

Energy Values In a Broadcasting System

By JESSE MARSTEN

PEOPLE are invariably awed when enormous magnitudes are brought into play. Thus, tremendous wealth incites more wonder than the most abject poverty, though it is logical to expect abject poverty existing side by side with abnormal wealth to be an equal source of wonder. Again the onrush of a tremendous waterfall amazes people, often not so much because of the natural beauty of the fall as that, as advertisements might put it, "these falls light the homes of five states, furnish the power to run all the railroads within a radius of so many hundreds of miles, furnish the power for all factories and industries in these states, help mine one-third the coal output of the country," and so on. Yet few people pause to marvel, or think that there is at all any cause for marveling, at the minute amount of energy in the light of a little candle which throws its beams so far, or the microscopic amount of energy in a whisper which the ear so readily detects. The explanation of this may perhaps be found in the natural appeal of the spectacular, and large magnitudes are spectacular.

OUR MEANS OF INTELLIGENCE

Yet when it comes to the matter of transmitting or communicating intelligence, which is one of the most important functions of modern life, we have to fall back primarily on almost infinitesimal sources of energy. Thus the chief organs for the transmission and reception of intelligence between human beings are the mouth (vocal organs), the eye, and the ear. Each of these organs gives rise to, or is actuated by minute amounts of energy. The light energy in a small candle may be of the order of hundredths of a watt, yet the eye can detect this light many blocks away, even after the greater part of the light has been frittered away by absorption, refraction and reflection. The mouth in voicing a sound produces a displacement of the air so small that the wave-length of a light wave is enormous in comparison. Yet the microscopic energy contained in the motion of the air is sufficient to actuate the ear, which hears the sound, a splendid illustration, by the way, of the frugal and efficient manner in which Nature operates. The farsightedness of such an arrangement is apparent when you consider the effect of a one-hour talk on a speaker. Fleming states that the sound wave energy generated by a man speaking for one hour in a normal tone is of the order of 20 foot-pounds. This is as much energy as is expended in moving a weight of one pound through a distance of 20 feet, which is hardly felt by a normal man. Yet after talking for one hour a man is very much exhausted. If the ear were an organ which required considerable amounts of energy to actuate it, people might not be able to talk steadily for more than a few minutes without tiring, assuming a proportional effect on the nervous system—a state of affairs which many people might consider desirable.

