1933

MODERN RADIO

EDITED BY ROBERT S. KRUSE

CONTENTS

Now 15¢ Everywhere

All rates reduced to correspond

March Number 21 20 cents

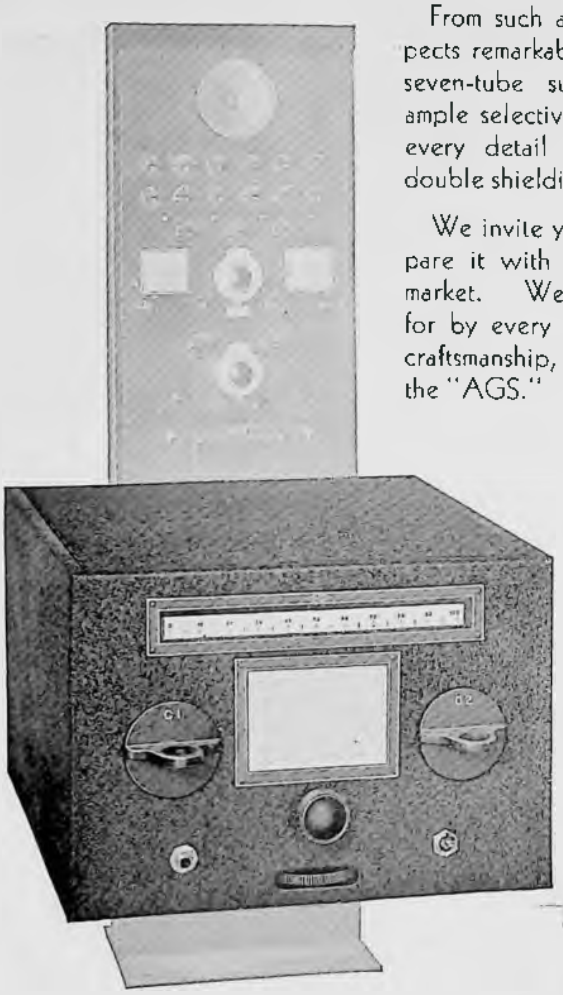
A NEW NATIONAL

THE FB-7

Designed specifically for the amateur, but embodying professional design details, this exceptional receiver offers a number of unusual refinements. Strictly single-control tuning and front-of-panel coil changing for swift and convenient operation —full vision dial and panel-mounted calibration curves for fast logging — efficient — compact — and inexpensive.

From such a receiver, National-built, one expects remarkable performance — and gets it. A seven-tube super-heterodyne circuit provides ample selectivity and high gain. And quality in every detail from Litz-wound transformers to double shielding provides reliability and stability.

We invite you to inspect the FB-7 and to compare it with any other H. F. Receiver on the market. We are confident of your approval, for by every nicety of design and mark of fine craftsmanship, the FB-7 reveals its heritage from the "AGS."



THE "AGS"

is shown in the background of the FB-7 in a complete rack-panel installation. Panels from top are speaker panel, spare coil panel, "AGS" Commercial Type Receiver, T. R. F. Standby Receiver, and Power Supply.

NATIONAL
PRECISION
RADIO PRODUCTS

H. F. RECEIVER

FB-7
SPECIFICATIONS

THE CIRCUIT

- 7 tubes; one 57, two 24's, two 58's, one 56, and one 59.
- Electron Coupled Oscillators.
- Separate Oscillator for CW beat frequency giving "semi-single signal" or "offset" tuning.
- High efficiency Litz wound IF Transformers.
- Class A Power Pentode Output.
- R-39 Coil Forms with grounded metal shield handles.
- Band Spread Coils available for 20, 40, 80, and 160 meter amateur bands, each covering 100 full dial divisions.
- Standard coils for continuous coverage from 20 MC to 1500 KC.
- No frequency drift.
- Double Shielding.
- May be used with either conventional antenna or "doublet" with transposed transmission-line lead in.

THE CHASSIS

- Single Control Tuning (No trimmers.)
- Full Vision Dial with SFL 270° (Condenser.
- Front-of-panel coil changing, without disturbing shielding.
- CW Beat Oscillator Switch on panel.
- Front of Panel Switch for "cutting" B voltages during transmission.
- Phone Jack, connecting ahead of final audio stage.
- Calibrated Volume control located under tuning knob, for one hand operation.
- All fixed adjustments, such as I. F. peaking, accessible from top without removal of chassis from cabinet.

SINGLE SIGNAL OPERATION

- Both the circuit and the chassis layout have been designed for ready addition of mechanical filter (quartz crystal) when desired for full "single signal" operation.

Your distributor will be glad to show you the new National FB-7. The list price, equipped for 80 meters, less tubes is **$55**

THE POWER SUPPLY

- May be operated from a filament transformer and B batteries; the new National 5887 low price Power Supply, or the standard National 5880 Power Supply (as used with the SW-3), R. C. A. Licensed.

NATIONAL CO. INC., 61 Sherman Street, Malden, Mass.

Please send me full particulars on the new NATIONAL FB-7 Ham-Band H.F. Receiver.

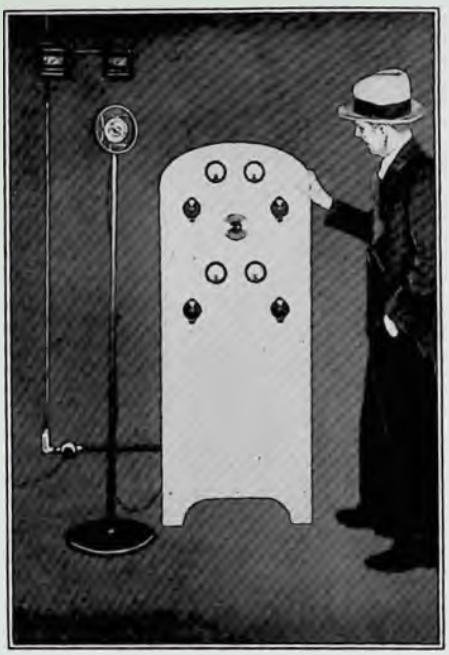
Name _____

Address _____

The Toth Unit-type Transmitter

A Voice and C.W. Transmitter Without Batteries

• • •



The Transmitter and its builder, L. E. Toth.
This may be a 10, 20, 60 or 100-watt set—wait and see.

So many transmitters have been described that there must be definite advantages in a new type if it is to deserve description. The Toth unit-type transmitter offers such definite advantages. Electrically—and financially—it has the merit of requiring no batteries at all, and of using principally receiving tubes, none of which is run in a manner which will result in unsatisfactory life. Mechanically it has the very shining advantage that it is assembled in simple units, any one of which may be removed and bench-tested without unsoldering a single joint! What a difference THAT makes!

In describing the transmitter it will be simplest to go first through the radio system, then through the audio system, and finally through the mechanical structure.

For the present we will talk about a low-power form of the set.

The r.f. System

The r.f. system is very simple and consists of a crystal-controlled pentode oscillator, a triode buffer (sometimes neutralized) and a screen-grid output tube.

The oscillator is not altogether orthodox as the general diagram will show, but has been thoroughly tested during a year's operation under various conditions and found somewhat more stable than the usual type, particularly where line-voltage variations are encountered. This is due to the manner in which the negative bias and the positive (screening) grid voltage are applied. While the advantage is not large the circuit happens also to be very simple.

The buffer is fed from the top of the oscillator tuned coil through an AIR condenser C2. The air condenser is used because its very high leakage resistance prevents the oscillator plate voltage from reaching the buffer grid more effectively than do some mica condensers. At the same time it permits easy adjustment of the feed. The buffer may be either a 45 or a 10, with the proper filament supply. If the crystal works at the same frequency as the output stage this tube must be neutralized by means of C3. The buffer receives a part of its bias from R7 (autobias) and a part from the gridleak R5, the former acting as a safety device to prevent excess current, and the latter as an automatic adjustment to equalize results at different frequencies.

The output tube is fed from the buffer in a manner similar to that just mentioned, but in this case the bias is derived altogether from the gridleak, as this was found to give slightly better modulation linearity.

The obvious disadvantage of this bias scheme is that if the oscillator or buffer

misfire or be badly mistuned, the tube is left without bias, but with plate voltage. The method of screen-voltage feed shown will prevent damage to the screen, but rather severe momentary heating may take place with a theoretical possibility of damage to the 865 filament. Since autobias would tend to lower the amplification by degeneration there are three obvious safety devices. One is to put a battery bias in series with R8—which seems too much like admitting defeat. Another is to provide a C substitute which seems like too much complication for a small transmitter. The third is to provide an indicator which will show whenever the stage for any reason "goes off the reservation." This device belongs in front of the operator—not on the panel. It is idiotically simple—the "plus 500" supply does not go directly to the 865 tube but is run in "ignition secondary" cable to a miniature socket on the operating table. In this socket is a 6-volt dial-light shunted by a 200-ohm rheostat adjusted to make the lamp dull red when everything is normal and one is not talking. When talking the lamp flickers —if something goes wrong the lamp blinks and the filament vanishes. 10c is much less than the price of an 865, even in 1933.

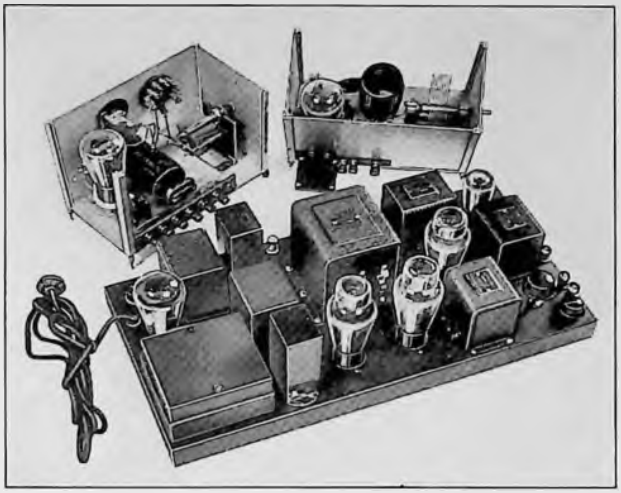
Keying and Modulation

Modulation up to 100% with voice is provided by the audio system which terminates in a pair of the 2A3 triodes, delivering 15 audio watts through a National BM output transformer. This transformer, incidentally, has also a low-impedance secondary winding so that it may be used for feeding a bank of loudspeakers, when used for public address work.

