KENYON ENGINEERING NEWS

DEVOTED ENTIRELY TO THE AMATEUR, SERVICE ENGINEER SOUND TECHNICIAN AND THE EXPERIMENTER

No. I NOV. 1936 Vol. I

THE LIVE WIRE IN RADIO

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FEATURES

A NEW COMBINATION MIXER AND PRE - AMPLIFIER

TONE EQUALIZATION

RAMBLING THROUGH AUDIO AMPLIFIERS

IMPROVING MODULATION IN TRANSMITTERS

FOUR LARGE KEN-O-GRAFS

THE ELECTRONIC MIXER

A Successful Combination Three Channel Mixer And Pre-Amplifier in One Unit

WITH the advent of high fidelity it is important especially in low level audio circuits that frequency distortion be kept to a minimum.

In high quality mixer circuits this is usually accomplished through the use of high grade audio transformers and constant impedance attenuators. It is essential that the attenuation controls used in these circuits should have inherent frequency characteristics which are uniform over a range of frequencies between 30 to 10,000 cycles. The various types of pads used which maintain a constant impedance between source and sink are difficult to construct due to the special methods employed to wind the resistances and hence are quite expensive. Another disadvantage common to the conventional type of mixer is the large insertion losses. The average loss in a three circuit mixer is approximately 30 db. However, as the number of channels are increased, the loss will become greater and consequently more gain is required. To compensate for this loss incurred in the mixer it is common practice to couple the output of the mixer to a pre-amplifier which in turn is coupled to the main amplifier through suitable coupling transformers.

From the foregoing discussion it is readily apparent that a high quality mixer system is not only a problem but is also quite an expensive proposition too. Keeping in mind all of the aforementioned disadvantages of such a system, the combination mixer and low level pre-amplifier shown on the opposite page was designed and developed in our laboratory to form a unit that would eliminate the undesirable features and at the same time prove to be ideal from an engineering standpoint. Some of the outstanding features that conclusively prove its superiority over existing systems are:

1. Mixer affords gain instead of loss
2. Elimination of expensive constant impedance attenuators
3. High efficiency
4. High fidelity frequency response.
5. Low cost

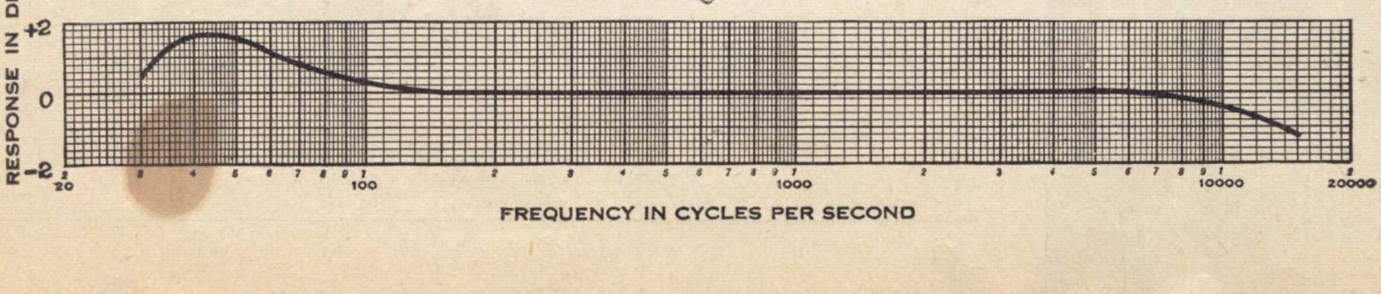
This electronic mixer makes provision for mixing three separate channels. By using suitable input transformers any three combinations can be mixed or faded into the other or any two or all three can be mixed together. The reader should bear in mind that the input transformers employed in this mixer may be varied to meet his own particular requirements. Of course, any one or two coupling units may be omitted, depending upon immediate requirements, while additional transformers may be added whenever the occasion arises for the coupling of some new input device. Ordinary potentiometers are used in the grid circuits of the three input channels and the variation of any one control has no effect on volume or frequency characteristics of the others regardless of their settings. A similar potentiometer is used in the grid of the 6C5 as the master control. The output of the mixer tubes are resistance coupled to the master gain control tube. A universal line output transformer is used between the plate of the master mixer tube which is coupled to the main amplifier.

The circuit is designed for all metal tube operation. Three 6F5 type hi mu triodes are used for each individual input channel and a type 6C5 for the master mixer amplification stage. The rectifier tube is the new heater type 6X5. These tubes are particularly outstanding in the new metal line and show a distinct improvement over their glass prototypes. Full advantage is taken of the high gain, low microphonics and low hum level of the 6F5 triode which provides the high efficiency of this circuit. An analysis indicates an overall gain of approximately 64 db; resulting from a voltage gain of 80 in the first tubes and a gain of 20 in the 6C5 tube.

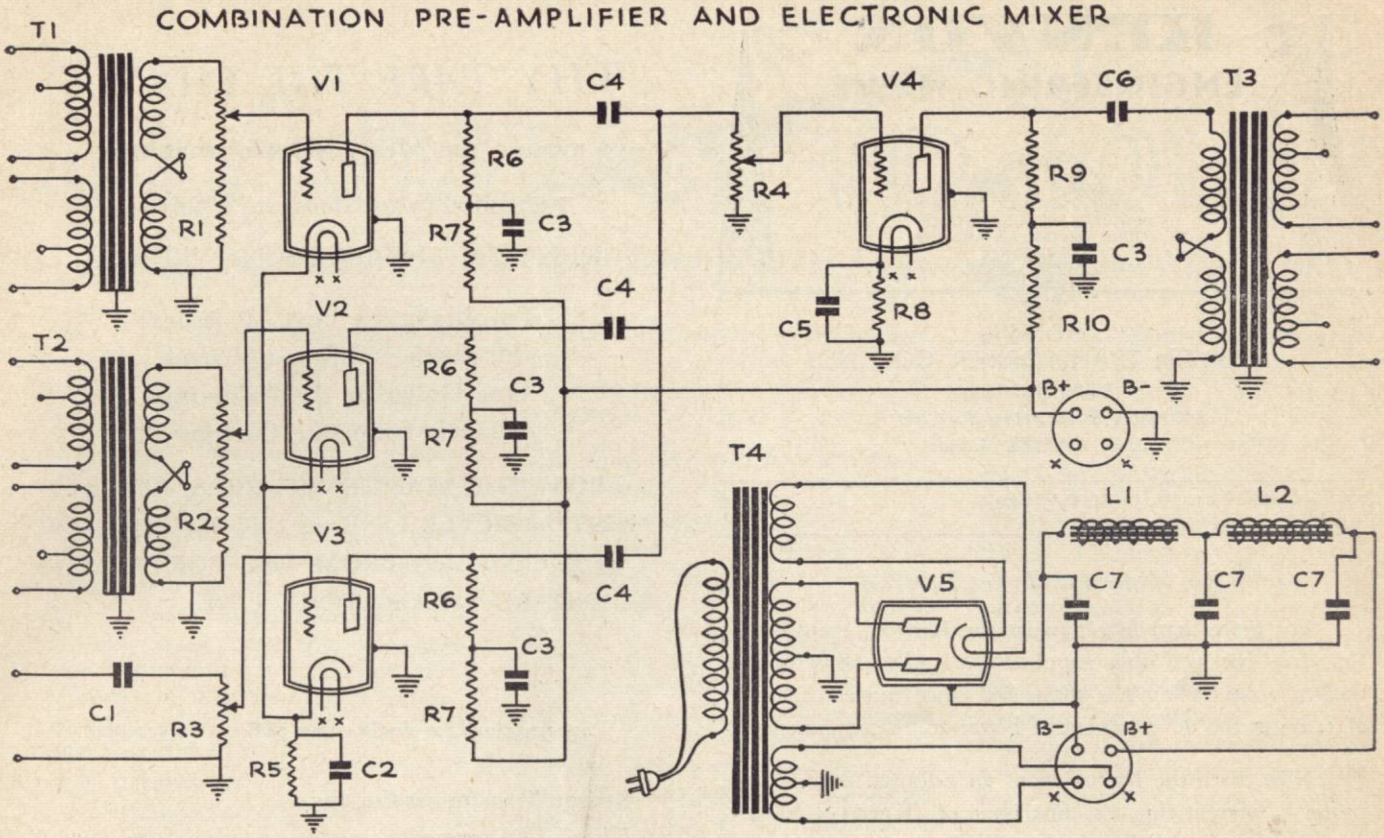
One of the major difficulties experienced with low level amplifiers when A. C. operated is hum. However, proper design and placement of parts has reduced the hum level to such a low value that it is not noticeable. The factors which determine the hum level in an amplifier can generally be traced to inductive pickup, electrostatic pickup and insufficient filtering of the plate supply.