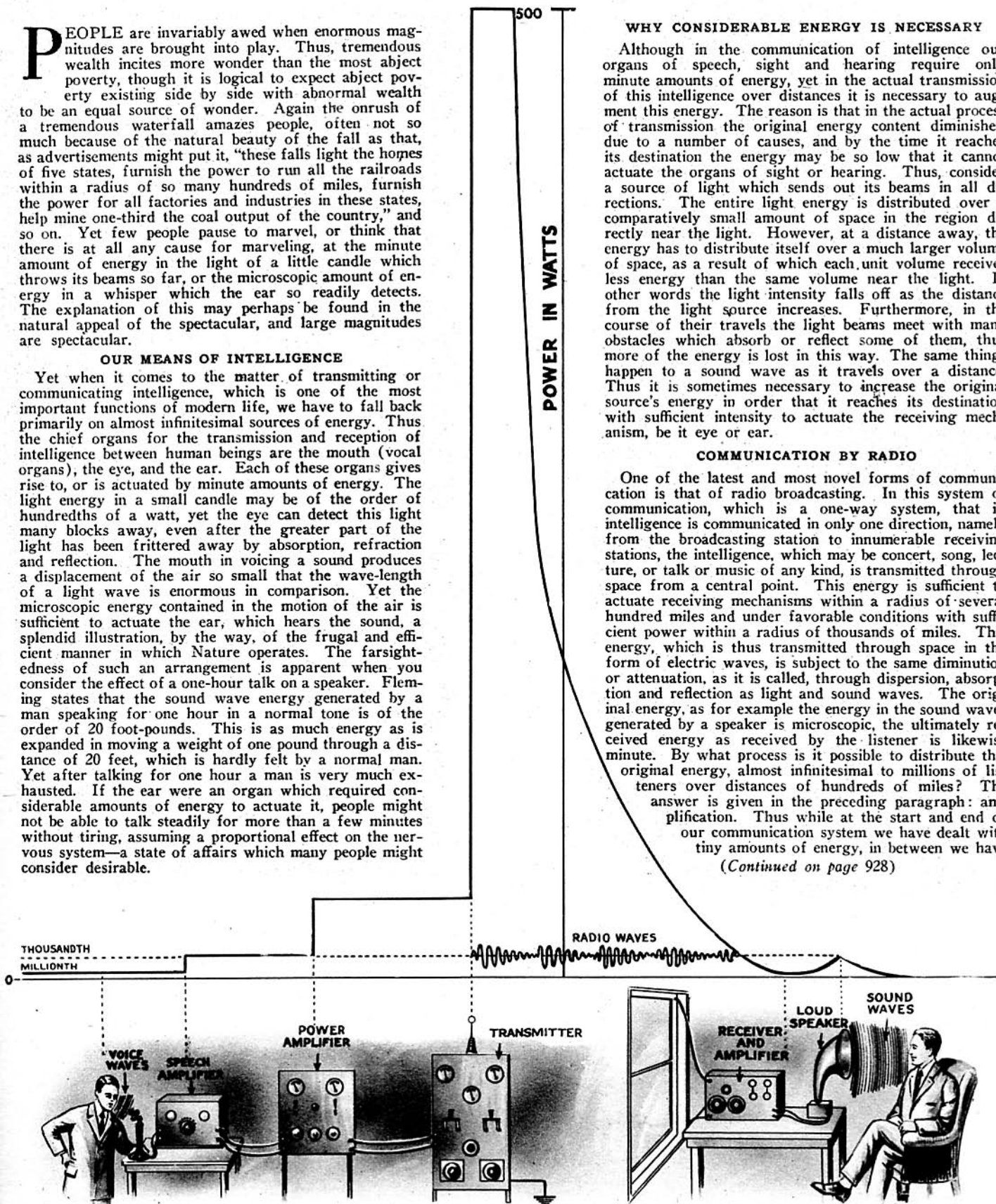
WHY CONSIDERABLE ENERGY IS NECESSARY

Although in the communication of intelligence our organs of speech, sight and hearing require only minute amounts of energy, yet in the actual transmission of this intelligence over distances it is necessary to augment this energy. The reason is that in the actual process of transmission the original energy content diminishes, due to a number of causes, and by the time it reaches its destination the energy may be so low that it cannot actuate the organs of sight or hearing. Thus, consider a source of light which sends out its beams in all directions. The entire light energy is distributed over a comparatively small amount of space in the region directly near the light. However, at a distance away, the energy has to distribute itself over a much larger volume of space, as a result of which each unit volume receives less energy than the same volume near the light. In other words the light intensity falls off as the distance from the light source increases. Furthermore, in the course of their travels the light beams meet with many obstacles which absorb or reflect some of them, thus more of the energy is lost in this way. The same things happen to a sound wave as it travels over a distance. Thus it is sometimes necessary to increase the original source's energy in order that it reaches its destination with sufficient intensity to actuate the receiving mechanism, be it eye or ear.