When modulating the 865 it is necessary to modulate BOTH the plate and the screen, else the modulation will not be linear.* For this reason, as well as for safety (see above) the screen voltage is supplied through a dropping resistor R4, from the modulated plate supply and the screen-bypass is only an r.f. bypass—not a large condenser.

*"Modern Radio" for December, 1931, p. 9, also "Modern Radio" for January, 1933, p. 9.

See p. 30, this issue.



THE OSCILLATOR, BUFFER AND MODULATOR UNITS

The oscillator at upper right is built in a "Blan" shield, the crystal holder being plugged into the side of the shield. Below this is a row of 6 binding posts providing for filament (the centertap resistor is external), also the screen and plate supply of the 47 oscillator and the output tap. Between the inductance and the 47 is seen the screen bypass; behind the tube is the pair of autobias resistors.

The buffer at upper left (also in a Blan shield) is here shown with a '10 tube instead of a 45, either being useful with only a change of filament voltage. On the end wall is the tuning condenser, on the side wall the neutralizing condenser and tap switch. The tube-socket, like that of the oscillator and final tube, is of isolantite. The plate stopping condenser is near the end of the coil, the filament bypasses nearest the reader. The 6 binding posts (reading from the right) provide for output, plate supply, connection to external bias resistor, and filament supply and centertap. The audio system in the foreground is described elsewhere in this issue.

The Unit System Starts to Work

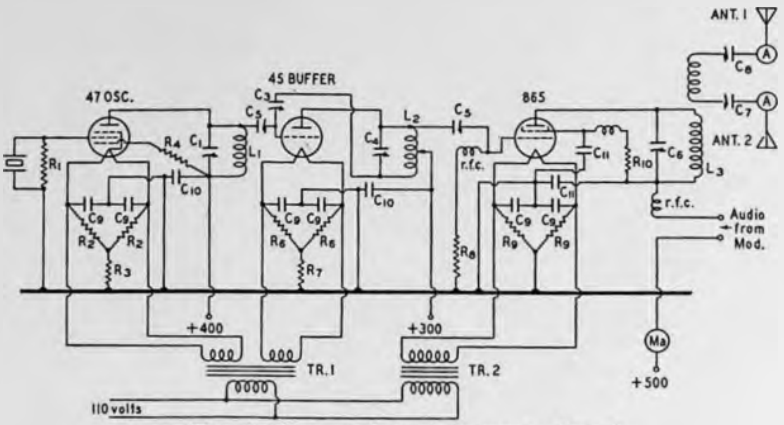
If the transmitter is to be used for telegraphy the audio input posts are not necessary and the audio unit is quietly omitted—the panel looks exactly as before. The circuit change is a small one and is explained under the diagram. Note that it adds not even a pair of binding posts—one may borrow those intended for "audio input."

As one of the illustrations shows, the audio system comes out as a unit, and in fact it is described as such elsewhere in this issue. In the particular set shown here the 110-volt supply for this unit came from a socket controlled by a snap-switch at the operating desk, but there is no reason why this socket cannot be placed inside the transmitter frame and

controlled by a switch on the panel.

The Oscillator Unit

The oscillator unit is in a 3″ by 7″ by 9″ "Blan" can which has had a trick played on it to permit handling it as a unit. The screws holding the bottom are removed and replaced by 2″ headless machine screws. The bottom is then slid on over these screws and held by a nut on each screw. A 1″ spacer and another nut are now put on each screw. The whole thing is then set on the shelf the screws going through drilled holes and being held by a nut and lock washer underneath if desired. All connections go to the binding post strip shown in the photo but R2, R2, R3, and R4 are UNDER the shelf so that their heating will not tend to cause drifting of the frequency. The BM National dial driving the tuning condenser C1 must not be "hot" therefore it carries only a "stub" shaft about 1½″ long which is pinned into a bakelite coupling (see photo of rear of set) and this in turn holds the condenser shaft with the aid of a set-screw, so located as to be readily loosened when the unit is to go in or out. Incidentally all the dials in the set have such couplings.



The circuit as used for low power. Part 2 gives all constants and dimensions, also details of operation and a variety of circuit variations permitted by the "Unit-type" construction.

TO BE CONTINUED

There will follow full details as to the unit construction behind the panel, with constants and dimensions for each band, also operating instructions and finally a new sort of flexible output stage—a real surprise, we think.

Editor ROBERT S. KRUSE
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Published Monthly by
MODERN RADIO CO.
101 Allyn Street
Hartford, Connecticut

Business and Advertising Manager N. T. YOUNG
Tel. 5-2733

Contributing Editors—BOYD PHELPS, R. R. BATCHER

Advertising and Subscription Representative for California, Washington and Oregon, DON C. WALLACE, 4212 Country Club Drive, Long Beach, Calif.

Entered as second class matter at the post office at Hartford, Conn. (permit application pending), June 20, 1931, under the act of March 3, 1879. Yearly subscription $2.00 in U. S. only, $3.00 in foreign countries including Canada. Single Copies, 20c.

The FB-7 Amateur Voice . . . . and C.W. Receiver

By Dana Bacon

THE FB-7 TRANSMITTING AMATEUR'S RECEIVER

The finger-height tuning and volume controls are unique. The AGS style plug in coils add to operating convenience. Grounded metallic coil handles complete the shielding.

The continuous-range tuning chart shown is readily replaced by the bandspread chart. The phone jack has been moved from the position shown to make room for the send-receive switch.

The receiving needs of the transmitting amateur are too specialized to be met by adding extra dials or special coils to a receiver intended primarily for commercial reception or home entertainment. This fundamental fact underlies the shortcomings of most of the present receivers, when viewed from the standpoint of the transmitting amateur, whether he uses voice or key. In undertaking the design of a new amateur receiver the first step was therefore to consider the special needs referred to, and to decide what they demanded of the designer. Omitting those that bear only on minor points there remains the following formidable list:

1—One-handed tuning, with the same station always in the same place on the dial.

2—No auxiliary controls, but wide bandspreading.

3—Extreme selectivity, even to the extent of receiving but one sideband of a voice signal.

4—Freedom of blocking by thumps or static splashes.

5—No tuning effect from the antenna.

6—No uncontrolled tuning effects such as frequency creeps, or vernier-tuning by a volume control.

7—Humless headset reception.

Taken together these constitute a large order, and on examination they are found to disqualify all existing receivers. Furthermore, one may fairly add as occasional requirements:

8—Ability to receive between the bands if desired at any time.

9—Ability to change from c.w. to voice or the reverse.

The Designer Begins

With this list before him it was apparent to the designers that requirement number one was a true one-handed single-control receiver with a one-handed method of band-shifting. Careful testing having cast little light on the possibilities of low-loss range-changing switches it was felt that it would be folly to discard the highly developed plug-in coils used in previous receivers, and there were retained—with the main shortcoming removed by plugging them in through the front panel as in the AGS receiver. The provision of a true single control, as in the other receivers in the same line, was of course felt to be desirable if at all possible, and in the final design it was not only found possible to do this but to fulfill the exceedingly bothersome requirement (Number 5 in the list) of avoiding all tuning effect from the antenna.

The Choice of the Circuit

So far nothing but the front panel had been settled. As soon as requirement 3 for extreme selectivity, and re-

quirement 4 for freedom from blocking were considered, the choice of the superheterodyne was unavoidable. The anti-blocking problem had previously been worked out in the SW-5 and the SW-58 receivers with results most acceptable to amateurs, but it was virtually certain that more could be done with the superheterodyne. As to selectivity, there was of course no doubt at all.

The Circuit Details

By reading down the list from this point on one will see that the other requirements are only to be answered in the process of design by suitable circuit details. We must accordingly go to a somewhat point-by-point discussion from here on, knowing that the set will be some type of specialized band-spreading superheterodyne with but one tuning control of any sort—either deliberate or accidental!

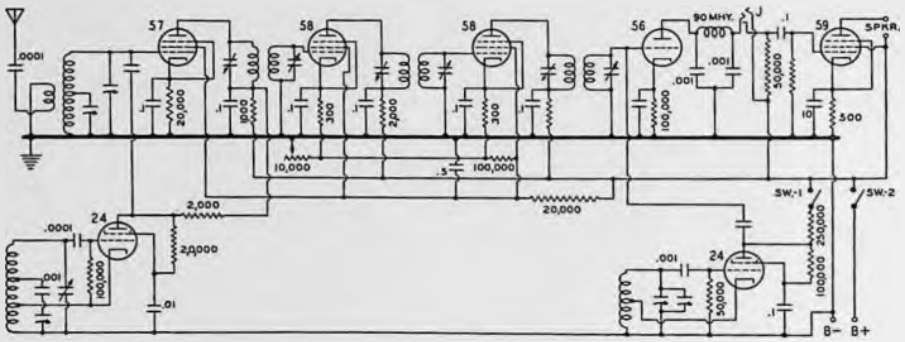


Fig. 1. The Unusual FB-7 Circuit.

The FB-7 receiver uses, as its name implies, 7 tubes:

First detector or mixer	57
First (high freq.) oscillator	224
First and second i.f. amplifiers	58
Second detector or demodulator	56
Second (beatnote) oscillator	224
Output tube	59

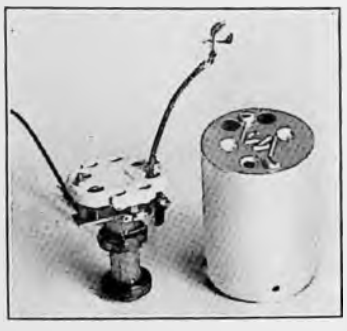
The circuit will now be followed through these tubes, showing why the somewhat unusual tube-array was used.

