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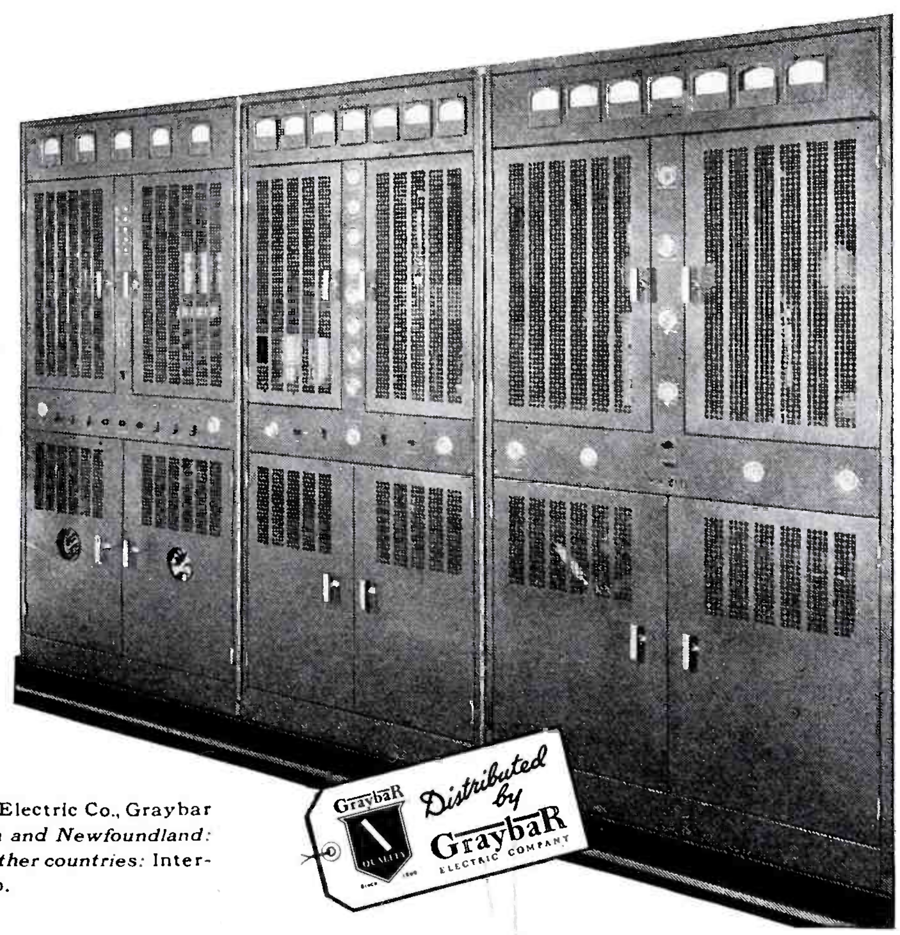

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VOLUME 19
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RAY D. RETTENMEYER
Editor

• Editorial Comment •

IN this issue we present a number of charts dealing with microphone and recorder characteristics. This material, which has been assembled from data furnished by the various manufacturers, should be useful as a reference guide for prospective purchasers of new or replacement equipment. While we have made an attempt at accuracy in assembling this information these charts are intended only for use as approximate guides . . . the reliability of the manufacturers as well as the user's past experience should be given more weight than the figures presented. Equipment purchasers should obtain final prices and specifications directly from the manufacturers.

TENTATIVE plans for the annual gathering of the radio industry at Chicago next June, for the Fifteenth Annual RMA Convention and the National Radio Parts Trade Show at the Stevens Hotel, have been completed. The RMA Convention will be held June 13-14 and the National Parts Show will occupy the Stevens' Exhibition Hall from June 14 through 17. Considerable interest is being evidenced in the gatherings and they are likely to set a record for attendance.

MOST of us are aware of the importance of sound effects in aural broadcasting. Few indeed are the variety programs, plays or dramatic productions that are done without the aid of artificial sounds, and with the increasing interest in synthetic reverberation, it is likely that the scope of sound effects will be extended to other types of programs.

As television broadcasting expands, a considerably more important role is likely to be played by "video effects," both from the artistic and economic standpoints. While it is always hazardous to predict the future, it seems logical to believe that this new phase of television broadcasting will develop rapidly with the advent of commercial programs. Hence, we are pleased to present on following pages an article on this subject from an organization that has pioneered in this field.

• Contents •

COVER ILLUSTRATION

Searching with a beam of polarized light for infinitesimal flaws in a lump of raw quartz. Photo courtesy Western Electric Co.

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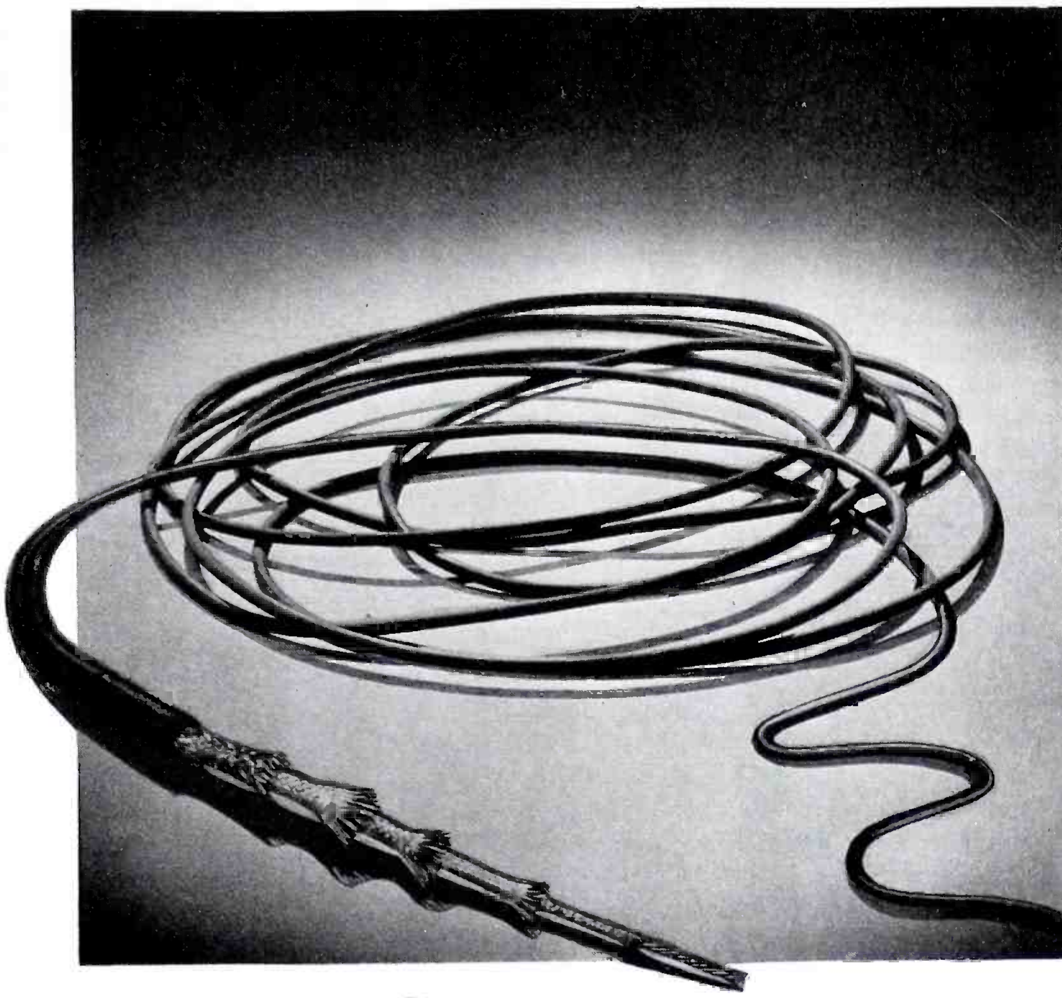

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COMMUNICATIONS

FOR APRIL, 1939

The Radio Receiver as Part of THE BROADCAST SYSTEM

Part II

By Arthur Van Dyck

Manager, RCA License Laboratory

CHARACTERISTICS OF PRESENT RECEIVERS

NEARLY two decades of intensive commercialization have given us receivers of advanced development and definite characteristics. We will examine the more important characteristics individually, but before doing so, we should summarize the broad aspects of the present situation.

Receivers have reached the ultimate in cost reduction, or at least so closely thereto that further reduction can not have important effect on the system. In broad performance aspects, they have reached that point where further improvement is but refinement, and if not obtained, will not seriously handicap the service.

Distribution of receivers is universal. They are not only in the home, but in the automobile, the boat, the train, the club, and public places of all sorts. Increasing use of portable receivers is further widening the possibilities of listening. Reception of programs is worldwide. Only the limits of the earth itself now circumscribe what sound broadcasting is doing.

There is still room for improvement in convenience of operation and aesthetic aspects of construction, and by the addition of new services. The next few years will see changes to accomplish these.

Now let us examine receiver performance characteristics individually. Beginning with sensitivity, we find that present receivers are able to detect and reproduce radio signals of such small magnitude that the final limitation is introduced by interfering noise. The available high sensitivity is being utilized to permit use of small receiving antennas. Automobile reception is satisfactory because high-sensitivity receivers receive enough voltage from the very small antennas which are all that the automobile permits. Even smaller antennas, such as may be entirely enclosed within the receiver cabinet, provide sufficient pick-up for satisfactory reception under many circumstances, and small loop antennas and small completely portable receivers have become feasible as a result.

The status of the selectivity characteristic is difficult to analyze, because it is intimately related in design and performance to fidelity. In so far as design is concerned, it is possible to arrange for any desired degree of selectivity. Furthermore, any desired nature and degree of compromise between the opposing characteristics of selctivity and fidelity may be chosen, with the limiting factor that of construction cost. It can be said that general practice in receiver design is such as to provide adjacent-channel selectivity sufficiently good in most areas of the country, in relation to transmitter frequency and power assignments. In certain rural areas, higher selectivity could be used advantageously, but the current practice of using the same receivers throughout the national distribution system prevents the marketing of special receivers in particular areas. Selectivity discrimination against signals two or more channels away from the desired channel, is so good as a result of the powerful superheterodyne principle, that urban reception, that is selection of each of numerous transmitters in one locality, is eminently satisfactory in this respect throughout the country. At present when interference between two local stations is encountered, it is practically certain to be caused by external cross-modulation, rather than by inadequate receiver selectivity.

Fidelity is a characteristic worthy of most serious consideration by all radio interests, and is one which should respond to joint treatment by transmitter and receiver engineers. Unfortunately, the fidelity characteristic has fallen into disrepute, and it is almost universal belief in the radio industry that it is not important, that the public is not interested in better fidelity, and even that it will not sell. Now it is perfectly true that there are conditions under which high fidelity, or even good fidelity, is less desirable to the listener than some compromise adjustment. However, it is equally true that there are other conditions under which no present receiver and few present transmitters can deliver the degree of fidelity which would be desired if it were available. It is the attempt to use high fidelity under conditions where the signal-noise ratio is not favorable, which results from the market practice of selling all designs to all areas, rather than special designs to special areas, which has caused the general feeling that high fidelity is not worthwhile. This feeling will change only when buyers are educated to seek receivers suited to their particular conditions, and do not expect one receiver to serve equally well in the suburbs of New York, the plains of Montana, and the valleys of New Hampshire.

Good as today's reproduction is, it is still considerably short of realism, or the illusion of realism, and there is no reason why we should be satisfied with the present state. It seems to be true that the "bottle-neck" in the path of further progress is the loudspeaker, and yet it seems also that present loudspeaker technique has not been fully utilized in commercial receivers. The problem warrants more serious attention by receiver manufacturers, I believe, but also it is desirable to continue efforts along all lines which contribute to fidelity improvement, such as: increase in transmitter power, decrease in man-made interference, better wire telephone lines, better audio-frequency characteristics in all elements of transmitters and receivers, better linearity of the phase vs. frequency characteristic.

The cost of operation of radio receivers is extremely low, but should be considered in order to see how much room for increase there is, in connection with additional services which will involve more cost. With assumptions based on average use as follows: Number of tubes in the receiver, 7; cost of tubes, $7.00; hours use per year, 1000; life of tubes, 4 years; power drawn, 75 watts; cost of power, 5 cents per kw-hr; the operating cost is $5.50 per year, 46 cents per month, or 1½ cents per day. Approximately one-third of this cost is for tubes, and two-thirds for power. Inasmuch as the tube cost for the first four years of service appears as part of the initial receiver cost rather than as a maintenance expense, the apparent cost is that of power only, or about one cent per day. Obviously new devices, or new uses of present-type receivers, may include considerably greater power requirement, or considerably greater use per day, without entailing excessive cost in receiver operation. This is fortunate because many of the new services now on the horizon will require more power, or more use, or both.

CHARACTERISTICS OF FUTURE RECEIVERS

It is not intended that this section of the paper shall attempt to prophesy, but rather that it be confined to observation of existing trends and their natural results. Barring radically new discoveries, which naturally have unpredictable effect, it is possible to foresee possibilities for at least a few years in advance, whenever commercialization follows the laboratory with an interval of a few years, as it does in radio. This section of the paper will attempt to show certain possibilities of broadcast service, with special reference to matters wherein utilization of the possibility depends upon coordination and cooperation between the transmitter and the receiver.

First, we should realize clearly that large improvements of the future can not be looked for "inside" the receiver and transmitter, so to speak, as much as has been possible in the past. As described earlier in this paper, the receiver has approached closely to its ultimate limits in all performance characteristics except fidelity, is available in forms to suit all places where people want to listen, and is available at prices to suit all demands. Similarly the transmitter is asymptotic in its development progress. New developments, in order to have noteworthy effect, must be more than minor improvements. *They must be of such nature as will provide new service possibilities, new uses.* They must, for example, give pictures in the living room, or wash dishes in the kitchen.

There is perhaps one internal receiver development yet possible, and having system importance. This is convenience of operation, as affected by automatic means and especially by remote control. Automatic tuning has taken a good start during the past two years, and will become standard and universal practice during the next few. Remote control has had less utilization, and more difficulty getting started. However, satisfactory methods are known, and when these are made available, there is little doubt that remote control will find ready public acceptance. Remote control, or any other considerable aid to operating convenience, increases the amount of listening, and therefore has significance to the system. Furthermore, some of the system possibilities to be described later will be more feasible, or usable with less additional cost, in those receivers which already have the remote-control feature. Therefore, it is desirable from various standpoints that receiver manufacturers make available satisfactory remote-control receivers.

Another purely receiver consideration which can have ameliorating influence on the prestige and degree of use of the system is that of receiver appearance. This is now a serious problem, and as new features and services are added, it will be increasingly difficult to maintain the aesthetic aspects of home instruments, and at the same time meet tech-

Fig. 18. An experimental television receiver. Illustrations of a number of commercial models which will soon be placed on the market will be found on page 24.

Fig. 16.—A modern automobile receiver.

nical requirements satisfactorily. There is vital need, even now, for new receiver forms which will have greater flexibility of arrangement, and permit more individuality of design. It might be said that broadcast receivers now stand at the crossroads—down one road lies development with smaller and smaller cabinets, hidden in furniture, with the eventual goal of classification with household facilities such as the furnace and the kitchen cabinet. Down the other road lies development toward an instrument which will be perceived as the center of the home's cultural activity, classed with the piano, the fireplace, and the reading corner.

It will be interesting to see which way the radio instrument finally goes, but as an encouragement toward making the second road more attractive, I make the following suggestion for immediate improvement of cabinets. Utilize flexible shafts to connect control knobs with the chassis, and locate controls, chassis and speaker wherever necessary to accomplish desired new arrangements, with no limitation except that the controls shall be convenient to operate. This simple change frees the designer from the present highly restrictive conditions of layout, and presents enormous possibilities for attractive, individualistic designs. Such designs would do much to elevate the standing of the radio receiver in the home. Incidentally, the cost will be little if any higher, despite the addition of shafts, because chassis costs can be reduced thereby.

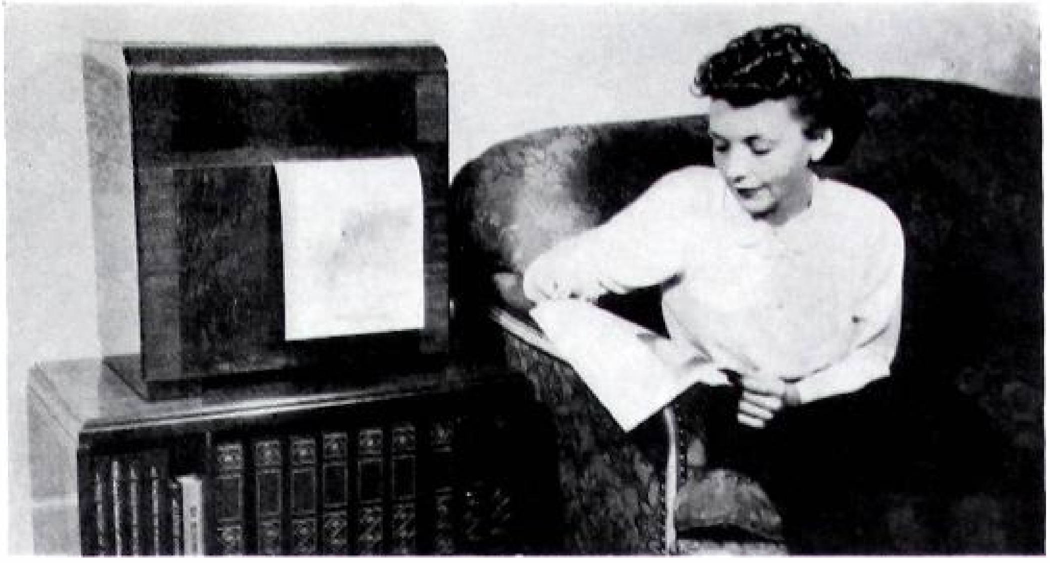


Fig. 17. A facsimile receiver.

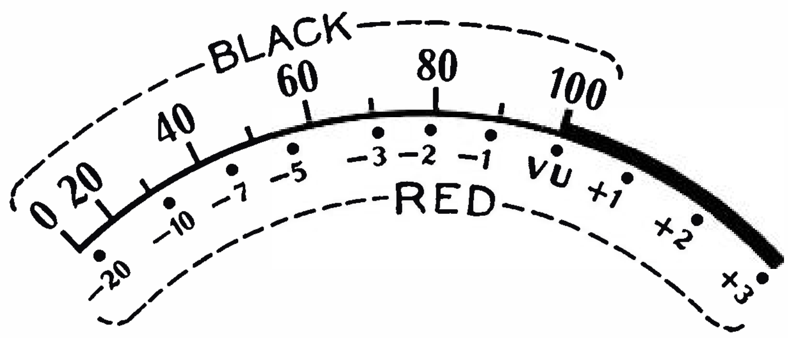
Fig. 15. A modern broadcast receiver. As may be seen this particular model is equipped with an automatic phonograph unit.

A characteristic, or function, which will be badly needed in future receivers, and which even now is much to be desired, is that of program information. This is vitally important to the system because it affects listening habits. Nowadays, most listening is done on the basis of choice of type of program desired, which requires knowledge of programs in advance. Since the information on programs is scarce and incomplete, it is difficult for the listener to find out where and when he may find any particular type of program in which he may be interested. As a result, many listeners are discouraged from listening, and we hear of many people who listen but a few hours per week. Presumably station program departments will welcome any means of advertising their programs efficiently. Perhaps when facsimile broadcasting becomes universal, we will have an ideal means for distribution of program information, but it seems desirable to have some means sooner than the time when that condition will have arrived. At least one possible method exists, as described later, and it is one which must be developed and instituted by the technical departments.

What is most needed by the listener is information as to the characters of the programs being transmitted by all his good service stations at any given time. At present he can not obtain that information even by listening, unless he spends considerable time listening to each station. As programs are organized, when one tunes in to station ZYX and hears music, that is no guarantee that the music will not change into a political speech within two minutes, and when one is looking for a comedy program, it may be on that station which had dance music when the tuning passed it.

Now suppose that programs were classified, perhaps into the divisions of dance music, serious music, lectures and speeches, news and sport events, variety shows. Suppose further that each classification were assigned a sub-audible frequency, and that the appropriate distinguishing frequency were radiated continuously during each program. Finally, suppose that receivers were equipped with indicating devices selectively responsive to these sub-audible frequencies, probably through mechanical resonance arrangements. These devices would then enable the user of the receiver readily to find the type of program which he desires. Lest this suggestion be considered wholly visionary and impractical, let me hasten to add that tests made on a high-quality transmitter show that the added sub-audible modulation has no effect on the regular

(Continued on page 44)

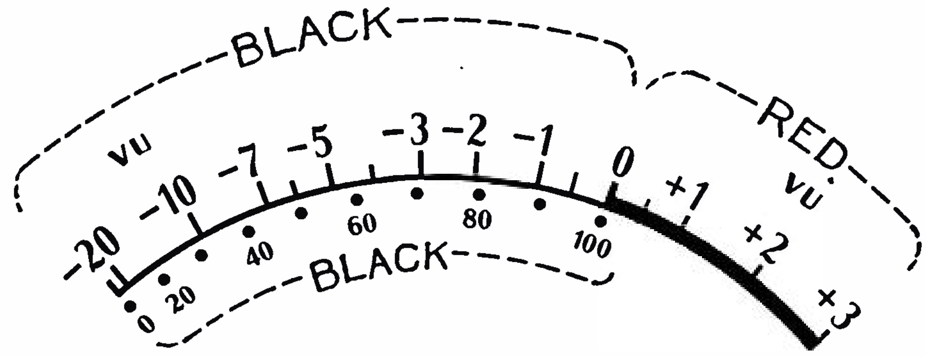


A Standard VI & Reference Level

By
H. A. AFFEL
BELL TELEPHONE LABS.

HOWARD A. CHINN
COLUMBIA BROADCASTING SYSTEM

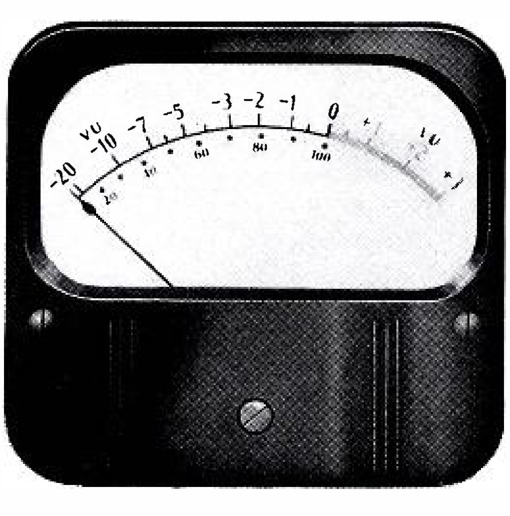
ROBERT M. MORRIS
NATIONAL BROADCASTING CO.



Top left: Scale A. Above: Scale B. Shown actual size. Scales are black and red on yellow background.

IT has been apparent for some time that there has been needless confusion because the different companies whose plants are involved in giving radio broadcast service have been using different instruments and standards for measuring volume levels. Accordingly, the Bell Telephone Laboratories, the Columbia Broadcasting System and the National Broadcasting Company entered upon a joint effort more than a year ago to improve this situation. The outcome of their work was announced on December 16, 1938, with a statement that joint agreement had been reached upon a new standard volume indicator and upon a new standard reference level for volume measurements. Although the new standards directly and immediately affect only the broadcasting branch of the communications industry, it is believed that others, in both the motion picture and the general communications field will be interested in and wish to adopt the new volume indicator and the new reference level.

Model 862, Type 30, Scale A.



During the course of the investigation, a number of informal meetings were held for the purpose of demonstrating the improved volume-indicator instrument to other organizations in order to obtain their reactions to it and to the question of a standard reference level. One of these conferences was held on June 2, 1938, and another on June 17, 1938, at the IRE annual convention in New York. At the former meeting, thirteen organizations concerned with the broadcasting industry in the U. S. and Canada were represented while at the latter meeting eleven additional companies were represented.