In this circuit inductive and electrostatic hum is entirely eliminated through the use of bilateral wound and thoroughly shielded input and output transformers. This constructional feature provides automatic cancellation of induced hum voltage without interfering with the normal operation of the transformers. As a precautionary measure to insure hum free operation the power supply unit is constructed on a separate chassis.

(*Continued on page 9*)



COMBINATION PRE-AMPLIFIER AND ELECTRONIC MIXER



LIST OF PARTS

Kenyon Components

Suitable Input Transformers T1, T2.

Multiple Line to Grid	Type K200 or K203
10, 20, or 30 ohms to Grid	Type K202

Suitable Output Transformers T3.

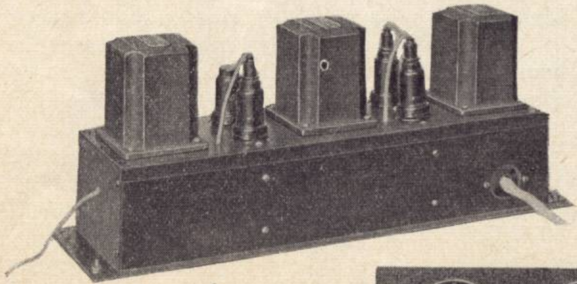
Plate to Multiple Line	Type K400
Plate to Grid. Turn ratio 1:2	Type K300
Plate to Push-pull Grids Turn ratio 1:2 Overall	Type K304
L1, L2 40 Henries	Type P40-10
T4 Power Transformer	Type K620
Blank Chassis for Amplifier	Type U 101
Blank Chassis for Power Supply	Type U 100
4 Gain Control Escutcheons	Type KEN

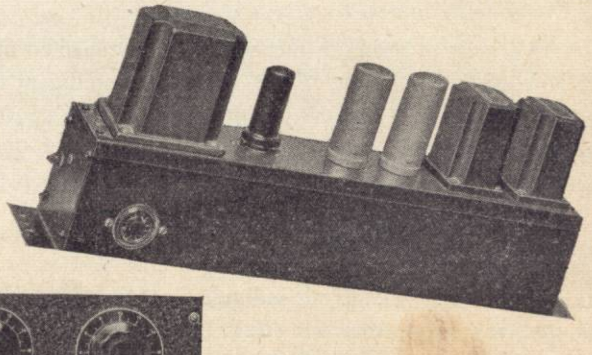
Tubes

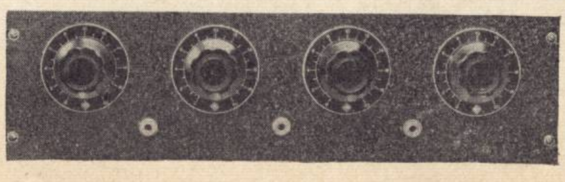
V1	6F5
V2	6F5
V3	6F5
V4	6C5
V5	6X5

Miscellaneous Parts

R1	150,000 ohm potentiometer
R2	150,000 ohm potentiometer
R3	500,000 ohm potentiometer
R4	250,000 ohm potentiometer
R5	1500 ohm 1 watt resistor
R6	150,000 ohm 1 watt resistor
R7	50,000 ohm 1 watt resistor
R8	2500 ohm 1 watt resistor
R9	100,000 ohm 1 watt resistor
R10	20,000 ohm 1 watt resistor
C1	.02 mfd. 400 v. Mica
C2	50 mfd. 25 v. Electro
C3	4 mfd. 450 v. Electro
C4	.02 mfd. 400 v. Mica
C5	50 mfd. 50 v. Electro
C6	.25 mfd. 400 v. Paper
C7	8 mfd. 450 v. Electro







KENYON
ENGINEERING NEWS

DEVOTED ENTIRELY TO THE AMATEUR, SERVICE ENGINEER SOUND TECHNICIAN AND THE EXPERIMENTER

Published by
KENYON TRANSFORMER CO., INC.
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J. B. CARTER, Editor

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By Way Of Introduction

For more than fifteen years the Kenyon Transformer Co., Inc. has not only supplied the radio industry with quality products but has pioneered since the earliest days of radio in the development of better audio components.

Now, with the formation of an Editorial Staff we are proud to present this, the first issue of "KENYON ENGINEERING NEWS", and hope you will like it.

Our policy is to provide authentic and dependable information on the newest developments in the radio and associated electronic fields. This information will be of interest to "the old-timer" as well as the serious-minded newcomer.

The facts about new equipment, new circuits and new methods will be published only after they have been thoroughly tested and found worthy in our own laboratory by engineers who will see to it that the apparatus is as good in actuality as it appears to be on paper.

Aside from new developments and constructional articles, we will also include in every issue full page Ken-O-Grafs, kinks, service hints and similar information that will be of use to the amateur, sound-technician and experimenter alike.

We want to make, in fact we are determined to make, "KENYON ENGINEERING NEWS" what the intelligent technician wants. It is not our intention to fill each issue full of plain junk in order to complete it; we prefer quality to quantity.

While we believe we know what you want and how you want it, constructive criticism will be welcome even though time may not permit individual replies. By writing us, you will prove that our efforts have not been wasted. If we do our part, we feel sure that you will do yours.

The Editor.

In Answer to Yours

Only Questions of General Interest will be Answered in these Columns

(Q) *What type of microphone do you recommend for general P. A. work?*

(A) The particular advantages and disadvantages of each type of microphone make it difficult to recommend any one of the popular types for all possible applications. While a high gain amplifier will operate quite satisfactorily with any microphone, providing a correct input transformer is used, it becomes necessary to select one or more, depending upon the intended application of the system. The following points should be kept in mind when selecting a unit:

1. Sensitivity
2. Frequency response
3. Local acoustic conditions
4. Cost
5. Ruggedness

The most sensitive microphone is the carbon type. Sensitivity is merely a matter of damping. Highly damped carbon microphones are best for outdoor use to prevent extraneous noises from being picked up. For indoor work the undamped type is to be preferred, particularly when the sounds to be picked up cover a large area.

The multi-cell crystal and the velocity type microphone lead all others in uniform frequency response.

Troublesome local acoustic conditions such as feed back can usually be rectified by using directional microphones. These are the velocity, dynamic and the crystal.

The cheapest are the carbon type. However, they require the most care and cannot be operated while in motion.

Ruggedness depends more upon the individual construction of the microphone rather than upon the type. With the exception of the carbon type, all others are so constructed so as to be mechanically shockproof. A well constructed velocity microphone can probably take more abuse than any other type of microphone.

For best results in any type of installation, it is recommended that a low level directional microphone such as a velocity or crystal be kept on hand together with a sensitive double button carbon type to meet any kind of an emergency.

(Q) *What is meant by the "apparent reverberation"?*

(A) The "apparent reverberation" as perceived in a sound pick-up system depends upon the ratio of generally reflected to direct sound. The direct sound travels from the source to the microphone without being reflected from any surface. The generally reflected or reverberant sound may encounter one or more reflections by walls, ceilings and floors before it reaches the microphone. The direct sound picked up by the microphone varies inversely as the distance between the sound and the microphone. The generally reflected sound is, in general, independent of the relative position of the source and the microphone. To reduce the apparent reverberation, it is necessary to reduce the ratio of generally reflected to direct sound, that is, the generally reflected sound must be increased by decreasing the distance between the sound source and the microphone. This, of course, places a limitation upon the sound pickup system.

(Q) *Transmitting tubes are rated at a certain wattage. What is meant by this?*

(A) As employed by most manufacturers, the rating of a transmitting tube is "safe plate dissipation in watts". It is possible to load a 100 watt tube so that approximately 100 watts will be radiated as heat from the plate and of course the glass bulb. A 100 watt tube is not a tube that will deliver 100 watts of power output, but will in the average circuit deliver about half of the input power as output. If a transmitter circuit is operating properly with circuits of low resistance, the output may be more. Tube overloading, it must be remembered, shortens tube life.

(Q) *What are the advantages in using push-pull stages in audio amplifiers?*

(A) All amplifiers produce more or less distortion. However, certain types of distortion can be neutralized by the use of push-pull circuits. This is most evident in amplifiers operated in class B or class A prime. The even harmonics of the frequencies being amplified are neutralized, and thereby reduced. Push-pull circuits have other advantages too. In transformer coupled circuits the D. C. plate current tends to saturate the core of the audio transformer which reduces the response of the amplifier at the lower audio frequencies. Push-pull avoids this saturating effect because the D. C. is balanced between the two tubes in the circuit.