The Antenna Coupling

Before reaching the first tube the signal passes through the antenna coupling. Here—if at all—is the place to avoid antenna tuning effects. The main idea is to employ a fairly high coupling without coupling into the system too much of the antenna's capacity and inductance. Accordingly the antenna primary winding is "interwound" with the tuned secondary—that is the turns are laid between those of the secondary. The TOP end of the primary is grounded, and the lower end goes to the antenna through a fixed condenser of small capacity. The coupling is thus not only made principally inductive but in addition the maximum capacity effect is limited. Practically the desired effect has been attained—the tuning changes very little if the antenna post is grounded. More of this later.

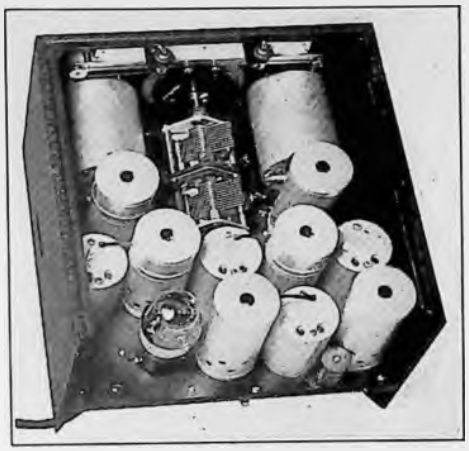
The First Detector

On paper the 58 looks like a very desirable first detector tube, but when covering such widely different frequency ranges as needed in amateur band work it is most difficult to provide an oscillator voltage to the detector grid which



The litzendraht i.f. transformer. The insulation for the trimming condensers, like that of numerous other important parts in the set, is of isolantite.

will fall within the requirements of the 58 in all bands, and with all tubes the user may employ. Accordingly there was used a 57 which is less fussy in these regards and gives better average results. With this tube the main requirement is that the oscillator input be high enough. Since the tendency is obviously for the oscillator to become weaker at shorter wavelengths — higher frequencies, a coupling from oscillator to detector was



Interior view of the FB-7 receiver, showing relative position of the coil shields and the isolated-rotor condenser.

used which acts in the opposite direction —that is to say a condenser coupling whose reactance decreases as the frequency increases.

The High-Frequency Tunable Oscillator

The first, or high-frequency, or conversion, oscillator is of the electron-coupled sort using the Hartley type of circuit. These circuits have special quirks but experience gained in previous types of sets had indicated ways of avoiding them. In particular it was found desirable to feed the screen and plate power in through resistors, which are not only nearly equally high impedances at all r.f. frequencies, but in addition act as d.c. ballasts and as powerful deterrents against frequency wander caused by line-voltage changes.

Tuned Circuits

As suggested before—the tuned coils are of the familiar R-39 variety. Each carries its own small "trimmer" inside, a small hole being provided for adjustment by means of the usual serviceman's tools. The coil when plugged in enters a rigid shield carrying the coil-socket and terminals at the back, close to tubes and tuning condensers.

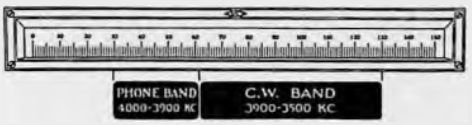
The i.f. circuits are of the double-tuned variety so that there are 6 tuned circuits in this part of the system. The losses in these circuits are reduced by the use of insulated-strand wire which older radio men will recall as being used in the high-gain circuits of receivers built without regard to cost in days when there were no screen grid tubes and coils HAD to be good. In the short-wave receiver the problem to some degree returns—a comparatively high intermediate frequency is being used and the coils cannot be too good.

The Second Detector

Experience dating back to the first SW-5 affirmed the extreme importance of a headset connection to the next-to-the-last tube, where reception is necessarily quieter than if the output is taken from the last tube through an attenuator. This called for a second detector suited for working into a headset, and automatically pointed out the 56. This tube also permits good r.f. filtering without loss of high audio—and in these days radiophone fidelity is of some importance.

The Beat Oscillator

The second oscillator is seen to be of the same general type as the first, but its coupling is made very loose—in fact



The bandspreading is best shown by this example for the 80-meter band. The shaping of the condenser plates is such as to give unusually good phone-band spread.

the input is so low as to increase the second detector bias but 10%. This is important since the detector must be able to work with this oscillator (c.w.) and also without it (voice).

The main problem in such an oscillator is to provide such thorough shielding as will prevent any pickup by the i.f. and first oscillator or detector with

the consequent tiresome "birdies" found in many sets of this sort, not to speak of the even more irritating effect of "pulling in" which may be described about as follows—although it hardly needs any description before an audience of shortwave receiver users. If there IS any pickup of the oscillator by the I.F. system the zero-beat region will appear to be extremely wide, especially when the volume control is advanced. After some difficulty the FB-7 circuit was given an arrangement such that stray feed from the second oscillator to the i.f. is virtually wiped out by the shielding and the feed-lead filters. If the coupling condenser is removed almost no beatnote can be heard when one tunes across a carrier. Low operating voltages on this oscillator aid in producing this effect.

Single-Sideband

In order to receive in the single-sideband, or single-signal manner a superheterodyne receiver must have an i.f. system with an assymetrical response curve; in plain U. S., the resonance curve must be lopsided. The ability to receive

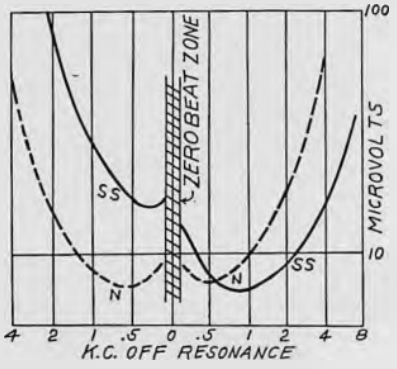
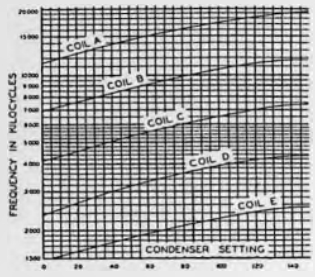


Fig. 2. The Single Sideband Effect.

so manifestly reduces interference, but as ordinarily accomplished (Stenode) this requires a crystal filter unbalanced by a definite amount. Space for such a device has been left on the FB-7 chassis but in the standard sets the effect itself is produced to a considerable extent by a simpler scheme, that of runnng the oscillator 2,000 cycles off-tune, so as to produce the one-sided response curve shown as SS (single-sideband) in Fig. 2, instead of the normal (N) curve shown dashed in the same figure. Note that the sensitivity is not greatly changed, but that the one sideband is greatly reduced so that the practical effect is a material selectivity improvement without damage to audio fidelity—observe shape of curves.

Thus the requirements of both the phone and c.w. man are met without adding any controls whatever.



And—continuous tuning range whenever you want it!

Send-Receive Switch

One seemingly minor point that the transmitting amateur will appreciate is the "Receive-send" switch which cuts off the plate supply ONLY—so that the receiver goes to work instantly when the switch is flipped back at the end of the transmission period. This saves eardrums, tubes and nerves. Incidentally, in battery operation the switch saves batteries.

Power Supply

As has been inferred, the set may be run from batteries or from the usual power supplies. The power supply cable therefore terminates in a 4-prong plug for insertion in a socket to which the desired supply is connected. A power supply particularly intended for this set and called No. 5887, has a socket to take the plug.

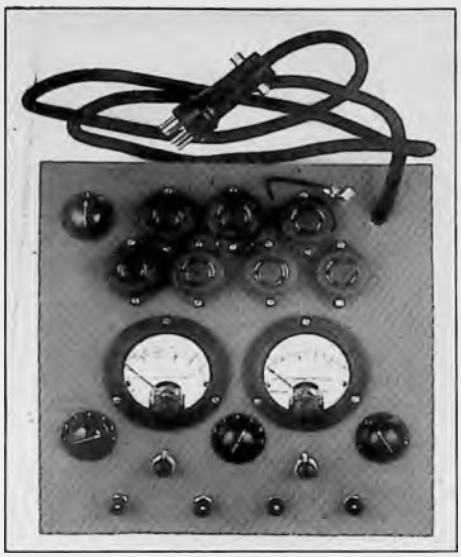
The Output Tube

From what has been said it is apparent that such tubes as the 47 are to be avoided because of the possibility of accidental hum introduction, especially when receiving with a headset. The 59 tube is accordingly used. It is connected as a pentode since the headset is

(Continued on Page 22)

THE PERPETUAL ANALYZER Part 2* . . . NEVER OUT OF DATE

By L. W. Hatry



A "Perpetual" analyzer made up from standard parts. The toggle switches are double-pole. In this case the selector switch markings have the meanings of the table except that the "cap" point is No. 4.

In Part 1 of this paper it was pointed out that an analyzer has no reason for existence unless it SAVES TIME, also that it can best do this if it permits one to read AT THE SAME TIME the plate current and any desired one of the tube's voltages, so that two meters are essential. However, it was also shown that much of the usefulness of analyzers is lost if they attempt to provide for every possible measurement from-the-socket, if many adapters are necessary or IF IT FAILS TO PROVIDE FOR FUTURE TYPES OF TUBE-BASES.

Of course it is necessary to provide for the use of the voltmeter with a pair of leads and prods, both as a voltmeter, and as an ohm-meter. This is admitted in all designs.

The Circuit

The circuit diagram is mainly self-explanatory and only the following points need be brought out:

A—*No adapters* are needed in the analyzer itself, enough 4, 5, 6 and 7-prong sockets being provided to take care of existing tube types, with space for more if need be. Some types are NOT provided for because it would be senseless. Thus a duo-diode-triode or a duo-diode-pentode has its elements operating at such low voltages, and has such high impedances in series that ordinary meters are useless; the best test is to try a new tube and to check voltages BACK of the impedances with the voltmeter and prods.

