason for the requirement, according to the local government, was that it would allow the township concerned to control the type of installation, and to check its safety. The system is also being adopted in other municipalities. Since it involved only an initial payment of the fee, rather than a recurrent license payment, it was expected that the new rule would not cut sales of new TV sets in the area.

ZENITH SCRAMBLES PHONEVISION SOUND

A follow-up to the stories about the first Phonevision test, reportedly very successful since its initiation in Chicago recently, with 300 families trying out the pay-as-you-watch TV system, was the scrambling of the sound as well as the picture by the company. When the tests began, many TV set owners who were not in on the experiment, and did not have decoders in their sets, listened to the clear sound and looked occasionally at the jumbled picture. Still others found that they could see a relatively clear picture by looking through rotating electric fans. Zenith spoiled this by changing the coding signals, and by scrambling up the sound too.

PROFIT-SHARING PLAN INSTITUTED BY SCHOTT

What may be indicative of a trend in electronics manufacturing was the announcement that the Walter L. Schott company, Los Angeles, instituted a profit-sharing plan for its employees recently, retroactive to October of 1950. The plan, which will be paid for out of company profits, will provide a pension fund for retiring employees, with the amount given to each determined by his salary and length of service. The size of the fund will depend on the profits of the company.

OLD LAMPS GIVING TV INTERFERENCE

One type of TV interference which has been found to be surprisingly common is that caused by old-fashioned straight-wire filament lamps, which are 25 or more years old. According to the GE Lamp Department's John H. Campbell, the old lamps sometimes radiate signals strong enough to interfere with even strong TV signals.

→ to page 14

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FEATURES

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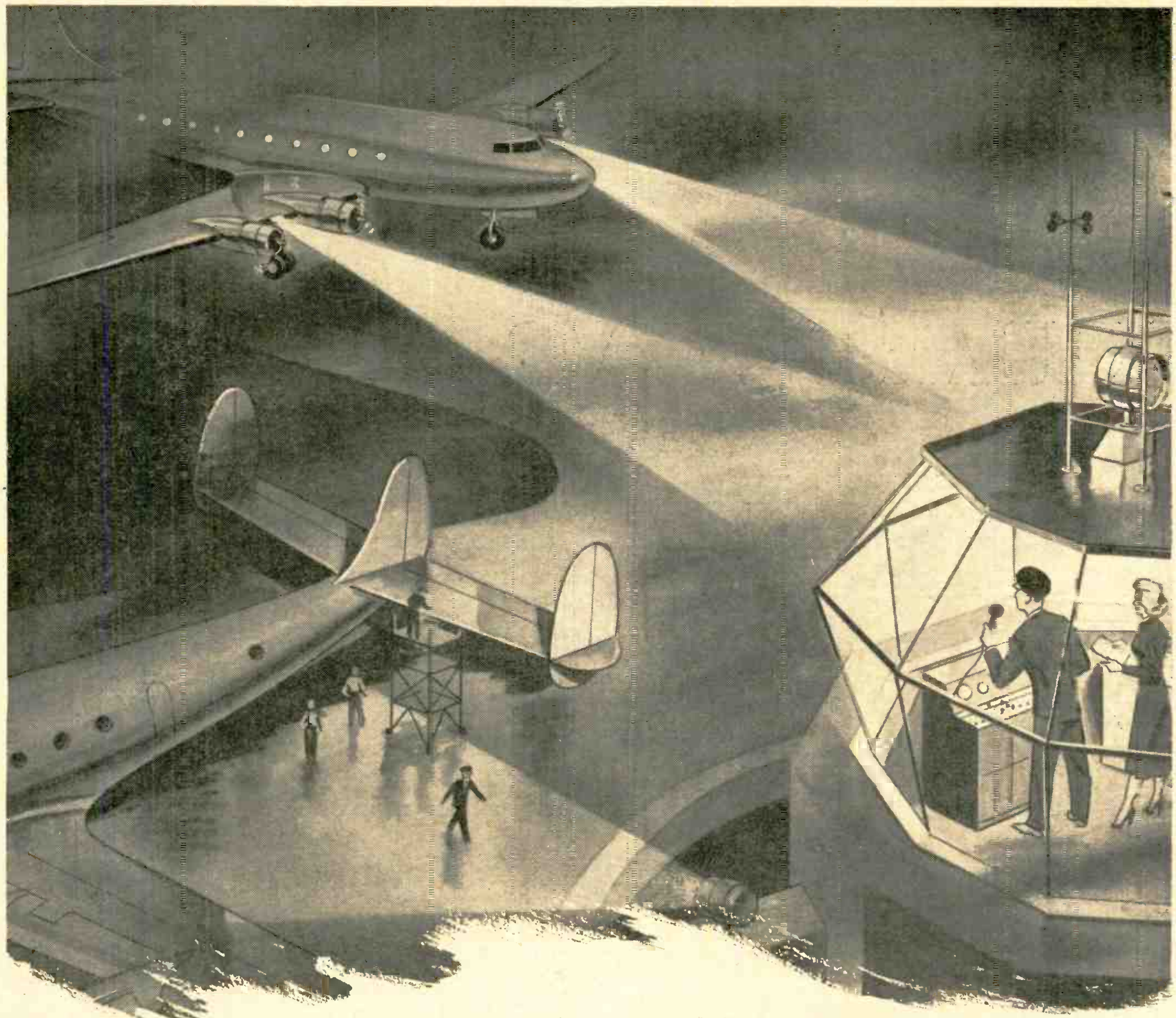

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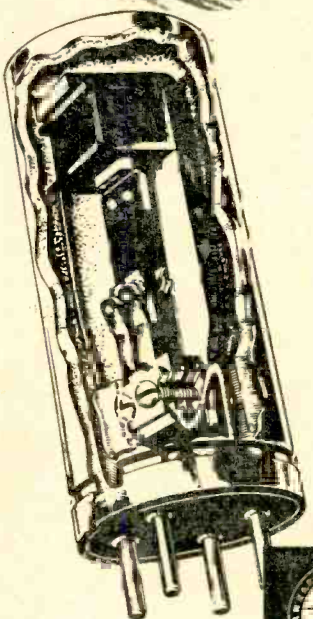

★ a drifting fog has no heart ... it cares nothing of life it holds in the balance. Yet man has conquered its insidious threat in many ingenious methods. One progressive step is radio communication. An important part of every good receiver is the vibrator. Every time it is used may not be a crisis ... but it must answer each call with peak performance.

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Test Equipment

SQUARE-WAVE ANALYSIS OF AUDIO EQUIPMENT

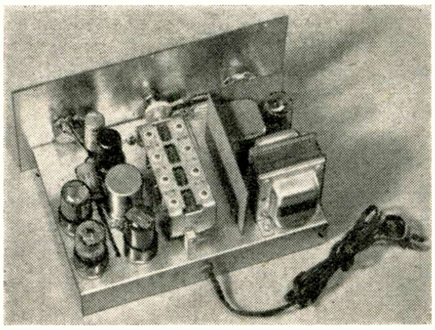
By RUFUS P. TURNER

A GREAT deal of material has been published lately on the subject of square waves and their uses. Some of the information disclosed has been practical, but a large amount of it has been only of academic interest. Many service technicians have failed to investigate fully the value of square waves as a time-saving and profit-making tool. There has been a tendency to regard the whole matter as a novelty insofar as workaday servicing is concerned.

We would like to dispel this notion. In the testing of audio amplifiers, in and out of radio and TV receivers, and of certain audio components, such as transformers, the square wave earns its keep in a hurry by giving a one-picture story of what is going on in the way of frequency response. To obtain similar results otherwise, the technician would have to check frequency response laboriously at a multitude of points throughout the audio range and then plot the response curve. The square wave test is applicable to the audio channels of receivers, as well as to complete AF amplifier systems. It may be used also to appraise lower-frequency performance of video amplifiers in TV sets.

Output Waveshape Interpreted

In square wave testing, the wave, at any suitable frequency is applied to the amplifier or component under test. The output waveform then is observed on an oscilloscope. If the amplifier is operating properly, that is, its frequency response is flat, the output wave also will be square. Any departure from the original squareness is an indication of variation within the system under test from prescribed operating conditions. With thought and some practice, the technician can learn to interpret the distorted waves he observes in terms of irregularities within the system under test.



The author's Heathkit Model G-2 Sine and Square Wave Generator, out of its cabinet.

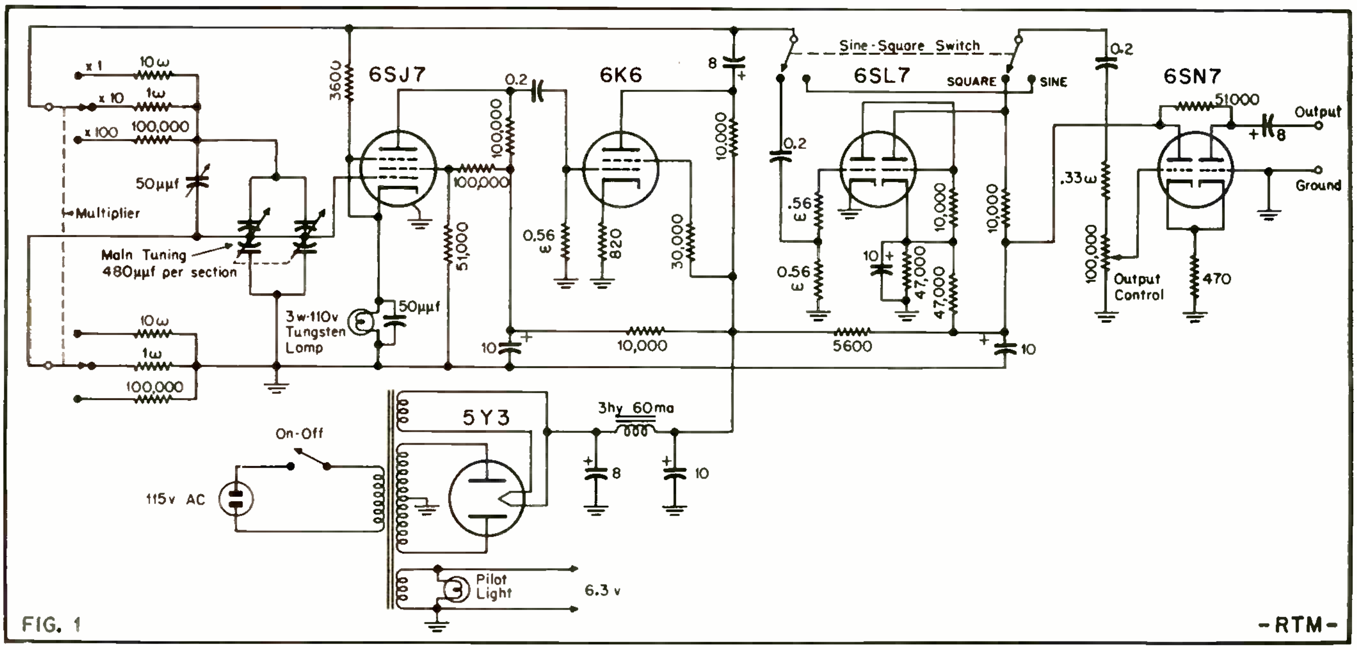
The square wave test appraises amplifier response simultaneously in terms of both frequency and phase. A great deal of information thus is packaged into the output signal wave pattern as viewed on the oscilloscope screen. The answer to the question "how is the amplifier operating?" is given in less than one-tenth of the time otherwise required. The square wave has a steep wavefront, and the transient response of the amplifier or component under test to this suddenly-applied voltage determines completely its characteristics.

Harmonic Content

The steepness of the square wave richens the harmonic content of this signal. When the square wave is applied to an amplifier, the latter is in effect tested simultaneously at a number of frequencies corresponding to the fundamental and to the several important harmonics of the square wave. It is important to note, however, that harmonics of the square wave fundamental frequency are odd-numbered. For this reason, care must be exercised in the choice of a fundamental frequency, so that one of the odd harmonics will coincide with a particular high frequency of interest. Thus, if a resonant point is expected at 3000 cycles, a fundamental frequency of say 600 cycles would be a better choice than 500 cycles. The reason being that an odd harmonic of 600 cycles (the fifth) coincides with 3000 cycles, while the even harmonic (the sixth) of 500 cycles would not be present in a square wave of the latter frequency.

Commercial Generator

Generally, the two-frequency square wave test will serve to appraise completely the performance of an amplifier or component. Common test frequencies are 60 and 1000 or 2000 cycles.



Schematic circuit diagram of the audio generator. For sine waves, the sine-square switch shown simply cuts out the 6SL7 squaring tube.

There is no objection, however, to adding as many test points as may be thought desirable. The test signal must be well-formed, not just "nearly square."