The problem involved in properly by-passing the cathode bias resistor is also eliminated in the push-pull circuit. This prevents what often amounts to a tremendous loss in the low audio frequencies.

In most high gain amplifiers there is always a tendency towards oscillation which is very harmful on the quality. Push-pull usually eliminates this condition because all bias and plate voltages are applied to the circuit at points of minimum audio frequency voltage. This reduces coupling between stages and keeps feed-back out of the power supply. This relieves the necessity of using isolating reactors and large by-pass condensers which are usually more expensive than the additional tube required for push-pull.

(Q) *What are the output levels of the various modern microphones?*

(A) A check recently made indicates the following levels (reference level 0.006 watts). Only average levels are indicated, as there is quite a difference in the output level for the same type of microphone as manufactured by different organizations.

Velocity Microphone	-96db.
Dynamic Microphone	-85db.
Condenser Microphone	-80db.
Crystal Microphone	-70db.
Carbon Microphone Double Button	-40db.
Carbon Microphone Single Button	-30db.

Increasing Audio Fidelity with Equalization

The Tone Quality of An Amplifier Can Be Greatly Improved By A Correctly Designed Equalizer For Low And High Tones.

THE prime object of any audio amplifier used for P. A. or sound picture work is to reproduce the music or speech faithfully without any noticeable change or distortion of any kind. Speaking in more detail, to obtain true reproduction the entire equipment should not introduce or suppress any of the frequencies present in the signal, nor should they be partial to certain frequencies and amplify them more than they do others. While this is ideal in theory, in practice it is rarely accomplished. Unfortunately, high fidelity as it has been employed in audio power amplifier systems has been far too theoretical. While it is true we have high fidelity audio transformers that are flat within plus or minus ½ db. - 30 - 15,000 cycles there are other links in the high fidelity system that are often overlooked. The weakest link in the entire system is usually the speaker and though speakers have been greatly improved within the last year it can be truthfully said the perfect loudspeaker has not as yet been developed. In addition to this, the acoustic conditions of the various locations in which sound systems are used often accentuate certain frequencies which result in a change of timbre or tone color.

As an aid in overcoming some of the above problems the inclusion of tone controls has become common. Many of these so-called tone controls merely consist of a condenser in series with a rheostat. The effect of this type is to bypass the higher frequencies through the condenser, the setting of the rheostat determining the amount of bypassing. This method of apparent low note boosting does not produce natural reproduction, for since the high notes are cut off, the sound loses its brilliance and crispness.

A new form of tone control which actually increases or decreases the low or high frequencies is shown in Fig. 3. This unit is a simple device which may be bridged directly across any 500-ohm line or, by means of an impedance-matching transformer, may be bridged across any line for the purpose of modifying the charatcer of the input signal to an amplifier. It is designed to correct for deficiences in response characteristics of an amplifier, or to reinforce the high and low frequencies of the signal itself—if this be found desirable.

Three major frequency response modifications or types of equalization are provided:—

(1) Low frequencies can be emphasized (Fig. 1).

(2) High frequencies can be emphasized (Fig. 2).

(3) Both high and low frequencies can be emphasized (Fig. 3). Through the use of a selector switch any three of the equalization characteristics may be obtained at will.

The degree of the change produced by the unit may be controlled by a variable 1000-ohm resistor from no change at all, to maximum difference between 60-cycle and (or) 8000-cycle response; and 1000-cycle response of approximately 10db. Fig. 4 shows the equalization obtained with the 1000-ohm resistor set at 0, 60, 180 and 670 ohms for all three available conditions.

The use of this unit will generally be found to add considerably to the quality of electrical reproduction of phonograph recordings. An amplifier, which by itself, has only a fair frequency response may be corrected to give the performance of a much better unit. It is also possible to attenuate any particular frequencies that are over-emphasized (because of resonance in the electrical or mechanical network); or because of the particular physical or acoustical conditions existing in the places where the reproduction is taking place, or where the recordings were made.

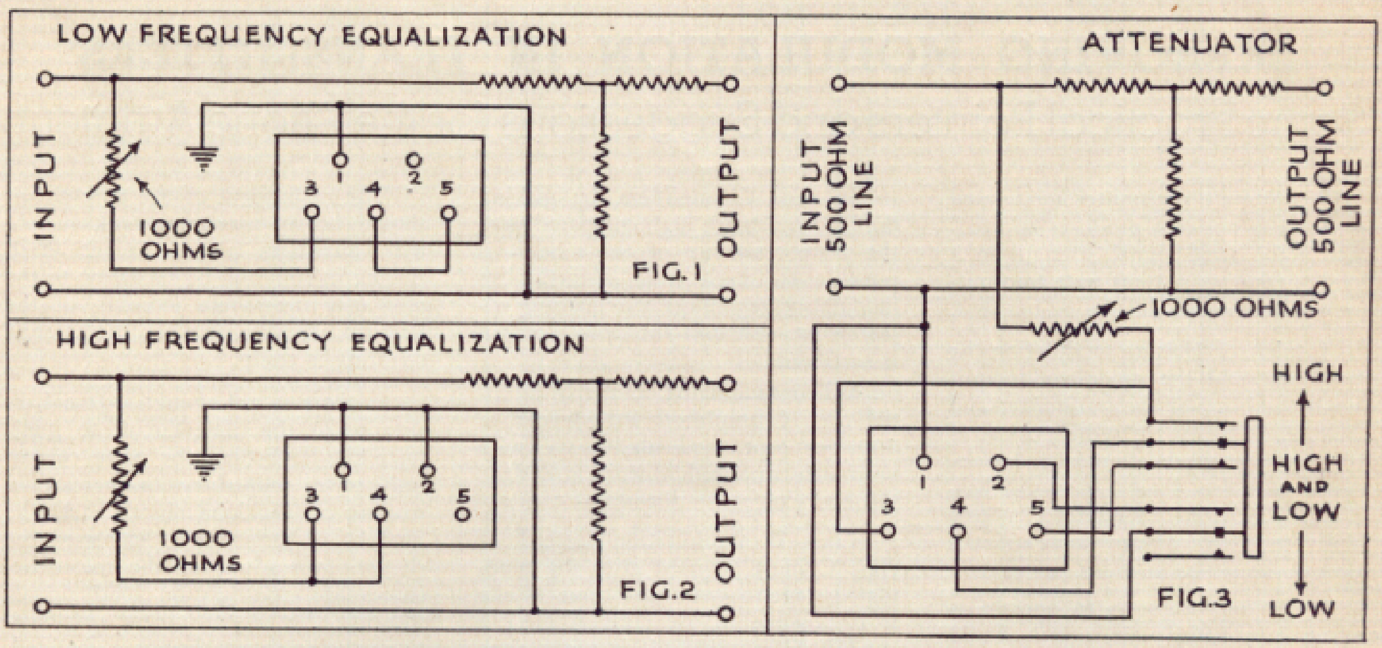
This unit may also be used to advantage with home amplifiers by utilizing simultaneous high and low—frequency equalization for tone compensation when listening to programs at low volume.

Those who contemplate installation of this unit must bear in mind that the high equalization obtainable with this unit lowers the gain at the frequencies where response is too prominent. In order to utilize this device to maximum advantage, the associated power amplifier should have at least 15 db. more gain than is required to obtain maximum desired output without the equalizer.

In many instances, especially in old or cheap amplifiers, an appreciable amount of hum may be noticeable when the low note response is increased. This is natural and is occasioned by the fact that the amplifier is being made to respond to the lower frequencies including the 60 cycle power line supply and the 120 cycle ripple from the full wave rectifier. Undoubtedly, additional filtering of the rectified B supply may be necessary and in extreme cases the input transformer and grid leads will have to be thoroughly shielded before the hum will be finally eliminated. However, the veritable new life afforded to these old type amplifiers through the use of this equalization method will amply repay the technician for the time and effort spent.

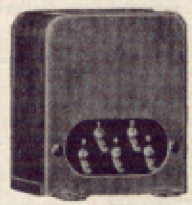
In concluding, it should be understood that while this unit is no cure-all for all the prevalent ills found in sound systems, it will however, eliminate in a speedy, economical and thoroughly practical manner, many of the undesirable features outlined.