B—*No provision is made for rectifier measurements.* Rectifier trouble is apparent to the eye in most cases—no meters are needed. If a new tube does not cure things, voltmeter examination of the B filter and associated circuits is necessary—the voltmeter with prods again serving. This is an excellent example of the sort of thing that should NOT be done from the socket. One might think of hunting for a grounding short at some OTHER socket by means of the analyzer plug—but since one already has the base off the set for filter examination this also is most quickly done with the prods.

C—*The milliammeter* is put once for all into the PLATE circuit and left there. The writer has yet to find any actual use for it elsewhere. For example—why measure screen current? If the screen current is abnormal the plate current will certainly be abnormal and tell the story just as well—the voltmeter will tell what is wrong, provided a new tube makes no improvement.

This meter has a range switch—nothing else.

D—*The voltmeter is cut off from the analyzer plug* when switched to the posts—the plug can be left in the set without the usual fireworks.

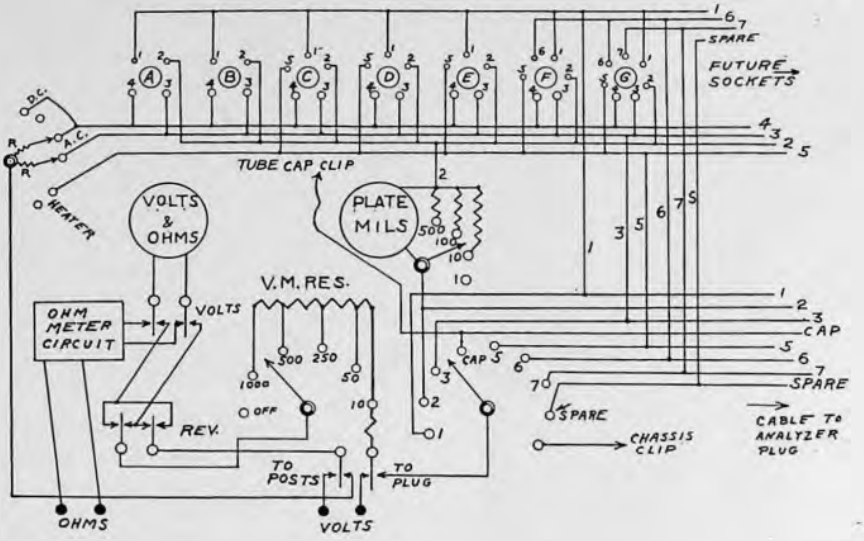
*Part I, February "Modern Radio." See p. 30 of this issue as to back copies.

E—*The ohm-meter circuit* has been intentionally omitted from the diagram. Not only has each serviceman his own pet circuit, but enough such have been printed in MODERN RADIO and elsewhere. A good one was shown in Part 1 of this article.

F—*No adapters are used at the analyzer panel.*

G—*Future tube and socket types are provided for as follows:*

1—The only fixed things about the present tube system are that the socket prongs in every type of socket never change numbering and the filament (whether d.c. or a.c.) always turns up on socket prongs 3 and 4, everything else comes and goes—or moves from one prong to another. However, the numbering of the prongs stays put always—therefore the voltmeter selector switch has its positions marked for the socket terminals—not for the tube elements. The appearance of another sort of tube only calls for the addition of one line of words to the table in the analyzer lid—not



SETTINGS OF VOLTMETER SELECTORS FOR DIFFERENT TUBE TYPES

Numbers refer to the standard base-prong designations in which prongs No. 3 and No. 4 are always filament, No. 2 ordinarily plate.

Where grids are numbered the one nearest the cathode is No. 1.

Caution: Rectifiers must not be tested in the analyzer sockets. Substitute new rectifier in set or apparatus and test its load circuit with voltmeter prods.

TUBE	Use Socket	Set 3-Point Selector	Position of 1	2	3	Main Cap.	Selector 5	Switch 6	7	Chassis
d.c. fil. triodes	A	d.c. (1)	G	P	F	....	....	....	....	.....
a.c. fil. triodes	A	a.c. (2)	G	P	....	....	....	....	....	.....
Heater triodes	D	h (3)	G	P	Cath. to F	....	...	....	....	Cath. to chassis
d.c. fil. tetrodes	B	d.c. (1)	Sc.	P	F	G	....	....	....	.....
d.c. or a.c. fil. pentodes like 33 and 47	C	d.c. (1) a.c. (2)	G	P	....	....	Sc.	....	....	Fil. to chassis if a.c.
5-pin heater tetrodes and pentodes	E	a.c. (3)	Sc.	P	Cath. to F	G	0	....	....	Cath to chassis
6-pin heater pentodes (r.f.)	F	a.c. (3)	Sc.	P	Cath. to F	G	0	Sup.	....	.....
59 type triple grid	G	a.c. (3)	G No.2	P	Cath. to F	....	0	G No.3	G No.1	.....

Extend list to other types as desired, adding sockets if necessary.

a wire need be changed, nor an adapter bought.

2—If new socket types appear (9 prongs?) add a socket in the panel space left for that purpose and run a lead from each terminal to the corresponding point (same number) of the selector switch. When such tubes appear a little thought will show whether a new cable and plug with more wires is needed.

3—The cable plug (unfortunately) still needs adapters.

H—*The voltmeter reference point,* that is to say the point "against" which voltages are measured, must be shifted to accord with tube types. Thus our reference is:

For d.c. filaments—one end of the filament (201A, 230, etc.).

For a.c. filaments—the centertap of a resistor switched across the filament (245, 247, etc.).

For a.c. filaments with cathodes separate (heater type) the reference is to this separate cathode (56, 58, etc.).

For EXISTING tubes this could be provided for by doing the voltmeter-selecting with a multi-blade switch—thereby automatically tying the "socket terminal selecting" feature up with the "reference selector" and spoiling all chance of being able to handle new and peculiar tubes. This is why two voltmeter selector switches are used—with the more common types of tubes one soon automatically flips both to the proper position—and in fact most tubes give no readings of the 3-point "reference" switch is in the wrong position. In any case—the table in the lid tells.

TUBE AND SOCKET LIST

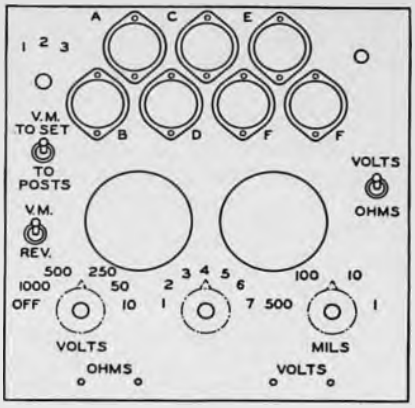
SOCKET A—200, 01A, '11, 20, 26, 30, 31, 40, 45, 50, 71A, 99, 210, 2A3.
SOCKET B—22, 32.
SOCKET C—33, 47.
SOCKET D—27, 56.
SOCKET E—24, 35, 36, 38, 39, 51.
SOCKET F—57, 58.
SOCKET G—59.

Tubes not in enough use to warrant socket as yet: 46, 89, 48, 2A5, 53, 75, 77, 78, 79, 2A5.

Tubes not suited for from-the-socket methods, regardless of analyzer used: See text—55, 85, 90, 92, 2A7, 2B7, 6A7, 6B7—all rectifiers.

Conclusion

It is not claimed that this is the last word in analyzers—but it is claimed that this type has for many months been found very useful by numerous servicemen who built it with variations to suit their individual needs or opinions. The appearance of several crops of new tubes



Layout of a 10½" x 11" panel type "Perpetual." The arrangement is somewhat different from the photograph to allow more space for engraved or incised markings.

has not bothered them in the least and nothing we have heard about additional forthcoming tubes seems to make these "Perpetual analyzers" any less suited to the daily needs of the serviceman.

THE NEW TUBE NUMBERING SYSTEM

The Radiotron-Cunningham organization has initiated a new tube numbering system which works as follows:

The first number indicates the filament voltage. Thus a 2A5 or 2A3 has a filament voltage between 2 and 2.9, while a 25Z5 has a 25-volt filament.

The letter after this first number is somewhat arbitrary, although in general rectifiers take letters in the last of the alphabet (25Z5) while other tubes take letters in the first part of the alphabet.

The final number shows the number of usable tube elements which have external connections. Thus a 2A3 has external connections to 3 usable elements—in other words, it is a triode. On the other hand a suppressor grid not going to an external connection is not counted in this system.

OLD TUBE NUMBERS ARE NOT CHANGED AT ALL.

MICROPHONE and AMPLIFIER LEVELS SIMPLIFIED

By E. E. Griffin *

There seems to be some uncertainty in the minds of radio men as to the output level which may be expected from a microphone, and as a natural result there is likewise uncertainty as to the amplification that will be required to produce some certain final amplifier output for public address work or to modulate a radiotelephone.

Somewhat naturally the radioman feels that the microphone manufacturer should state once for all what output level is to be expected from each type of "mike." As will be shown, this is not practical and any such figure would be the worst of mis-information. However, it is possible to lay down guiding rules and this will be done here in a brief way, with the hope that it will be of aid to the user of microphones.

It is seldom that a technician can talk without making pencil marks on paper, and this discussion will therefore begin with the printed equivalent of such pencil marks. With them before us we can get down to business.

First I refer you to the large chart on the logarithmic scale. After a slight analysis you can readily see that it has all mathematics of amplifiers, microphones, photo-electric cells, etc., worked out on a fairly usable scale and gives you an exact mental picture of the whole amplifier and acoustic set-up. On the right-hand scale you will find the power lever in D.B. (referred to .006 watts as zero) while the diagonal lines represent the actual power in watts, milowatts and microwatts. Just for an enlargement on our mental picture we have placed the most popular output tubes at their various wattage handling capacity on the upper scale, while also you will find the average range for magnetic pick-up, the maximum and minimum power outputs of various carbon microphones and below that the various power outputs of various photo-electric cells as used in sound production work.