At these conferences, approval of the new meter was expressed, and it was agreed that the originating group should determine upon a generally acceptable reference level for volume measurements. The following agreement was subsequently reached:

Zero or reference volume level shall be defined by specifying (a) the characteristics and method of use of the volume indicator instrument and (b) a steady-state reference of one milliwatt. The impedance of the circuit across which the instrument is calibrated shall be 600 ohms. The characteristics of the instrument, as well as the value of the calibrating power, are important features of the definition.

In order to avoid the more cumbersome term "db above zero volume level" and confusion with several existing standards, it is proposed to designate the readings of the new instrument as so many "vu," numerically equal to the number of db above the reference volume level.

The three originating companies plan to install the new instruments as soon as possible and to inaugurate their use on the one milliwatt in 600-ohm basis, together with the adoption of the term "vu," in their plants on May 1, 1939. It is hoped that others will join in adopting the new standards at the same time.

At the present time there are a wide variety of volume-level indicators[1] in use throughout the communications field. The large number of different types of apparatus and methods used for the determination of a certain type of phenomena is ample evidence that there is considerable question, even in this day of precise measuring technique, as to the proper means to be employed. Some of the questions involved are whether the instrument should be r-m-s or peak reading; slow, medium, or high speed; half- or full-wave rectifying; critically or lightly damped or if the reference level should correspond to a calibration with 10^{-9}, 1, 6, 10, 12½ or 50 milliwatts in 500 or 600 ohms.

These conditions have led to widespread confusion and misunderstanding in the communications industry, particularly when an attempt is made to correlate the measurements and results of one group with those of another. For example, the use of various reference levels has been the cause of an apparent difference in the output and the input ratings of a given equipment; it has

[1]Volume-level indicators are not to be confused with power-level indicators since the former are intended for the measurement of program material involving speech, music, etc., whereas the latter should be limited to the measurement of steady-state "sine-wave" power. This latter measurement is not, obviously, influenced by the ballistic characteristics of the instrument employed. Since sine-wave power is considered a form of program material, it is evident that a volume-level indicator is also capable of power-level measurements, but not vice-versa.

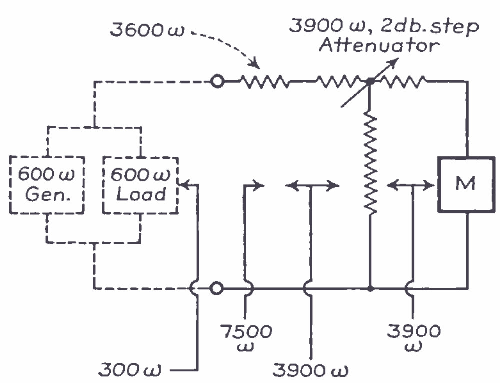
caused apparatus and circuits, void of amplifiers, to have an apparent gain; and it has caused countless controversies as to the volume level being transmitted on program circuits or that has been recorded on various media.

It is evident, under the circumstances, that the need for standardization of volume indicators and of reference levels is of vital importance. Consequently, the three organizations mentioned above instituted a cooperative investigation and study of the matter. For convenience, the project was divided into two parts: (*a*) *The determination upon a standard volume indicator;* (*b*) *The determination upon a standard reference level.*

STANDARD VOLUME INDICATOR

The scope of this paper does not permit a detailed account of the fundamental considerations which influence the design of an "ideal" volume indicator nor is it possible to present a complete description of the tests and measurements undertaken. The results obtained, however, culminated in the previously noted agreement upon the specifications for a new volume-indicator instrument.

Certain of the characteristics specified are fundamental and must be conformed to by any instrument which is to be called a standard volume indicator. Others are matters of engineering and have been agreed to by the three



Proper application of VI when used with associated attenuator switch.

originating organizations as requirements for use in their plants. The specifications are briefly summarized as follows:

Fundamental Characteristics

1. *General Type*—The volume indicator employs a d-c instrument with a non-corrosive, full-wave copper-oxide rectifier (mounted in the instrument case), and responds approximately to the r-m-s value of the impressed voltage.

2. *Scale of Instrument*—The face of the instrument may have either of the two scale cards shown in the illustrations. Each has two scales, one a vu scale ranging from —20 to +3 vu, and the other a percent voltage scale ranging from 0 to 100 with the 100 point coinciding with the 0 point on the vu scale. The normal point for reading volume levels is at the 0 vu or 100 scale points which are located to the right of the center at about 71% of the full-scale arc.

3. *Dynamic Characteristics*—With the instrument connected to the proper external resistance, the sudden application of a sine-wave voltage sufficient to give a steady-state deflection at the 0 vu or 100 scale points, shall cause the pointer to overshoot not less than 1% nor more than 1.5%. It shall reach 99 on the percent voltage scale in 0.3 second.

4. *Response vs. Frequency*—The instrument sensitivity shall not depart from that at 1000 c-p-s by more than 0.2 db between 35 and 10,000 c-p-s, nor more than 0.5 db between 25 and 16,000 c-p-s.

Other Characteristics

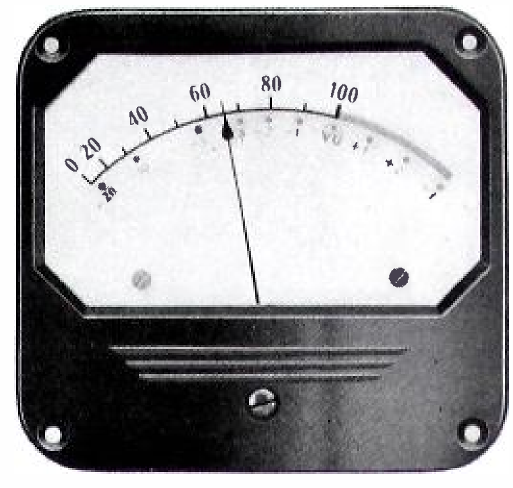
5. *Sensitivity*—The application of a sinusoidal potential of 1.228 volts (4 db above one milliwatt in 600 ohms) to the instrument, in series with the proper external resistance, shall cause a deflection to the 0 vu or 100 scale points. The meter therefore has sufficient sensitivity to be read at its normal point (0 vu or 100) on a volume level of +4 vu.

NOTE: *It should be remembered that the instrument scales, as in most past practice, are purely arbitrary. A complete volume indicator includes a variable attenuator external to the instrument for reducing the sensitivity. In use, the attenuator is adjusted until the needle deflects to the 0 vu or 100 scale point, and the volume level is then read from the marks on the attenuator and not from those on the instrument. The most sensitive position of the attenuator (0 db loss) will therefore be marked +4 vu.*

6. *Impedance*—For bridging across a line, the volume indicator including the instrument and proper series resistance shall have an impedance of 7500 ohms when measured with a sinusoidal voltage sufficient to deflect the meter to the 0 vu or 100 scale points.

7. *Harmonic Distortion*—The harmonic distortion introduced in a 600-ohm circuit by bridging the volume indicator across it is less than that equivalent to 0.3%, under the worst condition (when there is no loss in the variable attenuator).

8. *Overload*—The instrument must be capable of withstanding without injury or effect on calibration, peaks of ten times the voltage equivalent to a reading of 0 vu or 100 for 0.5 second, and a continuous overload of five times that voltage.



Model 802, Type 30, Scale B.

As manufactured at present, in order to provide an equal impedance point for the insertion of a variable attenuator, 3600 ohms of the internal resistance has been omitted from the meter and must be furnished in the external circuit, in order to meet the above requirements as to dynamic characteristics, impedance and sensitivity. The attenuator (impedance 3900 ohms) is inserted between the meter and this external series resistance.

PEAK VS. R-M-S INDICATORS

From a study of the fundamental considerations involved, it may appear that an instrument responding to the peak or crest value of the program wave—that portion which causes distortion—would be more satisfactory than an r-m-s instrument. Furthermore, in the case of the peak-reading instrument, the rate of the needle upswing and downswing may be readily controlled over wide limits—a rapid upswing and a slow decay, for example, providing the advantages of a "high-speed" volume indicator without its disadvantages as regards ease of visually following the pointer movement.

However, the results of a series of cooperative and individual tests, that began in 1935 and have been in progress until the present time shows that, on the average, within a range of 1 db, neither the peak nor the r-m-s instrument of the design finally determined upon exhibits any superiority. It is the intention to publish, at an early date, more complete details of the methods and the results of the tests which substantiate this finding.

It was found, furthermore, that the phase distortion on program circuits, some of which are only a few miles in length, may be such that considerable discrepancies are obtained when using peak-indicating instruments even when the distortion is not aurally detectable. A full-wave r-m-s type was not, of course, subject to these errors. Since program circuits are almost always in-

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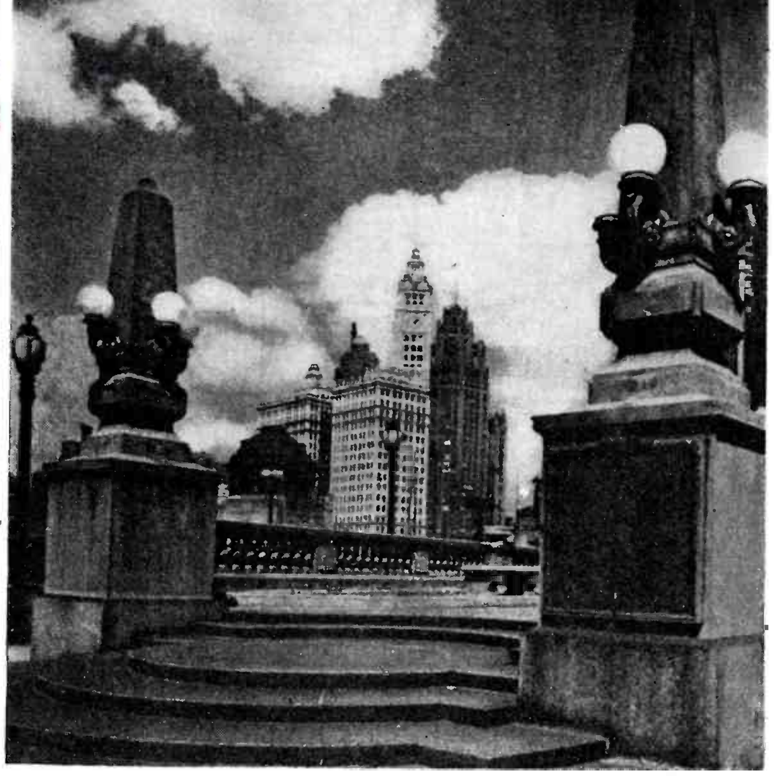


Chicago picture received at New York by wire facsimile.

The AUTOMATIC TELEGRAPH

By G. W. JANSON
Equipment Engineer
WESTERN UNION TELEGRAPH CO.

FOR several years the dazzling floodlights of publicity have been so constantly focused upon other sensational developments in communication engineering that telegraphic facsimile appeared to be cast in the role of a stepchild. Nevertheless, at least insofar as commercial applicability is concerned, it would seem that the position of some of these arts is about to be reversed, for the automatic telegraph which operates by facsimile methods has emerged commercially.

Telegraphic facsimile is not a new art, for the first attempts in this field were made shortly after the Civil War. The lack of modern facilities offered such great obstacles to the early workers that it was only in recent years that it became commercially practical.

The engineering staff of the Western Union Telegraph Company has devoted considerable time to the development of telegraphic facsimile. It is believed that a brief description of recently developed equipment will be of interest to communication engineers.

TYPES OF EQUIPMENT

There are, at present, three different types of telegraphic facsimile machines, (1) the *automatic loading* machine, intended for central telegraphic office use; (2) *customer's* machine, which is a combination transmitter and receiver, and which is installed in the offices of customers desiring this service; and (3) the *automatic telegraph* which is a transmitter installed in offices, hotels, or other public buildings and which requires merely the insertion of a message into a slot in the machine whereupon it is automatically transmitted.

The description which follows applies equally to all three machines unless specific mention is made to the contrary.

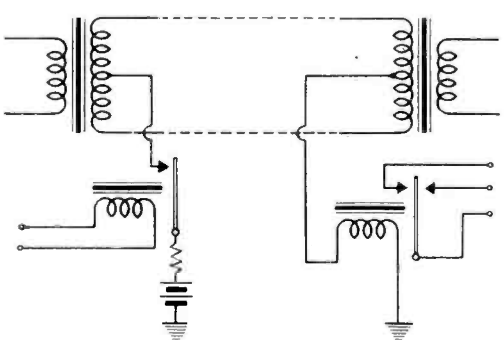


Fig. 2. Ground circuit for local synchronization.

A block diagram of the equipment is shown in Fig. 1. By means of a suitable lens system light is concentrated into a point upon the revolving cylinder. The reflected light passes through another lens system, then through a light chopper, and falls upon a photoelectric cell. A second photocell responds to a beam of light from an adjustable, balancing light source which passes through the same light chopper. The respective outputs of the two photocells can be optically oriented so as to correctly intermesh and feed into an amplifier 2500 cycles per second whose amplitude will be governed by the difference in output between the two photocells. In practice the balancing lamp is adjusted until the output of its associated photocell is equal to that of the informational photocell when the latter is scanning blank paper. When a black pencil mark or other form of intelligence comes into the field of scanning, the output of the interlaced photocells attain maximum difference, and an alternating current of maximum marking amplitude is borne to the line through an amplifier and is transmitted by wire to the recorder. At the recorder the attenuated signal impulses are again amplified and are then fed to the recording stylus and cylinder.

TRANSMITTER

The transmitter is of the familiar revolving cylinder type. The regular speed is 180 revolutions per minute, and, since the picture is scanned along the cylinder at a rate of 1.8 inches per minute, the area covered amounts to 14 square inches per minute. When necessary, the machine can be speeded up to give a maximum commercial speed of 225 revolutions per minute.

In the initial development work the varying amounts of light and shade reflected from the picture on the cylinder were permitted to fall directly upon the photoelectric cell. In order to obtain the advantages inherent in the usual type of audio-frequency amplifier the light from the photoelectric cell is converted into an alternating current by inserting a light chopper between the revolving cylinder and the photoelectric cell. This light chopper is a toothed wheel which alternately allows and prevents light to pass through to the photoelectric cell. The number of teeth and speed of revolution are adjusted so as to create a carrier frequency of 2500 cycles per second. The photoelectric

A central office facsimile machine.

Left: Customer's machine; transmitter and receiver.
Right: Facsimile telegraph operation at NYC.

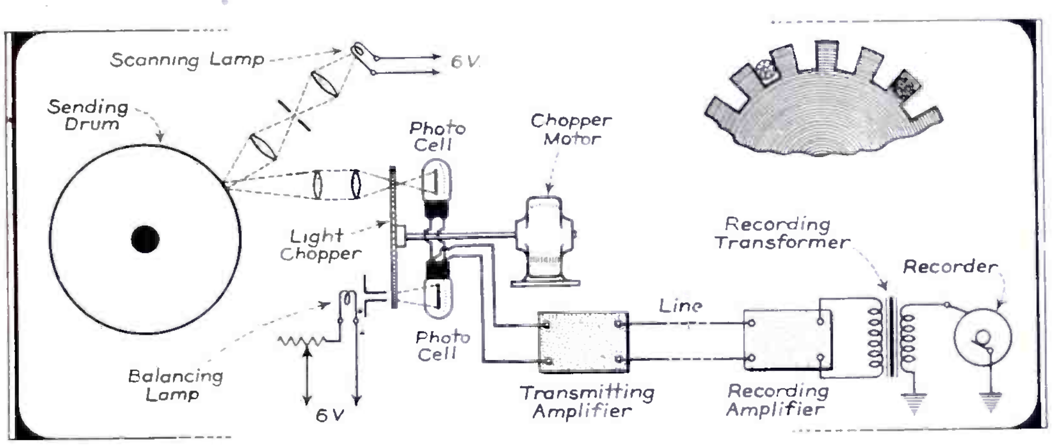
cell output is thereby converted into an amplitude-modulated alternating current, the amplitude of modulation varying in strength according to the light and dark areas of the picture.

In the large central office set, the photoelectric cell and a two-stage amplifier are housed in the same case, which, in order to avoid possible defects in the transmitted picture is mounted on springs. For each revolution of the cylinder the photoelectric cell moves 0.01 inch, that is, the cylinder only revolves while the photoelectric cell moves to scan the picture. In the customer's set, in order to simplify the equipment, the cylinder both revolves and moves laterally in order to scan the picture.

Any kind of paper may be used at the transmitting end, although, in order to obtain sufficient contrast, black writing on white paper is preferred. In the large central office machine any size of paper may be employed up to legal cap size, the size ordinarily used being 8½ by 11 inches. The customer's machine utilizes a special message blank size of 8 by 5⅜ inches. The automatic transmitter requires a special message blank size of 8 by 6⅛ inches with the upper left-hand corner of the blank cut off diagonally so that the telegram will be correctly placed into the machine.

The modulated carrier frequency, after amplification, is fed to a stylus which is in contact with a special recording paper wrapped around a revolving cylinder. The point of the stylus is 0.01 inch in diameter so that a line of 0.01 inch is obtained on the recording paper with a very slight overlap. At this point it might be well to mention that a stylus is incorporated in the transmitter so that it may be converted into a recorder if need arises.

On the customer's set there is a control for regulating the amount of current through the recording paper and consequently the contrast between light and dark. This customer's set consumes power only when it is operating and then the power is about the same as that taken by a small radio receiver.



Above: Fig. 1. Block diagram of system.
Right: Automatic telegraph (slot machine type).

RECORDING PAPER

One of the important features of the Western Union telegraphic facsimile system is the fact that the message is electrically reproduced upon *dry* recording paper which requires no further processing and is ready for delivery upon removal from the receiving cylinder. This result is accomplished without the use of special marking ink and, furthermore, the action is not electrolytic as in older methods.

The positive prints obtained are due to electro-chemical changes which result in a blackening of the paper depending upon the amount of current passing through the paper. This varies from a light gray for small amounts of current to a black for a current of approximately 25 milliamperes. The paper is unaffected by light and can therefore be used in bright surroundings.

(*Continued on page* 16)

VELOCITY MICROPHONES

MANUFACTURER	MODEL	PRICE $	IMPED-ANCE (Ohms)	OUTPUT FOR REFERENCE LEVEL SEE FOOTNOTES	FREQ. RANGE (Cycles)	db. VARI-ATION OVER FREQUENCY RANGE	DIRECT-IVITY	CABLE SUPPLIED (Feet)	FINISH	ACCESS-ORIES INCLUDED	SWITCH	WEIGHT (Lbs)	SIZE	SPECIAL FEATURES	COMMENTS
AMPERITE COMPANY	RBHn	42.00	2000	NOTE 2 −65	40−11,000	±2 APP'X.	BI-DIR.	25	GUNMETAL OR CHROME	CABLE CONNECTOR	YES	3	$3X2\frac{1}{2}X8$	—	—
	RBMn	42.00	200	−65	"	"	"	25	"	"	"	"	"	—	—
	RBHK	42.00	2000	−65	"	"	UNI & BI-DIR.	25	"	"	"	"	"	ACOUSTIC COMPENSATOR	CLOSING ACOUSTIC COMPENSATOR CONVERTS MICROPHONE TO DYNAMIC OPERATION
	RMBK	42.00	200	−65	"	"	"	25	"	"	"	"	"	"	
	RBBHn	42.00	2000	−65	"	"	BI-DIR.	25	"	"	"	"	"	—	—
	RBBn	42.00	200	−65	"	"	"	25	"	"	"	"	"	—	—
	RSHK	32.00	2000	−68	60−8000	"	UNI & BI-DIR.	12	"	"	"	"	"	ACOUSTIC COMPENSATOR	CLOSING ACOUSTIC COMPENSATOR CONVERTS MICROPHONE TO DYNAMIC OPERATION
	RBSK	32.00	200	−68	"	"	"	12	"	"	"	"	"	"	
	SR80-Hn	80.00	2000	−56	40−15,000	"	BI-DIR	25	"	"	YES OR NO	5	$3\frac{1}{2}X3X9$	—	—
	SR80n	80.00	200	−56	"	"	"	25	"	"	"	5	"	—	—
	RAH	22.00	2000	−68	60−7500	"	"	12	"	NONE	NO	2	$3X2\frac{1}{2}X8$	—	—
	RAL	22.00	200	−68	"	"	"	8	"	"	"	2	$3X2\frac{1}{2}X8$	—	—
	7JH	22.00	2000	−70	"	"	"	25	"	"	"	1/2	$2\frac{1}{2}X1\frac{1}{2}X2\frac{1}{2}$	—	LAPEL MICROPHONE
	7J	22.00	200	−70	"	"	"	25	"	"	"	1/2	"	—	"
	ACH	25.00	2000	−70	"	"	"	25	"	CABLE CONNECTOR	YES	3/4	$1\frac{1}{2}X2\frac{3}{8}X1\frac{3}{8}$	—	SLIGHTLY LARGER THAN MATCH BOX
	ACL	25.00	200	−70	"	"	"	12	"	"	"	"	"	—	
BRUNO LABORATORIES, INC.	VD-HP	21.00	HIGH	NOTE 2 −63	80−10,000	±5	120°	0	GUNMETAL OR CHROME	NONE	—	1 3/4	$6\frac{1}{2}X2\frac{3}{16}X1\frac{1}{2}$	—	—
	VD-HF	22.00	"	−63	50−10,000	"	"	0	"	"	—	"	"	—	—
	VD-LI	23.00	200	−63	"	"	"	8	"	"	—	"	"	—	—
	VR-HP	31.00	HIGH	−64	80−12,000	"	"	0	"	"	OPTIONAL $1.50 EXTRA	3	$7\frac{1}{4}X3\frac{1}{8}X2\frac{7}{16}$	—	—
	VR-HF	32.00	"	−64	50−12,000	"	"	0	"	"	"	"	"	—	—
	VR-LI	33.00	200	−64	"	"	"	8	"	"	"	"	"	—	—
	WM-HP	39.00	HIGH	−59	80−12,000	"	160°	0	"	"	"	3 3/4	$7\frac{1}{4}X3\frac{1}{8}X2\frac{1}{4}$	—	—
	WM-HF	40.00	"	−59	50−12,000	"	"	0	"	"	"	"	"	—	—
	WM-LI	41.00	200	−59	"	"	"	25	"	"	"	"	"	—	—
	PR-HF	90.00	HIGH	−55	30−14,000	"	120°	35	TELEPHONE BLACK	CABLE CONNECTOR	—	5	$9X4\frac{5}{8}X3\frac{3}{8}$	—	—
	PR-LI	90.00	50 OR 200	−55	"	"	"	35	"	"	—	"	"	—	—
	PR-CL	135.00	"	−55	"	"	"	35	"	"	—	"	"	CALIBRATED FOR SOUND MEASUREMENT STANDARDS	—
	MB	22.50	HIGH	−44	70−9000	±10	"	0	GUNMETAL OR CHROME	—	—	2	$8X2\frac{3}{4}X3$	—	VELOTRON
	MS	30.00	"	−39	"	"	WIDE ANGLE	0	"	—	—	"	$7X3\frac{1}{8}X2$	—	"
	MS-S	31.50	"	−39	"	"	"	0	"	—	—	"	"	—	"
	MP	13.50	"	−49	"	"	120°	3	"	CABLE CONNECTOR	—	1/4	$2\frac{7}{8}X2\frac{3}{4}X\frac{1}{2}$	VERY SMALL IN SIZE	"
	MH	15.00	"	−44	"	"	"	0	BROWN OR GREY CRYSTALLINE	—	NONE	2	•	HAND MIKE	INTENDED CLOSE TALKING OPERATION
	OR-HF	47.00	"	−59	50−12,000	±5	WIDE ANGLE	0	GUNMETAL OR CHROME	STAND	OPTIONAL $1.50 EXTRA	3	$3\frac{3}{4}X7X2$	PULPIT OR DESK MIKE	—
	OR-LI	49.00	"	−59	"	"	"	25	"	"	"	"	"	—	—
CARRIER MICROPHONE COMPANY	300-V	50.00	200 500 HIGH	•	30−10,000	±2½ APP'X	•	20	BRONZE AND BLACK	NONE	—	•	•	ACOUSTICAL EQUALIZER	—
ELECTRO-VOICE MFG. CO., INC.	V-1	25.00	OPTIONAL †	NOTE 4 −65	30−10,000	±3 APP'X	BI-DIRECT-IONAL	20	GUNMETAL & CHROME	PLUG	YES	•	•	—	—
	V-2	35.00	"	−65	30−12,000	"	"	20	BLACK & CHROME	—	—	•	•	—	—
	V-3	50.00	"	−64	30−13,000	"	"	20	"	—	—	•	•	—	—
	K-20	19.50	"	−68	40−8000	"	"	8	BLACK	—	—	•	•	—	—
RCA MFG. COMPANY, INC.	MI-4001	44.35	250	NOTE 8 −80	70−7000	±5	•	30	DULL BLACK NICKLE	—	—	•	•	LAPEL MICROPHONE	—
	4036G	43.50	50 250 15,000	−59	40−9000	±5	•	30	CHROMIUM AND BLACK	—	—	•	•	—	CROSS-OVER CIRCUIT
	MI-4027	130.00	50 250	−58	40−12,000	±2	•	30	"	—	—	•	•	—	—
	4042	130.00	"	−61	40−10,000	±3	UNI-DIRECT-IONAL	30	"	—	—	•	•	—	—
	4042A	170.00	"	−61	"	±3	•	30	"	—	—	•	•	SWITCH FOR UNI-DIRECT'L OR BI-DIRECT'L OPERAT'N	—
SOUTH BEND MICROPHONE COMPANY	R	25.00	50 200 500 10,000	NOTE 9 −64	40−9000	2 APP'X	BI-DIRECT-IONAL	25	CHROME BLACK NICKLE BRONZE	CABLE CONNECT-OR	—	•	2X3X7	—	—
	Rv	25.00		−64	30−9000	"	"	25	GUNMETAL BRONZE & GUNMETAL LACQUER		—	•	"	—	—
UNIVERSAL MICROPHONE COMPANY	M4H	22.50	33 200 500 HIGH	NOTE 2 −64	40−10,000	2 APP'X	BI-DIRECT-IONAL	25	BLACK & CHROME	—	—	•	•	—	—
	5MM	24.50		−64	"	2 "	NON-DIRECT-IONAL	25	POLISHED CHROME	DUVELO CLOTH HEAD	—	•	•	—	—
	AV	24.50		−62	30−12,000	1 "	BI-DIRECT-IONAL	25	SATIN CHROME	—	—	•	•	—	—
WESTERN ELECTRIC COMPANY	639A	119.25	30	NOTE 3 −85	•	•	CARDIOID DIRECT-IONAL 120°	20	ALUMINUM GREY	—	—	$4\frac{1}{2}$	•	REDUCTION OF ACOUSTIC FEED-BACK CARDIOID DIRECTIONAL CHARACTERISTIC	COMBINATION OF VELOCITY AND DYNAMIC

NOTE 2: 0.006 WATTS. NOTE 3: 1 VOLT PER BAR. NOTE 4: 0.01 WATT ON 500ω LINE. NOTE 8: 10 BAR SIGNAL, 0.006 WATTS. • INFORMATION NOT SUPPLIED.
† 50, 200, 500 OR DIRECT TO GRID. NOTE 9: 2½ BAR SIGNAL, 1 VOLT ON 500ω LINE.