These requirements bring up the variable-frequency square wave generator. Fig. 1 is the diagram of a satisfactory instrument of this kind which is priced within reach of the average service technician. The Heathkit Model G-2 is a combination sine and square wave generator continuously tunable from 20 to 20,000 cycles. It is a conventional resistance-capacitance-tuned oscillator in which the position of the SINE-SQUARE switch will change the output waveshape at will. The 6SL7 is the squaring tube. When the waveshape switch is in its SQUARE position, this tube is cut into the circuit between the oscillator and output amplifier. The sine wave delivered by the oscillator is squared electronically and presented to the grid of the 6SN7 output tube.

This instrument is small, only eleven by seven by six inches. It is transformer-powered and readily adapted to the testing of complete audio amplifiers, audio stages in radio and TV receivers, video amplifiers, and audio components.

Wave Analysis

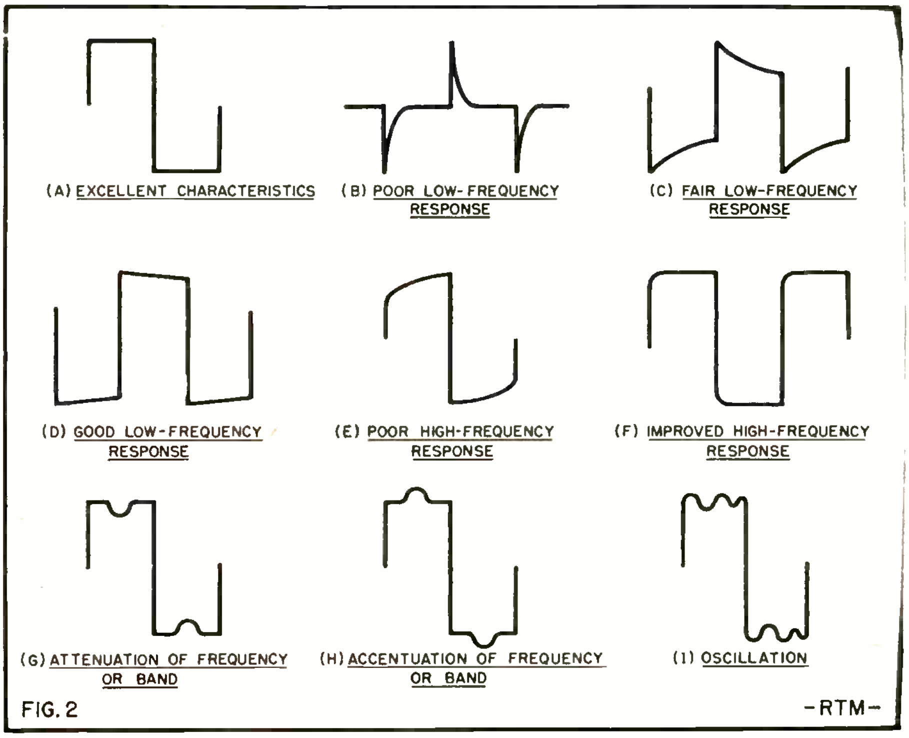
In affording a spot check of overall amplifier performance, the square wave test makes it possible to observe quickly the effect of tone control settings, introduction of frequency-selective networks, effect of changing values of circuit components, result of replacing faulty circuit components, effect of changing circuit voltages, and other variables.

Fig. 2 catalogues some of the output waveforms commonly encountered when a good square wave is applied to the system under test.

When the wave is passed without any deformation, (Fig. 2-A), the system has excellent response characteristics. It is flat. The chances are, however, that in a given amplifier, some distortion of the original squareness will result and that a waveform resembling one of the other figures will be obtained.

Various degrees of low-frequency response appear in order of improvement from 2-B to 2-D. Fig. 2-B is the pattern obtained when the low-frequency response is very bad. This pattern is common to poor-grade transformers. It is obtained also in circuits in which there is an appreciable amount of stray capacitance between input and output terminals. In 2-C, the low-frequency response is somewhat improved but still

→ to page 28



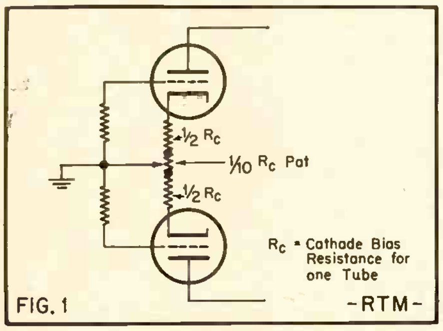
Sample oscilloscope traces resulting from various defects in a piece of audio equipment or a single component, shown with the undistorted wave passed by a first-rate amplifier.

Service Technique

AUDIO AMPLIFIER SERVICING

By THEODORE FISHMAN

THE servicing of audio amplifiers can be a profitable and interesting sideline to the activities of your regular radio and television repair business. The equipment necessary to do an efficient service job you probably have on hand now; the only items you might be lacking are a good audio oscillator and cathode ray oscillograph. However, there are several excellent models of oscillators on the market at prices no higher than you would pay for a good RF test oscillator. Choose one



Balancing cathode resistances in a push-pull output stage to equalize the sections.

that has good waveform, fairly uniform response, an output of 20 to 25 volts and a range of 20 cps to 20 kc. As for your scope, it should have an amplitude response of 10 to 20 mv/in. and a frequency response of 20 cps to 100 kc; it should also have push-pull deflection to avoid distortion.

Having set yourself up with this equipment, plus a good volt-ohm-milliameter and a pair of sensitive headphones (preferably crystal), you are now ready to solve a service problem.

Localize Defects

When you are called on to service an audio system, first determine whether the defects exist in the mike, phono-pickup tuner, or the speaker(s). The easiest way to check the speaker(s) is by substitution. By introducing a low level signal from an oscillator or touching the input contacts with the finger you can check the input channels of the amplifier. Remember, you must use a signal that approximates in magnitude the signal available from your input. Otherwise you may get very misleading results.

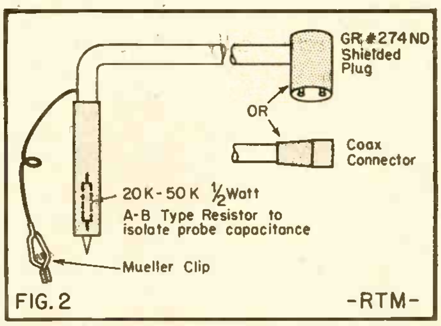
After you have determined that the devices external to the amplifier are in operating order, you will probably remove the amplifier to your shop for service. First, of course, examine the unit for obvious defects such as charred resistors, poor grounds, and badly soldered joints. Having taken these preliminary steps you are now ready for thorough trouble shooting.

For the sake of clarity we will divide our procedure into two parts; i.e., trouble shooting a completely dead amplifier, and trouble shooting an amplifier that hums, oscillates, or distorts.

Dead Amplifier

If your preliminary inspection has not disclosed the source of the trouble in a dead amplifier, set the unit up on your bench and connect a dummy load to its output. The impedance of this load should, of course, approximate the output impedance of the amplifier. If your VOM has an OUTPUT VOLTS or Db scale, it is probably calibrated with reference to a 500 ohm line, and if the amplifier has a 500 ohm output, terminate it with a non-inductive 500 ohm resistor and shunt the meter across it. This will enable you to make absolute power measurements directly. If you cannot terminate the meter correctly, don't worry. You will still be able to make absolute gain measurements, for, while your individual readings will not be correct, the differences between them will be. This done, make sure that there are no B+ shorts with the aid of your ohmmeter, and then apply power to the amplifier. Starting with the power output stage, apply a signal from your oscillator first to the plates and then the grids; be sure to insert a protective capacitor in series with the lead from the oscillator. If the oscillator output is balanced to ground take your output between ground and one high side, and apply it alternately to each plate of the push-pull output stage. The readings of your output meter should be the same in either case—a plus or minus 15% variation is an acceptable tolerance.

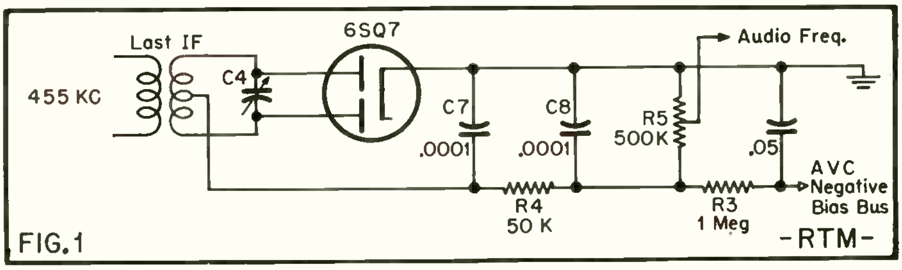
If the readings are not equal, there is



Hum-reducing leads for oscilloscope probes.

something wrong with the output transformer and it should be replaced. Continuing, apply your signal now to the grids, each one in turn; once again the readings should be equal. If they are

→ to page 26



Note similarity of this AVC circuit to that of a full-wave rectifier.

OPERATION AND SERVICE OF AUTOMATIC VOLUME CONTROL

By DAVID T. ARMSTRONG

IN MOST modern receivers both detection and automatic volume control are accomplished in one tube, but they are two distinct functions which should be treated separately. Here, we consider only the AVC system.

An AVC system controls the signal, so that the loudspeaker volume from station to station, or from moment to moment on the same station, is relatively uniform. When there is a strong signal, AVC operates to reduce what is delivered to the speaker; on a weak signal, the AVC operates to increase the signal.

Operation

The fundamental principle on which an AVC system works is quite similar to that of a rectifier system in a power supply. These are among the simplest radio circuits, and are chiefly composed of a diode rectifier and a filter system.

This generator develops a bias voltage; the bias voltage is fed into a distribution system, whence it is applied to the IF and RF circuits through a network of resistors and capacitors. Eventually, the bias voltage is applied to the grids of the RF and IF tubes to be controlled.

Control is usually effected by use of variable-mu tubes in the RF and IF stages. The gain of such tubes varies with grid bias changes; with high negative bias the gain of the stage is low; with low negative bias the gain of the stage is high.

This is because a strong signal generates much negative bias, which is impressed upon the grid of the tube controlled to reduce the gain of that stage; a weak signal generates little negative bias, which has the net effect of increasing the gain of the stage.

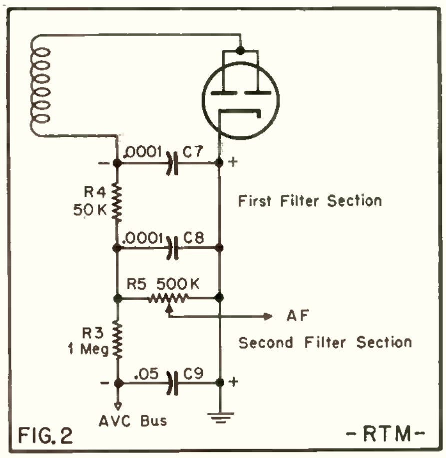
Generation of Bias Voltage

In Fig. 1, a typical full-wave AVC voltage developer is shown. Note its similarities to a full-wave power-supply. The principle of generation of DC voltage is the same in both types of circuits, but these differences should be considered:

1. The power supply operates from relatively constant line voltage through a transformer at a frequency of 60 cycles. The diode rectifier for AVC operates from an IF transformer at a much higher frequency and at a very low voltage. The voltage impressed upon the rectifier plates varies as the signal voltage increases and decreases. As a result, the rectified DC from the diode varies in proportion to the IF voltage on the plates.

2. There are important differences in the filter system. A power supply filter system operating on 60 or 120 cycles is much larger and more complex than a filter system for an AVC supply. For the relatively high frequency at which AVC operates, however, the entire filter may be reduced to one or perhaps two small condensers, with a resistor in place of the choke.

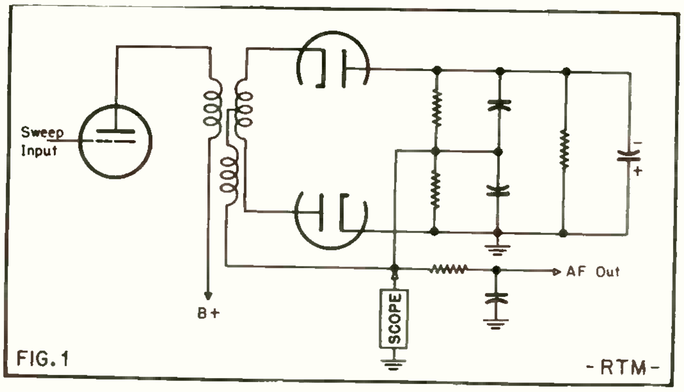
3. In a typical power supply, the negative side of the receiver load is grounded, but in an AVC rectifier system the positive side of the AVC load is grounded. This is because we want a positive voltage in the power system,



Two-section AVC filter, designed to prevent feedback of audio signal with control voltage.