"Zero Level"

As you no doubt know there is considerable confusion existing as to just what zero level on our present D.B. scale is supposed to be. Some authorities consider zero level as the threshold of audibility while others take it as the output of a certain carbon microphone. This company has adopted the standard as set forth by the General Radio Company, which standard, I might also state, is being gradually adopted throughout the motion picture industry here on the Coast. Accordingly, if you follow the zero line of the present chart through you will find that it passes the diagonal "power" line at 6 milliwatts.

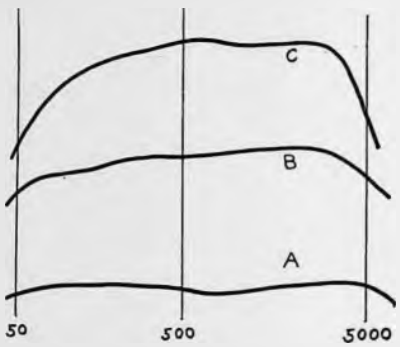


Fig. 2. Representative response curves for a high-quality studio microphone A, a good "close talking" microphone B and a good medium-priced microphone, the corresponding prices being about $90, $75 and $25.

Microphone Levels

Now with this chart to base on let us get at the subject in which we are primarily interested. First of all, I wish to point out the fact that microphones run in considerable variation of grades, types and purpose. In general, the more sensitive a microphone, the less tone quality it has (Fig. 2), while the greater fidelity of tone quality, the less its sensitivity.

* Chief Engineer, Universal Microphone Co., Inglewood, California.

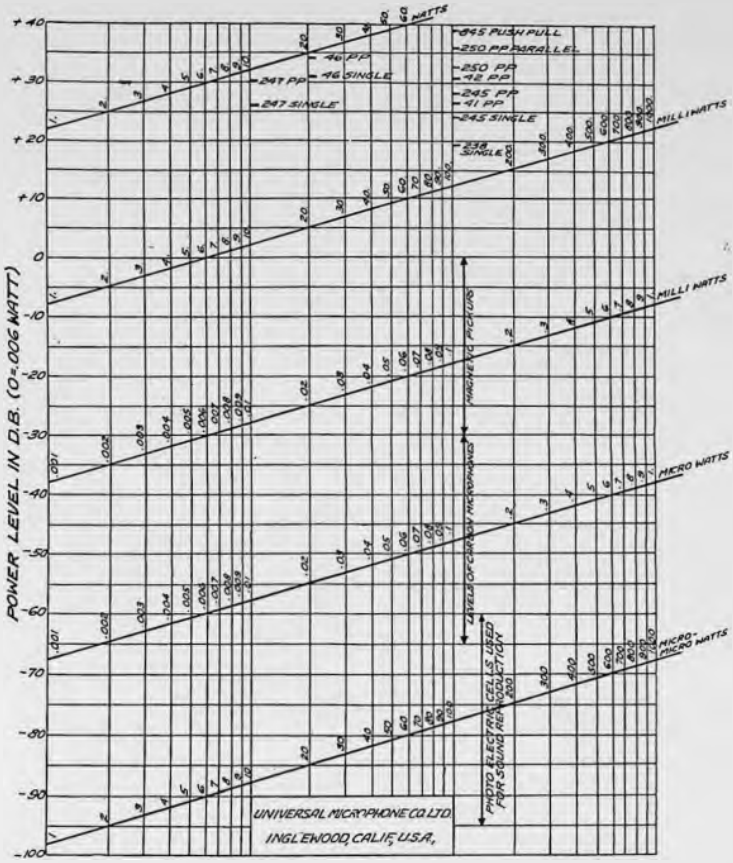


Fig. 1. The decibel chart.

Suppose we have a microphone known to deliver about "minus 50 D.B." when drawing 10 ma. per button and being spoken to at one foot. We need an amplifier output of 500 peak volts across a 10,000-ohm load. What must the amplifier be like?

500 volts peak = 350 volts r.m.s. and if connected across 10,000 ohms produces an input of $E^2/R = (350)\ (350)/10{,}000 = 12.25$ watts. This output level at once suggests a push-pull pair of 2A3 tubes coupled to the load through an output transformer which will convert the 10,000-ohm secondary load into a 5,000-ohm load (plate to plate) as required by the 2A3 tubes. (The turns ratio is 1.4/1 comparing secondary to whole primary.)

Meanwhile we see from the chart that 12.25 watts is about 33 D.B. "up", which is 83 D.B. above the microphone level. The amplifier gain overall should be about 90 D.B., a rather high gain preferably broken into two sections—a "pre-amplifier" and a main amplifier separated from each other—a fact better appreciated if one considers that 90 D.B. gain is a power multiplication of 1,000,000,000 times so that a very small percentage of feedback causes distortion. If the input and output load impedances of the amplifier were equal the voltage amplification would be 31,600. The final line-up is accordingly a 3-stage main amplifier and a 1 or 2-stage pre-amplifier, choice in the latter case depending on the tubes used in the main amplifier.

Again—the same problem but with a high sensitivity microphone spoken to at 3 inches, with 20 ma. per button and an output level of —22 D.B. The gain required is now from —22 to plus 33 or 55 D.B. This can be done nicely by the 3-stage main amplifier alone, as it is (from the chart) a power ratio of 12.25 watts/.04 milliwatts = 300,000 or for equal impedances a voltage gain of 546.

Likewise the tone quality is generally directly proportional to price.

The Effect of Distance

There are two highly variable factors affecting the output of a microphone in general use. First, the volume of sound reaching the microphone (or the actuating pressure), and second, the amount of d.c. exciting current with which it is supplied. First let us consider an actuating sound pressure which would be a duplicate of a person speaking in a perfectly normal voice with his lips at a distance of 6 inches from the microphone. If this microphone happened to be a Universal Model LL in the "M" or Medium sensitivity grade we would get an output of approximately —48 D.B., provided the button current on the microphone averaged 8 milliamperes per button. Should the speaker move one foot away from the microphone the volume of output would drop to —54 D.B., while if he should move away to

a distance of two feet the output would drop to approximately —61, all other conditions remaining the same. Should he move up to the microphone and speak directly into it, the output level would be approximately —30 D.B., quite a whale of a difference between the two-foot distance—in fact, CONSIDERABLY MORE THAN ONE STAGE OF HIGH QUALITY AMPLIFICATION.

The comparative output levels of microphones at variable distances are

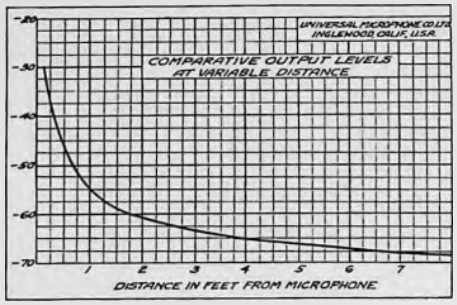


Fig. 3

graphically illustrated in Fig. 3, which is generally quite surprising to those who have not given it consideration before. This chart really has nothing to do with a microphone at all. It simply illustrates the falling off of energy with increase in distance from the source and is applicable to any sound radiating body in free space.

Microphone Current

In carbon microphones the next variable factor is the variation of sensitivity or output with variation of button current, which you will find graphically illustrated in Fig. 4. Here I might state that the hiss or "carbon rush" level in the granular type of microphones also varies in approximately the same relation with button current as is given by the graph and is generally about 30 D.B. below its output level. The graph is taken on the same grade and type of microphone as we described heretofore, that is a Medium grade that is subjected to a sound pressure equivalent to a normal speaking voice spaced six inches from the face of the microphone. It is quite surprising to note that with a current variation of from 2 milliamperes to 30 milliamperes we can get a variation of output from —70 to —28 D.B. which explains why it used to be common practice to include a potentiometer in the microphone circuit and have a continuously variable current range of from 0 to an enormous value. These were the days when amplifiers generally fell short and the microphone had to be depended upon to furnish enormously high output in order to drive them at sufficient usable level.

From Figs. 3 and 4 it can be readily seen that if a microphone is given the absolute maximum of current and a person talks directly into the microphone an output level closely approaching zero level will be obtained. Considering the variations possible in both the button current and the sound pressure actuating the microphone it can be seen that an overall variation of from 60 to 80 D.B. is possible. Greatest fidelity of response to variations in sound pressure will be had when the microphone is used at the lower levels. Our recommendations are a button current of from 5 to 10 milliamperes, while the spacing to the microphone will naturally vary with the particular model chosen.

Where Figures Lie

In regard to this point, I am submitting to you Fig. 5 which gives the various output levels of our complete lineup of carbon microphones when used with a button current of 10 milliamperes and subjected to a sound pressure variation equivalent to a normal speaking voice

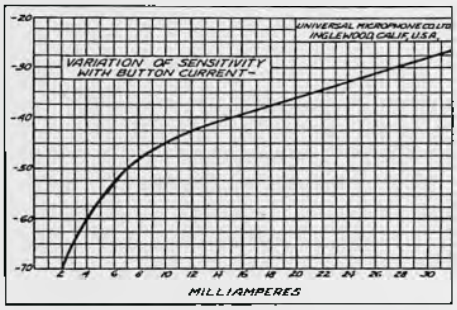


Fig. 4

spaced six inches from the microphone itself. In this chart observe the little notation specifying the zero level on this scale as equal to —62 D.B. on the other charts. Reasonable as such a chart may appear, these volume levels are IN NO WAY representative of what the microphone's outputs would be in prac-

tice. In normal use the conditions are quite different. For instance, an aeroplane Handi-Mike would be used pressed tight against the mouth, which position when considered in the light of Fig. 3 would immediately raise its level some —25 D.B. In addition to this, the aeroplane type is used at a much higher current value per button than the 10 ma. current taken in Fig. 5, and thus in the

Fig. 5. The zero level in this diagram is different from that of the other figures.

end its output might be in the neighborhood of —10 to —20 D.B. Another example is the Baby and QRQ. Either of these high sensitive models when spoken directly into may have an output level closely approaching "zero level"—that is 6 milliwatts.