COMMUNICATION BY RADIO

One of the latest and most novel forms of communication is that of radio broadcasting. In this system of communication, which is a one-way system, that is, intelligence is communicated in only one direction, namely from the broadcasting station to innumerable receiving stations, the intelligence, which may be concert, song, lecture, or talk or music of any kind, is transmitted through space from a central point. This energy is sufficient to actuate receiving mechanisms within a radius of several hundred miles and under favorable conditions with sufficient power within a radius of thousands of miles. This energy, which is thus transmitted through space in the form of electric waves, is subject to the same diminution or attenuation, as it is called, through dispersion, absorption and reflection as light and sound waves. The original energy, as for example the energy in the sound waves generated by a speaker is microscopic, the ultimately received energy as received by the listener is likewise minute. By what process is it possible to distribute this original energy, almost infinitesimal to millions of listeners over distances of hundreds of miles? The answer is given in the preceding paragraph: amplification. Thus while at the start and end of our communication system we have dealt with tiny amounts of energy, in between we have

(Continued on page 928)



This Illustration Will Give the Reader a Good Idea as to Energy Values in Broadcast Transmission and Reception. The Voice Waves, a Matter of a Millionth of a Watt in Energy, Are Transformed Into Electrical Vibrations of Much Greater Magnitude in the Speech and Power Amplifiers and Increased Finally to 500 Watts in the Transmitter from Which They Are Shot Into Space. An Immense Amount of This Energy of the Radio Waves is Dissipated in Space, But When Picked Up by a Receiver It is Again Increased By Its Passage Through Amplifiers.

**Thrill your best Friend
this Christmas!**

—make him a present of
a distance-getting



ALL-AMERICAN AMPLIFYING TRANSFORMER

(Audio or Radio Frequency)

Largest selling transformers in the world. Over a quarter million in use. Standard equipment on the better sets. They defeat interference, abolish foreign noises, add distance without distortion. You get volume and tone-quality that mean real thrills. Suitable for all circuits.

All better dealers sell "All-American."

RAULAND MFG. CO.

200 North Jefferson St., CHICAGO

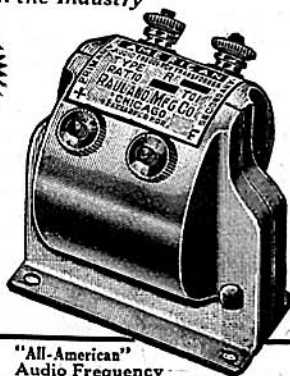
Pioneers in the Industry



"All-American"
Bakelite Tube
Socket—Base or
Panel Mounting **75c**

FREE!

Book of tested
hook-ups. Send
2 cents to cover
postage.



"All-American"
Audio Frequency
Transformer

SALESMEN

Largest radio publishing organization in the world, wants salesmen, either whole or side line, to sell an assortment of 20 books to the trade.

Liberal commission to hustlers.

Box 233, RADIO NEWS
New York City.

SEND FOR YOUR FREE COPY

TESTED HOOK-UPS

SUBMITTED BY USERS OF OUR



Price \$1.00
POSTPAID
with instructions

**WONDERFUL
TRANSMITTER**

**BUTTON FOR LOUD
SPEAKERS**

**AMPLIFICATION
AND EXPERIMENTS**

K. ELECTRIC CO.

15 PARK ROW

NEW YORK

This transmitter radiates from 25 to 30 amperes as compared with 80 amperes previously used by the spark set. However, the range of the new set, even though it uses only one-tenth of the power of the spark is about twice that of the latter transmitter. This fact was determined in a series of transmission tests in which stations on both coasts were asked to listen in. It was desired to make sure that the new set had at least the range of the old one before it took over the traffic. This cautiousness is only one example of the thoroughness of Navy radio and the shutting down of the Arlington spark is testimonial to the fact that the Navy is alive to the problem of interference with broadcast reception. As funds and conditions permit, this interference is being eliminated, always making sure that whatever changes in Navy radio material are necessary will be done with caution so as at no time to disrupt the communication needs of our first line of defense.

In closing, the writer hopes that this new transmitter will make as many friends as that older voice of NAA, the famous Fessenden spark, which has at last fallen behind the march of Progress.

A Broadcasting Station De Luxe

(Continued from page 874)

set or loud speaker and adjusts the amplification so that the concert program is clear to the audience at all times.