DYNAMIC MICROPHONES

MANUFACTURER	MODEL	PRICE $	IMPED-ANCE (Ohms)	OUTPUT FOR REF. LEVEL SEE FOOTNOTES	FREQUENCY RANGE (Cycles)	db. VARI-ATION OVER FREQUENCY RANGE	DIRECT-IVITY	CABLE SUPPLIED (Feet)	FINISH	ACCESS-ORIES INCLUDED	SPECIAL FEATURES	COMMENTS
AMERICAN MICROPHONE COMPANY, INC.	D3	90.00	30	NOTE 3 −81	30-10,000	•	SEMI	25	GUN METAL	YOKE PLUG	DEMOUNTABLE YOKE	—
	D5	27.50	30	−84	50-8500	±6	"	25	CHROME	PLUG	ADJUSTABLE HEAD	—
	D5T	32.50	200 500 38,000	−74 −70 −75	"	"	"	25	"	"	"	—
	D6	•	20	−80	40-8000	•	"	12½	"	"	—	—
	D6T	•	200 500 50,000	−70 −66 −46	"	•	"	12½	"	"	—	—
	D7	20.00	25	−83	55-7500	±6	"	12½	"	"	LIGHT WEIGHT	—
	D7T	22.50	200 500 38,000	−74 −70 −56	"	"	"	12½	"	"	"	—
	D9	35.00	45	−82	45-8000	•	UNI	25	"	"	—	—
	D9T	37.50	200 500 3800	−76 −72 −55	"	•	"	25	"	"	—	—
CARRIER MICROPHONE COMPANY	105-D	27.50 32.50	30 200 500 HIGH	•	40-8000	±4 APP'X	•	20	SATIN NICKLE	PLUG	—	—
	702-D	60.00 68.50	"	•	30-10,000	±2½ APP'X	•	0	STATUARY BRONZE	"	ACOUSTICAL EQUALIZER	—
ELECTRO-VOICE MFG. CO., INC.	600	25.00	OPTIONAL †	NOTE 4 −58	50-7500	±5 APP'X	DIRECTIONAL	8	GUNMETAL AND CHROME	—	HAND MICROPHONE CLOSE TALKING	—
	610	22.50	"	−58	40-8000	"	DIRECTIONAL OR NON-DIR.	8	GUNMETAL	CONNECTOR	—	—
	620	27.50 30.00	"	−55	30-10,000	"	"	20	GUNMETAL OR CHROME	REMOVABLE STAND AND CABLE CONN.	180° SWIVEL	—
RCA MFG. COMPANY, INC.	MI-4048	70.00	50 250	NOTE 8 −54	60-10,000	±4	•	6	BLACK & POLISHED CHROMIUM	30 FT. CABLE $4.50 EXTRA	—	—
	MI-6226	22.95	250	−66	80-8000	•	•	6	CHROMIUM	30 FT. CABLE $3.00 EXTRA	—	—
	MI-6228	•	40,000	−66	"	•	•	30	"	—	—	—
TRANSDUCER CORP.	MK-21	19.50	200 50,000	NOTE 2 −55	80-7500	±10 APP'X	SEMI	25	BLACK CRINKLE	CABLE CON. & SWIVEL	—	—
	MK-31	27.50	"	−55	80-8000	±8	"	"	CHROMIUM	"	—	—
	MK-35	34.50	"	−55	60-8000	±6	"	"	"	"	—	—
	MK-40	39.50	"	−50	40-8500	±4	"	"	BLACK BAKELITE	"	—	—
THE TURNER COMPANY	99	29.50	30 200 500 HIGH	NOTE 3 −54	60-9000	±4 APP'X	SEMI OR NON-DIR.	25	GUNMETAL	CONNECTOR	—	—
	999	32.50	"	−54	"	"	"	25	"	—	BALANCED UNIT CONNECTION	—
	88	25.00	"	−56	60-8000	"	NARROW BEAM	25	CHROME	—	NARROW BEAM PICKUP	—
	66	25.00	HIGH	−54	40-8000	"	SEMI OR NON-DIR.	25	"	—	—	—
UNIVERSAL MICROPHONE COMPANY, LTD.	15MM-D	24.50	33 200 500 HIGH	NOTE 2 −64	50-8000	±2 APP'X	"	25	POLISHED CHROME	DUVELO CLOTH HOOD	—	—
	SUPER-DYNAMIC	64.50	"	−60	50-10,000	±2 APP'X	SEMI-DIRECT'L	25	SATIN GOLD	MICROPHONE STAND	—	—
WESTERN ELECTRIC COMPANY	630A	77.00	30	NOTE 3 −80	40-10,000	•	•	0	BLACK	—	—	—
	633A	59.50	"	−80	"	±2 APP'X	SEMI OR NON-DIR.	0	ALUMINUM GREY	DIRECT'L BAFFLE	ONLY 10 OZ.	CYL. HOUSING 2" DIA. X 3" LONG
	639A	119.25	"	−85	•	•	CARDIOID DIREC'L	0	"	—	CARDIOID DIRECT'L RESPONSE. SWITCH TO CONVERT INTO EITHER VELOCITY OR DYNAMIC MIC.	

NOTE 2: 0.006 WATTS   NOTE 3: 1 VOLT PER BAR   NOTE 4: 0.01 WATT ON 500ω LINE   NOTE 8: 10 BAR SIGNAL, 0.006 WATTS

† 50, 200, 500, OR DIRECT TO GRID   • NO INFORMATION SUPPLIED

CRYSTAL MICROPHONES

MANUFACTURER	MODEL	PRICE $	IMPED-ANCE (Ohms)	OUTPUT FOR REF. LEVEL SEE FOOTNOTES	FREQUENCY RANGE (Cycles)	db. VARI-ATION OVER FREQUENCY RANGE	DIRECT-IVITY	CABLE SUPPLIED (Feet)	FINISH	ACCESS-ORIES INCLUDED	SPECIAL FEATURES	COMMENTS
AMERICAN MICROPHONE CO., INC.	AG	22.50	HIGH	NOTE 3 −52	50-7000	•	SEMI	8	CHROME	YOKE	—	—
	B9	22.50	"	−55	40-8000	•	"	8	"	MIC. PLUG CABLE CONNECTOR	—	—
ASTATIC MICROPHONE LABORATORY, INC	T-3	25.00	5 MEG.	NOTE 3 −52	30-10,000	±5	SEMI	25	CHROME	PLUG & SOCKET	—	RISING CHAR. ABOVE 500 ~
	D-104	22.50	"	−48	30-7500	•	"	8	"	"	—	" 6000 ~
	K-2	27.50	"	−60	30-10,000	•	NON	25	"	"	—	" "
	D-2	25.00	"	−61	30-10,000	•	"	25	"	"	—	—
	L-1	25.00	"	−62	30-10,000	•	"	25	TELEPHONE BLACK	CLIP FASTENER	—	" 6000 ~
	218	22.50	"	−46	30-5500	•	SEMI	8	"	"	—	" 500 ~
	MU-2	29.50	"	−56	30-10,000	•	NON	25	CHROME & BLACK	PLUG & SOCKET	—	" 6000 ~
	MU-4	39.50	"	−56	30-10,000	•	"	25	"	"	—	" "
BRUSH DEVELOP-MENT COMPANY	HL	23.50	HIGH	NOTE 3 −46	100-5000	±5	SEMI	25	SATIN CHROME	FLEXIBLE MOUNTING OR SOCKET	—	—
	HM	32.50	"	−46	"	"	"	25	"	"	—	—
	D-1	23.50	"	−62	30-5500	±3	NON	25	"	"	—	—
	BL-1	25.00	"	−72	30-7000	±2	"	25	BLACK RUBBER	CLOTHING FASTENER	LAPEL TYPE MICROPHONE	—
	BR2S	29.50	"	−66	"	"	"	0	SATIN CHROME	SOCKET	—	—
	AR43	75.00	"	−60	30-10,000	±3	"	0	"	"	—	—
	AR 26	90.00	"	−66	"	"	"	0	"	SOCKET & TRANSF.	—	—
	R-34	75.00	"	−67	"	±2	"	0	"	SOCKET	—	—
	R-22	65.00	"	−70	"	"	"	0	"	"	—	—
	BP-2	47.50	"	−66	30-7000	±3	"	0	BLACK CRACKLE	—	—	—
	Lab	200.00	"	−86	30-20,000	±1	"	0	SATIN CHROME	—	LABORATORY MICROPHONE	—

CONTINUED ON NEXT PAGE

MANUFACTURER	MODEL	PRICE $	IMPEDANCE (Ohms)	OUTPUT FOR REF. LEVELS SEE FOOTNOTES	FREQUENCY RANGE (Cycles)	db VARIATION OVER FREQUENCY RANGE	DIRECTIVITY	CABLE SUPPLIED (Feet)	FINISH	ACCESSORIES INCLUDED	SPECIAL FEATURES	COMMENTS
					CRYSTAL MICROPHONES (Continued)							
* SHURE BROTHERS	700D	25.00	NOTE 1 5 MEG.	NOTE 3 −52	30-10,000	±5	NOTE 6 SEMI	NOTE 7 25	SATIN CHROME	—	TILTING HEAD	—
	701D	"	5 MEG.	−52	"	±5	SEMI	" 25	"	—	SKYSCRAPER GRILL-TYPE CASE	—
	702D	"	"	−52	"	±5	SEMI OR NON-DIR.	" 25	"	—	SPHERICAL CASE	—
	705D	"	"	−52	"	±5	SEMI	" 25	"	—	TILTING HEAD	—
	706S	27.50	GREATER THAN 500,000	−50	SPEC. RISING CHARACTERISTIC	●	"	" 7	"	DESK MOUNT	"	COMMUNICATIONS TYPE
	720B	45.00	5 MEG.	−74 −69 −74 ‡	NOTE 5 30-10,000 30-10,000 40-10,000	±5 ±6 ±7	NON UNI BI	" 25	"	—	UNI-DIR., BI-DIR. OR NON-DIR. RESPONSE SELECTED BY SWITCH IN MIC.	—
	730A	29.50	"	−62 ‡	30-10,000	±	UNI	" 25	"	—	TILTING HEAD	—
	750A	25.00	"	−50	"	±7½	—	7	SATIN CHROME IRIDESCENT GREY	—	HAND MIC.	—
	760A	30.00	"	−40	SPECIAL HIGH INTELLIGIBILITY VOICE RESPONSE	●	—	7	"	—	HAND MIC. SPECIAL DISCRIMINATION AGAINST BACKGROUND NOISE	—
	70H	22.00	"	−44	30-10,000	±7½	SEMI	NOTE 7 7	SATIN CHROME	—	—	HEAVY DUTY MODEL
	70SW	25.00	GREATER THAN 500,000	−44	SPEC. RISING CHARACTERISTIC	●	"	" 7	"	DESK MOUNT	—	COMMUNICATIONS TYPE
	76B	25.00	5 MEG.	−50	SPECIAL CHARACTERISTIC	●	"	25	IRIDESCENT GREY	—	WEIGHT ONLY 1½ OZ. CLIP LAPEL TYPE	SPECIAL CHARACTERISTIC TO COMPENSATE FOR ANGULAR PICKUP
SUNDT ENGINEERING COMPANY	211	30.00	5 MEG.	NOTE 3 −48	●	±5	30°	25	BLACK	—	MIC. HANGS AROUND NECK, LEAVING SPEAKERS HANDS FREE WHILE TALKING	—
THE TURNER COMPANY	77	27.50	1 MEG. APP'X	NOTE 3 −54	40-8000	±4 APP'X	SEMI OR NON-DIR.	25	BRONZE	—	—	—
	55-C	15.95	"	−56	50-7000	"	SEMI	15	PLATED	—	—	—
	55	14.95	"	−56	"	"	"	8	BLACK & ALUMINUM	—	—	—
	30-30	22.50	"	−54	40-8000	"	"	25	BLACK & CHROME	—	—	—
	78	30.00	"	−70	20-2000	"	"	8	CHROME	—	HEART BEAT PICKUP	—
	83-B	25.00	"	−60	60-8000	"	"	25	BLACK	—	LAPEL MIKE	—
	30-36	27.50	"	−52	150-8000	"	"	8	CHROME & BLACK	SPEC. SW.	—	—
	30-B4	24.00	"	−52	160-8000	"	"	25	"	—	—	—
	VT-73	18.00	"	−50	150-8000	"	SEMI OR NON-DIR.	6	"	—	—	—
	30-36	26.50	"	−52	"	"	SEMI	8-25	"	—	HAND MIKE	—
	30-BT	24.00	"	−52	100-8000	"	"	8-25	"	—	—	—
	30-BTS	25.00	"	−52	10-8000	"	SEMI OR NON-DIR.	8-25	"	—	—	—
	T-9	19.50	"	−56	50-7500	"	SEMI	8	"	—	—	—
	24	22.50	"	−52	"	"	"	8	CHROME	—	—	—
	DB-50	22.50	"	−50	"	"	"	8	BROWN & CHROME	—	—	—
	2-X	50.00	"	−65	20-10,000	"	NON	25	CHROME	—	LABORATORY MIC.	—
	38	22.50	"	−56	40-7500	"	"	25	"	—	—	—
UNIVERSAL MICROPHONE COMPANY LTD	202	18.50	5 MEG.	NOTE 2 −70	50-5000	±3 APP'X	UNI	10	POLISHED CHROME	—	HAND MIKE	—
	203	22.50	"	−60	"	"	"	10	"	—	"	—
	15MM-X	24.50	"	−64	"	±2 APP'X	SEMI OR NON-DIR.	25	"	DUVELO CLOTH HOOD	—	—

* NOTE 1: IMPEDANCE IS VALUE OF TERMINAL RESISTANCE TO BE USED FOR SPECIFIC FREQ. RESPONSE. LOWER TERMINAL RESISTANCE CAN BE USED WITH SOME LOSS OF LOW FREQ. RESPONSE.
NOTE 5: LOW FREQ. RESPONSE DEPENDS ON DISTANCE BETWEEN SOURCE AND MICROPHONE.
NOTE 6: DIRECTIVITY CONSIDERED IN BOTH HORIZ. AND VERTICAL PLANES.
NOTE 7: BUILT-IN CABLE CONNECTOR WITH PLUG ATTACHED.
‡ OUTPUT AT END OF 25 FT. CABLE.
NOTE 2: 0.006 WATTS.
NOTE 3: 1 VOLT PER BAR.
● NO INFORMATION SUPPLIED.

THE charts shown on the preceding pages represent an attempt to present the specifications and characteristics of most of the commercially available microphones. They are compiled from data supplied by the various manufacturers.

Information on the subject of microphone characteristics is scarce, largely because such characteristics are exceptionally difficult to determine and any discussion is extremely involved and rather uninteresting.

We can only say that the reliability of the manufacturer as well as your own past experience should have more weight than the figures presented.

The output ratings given by the manufacturers are based upon several reference levels. To be able to convert from one to the other the exact test conditions should be known. There is, however, only 4 or 5 db difference between the ratings based upon the 0.006-watt level and those based upon the 1-volt-per-bar level. Those with the latter reference level usually look worse, that is, the rating will be a larger negative number for the same output.

● ● ●

THE AUTOMATIC TELEGRAPH

(*Continued from page* 13)

Although no definite figures are available as regards the cost of this paper, it is very much less expensive than photographic paper. The contrast obtainable is less than that in a photograph but is ample for most purposes.

The method employed for synchronization is extremely simple and foolproof. For local use the synchronous motors of both the transmitter and receiver are tied to the same power system and therefore rotate at precisely the same speed. For distant operation where a common power system is not available the motors are controlled by means of 60-cycle temperature-controlled tuning forks. These sources are sufficiently accurate that no variation of motor speed is apparent during the interval required for the transmission of a message.

In distant operation the first pulse initiates the movement of the recorder, whereas for local operation synchronizing pulses are sent on the ground circuit (Fig. 2). In either long distance or local operation, the receiving drum is brought into phase by a current pulse before each message is transmitted.

Since there are 100 lines per inch and the cylinder is moving laterally at the rate of 1.8 inches per minute on 8-inch wide paper, 14 square inches are covered per minute. There are 10,000 picture elements to be reproduced in each square inch, and as the machine scans 14 square inches per minute, the electrical connection must be capable of reproducing at least 140,000 elements in a minute. Normally a frequency of 2500 cycles per second is used as a carrier for the facsimile signals.

TELEVISION ENGINEERING

A 441-line television image of L. E. Gubb, President, Philco Radio & Television Corp. Picture transmitted over portable system using RMA standards.

FUNDAMENTALS OF Television Engineering—

The ESSENTIAL ELEMENTS of a TELEVISION SYSTEM

Part I

441-line television picture transmitted by Philco system using RMA standards. Jean Muir, Warner Bros. Star.

By F. Alton Everest
Instructor in Electrical Engineering—OREGON STATE COLLEGE

THOSE in the communication field today are witnesses to the addition of a new phase to this already manifold field, namely, instantaneous sight at a distance. Communication over great distances has been developed through the perfection of the arbitrary signal-symbol stage, through sound broadcasting, and now the addition of sight to sound promises to open up a multitude of new opportunities for exploitation and development. It should be pointed out here that to the careful student of these matters, there appears to be no factual basis for expecting the combined sight and sound type of broadcast to supplant the common aural broadcast as an entertainment and educational medium for many years to come. Even though the present-day television equipment is in an apparently advanced stage as compared to the broadcast equipment at the inception of that service, there are many problems, both technical and commercial which seem almost insurmountable at this time. Based upon past attainments in technological fields, however, there is no reason to doubt the ultimate solution of these difficulties.

In the translation of a picture from light values to electrical currents, some manner of photo-electric device is needed. The accidental discovery of the photo-conductive properties of selenium by May in 1873 appears to be one of the important stimuli to the development of means to transmit sight. At about the turn of the century, results from Hertz's discovery in 1887 of the photo-emission phenomenon began to appear. This finally bore fruit in the photo-electric cell which was so prominent in the early development of television and which has such widespread application in other fields today.

There is something else essentially

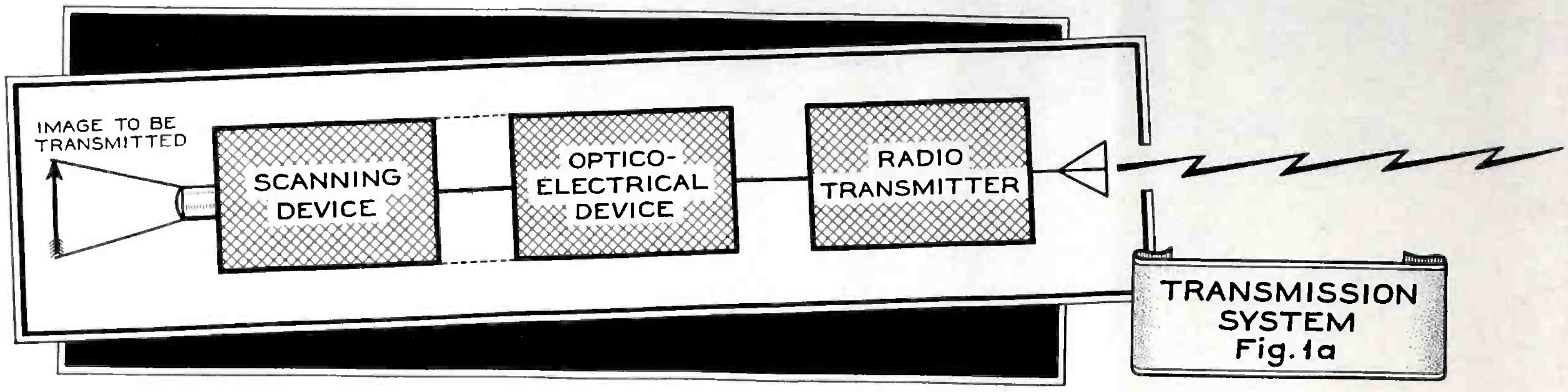


Fig. 1a

necessary, however, beside the translation of light to electric current. For instance, if a photo-sensitive device were held up before an image to be transmitted, it is obvious that the transmission of the image as such would be unsuccessful. A signal would be transmitted which would be proportional to the *average* illumination of the subject only. A comparable occurrence in photography would be snapping a picture with the lens removed from the camera. True, the film would be exposed, but absolutely no information would be revealed because the film would be uniformly exposed over all of its surface to a degree depending upon the illumination of the subject and the length of exposure.