These variations are so large as to be confusing to the user until he understands their causes as shown in Figs. 3 and 4. With these figures in mind the information of such a tabulation as Fig. 5 can be translated with some correctness into the probable performance under the conditions actually to be used. Then with the microphone's output fairly well known the amplifier may be laid out to provide whatever gain may be necessary to rise from the level of the microphone to that of the amplifier's required output—always with due allowance for some spare gain to compensate for adverse conditions or for power-wasting devices such as "mixers" or "equalizers."

Cheap automobiles are now much better than the expensive ones—the ads say so.

A 15-Watt High Quality Amplifier for Modulation & Public Address Work

Using the 2A3 and Other New Tubes

(The 5Z3) (The 2A3)

The audio system is built on a special National base 10 inches by 20 inches.. In the front row, left to right, are the VSA power transformer, filter condenser and choke, 2A3 output tubes, B1 push-pull input transformer, volume control, microphone current control and 5 binding posts for microphone battery and microphone or line connections. In the rear row, left to right, is the line switch, the 5Z3 rectifier tube, filter choke and condenser, grounding post, type BM special output transformer, the interstage transformer and the 56 first-stage tube. In front of the 56 is the microphone transformer, and just to the left of it is the 59 second stage tube.

The recent new tubes have removed some of the most stubborn difficulties in the way of a self-contained audio amplifier with high-quality output adequate for either a public address system or the modulation of a radiophone transmitter suited for amateur use.

These problems all boil down to four—gain, hum, fidelity and power-capacity. It has been unfortunate that most of our tubes with fairly high gain were not of the separate-cathode type, so that they tended to introduce hum, or else they failed to provide enough output to swing the grids of a final push-pull output stage hard enough—or finally they were of the pentode type. The present tubes provide everything needed.

The First Stage

In the amplifier diagrammed herewith the first stage is a '56 tube with a "mu" of more than 13 and a separate cathode, so that one can in this important stage get safely above the hum level. The input is from a National microphone transformer which is adapted for use with either a 2-button microphone or the usual phone lines. A "close talking" mike fed directly into this transformer and spoken to in the average manner at a distance of about 8 inches will swing the last stage fully—15 watts out. This is the condition found in an amateur radiophone station. However, a line does not produce such a high level, nor does a high-grade studio "mike." For these there should be a pre-amplifier, preferably battery-operated and self-contained device. The present crop of 2-volt low-microphonic tubes make such a thing possible and a suitable pre-amplifier is pictured herewith.

The Second Stage

The second stage, while less fussy than the first, should still be low as to hum and high as to gain—and fidelity. The 59 tube, when connected for Class A amplification, exactly fills the description and in the bargain provides adequate audio power to swing the output stage easily. The grid of the 59 is driven from the 56 through a normal audio transformer, in this case a National type A-100 and in turn feeds the 2A3 push-pull stage through a National push-pull transformer connected in a somewhat freakish manner, not intended by the designer but producing the desired result. It happens that there is no stock transformer whose primary fits into the 59 Class A plate circuit but a match is obtained by using in series the ENTIRE primary of a transformer intended to work out of a push-pull pair of 45 tubes. The secondary was intended to work into a pair of Class B push-pull tubes but is here used to drive a pair of 2A3 tubes

ANSWER FACTORY RATES

How?—What?—Why?—Who?—When?

A—Letter with one question	$ .50
No charge for small incidental pencil sketches.	
B—Additional questions, each	.25
C—Schematic diagrams of battery-driven receivers up to 6 tubes, transmitters up to 5 tubes, antennas (other than beam types), switching schemes, metering, and power circuits of reasonable simplicity	.75
D—Matters such as given under C, where all constants are desired	2.00
E—a.c. or d.c. socket-power receiver circuits without constants	1.50
F—Same as E but with all constants	3.00

G—Transmitter diagrams of greater complexity, bibliographies, operating instructions, analysis of complex operating difficulties in apparatus, and other questions not covered by the above will be estimated on receipt of a clear and complete statement of the problem.

NOTES

1. Keep a copy of your letter, including diagrams, numbering questions 1, 2, 3, 4 and lettering diagrams a, b, c, d.

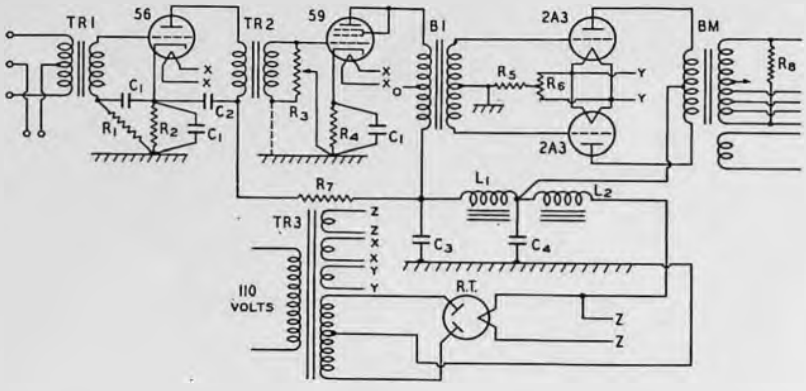
2. The right is reserved to return remittances for any questions which it is impossible to answer.

3. No attention will be paid to radiograms, telegrams or letters (other than those under class G) which are not accompanied by a remittance. Please use money order—loose cash may not arrive.

4. Address letters, Robert S. Kruse, R. F. D. No. 2, North Guilford, Conn.

in Class A prime. Those familiar with the National type B1 transformer will be able to check over the impedances and see that they are sufficiently correctly matched for the purpose. In fact the

The variable mu tube's advantage does not appear on single-frequency laboratory tests, but it aids materially in reducing sharp accidental noises of high peak value. The grid lead must be



THE GENERAL DIAGRAM

TR1—Microphone or line transformer, type M.
TR2—Interstage transformer, type A-100.
TR3—Power supply transformer, type VSA.
B1—Class B input transformer used as Class A coupling device.
BM—Special output transformer, see text.
L1 and L2—Type 80 chokes, 20 Hy. each.
C1—1 mike, low voltage paper condensers.
C2—1 mike, 600-volt paper condenser.
C3, C4—4 mike, 800-volt, paper or electrolytic.
R1—100,000 ohms, 2 watts, filter.
R2—2,000 to 2,500 ohms, 2 watts, bias.
R3—500,000 ohms volume control.
R4—1,200 ohms, 2 watts, bias.
R5—700 ohms, 20 watts, bias.
R6—60 ohms, center tapped.
R7—50,000 ohms, filtering voltage reducer.
R8—200,000 to 500,000 ohms, 4 watts, peak absorber.

amplifier output is excellent. The 2A3 pair is operated self-biased by a 700-ohm resistor and its output goes through the only piece of new equipment used, a National type BM transformer, whose primary is push-pull to work out of the 2A3 tubes and whose secondary is designed to work into a variety of loads in the vicinity of 5,000 to 10,000 ohms and also, by means of an auxiliary low-impedance secondary, into a 15-ohm load such as a bank of loud speakers.

Modifications

Several modifications are possible with little difficulty. For example, the 56, first-stage tube may be replaced by a 58 tube, with some loss in high-note response and a considerable gain at other frequencies. The use of a 58 is not quite "kosher" theoretically, but practically the audio fidelity is materially better than with a fixed-mu tube in this circuit. The same expedient will be found used in a number of makes of amplifiers.

shielded. The proper bias resistor in this case seems to be about 500 ohms—which is also a compromise between gain and low background.

The transformers should be left where shown, the positions having been found to give the least hum.

The resistors seen at the secondary terminals of the output transformer are of 250,000 ohms each, one across each half of the secondary. They are peak-absorbers to prevent damage from thumps and accidental sharp noises.

As a Driver for Larger Phones

Finally the amplifier as a whole may be used to drive a pair of 845 ("50-watt") Class A or A prime tubes, or a pair of 203A Class B tubes, the output levels of which are about 40, 75 and 200 audio watts respectively. Thus the unit is a good start for medium-sized radiophone transmitters. The BM transformer is provided with a low-resistance center-tapped secondary to permit such use.

not to be used here. When used with a dynamic speaker an output transformer and adequate plate supply are added—when used with a magnetic speaker it is anticipated that the occasion is a necessity for operating from B batteries or a limited B supply of some other sort —which is again quite o.k. as the 59 does not draw excessive current at 135

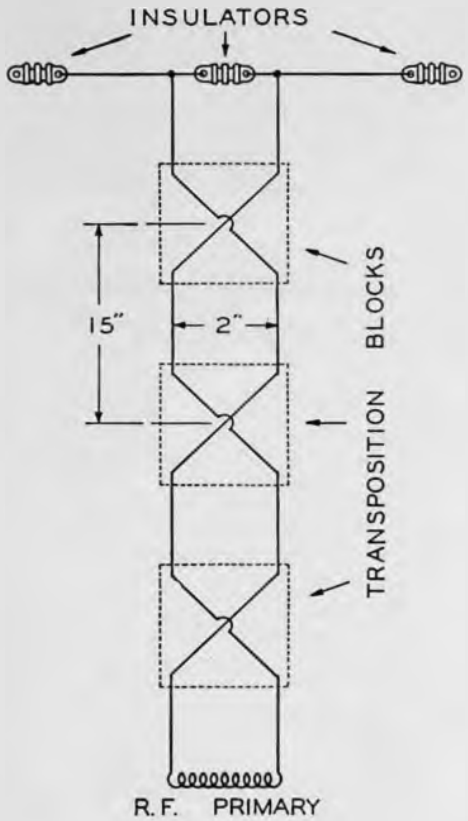


Fig. 3

or even 180 volts. Meanwhile the fact that it uses an indirectly heated cathode permits one to avoid a large part of the noises with which a filament-emission tube such as the 47 may afflict the circuit, by the simple process of grounding one side of the filament circuit—which is common to all the tubes. In view of the use of electron-coupled oscillators whose cathodes are off-ground at radio frequencies this would not be possible except for recent tube improvements.