To make the program available to the public, Colonel Green has had installed a set of loud-speaking sound-projectors on a water tower a short distance from the main station, WMAF, on his estate, and there is plenty of parking space around the tower. When the outfit was first used the program could be heard for some distance outside the grounds of the estate and later the loud-speaker sound-projectors were tipped downward a little so that the sound carried only a short distance away from the tower.

Energy Values in a Broadcasting System

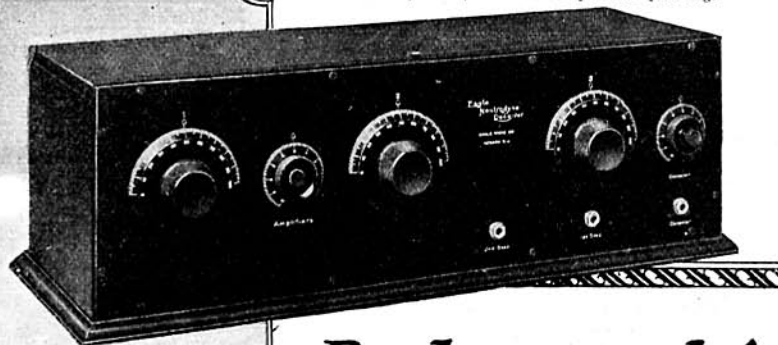
(Continued from page 873)

considerably increased energy. It is of interest to trace the various levels of energy through which the intelligence to be transmitted must pass as it proceeds from its source to its final destination.

THE TRANSFORMATION OF ENERGY

We will assume that a talk or lecture is to be transmitted: The speaker talks into a telephone transmitter in a normal tone at a distance of two or three inches from the transmitter. The power of the sound waves generated by such normal talking is of the order of millionths of a watt. How ridiculously small this energy is may be realized when it is said that the power delivered to the ordinary electric lamp is five million times as great as that of the sound waves generated by normal talking. This minute amount of energy in the sound waves is transmitted by the motion of the air to the diaphragm of the telephone transmitter. The actual motion of the air is likewise minute, probably of the order of millionths of an inch,

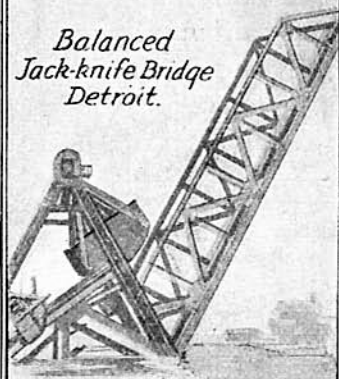
Licensed by Independent Radio Manufacturers, Inc., under Hazeltine Patent No. 1,450,080. Dated March 27th, 1923, and other patents pending.



Balanced!

THE portals of advanced radio—new realms of pleasure and utility once locked to all but the professional—now swung wide open to everyone, however unfamiliar with radio, by the marvelous proficiency and easy operation of this super-set.

Balanced
Jack-knife Bridge
Detroit.



The Eagle

Balanced Neutrodyne

RADIO RECEIVER

The uncertain element—tube capacities—balanced (neutralized) as perfectly as the jack-knife bridge, removes the guess from radio reception. Gone for good are the familiar annoyances—regeneration, reradiation and body capacity effects. Extremely sharp tuning and a perfect ease of adjustment. Each Eagle Neutrodyne Receiver individually tested. A splendid reputation staked on each Eagle Receiver. Guaranteed absolutely without reservation.



Write for Illustrated
Booklet NOW!

20 Boyden Pl., Newark, N. J.

or if we lean towards the optimistic, of the order of hundred thousandths of an inch. This small motion is transmitted to the telephone transmitter diaphragm which then moves in unison with the motion of the air. Due to the construction and mechanism of the telephone transmitter this small power of ten millionths of a watt of sound energy is converted into electrical energy having power of the order of a thousandth of a watt, so that in this instrument only, we have already magnified the originally minute sound wave energy about one hundred to one thousand times.