→ to page 24

Newer FM Demodulators --- the Ratio Detector, the Locked-in Oscillator, and the Gated-Beam Detector Circuit



Basic ratio detector circuit. Note symmetrical networks across the diodes, large capacitor (shown polarized) across the networks, scope connections.

FM ALIGNMENT AND EQUIPMENT

PART 2

By NORMAN L. CHALFIN

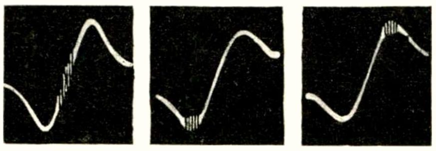
ALTHOUGH the limiter-discriminator, which we described here last month, was once at the top of the list as far as frequency modulation detectors are concerned, several other circuits have been coming into their own recently.

Ratio Detector

These are the ratio detector, the locked-in oscillator, and the gated-beam circuit. The ratio detector, today one of the most widely used of all FM demodulators in modern FM receivers and television sets, is somewhat analogous to the discriminator in that it utilizes two diodes, but it has the advantage of being self-limiting, and it is different in basic theory as well. In most of the commercial arrangements, this circuit is centered around a duo-diode tube, so that it uses only one tube where the limiter-discriminator commonly uses three. This, of course, effects an economy in production.

The ratio detector, the circuit of which is shown in Fig. 1, produces an alignment pattern similar to that of the discriminator, that is, an "S" curve, with the sweep generator and oscilloscope connected as indicated.

Operation of the ratio detector depends on the instantaneous voltage



Response curve of ratio detector, as obtained from hookup shown in Fig. 1. Marker signal is shown at center frequency, or IF value, in first picture, and at the two limits of the band pass of the detector in the second and third pictures.
(Courtesy John F. Rider, Publisher)

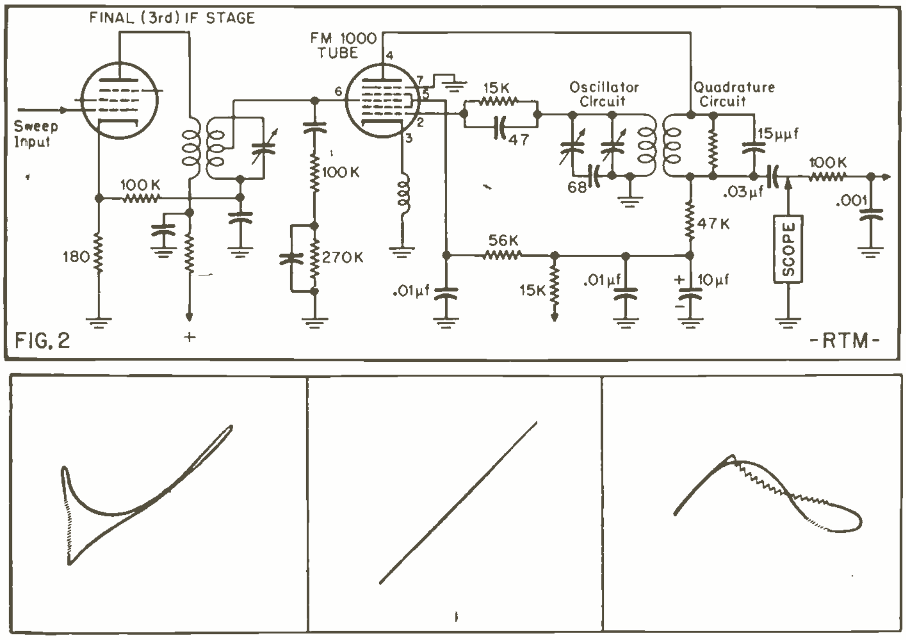
comparison across the two symmetrical condenser-resistor networks connected between the cathode of one diode and the plate of the other; the sum of the two voltages is fixed by the large condenser across the networks, and only their ratio changes. It is well to remember that in FM, the audio signal produced varies in amplitude according to the amount of frequency swing from the carrier of the modulated signal, while the audio value varies in frequency according to the number of changes per second.

The effect of a frequency swing on the detector is, by the action of the networks associated with the diodes, to produce a higher voltage across one of the series-connected diodes than it does across the other. The two values, for example, might be eight and six volts; the ratio would then be four to three. With double the signal strength, the values would be 16 and 12 volts, but the ratio would still be four to three. The amplitude of the resulting signal at that instant, then, would be proportional to the difference between four and three. The pitch, or frequency, of the audio signal, would depend on how long it took for the ratio to change from four-to-three, over to three-to-four. The polarity change is made possible by the connection of the center tap on the transformer secondary to the midpoint of the diode networks.

From this discussion, it may be seen that this detector, like the discriminator, must be aligned so that the point of resonance of the transformer lies at the IF value, and that the upper and lower peaks of the curve are each at least 100 Kc away from the IF, that is, at 10.6 Mc and 10.8 Mc for the conventional FM receiver. In the 'scope traces shown, the marker pip is put at center frequency, and at the peaks above and below resonance.

Visual Alignment

For visual alignment of the stage, the oscilloscope vertical input is connected, in series with a 10,000 ohm resistor, to the midpoint of the resistor network across the diodes. The FM and AM



Circuit diagram and 'scope traces of the locked-in oscillator detector. From left, the traces illustrate incorrect alignment of the quadrature circuit; correct response about the center (IF) frequency; and quadrature misalignment plus misalignment of the secondary of the last IF transformer.
(Courtesy John F. Rider, Publisher)

generators, if both are used, are connected in parallel to the control grid of the last IF tube. The sweep generator is adjusted to cover the passband of the system, with the center frequency at the IF value, and the AM or marker generator provides the pip at the chosen locating frequencies. The transformer slugs are then adjusted for greatest linearity and symmetry of the curve. If no linearity check is thought necessary, the job may be done with the AM generator only, with a VTVM in place of the 'scope. The secondary slug is then set so that a null is found, and a slight turning in one direction produces an upscale deflection, and a turning in the other direction gives a downscale movement. The primary is set for maximum meter deflection.

Locked-In Oscillator Circuit

Another detector which operates without a limiter is the locked-in oscillator, or "Philco" circuit. Using a special tube, the FM-1000, which is somewhat similar in setup and operation to a pentagrid converter, this circuit produces an oscillation at the same frequency as the IF, which is commonly 9.1 Mc. The oscillatory circuit, which uses the first and second grids of the FM-1000 tube as grid and anode, is a variation of the Colpitts oscillator, and has a natural frequency of 9.1 Mc.

The IF signal is fed into the tube, at the third grid, and the plate circuit, reactively coupled to the oscillator section, causes the lock-in action, and forces the frequency of the oscillator to follow the variations in frequency of the IF. With the oscillator thus changing in frequency, the plate current also changes, at the audio rate, and the audio signal is picked off and fed to the first audio amplifier. Since the plate current change is caused by the frequency change of the oscillator, and the plate current response is linear according to frequency deviation, changes in the amplitude of the IF do not produce corresponding AM in the plate current, and no limiter is required. On the debit side, the oscillator will not remain locked in if the signal voltage is too small, or if the frequency shift is too large. The audio voltage appears across a 47,000-ohm resistor in the plate circuit of the FM-1000 tube.

Alignment

For alignment of sets using the locked-in oscillator circuit, pin 2 of the detector tube, that is, the first grid, is grounded. This makes it an AM detector, since the oscillator is put out of commission. Then the set is aligned just as an AM set would be, with an output meter across the voice coil. A loading network of a 4700 ohm resistor and a 0.1 mfd condenser is connected across one winding of each interstage transformer while the other winding is peaked. This process will provide the correct overcoupling.

To align the detector, the plate of the FM-1000 tube is shorted to the top of the 47,000 ohm resistor in the plate circuit, and the oscillator is put back in operation by ungrounding the first grid. The IF signal is fed into the grid of the last IF tube from a signal generator, and the oscillator frequency is adjusted for zero beat. The short across the tuned plate circuit is removed, and with the generator signal level kept very low, the tuned circuit is set for zero beat.

Using the oscilloscope and sweep generator, the proper curve to be obtained

→ to page 26

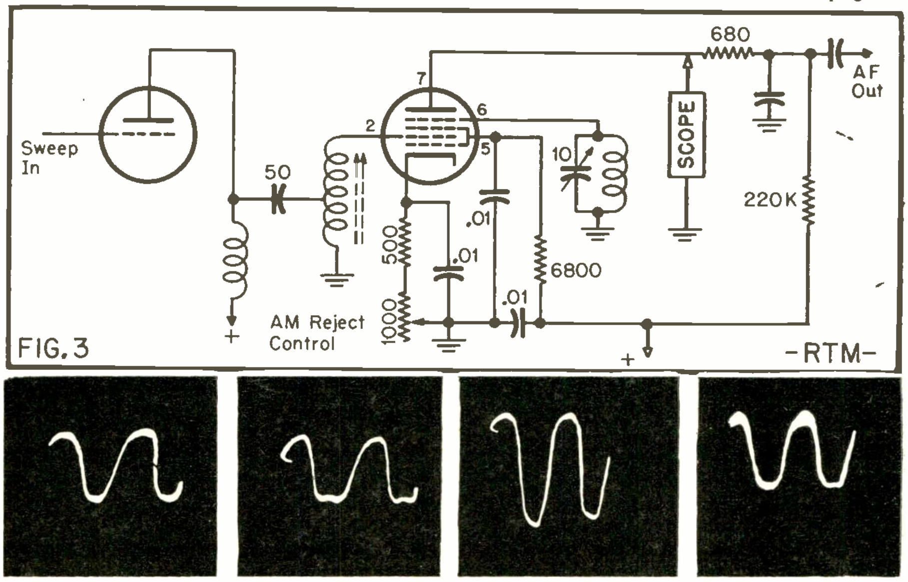


Diagram and response curves of the gated-beam detector circuit. From left are shown the normal center-frequency response of the detector; signal lower than center frequency, indicated by double peak; signal higher than center frequency, indicated by drop-off of response on lower peak; and presence of AM in the signal, which can be eliminated by adjustment of the AM rejection control. Traces made in the John F. Rider Laboratories, using Measurements Corp. 78FM Signal Generator and IF Adapter, with an intercarrier-type TV set.

A Few of the TOUGH ONES

By R. F. SHAUGHNESSY

THE satisfactory operation of an electronic tube in any particular piece of apparatus depends, not alone on the tube's condition, but also on the circuit arrangements existing in the apparatus. The mechanical conditions under which the tube is operated also contribute to the determination of its optimum performance.

The positions occupied by the various tubes on a typical broadcast receiver chassis are highly important to the efficiency of the tubes. A tube might, for example, produce the familiar microphonic howl when subjected to the changing air pressure emanating from the rear of the loudspeaker. The same tube, however, placed in a different receiver in a similar position with regard to the circuit but different in a mechanical sense, would operate with complete satisfaction.

Checked on a tube checker, the tube would give a reading well over on the GOOD scale, but slight tapping on the envelope would undoubtedly produce a very distinct flickering of the meter needle.

Different Circuit

Another case, showing the effect of different circuitry, is that of a tube being used in its appropriate section in an amplifier having a low overall gain. The tube will operate perfectly in this position but, if transferred as a replacement for a similar tube in an amplifier having a high gain, it may introduce an intolerable amount of noise. The noise was not apparent in the first amplifier because of the circuit's low gain. The high gain circuits of the second amplifier, though, built up the tiny fluctuations of current to a high value. These amplified variations, then, appeared as noise in the loudspeaker. Another fairly common observation is the apparent difference in the performance of a converter tube which, when tested on the tube checker, reads "good," but when placed in position in two different receivers is found to function perfectly in one and to fail in the other. The reason, of course, is the different characteristics of the oscillator sections in both receivers.

Instability

A common cause of instability in the RF and IF stages of receivers in general is a high resistance connection between ground and the suppressor grids of RF pentodes. This fault is uncommon with tubes whose suppressor grids grounded internally, and should be looked for only in those tubes which employ a separate pin on the base for this purpose. A dirty pin or faulty tube socket is often found to be the cause of this trouble.

Excessive Emission

Cathode emission is next in importance to electrode insulation when checking tubes, both in the receiver and on the tube checker. Excessive emission can be detected very easily by observing the familiar glow inside the bulb which accompanies the phenomenon. It results from the deterioration of the vacuum which existed initially inside the envelope, and also from the bombarding, by the electron stream, of gas molecules in the electrode assembly. The bombardment causes the gas molecules to ionise, and the ions, carried along in the stream, add considerably to the plate current. They may, in some instances, completely ruin the tube.