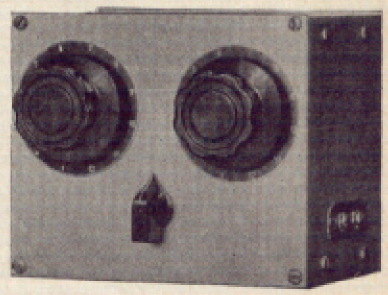
At the time of going to press our engineering research staff has just completed a new line equalizer for broadcast station use. This unit can be used on transmission lines up to ten miles in length for the purpose of maintaining high fidelity standards. An equalizer of this type will be of great value to broadcast engineers due to its flexibility and simplicity of operation. Encased in a standard laboratory cast case which provides excellent magnetic shielding. Standard construction provides top mounting. Bottom mounting may be had on special order.

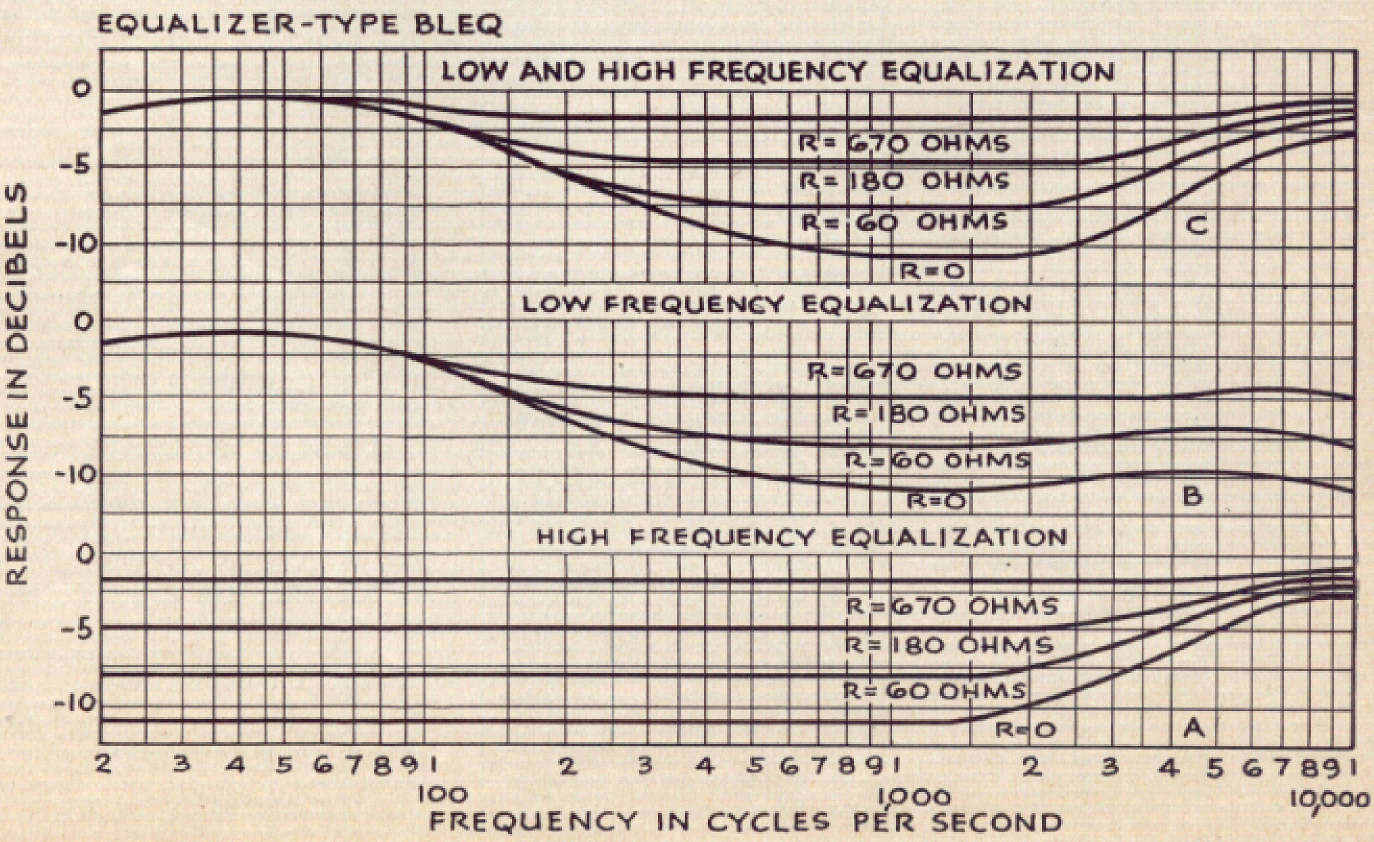


LIST OF PARTS

- 1 Kenyon Equalizer type BLEQ
- 1000 ohm rheostat
- 1 500 ohm T-Pad
- 1 D.P.D.T. Switch with neutral position







IMPROVING MODULATION IN TRANSMITTERS

Some Practical Pointers and Suggestions for the Phone Amateur

A 100 watt transmitter modulated 100 per cent produces approximately the same signal strength in a loud speaker as a 1000 watt transmitter would when modulated 32 per cent.

In plate or Heising modulation the modulator and the modulated amplifier is the heart of the transmitter and their adjustments are quite critical if 100 per cent modulation is to be obtained with less than 5 per cent harmonic distortion. Therefore, a few kinks to help remove some of the "bugs" should be in order.

If the modulator is to operate as a class A tube, the plate current should be midway between that obtained by zero and cut-off bias. The tubes most suitable for use as class A modulators are those having large undistorted power output. They generally have low plate impedance and low amplification factor. When operated as class A the output wave will have the same shape as the input wave and must be able to supply a 50 per cent increase in the transmitter output power if 100 per cent modulation is desired.

The modulated tube is usually worked as a class C amplifier and the bias must be approximately twice that required to give cut-off bias and plate current saturation must be supplied by the excitation from the preceeding stage. Class C modulated amplifiers require more excitation than similar amplifiers in C. W. transmitters and a surplus of excitation is very desirable.

It is just as necessary for the modulation to work into a load resistance of proper value for maximum undistorted power output as it is for an audio output tube to work into the proper load value for maximum undistorted power output; therefore, there is a proper value of class C amplifier plate current for any modulator amplifier combination and the amplifiers must be operated at this value of current if maximum undistorted modulation is to be obtained.

A fault with some transmitters is to operate the modulated amplifier with excessive plate current. This lowers the effective load resistance into which the modulator tube must work and means a low value of modulation without distortion.

In class C amplifiers, by making the load resistance high compared with the plate resistance of the tube it is possible to reach near distortionless modulation regardless of remaining adjustments, although the power output is sacrificed.

When modulated, properly adjusted class C amplifiers will develop a 100 per cent modulated wave with very little amplitude distortion and no frequency or phase distortion.

Class B amplification instead of class C must be used after the modulated stage to avoid distortion. While it is possible to use class A after a modulated amplifier, it is never done in practice because plate efficiency of class A amplification is much less than in class B.

To put a class B tube in operation: first adjust the bias to near cut-off point. Then obtain proper A. C. grid excitation. Use convenient load impedance in the plate circuit and vary the grid excitation until the milliameter in the grid circuit indicates there is a small D. C. grid current when the exciting voltage is modulated as completely as the apparatus will allow. Finally the load impedance is adjusted to give the highest plate efficiency. The load impedance should be twice the plate resistance of the tube for maximum output. Lower values of load impedance giving less output than maximum at lower plate efficiency should not be used.

The safest way to adjust the load impedance is to start with the greatest load impedance available. This is then reduced until the plate losses become excessive or until the maximum output is obtained.

If plate losses are excessive at the highest plate impedance that can be obtained, it is necessary to reduce the plate voltage and re-adjust the bias and excitation. If on the other hand the tube is not operating up to full capacity when the plate load impedance is the value giving maximum output, it is necessary to increase the plate voltage, bias and excitation.

It is impossible to get true class B amplification with grid leak alone. The approximate bias will be the plate voltage used divided by the amplification factor of the tube.

The adjustment of the tank circuit should be for maximum tank current with minimum plate current. Each change in coupling or excitation to the grid may necessitate retuning of the tank circuit, likewise when the antenna coupling is made.

If there is not enough external resistance in the plate circuit to minimize the distortion, the plate current milliameter will show an increase in reading on the loud signals. As the amount of resistance is increased the change in reading of the meter becomes less and less on loud signals showing that distortionless amplification is being approached or is obtained.