However, this available power is not sufficient to enable the transmission of intelligence via radio. It is, perhaps, sufficient to transmit intelligible speech over a telephone line for about 20 miles. But in the transmission over a telephone line all the energy is confined to a limited path, namely the two copper wires constituting the telephone line and none of the energy leaks out appreciably. In the case of radio the energy is diffused over enormous space, hence this energy must be still further amplified. For further amplification it is now essential to call into play the vacuum tube which is able to amplify speech energy without appreciably distorting the speech. In order to obtain the total amount of amplification required, it is necessary to divide this process into a number of steps, that is, grade the amplification. The first step consists in amplifying the above small amount of speech energy to the level of about five watts. This may be accomplished by one tube, or by a number of tubes, but the net result is the same, namely energy of the order of about five watts is now obtained. Thus in this step the energy has been amplified from approximately one one-thousandth of a watt to about five watts, giving a total energy amplification of five thousand times approximately.

The next stage in the amplification process is that of raising the available energy to the order of 50 watts. This again may be accomplished by one or several tubes, but the end result obtained is the same, namely, the tube amplifies the five watts of speech energy put into it, to about 50 watts. Finally in the last step these 50 watts are amplified to the order of 500 watts, this being the power of the average broadcasting station. Thus, in these last two steps we have amplified the five watts to 500 watts, a total of 100 times, and these 500 watts are launched into the ether by the broadcasting antenna.

A broadcasting station starts out with speech energy in the form of sound waves, of the order of ten millionths of a watt, or about one five-millionth of the power required to light an ordinary lamp, and ends up with about 500 watts, or enough power to light about 10 lamps. The original energy has been amplified by no less than 50 million times! In spite of this enormous amplification the total power launched into space is relatively small, only 500 watts, as compared to power transmitted for lighting houses, or driving motors. This relatively small amount of power is not confined to a narrow channel or definite limited path, but is distributed in all directions, which will explain why the power falls off so rapidly as we move away from the broadcasting station.

LOSS OF ENERGY IN SPACE

Power equal to 500 watts is therefore impressed on the ether in the immediate vicinity of the broadcasting antenna, this power being in the form of electro-magnetic waves, waves similar to light waves in their properties, but tremendously



PRICE, \$1.00

JUST THE BOOK YOU WANTED

"Radio News"

Amateurs' Handibook

Volume No. 1

Chock full of radio constructive and instructive articles from cover to cover. Written by foremost radio authorities, in plain everyday language which everyone can understand. Sections include articles on Receiving Sets and Sundry Apparatus, Transmitters and Accessories, Radio Theory, Vacuum Tube Data, and Practical Hints for the Amateur. A book which also serves as a ready reference and should find a place in the library of every amateur. It contains 224 pages and over 375 illustrations, diagrams, and photographs, bound in a multi-colored heavy board.

On sale at all leading radio stores. If your dealer cannot supply you, pin a dollar bill to this ad and write your name and address in the margin below, and book will be forwarded to you postpaid.

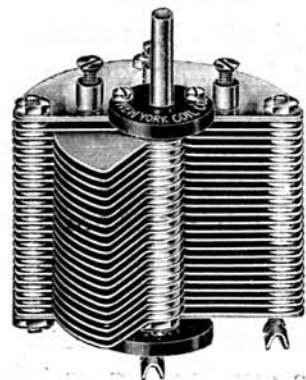
EXPERIMENTER PUBLISHING Co., INC.