An interesting test can be carried out in such an instance without removing the tube from its socket or recourse to specialized test apparatus. An ordinary bar magnet, brought close to the glass envelope, may or may not have an effect on the glow. If the field of the magnet causes the glow to be deflected, it shows it to be an electron glow, which is unlikely to have a detrimental effect. If, on the other hand, it is not deflected by the magnet, it is evident that the glow is the result of ionisation, and the tube is no longer in good condition.

These are important points, to be kept in mind when confronted with apparently insoluble difficulties in the servicing of modern high gain radio and audio equipment.

Fixed Resistors

The simplest and most widely used component in radio and allied fields is the resistor. Because of its simple con-

→ to page 23

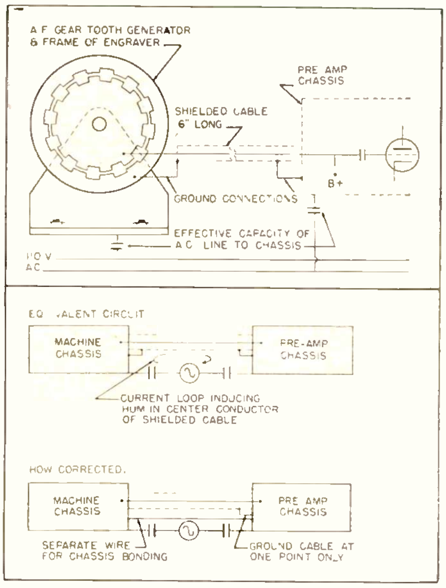
Service Problems With the

AF ELECTRONIC PHOTO-ENGRAVER

Ed. Note: The material in the following article has no direct connection with service of radios and television, and very few RTM readers will ever work on the machine described. Some of the problems, however, which were solved in the maintenance of this device are applicable to work with other audio-frequency equipment. Furthermore, many readers will no doubt be working on similar electronic units in the near future, in connection with war mobilization.

THE Fairchild Photo-Electric Engraver is a device using fairly conventional audio equipment in an entirely novel application. Its function is to produce halftone engravings on a sheet of plastic. Electrically, the engraver uses an audio frequency generator, two controlled light sources, a phototube pickup, voltage and power amplifiers, and a magnetic cutterhead.

The photograph to be reproduced is scanned by a photoelectric cell which converts the tonal values of the picture into an electric signal. This signal is superimposed on a fixed frequency that represents the screen of the engraving. The result is an amplitude modulated audio wave that contains both the picture and screen information. It is amplified and sent to a magnetically activated stylus which produces dots of varying size thermally on a sheet of plastic revolving on a drum. The original photograph is thus translated into a screen or dot pattern.



Partial block diagrams illustrating the hum problems encountered in service of the electronic photo-engraver. A ground loop was found to cause hum, which ruined the engravings.

The frequency of operation is fixed: 220 cps for a 65-line screen engraving. The maximum power consumption is 55 watts.

Service System

Servicing the machines, which are leased to newspapers and other publications, is a team of 26 service engineers, one for each of 21 service areas covering the entire country, four district engineers and one service engineer at large.

Each engraver is serviced once every three months. In case of an emergency, the technicians will answer a call for help any time of the day or night. On the whole, however, the machines don't require much "extra-curricular" servicing these days. In fact, one remote installation at the *Mid-Ocean News,* in Hamilton, Bermuda, operated continuously for nine months without the attention of any service engineer. Some baffling quirks have developed, however, in the engraver and have been smoothed out by the work of the service engineers in the field.

Eliminating Hum

The machine is very sensitive to hum pickup, which shows up in the engraving as a pattern of bars superimposed on the photograph. Due to the mechanical layout of parts, long signal leads are a necessity. It was found that careful shielding of all leads did not com-

→ to page 22

NEWSLETTER

→ from page 3

RADIO GAINING FAST ON VIDEO

Radio listening in homes with television has climbed fast in recent months, at least in the three big TV markets of New York, Chicago, and Philadelphia, according to a survey just made by The Pulse, Inc., public-opinion research group. Facts revealed in the survey showed that AM listening increased more than 30 percent in December, 1950, as compared to December of 1949, in New York, while the ownership of television sets represented about 2,000,000 homes in 1950, as against only 800,000 homes in the previous year. In addition, it was pointed out that TV viewing went down in New York last month, for the first setback to video in what is usually a peak season for viewing. The trend towards increased radio listening was most pronounced in Chicago, where radio gained every month during the past half-year. In Philadelphia, listening to the radio increased steadily for five straight months.

VINYL CUTBACKS THREATEN MFRS.

Dwindling supplies of Vinylite for phono records may bring about an exchange program involving dealers, it was forecast, although three big producers said that the tight situation should ease by the end of the year. The possible exchange arrangement, like that used to aid suppliers during World War II, would mean that dealers would have to give old records back in order to get new disks. Until new plants are completed, however, and until the National Production Authority is able to work out an allocation plan, it is expected that supply of the resin to record manufacturers will be rationed.

N. Y. FM OUTLET SELLING 55 PCT.

The New York FM station, WABF, reported that it pulled up to a total of 55 percent on sponsored broadcast, a high figure for an FM station. Transmitting mostly recorded and transcribed classical music, the station made its biggest step in 1950. Its monthly magazine listing programs became self-supporting, taking a jump along with the broadcasts. Five years ago, reports said, the station's programs were only 10 percent sponsored.

ELECTROSTATIC TUBES EASE COPPER FAMINE

Some cathode-ray tube producers are working against the copper shortage by going in for electrostatic focusing and deflection in picture tubes for television. One manufacturer, Sheldon Electric Co., reported that a full pound of copper may be saved in each receiver through the use of electrostatic focusing, and that 50 percent of the set's cobalt can be saved the same way.

TWO-WAY RADIO STARS IN BLAZE

Mobile two-way FM radio, in the form of a handie-talkie, got a real demonstration in Chicago during the recent $1,500,000 warehouse fire. The city's fire officials were testing four Motorola units in a mock atom bomb attack, on the afternoon that the fire started. When the blaze was reported, Fire Marshal Anthony Mullaney, who had been directing the civil defense practice run, still had the sample units with him. He then took a position where he could see the burning building, and put one of the two-way radios on a fireboat on the Chicago river. The remaining two units were put to work on the opposite side of the warehouse. Thus organized, the fire chief was able to direct the work of firemen with increased speed and efficiency.

LABOR MARKET TO BECOME TIGHTER

Increased labor problems are expected in the electronics industry as mobilization moves forward. The National Association of Broadcasters forecast a serious pinch in the personnel of AM, FM, and TV facilities, intensified by the wage freeze, while RCA set up a new RCA Victor Employment Division, specifically for the purpose of hiring qualified engineers.

TV COVERAGE WIDER THAN WAS KNOWN

Figures on the efficient coverage of television stations have been revised upwards by two large broadcasters. NBC and CBS now base their coverage estimates on areas within 60 miles of each transmitter, instead of the 40 miles previously figured on. This new estimate, calculated on a 0.1 millivolt per meter contour, instead of the former 0.05 millivolt per meter basis, results in an estimate that 62 percent of the nation's population is reachable by TV, where only 53 percent was previously thought to be within range.

PLENTY OF BUSINESS IN INTERCOM SYSTEMS

SERVICEMEN are ordinarily right up to their toes when it comes to spotting and cultivating likely ways of supplementing their incomes, but it seems to me that there is one very remunerative field that we have pretty well overlooked, or at least neglected. I mean the sale, installation, and service of intercommunication equipment.

This is all the more strange because such work really is a natural as a sideline for the radio and television serviceman. The price of the equipment is low enough that a few essential units can be stocked by even the smallest shop. Circuit-wise, intercoms are so simple that servicing them is a breeze with only the instruments already found on any service bench. In fact, after wrestling with radio and television sets, the serviceman will find these short distance telephones so simple that he can even undertake their *construction* for those customers who have a particular problem or whim that requires a custombuilt job.

Can Be Sold Everywhere

As to where they can be sold, you should not have to be told that. Every office, store, shop, and garage needs an intercom set; but the beauty of it is that you do not have to depend upon actual *need!* There is enough of Andrew H. Brown's "Buzz me, Miss Blue" in the makeup of all of us so that this ability to give orders or obtain information simply by flipping a little lever has a tremendous appeal. There is nothing like a talk-box unit sitting on the desk of a minor official to make him feel like a real big shot.

JOHN T. FRYE

The home, though, is the really untouched field for the sale of intercoms. There are a dozen places in the home where an inexpensive inter-communication set will make life ever so much more comfortable and enjoyable. A few such places are: from the nursery to the living room or bed room, from the kitchen to the basement, from the house to the garage-workshop, from a sick room to the living quarters. And using the gain of an intercom amplifier into an outside speaker for calling the small fry will save a lot of wear and tear on the vocal cords. At the same time, that outside speaker used as a sensitive microphone will catch the faintest answer to the call. Such an arrangement, too, forms an excellent way to monitor the kids at play in the back yard without having to run to the door every few minutes to see what kind of childish mayhem they are engaged in at the moment.

Endless Variety

Modern inter-communication equipment offers an almost endless variety of application. With one master station and several sub-stations, the person at the master station can originate a call to any slave station; and, as long as the master amplifier is turned on, the substations can call the master station. When all master stations are used, any one station can originate a call to any other station, even though the amplifier of the receiving station is turned off.

By proper selection and installation of equipment, as much or as little privacy as wished may be had. This can vary all the way from a first-class "snooper" system that will permit the master station to monitor any one of the sub-stations whenever he wishes to an arrangement where it is impossible for any station to listen in on another station at any time.

Runs Continuously

When the equipment is to be in frequent use over long periods of time, ordinary AC-DC receiving tubes are usually employed and the amplifier is left running continuously; but when only an occasional use is to be made of the equipment and where great volume is not required, the 50 ma. battery type tubes are often employed in connection with a selenium rectifier for furnishing both filament and plate power. Since this arrangement provides an almost instantaneous warm-up, the amplifier is kept turned off until it is needed.

No attempt is going to be made here to tell you actually how to build intercom sets. A wealth of such material has been published in books, magazines, and even tube manuals. However, a few general suggestions both as to construction and service may well be in order.

It is very essential that hum be kept to a minimum in an inter-commounication unit. The master station speaker is normally directly across the output of the amplifier in the "standby" condition, and the unit often sits on a desk right at the elbow of the occupant. Under such conditions, especially in a quiet location, even a fairly low value of per-

→ to page 27

trade LITERATURE

AUDIO EQUIPMENT

HIGH-FIDELITY audio equipment, designed for use in broadcast applications, is included in the coverage of several leaflets put out recently by RCA. Among the products described in the booklets are a new tape recorder; the "Starmaker" ribbon-pressure microphone; the "Olson" loudspeaker and a new wall housing for use with the hi-fi speaker; and a lightweight pickup and tone arm.

To obtain the leaflets, write to the Broadcast Equipment Section, RCA Engineering Products Department, Camden 2, N. J.

—RTM—

Q-AND-A MANUAL

UP-TO-DATE as of September 1, 1950 FCC supplements, the enlarged second edition of "Radio Operator's License Q and A Manual" has questions and answers on the new element, Element VII: Aircraft Radio-telegraph and Radiotelephone for Flight Radio Operator. It also contains the new Elements II and V, and the Revised Elements III and VI.

Published by John F. Rider, the book has 766 pages and 240 illustrations. Cloth-bound, it sells for $6.60.

Element VII is now required of students to qualify for a flight radio operator's license. Subject matter of the manual includes FM and Television in Elements II and IV. A number of questions have been added to Elements V and VI on such topics as Frequency-Shift Keying, Marine Radar, and Lunar. This book covers these questions and offers a bibliography for those who want additional material. Two new appendices have been added to the second edition: *Small Vessel Direction Finders* and *Automatic Alarm.*

—RTM—

PHONO ACCESSORIES

PHONOGRAPH accessories manufactured by General Electric are described in a new catalog, which covers variable reluctance cartridges, replacement needles, tone arms and phono preamplifiers.

Pictures, descriptions and performance data are included in the booklet, which is free on request to the Parts Section, GE Receiver Division, General Electric Co., Syracuse, N. Y.

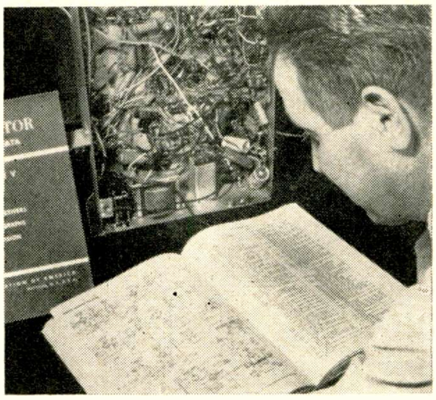
—RTM—

SOLDERING TECHNIQUES

A REPRINT of a recent article, "Modern Soft-Soldering Techniques," is now available free on request from the Multicore Sales Corporation, 164 Duane Street, New York.