From this fact that any photo-electric element delivers an electric current proportional to the *average* illumination falling upon it, it is evident that to convey visual information it is necessary that the photo-electric device does not look at the whole subject to be transmitted, but rather at one *elemental area* of it at a time. In this way, the signal corresponding to the average light intensity of each elemental area can be transmitted. The problem then resolves itself into a problem of analyzing the picture into many of these elemental areas, allowing the photo-electric device to look at each area in turn transmitting a signal corresponding to the average light intensity of each small area, converting this signal back to light of the correct intensity at the receiver, and the re-assembling of the picture. While this method is rather complex and unwieldy, at the present stage of the art it is the only practical one available. If, as in the eye, the image would be thrown upon a mosaic of photo-electric elements each of which was connected to a similarly located reproducing element on the receiving screen, we would have a simple system in its action but quite impractical. One reason for this impracticability can be seen in the fact that the eye has about five million of these discrete elements (the so-called rods and cones) and a separate connection between each and the receiver (the brain). The interconnection of just a few conductors between the television transmitter and each receiver would be hardly feasible, to say nothing of five million of them.

The image, then, must be broken down into many tiny elemental areas, each of which will be transmitted independently. There have been innumerable systems of scanning proposed such as, for instance, spiral scanning, radial scanning, and sine-wave scanning. Most of these suffer from the effects of a change in scanning rate on different parts of the image or some form of non-uniform resolution of detail over the image surface. The method which has withstood the test of years of experimentation is a simulation of the form resulting from the use of the scanning disc patented by Nipkow in Germany in 1884. By means of a relatively large disc with a spiral of small holes arranged near its periphery, the image was scanned along a narrow line by one hole and along another line just below or above the first line by the next hole in the spiral and so on across the image in a regular sequence.

A simple analogy of the form of scanning usually used today is that of reading a page of a book. The eye starts in the upper left-hand corner of the page and progresses at a uniform rate along the first line. At the end of the line, the eye snaps back to the beginning of the second line at a much faster rate and then along the second line at the original uniform rate. This continues to the bottom of the page and then is repeated in an identical manner on following pages. This could be classed as "uniform speed sequential scanning." If the book were especially prepared in such a code that the story was continuous by reading the odd lines first and then going over it again on the even lines, the same information could be imparted with only a little additional trouble, and it could be classed as an "interlaced scanning" process. In either case, the image is scanned in a definite, pre-arranged order, and the size of each elemental area would be determined mainly by the width of each strip. The greater the number of strips per picture, the smaller each elemental area and the smaller the picture detail that can be resolved. We shall discuss these essential qualities of a television image in more detail later.

Showing scanning strip and signals.

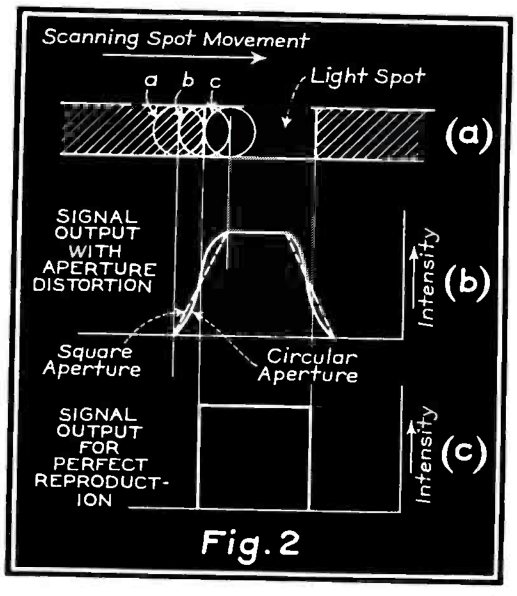


Fig. 2

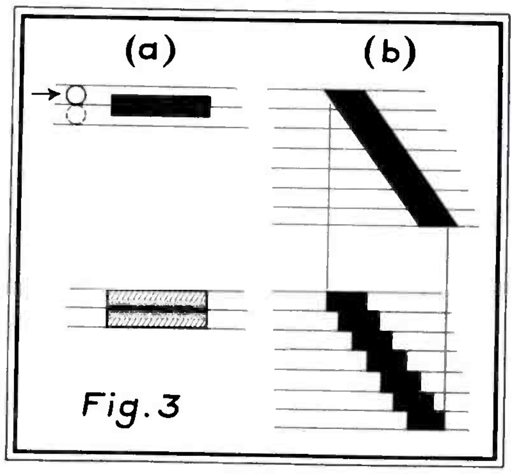
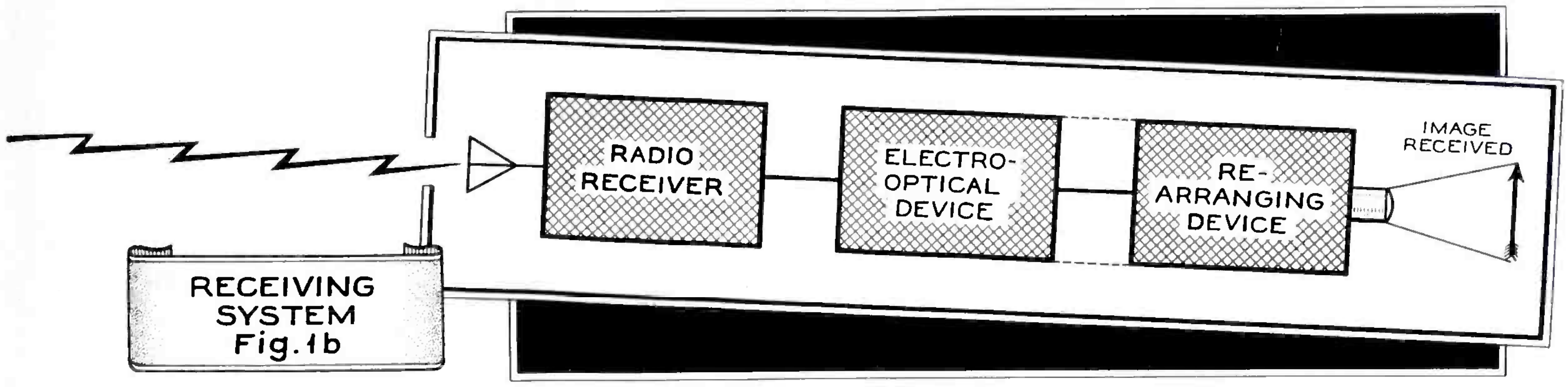


Fig. 3

Distortions. Scanning spot width comparable to scanned detail.

ANALYSIS OF TELEVISION SYSTEMS

All television systems can be broken down into a very few essential functions as shown in block diagram form in Fig. 1. Here we are dealing with the sight transmission and receiving system alone, because broadcasting the sound accompanying the image has already reached a high state of perfection and its working is more or less common knowledge. The scanning device by which the image is to be torn into the elemental areas can take any number of different forms. Representative of the mechanical methods are: (1)



Apertured disc, single or multiple spiral; (2) *apertured drum;* (3) *apertured endless band;* (4) *mirror drum;* (5) *vibrating mirrors;* (6) *prismatic disc;* (7) *mirror screw.*

The optico-electrical device could be the ordinary photo-electric cell arranged singly or in banks, possibly even equipped with electron-multipliers to increase the sensitivity. The radio transmitter section will not be discussed, because no new theories or modes of operation are introduced for television work. The suitable transmission of the wide frequency bands required, however, and the transmission at the ultra-high frequencies introduce many new problems, but they have all been met by extensions of fundamental electrical theory.

It will be noticed that the scanning device and the optico-electrical device are also connected with broken lines which indicate that these two functions can take place within one instrument. In this series, which will deal mainly with electronic methods, this is particularly the case. For instance, the Image Dissector and the Iconoscope which will be taken up in great detail later, utilize electronic methods of scanning in such a way that the photo-electric emission and the scanning take place within the same evacuated glass envelope. Basically, however, these highly developed devices take their place in the block diagram of Fig. 1 along with the humble scanning disc and photo-electric cell. For these two devices, we must add electrostatic and electromagnetic deflection of electron beams as two other systems of scanning to follow the list given above.

At the receiver the signals are demodulated and amplified by the customary methods (except for extension of the pass bands) and the varying voltage is used to actuate the electro-optical device. In the mechanical systems this device may take one of the following forms: (1) *flat plate neon lamp;* (2) *Kerr cell;* (3) *supersonic light valve.* The re-arranging device on the receiving end of mechanical systems can be any one of the devices listed as scanning devices at the transmitter. For electronic television, in which we are particularly interested, the electro-optical device and the re-arranging device are found in the same instrument as at the transmitting end. The cathode-ray tube ordinarily used contains an electro-optical device in the variation of fluorescent screen excitation and the resulting emission of light by the variation of the electron density of the beam. Here again the re-arranging system may be electrostatic or the electromagnetic deflection of this electron beam. This, too, is a special study and will be dealt with in detail later.

REPETITION RATE

As far as the units in the block diagram of Fig. 1 are concerned, there is no difference between facsimile and television transmission. Both demand a tearing down of the image to be transmitted into strips and the optico-electrical analysis of the light and shade intensities along that strip at the transmitting end, and the reconstitution of the image at the receiver by the translation of the electrical signals back to their corresponding light intensities, and the arrangement of these picture elements into their proper order. However, the speed with which the process takes place and whether or not a record is to be made of the received image determines whether we shall call ours a television or a facsimile system. A typical facsimile system might logically require fifteen minutes to transmit a photograph eight by ten inches. At the receiver, at the end of this time, a permanent record of the image will have been produced. For television, a complete picture of the subject would be transmitted and completely reproduced in, possibly, 1/30 second. Each picture will differ slightly from the preceding one due to any motion that has taken place in that time. Because of a characteristic of the eye which is called "persistence of vision," it will not be able to distinguish between the separate pictures, but will see what appears a continuous, uninterrupted flow of motion of the subject. Once the retina of the eye is stimulated with a single picture focused upon it, the impression remains for about 1/10th second after the stimulus has been removed. By impressing about fifteen separate pictures per second upon the retina, the eye will be unable to follow the dark spaces between pictures. However, at repetition rates as low as fifteen per second, the flicker may be objectionable, and it is standard motion picture practice to project twenty-four "frames" per second. Interlaced scanning giving thirty complete pictures per second, but scanned in such a way that each picture is traversed

(*Continued on page* 34)

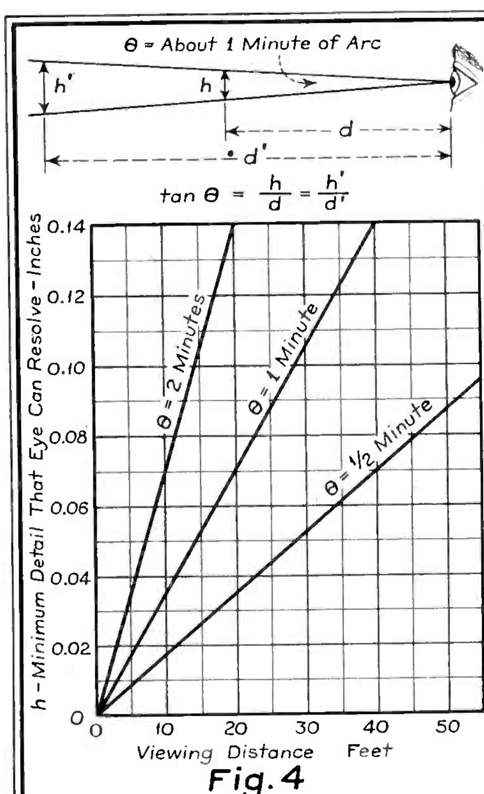


Fig. 4

Left: Showing minimum detail eye can resolve.

- Bibliography -

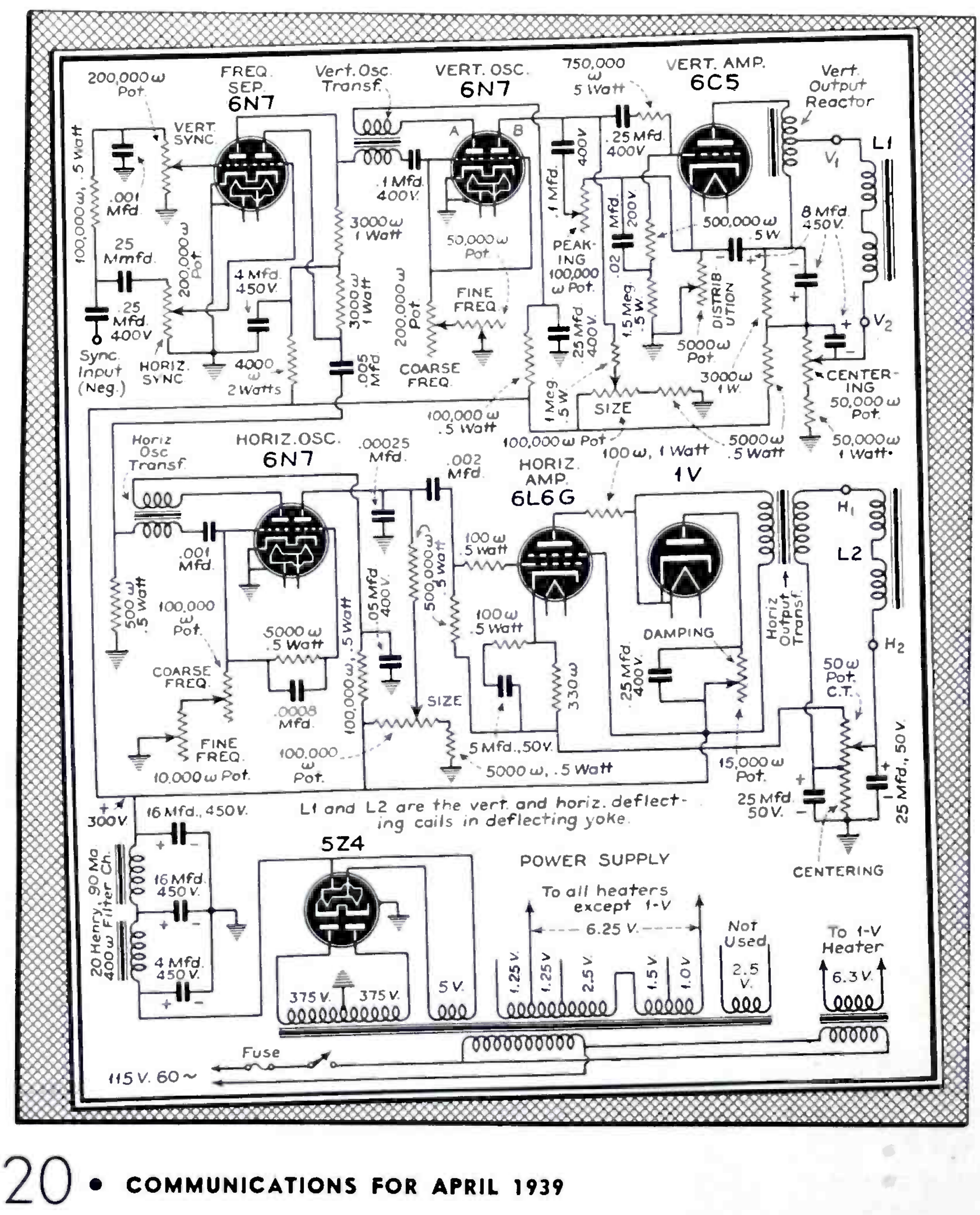
1. Gray, Horton and Mathes, "THE PRODUCTION AND UTILIZATION OF TELEVISION SIGNALS", Bell System Technical Journal, Volume VI, Number 4, October, 1927.
2. Engstrom, "A STUDY OF TELEVISION IMAGE CHARACTERISTICS", Proc. I.R.E.: Part I, Volume 21, Number 12, Dec. 1933 Part II, Volume 23, Number 4, Apr. 1935

KINESCOPES

for television receivers

Photo B. Picture taken on 1800 tube.

Above: The 1803-P4. Below: Fig. 2. An electromagnetic scanning circuit for 1804-P4.



THE heart of the modern electronic television receiver is the Kinescope—the cathode-ray tube which converts electrical impulses, received at the rate of several millions per second, into a life-like reproduction of the picture or scene being transmitted. The type of Kinescope employed determines not only the size and color of the received picture, but, to a large extent, the design of the associated apparatus and also the size, shape, and cost of the complete receiver. It is readily apparent, therefore, that before the engineer or experimenter can even begin to design a television receiver he must be thoroughly familiar with the characteristics and design features of all available types of Kinescopes. In addition, he must be able to interpret the published characteristics so that the tube finally chosen will be the one which best meets his individual requirements.

Kinescopes available at present can be divided into two major groups—those employing electrostatic deflection of the electron beam and those employing electromagnetic deflection. These tubes can be further classified according to their bulb diameters and the kind of phosphor employed on their viewing screens. The accompanying chart has been prepared to facilitate a comparison of the eight RCA Kinescope types now available.

The "P-suffix," following the type number, indicates the type of phosphor used on the viewing screen, which in turn determines the color of the luminescent spot and the color of the received picture. Phosphor No. 1 is the standard green screen material, widely used in cathode-ray tubes designed for oscillographic applications. Phosphor No. 4 is the new white screen material, which offers the nearest approach to the black-and-white reproduction of pictures with which we are so familiar from the movies. Kinescopes 1800 and 1801 do not have a P-suffix, due to the fact that they were announced before the new numbering system was begun. These tubes employ phosphor No. 3, the luminescence of which has a yellow tint.

KINE-SCOPE TYPE	COLOR OF FLUORES-CENCE	BULB SIZE (Inches)	TYPE OF DEFLECTION *	ANODE No. 2 VOLTAGE MAX.
906-P1	Green	3	S	1500
906-P4	White	3	S	1500
1801	Yellow	5	M	3000
1802-P1	Green	5	S	2000
1802-P4	White	5	S	2000
1800	Yellow	9	M	7000
1804-P4	White	9	M	7000
1803-P4	White	12	M	7000

* S is electrostatic-deflection type,

By L. C. WALLER
Research and Engineering Dept.
RCA MANUFACTURING CO., INC.
Harrison

Photo A. Photographed from the screen of a 3-inch Kinescope.

The preference of most "lookers-in" seems to be for the white screen, with yellow second and green third. However, the green phosphor has the highest luminous efficiency and, for the same anode voltage, produces the brightest picture.

The chart shows that the electromagnetic-deflection Kinescopes provide pictures of better definition than the electrostatic-deflection types. This is largely due to the fact that the former are designed for operation with higher anode voltages. An increase in anode No. 2 voltage increases the speed of the electrons in the beam, with the desirable result that spot size is decreased and spot intensity is increased. Some approximate figures on the resolution of which each tube type is capable are shown in column 6 of the chart. "Resolution" is used here to mean the maximum number of parallel lines which, if transmitted, can be identified as separate lines on the received picture.

A tube having a resolution as low as 250 lines is capable of producing a picture of good detail, as illustrated in photo "A." This picture was photographed from the screen of a 3-inch Kinescope, the video signal being generated by a Monoscope. The Indian-head picture of photo "B" was taken from a Monoscope pattern reproduced on the screen of type 1800; in this case, the detail corresponds to about 350 lines, although the 1800 is capable of a resolution of 450 lines. The limitation here was the picture receiver, rather than the Kinescope. This example well illustrates the point that little is gained through using a high-definition tube with a receiver having less resolution capability, for a given Kinescope bulb size.

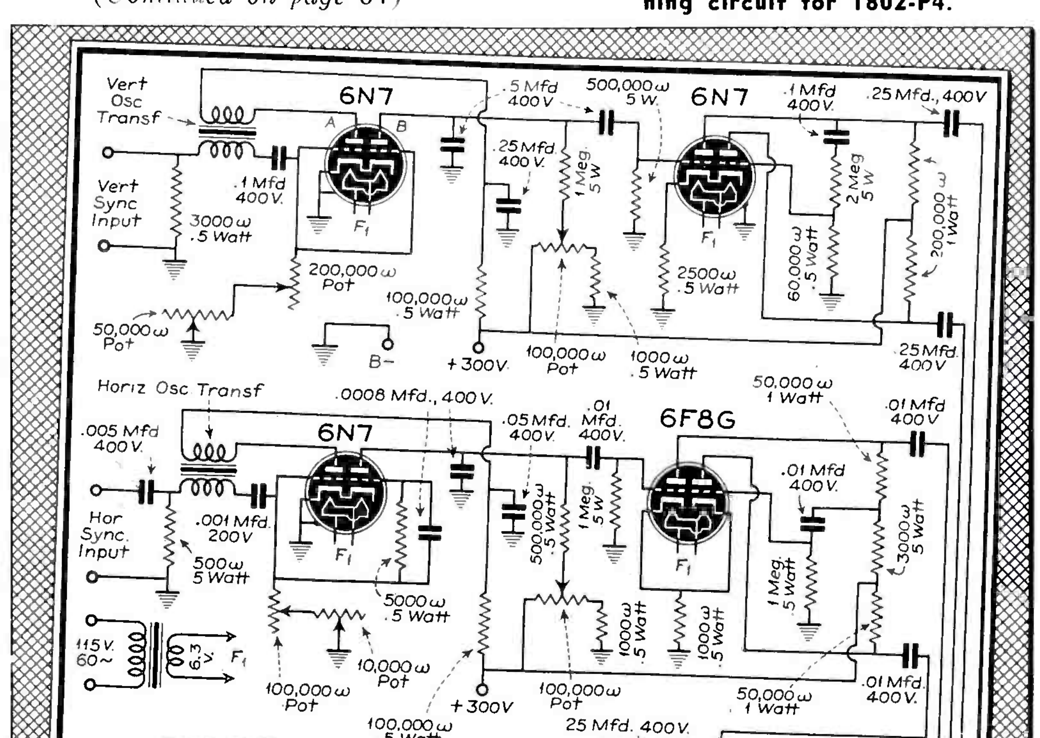
In general, the scanning amplifiers and auxiliary apparatus for electromagnetic-deflection Kinescopes are somewhat more expensive than for electrostatic tubes, even without consideration of anode-voltage supplies. Fig. 1 shows a typical electrostatic scanning circuit for the 1802-P4. In Fig. 2, a

(*Continued on page* 34)

RESOLUTION, LINES (Approx.)	PICTURE SIZE, INCHES (Approx.)	PICTURE AREA SQ. INCHES (Approx.)	KINESCOPE COST FACTOR PER SQ. IN. OF PICTURE AREA (Approx.)
250	$1\frac{13}{16} \times 2\frac{7}{16}$	4.5	3.0
250	$1\frac{13}{16} \times 2\frac{7}{16}$	4.5	3.3
400	3 X 4	12.0	3.3
300	3 X 4	12.0	2.1
300	3 X 4	12.0	2.3
441+	$5\frac{3}{8} \times 7\frac{1}{4}$	39.0	1.5
441+	$5\frac{3}{8} \times 7\frac{1}{4}$	39.0	1.5
441+	$7\frac{3}{8} \times 9\frac{3}{4}$	72.0	1.0

M is electromagnetic-deflection type.

Above: The 1800 and 1801. Below: Fig. 1. Electrostatic scanning circuit for 1802-P4.



Showing house of the miniature set described by the author.

The technical side of video effects

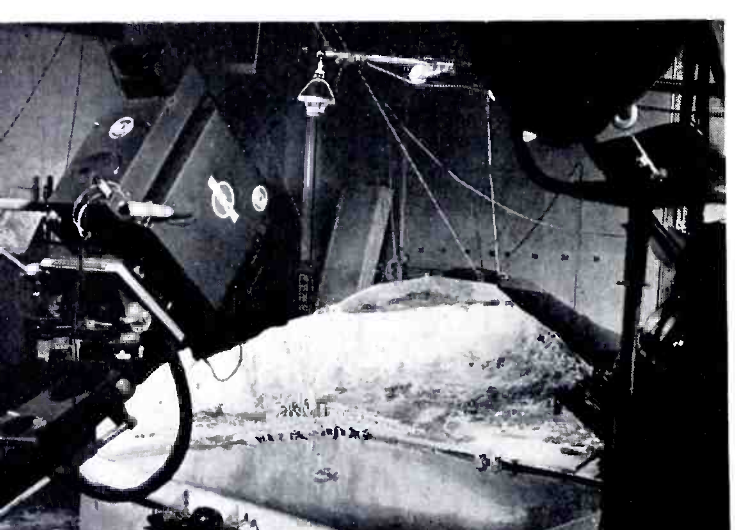
By W. C. EDDY
Television Department
NATIONAL BROADCASTING CO.