53 PARK PLACE, NEW YORK

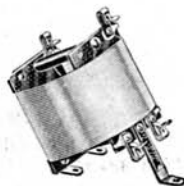
New York Coil Company's

Radio Products

Have An Established Reputation for Honest Value, Maximum Results and Ease of Installing

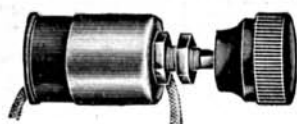


Our Perfected Radio Frequency Transformers deliver extraordinary results. A set of two will give the satisfaction you have so long desired.
Price\$4.00

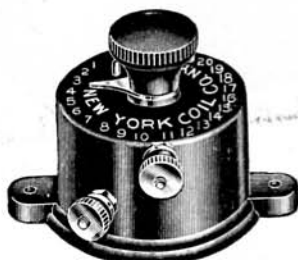


New York Variable Condensers are all equipped with GENUINE BAKELITE INSULATION. Positive contact and of the best value obtainable.

11 Plate	PRICE \$1.50
23 Plate	2.00
43 Plate	3.00



Supplementary Vernier Condenser. Just what you need for sharp tuning.
Price\$1.00



A Variable Grid Leak of quality and precision. Roller contact incomparably better.
Price\$1.50



Mica Fixed Condensers of tested and permanent capacity.
\$.35 to \$.75

Couplers, Variometers, Amplifying Distortionless Transformers

NEW YORK COIL COMPANY

338 PEARL ST.

NEW YORK CITY, N. Y.

Pacific Coast: Marshank Sales Co., 1240 S. Main St., Los Angeles, Cal.

HYGRADE SPECIALS

200 ft. 7 strand No. 22 Copper aerial wire.....	\$1.25
Morse Eureka Test Clips, per dozen.....	.50
Skinderviken Transmitter Buttons.....	.95
No. 763 Eveready 22½ V. Variable B. Bat.....	1.25
No. 766 Eveready 22½ V. Variable B. Bat.....	1.98
No. 767 Eveready 45 V. Variable B. Battery.....	3.98
2000 Ohm Murdock No. 56 Head Sets.....	3.50
3000 Ohm Murdock No. 56 Head Sets.....	4.25
Federal or Brandes Head Sets Complete.....	5.50
Ditograph 3000 Ohm Head Sets.....	5.98
Fada or Framingham Rheostats.....	.65
Acme Amplifying Transformers.....	3.75
Acme R. F. Transformers, Types R2-R3-R4.....	3.98
6 Volt Marko Storage Batteries.....	8.95
Fireco (Bull Dog Grip) Phone Plugs.....	.75
Federal Amplifying Transformers.....	4.75
23 Plate Var. Cond. Bakelite Ends.....	1.49
43 Plate Var. Cond. Bakelite Ends.....	1.95
No. 164A Fada Neutrodion Condenser.....	.98
No. 163A Fada Neutroformer.....	6.49
No. 165A Fada Hazeltine Parts.....	21.50

All orders must include Parcel Post charges

Hygrade Electrical Novelty Co.,
41 West 125th Street New York, N. Y.

Jones Condenser Cleaner



Dirt and dust will collect on the plates. You must clean them. Nothing will do this so well as the Jones Condenser Cleaner. Stiff enough to get between and remove dirt, but not to bend the plates. It is not a make-shift but a practical device, mounted 24 on a card for counter display.
10c at your dealer, if he cannot supply you, we will mail on receipt of 12c.

Send for folder of Howard B. Jones Radio Products.
HOWARD B. JONES, 612 S. Canal St., Chicago, Ill.