Covering the history, content, and construction of solders, with the uses and purposes of each, the article describes joints which can be made with various metals. Fluxes, with the way they work and their proper use, are covered, as is the right technique to avoid cold joints.

The pamphlet, which was written by R. W. Hallows, an authority on the



subject of solder and fluxes, is assembled in simple language, and is illustrated with diagrams. Material for both beginners and experts is included.

—RTM—

REVISED VTVM BOOK

"VACUUM-TUBE VOLTMETERS," a forthcoming book of John F. Rider, Publisher, is scheduled for publication in March.

Revised and almost completely rewritten, it is right up to date in its coverage of all types of meters (diode, triode, rectifier-amplifier, tuned, amplifier-rectifier, slide-back).

Starting with the theory of the instrument, the text goes on to discuss design, construction, calibration, maintenance, and applications.

A new chapter on DC and RF probes discusses the different types of probes and what measurements they can make. Also explained is the adaptation of the probe for particular jobs.

A chapter is devoted to more than 40 commercial VTVM's. Each is listed by manufacturer and model number with accompanying schematic diagram and list of parts values. A comparison tabulation of operating characteristics of the models discussed provides such information as circuit type, input impedance for AC and DC, frequency response, accuracy on AC and DC, voltage range and number of ranges for AC and DC, ability to measure resistance, and special features.

Review questions are placed at the end of each chapter so the reader may check his knowledge of the subject discussed.

A bibliography of about 200 listings permits the user to delve further into particular topics.

Containing approximately 370 pages in a cloth binding, the book is priced at $4.50.

—RTM—

SUBSTITUTION MANUAL

A NEW 40-page tube substitution manual for quick reference to substitute types of radio and television tubes has been announced by Sylvania Electric Products.

Distributed free on request, the manual is arranged in nine sections, providing text and charts on general tube classifications; circuit modifications in which additional resistors are needed; substitute battery type tubes; substitute 150 ma tube types; substitute 300 ma tube types; substitute transformer and auto tube types; substitute TV receiving tubes; substitute TV picture tubes; and frequently-needed change-over diagrams.

Types of tubes classified in the manual include: remote cut-off RF amplifiers; sharp cut-off RF amplifiers; converters; diode detectors; diode-pentodes; diode triode detector-amplifiers; indicators; multi-purpose tubes; duotriodes; power amplifiers; general purpose rectifiers including voltage dou-

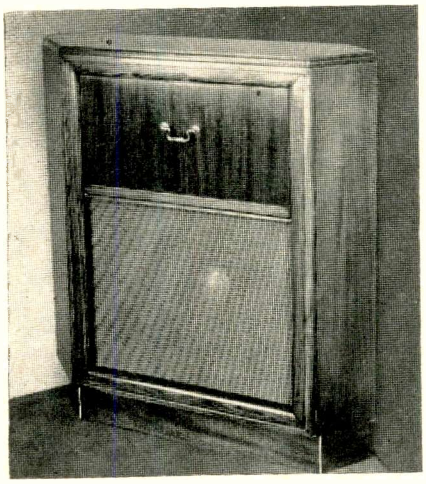
→ to page 19

Some of the interesting new items being made available currently in the Radio and TV service field are presented in this column. For further information, write to: Products Editor, RADIO AND TELEVISION MAINTENANCE, P. O. Box 867, Atlantic City, N. J.

CORNER SPEAKER SYSTEM

A woofer and tweeter are placed back to back in a new corner speaker system, the "Realist," produced by Sun Radio and Electronics Co.

The low-frequency speaker, a 12½-inch unit, and the eight-inch tweeter are positioned in what the manufacturer calls a "unique" setup, so that there is no hangover of bass notes, and the treble notes are reflected from the corner of



the room, according to an announcement of the item.

Speakers of various manufacturers can be selected for installation in the corner cabinet, while impedance matches from four to 16 ohms are provided for.

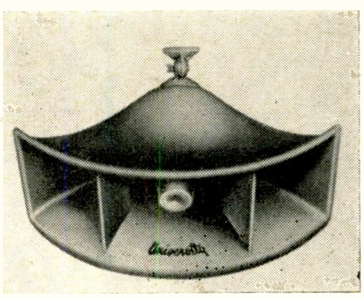
Available in Cordovan mahogany, walnut, natural mahogany, and blond, the cabinet is offered in either modern or traditional styling.

—RTM—

PAGING SPEAKER

A new design in paging speakers is incorporated in the model "Cobra-12," just announced by University Loudspeakers.

Frequency response of 250 to 10,000 cycles, and input capacity of 12 watts are features of the speaker, as is an extremely large angle of dispersion in the



horizontal plane, coupled with limiting of vertical dispersion.

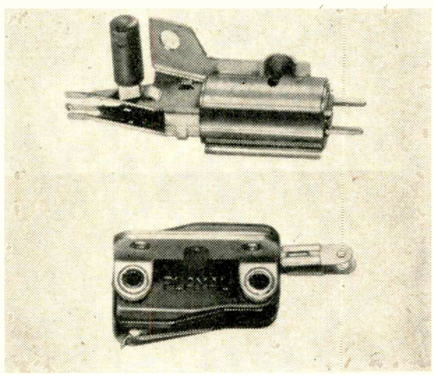
Use of heavy gauge metals, die castings, and hermetically-sealed driver, is reported to make the unit trouble-free, both mechanically and electrically. Combination of the reflex and "Cobra" horn shape give optimum acoustical characteristics, according to the manufacturer.

—RTM—

PHONO PICKUPS

Two additions to the "Titone" line of phonograph pickups produced by Sonotone Corp. are the "Playal" and the "Turnover."

For the "Playal," three types of needles—one-mil, for LP and 45 rpm records; three-mil, for standard shellac records; and 2.3-mil truncated osmium stylus



for all three types—are available and interchangeable.

Either diamond or sapphire needles can be used with the "Turnover," which also plays all three speeds. This cartridge holds two different needles at once, with a lever for selecting the desired one.

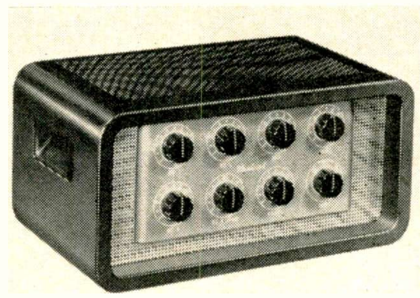
Advantages claimed for Titone, a piezo-electric ceramic, are that it provides wide frequency response, coupled with freedom from needle talk, and that it is unaffected by humidity and temperature changes.

—RTM—

REMOTE MIXER-PREAMP

Four inputs (high or low impedance microphones and/or crystal pickups) can be mixed on a new self-contained remote mixer-preamplifier just announced by Rauland-Borg Corporation. The program is then fed over cable to main amplifying equipment which may be as much as several miles away.

Features of the unit include a master gain control, separate bass and treble controls, self-contained 24 volt AC supply, and a switch for remote relay control of basic amplifying equipment.



Output of the preamp, measured at 100, 400, and 5000 cycles, is 300 mw, two percent at 600 ohms. Microphone gain is 109 Db on high impedance and 96 Db on low. Phonograph channel gain is 73 Db at 0.5 megohm. Output impedance is 150 or 600 ohms. Hum level is 47 DB below rated output on microphone, 60 Db below rated output on phono. Frequency response is plus or minus one Db, 40 to 20,000 cps.

The tube lineup includes four 6SQ7, two 6SC7, two 6SN7GTA, and one 6X5GT power tube.

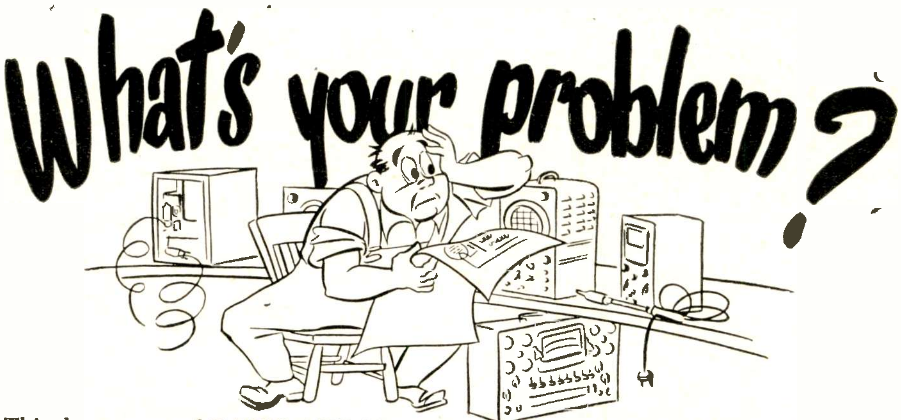
—RTM—

MOBILE FM RECEIVER

The "Monitoradio," a mobile FM receiver said by its maker, Radio Apparatus Corp., to bring in all two-way FM telephone communications, was recently made available.

Built in two models, one for the 30-50 Mc band and one for the 152-162

→ to page 20



This department of RADIO AND TELEVISION MAINTENANCE is devoted to helping to solve the difficult service problems of our readers. Tough ones of general interest will be printed, and readers will send in answers. The best solutions will be printed in later issues. If only one answer to a problem appears here, its originator will receive $5.00 in cash. If two or more different ways of beating the poser are of nearly equal merit in the opinion of RTM editors, the second best will be worth $3.00 to the man who submits it, and the third best will bring home $2.00. Send your question or solution to: Problem Editor, RADIO AND TELEVISION MAINTENANCE, P. O. Box 867, Atlantic City, N. J.

LOCK-IN TROUBLE

Bernard J. Hellman, a TV technician of St. Louis, Mo., and a reader of RTM, asked for help here in solving a problem he had in trying to repair the horizontal hold of a set he was working on.

Mr. Hellman's receiver—a Teletone—wouldn't stay locked in for more than two or three minutes at a time, he said, and the horizontal hold control was very critical, so that a slight turning of the control to either side started the picture running.

RTM sends $5.00 to Roy T. Fischel for his answer, which is presented here along with a problem he himself has run across.

GENTLEMEN:

In regard to the problem of Mr. Hellman in your December issue, I'd like to report that I once had a similar trouble in an Automatic 1249. My difficulty was a little different, though, since both the horizontal and vertical sync pulses were getting lost somewhere, and the picture rolled in both directions.

I could get it into synchronization by operating the controls, but it would stay only a few seconds. The picture was fairly good when it was in sync, although it wasn't perfect, and the sound was good all the time.

The antenna was OK, but there were no sync pulses at the video detector. Using a high gain 'scope, I traced the signal from a station, beginning at the first IF stage. I lost it at the output of the third IF.

Then I disconnected the third IF stage, and bridged it with a 0.02 condenser. This recovered the sync pulses, and the set performed fairly well, although the picture quality, as might be expected, suffered from the reduction in IF gain. I replaced the transformer associated with the defective stage, checked the alignment, and the set worked like new.

My suggestion to Mr. Hellman is to check for sync pulses at the inputs to the horizontal oscillator, to the output tube, and to the horizontal deflection yoke. He also could check the voltages and resistances of the entire horizontal oscillator and deflection circuit, if he hasn't already. Then he might find that the methods I applied would work for him, too. I assume that he knows all the tubes in the section are good.

I have a problem of my own, incidentally, that I'd like some help with. The set in question is a Motorola 16VK7R, and there is a nice large hum bar on two of the local channels. The other two channels come through all right. The hum shows up on channels 4 and 5, but not on channels 7 and 9. Sometimes it is worse than it is at other times.

All the electrolytic condensers in the set have been checked. They all take a good charge and show high resistance. The voltage and resistance values are all close to those specified in the manufacturer's data, and a check with an oscilloscope indicates only normal hum in the B plus.

The installation, which includes a folded dipole antenna with reflector, is in a weak signal area, where all residents in the neighborhood have poor reception. It occurred to me that perhaps a five-element Yagi would help. The trouble with this would be that it would severely limit the reception bandwidth.

Could the trouble be just normal hum in the receiver which shows up when the signal falls below a certain level? Or is it due to the type of antenna? Any help with this will be greatly appreciated.

—RTM—

Leotone Producing Special Magnets

NEW YORK—Leotone Radio Co. here has gone into production on specially-shaped Alnico magnets for radios and television sets.

The special service, which includes magnetizing the alloy and shaping to individual specifications, is in addition to the company's production of many standard shapes and sizes.