As the turns of the primary winding are decreased the step-up ratio of the transformer is increased, therefore the primary load impedance is decreased and the plate current increased. In any tube circuit, if the load resistance is too high, the plate current will be high without an increase in antenna current.

For best adjustment of antenna inductance start with minimum number of turns and gradually increase until proper loading is obtained but never to a point where increased plate current does not increase the antenna current.

The power amplifier tube draws more plate current when the antenna tuning is near resonance, and the change in plate current as the plate circuit tuning condenser is moved through resonance should be smooth. A sudden sharp change in plate current generally indicates the tube is breaking into oscillation and may have to be better shielded in order to eliminate this condition.

Downward modulation is caused by a reduction in power output with modulation when there should be an increase in power output. It may be due to any of the following:

Insufficient class C amplifier bias of modulated amplifier.

Insufficient class C amplifier RF excitation.

Excessive class C amplifier plate current causing overloading of the modulator.

(*Continued on page* 9)

Improving Modulation in Transmitters
(*Continued from page* 8)

In a linear amplifier following the class C modulated amplifier, downward modulation will result with 100 per cent modulation if the carrier excitation to the linear amplifier is greater than that which it can handle for peak loads.

Downward modulation may be the indication of a defective modulator tube.

If the bias on the class B tube is less than that required for cut-off downward modulation may result.

Before neutralizing or tuning it is necessary to remove any parasitic oscillations that may be present.

Parasitics result from stray couplings and resonant circuits, connecting wires, etc. and absorb energy. They can be eliminated by inserting suppressor resistors in the grids of the offending stage.

To test for parasitics disconnect the power amplifier from the preceding stage. Set the power amplifier tuning condenser at maximum. Set neutralizing condenser at minimum. Change neutralizing condenser from the minimum to maximum and if meter readings do not change, no parasitics are present.

To neutralize remove plate supply from tube.

Touch neon tube to grid or plate terminal of tube and adjust tuning condenser until tube glows with neutralizing condenser set at minimum.

Increase the value of the neutralizing condenser until the neon goes out and for finer adjustment, rotate tuning condenser again; also the neutralizing condenser.

Now turn the condenser through resonance and watch the grid meter. If any flicker in the grid meter is shown make a slight adjustment to the neutralizing condenser until there is no change in the grid reading when tuning condenser is turned through resonance. The circuit is then neutralized.

In case you cannot find the old neon, set the neutralizing condenser at minimum. Tune tank condenser until you get a dip in the grid current meter. This indicates the plate circuit is tuned to the preceding stage and also shows the tank circuit is drawing power. This is proof the tube is not neutralized as the dip in the grid meter shows the plate circuit is absorbing some energy. Neutralizing will prevent the plate circuit from absorbing energy and can be obtained by proper setting of the neutralizing condenser.

If necessary reduce the C bias on the tube being neutralized in order to get a good scale reading on the grid meter. The C bias must be returned to the original value after the stage is neutralized.

GLOW IN RADIO TUBES

The phenomena of gas ionization within a radio tube has always been the subject of discussion and interest, among all who are familiar with radio tubes. It is a well-known fact that certain types of tubes are more apt to show a slight blue glow between the internal elements than do other tubes, the reason being, in some cases, due to the material employed within the tube, which allows the phenomena to be observed more readily. However, such metals do not mean inferiority because of this inherent characteristic. Another condition of gas ionization might be caused by an inert gas,due to chemical reaction between the "getter" and another agent, manifesting itself by a glow between those elements farthest from the filament or cathode. Other types of glow are classified as fluorescent, mercury vapor base and gas.

The fluorescent glow is usually violet color and is noticeable around the inside surface of the glass bulb. This glow is a phenomenon caused by electronic bombardment taking place within the tube, and changes in intensity with that of the signal. It may at times be quite brilliant. Fluorescent glow has absolutely no effect on the operation of the tube. In fact, tubes with this characteristic are particularly good as regards gas content.

Mercury vapor haze is a blue glow which is noticeable between plate and filament in mercury vapor rectifier tubes, the perfect operation of which is dependent upon a mercury vapor that has been placed in the bulb during the exhaust period. Therefore this kind of blue haze is in no way detrimental to the operation of these tubes.

Naturally, we are prone to believe that tubes which show a glow within their elements are apt to be of inferior quality and do not represent the present day high standard of manufacture which has been attained within the industry. Nevertheless, there are marked distinctions between those tubes, which are actually defective and those which are inclined to possess such a phenomena as explained above. The defective can invariably be detected by a pinkish-blue or extremely pale-blue color, which generally is visible throughout the entire tube or in some cases betwen the filament and plate. Its presence, when of large content, affects the operation of the tube to the extent that erratic performance is noticeable. Gassy tubes should always be replaced with new tubes. Many tubes that show a distinct blue or violet color, which generally appears very close to the plate in most types and confines itself within a definite region, are perfectly good tubes for circuits in which they are designed to operate.

When in doubt as to the glow content of tubes, a sure test can be made by bringing a magnet close to the bulb. A gassy tube will not be affected while the fluorescent glow, which has no effect on the performance of the tube will shift about as the magnetic field is moved.

THE ELECTRONIC MIXER
(*Continued from page* 2)

Hum from the plate supply is totally eliminated through the use of an efficient filter circuit employing two 40 henry chokes and three 8 mfd electrolytic condensers. In some cases, the "B" supply for the mixer can be obtained from the main amplifier. If, however, the main power supply is taxed so that modulation causes variations in the "B" voltages, such variations on the electronic mixer will cause motorboating.

It is needless to say that although this circuit is a simple one, only high grade parts should be used in its construction. The final results cannot be any better than its poorest component.

As the input and output channels for the electronic mixer as described above will vary widely with individual services we cannot specify in the schematic what type of transformers to use for your specific requirements. Therefore, a comprehensive assortment of input and output transformers suitable for the majority of installations are included in the list of parts on page 3.

RAMBLING THROUGH AUDIO AMPLIFIERS

Random Observations Made with the Cathode - Ray Oscilloscope *

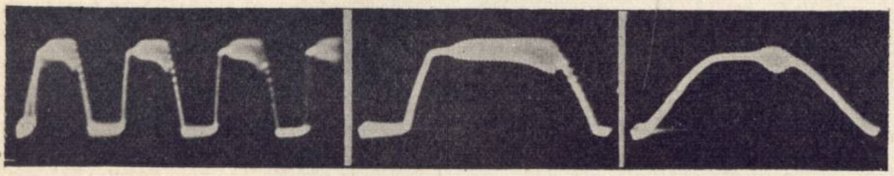
The Oscilloscope is one of the most important instruments in use today. For this reason we appreciate the opportunity of publishing this article by Mr. John F. Rider, well known to thousands of service men and an authority on this subject.

The Editor

ONE of the oft mentioned subjects associated with Class B amplifiers is fuzzy response. That is to say, the character of the speech is marred by "mush" and "fuzz". Usually, such distortion becomes quite pronounced when proper impedance relations are not maintained in the Class B stage and when appreciable signal input is applied.

Concerning the impedance relation, the trouble is most pronounced when the Class B stage is working into an impedance greater than the normal value. While it is true that Class B amplifiers are not very abundant in radio receivers, this type of amplification is found in very many public address amplifier systems. The men who work with such systems oftentimes operate with incorrect impedance relations and the following may be of interest.

The presence of such fuzz has been commented upon time and again in various publications and it is acknowledged that, under certain conditions, sustained oscillations are generated in the Class B stage. These oscillations may be generated as a result of operation of the Class B amplifier tubes in the zone of negative resistance, caused by the application of sufficient signal input so that the control grid voltage rises to the value where negative resistance characteristics exist. The frequency of these oscillations is determined by the constants of the units in the plate circuit. Such operation was more common with tubes first introduced for Class B operation, than it is today. However, such problems are still existent. These oscillations exist only over a portion of the audio cycle.



Figs. 1, 2 and 3. Fig. 1 (left) shows a transient oscillation in a Class B amplifier. Note that the oscillation is more clearly evident with a single cycle on the screen, see Fig. 2. Fig. 3 (right) shows a single cycle of the output voltage for decreased grid excitation.