larger in length. These waves carrying the transmitted or broadcast intelligence travel away from the antenna in all directions, giving up some of their energy to every antenna in their path. But the energy extracted from the waves by the antenna is but a very small part of the energy lost by the advancing waves. Most of their energy is lost in a natural diminution as they travel farther and farther from their source, the antenna. Just as light becomes dimmer and dimmer as we recede from the source of light, so the electric waves become weaker and weaker as we recede from the source of the waves. Furthermore these electric waves meet with numerous obstacles which extract large portions of the electrical energy uselessly. Thus the steel girders in modern buildings are consistent thieves in this respect, the energy of passing waves being absorbed by such girders and wasted in them. Also electric waves, being similar to light waves in their properties, are reflected and refracted when the properties of the medium through which they pass change appreciably. The net result of all this is that the electric waves lose the greater portion of their energy wastefully, and only a very small percentage of the total wave energy is utilized in actuating receiving sets. As a result the energy actually arriving at a receiving antenna is reduced to practically the same order of magnitude as the energy of the original sound waves, namely, the power of the receiving aerial is of the order of millionths of a watt. The actual power varies, of course, with the distance from the broadcasting station, the nearer the receiving station the greater the power received. But when appreciable distances are under consideration, say 25 to 50 miles or more, this state of affairs exists. Thus our original power of the order of a millionth of a watt was amplified several million times until it was increased to 500 watts, only to be reduced after its travel to the order of the original millionth of a watt again.

This power of a few millionths of a watt is sufficient to actuate the mechanism of the ear if only the ear could respond to the high radio frequencies employed. Since the ear cannot be actuated directly by such high frequencies it is necessary to reconvert this energy back to its original form, namely, to audible speech to which the ear does respond. The detecting device, the vacuum tube again, does this. But before it can do this the detecting tube itself must have sufficient power to actuate it efficiently, and so the receiving energy of the order of a millionth of a watt or less is amplified and then detected. When the energy finally emerges from the detector tube it is in the form of electric currents of audible frequency, and the power of these currents is of the order of thousandths of a watt, an amplification of the order of a thousand times. This electrical power of a thousandth of a watt or so is what moves the diaphragm of the telephone receivers, which moves a distance of the order of millionths of an inch. This motion of the receiver diaphragm is then transmitted finally to the air with a loss of energy. The thousandth of a watt in the telephone receivers is converted to the order of a millionth of a watt of power when transferred to the air, and this is sufficient to actuate the mechanism of the ear which now hears the original sounds as spoken in a broadcasting studio.

The illustration shows graphically how the energy level varies throughout the entire procedure; how we start with unbelievably small amounts of power of the order of a millionth of a watt, magnify it

Insure your copy reaching you each month. Subscribe to Radio News—\$2.50 a year. Experimenter Publishing Co., 53 Park Place, N. Y. C.

THE COIL
DOES IT

Samson

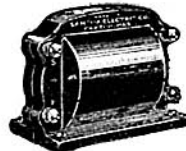
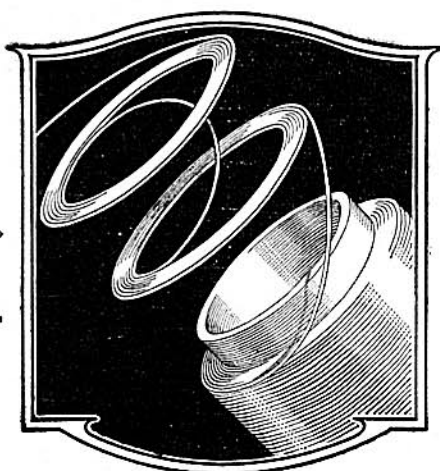
HW-A1
AUDIO FREQUENCY

Transformer

NOTHING
LIKE IT



THE SECRET OF



ITS SUCCESS

Constructed with Helical windings in both primary and secondary Coils (an exclusive feature) the Samson Transformer has proven its superiority under actual operating conditions. In a nutshell:—

- a—The Effect of Distributed Capacity Reduced to a Minimum.
- b—Resistance Reduced to a Minimum.
- c—The Effect of Current Leakage Between Adjacent Wires Reduced to a Minimum.
- d—Clearer Reception—No Howling.

Note the Coil pictured above; wires are in layers at right angles to the core. Write for detail story of the advantages of this *exclusive Samson Patent*. Free Chart No. 24 of Tests will be included.