The company also maintains a "small orders" department, to fill requests from individual servicemen and other non-volume customers.

Trade Literature

→ from page 16

blers; high voltage rectifiers for TV; gas triode and tetrode relays; horizontal TV scanners; vertical TV scanners; high voltage single and duo-triode oscillators; general purpose triodes; and special purpose tubes.

Copies may be obtained by writing to: Advertising Dept., Sylvania Electric Products, Inc., Emporium, Pa.

—— RTM ——

RIDER TV MANUAL, VOL. 6

RIDER'S Television Manual, Volume 6, the latest in the series of television servicing data, is now in production, John F. Rider, Publisher, Inc., has just announced.

Scheduled for availability in March, the new volume takes up where TV Volume 5 leaves off. Factory-authorized servicing data from 66 manufacturers are included in the 12 by 15-inch book. About 600 models are included, covering the period August 1950-January 1951. The inclusion of a cumulative index for Volumes 1 through 6 makes all models quickly accessible.

TV 6 contains schematics, chassis views, voltages and resistance readings, alignment procedures, test patterns, waveforms, parts lists and parts values, boosters, tuners, and other information. It is priced at $24.00.

—— RTM ——

TUBE TESTERS

THE four RTMA groups of tube testers are illustrated and described in a new booklet published by Hickok Electrical Instrument Co., in Cleveland. Write to the company for full details.

—— RTM ——

SPECIAL TUBE DATA

A REVISED and enlarged edition of the RCA booklet, "Phototubes, Cathode-Ray, and Special Tubes," has been announced. This new booklet and its companion, "Power and Gas Tubes," together present a fairly complete line of tubes for communications and industry.

The book provides detailed technical data on more than 150 RCA tubes, including single-unit, twin-unit, and multiplier phototubes; cathode-ray tubes; TV camera tubes; TV monoscopes; low-microphonic tubes; uhf tubes, and other types for special applications.

Technical information, which is ar-

→ to following page

→ from preceding page

ranged in tabular form, includes descriptions, ratings, operating conditions, dimensions, base and envelope connection diagrams, and applications. Many representative types are illustrated. Additional data includes spectral sensitivity curves for all phototubes and information about the characteristics of cathode-ray fluorescent screens.

The pamphlet is available from RCA tube distributors.

—RTM—

VEHICULAR CAPACITORS

A CATALOG of new by-pass and feed-through vehicular capacitors for the suppression of radio frequency interference is now being made available to the radio industry by Cornell-Dubilier.

The capacitors are hermetically sealed and built to withstand extremes of vibration and shock. They are designed for operation over temperature range from −55°C. to +85°C. Non-inductive windings, with short internal connections, are said to provide low impedance over a wide frequency range for the units.

The units will be provided with several bracket styles, one of them for universal mounting. All have terminal studs with fastener screws.

The bulletin, which gives connection, mounting and other data, is available from Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

REPLACEMENT CONTROL CHART

THE "Adashaft" chart, a new aid to servicing supplied by Centralab, shows various shaft and switch-cover combinations which can be used for replacement controls.

Among features claimed for the chart is that it enables the technician to combine basic controls with particular shafts and switches efficiently. Printed on cardboard, the table is covered with a special durable coating. It may be hung on the wall near the service bench. Additional information on the chart may be obtained from the Centralab Division of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee.

—RTM—

TV EQUIPMENT CATALOG

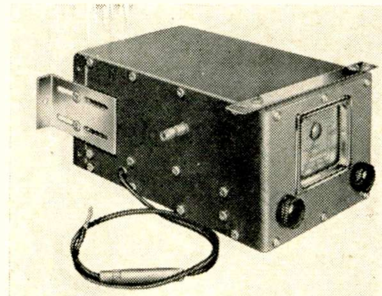
ALL new and current products of the Brach Manufacturing Co. are described in the company's new catalog, just released to the trade, according to Ira Kamen, director of TV Products.

The booklet is divided into two sections, one describing Brach TV antennas and accessories, and the other devoted to a discussion of the company's "Mul-Tel" system, a master TV antenna system for apartment house and other multiple-receiver installations. Except for minor accessories, where drawings are used for illustration, the descriptions of the line are accompanied by photographs of the products.

Products for the Trade

→ from page 17

Mc band, the receivers utilize whip antennas. The model M-51, the 30-50 Mc unit, is reported to be useful between 25 and 50 miles from the trans-



mitter, while the other receiver, the model M-101, will receive signals within a 10-mile range, the manufacturer states.

Each set uses five tubes plus rectifier and voltage regulator.

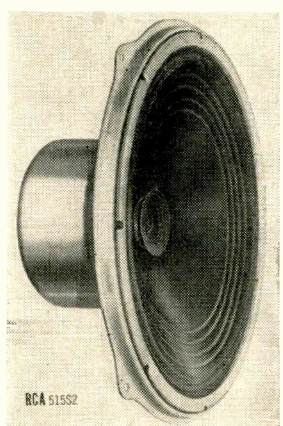
—RTM—

HI-FI SPEAKER

A new 15-inch "duo-cone" coaxial loudspeaker, designed for high-quality reproduction at both high and low-power levels has been announced by RCA. It is a direct low-cost adaptation of the LC-1-A speaker developed by Dr. H. F. Olson, acoustics authority.

The new speaker is of the permanent-magnet type, features high sensitivity between 40 and 12,000 cps, and is capable of handling 25-watt input. It is intended for use in high-quality radios, phonographs, television receivers and monitors, the company stated.

It employs a vibrating system consisting of a large cone and a small cone mounted so that, for all practical pur-



poses, the large cone is a continuation of the small cone.

A three-quarter-inch voice coil drives the small cone, while a two-inch coil drives the large cone. The small cone does not vibrate at the lower audio fre-

Association NEWS

PHILA. ASSOCIATION ASSUMES CONTRACTS

PHILADELPHIA—The Television Contractors' Association, of this city, recently stated publicly that it "has assumed the responsibility of maintaining service on unexpired service contracts issued by the now defunct firm, Weber's Television."

Claimed by the association to be an action without precedent in the TV servicing industry, the assumption of a member's contracts by the group was announced shortly after the member instituted voluntary bankruptcy proceedings.

After describing the illness of the firm's owner, the association said that its action was based on stand-by plans made several months previously. Through its executive secretary, Paul V. Forte, the contractors' group said it was forming plans to develop a pool of funds to be set aside for the purpose of guaranteeing all service contracted by members (see Editorial, RADIO AND TELEVISION MAINTENANCE, January, 1951).

In handling the contracts of the bankrupt company, the association will ask for proof of claims sent in by alleged contract holders.

The announcement said the group has been servicing the contracts of the member firms since the middle of January.

President Albert Haas of the association said he would press for "stringent membership requirements in the group."

quencies because of the high reactance of the coupling capacitor at those frequencies. This design eliminates need for a cross-over electrical network, the company said.

The magnetic structure of the speaker utilizes a single 2-pound Alnico-V magnet arranged with the pole pieces and yoke so that the magnetic paths form a bridge network to provide each air gap with equal flux density. Both air gaps are excited by the single Alnico-V magnet.

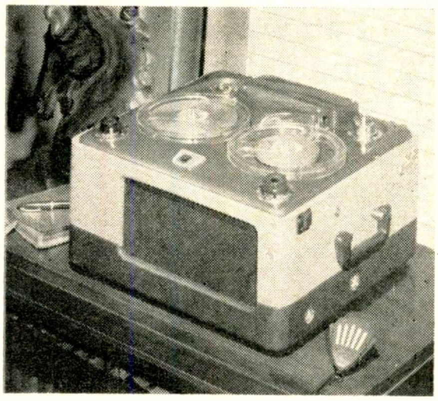
An additional feature of the speaker is the directivity, which is approximately uniform over the entire frequency range within a total angle of approximately 60 degrees.

—RTM—

NEW TAPE RECORDER

Webster-Chicago, manufacturer of record changers and wire recorders, has put a new tape recorder into production.

Able to operate at two speeds in both



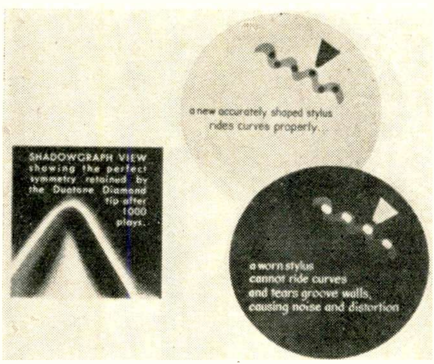
forward and reverse positions, the tape mechanism will record up to two hours on one reel, without turning the reel over, the company reports.

—RTM—

DIAMOND STYLUS

A new line of diamond phono stylus replacements, claimed to last 90 times as long as ordinary sapphire needles, is the Duotone series.

Pointing out that, in addition to lasting so long, thus saving money in the long run, the diamond tips actually protect records by staying smoother, the company says diamond styli "practically eliminate needle changes."



Available for most standard pickups, mounted in the holders required for each, the diamonds can also be ordered specially for special-type pickups. For this service, the pickup can be sent to the Duotone factory, where experts will install the stylus.

—RTM—

PREAMPLIFIER-EQUALIZER

Brociner Electronics is now marketing two improved versions of its Model A65 preamplifier-equalizer for magnetic phono pickups.

Called the A-100 and the A-100-P, the new designs provide an additional "turnover" step for low-frequency equalization of LP records, and increased gain (39 Db voltage gain).

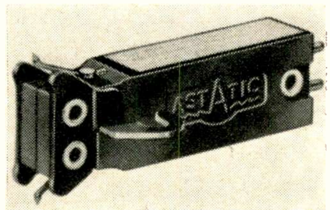
Screwdriver-adjusted gain control, and 20,000 ohm output impedance permit "use of longer cable for output without loss of highs," according to the manufacturer. The tube lineup includes a 12AY7 dual triode and a 6C4 for three stages of amplification. A selenium rectifier power supply is included in the Model A100P.

—RTM—

CERAMIC-ELEMENT CARTRIDGES

Astatic Corporation has announced that its miniature lightweight "AC" pickups are now available with ceramic elements as well as with crystal.

Said to stand up better than crystals under adverse conditions of humidity



and high temperature, the ceramic units are made with the same external specifications as the crystal pickups, although

→ to following page

the maintenance mill **by Ghyssels**

"Say, do you *have* to do all that testing?"

→ from preceding page
the output of the crystal models at about 1,000 cycles is one volt, with the Audiotone 78-1 and RCA 12-5-31V test records, as compared to the ceramic's output of 0.4 volt.

—RTM—

CONTROL ASSORTMENTS

Two kits of assorted controls have been announced by Centralab. Packed in metal cabinets to provide compact storage, the assortments each contain 22 controls, both plain and switch type.

The first kit, B-A, includes ½ and one-meg units, some with three-inch fluted mill shafts, some with 2⅛-inch split knurl shafts. The second group, B-B, contains assorted controls, all with standard three-inch fluted mill shafts.

—RTM—

AF Electronic Photo-Engraver

→ from page 13

pletely eliminate the problem. All of the usual steps had already been taken, such as good filtering in the power supply, decoupling filters for each stage careful dress of filament leads, DC bias voltage on filaments and separation of 110 V. leads from signal leads. This still did not remove all of the hum.

The difficulty was finally traced to the cabling running to the various units of the machine. There are two separate chassis, a scanner head, a cutter head, a control panel and an audio generator. All these units are connected by cables, which run up to 10 feet long.

It was found that *too much grounding* of the shielded signal leads was introducing hum by forming a closed loop with two chassis and the shielding in the loop. For instance, one particular case was a shielded cable running between the audio frequency generator and the pre-amplifier. The generator (an electro-mechanical gear tooth generator) is mounted on a heavy casting which also supports the drive motor.

The pre-amplifier is a separate chassis in a drawer compartment of the machine. The two units are connected by the metal frame of the machine, but the connection is not positive. The actual ground between the two chassis was the shielded signal lead, grounded at both the casting and the chassis. This resulted in the equivalent circuit with a hum voltage introduced to the grid of the first tube in the pre-amplifier. The solution was to bond the casting and amplifier chassis with copper braiding, and to ground the shielded cable at the amplifier only. This was done to all the long signal leads, and was found to reduce hum to the point where it no longer appears in the engraving.

Tube Replacement

A second service problem concerned a simple matter of tube replacement. A special purpose gas filled neon light with a very short life span is used in this particular application. Two are used in the engraver, one to produce the scanning light that falls on the photograph, and the other to illuminate the plastic to permit viewing the dots as they are being made. The difficulty in replacing this tube lies in the fact that it has to be positioned properly so that its light falls at the proper point on the photograph. At first, when a lamp failed, or became intermittent, a service call was necessary just to replace it. The operators of the engraver are usually newspaper personnel who have no electrical or mechanical training, and could not be depended upon to align the lamp properly. Otherwise, there was no reason why the lamp could not be changed by the operator of the machine, when the engraving showed the symptoms of scanner light failure.