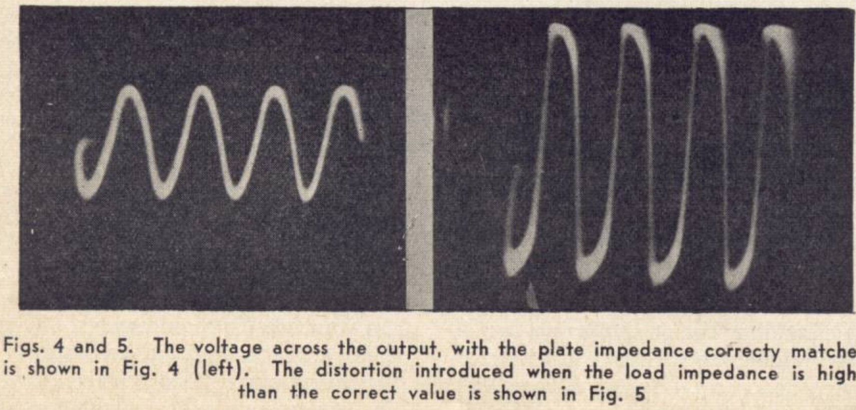
The three oscillograms of figures 1, 2 and 3 show the presence of these oscillations. These oscillograms were taken across one half of the plate winding. Fig. 1 illustrates a number of audio cycles. Figures 2 and 3 show a single audio cycle. Fig. 3 is the same as Fig. 2, except that the amount of signal input to the Class B stage has been reduced. This is evident in the illustration. Note that the duration of the transient, with respect to the cycle, is much smaller, thereby showing that the time during which the grid voltage is in the zone productive of oscillations is much smaller.

The frequency of these oscillations, judging by the number of cycles which appear upon the screen, is about 25,000 cycles. The amplifier referred to worked into a 25,000-ohm impedance, instead of the correct 4000-ohm impedance.

Any test made upon Class B amplifiers requires that correct load impedances be used, otherwise the information conveyed by the image appearing upon the cathode-ray tube screen will be misleading.

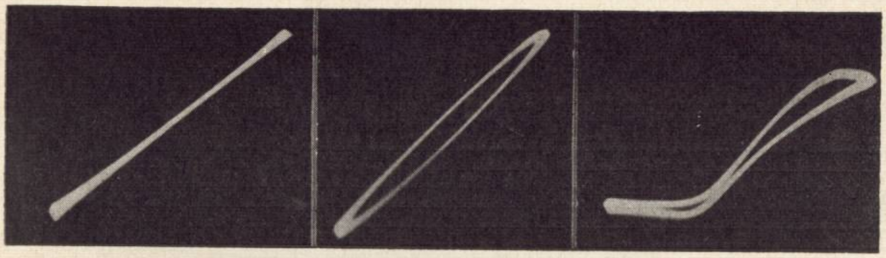
The two oscillograms in Figs. 4 and 5 show the effect of correct loading of the output transformer upon the waveform of the output voltage. The incorrect load impedance was higher than the correct load impedance, hence the greater amplitude.

Linear operation of an amplifier can be checked rapidly by developing an image indicating the relation between the input and output signal voltages. One such oscillogram, showing distortionless operation with a phase difference of 180 degrees between the input and output circuits, is shown in Fig. 6. The input voltage is applied to the vertical plates and the output voltage is applied to the horizontal plates. By proper adjustment of the controls, the amplitude of the two voltages is made equal. The presence of phase shift is indicated by a departure from a straight line and approach to an ellipse, as in Fig. 7. Non-linear operation is indicated by bending of one or both ends of the image, as in Fig. 8. In this case, phase shift as well as non-linearity and the resultant distortion, is indicated in the pattern.



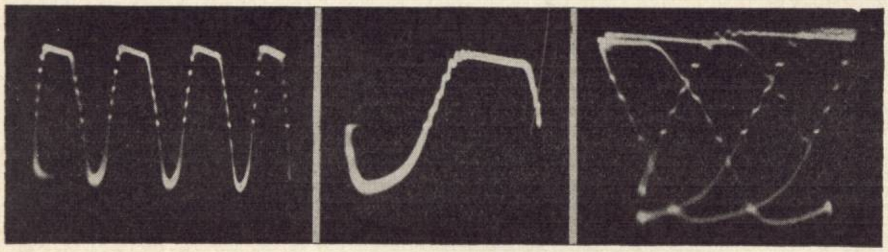
Figs. 4 and 5. The voltage across the output, with the plate impedance correcty matched, is shown in Fig. 4 (left). The distortion introduced when the load impedance is higher than the correct value is shown in Fig. 5

* Successful Servicing



Figs. 6, 7 and 8. The input-output voltage characteristic for an amplifier with no distortion and no phase shift is shown in Fig. 6 (left). Fig. 7 indicates the presence of phase shift. Fig. 8 indicates phase shift and amplitude distortion.

Concerning the application of the cathode-ray oscillograph to the observation of electrical phenomena, it is a good thing to remember that adjustment of the sweep frequency, so that it is higher than the frequency of the wave being observed, will often make observation of the wave very much simpler. This is evident in Figs. 9, 10 and 11. Fig. 11 shows four cycles of an audio wave, upon which is superimposed some sort of a transient. The presence of the transient is evident, but observation of the nature of the transient is impossible. Somewhat improved observation is made possible by increasing the sweep frequency so that a single cycle appears, as in Fig. 11. Much easier observation is made possible by increasing the sweep frequency still more, so that individual portions of a single cycle appear as separate traces.



Figs. 9, 10 and 11. An audio wave with a superimposed transient, as indicated by the "dots" is shown in Fig. 9 (left). One cycle of the wave is shown in Fig. 10. Note how the detail of the transient is brought out in Fig. 11 by the use of a higher sweep frequency.

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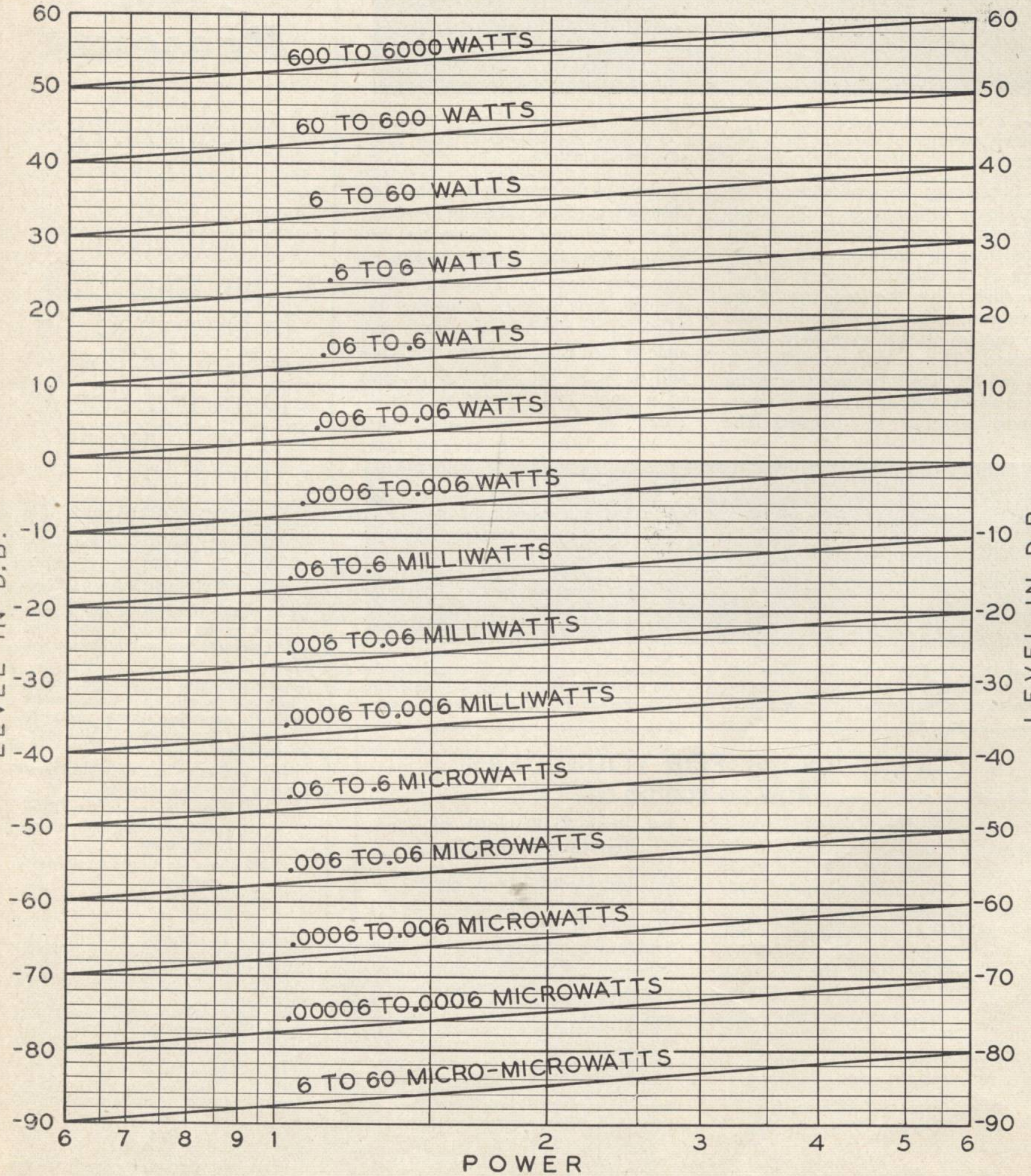
WATTS-VS-DECIBELS



Based on .006 watts at zero level.