Special Anti-Noise Features

It was inferred earlier in this paper that the antenna input circuit had added possibilities. In brief, the non-tuning antenna primary permits one to attach almost any sort of a feed system. Thus in noisy locations one may use such an anti-noise antenna system as shown in Fig. 3, either directly connected to the set as there suggested or—which is ordinarily much better—coupled in by means of the arrangement of Fig. 5, in which C1 and C2 are midget or regular variable condensers of a maxmum capacity of about .00015 uufd. (.00035 uufd. for top amateur band). They are not tuning condensers in the usual sense, their purpose being only to adjust the antenna tuning roughly when originally setting up. One condenser does nearly as well if the antenna coil of Fig. 5 is

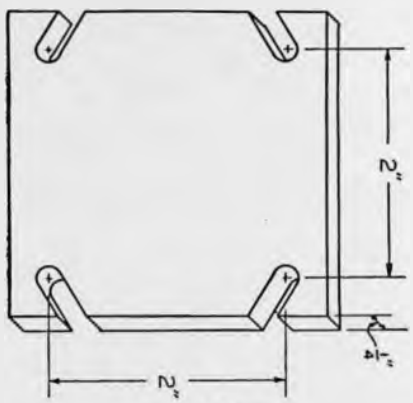


Fig. 4

split and the condenser connected between the two halves. The two coils may be wound on an R-39 plugin coil form, each having about as many turns as the primary of the coil (antenna input) then being used in the receiver. If this is too troublesome—wind 10 turns of No. 22 D.C.C. on the form, move on one-quarter inch and put on another 10 turns for a secondary. This is a fair general purpose combination. Fig. 4 shows a suitable leadin transposition insulator. Others have been described in MODERN RADIO.

(Continued on page 24)

The dimensions of such antennas are NOT critical in the least since we are not dealing with a Hertzian doublet and a feeder, but with a normal antenna system folded up. The system is in fact a near relative of the "Zeppelin" transmitting antenna, which likewise is highly uncritical as to dimensions, notwithstanding a great deal of published material in which unimportant dimensions are detailed. For example, a top (straight part) of the antenna one-half wavelength long suggests itself, and for the 80-meter band this would mean a length of 40 meters, or about 135 feet. Prac-

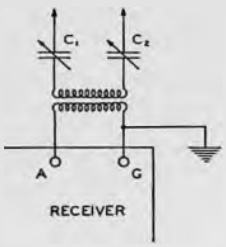


Fig. 5

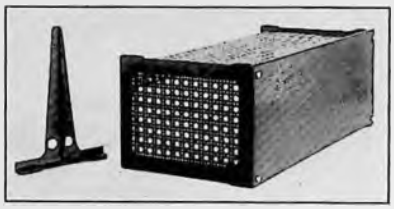
tically, however, the tuning condensers at the set (see Fig. 5) make any length within reason useful, and if the noise is not too severe no great care need be taken to keep the system symmetrical—that is the double downlead can come off somewhere beside the center—or even at one end. The transposition, incidentally, is a matter of mechanical convenience in fastening the bakelite spreaders. Needless to say the use of an anti-noise antenna is worth while only if the collecting top is put in a quiet place—not next to an elevator penthouse or a power line. The shielded leadin type is not suited in any case for shortwave work.

COMING IN MODERN RADIO

A New Sort of Modulation.
The Reversed Vacuum Tube.
5-Meter Tests.
More Batcher Charts.
Another Fizzlesnoot Story.
More Articles by Batcher, Phelps, Hatry.

ADD-A-SEKSHUN

Like sectional bookcases the "Add-A-Sekshun" metal enclosures may be stacked to provide an enclosure of any desired height for receivers, transmitters or other devices. Unlike the book-cases, the sections can be secured solidly together, the touching surfaces being machined for that purpose and provided with drilled and tapped holes for machine screws.



The smallest section has an end-frame 8¾" high by 7" (fore and aft), and carries an aluminum panel 8¾" by 19". The next size (see photo) has the same panel size but is 12" fore and aft. Either size of section sells for $5.90 complete with top and back enclosure, panel, end-frames and substantial laminated base-board. The finish is black crackled laquer. The enclosure is furnished plain instead of perforated if desired.

An interesting point about the Add-A-Sekshun is that double-height panel may be furnished if desired.

The sections may also be expanded to the REAR, either by purchasing parts or by combining section. In this way fore and aft dimensions of 7", 12", 14", 19" or 24" are possible, with the section height either 8¾" or 17½".

The photo also shows a special shelf bracket.

Details may be had from R. R. Batcher, 11335 198th Street, St. Albans, Long Island, New York.

WHERE TO BUY "MODERN RADIO"

CALIFORNIA
Associated Radio Buyers, Oakland
Coast Electric Co., San Diego
I. S. Cohen's Sons, Inc., San Francisco
El Cajon Radio Exchange, San Diego
Electric Supply Co., Oakland
Inter-City Radio Stores Co., Long Beach
Natick Book Store, Los Angeles
Offenbach Electric Co., San Francisco
Radio Manufacturer's Supply Co., Los Angeles
Radio Supply Co., Los Angeles
Sea Cliff Radio & Elec. Co., San Francisco
San Francisco Radio Exchange, San Francisco
Warner Bros., San Francisco
Warner Bros., Oakland
Wenger-Brill Co., Oakland
Zach Radio Supply Co., San Francisco

CONNECTICUT
Hatry & Young, Inc., Hartford
S. S. Kresge Co., New Haven

DELAWARE
Wilmington Elec. Specialties Co., Inc., Wilmington

ILLINOIS
Abbott's Sweet Shoppe, Berwyn
Chicago Radio Apparatus Co., Chicago

MARYLAND
Mattson's, Baltimore
Radio Electric Service Co., Inc., Baltimore

MASSACHUSETTS
T. F. Cushing, Springfield
H. Jappe Co., Boston
Neisner Bros., Boston
Sager Electrical Supply Co., Boston

MICHIGAN
Radio Specialties Co., Detroit

MINNESOTA
Lew Bonn Co., St. Paul

MISSOURI
Burstein-Appleby Co., Kansas City
Stone Electric Co., St. Louis
Walter Ashe Radio Co., St. Louis

NEW JERSEY
Kaltman & Kennyhertz, Newark

NEW YORK
Blan, the Radio Man, Inc., New York City
Gross Radio Co., New York City
Leeds Radio, New York City
Roy C. Stage, Syracuse
Sun Radio, New York City

OHIO
Klodag Radio Sales, Kent
Northern Ohio Sales, Cleveland

OREGON
Northwest Radio Supply Co., Inc., Portland
Guy B. Paine Co., Portland
Wedel Co., Inc., Portland

PENNSYLVANIA
Cameradio Co., Pittsburgh
Hall's, Harrisburg
M. & H. Sporting Goods Co., Philadelphia
Radio Electric Service Co., Inc., Philadelphia
Eugene G. Wile, Philadelphia

UTAH
Felt Radio Co., Salt Lake City

WASHINGTON
General Radio, Inc., Seattle
Spokane Radio, Inc., Spokane
Wedel Co., Inc., Seattle

WISCONSIN
Radio Parts Co., Inc., Milwaukee

FOREIGN
R. C. O'Connor, Tearo Book Depot, Wellington, New Zealand
McGill's, Melbourne, Australia

MORE NEXT MONTH

Tubes With New-Code Numbers

TYPE	Filament	Replaces	Mu.	Output	Plate Volts	Load	Plate Res.	Bias
2A3—A.F. Output Triode	2.5V.- 2.5A.	45	4.2	3.5 Watts	250	2,500	765	40
2A5—A F. Output Pentode	2.5V.-1.75A.	47	220	5 watts	250	7,000	100,000	16.5
2A7—Det. Plus Electron-Coupled Oscillator	2.5V.- 0.8A.	..	...		250	A.F.		**
6A7—Det. Plus Electron-Coupled Oscillator	6.3V.- 0.3A.	.	...		250	A.F.		**
2D7—Duo-Diode Detector Plus Pentode	2.5V.- 0.8A.	..	730		250	I.F.		*
6B7—Duo-Diode Detector Plus Pentode	6.3V.- 0.3A.	..	730	The 25 Z5	250	I.F.		*
5Z3—Full-Wave Rectifier	5V.- 3.0A.	..	...	250 Ma.	500	But.	The 2A5	†
25Z5—Full-Wave Voltage-Doubling Rectifier	25V.- 0.3A.	80 or 83	...	100 Ma.	125	But.		..

** In the 2B7 and 6B7 the input grid is biased by a 1-megohm resistor or 3-volt source. The screen is at plus 125 volts, the suppressor is permanently connected to the cathode. The pentode section may work into either an a.f. or i.f. amplifier.

* Depends on use for several of the grids present.

† Approximately equivalent to two 80 tubes in parallel, but with improved insulation.

MODERN RADIO

QUIZ-MATIC

NO. 8

As usual, one year's sub. (or extension) for the most to-the-point answer; six months' to the next four—our judgment to be final. (Winners of a first or two seconds are ineligible until their time is out, but good answers in that time put their names in the KING ROW.)
This time we have a diagram-less QUIZ-MATIC.

(Answer any or all as able.)

Part A—A transmitting tube is known to "show color" when working with an input of 65 watts and an efficiency of 60%. At present the plate is dimly red and the input is 100 watts. The antenna coupling device is wasting 10 watts. How many watts are going to the antenna. S'just arithmetic.

Part B—Two 45 tubes are working at 300 volts with a bias of 75 volts. The audio input is to the grids in push-pull. The plates are in parallel. Watts out?

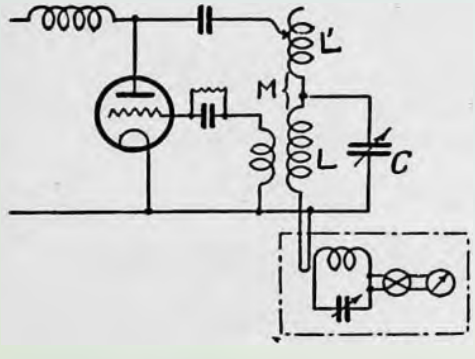
Part C—When is it necessary to bypass the bias resistor of a push-pull stage?