A method was developed to allow the operator to replace the lamp without having to do any aligning at all. This was accomplished by mounting the tube and socket in a fixture that could be aligned and then removed from the machine as a complete unit. The method of adjustment was so designed that the alignment of the lamp was not disturbed when the fixture was removed from the scanner head. The pre-aligned lamp could then be snapped into place by the operator with no difficulty at all.

The general principles involved here could possibly be applied to replacing critical parts in other equipment. Where a very delicate adjustment has to be made in replacing a part, the unit should be made so as to permit pre-adjustment, and the replacement can then be made by untrained personnel.

Voltage Regulation

The engraver is especially sensitive to changes in line voltage, these changes showing up as an overall darkening or brightening of a portion of the picture. The point where the voltage change occurs thus shows up as a streak in the picture and is very noticeable.

Several attempts were made to provide voltage regulations built into the machine. It was found, however, that the best job can be done by regulating the line voltage input to the machine with an electronically controlled unit such as the Sorenson Regulator. In this way the input to the entire machine is controlled, and it is not necessary to provide separate regulators for plate voltage, motor and cutterhead. The regulation provided is far better than that of a voltage regulator tube on the plate supply or of a constant voltage transformer.

—RTM—

A Few of the Tough Ones

→ from page 12

struction it may be regarded by many as too inconspicuous to deserve a more than cursory examination. In television receivers, however, where the operating voltages are much higher than those encountered in conventional sound receivers, there are some interesting points which are worthy of closer study. Resistors, like condensers, should operate within specified voltage limits. A representative limit for a one-watt resistor is in the region of 500 volts.

Consider the case of a one-watt, one-megohm resistor. The safe voltage which can be developed across it is, from the representative figure, 500 volts, and the wattage dissipated at this voltage can be reckoned from the usual formula, $W = \frac{E^2}{R} = \frac{500^2}{10^6} = 0.25$ watts. So that in actual practice we are faced with the anomalous condition of a "one-watt" resistor with an *actual rating of only 1/4 watt.* If we want to increase this figure to one which approaches more closely the nominal one watt specified, we will have to exceed the safe voltage limit of 500 volts, which can result in the destruction of the resistor.

High Voltages

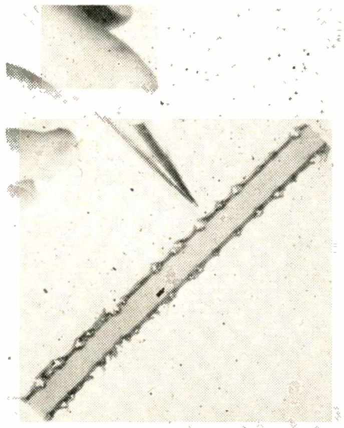
Suppose that in a television receiver we have a 5000 volt supply across a resistor chain. We measure the current flowing through the chain and find it to be .0006 amperes. If there is a one-watt, two-megohm resistor included in the network, the calculated dissipation is $W = I^2R = .0006^2\ (2 \times 10^6) = .72$ watt. Now the question is, whether the resistor is operating within the safety limits. The maximum permissible voltage is 500 volts. How about the actual voltage existing across it? From calculation it is $E = IR$. Using the information already available, this is $E = .0006(2 \times 10^6) = 1200$ volts!

Almost three times the safe maximum. Evidently such a resistor will not last very long in this position, even though its nominal rating is one watt and the actual dissipation is only 0.72 watts. The resistor to use here is obviously one with a nominal rating of three watts, which will have a safe voltage maximum above the calculated 1200 volts. A few simple calculations on these lines and a check on the voltage distribution and resistor ratings in any TV receiver will convince you on these points and bring home to you the very urgent need for careful choice of resistors intended for high voltage work.

Such resistor breakdowns are not experienced in ordinary broadcast receivers, because the voltages used do not reach such high values.

The troubles outlined here are, in a sense, not unusual. But in many cases the symptoms are misinterpreted. There are various indirect procedures which when applied to the particular cases will cure the trouble. Technically speaking, though, the apparatus is still faulty and cannot function correctly until the removal of the precise trouble is effected, although it may appear to be all right.

STRUCK BY LIGHTNING



A good argument for lightning arresters is this picture, taken by American Phenolic Corp., makers of "Amphenol" products. This line, struck by lightning, is completely ruined. The copper conductors were vaporized, and the polyethylene insulation was melted where it was in contact with the copper. According to the company, the entire line would have been destroyed if the conductors had been thicker.

—RTM—

Automatic Volume Control

→ from page 9

and a negative voltage (to use for negative grid bias) in the AVC system.

It is now evident that by connecting the control grid return of a variable-mu tube to the negative side of the AVC load, the bias on such a grid will

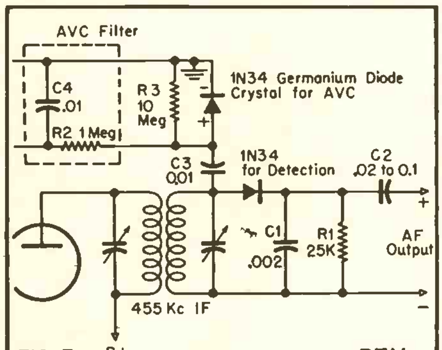


FIG. 3

increase when a strong signal generates a high negative voltage, and the amount of bias on this control grid will decrease when a weak signal generates a low negative voltage.

In the half wave AVC system, the usual IF transformer has only four leads, but in the full wave system, the transformer has five leads, three of them on the secondary, the center tap of which becomes the negative AVC lead.

AVC Distribution System

It is important to get the AVC voltage to the control grids of the variable-mu tubes so that it will operate properly.

There are three significant elements in the distribution of control voltage: voltage, filtering, and time-constant factor.

1. Voltage Distribution: Consider the cathode bias for the RF and IF tubes in a typical receiver using AVC. The cathode resistor raises the cathode about 1½ volts above ground potential. Thus the cathode is positive with respect to ground. When no signal is impressed on the control grid, the grid is biased positive also about 1½ volts, or the same as the cathode bias. To be sure that the RF, first detector, and first IF stages also have negative grid bias, a cathode resistor is connected to ground for each tube, giving a positive cathode bias of approximately 1½ volts.

The values of the cathode resistors for these tubes depend upon the tube used as well as the plate and screen grid current requirements. The bias voltage required in the AVC distribution system should be figured on the basis of this positive cathode bias.

We can calculate the bias voltage required in this distribution system on the basis of the following needs: A. About 1½ volts to cancel out the 1½ volts of positive potential applied initially; B. About 1 volt for minimum grid bias; C. About 2 volts to take care of gas and grid emission, which would buck out an equal amount of grid bias. This makes a total of about 4.5 volts; each cathode should be raised above ground potential that much. Note, however, that for maximum sensitivity a lower bias is sometimes used, while in some cases, a higher bias voltage may be applied to eliminate excessive gain.

2. Filtering: The filter is usually composed of two sections. The second section is made up of resistor R_3 (one or two megohms, depending upon the time-constant chosen) and a 0.05 mfd condenser, C_9, as shown in Fig. 2.

The value of the diode load resistor is usually about 500,000 ohms. In addition to the DC negative bias voltage appearing across this resistor, there is an AF voltage also present. The AF voltage is coupled to the grid of the first audio tube. Note that the AF voltage is applied across resistor R_4, which is usually about 50,000 ohms. It would be possible for this voltage to feed back to the grids of the tubes in the stages preceding the second detector, if provision were not made to prevent the action. This would be more likely to happen at low volume levels than at high volume levels. To prevent the feed back, the resistor R_3 combined with C_9, the second section filter, is incorporated. R_3 is made at least one megohm in value. It is larger than R_4 or R_5, in order to prevent trouble resulting from coupling between the second detector and any of the preceding tubes in the circuit.

The resistors which feed the AVC, or grid return lead on the transformers are usually 100,000 ohms. Note that the IF stage immediately preceding the second detector does not have any resistor in series with the AVC distribution bus and the AVC lead on the transformer secondary. The condensers which bypass the AVC bus to ground prevent RF and IF voltages from feeding back to a preceding stage. But since these condensers also complete tuned circuits to ground, they may not be too small, or some of the tuning range is likely to be sacrificed. The value of these condensers is between 0.01 and 0.05 mfd.

3. Time-constant Factor: Heretofore, not much attention has been paid to the time-constant factor in the AVC system, but many servicemen know something of it at first hand, for they have repaired AVC systems and found that the signals stopped for an instant after a burst of static. AVC has a definite time lag. The resistor R_3 and condensers C_5, C_6, and C_9 must have values small enough that it will not require too long a time for the AVC voltage to charge the condensers through the resistor.

As a general rule, when R_3 is one megohm the condensers may be as high as 0.05 mfd., but when R_3 is two megohms the values of the condensers should not exceed 0.02 mfd., to keep the time lag within reasonable limits.

It is important to know the fundamental theory of operation in order to replace parts correctly. The fundamentals about time constants may be stated as follows:

1. The time constant is the time it requires for a condenser to assume a

charge of 62.5% of the applied voltage. The length of time to charge a condenser does not depend upon the applied voltage, but rather is determined by the size of the condenser and the amount of resistance in the circuit.

2. The length of the time constant is measured as the product of resistance and capacitance.

3. Any resistor and condenser in series may be used as a timing device.

This R-C combination reduces the speed with which the AVC circuit works. Without this circuit in the AVC system the volume could be reduced so rapidly that a person's voice or music might be blotted out. The speed at which the AVC reacts is reduced to a fraction of a second by the R-C network.

In some communications receivers high speed AVC is used to reduce the effect of static. Here the AVC operates so rapidly that the effect of a crash of lightning is dissipated before it reaches the loudspeaker.

Use of Germanium Diode

One of the latest, and quite important, circuits is that shown in Fig. 3. This uses one of the germanium diode crystals for AVC. Since the use of these crystals may be new to some readers, the circuit is completed to show an IN34 crystal used for detection also. Fundamentally, there is no difference between this crystal circuit and a diode tube circuit. But there are important differences in the performance and maintenance of such a circuit. Note these features of the use of the germanium diode: No mounting hardware is necessary because the crystal is about the size of a resistor and can be connected point to point. There is no contact potential, as there is in a tube, nor the associated capacity. Finally, there is no filament voltage to be supplied. The crystal can carry a current of 40 ma and will have an average life of more than 10,000 hours.

Component Functions

The lead that feeds the AVC voltage to the controlled tubes is known as the AVC bus.

This bus goes directly to the grid return of the first IF stage at the output of the second filter section without any series resistor. The lead from the AVC bus to the RF stage and the converter stage goes through a decoupling filter made up of a 100,000 ohm resistor and an 0.05 mfd condenser. These components isolate the RF and mixer stages from the other stages and from each other.

Decoupling filters are important. Whenever two or more stages are operated from the same voltage supply, there is the possibility that there will be coupling between stages through the common power supply lead. Common supply leads are quite frequent in radio circuits, but there may be coupling in the plate circuit as a result of the common B+ power supply. In cathode circuits, individual self-bias resistors are used to avoid interstage coupling. Decoupling filters are also used in screen circuits to avoid coupling in the common B+ power supply. Here we are concerned with decoupling filters in the grid return circuits of the RF and mixer stages to avoid coupling in the common AVC bus.

A decoupling filter in the grid return of RF and converter stages is never omitted. In receivers which do not employ an RF stage there are fewer stages having a common coupling component, and, since the possibility of regenerative feedback is less, the decoupling filter may be omitted. Cost dictates this more than engineering design does.

The decoupling filter components are really standard. They are always made up of 100,000 ohm resistors and 0.05 mfd condensers.

Troubles in the AVC System

The voltages and currents in the AVC circuit are so small that the resistors seldom burn out. Condensers, also, rarely cause trouble, since they are usually molded bakelite with a mica dielectric. Mica condensers seldom leak.

The AVC circuit develops a biasing voltage which can be checked by a voltage test. This measurement must be made with a vacuum tube voltmeter, because this is a low voltage high impedance circuit.

The second section filter condenser sometimes opens or begins to leak. The signal becomes weak and sometimes oscillations are set up. The gain of the IF stage becomes abnormally low; tuning is very broad, and the trimmer on the secondary of the transformer becomes ineffective. There would be distortion on strong local stations, and reducing the setting of the manually operated volume control would have little

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effect on the distortion. Replace the condensers with one of the same capacity and preferably of a higher voltage rating to keep any possible leakage resistance large.