THERE have been several stories written to date in which the human interest angle of an activity called "video effects" has been publicized, but little or nothing has been said about the technical considerations that might underlie this work. The engineering aspects in this new field will therefore be the subject of this article.

Before discussing the problems inherent in each new television production, let us first briefly review the events leading up to the development of "video effects" in television. In 1936 the National Broadcasting Company launched an extensive experiment in television programming as a part of the general RCA field test already in operation. This test was to furnish a definite cross section of the public's likes and dislikes as far as visual programs went, and also to train under production conditions the nucleus of a combined engineering and program staff to operate the system on the air. Starting with a series of simple one-act scenes this group soon got the feel of the new medium but with the advent of the more complicated shows there began to appear certain duties that fell between the program and engineering divisions' routine duties. Animation, titles, and miniature staging were a few of the subjects in this category, material necessary to the production yet unprovided for in the original assignment of personnel. To centralize the development as well as to facilitate the production of such material as might be required led the National Broadcasting Company in 1938 to consider a video-effects group operating directly under the Development Section of the Engineering Department. Since then this activity has been given a series of both developmental and constructional problems in connection with television programming but rather than describe our work in the unrelated sequence in which it was presented to us we prefer to cover it in somewhat its order of importance. Miniature staging in television can be considered one of our most interesting and significant fields of investigation.

In our terminology, this heading covers any miniature reproduction whether it be a sign board or a stage complete with its proscenium arch. In any case, our first consideration is the lens to be employed in shooting the set, for it is around its limitations that we determine our design. If the lens is of the wide angle, short-focal length type, it is necessary for us to build a shallow, foreshortened stage to maintain usable detail throughout the set. If a longer lens can be satisfactorily employed, a deeper design may be built. However, knowing the depth of sharp focus in which we will be required to operate, we can lay out our working plan to keep all important details within these limits. Outside of these boundaries we can create block backgrounds and indefinite foreground work to give the illusion of third dimension to the transmitted picture. The further out of focus we build these primary backgrounds, the less the detail required, although the intervening space must carry sufficient subject matter to maintain the illusion and absorb any unnatural shadows. As an example, let us consider a miniature set actually used on the air.

The problem as it was presented to us was primarily a title job; that is, the director handling this particular show was interested only in presenting the cast and setting the scene so that the audience would quickly grasp the significance of the opening action on the set. We had two alternatives, (1) a straight series of titles and a printed résumé, or (2) the more subtle method of telling the story with a miniature. We chose the latter not merely to demonstrate the possibilities of television, but because it appeared to be the more normal solution to this particular problem. We realize full well that the primary function of a title is to display the printed material in the quickest and most legible way possible but in this particular instance we were confronted with not only a simple title but



Televising another miniature set-up. See opposite page.

Part of the miniature set leading up to house shown on opposite page. Notice detail and the method of presenting titles.

an explanatory sequence as well. This would have meant a somewhat lengthy roll title would have to be used to properly set the scene in addition to the four screens of type that would be required for the cast. If it were a moving picture production, such a leader would be considered insignificant as a prelude to a feature film but here we must consider that our average production seldom runs over fifteen minutes. It therefore is necessary that we do not overbalance the program with title work and also that we tell our story in the quickest, most subtle, and entertaining manner to the end that we maintain the interest of the audience. Lengthy printed resumes, no matter how cleverly done, are not as interesting to the average viewer as its three dimensional equivalent in a miniature. Whenever possible, therefore, we try to incorporate the title work into a set that will assist us in telling the story.

The locale of this particular program was to be a suburban section of an unidentified town where a young doctor had hung out his shingle on a new and rather pretentious home. The appreciation of the opening sequence depended on the audience recognizing the financial predicament of this doctor in his too ornate surroundings. The opening leader and cast were printed and mounted as bill boards fronting on a miniature street in this suburban development. A sidewalk, hydrants, a lamp post and street signs were added for realism. Several miniature trees, made of pampas grass and blown by electric fans off the set were arranged at salient points along the miniature. I say "salient points" for a reason; for we have discovered that the slight bit of movement created by the waving of one of these trees goes far towards making our work appear realistic and destroying the static feeling that is so common in such work. If we place these trees at such points that they will carry the effect of movement from one part of a long miniature, such as this, to the next they add a very definite element to our design. With this in mind we place one tree so that it will be a part of the opening shot and distribute the rest at irregular intervals over the set.

This particular miniature, as may be seen, was designed for televising by a trucked camera, the "dolly" being moved parallel to the sidewalk over its entire length. To insure consistent lighting angles without recourse to the main studio lighting installation we "trucked" a floor unit ahead of the camera during the take. It was originally intended to continue this street into the miniature of the doctor's house, but due to space limitations in the studio we were forced to make a process shot and to use, not one, but three separate sets to tell the story.

This brought up the interesting problem of successfully tying three sets together by camera switching so that the illusion of one continuous set would be created on the receiver. To do this we employed a simple trick which we term "the psychological tie." It makes use of the tendency of the mind to carry over for short periods certain emphatic features of what the eye has seen. The more pronounced or emphatic the picture the longer the retention of the image seen so we strive to make the section preceeding the camera switch as simple and emphatic as possible. As you will notice from the photographs, the end of the street on number one set has a white picket fence, considerably different in structure, background and arrangement from the subject matter that preceeds it. This serves to attract the eye by both its simplicity and composition. On the next set, in this case the deep cottage miniature, another section of this same fence has been built in the lower left-hand corner, the particular part of the set where we wish to have the audience mentally fit them together. The average viewer will do just that. Having seen the billboards pass across the screen his eye is attracted to a sudden change in composition, simple and easy to digest. At this point we electrically switch the cameras to the second set where the audience finds a continuation of the identifying fence and accepts the sequence on this miniature as a logical and satisfying part of the first. In other words we merely satisfy the pictorial requirements on the second set that we have placed in your mind on the first.

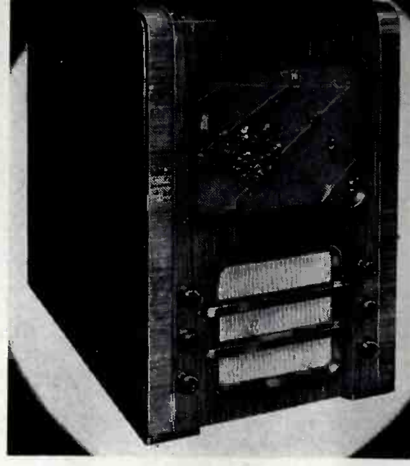
Now that we have satisfactorily switched to the second camera, we can continue our story. With the set designed for a deep focus lens and the camera in a long shot position we open on this cottage and disclose rolling lawns and a stone walk leading up to the cottage. Incidentally, as we cut to number two camera and number two set the miniature is already in motion, decreasing the length of shot by being moved down a "trucking table" towards the fixed camera. In many cases we prefer to move the miniature rather than the cameras and have therefore provided ourselves with a series of tracks and rolling tables on which our sets are built. I mention motion because we have found that it enhances any televised picture from a miniature set. As long as our scene is changing, the audience will remain interested in what we are attempting to tell but a televised picture of a stationary set challenges them to search out details that identify the picture as a miniature. To con-

(*Continued on page 33*)

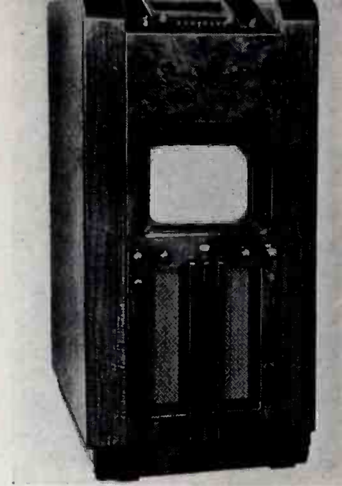
The author examining a set before televising.

RCA's Model TRK-9. 9" Kinescope, images $5\frac{1}{2}$" x $7\frac{1}{4}$", includes 12-tube, 3-band radio and switch for victrola attachment. Model TRK-5 (not shown) has 5" tube and 8-tube all-wave radio.

RCA television attachment TT-5. Utilizes chassis and speaker of any a-c radio for sound. Plugs into jack on 1938-39 RCA radios. Uses 5-inch Kinescope.



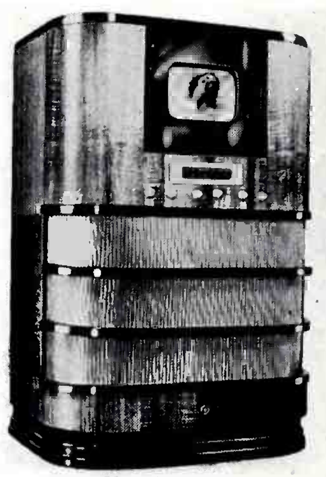
DuMont Model 180. The screen size on this 24" x 15" x 25" television sight and sound receiver is 8" x 10". Direct-vision type.



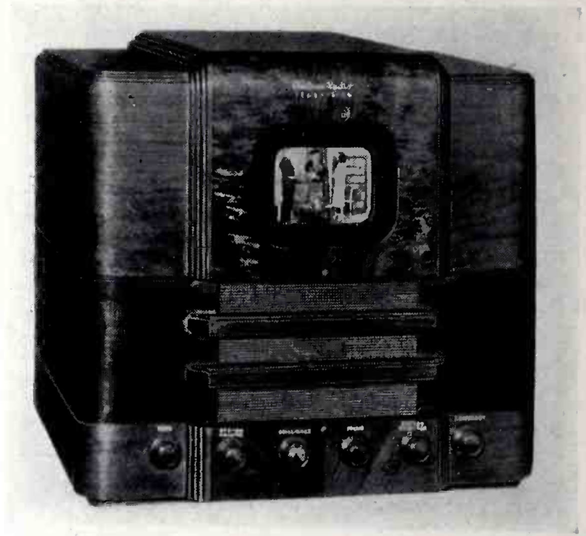
DuMont 181. Direct-vision, 8" x 10" screen, four-channels, band selector switch, incorporates all-wave radio.

TELEVISION • • • • RECEIVERS

RCA Model TRK-12. Indirect viewing 12" kinescope, picture $7\frac{3}{8}$" x $9\frac{3}{4}$". Electric tuning for sound reception is provided for 9 stations.



G. E. HM-225. 2 chassis, video sound and power, audio. 9" tube. Similar, slightly smaller model, HM-185, not shown.

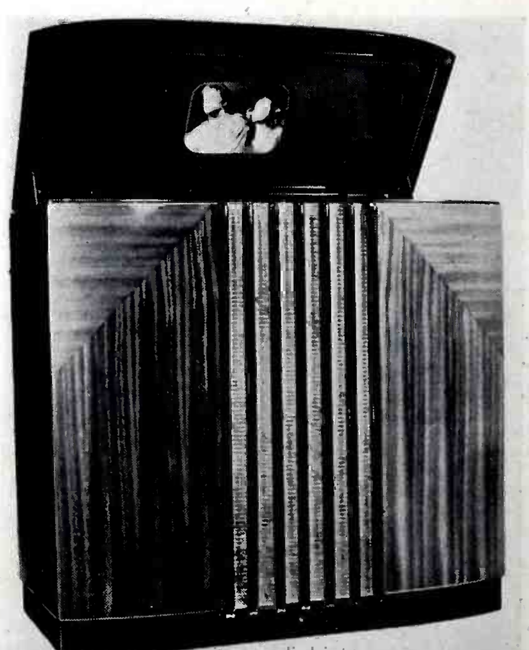


Above: Andrea Model 1-F-5. Tuning on 44-50, 50-56 mc sight and sound channels. Employs 5" picture tube.

Right: G. E. HM-171 picture receiver and sound converter. 5" tube. Can be used with special receivers to be announced, or for pictures only.

Stewart-Warner. 12" picture tube, image $9\frac{5}{8}$" x $7\frac{1}{4}$". Video and sound receiver, also broadcast band reception.

Below: G. E. HM-275. All-wave radio and television receiver. 12" picture tube.



Below: Pilot Model T-90 television sight and sound receiver, 9" picture tube.

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Television Economics

By

Dr. ALFRED N. GOLDSMITH
Consulting Industrial Engineer

Part III

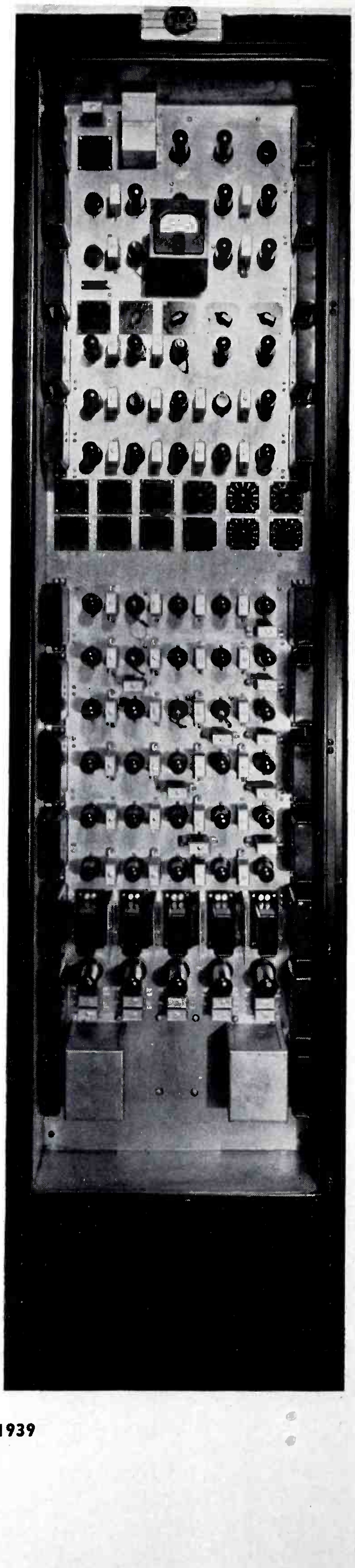
E-2 Studio Video Control Equipment

THE unit of this class of equipment is the "camera chain." This includes all optical, mechanical, and electrical equipment starting with the output of the pick-up camera, running through the control-room equipment and signal-forming apparatus, and ending with equipment delivering the final signal to the transmitter or to a link connected to the transmitter. The number of camera chains available in a given studio determines, up to a certain point, the flexibility, smoothness, and elaboration of the possible productions. The cost of a number of camera chains is greater than the sum of their individual costs because of the necessity for interconnecting, change-over, and multiple monitoring equipment. As a general rule, two camera chains represent a minimum for reasonably smooth studio operation using present technique.

The video control room provides convenient means for the operating engineers to handle the contrast control (video gain control), the brightness control (height of the blanking pedestal), the focusing control for the iconoscope beam, the shading panels for eliminating iconoscope-produced shadows in the picture field, and push-button controls for the relays that handle change-over from one camera to the other (such relays becoming operative in a selected order and at determined speeds so as to avoid such disagreeable pictorial effects as instantaneous brightness or line-structure irregularities or even loss of framing during changeover). Switching from camera to camera is accomplished in center-grounded low-capacity relays. Alternatively, fading and lap dissolves may be used. Where several operating positions or adjustments in the control room are to be interlocked, Selsyn or similar motor controls attached to the corresponding operating-knob shafts may be used.

Instantaneous communication from the control room to the cameramen is necessary. Smooth operation requires that both the active or outgoing camera output and the incoming camera output be separately monitored. Special consideration is required for instant and reliable communication between members of the control staff; and probably close juxtaposition of these men is as desirable a solution as any. The control room is sound-proofed and acoustically treated. Good practice will require that the video control men and the audio control men shall each have available both picture *and* sound.

Front view of RCA signal generating equipment for transmitting stations.



Consideration must be given to proper location of the video control room, preferably so that it overlooks the set. Tilted windows and colored transparent (e. g., green cellulose) shades over portions of the windows are desirable to avoid glare in the eyes of the control men. In the control-room equipment, cost must be subordinated to some extent to the pressing need for speedy, reliable, and simple operation of complicated circuits.

Video wiring is of the coaxial-cable type, and great care is necessary to avoid electrical induction (cross-talk) between circuits as well as electrical echoes, all of which will affect picture quality. Accordingly, connection blocks are electrically shielded and all circuits are properly terminated. In Europe, camera cable lengths up to 1,000 feet have been used, and in this case the proper time of arrival of impulses at the camera from the synchronizing generators is controlled by suitable and adjustable delay circuits.

E-3 Synchronizing and Video Controls

In one typical instance the following groups of apparatus were included in the synchronizing and blanking-generator assembly.

(a) A master timing unit is provided to produce the field frequency (60 cycles) and the line frequency (13,230 cycles). It is desirable that the 60-cycle output of the frame-frequency generator shall be locked into the power supply. This can be accomplished by generating it by the following rather unusual procedure. A multi-vibrator oscillator is provided which produces 13,230 cycles. Thereafter a frequency of 26,460 cycles is provided by doubling, from which any 13,230-cycle component is carefully filtered. Submultiples of 26,460 cycles are then produced having the frequency ratios of 1/7th, 1/7th, 1/3rd, and 1/3rd, the final frequency therefore being 60 cycles. A means of automatic frequency control is then provided which functions on the master oscillator of the multi-vibrator with dependence on any instantaneous phase differences between the multi-vibrator-generated 60-cycle output (or framing impulses) and the 60-cycle power supply, thus providing the locking means mentioned above. A typical timing unit has 10 to 20 tubes and 100-150 component parts, together with a small group of tubes and 10 or 20 components for the requisite power supply.

(b) A shaping unit is used to produce the iconoscope horizontal deflection voltage (which is keystoned by modulating at frame-deflection frequency to compensate for the oblique incidence of the scanning beam, thus providing the so-called trapezoid correction), the iconoscope vertical deflection voltage with changes in angular velocity across the mosaic to avoid uneven line spacing resulting from keystoning, the iconoscope blanking voltages, the kinescope synchronizing currents, and the kinescope blanking impulses (which latter kinescope currents constitute a unitary group sometimes referred to as the "supersynch"). This shaping unit is a complicated assembly of circuits using a number of special wave-shaping methods including clipping, delaying, and narrowing of waves together with keying or injection of other waves. A typical unit of this sort may have about 20-30 tubes (which function as about twice their number so far as circuit operation is concerned) and approximately 150-200 component parts.

(c) A closely regulated power supply is necessary for the shaping unit, such supply generally requiring 5-10 tubes and about 25-50 component parts.

(d) The convenient distribution of the output of the units mentioned under (a) and (b) above requires a suitable distribution panel, which typically will have about 25-50 component parts. The preceding units (a) and (d) may conveniently be combined into one or two pieces of apparatus.

(e) It is necessary to combine the picture signals and the blanking signals and then to superimpose the synchronizing signals on the blanking signal pedestals, all of these combinations occurring with suitable relative amplitude and in correct phase. This requires a video-signal amplifier unit of several stages whereafter the blanking input is injected, for example, by feeding it into a common plate-load resistor. The output then passes through several stages of v-f amplification and into a limiting or clipping stage wherein the specified level of "picture black" is set. The synchronizing-signals are again added, for example, by electrical injection into a common plate-load resistor. Various detailed processes are used to clear up the signal. For example, any v-f signal higher than "black" level is clipped, and the "black" level is adjusted manually or automatically in a circuit which flattens the pedestal tops to avoid influencing the shape of any synchronizing signals which are later inserted. One method of clipping consists in introducing degeneration into a limiting-tube circuit through the use of cathode loading. Linearity of the plate-output cutoff is improved by such degeneration. A typical video mixing amplifier may contain about 7-12 tubes and about 25-50 component parts.

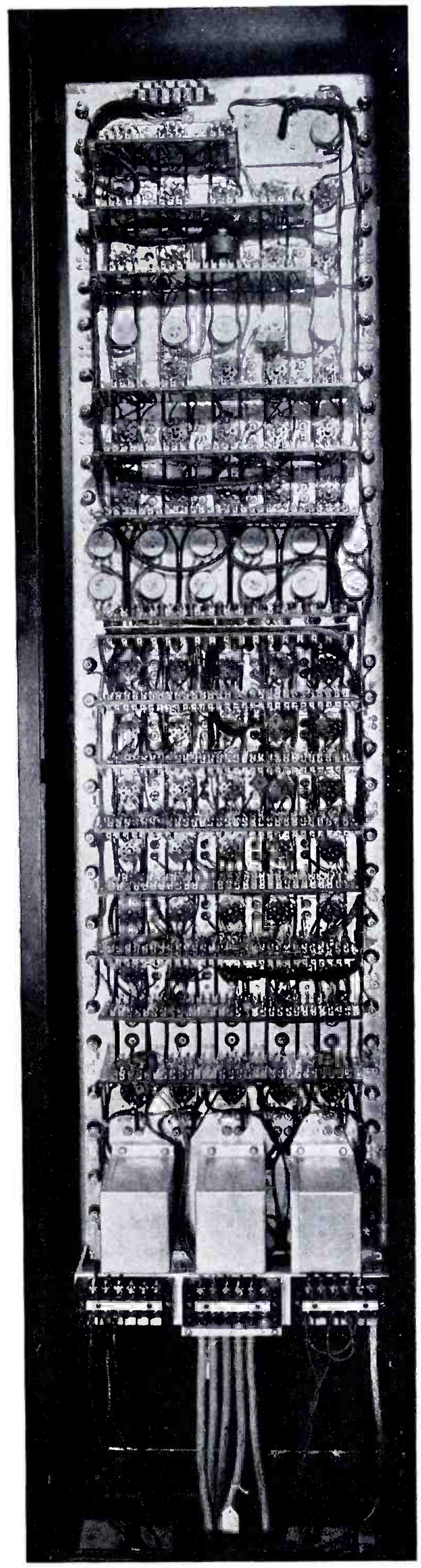
(f) It has been mentioned that spurious signals are produced in the iconoscope as the result of output changes during the scanning of each line or section of the picture. Such shading produces as one effect a change in the d-c component generated along the line. This is equivalent to an increased secondary-emission charge on those elements of the mosaic lying near the end of the line, and this in turn is equivalent to an over-bright picture at the end of each line. To compensate for this effect a shading control is necessary which functions according to the following general plan. As previously stated, the scanning of the iconoscope mosaic produces (even without illumination on the mosaic) an output consisting of cyclic signals which cause shadings or the so-called "black spot" on the receiving kinescope screen. While some of the causes of this effect are not fully understood in all cases, as a practical matter is is found necessary to neutralize such effects in the output circuit to get a smooth and uniformly illuminated field.