JANUARY WINNERS

Nobody caught both questions—hence no first prize award. Second prize winners—one question killed and the other crippled—Guy A. Simmons, Little Rock, Arkansas; Marvin Bockstein, East Haddam, Conn.; Paul E. Griffith, Iowa City; James R. Donovan, Savannah. In the King Row—answer o.k. but not eligible for a win because of previous wins—Herb Walleze, Hazelton, Pa.

Here are the questions and their answers:

Part 1.—In the Kusonose harmonic eliminator shown LC is tuned to the working frequency, then the slider on L' is moved until the smallest second harmonic current is shown by the wavemeter (dashed rectangle) which is tuned to that harmonic. The adjustment of L' is fairly sharp (within ½ turn) and can reduce the second harmonic as much as 90%, which is better than a tuned trap will do at the same place. Now then—what is the action of the circuit?



Answer—The harmonic flows mainly in the L branch of the tank, also necessarily through L'. When the clip is moved the COUPLING of the two changed. When the field of L' just bucks the second harmonic field of L—no more second harmonic!

Part 2.—Almost any antenna that isn't a loop, and isn't grounded at a high-current point must be called a "Hertz antenna." If you don't feel that way about it—just let it pass for the moment. Now then—we have a straight wire 1½ wavelengths long which we intend to use as a Hertzian antenna, and we intend to feed it by means of a single-wire feeder tapped directly on the antenna. Where is the tap to be located, need the feeder have any special length, and how can we tell when the thing is properly adjusted. You are supposed to have a transmitter with some adjustment of frequency, the usual meters and lamps—BUT THE ANTENNA IS NOT VISIBLE FROM THE TRANSMITTER.

Answer—Since the antenna is 1½ waves long it is possible to tap at 6 different places for a 1-wire feeder of matched-impedance type. Locate one of the 3 current maxima (voltage minima) with a ruler and tap 1/14 wavelength either side of it—feeder can be any length. Run feeder to ground through a coil. Coupled loosely to output tank. Tune transmitter around and watch for wavelength at which it shows most load—that's resonance. Confirm with lamp-loop coupled to feeder coil. Or finally—hitch feeder to either END through a very small condenser and feed from a tuned coil coupled to tank and not grounded.

THE KING ROW
Herb Walleze, W8BQ
?? Who'll Be Here Next Month ??

$100 FOR "BLOWING" A METER!

The Littelfuse Laboratories, 1772 Wilson Avenue, Chicago, makes the unique announcement of a $100 Indemnity Protection guaranty on instruments protected by Instrument Littelfuses.

This policy has been made possible by several improvements in this line during the past year, including the use of Platinum wire which is now used in the lowest capacities and is said to be much more reliable than the metallized quartz fibre formerly used. The wire used in the 1/100 ampere Littelfuse is only 1/30 the diameter of a human hair, barely visible.

Instrument Littelfuses are made in 1/100, $\frac{1}{32}$, $\frac{1}{16}$, ⅛, ¼, ⅜, ½, ¾, 1, 1½, and 2 amps. capacity. Full details describing this line, its guaranty, and other new features are given in the 1933 Littelfuse catalog.

Short Circuits

In response to many requests—and that's no advertising talk—we now offer any and all back copies at the price of 20c for one, 30c for two and 40c for three. We reserve the right to withdraw the offer or limit the number—and of course we can't send copies that are gone.

BY NO MEANS!

An unfortunate implication appeared in the caption of the oscillogram shown on page seven of our February issue (No. 20). It is possible to read this caption to mean that mercury rectifiers are ALWAYS productive of such bad wave forms as shown. This is of course not true. On the contrary the oscillogram shows an exag-

gerated case for purpose of illustration. It was published through the courtesy of Dr. F. S. Dellenbaugh, Jr., who obtained it during special studies carried out in the laboratories of the Delta Manufacturing Company while examining the cause, control and prevention of parasitic noises in mercury vapor rectifiers.

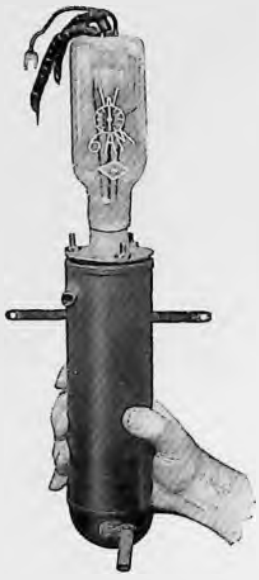
For many purposes properly designed rectifiers using mercury vapor tubes can be used with entire success. In this connection see "Mercury Magic" on page 24 of the issue referred to.

When there isn't room for even a ratchet brace use a square-shank drill or augur and drive it with an ordinary doorknob. Idea donated by J. F. Furey.

"Modern Radio" back copies: A few October, November, February, March and April, 20 cents each. Issues include Batcher's Perpetual Triode Chart, Progress in Converters, Painless Mathematician, Improved Anti-Noise Aerial, Stability Without Crystal, Super-Het First Detector Regeneration, Modulating Tetrodes, Making Output Meters, 500 Watts Direct from Crystal, Seeing Power Factor, Electrolytic Condenser Tester. "Modern Radio," Hartford.

Did You See the Offer on Page 29?

After soldering with paste, paint the joint with a quick-drying black lacquer. This conceals the slimy green corrosion and keeps you from worrying until the joint falls off.



Since you-all ask so insistently we will tell you. The alarm clock is NOT etched on the inside of the glass in the W6AM tube shown above—once more—but is made of wire and mounted inside by the makers—National Radio Tube. The hand is Wallace's, the photo is by the boss of W6DEP, thank you!

The only thing ever successfully standardized in radio is radio advertising. The best eye cannot tell whether the advertiser is recommending a midget with no performance or a $300 deluxe rattler with some.

Sure there is such a thing as Sales Resistance—"I ohm little because I bought little."

Scuse it please—but why is it a velocity mike when the wire is straight and a dynamic mike when it is coiled up?

Disinfection is the better part of squalor.

NATIONAL "AGS"

COMMUNICATION TYPE RECEIVER

NATIONAL'S LATEST AND FINEST

The amateur who is particular about his receiver; who knows and appreciates the little touches of refinement in design that give TOP QUALITY to radio equipment; will welcome the NATIONAL "AGS" Communication Type Receiver.

The "AGS" has been developed in cooperation with the Airways Division of the United States Department of Commerce to meet the exceedingly strict requirements of aviation ground station service. Every latest development has been included to make the "AGS" the very best possible in performance and every day reliability.

NOW AVAILABLE WITH BAND-SPREAD COILS

The "AGS" has band-spread coils for the 20, 40, 80 and 160 meter ham bands either in place of the standard 15 to 200 meter coils or as additional equipment.

ELECTRON-COUPLED OSCILLATOR

Made with electron-coupled oscillator, the "AGS" has maximum stability.

OUTLINE SPECIFICATIONS

1. CW or Voice, by shift of one control.
2. Optional manual or automatic volume-control by turn of switch.
3. Coil change from front of panel.
4. Tuned RF ahead of front detector. Very high signal-to-noise ratio, and high weak signal response.
5. Suppressed image.
6. Single control S.F.L. tuning by 270° precision Velvet-Vernier Dial with German silver scale and vernier reading to 1/10 division.
7. Calibration curves and tuning log on front of panel.
8. Phone or speaker output.
9. Relay rack mounting, extremely rigid construction—front panel 8¾" x 19".
10. Frequency range 1500 to 2000 kc. Band spread coils available.

OPERATED ON AC

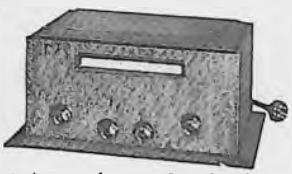
NATIONAL Power Units for AC operation. RCA Licensed.

IN THE LEAD for 4 Years NATIONAL SW-58 THRILL BOX

More than four years ago short-wave broadcast listeners heard programs the world over with NATIONAL Thrill Boxes. Each year since then the THRILL BOX has been improved . . . kept in the lead, with new and better tubes and new and better circuit design. Now the SW-58 THRILL BOX offers performance not dreamed of in September, 1928.

THE SW-58 THRILL BOX HAS

Utmost Sensitivity, Extremely Low Background Noise (highest signal-to-noise ratio), Unequalled Flexibility and Ease of Control. "Controlled Selectivity." An entirely new feature, found only in the SW-58, which allows the set always to be operated at the best selectivity consistent with signal strength and reception conditions. Loud Speaker Performance. A Push Pull Stage with 245 tubes for best tone-quality gives fine loudspeaker volume. There is also a jack for headphones.



Full AC or DC. The AC set operates with the NATIONAL 5880 Special SW Power Supply with extra shielding and filter sections for humless operation. RCA Licensed. Battery model also available for use where there is no AC current.

ONE USER SAYS:

"I would like to tell you that the Thrill Box is absolutely the best short-wave set I have heard, regardless of price. I have received stations in Australia, Holland, England, Germany, South America, Central America, all on the loudspeaker . . ."

San Antonio, Texas.
(Name on request.)

This is one of countless similar unsolicited, unpaid for testimonials from THRILL BOX users who bought and paid for their THRILL BOXES. Send for free book.

SEND FOR THIS FREE 24-PAGE BOOK

If you did not get a copy of this book with your November issue of "Modern Radio," send for it at once. Only a few copies still available.

Full and up-to-date information on short-wave receivers, radio time and revised call list of international short-wave broadcasting stations giving wave lengths, call letters and full particulars. USE COUPON BELOW.

NATIONAL

A. C. SW-58 THRILL-BOX

NC

NATIONAL CO., Inc.,
61 Sherman St., Malden, Mass.
Gentlemen: Please send me your new free 24-page book, WORLD WIDE SHORT-WAVE RECEPTION. I enclose 10c in stamps to cover mailing cost.
Name .....
Address .....