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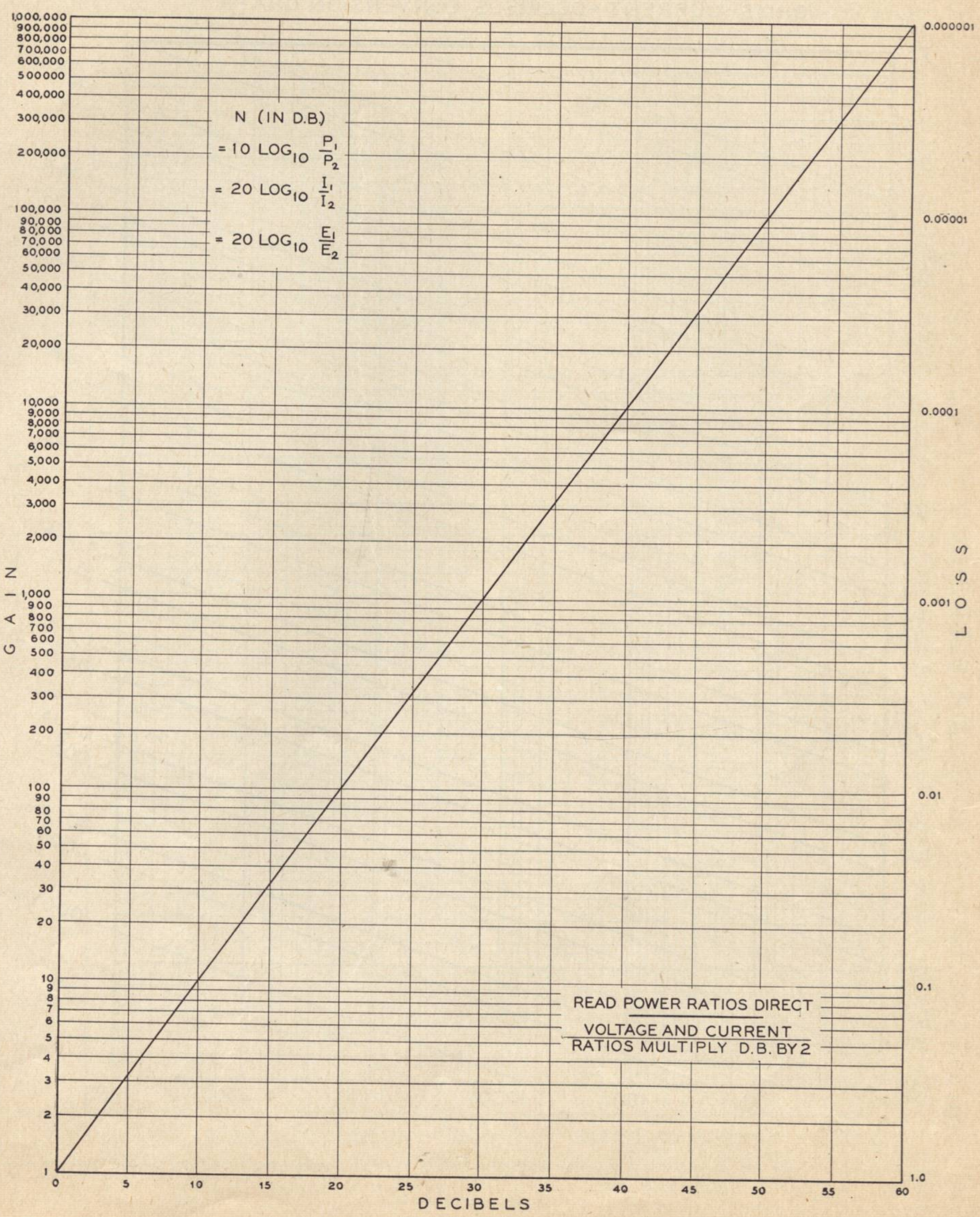
CONVERTING LOSS OR GAIN INTO DECIBELS



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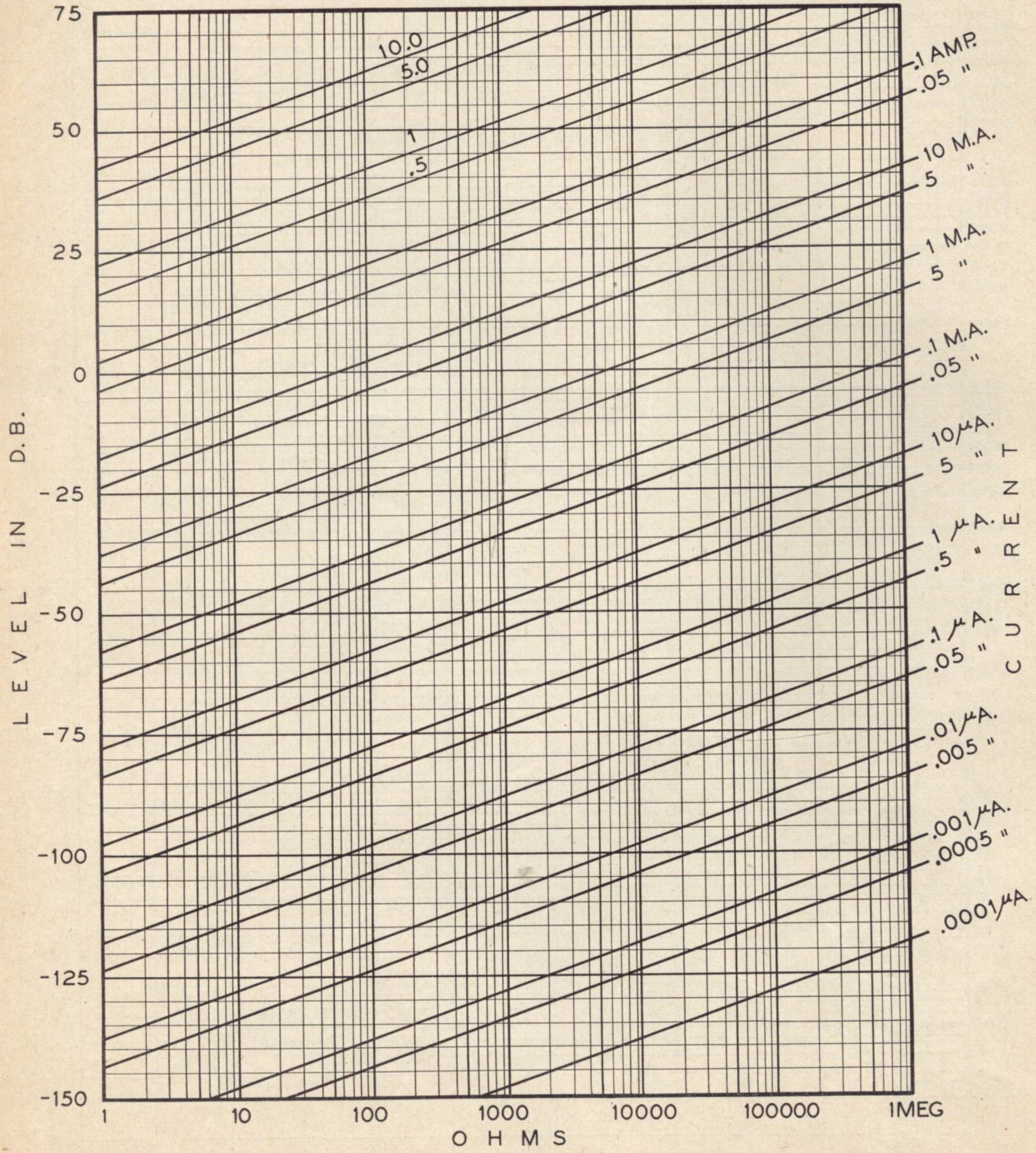
OHMS-CURRENT-DECIBELS CONVERSION GRAPH



This graph may be used to find ohms, current and level in decibels, e.g: What is the level in decibels at 600 ohms at a current of 10 M.A. Enter the graph at the bottom (ohms) at 600 ohms and read up to where the slanting 10 M.A. line intersects. From this point, project horizontally to the left, and read +10 db

Based on .006 watts at zero level.