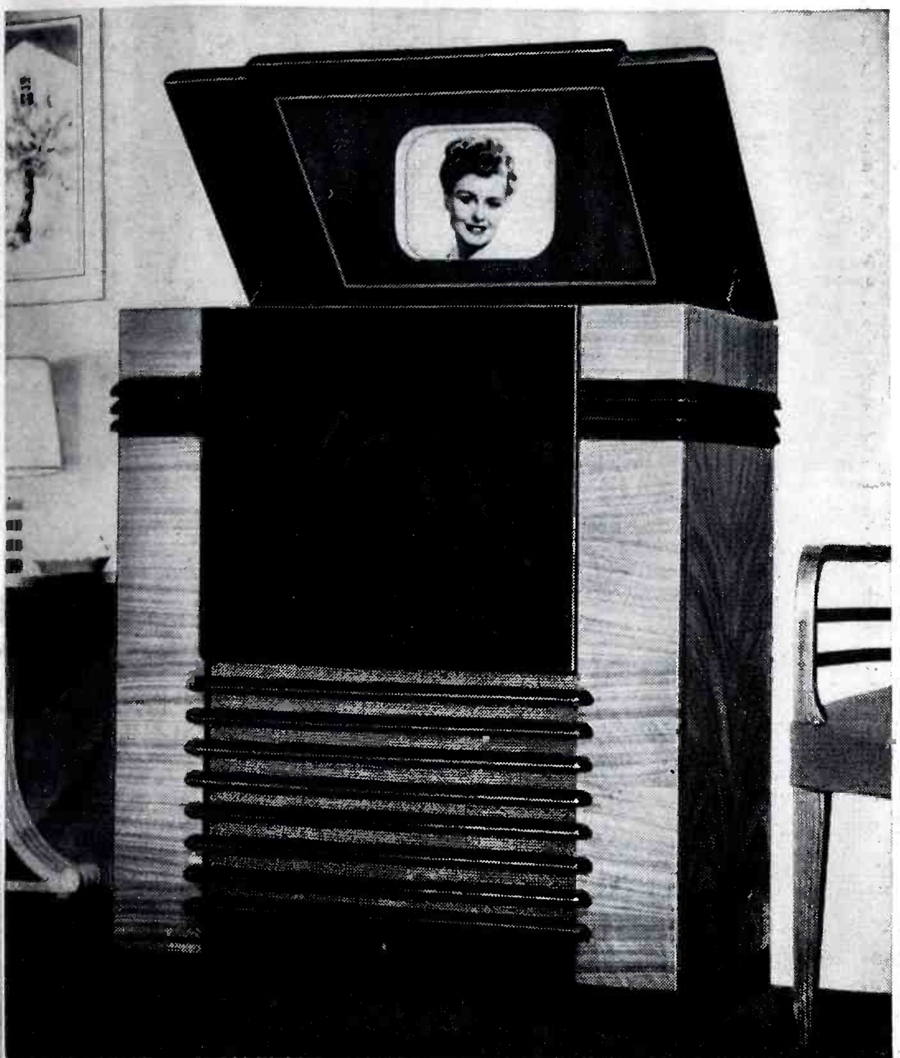
It appears that the intensity of the shadows thus produced depends primarily on the scanning-beam current of the iconoscope, and therefore depends secondarily on the brightness of the picture projected on the mosaic since in practice the gun grid control is adjusted so as to give a stronger beam for fainter pictures to increase iconoscope sensitivity even though this procedure, at the same time, causes an increased shading effect.

The shadows in the field are generally reduced, or eliminated, by manual operation of a shading-control system for injecting suitable neutralizing signals into the output of the iconoscope before or after amplification. Since the original shadings across the field are gradual, with indefinite edges, and no marked contrast, it can be theoretically shown that video signals corresponding to such shadows are represented to an acceptable degree of accuracy by the sum of a constant component; a component consisting of linear sawteeth (a "tilt") of line frequency (that is a signal varying proportionally to the time); a component consisting of parabolic sawteeth (a "bend") of line frequency (that is a signal varying as the square of the time); a component consisting of linear sawteeth of frame frequency; and

(*Continued on page* 35)

Back view of signal generator shown on opposite page. It produces RMA standard synchronizing and blanking impulses, and also special blanking, vertical and horizontal impulses for iconoscope.





(*AT LEFT*) MODEL TRK-12 is the finest television instrument offered by RCA Victor. It contains an RCA 12" white screen Kinescope which provides a picture size of 7⅜" by 9¾", viewing is indirect through mirror attached to cabinet top. Other fine features of this instrument are as follows: 36 tubes exclusive of Kinescope, 4 chassis (1 video, 1 power supply for video, 1 all-wave, 1 power supply for all-wave), 5 television channels, selector switch for television tuning, 12-tube all-wave sound chassis, 12 watts (pentode push-pull) sound power output, high fidelity reproduction, inverse feed-back included with control, 12" high fidelity speaker, phonograph jack. This instrument uses sprayed silver compensated condensers and Styrol R-F and I-F transformers as mentioned below in description of Model TRK-5. Backed by $2,000,000 field test.

RCA Victor Model TRK-9 (not illustrated) is similar to Model TRK-12, except that it is direct viewing and uses a 9" Kinescope.

(*BELOW*) MODEL TT-5 RCA Victor Television Attachment is for use connected to modern radios through which sound is heard. It contains an RCA 5" white screen Kinescope . . . presents a picture about 3⅜" by 4⅜" in size . . . uses direct method of viewing . . . has 16 tubes exclusive of Kinescope . . . is a table model . . . has 5 television channels and selector switch for television tuning. Like the TRK-5 this instrument uses sprayed silver compensated condensers and Styrol R-F and I-F transformers. Backed by $2,000,000 field test.

(*ABOVE*) MODEL TRK-5 RCA Victor Television Console. Features of this instrument in which you will be interested include an RCA 5" Kinescope with white screen . . . 24 tubes exclusive of Kinescope . . . 3 chassis, one an all-wave radio receiver, one an all-wave power supply and one for television . . . 5 television channels . . . a selector switch for television tuning . . . an 8-tube, 3-band push-button radio . . . 5 watts (pentode push-pull) of sound power output and a 12" loudspeaker. This instrument reproduces a picture in size of about 3⅜" by 4⅜". Picture may be seen by direct method of viewing. Sprayed silver temperature compensated condensers are used in this instrument. These have proper temperature coefficient to maintain circuit stability regardless of temperature changes. This instrument uses Styrol R-F and I-F transformers to greatly simplify mechanical and electrical construction and to give highest type insulation. Backed by $2,000,000 field test.

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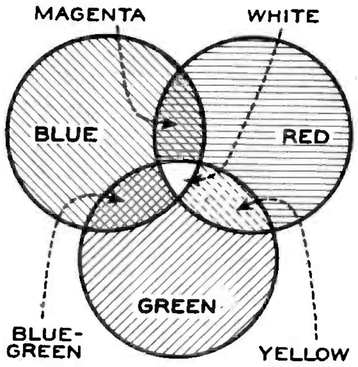
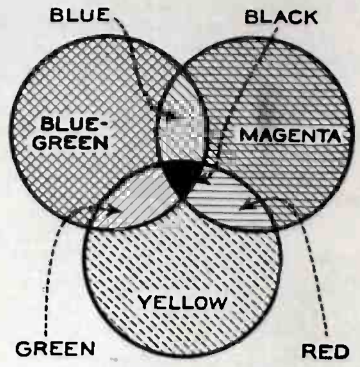


Colored fluorescent materials are mixed to produce white.

Fluorescent Materials

for television tubes



Showing the combination of blue-green, yellow, magenta.

By

GILBERT T. SCHMIDLING

Director of Research

CALLITE PRODUCTS CO.

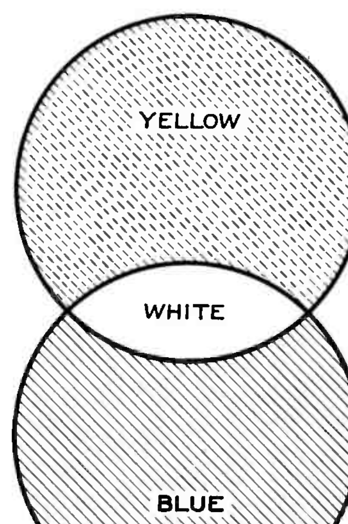
CONTRARY to the general impression no startling advance has been made in the last decade in the preparation of fluorescent materials used in cathode-ray tubes. The best white fluorescent materials are still made by mixing several colors to obtain the desired tint of white, mainly because the known white fluorescent materials are not as efficient as those obtained by mixture of several efficient colors. A secondary reason for the use of mixtures is that it is easier to get a greater variety of whites to choose from. By leaving the percentage of green component constant and varying the red and blue, one can obtain all the variations of daylight, from the cold north sky shine, through the rainy day overall spectrum to noon sunshine.

Inherently, white sources of light can never be more than one-third as efficient as the yellow-green at a wavelength of 556 mu if the latter could be made to give all its energy at this wavelength. The efficacy, or effective efficiency on a visual basis, of such a material would be 620 lumens per equivalent watt. The white could only be one-third as efficient because it contains all the colors of the visual spectrum. However, there seems little chance at the present time of making such a perfect monochromatic material, and since the present yellow-green materials are not at all monochromatic, but cover the whole visual spectrum, and peaked at 510 to 540 mu, it is easy to see that with further development the white source can approach in luminous efficiency the best figures obtained for the present yellow-green.

MIXING COLORS

The types of fluorescent materials most used in commercial tubes at the present time are the silicates, tungstates, and sulphides. In mixing colors to obtain light it is convenient to cause fluorescence while mixing in order to get an approximation of the final color. The sulphides in general can be excited by the near ultra-violet bands in the 3650 A.U. region. A good source for this region is a high-pressure mercury lamp with a purple Corex filter. If the silicates and tungstates are being mixed, a low-pressure mercury arc in quartz is very effective. No filter is necessary if a tube 12 mm in diameter is operated at 15-30 ma. The tube will give most of its light at 2537 A.U., to which the silicates and tungstates, with the exception of a few, are very sensitive. Goggles with plain glass should of course be worn when using these sources.

The exact color of fluorescence which is obtained with these ultra-violet sources is not exactly the same tint or shade of color obtained with an electron beam, but the source should be of great value nevertheless because of the time saved in preliminary mixing. All of the materials mixed must, of course, have the same rate of decay or afterglow at the same temperature when excited by cathode rays, or else a luminous trail of another color will be seen in the trace.

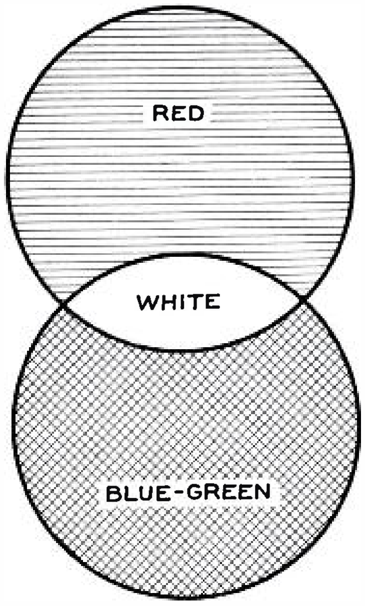


Yellow and blue are used to produce one type of white.

After a preliminary mix is obtained a color test can be made which will give a close approximation to final conditions insofar as color is concerned, by sealing a few grams of the mix in a standard ampoule about 4" long and 12 mm in diameter, exhausting on a fore-pump to a pressure of 100 microns and applying a spark coil of the high frequency type. Spectral and rate of decay measurements are best made in a high vacuum with a hot cathode.

It might be of interest to point out why in practice the fluorescent color is not exactly the same with different exciting sources, even though many of the older texts on this subject state that the fluorescent color is the same regardless of the exciting source. It is true that when different wavelengths are used the excited fluorescent bands will always occur in the same part of the spectrum, but the intensity of different parts of the band will vary with the spectral distribution and intensity of the exciting source. Fluorescent light is that part which seems to go out immediately after the exciter is withdrawn, and the light of the afterglow is called phosphorescence. The phosphorescenct color is always different than the fluorescent color, i.e., each occurs in a different part of the spectrum, and each band is caused by a different wavelength of the exciting source. The color of the fluorescent band is modified by the color of the phosphorescent band, which mix in the eye to form a composite color of the material. Both bands are present when the exciting source is not monochromatic and the composite color can be said to be dependent upon the spectral distribution of the exciting source.

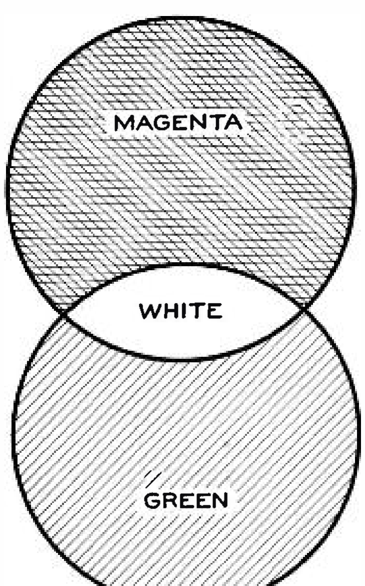
Another factor which complicates and effects the final color is that due to temperature. This is because the phosphorescent band is quenched by light of longer wavelength than the emitted light, in other words, heat. Now, the phosphorescent band is always of longer length than the fluorescent band so that if the former is partly quenched or dimmed, the color balance will be upset and the composite will be of colder hue as the temperature is raised. This explains why flourescent colors are more bluish when hot and more reddish when cold. It also explains why the flourescent material, near the end of its life, loses its warmth of color. It is because that part of the spectrum



Another method of producing white.

which gives rise to the afterglow has undergone decomposition due to heat. The afterglow curves are never smooth and the rate of decay occurs in steps.

The shorter life of the afterglow part of the spectrum is caused by a chemical reduction which takes place in that part of the chemical which causes the afterglow, sooner than it takes place in that part of the chemical giving the fluorescent spectrum. This is easily proven by opening up a device having such a worn out material and heating it in the presence of air which permits enough oxidation to occur for the



Using Magenta and green to produce white.

fluorescent material to recapture its original efficiency. If the device is opened in the dark a flash of light will be seen when oxygen strikes the reduced fluorescent material. This is further evidence that fluorescence is caused not by the exciting source impinging on the material but that the source drives away a cloud of oxygen which on recombination with the material causes fluorescence.

In a previous article* it was pointed out that with light sources of low intensity, comparable to conditions which obtain on a television screen, the human eye sees a shift in the visual response peak, i.e., the predominant hue shifts to a longer wavelength with increasing intensity. The result is that when a cathode-ray tube is modulated the low intensities of light will appear bluer and dimmer than they really are. This is not so important in the cinema where high-intensity light sources are used. But on a fluorescent screen this becomes important because the fluorescent screen also has this property, i.e., the peak in energy response shifts towards the red with increasing intensity of the exciting source. This can be compensated for by having the afterglow in the red slightly longer than in the blue and green components.

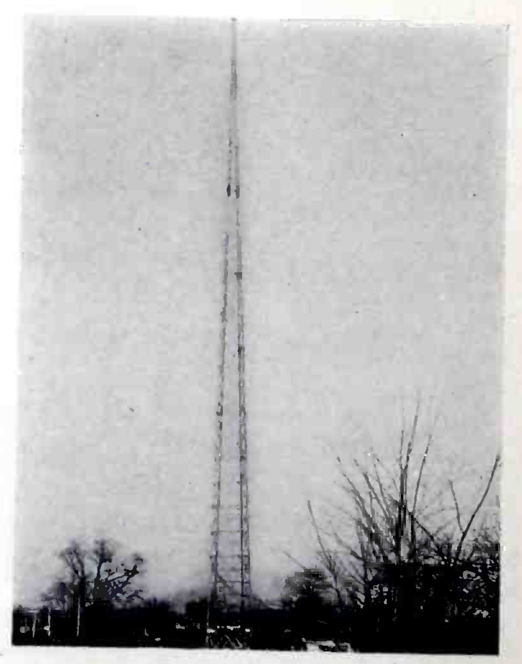
There is no simple, inexpensive method for accurately measuring the light output from the fluorescent screen, but a small pocket foot-candle meter will be found very useful for comparative measurements if it is equipped with a yellow-green filter to change its responsive curve to that of the human eye. In general, the sulphide colors are more efficient but they are not as stable as silicates nor as easy to apply successfully.

THE COLORS TO USE

Since mixing sources of light involve different principles than the mixture of pigments a review of the principles involved in the mixture of sources of light would not be out of place in this discussion. In mixing light sources all colors added together make white. In mixing pigments a mixture of all colors will give black. Most of us are familiar with the rudimentary principles of mixing colors as pigments, but if an attempt were made to mix light sources on the basis of one's knowledge of pigments, the results will be very disappointing. As a very good example let us mix blue and yellow which, if done with paints, will give us green. Now blue and yellow colors do not actually make green. In the blue paint we have a mixture of blue and some green. The yellow paint contains yellow and some green. When mixed the blue and the yellow cancel out each other to make black and the green remaining from each paint causes the final color to be green, but less brilliant than each of the original pigments. If blue light from a spectrum is mixed with yellow light from a spectrum, no green will be observed, but instead, if the proportions are correct, will show white so that the results obtained with blue and yellow pigments are green and the resultant color of blue and yellow sources of light are white. In the mixture of light sources any two colors which are complimentary to each other will produce white. These need not necessarily be the exact primaries but of sufficient wavelengths apart to be complementary to each other. The quality of white will be dependent upon the purity of the two primaries used. Since usually the primary colors are not of such purity, three colors or components are used to make white.

The primary colors for sources of light which when added together will make white are red, blue and green. The pigment primaries which are complementaries of above are magenta, yellow, and blue-green. These when mixed together will give black. In mixing the fluorescent powders to make white, the pure colors are not available nor necessary. Each fluorescent material is composed of several colors of the spectrum. In some cases they cover the complete visual spectrum, their fluorescent color to the eye being caused by their being peaked at some wavelength. In other words the greatest amount of their energy occurs at that wavelength. Hence if a warm white fluorescent material, for example, contains red in sufficient quantity, when mixed with the yellow-green which also contains red, it is only necessary to choose materials of composite nature which when added together will give enough blue and green to make up the composite white.

The Blaw-Knox 350′ self-supporting, shunt-excited radiator of WMAS, Springfield, Mass.



*See "Some Notes on Luminescence," by Gilbert T. Schmidling, p. 21, November, 1936, Radio Engineering.—Editor.

MINIATURE STAGING

(*Continued from page 23*)

tinue with the particular sequence under discussion, as the set approaches the camera, the illusion of a gradual approach to the house is created. Trees and shrubbery are arranged on the lawn to complete the pictorial composition of the picture and to break the static characteristics of the foreground.

At this point it might be wise to point out several interesting design considerations, "musts" in any miniature, that are observed in this set. Taking the foreground limit and the ridgepole of the house as the complete opening picture we find the aspect ratio is exactly three to four. As we approach the house these limits diminish in proportion, but so does our house. At the point where the dormer roof marks the top of the picture, the width of the entrance hall corresponds in true aspect ratio. This is also true of the porch enclosure itself; each successive picture is complete as to content and composition.

When the length of shot has finally been reduced to the limit, the camera has completed its imaginary trip up the path and has brought the miniature door up to full screen size. Here, on one side of the door, emphasis is laid on the doctor's identifying shingle and on the other side, the functional mail box. Having thus stressed the design of this particular door we are free to shift to the next camera which is focused on a full sized door in the back of the studio. By watching the two images on the monitors and switching when they are approximately the same size the transfer from the second miniature to the full-sized set is easily made. The door opens, the doctor comes out, looks in the mailbox and removes its collection of bills, and the show is on.

All of this no doubt sounds very complex and unnecessary; but when you consider that it has told the story leading up to the action on the main set as well as having presented the cast in an acceptable manner, it is apparent that it is a logical and satisfactory technique. Such a miniature may be stored away for future showings of the same production or redesigned for other programs, an economic factor that covers its small production cost.

In addition to the various considerations already discussed, there are a few general principals to which we adhere. We design all of our work in natural color, depending on variations of material to get the proper tonal modulation. We find that such a practice assists materially in producing a "natural" arrangement. We build our sets in considerable detail, as evidenced by the cottage in the miniature under discussion. On this set the shingles were tapered and cut to scale; the windows were paned with celluloid and backed with scale models of venetian blinds. With such intricate subject matter it is possible to arrange our set lighting so that it creates natural shadows on the model thus enhancing the dimension of the picture. We make it a practice to have the miniature sets carry their own lighting for two reasons. First, individual lighting makes operation of the set possible in any part of the studio under the best conditions, and secondly, a miniature set requires a large number of small lamps to approximate the character of the main foundation light in the studio.

We have purposely gone into detail in describing the construction and operation of this particular miniature because it is representative of the average large model set now being used in the National Broadcasting Company's studios in Radio City. We do not, of course, attempt such a set for each and every program, but we do strive to carry out developmental work along these lines as the opportunity presents itself.

• • •

TELEVISION CAPACITOR BULLETIN

Solar Manufacturing Corp., 599-601 Broadway, New York City, have just issued an interesting bulletin dealing in considerable detail with their line of television capacitors. Five different types of special paper capacitors are listed. Copies of the bulletin are available from the above organization.

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KINESCOPES

(*Continued from page 21*)

typical electromagnetic scanning circuit for the 1804-P4 is illustrated.

The set designer, in choosing between a 5-inch electromagnetic type (1801) and a 9-inch electromagnetic type (1804-P4), will find that the main difference in cost is in the price of the Kinescopes themselves and in the cost of the high-voltage anode supplies (3000 volts versus 7000 volts). The same deflecting yoke is used for either type, and there is little difference in the scanning amplifiers required. In addition, both types are capable of sufficiently high definition to justify the use of a high-quality picture receiver. In going from the 9-inch 1804-P4 to the 12-inch 1803-P4, the only appreciable difference in cost is in the tubes and in the cabinet size, inasmuch as the anode supplies and scanning amplifiers required are practically identical.

Against such design factors as these must be set the obvious desirability of using the tube providing the largest picture. In this regard, it is of interest to remember that the picture area is approximately proportional to the square of the tube diameter; thus, a 9-inch tube has over 3 times as much picture area as a 5-inch tube.

One question which sometimes arises with respect to the use of the smaller Kinescopes is that relating to the use of a magnifying lens through which to view the received picture. A suitable

The Types 906-P4, 1802-P1, 1802-P4.

lens can be used to enlarge a television image, but increased size is obtained only with a proportional loss of brilliance, with a marked reduction in viewing angle, and with no increase in picture detail. A poor lens may result in a slight loss of detail and in distortion.

The accompanying photographs show the various types of RCA Kinescopes, with the exception of the 1804-P4. This tube looks very much like a small edition of the 1803-P4. Each RCA Kinescope employs an improved type of electron gun, which is designed for the maximum beam current consistent with the desired focusing qualities.

To summarize the foregoing discussion of Kinescopes for television receivers, it has been pointed out that a number of factors are of primary importance to the set designer. These are, briefly:

(1) The size and cost of the Kinescope; (2) the type of deflection desired; (3) the color of screen luminescence; (4) the anode No. 2 voltage required; (5) the resolution of which the Kinescope must be capable in order to equal or better the resolution capability of the associated picture receiver.

• • •

TELEVISION FUNDAMENTALS

(*Continued from page 19*)

twice with scanning lines which do not coincide, actually shows sixty pictures per second, and hence the flicker effect is practically eliminated.

APERTURE DISTORTION

The number of lines with which a subject is scanned determines the fineness of the detail which can be resolved. It is obvious that we cannot expect to reproduce clearly details that have dimensions comparable to the scanning spot, or in other words the width of the scanning strip. An effect which is important in this regard is a distortion due to the finite size of the "aperture" or scanning spot which is called "aperture distortion." Fig. 2-a shows in greatly magnified form a scanning strip having a light detail on it which changes abruptly from dark to light at its edges. As we have seen, the reason we are scanning the picture at all is because our photo-electric devices can respond only to the average illumination and, therefore, we get the average illumination of the area covered by the spot in this case. When the spot is in position (a), the photo-electric current will be zero because of the black surface. At (b), half the circle is on white and half on black, and the resulting photo-electric current would correspond to gray. At (c), maximum signal corresponding to white will result. At the right edge of the white detail, similar signals would be produced in reverse. While the signal for ideal reproduction is that shown in Fig. 2-c, the actual signal resulting is shown in Fig. 2-b both for circular and square scanning spot. Therefore, when the scanning strip width is comparable in size to the detail being scanned, we must expect distortions such as shown in Fig. 3. In (a) is shown the case of a horizontal detail unfortunate enough to lie between two strips, and in (b) is shown the stair-step effect produced in diagonal elements.

It is evident from this that in order to analyze the details of, say, the face of a subject, there must be a relatively great number of lines scanning it. If the eyes of the subject are about the same width as the scanning strip, all one could expect is a blur. If in the scene being televised a man is in the far distance, perhaps a blur is enough, for the observer's eye has very definite limits in analyzing fine detail. The acuity of vision of the normal eye is between 0.5 and 2 minutes of arc. This means that if two details are separated by an angle greater than this, the eye can distinguish them as separate details, but if their angular separation is less than this amount, the two details will merge into a blur. This results from the fact that the rods and cones on the retina of the eye are spaced a finite distance apart, and each is capable of responding only to the average illumination falling upon it. Fig. 4 shows the relation of the minimum size of the detail that the eye can appreciate in relation to the viewing distance.