The next time at your dealers, examine Radio's newest achievement; ask about the

Ratio 6 to 1

Samson
HW-A1
AUDIO FREQUENCY
Transformer

\$7 at Dealers

SALES OFFICES:

Boston, Atlanta, New York, Philadelphia, Pittsburgh, Chicago, Cleveland, Detroit, Indianapolis, St. Louis, Minneapolis, San Francisco, Los Angeles, Seattle, Portland, Montreal and Toronto.

SAMSON ELECTRIC COMPANY, CANTON, MASS.

RADIO FANS

Tune in on station
WEAF (New York)
every Thursday at 8.50 P. M. and listen
to a story or article selected from

**HEARST'S
INTERNATIONAL**

This is one of the most popular weekly features
"on the air"

FREE

Write for Free Copy of the Latest Radio Reprint B.
It contains a complete story from "Hearst's
International Magazine."

Address Radio Editor, Hearst's International Maga-
zine, 119 West 40th Street, New York City.

THE CRYSTAL
ATOMITE FOR **POWER+VOLUME**

GUARANTEED

LOUD ALL OVER. A SIZABLE
CHUNK—SENSITIVE EVERYWHERE
ATTRACTIVELY MOUNTED.

PRICE 50c POSTPAID.

NION
FIXED DETECTORS—

GUARANTEED LOUD—95% METAL—NICKEL PLATED
COMPARATIVELY INDESTRUCTIBLE.

THE KEYSTONE PRODUCTS CO.
ROYAL OAK, MICHIGAN

several million times to 500 watts; how it diminishes, as it travels, to its original level of millionths of a watt; how it is then amplified again to the order of thousandths of a watt, and then finally diminished again to millionths of a watt, its original microscopic value, but sufficient to actuate the sensitive human ear, even at distances of thousands of miles.

Measurements of Frequencies of Stations

(Continued from page 905)

Special attention is being given by the Bureau to the stations which do maintain such standards, and an announcement will be made later stating the degree of constancy that has been observed, so that persons may utilize the transmissions from these stations as a standard for the calibration of apparatus.

The method used by the Bureau in measuring the frequency of distant stations involves the use of a local radio-frequency generator. This is adjusted to the same frequency as the received wave from the transmitting station, this adjustment being determined by receiving both frequencies in a receiving set and varying the local generator until a zero beat note is obtained. The frequency of the local generator is then measured with a wave-meter.

Further details of the method are given in the Bureau of Standards' Letter Circular 92, "Radio Signals of Standard Frequency and their Utilization." A limited number of copies are available at the Bureau and can be obtained by those having actual use for this information.

The Radio Police Car

(Continued from page 870)

But radio now interests Mr. Wootton more than the systems that he has perfected. His office has all the ear-marks of an amateur wireless station. By removing the apparatus from a chair and holding it in his lap he is able to make room to sit down. No one should interpret incorrectly the use of the term "amateur" in this connection. It is the designation made sacred by the American Radio Relay League, by whom it is never, never, never applied to listeners-in, folks who copy local stations, or that kind of people. Mr. Wootton is one of those amateurs who apply the term "professional" to the next grade in a descending series. He knows where each little electron is and what it is planning to do next.

"Are the American amateurs having much success with the Armstrong super-regenerative circuits?" he asked, picking up a small suitcase.

It hurt me to do it, but I told him the truth.

"This Armstrong set looks crude, but it works all right up to a radius of 15 miles," he said, opening the bag.

The first part of the statement was correct and I took his word for the rest. No one could doubt anything Mr. Wootton said, even if he wanted to, he is so conservative and careful not to over-state anything. He would make a very poor newspaper man.

Out in the Yard is his wagon, the auto that runs 40 miles an hour while a cop inside chats with headquarters in the city, stations in the field, an airplane overhead

Insure your copy reaching you each month. Subscribe to Radio News—\$2.50
a year. Experimenter Publishing Co., 53 Park Place, N. Y. C.