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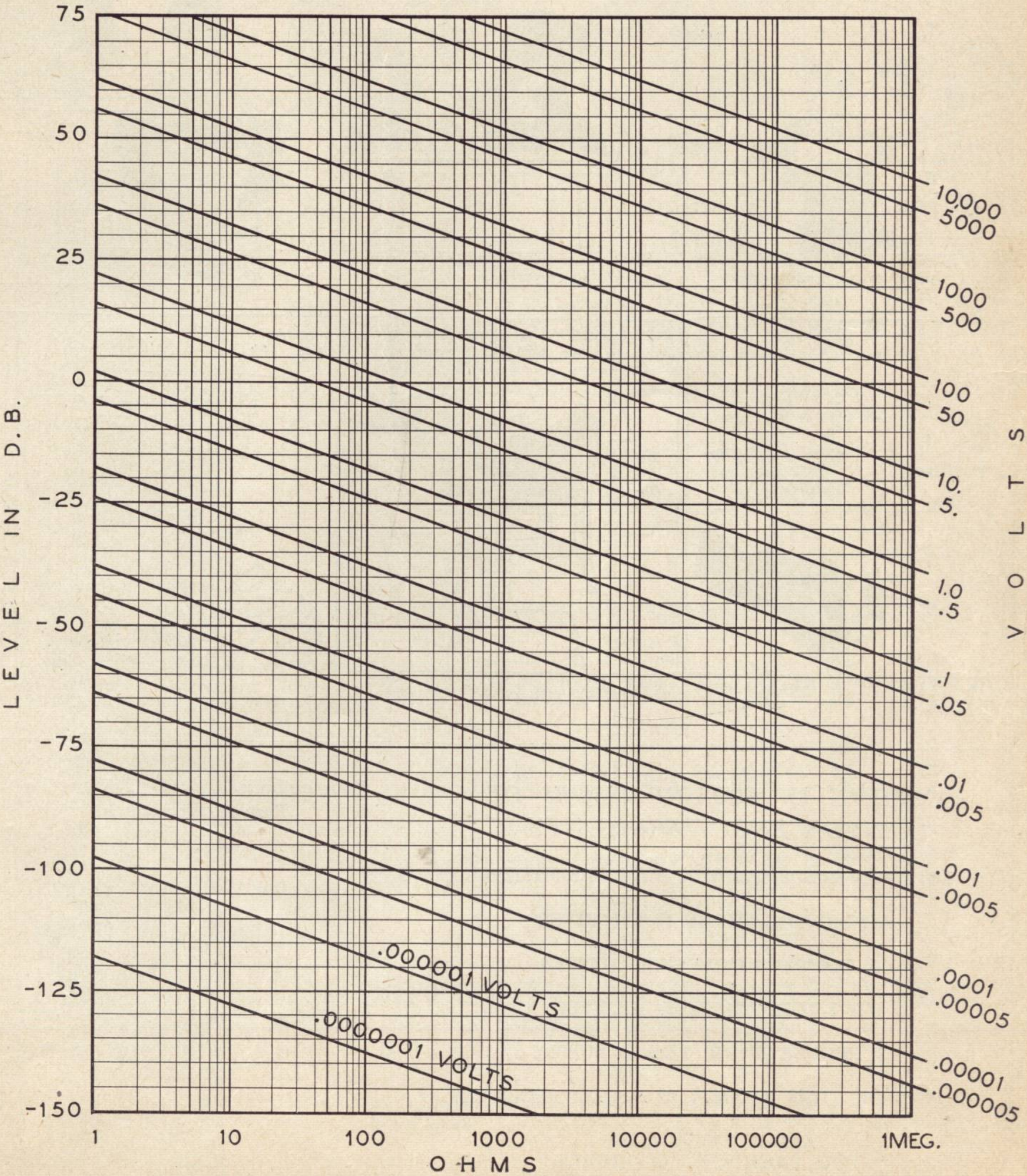
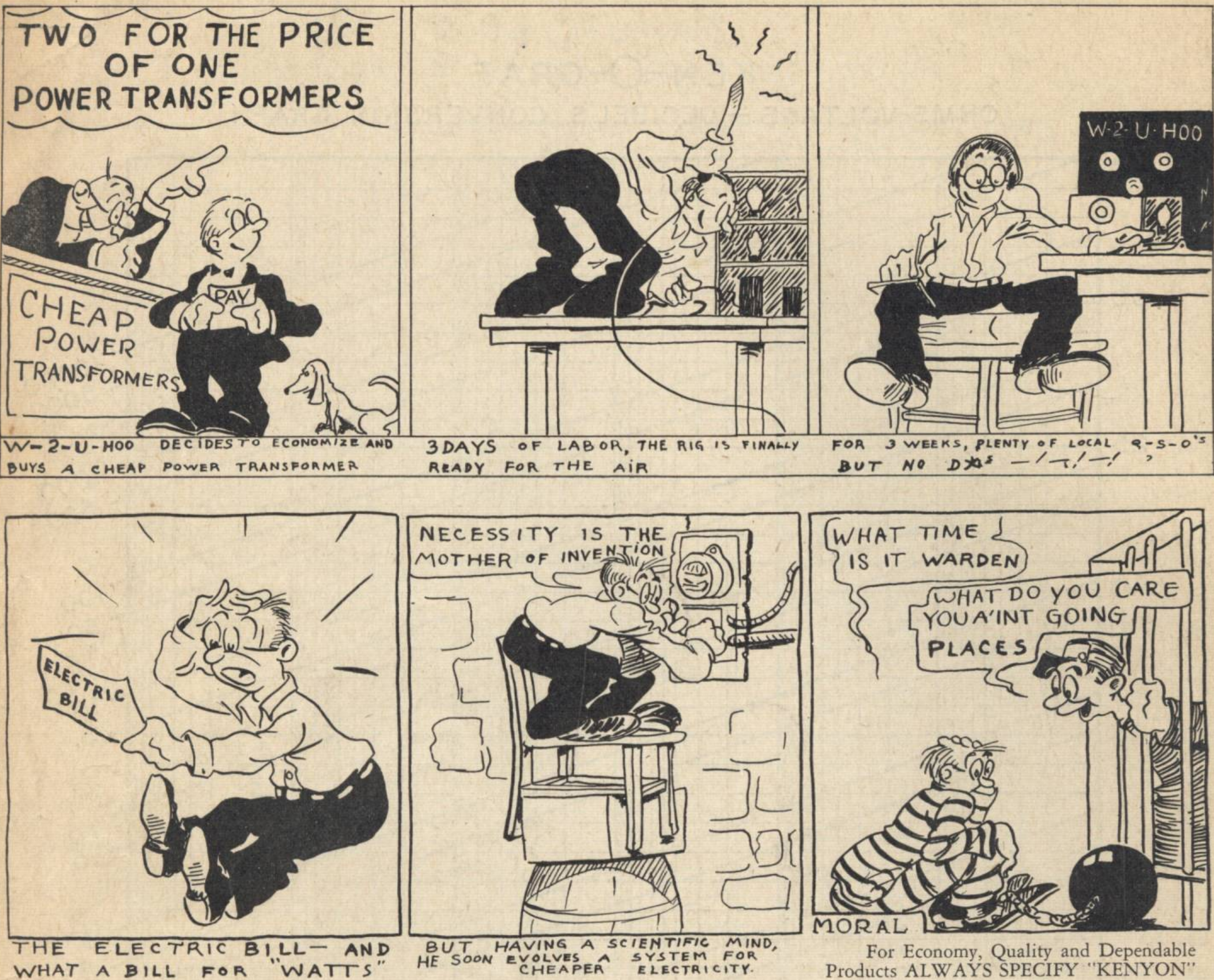
OHMS-VOLTAGE — DECIBELS CONVERSION GRAPH



This graph may be used to find ohms, volts and level in decibels. e.g. What is the level in decibels at 500 ohms at a voltage of 1 volt? Enter the graph at the bottom (ohms) at 500 ohms and read up to where the slanting 1 volt line intersects. From this point, project horizontally to the left, and read —5 db.

Based on .006 watts at zero level.



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