SUMMARY OF PICTURE QUALITIES

The excellence of the television image is a function of many things, all intimately connected together. The contrast range, or the relative difference in intensity between "black" and "white" on the reproduced image is very important. The brightness of the image is another factor, and its overall value may be quite low because the screen is illuminated on only one elemental area at a time. For a modern television picture, the spot brightness may have to be several hundred thousand times the required overall picture brightness because of this fact. The definition of the picture, of course, is a function of the number of scanning strips per picture which goes hand in hand with the spot size. With cathode-ray reconstitution, a doubling of the number of lines in a picture will increase the definition and require a spot size of half the former value. As the light flux is proportional to the square of the spot diameter, the received picture brightness will be reduced to about one-fourth its original value.

Picture size, the number of strips per picture, and the viewing distance are also closely tied together. For a given picture size and number of lines, there is a proper viewing distance at which the acuity of the eye as expressed in Fig. 4 and the smallest detail that can be resolved in the picture are at such a balance that the eye does not notice deficiencies in the picture. At a closer viewing distance, the picture will appear coarse, and at greater distances some of the definition will be going to waste.

(To be continued)

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TELEVISION ECONOMICS

(Continued from page 27)

finally a component consisting of parabolic sawteeth of frame frequency. The first-mentioned constant component presents no problem since it involves merely the average brightness of the picture which, in any case, is manually or automatically set at the transmitter, the receiver, or both. The linear sawteeth may be produced in the usual manner by charging a condenser from a constant-voltage source through a high resistance, suitable potentiometer arrangements being used to control the magnitude and polarity of the desired waves. The parabolic sawteeth may be produced by applying a linear sawtooth voltage across a suitable resistance and capacity in series, the parabolic-sawtooth component being then tapped from across the condenser terminals. Sinusoidal components are also sometimes made available. Any spurious signals at and after the ends of lines are of course eliminated.

In practice, the shading control works well in the hands of a skilled operator, with direct pick-up. With film transmissions having wide and sudden variations in picture brightness, it is sometimes difficult to avoid a certain raggedness in the shading compensation at each abrupt change-over.

Background or brightness control of the signal is accomplished, as indicated above, by means of the height of the pedestal at the end of each line (with *negative* modulation as used in America), the pedestal height corresponding to black or to slightly blacker-than-black. The average height of the video signal controls the pedestal height. This can be done either manually by a skilled operator or automatically by means of an illumination integrator of the photocell type the output of which acts appropriately on the pedestal-height-controlling circuit.

From the foregoing it is clear that there are more numerous and difficult monitoring problems in video transmission than in audio transmission and that a considerable simplification of circuits and methods will be necessary, assuming it to be possible, before the cost of video monitoring can approach the lower level of cost of audio monitoring.

The current corresponding to the entire picture signal assembly, as stated, is sent through coaxial cables within the studios. There are a number of possible cable arrangements. One of the less usual methods of signal transmission involves the "back-to-back" arrangement wherein two coaxial cables are used with their shields connected together and then grounded, the signal passing through the inner conductors. This system is, or can be, electrically balanced. The final output signal from the studios was, in a certain specific instance, about 2 volts across 30 ohms to match the impedance of the cable passing to the distant transmitter.

Cathode-ray oscillographs have been found useful in the monitoring equipment at a number of points to enable the instant supervision of wave forms and actual pictures. In one European installation, oscillographs at the transmitter permit monitoring simultaneously the television image at the transmitter input, the same as obtained from a linear rectifier at the transmitter output, the video signals at the modulating amplifier input, the same as derived from a linear rectifier at the transmitter output, and the envelope of the r-f output fed to the antenna. The use of such indicating equipment, which broadly resembles the volume indicator in the audio control system so far as general overseeing is concerned, deserves encouragement and enables the early detection of incorrect adjustments. Despite their first cost, such continuous and effective supervising facilities are generally a net economy.

Since television picture definition depends largely on the accuracy of synchronizing signals, the generators for such signals must be extremely precise. Naturally a single generator must feed a group of cameras if pictures are to be smoothly faded from one camera to another. Successful television reception on mechanico-optical receivers is stated to require an even higher degree of accuracy than for cathode-ray reproducing systems in view of the effect of the inertia of mechanical parts. A European organization producing mechanico-optical receivers accordingly also supplies a mechanical synchronizing-signal generator based on the following considerations. It is claimed that electronic generators in general use a free oscillator with a framing pulse obtained therefrom by subdivision, and thereafter maintained in a constant phase relationship to the power supply. It is stated that one form of such electronic generator has a small time constant (about 0.2 second) for the automatic frequency control and this produces "fast and erratic" phase modulation of the oscillator output (at several hundred cycles per second per second). It is added that this control acts only after a considerable phase displacement has occurred, and accordingly functions as a rapid over-correction with resulting swinging.

Another form of electronic synchronizing-signal generator is stated to have a larger time constant. In this latter form, the frequency change on correction is at the rate of only about 10 cycles per second per second, but there is supposedly excessive phase drift of the frame frequency.

Accordingly a mechanical synchronizing-signal generator has been produced by this organization. A multiple-tooth rotary disc turns between two similarly-toothed stator rings, thus producing a systematically variable capacity between the rotor and the stator. The accuracy of positioning of the teeth is to within 6 seconds of arc; and since averaging of any residual inaccuracy occurs because of the multiplicity of teeth, skewed mounting or eccentricity of the rotor does not injuriously affect operation. The claimed frequency variation is less than 2 cycles per second per second, and the maximum phase drift of the framing impulses is 0.0001 second, or about 0.5 percent. Such a mechanical generator is stated to give better synchronization and superior interlacing and it is urged that this improves cathode-ray-tube receiver operation, and also is, in fact, essential in mechanical receivers.

E-4 Sound Pick-up

The method of pick-up of sound in television programs differs from that in present-day broadcasting. The microphone obviously must be manipulated so as to get the best pick-up consistent with non-inclusion of the microphone in the resulting picture. On long shots or wide-angle shots the microphone has to be swung well out of the field; on close-ups or narrow-angle shots, the microphone may more closely approach the actors.

The velocity microphone with or without a wind shield may be mounted at the end of the usual counterbalanced microphone boom such as is used normally in sound-motion-picture recording. For outdoor work, a microphone wind shield is a necessity; and highly directional microphones of the parabolic-reflector or "machine-gun" type are suitable. Thus extraneous noises and undesired-noise pick-up are minimized.

Considerable skill, adequate staff, and fast thinking are needed in the coordination of picture and sound pick-up in studios. Since retakes are inherently not possible, the television broadcaster will find it advisable to accept the economic problems involved in an adequate studio staff.

E-5 Studio Audio Control Equipment

Audio control equipment in television does not differ fundamentally from that in present broadcasting. It is necessary, however, that there be a certain added coordination between picture and sound in order that naturalness of reception may be preserved. Accordingly monitoring images as well as a view of the set should be provided for the sound-control men.

Studio television practice is far from crystallized. One studio group in America is stated to be about 60 by 180 feet in size and to be provided not only with various camera chains but with 3 film channels of diverse types. Another large studio has 5 camera chains, 9 local monitors, and is engineered on the basis of a band width of all wiring and amplifiers of 3.5-4 mc.

It seems certain that future studios for television personal presentations will probably be not only larger but more numerous than at present. Television requires numerous rehearsals. The space required for the sets, lights, cameras, microphones, and directing, technical, and acting personnel is considerable. It is possible that "simplified" studios may be successfully used for rehearsals, thus affording considerable economy, although, at best, lighting methods and audio and video pick-up must all be rehearsed adequately to insure a later smooth performance. Television studios of the future will probably approximate modified small motion-picture studios, particularly if it proves desirable to photograph programs for record or syndication purposes, as now appears likely. On the other hand, it is obvious that far more rigid control of expense and the use of ingenious cost-reducing methods will be essential if television program production is to be economically feasible since motion-picture-production base costs are manifestly not likely to be financially endurable by television on any basis which can at present be foreseen.

E-6 Motion-Picture Film Transmission

(a) Film. It is clearly practicable suitably to transmit programs directly from appropriate motion-picture film with at least the same effect and entertainment value as from direct studio pick-up (neglecting the psychological factor of the appeal of simultaneity of performance). It is therefore likely that motion-picture film will constitute an important part of the future program contents. The least expensive television station which can be imagined at this time would be one based entirely on film program transmissions. Such a station would require no studio facilities, directors, actors, writers, and similar incidental program elements which are needed when and if personal presentations are involved. The next simplest form of station would involve a single film channel and one camera chain.

For television purposes 35-mm film is entirely adequate so far as picture quality is concerned. Sub-standard or 16-mm film is usable provided exceptional care is taken in the photography, printing, processing, and projection on the iconoscope mosaic of such film. Camera weave (that is, non-uniform placement of successive pictures or frames on the film in relation to each other and the guiding edge or sprocket perforations) leads to an unsteady picture in the receiving set. Weave in the printer in which the positives are made or in the projecting equipment causes a similar effect. Processing (development, fixing, and washing of the prints) must be carried out with particular reference to a suitable fineness of grain of the image and appropriate density and gamma (contrast) of the print. Sub-standard film, requiring a 2.5-fold greater magnification for its television use than standard film, naturally imposes closer requirements on the precision of the print-producing process at each stage as well as the requirement of fine grain in the image and highly corrected optics. Still smaller film, for example, of the 8-mm size, is definitely unsuitable for 441-line television purposes with presently available photographic technique.

The principal advantages of 35-mm films at present are their immediate availability, the relatively non-critical nature of their photography, printing, processing, and projection, and the comparative ease of securing high-fidelity sound therefrom. On the other hand, 35-mm "nitrate" film is expensive in terms of a given playing time, and is highly inflammable and thus necessitates elaborate storage facilities, careful fire protection, costly projectors, skilled professional projectionists, municipal approval of installations, and a number of related requirements. The 16-mm "acetate" film has the present disadvantage of requiring unusually accurate photography and processing as well as projection, and also is limited in audio-frequency range of the recorded sound as compared to 35-mm film. For a given number of frames per second, the frequency range which can be covered on 16-mm film will extend upward about 40 to 60 percent as far as for 35-mm film, although improvements in recording and processing may nevertheless make 16-mm sound recordings adequate for television purposes, particularly for newsreel uses. It has the major advantage of greatly reduced cost, and freedom from expensive projection-room installations and fire hazards. It has the further advantage that the camera equipment is highly mobile in comparison with 35-mm equipment, and that a considerable supply of amateur-produced and semi-professional or "free-lance" films in the 16-mm size may be expected to be generally available. It is obvious that the trend of of television, as a matter of economy in production, must be toward the smallest gauge film which will meet television requirements reliably—and this gauge is apparently not far from 16-mm film. Experience has shown that either black-and-white film or three-color film is usable for television transmission, the iconoscope color response being seemingly adequate for color-film transmission.

In addition to the direct transmission of films, it is possible to "inject" backgrounds either optically or electrically into the television transmission. For example, the action may take place in front of a translucent screen against the back of which there is projected (toward the camera) either a still or motion picture of some desired scene. Under suitable lighting and field-timing conditions, the scene will then appear to be physically present behind the foreground action. This is the technique which is largely used in the motion-picture field for such shots as views through taxi-cab or train windows, night views of the ocean past the railing of a ship, and the like. This optical injection of backgrounds has been attempted in television principally with still projection from lantern slides. The limited sensitiveness of the television camera has required an extremely brilliantly illuminated projected background, and one beyond the convenient capabilities of present motion-picture projection equipment if the thus injected background comprises more than a relatively small portion of the field of view (e. g., a view through a small window). It is also possible to inject still or motion-picture backgrounds by electrical means involving in principle essentially the association of a foreground pick-up iconoscope and a separate background pick-up iconoscope, the output of the foreground iconoscope being arranged by suitable electrical means to eliminate the output of the background iconoscope from the resulting composite picture at all points where foreground objects exist. The electrical injection of backgrounds, from lantern slides or motion-picture films, presents attractive possibilities of economy in production since background scenes unavailable in the studio (except on film or slides) as well as expensive actual background sets may thus be avoided. In the motion-picture field the trend is toward the increasing use of background projection; and there is reason to believe that a similar trend will dominate television production. Since such systems permit the personal action to take place before a neutral background, studio costs are reduced and flexible operation in the control room enables the assembly of any desired foreground and background actions.

The use of projection methods may therefore largely increase in television. Captions, brief flashes of still or moving scenes, advertising inserts, and the like are most readily inserted in the program by projection means. Further, it is frequently dramatically desirable to mix personal presentations in the studio with direct pick-up and film pictures taken outside of the studio (sometimes with the same personnel). Such inserts greatly add to the naturalness and "finish" of the performance.

When film programs are projected on the iconoscope mosaic, it is generally desirable to be able speedily to substitute a second iconoscope for the one in use (e. g., in case of breakdown or the development of operating faults). The mosaic of the substituted iconoscope must be in accurate alignment and in the focal plane of the projector. In one important installation, all projection equipment is in one room, the image-forming beams passing through optical-glass windows into a second room wherein a group of iconoscope units are mounted on carefully aligned and rigid railings along which they may be slid into position before any desired projector. This arrangement has the advantage of isolating the iconoscopes and their associated equipment from the projection room and its equipment. It has the disadvantages of introducing a glass plate into the projection path and somewhat adds to the problems of intercommunication between the video control men and the projectionists. The iconoscope used for motion picture work is not necessarily identical with that used for direct studio pick-up as previously indicated. In general, iconoscopes used for motion picture work do not have photo-sensitized internal walls because of the effect of the *intermittent* illumination of the mosaic by the film picture.

Where two or more projectors are used, it is desirable to be able to monitor each simultaneously so that both the incoming and outgoing projector pictures can be separately watched. The projectors are provided with the usual sound heads (unless it is planned to use them with disc records of sound). Monitoring of the sound output of the projectors should similarly be available for each projector in use.

The use of a shrinkable and non-rigid medium like film brings with it certain problems in producing "rock-steady" television pictures. Extreme accuracy of sprocket perforations, sprockets, film-driving systems, and optical parts is clearly necessary throughout the photographic and projection processes. Theatre pictures are acceptably steady with a "bounce" or vertical weave of approximately one-quarter percent of the height of the screen. Line interlacing in television brings with it serious handicaps and limiting conditions so far as film projection is concerned. A bounce of one-quarter percent represents one line width, and would therefore cause line pairing and noticeable loss in overall picture definition. While there is no general agreement on the tolerable amount of bounce in picture projection for television, figures of one-eighth percent as a maximum to as small as one-twentieth percent as a minimum have been suggested. The smaller the gauge of the film and the wider the range of its probable shrinkage, the more difficult becomes the attainment of a steadily-framed television picture. Nevertheless it appears likely that the television projection of 16-mm film can, with proper design and supervision of equipment and processing, be brought within permissible performance limits.

(To be continued)

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UTAH STOCKHOLDERS MEETING

G. Hamilton Beasley, President, Utah Radio Products Co., has announced, at the annual meeting of the stockholders, that all directors and all present officers, with the exception of John A. Snyder, Vice-President, were re-elected. J. W. Caswell, General Manager of the Caswell-Runyan Co., a subsidiary of Utah, replaces Mr. Snyder. The change was made to allow Mr. Snyder more freedom to carry on his duties as Vice-President of the Caswell-Runyan Co.

The 445-foot Lingo tubular steel radiator at WIBW, Topeka, Kan.

IRC PROMOTIONS

The appointment of Jesse Marsten as a Vice-President and Harry A. Ehle as Assistant to the President of the International Resistance Company, Philadelphia, has been announced by President Ernest Searing. The appointments were effective as of January 1st.

DYNAMIC MICROPHONES

Two new types of dynamic microphones, known as the "Unidyne" and the "Rocket," have just been announced by Shure Brothers.

The Model 55 "Unidyne" is a basically new cardioid type uni-directional moving-coil dynamic microphone for broadcast, recording, public-address and similar applications. Uni-directional action is secured by phase-shifting acoustical networks in a single element.

Model 50 Rocket dynamic microphones utilize the principle of a moving-conductor in a magnetic field. They are intended for public-address, remote broadcasting, recording, call systems, communications radiotelephone and similar applications. Response is high-quality wide-range with semi-directional pickup characteristics.

Further information may be secured from *Shure Brothers*, 225 W. Huron St., Chicago, Ill.—COMMUNICATIONS.

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– RECORDER CHARACTERISTICS –

BY MAURICE APSTEIN

Manufacturer	Model	Type	Turntable Size, Inches	Record Size, Inches	Motor Speed	Speed Change System	Type of Motor	Turntable Drive System	Pitch, Lines per Inch	Cutter Feed System	Feed Direction	Cutter Type	Cutter Impedance	Record Types	Micro-scope	Pickup	Pickup Type	Amplifier	Amplifier Gain, DB.	Addition-al Amp. Inputs	Amp. Input Level, DB.	Input Impedance Ohms	Undistort-ed Power Output, Watts	Speaker Dia. Inches	Level Indicator	Amp. Tube Complement	Radio	Other Access-ories
ALLIED RECORDING CO.	12	Portable	12	13½	Dual	Panel Control	Sync.	Rim	96-104 112-120	Overhead Lead Scr.	Either	Magnetic	500 or 15	Aluminum or Coated	Yes	Standard Equip.	Crystal or Mag.	Separate	110	Microphone and Line	⊗	2-High 1-500	10	10	Meter	2-6C6 2-6A6 2-6A3 1-5Z3	Separate	—
	16	"	17	17¼	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	⊗	"	"	"	"		"	—
	A	"	"	"	"	"	"	"	"	"	"	Mag.-Ind.	"	"	"	"	Crystal	Internal	115	"	⊗	1-High 1-Int.	"	"	"	1-6J7 2-6N7 2-6L6, 1-80	⊗	—
DAVID BOGEN CO.	R12, 212R R12P, 212RP	Stationary	12½	13½	Dual	Idler Wheel Change	Self-start Constant Speed	Rim	100 Change-able lead screw	Overhead Lead Scr.	Either	Magnetic	500	Acetate	No	Standard Equip.	Magnetic	Separate	RA6 † 116 RA10† 118	Two-Mike or Phono-tuner	-84	High or Low	6	8	Meter	1-6J7G 1-6K5G 1-6L6G [illegible]	Separate	—
	212 RC	Portable	"	"	"	"		"		"	"	"	"	"	"	"	"	Internal		Three-Mike Phono-tuner	-85	"	10	10	"	1-6F5, 2-6C8 2-6N6 1-5Y4	"	—
	16RP, 16RC 16R	Portable Stationary	17⅛	17½	"	Change-over Sw.		"		"	"	"	"	"	"	"	"	Separate 16RC. Int.		⊗	⊗	⊗	⊗	⊗	⊗	⊗	"	—
BRUNO LABORATORIES INC.	10R12 10R16	Portable Stationary	12¼ 17¼	12 17¼	33⅓ 78	Reverse Pulley Rotary Sw.	Self-start Constant Speed Sync.	Inter-Pulley	90-100 110-120 130 Stan. 100	Overhead Lathe Type	"	Mag., Std., Crystal Available	500	Aluminum or Acetate	No	"	Symphonic	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	—
CELLUTONE RECORD & MFG. CO.	RR 13.5	Portable or Stationary	12⅜	13½	Dual	Lever	Manual Starting Sync.	Rubber Pulley	85 to 150	Lathe Type	Either	Magnetic	4,6,8,6,12 22,30,100 400,500,700 2800-8500	Aluminum or Coated	Available	"	Crystal	Separate	AMR‡120 AMR3-120 AMP-130	Phono and Mike	-80 to -50	High	AMR-6 AMP-15	12	AMR-Mon AMP-VI Meter	AMR-77 6C6, 112 AMP-16030 6L6's	AMR-Radio Tuner	Amp. has separate controls for scratch filter
	RR 16		16	17	"				"	"		"					"	"				"		"				
DUPLEX RECORDING DEVICES CO.	39-A	"	17	17¼	"	Single Control	Sync.	Gear & Worm	96 to 132	Positive Drive Lead Scr.	"	Magnetic or Crystal	5000	Aluminum and Acetate	No	"	"	No	—	—	—	—	—	—	—	—	—	16 & 24 frame camera drive
FAIRCHILD AERIAL CAMERA CORP.	F 29 F29A	Portable	16	17	"	Press on Shaft	Sync.	"	98, 118, 141, 161	Overhead Lead Screw	"	Crystal	500	"	No	"	"	Separate	105	⊗	⊗	50-500 150,000	12	10	Meter	4-6C6 2-6B5 1-6H6 1-5Z3	None	—
FEDERAL RECORDER CO.	P12, PR12 CR 12	Portable Port. or Stat.	12	12	78	Lever	Induct-ion	Rim	100	Lead Screw	Either	⊗	⊗	Aluminum	⊗	Yes	"	Internal	125	⊗	High	5 Meg. (Mike)	15	8	Meter	6F5 6N7 2-6V6G 5V4G	Yes	—
	PR 16 CR 16	Portable Console	16	16	Dual				112															12				
PRESTO RECORDING CORP.	M, MP	Portable	(Two) 12	12	Dual	Pulley Change	Self-start Ind.	Rim	100	Worm & Gear	Optional*	Magnetic	8,15,50 250 & 500	Aluminum or Cellulose	No	Standard Equip.	Magnetic	Internal	M, 120 MP, 150	Phono-Mike Radio	-95 -125	100,000	5	None	Meter	2-6C8G 2-45's 80	None	—
	G	"	12	"	"	"	"	"	"	"	" *	"	"	"	"	"	"	"	120	"	-95	"	10	(Two) 10	"	2-6C8G 2-2A3 5Z3	"	—
	12-C	"	"	13½	"	Lever	"	"	80 to 160 *	Overhead Lead Scr.	" *	"	"	"	Extra	"	"	Separate	125	"	-105	50, 200 or 500	"	8	"	4-6C6 2-76, 2-2A3 1-5Z3	"	—
	16-D	"	16	17¼	"	"	"	"	"	"	" *	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	—
	16-X	"	"	"	"	"	"	"	"	"	" *	"	"	"	None	"	"	Internal	120	"	-95	100,000	5	"	"	3-6C6 2-45 80	"	—
	12-D, 12-E	"	12	12	12-D, 75 12-E, Dual	"	"	"	"	"	" *	"	8	"	"	"	"	"	"	"	"	"	"	"	"	"	"	—
	5J, 6J	"	"	"	78	⊗	"	"	100	Worm & Gear	" *	"	"	"	"	"	"	"	105	"	-80	"	"	6	"	2-6C8G 2-45 80	"	—
RCA MFG. CO. INC.	MI 12701	Portable	12	12	78	⊗	⊗	Rim	112	Overhead Lead Scr.	⊗	Magnetic	⊗	Aluminum or Acetate	None	Standard Equip.	Magnetic	Internal	100	Mike & Phono	⊗	100,000	3	6	Meter	2-6J7, 1-6F6 1-5Y4G	Separate	—
	MI 12702	"	"	"	"	⊗	⊗	"	"	"	⊗	"	⊗		"	"	"	"	"	"	⊗	"	"	"	"	"	"	—
	MI 12700	Console	16	16	Dual	⊗	⊗	"	"	"	Outside-in Inside-out	"	⊗		"	"	"	"	"	"	⊗	250	"	12	"	"	"	—
	MI 12700A	"	"	"	"	⊗	⊗	"	"	"		"	⊗		"	"	"	"	"	"	⊗	"	"	"	"	"	"	—
RADIOTONE, INC.	PR 20	Stationary	16	17¼	Dual	Lever	Sync.	Rim	90 to 125	Overhead Lead Scr.	Either	Magnetic	500	Process-ed	Yes	Standard Equip.	Crystal	Separate	130	"	⊗	⊗	25	15	Meter	1-6C6 1-76 1-6C8G 1-6F8G 2-6L6 1-5V4G	Separate	Line Spreader
	PR 16	Portable	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	⊗	⊗	"	"	"		"	"
	PR 50	Console	"	"	"	"	"	"	"	"	"	"	"	"	⊗	"	"	Internal	"	Mike	⊗	⊗	"	"	"		Internal	"
SCULLY MACHINE CO.	⊗	Stationary	16	18	"	"		Belt •	88, 96, 104 112, 120 128, 136	Lathe Type	Either	None	—	Aluminum	Yes	"	Crystal or Magnetic	None	—	—	—	—	—	—	—	—	None	Suction Equipment for Chip Removal
SOUND APPARATUS CO.	A-1	"	16	18	Dual	⊗	Manual Starting Sync.	Direct	84, 94 106	Overhead Lead Scr.	"	Magnetic	15 or 500	Acetate & Wax	Yes	"	Magnetic	None	—	—	—	—	—	—	—	—	None	—
	Profess-ional	Portable	12 or 16	12 or 16	"	⊗	"	"	90	Special	Optional	"	15	Aluminum and Acetate	None	"	Crystal	Separate	100	2 inputs	⊗	High	12	8	Meter	⊗	Internal	—
	Port-O-Vox	"	12	12	78	⊗	Self-start induct.	Belt	"	"	"	"	"	Aluminum Processed Acetate	"	"	"	Internal	"	⊗	⊗	"	5	6	Neon Lamp	4 Tubes	None	—
UNIVERSAL MICROPHONE CO., LTD.	Portable	"	16	17	Dual	Shift Belt	Self-start sync.	Belt	90, 110, 130	Overhead Lead Scr.	Either	Magnetic	15	Aluminum	Yes	Optional	Crystal	Separate †	—	—	—	—	—	—	—	—	—	Timing Scale Micrometer Caliper
	Profess-ional	Stationary	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	" †	90	⊗	⊗	500-50 or High	12	None	Meter	1-56, 1-5Z3 2-56, 2-2A3	None	Micrometer Caliper, Timing Scale & Microscope Light
	Master	"	"	"	"	Reset Belt	"	"	70 to 130	"	⊗	"	"	"	"	"	"	" †	⊗	Phono-mike Radio & Line	⊗	2-High 1-Int. 1-500ω	⊗	"	"	1-1603, 1-6F6 2-6D6, 1-6B7 1-76, 1-603 4-2A3, 5Z3	Internal	
VIBRO-MASTER CO.	F	Portable	⊗	12	Dual if desired	⊗	Induction	Rim	96	⊗	⊗	Magnetic	500	Aluminum Acetate	⊗	Optional	Crystal	Internal	⊗	Microphone	⊗	⊗	4	8	Meter	⊗	Separate	—
	H	"	16	"	Dual	⊗	"	"	"	⊗	⊗	"	"	"	⊗	"	"	"	⊗	"	⊗	⊗	"	"	"	⊗	"	—

⊗ INFORMATION NOT SUPPLIED. * BY CHANGE OF FEED SCREW. † SEVERAL MODEL SEPARATE AMPLIFIERS AVAILABLE AS INDICATED.