The resistors in the decoupling filters rarely cause trouble, but the 0.05 mfd bypass condensers for these resistors may. When these condensers open or leak these are the symptoms; reception may be weak; trimmer condensers do not produce a peak; the noise level increases and strong local stations come in as a weak station would during normal operation; the receiver may overload and distort. If an external antenna is used and the sound improves when this lead is disconnected there are undoubtedly leaky condensers in the AVC system, possibly in the decoupling filters.

Of course the tube is the most likely source of trouble and should be checked first.

The serviceman who learns to look for and to recognize these symptoms will have little trouble with the AVC system in a typical radio.

—RTM—

FM Alignment and Equipment

→ from page 11

is the single straight line illustrated. The AM generator is connected in parallel with the sweep generator, and the center of the curve is adjusted to lie at the IF value. The extremes of the curve should now fall at 100 Kc. above and below the IF. A series of short lines parallel to the curve proper, at the extremes, may be observed; these are the result of the oscillator's slipping out of the lock-in state and returning to its natural frequency, when the frequency deviation becomes too wide.

Gated-Beam Detector

The gated-beam FM detector, the newest and probably the least used of all the FM demodulators, uses the principle of the gating tube to provide on-off operation in the circuit, thus providing limiter action.

In this arrangement, a novel control, the "amplitude modulation rejection control," is incorporated. This control, which is a 1000 ohm variable resistance included in the cathode circuit, varies the cathode bias, so that the limiting or saturation level can be fixed at a desired point.

Illustrated here are the 'scope patterns obtained with correct adjustment of the associated components, and with off-frequency settings of the adjusting screws, together with the response when AM is present in the signal. Since the set used for the pictures was an intercarrier type TV receiver (a Tele King), the IF generator, a Measurements Corporation IF adapter used with the same company's 78FM signal generator, was set to produce a 4.5 Mc signal, and the swept signal was put into the receiver's video output stage.

General

In general, then, alignment of FM circuits can best be accomplished visually, using sweep and marker generators, and an oscilloscope. It is possible to do the job fairly well with only an AM or cw generator, if it covers the proper frequencies, but much time can be saved if the visual method is employed. Besides, the technician who is able to see the exact response he is getting on the 'scope, knows whether the set has proper linearity, and he knows what irregularities may be present due to slightly incorrect circuit values. At least one important time saver which results from the use of visual alignment is the fact that loading networks are not needed when the entire response curve is shown, on the IF stages. For RF stages, however, the AM generator should be used, since single-peaked coils are utilized in these sections.

—RTM—

Audio Amplifier Service

→ from page 8

not, mismatch in tubes and/or grid bias is indicated (a very frequent cause of distortion).

Choose an equal pair of output tubes, with an emission checker, and install them in the amplifier, then correct any final unbalance by inserting in the cathode leg of each tube a milliameter and adjusting the cathode resistors for equal readings. Some amplifiers already incorporate a screw-driver adjustment for this purpose. If not, it pays to take the time to install a potentiometer whose outside legs are connected to the low potential end of the cathode resistors and whose center leg is grounded, as in Fig. 1.

Having completed tests of the output stage, work backwards to the input, in a stage-by-stage, component-by-component fashion, clearing up difficulties on the way. As you can see, it is very much like trouble shooting a completely dead radio.

Rigorous Use in PA

It may be well to mention at this point that a PA amplifier generally receives pretty rigorous use and a breakdown can sometimes prove extremely embarrassing to its owner. The service man, therefore, must trouble shoot them

→ to following page

— RTM —

Fix On the Facts

→ from page 15

sistent hum can get on the nerves quite badly.

Precautions Against Hum

When building or servicing an intercom amplifier, all of the usual precautions against hum should be taken—plus a few more. A good choke, rather than a resistor, should be used in the power supply, and the filter condensers should be large and in good condition. Care should be taken to place the filament of the voltage amplifier tube at the ground end of the filament string so that the cathode to filament potential will be at a minimum. Coupling condensers should never be larger than .01 mfd., and even smaller condensers will often help attenuate the 60-cycle frequency. Grid leads should be carefully dressed away from those carrying AC. It will often be found that substituting different tubes will reduce the hum, even though the ones removed show no defects on a tester.

You might think that using a transformer instead of the transformerless arrangement would aid hum-reduction because of the more easily filtered full-wave output of the rectifier; but this is not the case. The input of the intercom amplifier is through a special transformer that couples the voice coil of a speaker to the grid of the first tube, and this transformer is very sensitive to inductive pickup from any inductance carrying AC, such as a power transformer primary. Tests made by the present writer showed that a power transformer placed as far as three feet away from such an input transformer can produce a very noticeable hum.

Ordinary Shielding Useless

Ordinary shielding is practically useless against this low-frequency inductive field. Mu-metal, the material from which cathode ray tube shields is made, would probably be effective; but is is much simpler to dispense with the transformer. However, this source of hum should be kept in mind, and the intercom amplifier should not be located near such devices as electric typewriters, electric adding machines, transformer-type radios, etc.

Potential faults in intercom units fall into the usual tube, condenser, and resistor troubles, plus an additional amount of mechanical failure of the switches used so lavishly in these gadgets. The pushbutton switches often used to select the various sub-stations frequently develop dirty and corroded contacts. These can usually be restored to working condition by means of a good cleaning with carbon tetrachloride. The TALK-LISTEN switches suffer from the same trouble; and, in addition, the springs of the spring-return mechanisms frequently break. If you can secure some of these simple springs—or make them from piano wire—it will not be necessary to replace the whole switch each time one of the springs breaks.

Once you sell and install a few complete inter-communication systems, you will find that maintaining this equipment provides a steady, lucrative, and easily-earned source of income. So why don't you sit down right now and order descriptive literature from several intercom manufacturers so that you can decide what you are going to stock?

→ from preceding page

carefully, using parts with a generous overload capacity to anticipate trouble before it starts.

Hum, Oscillation, Distortion

The amplifier that hums, oscillates and distorts can turn into some of the most aggravating work the service man faces, but it must be remembered that any difficulty, no matter how obscure, will always fall before the onslaught of a logical trouble shooting procedure.

First of all, before looking for hums you must make sure that your test equipment does not introduce or pick up extraneous hum. This last precaution is particularly important with regard to oscilloscopes. In Fig. 2, note the constructional details of a practically hum-proof 'scope probe. If your 'scope is not equipped with connectors having the standard G. R. spacing (0.75 inches), or with a coaxial connector, it will be necessary to equip it with one. Failing that, use the shortest possible length of unshielded cable at the present connectors.

The next step is to determine whether the hum is 60 or 120 cycles (the result of full wave rectification).

To do this connect your 'scope to a source of 60 cps and adjust your time base and synch. controls for a single sine wave, then connect your 'scope to the output of the amplifier. If you get a single wave, the amplifier is suffering from 60 cps pickup; if two waves, the hum is 120 cps probably coming from the power supply. Generally speaking, this is due to insufficient filtering, and the remedy is obvious.

Poor Shielding

If you find the hum to be 60 cps operate the input gain controls. If the hum level varies, it's a safe bet that the input circuits are not properly shielded or that the shield ground bond is ineffective due to poor soldering or a ground loop. To cure a ground loop, bring all your grounds to one central point and bond this to the chassis.

Oscillation is, of course, the result of positive feedback. The coupling can take place between two unshielded leads carrying voltage in the same phase or, more likely, across the power supply impedance. The remedy is again obvious—the leads can be spaced differently or shielded and the power supply impedance can generally be brought back to normal by replacement of the filter and/or decoupling condensers of the offending stages.

Distortion is a subject so complex that it would take books to cover it. The handiest thing for checking distortion is an oscilloscope. For precise quantitative distortion analyses, a harmonic analyzer is a necessity. In checking the distortion of an amplifier, connect it to its dummy load, run it wide open and feed a signal into it great enough to develop its maximum rated power output. Then check it stage by stage with the 'scope for the amount of distortion introduced in each stage. I recommend that you refer to the "Encyclopedia on Cathode-Ray Oscilloscopes," published by Rider, for descriptions of oscillographic representations of distortion. The most frequent cause of distortion is bad grid biasing. Remember that distortion adds in quadrature, that is, the square root of the sum of the squares.

—RTM—

Square-Wave Analysis Of Audio Equipment

→ from page 7

substandard in the vicinity of the fundamental frequency of the square wave. In 2-D, the low-frequency response is good in the region of the fundamental but there still is evidence of phase shift.

In Fig. 2-E, rounding-off of the corners of the pattern reveal dropping-off of response at high frequencies. In some instances, the vertical lines of the pattern are tilted as well. Figure 2-F shows some high-frequency improvement.

The dips in the horizontal portions of the pattern in Fig. 2-G indicate attenuation of a single frequency or a band of frequencies. The bandwidth of frequencies attenuated is proportional to the width of the dip along the horizontal trace. Response of this kind might result from the deliberate introduction into the test circuit of a band suppression filter. It might be caused also by various circuit constants which interact to set up a phantom band suppression circuit.

The opposite condition is shown in Fig. 2-H. In this pattern, a frequency or band of frequencies is accentuated or emphasized. This condition might be expected to result from the deliberate introduction into the circuit under test of a bandpass filter, or it might arise from the accidental interaction of various circuit components acting in a way to establish a phantom bandpass subcircuit.

A damped wave oscillation appears along each horizontal trace in the pattern given in Figure 2-I. This oscillation usually occurs at the frequency of a resonant peak in the system under test. Such peaks are encountered in transformers and also in amplifier circuits.

While the patterns given in Fig. 2 are by no means the only ones which may be encountered in square wave testing, they are representative. Other distorted square wave shapes may be referred to these basic figures for comparison and analysis.

Additional Notes

1. A square wave may be viewed as a combination of a large number of sine waves of different frequencies. The square wave accordingly contains numerous harmonics and may be regarded as the equivalent of the same number of separate signal generators all working at the same time into the circuit under test. In many instances, the response of a circuit to this type of wave is more indicative of its overall performance than its amplitude-frequency response curve.

2. Numerous circuits have been offered in the literature for conversion of sine waves (derived from an audio test oscillator or the power line) into square waves for test purposes. The simplest of these circuits are the diode-type *clippers* or *limiters*. Not all such circuits produce good square waves. The best such square wave "converters" are the multivibrator type and the diode clipper followed by a saturated pentode or triode. Several commercial audio signal generators, such as the one described here, have provision for variable-frequency square wave, as well as sine wave output.

Test Frequency Selection

3. When making a complete square wave test, select at least one fundamental frequency which is as low as the lowest frequency of interest in the circuit under test. Also, select at least one fundamental frequency which has an odd harmonic (preferably not greater than the 9th) coinciding with the highest frequency of interest in the circuit under test. Select enough additional

→ to following page

test frequencies so that odd harmonics will occur at each frequency of interest throughout the entire response band of the circuit.

4. Always employ an oscilloscope which itself has good frequency response. Otherwise the test will be meaningless. Prior to making any other test, feed a known series of square waves into the vertical amplifier of the oscilloscope and observe critically the squareness of the waveform reproduced on its screen.

5. When preparing a transformer for a square wave check, terminate both primary and secondary windings with non-inductive resistors having the same ohmic value as the impedances into and out of which these windings normally operate.

Video Amplifier Response

6. The response of video amplifiers may be checked by the square wave method. However, it is only the lower-frequency response which will be appraised. The highest frequency involved will, for reliability, be perhaps not much higher than the ninth or tenth harmonic of the fundamental square wave frequency. Satisfactory square wave generators to cover the higher frequencies passed by video amplifiers are not offered at the present time. When testing a viedo amplifier, terminate the latter with the kinescope tube circuit into which it normally will operate, or with an equivalent network.

7. The effective, practical frequency range which may be considered to be covered by a square wave test extends from 1/10 of the fundamental frequency of the square wave signal to 10 times the fundamental. The sinusoidal response of the system under test must extend from 1/10 to 10f in order to transmit the square wave faithfully.

8. Blanking pulses may be applied readily to a square wave pattern, for timing and other purposes, by modulating the control grid of the cathode ray tube with the impulses. The impulse repetition rate must be higher than the fundamental frequency of the square wave signal. For sharpest blanking action, the pulses must be narrow (preferably spiked in shape), although somewhat less distinct blanking may be obtained with a sine wave Z-axis signal. The blanking dots or spaces appearing along the square wave pattern may be used for timing purposes or for identifying various portions of the trace.

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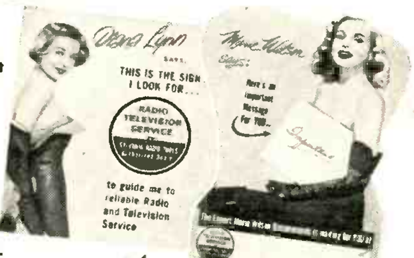

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