COMPILED FROM DATA SUPPLIED BY THE VARIOUS MANUFACTURERS.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President | RCA Building, 30 Rockefeller Plaza, New York, N. Y. | H. H. PARKER, Secretary

CRUISE

WE quote from the *New York Times* of Sunday, February 12th, 1939. Headline: "Sea Captains Meet Long After Crash. Masters of the *Republic* and *Florida* Introduced 30 Years After Vessels Collided. Guests of Wireless Men. David Sarnoff, Lee de Forest, T. D. Haubner and Jack Binns Receive Awards."

The *Times* article continues—"The captains of the steamships *Republic* and *Florida,* which figured in one of the most dramatic disasters of the North Atlantic when they collided on January 23, 1909, met for the first time last night.

"The occasion was the Fourteenth Annual Dinner of the Veteran Wireless Operators Association at the Hotel Astor. Few of the guests realized the significance of what seemed a casual before-dinner introduction by William J. McGonigle, President of the organization, until the men he had introduced were presented to the assemblage during a radio program.

"Yet both Captain William Inman Sealby, iron-gray-haired and sturdy at 75, and Captain Angelo Ruspini, tall and suave at 58, smilingly confirmed that they had never met before. In fact, Captain Ruspini, who was master of the *Florida,* pointed out it was actually the first time they had seen each other, because it was far too dark on the night of the tragedy.

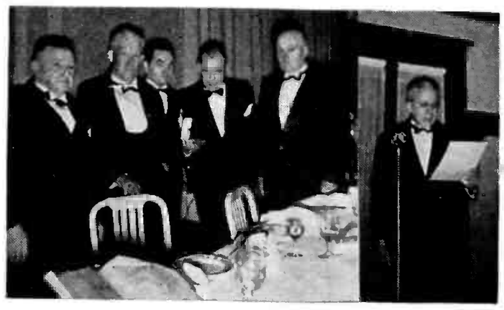
"The two veteran seamen said they had spent a half hour or so before taking their seats—four places apart on the dias—in talking over their careers since the crash, rather than the celebrated event itself.

"'We spoke very little about the accident,' Captain Ruspini said. He retired from the sea in 1914, represented the Italian line here, and now lives in Great Neck. Captain Sealby practiced law, commanded the transport *Monticello,* served with the United States Shipping Board and retired six years ago. His home is in Vineland, N. J.

"To round out the reunion, John G. Orr and Jack Binns were introduced. Mr. Orr was chief quartermaster of the *Baltic,* the rescue ship which brought the survivors of the lost *Republic* into port. And neither he nor Mr. Binns, radio operator of the *Republic* had ever met Captain Ruspini before, although they had been among the admirers of his seamanship on the historic night down the years.

"Other features of the unusual program were awards to David Sarnoff and Dr. Lee de Forest, and responses by long-distance telephone. Mr. Sarnoff, receiving the Association's first Marconi Memorial Gold Medal (of Achievement), said in Palm Beach, Fla., the award was more a tribute to a 'land of opportunity' than to the recipient. Dr. de Forest spoke briefly from Los Angeles.

"T. D. Haubner, who in August of 1909, from the *Arapahoe,* sent the signal SOS for the first time—the previous call having been CQD—received a medal similar to



Group: l. to r.: Qm. Orr, Capt. Sealby, Pres. McGonigle, Binns, Capt. Ruspini, Right: Ted Haubner.

that awarded to Mr. Binns on the thirtieth anniversary of his grim stay at his post aboard the *Republic.*

"Honor scrolls went to Patrick Chapman, radio operator of the flying boat *Cavalier*; Andrew Hamilton of the rescue ship *Esso Baytown,* and Richard Stoddart, Howard Hughes, radio man, none of whom were present, and to Charles Hogger, a much-honored operator once personally decorated by the Czar of Russia. Mr. Hogger, his lapel heavy with medals, was a guest.

"Vaughn de Leath, who sang 'Swanee River,' in December 1919, in what is regarded as the first broadcast of a song, repeated the tune, without benefit of orchestra."

DISTINGUISHED GUESTS

Seated at the Distinguished Guests table were left to right: Lieut. William Bell, U.S.N. ret., Navy Wireless Veteran Number 1; Charles W. Horn, Director of Development and Research, National Broadcasting Company; Charles Hogger, much-honored radio operator who received a Marconi Memorial Scroll of Honor; Mrs. Hogger; John G. Orr, former Quartermaste of the rescue ship *Baltic*; Captain Sealby, master of the *Republic* at the time she collided with the *Florida*; T. D. Haubner, sender of the first SOS who received a Silver Commemorative medal in recognition of the thirtieth anniversary year of the first SOS; William J. McGonigle, our President who acted as toastmaster; Jack Binns, heroic radio operator of the *Republic-Florida* disaster who received a Silver Commemorative medal on the Thirtieth Anniversary of his famous CQD; Mrs. Jack Binns; Captain Angelo Ruspini, master of the *Florida* thirty years ago when she crashed with the *Republic*; Robert Hand of the Marine Department of the Standard Oil Company who was present to receive the Scroll awarded Andrew Hamilton; A. J. Costigan, VWOA v-p and Director and Traffic Manager of Radiomarine Corp.; C. H. Taylor of RCA Communications; and George H. Clark, Director VWOA and radio script writer par excellence, and Honorary Toastmaster.

DE FOREST

In the February issue we included Dr. de Forest's message to the Fourteenth Annual Cruise of our Association in which he mentioned the name of Mr. Athearn as his very first operator. On March 9th, 1939, we received a letter from Mr. Athearn saying "Will you be so kind as to forward me the mail address of Dr. Lee de Forest? The writer has not contacted him for just twenty-nine years." By now Mr. Athearn and Dr. de Forest should have renewed a friendship well over a quarter of a century after parting.

Our Association has under consideration a plan for a De Forest Day at the World's Fair and a monster Birthday Dinner to Dr. de Forest to be participated in by all his many friends and admirers. Details of the plan as they are developed will be included in this page. We welcome your comments and suggestions in this connection.

In attendance at the Fourteenth Annual Dinner Cruise of the Veteran Wireless Operators Association at the Hotel Astor.

AS GOOD AS THEY LOOK

Blaw-Knox Vertical Radiators are clean cut in appearance and performance. They are in keeping with the high standards set by the broadcasting industry for other equipment.

Stations take pride in Blaw-Knox Radiators which are associated by the public with the best in broadcasting.

The self supporting type of Blaw-Knox Radiator has uniform taper and is recommended by radio engineers for either shunt or series excitation.

They give greater coverage with long life and low maintenance cost.

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. . . Blaw-Knox Directional Radio Beacons are used exclusively to guide all air transport service in the United States and Canada. What greater proof of efficiency in the broadest use of the term, can be desired?

BLAW-KNOX
VERTICAL
RADIATORS

THE BROADCAST SYSTEM

(*Continued from page 9*)

program, if kept below 5%, and that this degree of modulation is sufficient to actuate low-cost indicators on receivers in the primary service area of the station. I submit that this feature would be welcomed and appreciated by the listening public, and that it is not impractical technically, or in program or advertising aspects.

The use of sub-audible modulation has several possibilities of usefulness, all requiring study and action which are coordinated between the transmitter and and the receiver. For example, it could be used for volume range expansion with control furnished by the transmitter control room engineer in accordance with the musical or technical needs of the program. However, it does not seem that the value of this provision would be sufficient to justify its cost.

Another example of a possible service through use of sub-audible modulation is that of time indication. With suitable modulation by combinations of a few different sub-audible frequencies, simple indicators in receivers can be caused to show the time of day whenever the receiver is turned on, and without requiring the receiver to be on continuously. This service, too, does not seem to have sufficient importance to justify its cost, or the tying-up of so much of the sub-audible spectrum.

There is one use of sub-audible modulation which does seem to me to be not only worthwhile at present, but even that it will be necessary in the near future. I would like to suggest this one as an immediate possibility for an extension of broadcast public service usefulness. It is one which requires cooperation between transmitter and receiver interests, and can be described very simply. It is the turning on and off of receivers by signals from the transmitter, accomplished by a special control signal having either audible or sub-audible modulation. I have said that it may be necessary even, because in facsimile broadcasting, possibilities of usefulness are much greater if the receiver can be turned on and off at any time by control from the transmitter, rather than be turned on and off by a time clock at the receiver at specific times only. Furthermore, in ordinary sound broadcasting, it would be highly useful if receivers could be turned on by transmitters, in the event of important news flashes, for example. Especially in times of national emergency or international crises, such a device would be appreciated. During recent events such as the New England hurricane, the Munich crisis, and

the sinking of the "Cavalier," thousands of receivers were left on continuously, to catch news bulletins occurring at intervals of hours.

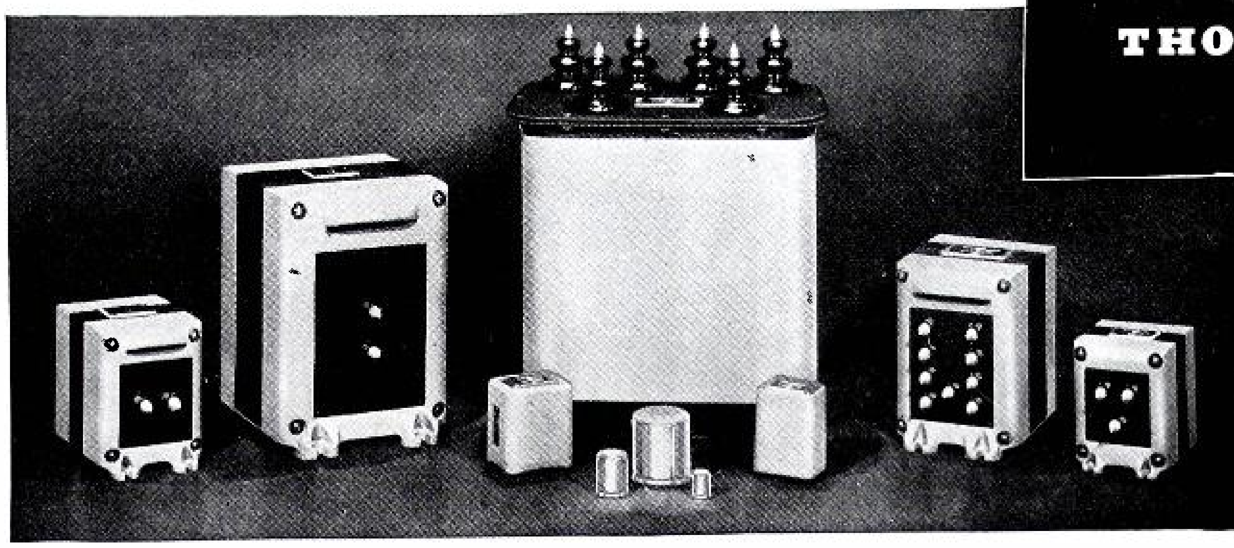
In such an arrangement, of course, one of the first steps of coordination should be agreement among broadcasters not to turn on receivers for special spot advertising announcements, and to confine use of the turn-on facility to its intended purpose.

Of course this service requires a stand-by receiver, continuously energized. However, it can be designed with only two or three tubes, conservatively powered and therefore long-lived, and with low cost. It is estimated that the retail price of such an attachment receiver, as a completely separate accessory to control any present receiver, would be between five and ten dollars. If built into new receivers, the addition to the regular receiver would of course be less than this figure. At present, there is a feeling among receiver manufacturers that any increase in cost, for any reason, is a sales deterrent. Experience has shown, however, that this is not true where the addition is accompanied by a new and desirable service. It is usually true when the added cost is caused by a mere improvement in an existing service, but the situation is quite different when a totally new service is added. It is *only* by such added service, or added value to the user, that average sales prices can be elevated to profitable levels in a sound, permanent manner. I recommend this possibility to your serious consideration, with the idea that it offers worthwhile opportunity to extend the service of broadcasting in a manner which is needed by and will be appreciated by the public. It will give information as to the general character of each program, and it will enable broadcasters to reach the full audience, whenever that is desirable, whether or not all receivers are turned on at the moment.

WHEN YOU CHANGE YOUR ADDRESS

Be sure to notify the Subscription Department of COMMUNICATIONS at 19 E. Forty-seventh St., New York City, giving the old as well as the new address, and do this at least four weeks in advance. The Post Office Department does not forward magazines unless you pay additional postage, and we cannot duplicate copies mailed to the old address. We ask your cooperation.

Tru-Fidelity by THORDARSON



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Thordarson components for broadcast applications are now available through Thordarson distributors located throughout the United States and practically all foreign countries. This means service at your finger tips.

For years Thordarson has supplied special transformers to discriminating engineers and laboratory technicians in broadcast stations, universities, industrial fields and the general radio industry. Standardization of broadcasting equipment and uniform power ratings now make it more practical to catalog representative designs. Others can be supplied to order from standard or special specifications. From microphone to loud speaker, Tru-Fidelity transformers are now available.

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Especially designed to limit starting current of transmitting tubes to a safe value.

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500 V.A. to 4,000 V.A. capacity for line voltage connection.

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THREE SERIES OF AUDIO TRANSFORMERS "MAJOR"—"BANTAM"—"INCHER"

The result of months of painstaking research, careful engineering and designing, plus rigorous laboratory testing. All units have magnetic shielding provided by self-shielding or humbucking construction and cast or high permeability drawn, chrome cases. The various case styles and sizes are illustrated in the center foreground of the picture above. The smallest unit shown is 15/16″ in diameter and 1⅛″ high. These are especially desirable for portable units and to meet conditions where space and weight are at a premium.

Many new features are incorporated in modulation transformers, reactors, etc. The entire series presents a uniform appearance.

Complete listing of "Tru-Fidelity by Thordarson" in Catalog 500-D.
Get your free copy from the local Thordarson distributor or write to factory.

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NEW BASIC SERVICES

In the foregoing, we have considered only improvements, refinements, or extension of the existing basic service of sound broadcasting. Obviously, new basis services are more important. Such new services, and the only ones now on the horizon, are facsimile and television. It is beyond the scope of this paper to go fully into these extensive subjects, but it is in order to remark their wide opportunity and even necessity for greater coordination between receivers and transmitters.

It is well and thoroughly recognized that a high degree of coordination in basic technical matters is necessary in the case of television, and the excellent, effective standardization work which has been carried on in this country for many years past is tangible evidence of this. It is difficult, in a service which has had no actual public experience, and wherein basic problems are as yet unsolved, to foresee possibilities for improvement of relatively minor matters. It might be said even, that it is wholly unnecessary to attempt to do so. However, it may do much good if the systems' viewpoint of television, which has been applied so effectively to date, is maintained in so far as possible, rather than allowing each branch to develop independently as has been so largely the case in sound broadcasting. For example, the possibility of turning on receivers by signal from the transmitter, as discussed previously in connection with sound broadcasting, may be even more worthwhile in television where scheduled programs will presumably not utilize many hours per day for some time to come, and therefore where unexpected and unscheduled events are more likely to occur.

Facsimile broadcasting likewise presents opportunity for coordination, and requires a considerable degree of it for satisfactory performance. Synchronization, form and speed of copy, wave frequencies to be used, control of receivers, are among the matters subject to more satisfactory result from more complete cooperation between transmitter and receiver interests.

It is quite certain that broadcasting is about to enter a new era of its development, and one of even greater magnitude, significance, and effect. We who are engaged in the work of bringing it about will be very close to the trees, but if we keep the forest in perspective as well, we may look forward to experiencing many a thrill and satisfaction of useful public service accomplishment as we carry on.

VI AND REFERENCE LEVEL

(*Continued from page* 11)

volved, even though they are only from a remote point to the studio or from the studios to the transmitter site, errors of this type and magnitude cannot be tolerated.

The use of a full-wave rectifying device is essential whether the instrument indicates r-m-s or peak value. This is necessary because of the fact that the wave form of program material, particularly voice, is not generally symmetrical with respect to the zero axis. Some speakers, for example, consistently generate greater peaks of one polarity than of the other. Reversing the polarity of circuit or reversing the physical position of a bi-directional microphone, reverses the relative polarities of the peaks. Under these circumstances, the use of half-wave rectifiers are unsatisfactory unless each instrument and all circuits are properly poled and this polarity maintained. This procedure, obviously, is impractical in a broadcasting system which involves program originations from both studio and remote points and which involve interconnection of stations from one end of the country to the other.

Still another consideration was the fact that the instrument must be suitable for use at both fixed and field locations if complete standardization is to be accomplished. The use of a peak-reading instrument which, at present, involves a number of tubes and an associated power supply was not considered feasible in portable equipment, particularly in view of the fact that no great benefit was to be derived from its adoption.

Under these circumstances, and also since it is essential that the instrument be relatively inexpensive in order that its general adoption is not hampered by economic considerations, an r-m-s instrument of the type described, has been determined upon.

Final decision concerning the instrument specifications was not made, however, until every possible phase of the matter was thoroughly investigated. For example, the painstaking consideration given the layout of the scale card, which might have been considered by some to be of only minor importance, illustrates this point.

Both vu and percent-voltage markings are incorporated on the new instrument scale. The need for the former is obvious, but the philosophy which led to the inclusion of the latter requires explanation. It is evident, assuming a linear system, that the voltage scale is directly proportional to percentage modulation. If the system is adjusted for complete modulation of a

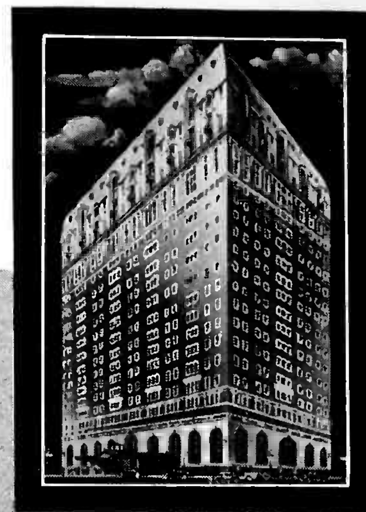
broadcast transmitter for a deflection to the 100% mark, then subsequent indications show the degree of modulation under actual operating conditions. In the interest of best operation, it may be desirable, of course, to adjust the system for somewhat less than complete modulation when the 100% indication is reached.

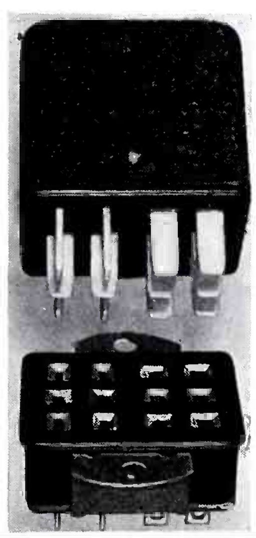
In any event, the indications always show the *percentage utilization of the channel.* This is a decided advantage because everyone involved, including the non-technical persons concerned with program production, has a clear concept of a percentage indication. Furthermore, since the scale does not extend beyond the 100% mark (except in the form of a red warning band) and since no one would expect to obtain more than 100% "utilization of the facilities," there should be no incentive to request an extra loud "effect" on special occasions.

All irrelevant markings have been omitted from the scale in order not to detract the user's eye. The color of the scale card (cream yellow) is the best compromise between high contrast and reduced eye strain fatigue. This choice was based upon the preference of a large group of skilled observers (80 broadcast technicians) and upon the reports of certain societies for the improvement of the vision.

The location of the reference point, combined with the use of a larger sized instrument, results in a useful scale more than 2.5 times the length of former scales.

Simultaneously with the study of scale cards, consideration was given to various types of instrument cases, particular attention being paid to the shape of the window openings and, in the case of illuminated instruments, to the effectiveness of the scale and needle illumination. The problem of installing the new instrument in new and in existing panels was also considered and resulted in an instrument case which re-





quires a round mounting hole rather than a rectangular one since the former is, generally, easier to provide.

The adoption of the new volume indicator will not permit full realization of all of the advantages of proper correlation unless the manner of use and calibration of the instrument by each user are identical. The first step in this direction is an agreement upon a standard reference level to replace the numerous "zero" levels now in use. As already mentioned, this problem was given a great deal of consideration and agreement was finally reached on a one milliwatt calibration standard.

A standard reference level based on one milliwatt has considerable to commend itself, as compared to former reference levels, some of which seem to have just "happened" into being. The value of one milliwatt was chosen because it is: (a) a unit quantity and readily applicable to a decimal system, (b) related to the "watt" by the "preferred" factor[2] of 10^{-3}, (c) it results in positive values for the majority of measurements made at the present time, and (d) it was found to be the one value to which general agreement is possible.

Theoretically, the new instrument is calibrated in such manner that an indication of 100% or 0 *vu* is produced by the instrument when it is connected across a 600-ohm resistor in which is being dissipated one milliwatt of 1000 c-p-s sinusoidal power. This corresponds to a voltage across the resistor of a 0.775 volts, r-m-s. Instruments available at the present time, however, are not sufficiently sensitive to indicate this value directly. Measurements and calibration at the 100% or 0 *vu* point must be effected, in practice, at a volume level of +4 *vu* or higher.

An important advantage of the new instrument is that, since they are all exactly similar, the various instruments on a given circuit may be lined up with 1000 c-p-s sinusoidal power with the assurance that they will then read alike on program waves.

A precaution to be observed in connection with the use of the new instrument is the fact that as at present available, it should *not* be mounted on a steel panel. The deliberate, highly-damped characteristic of the instrument has been obtained by the use of a greater magnetic flux than is required in a normal instrument. This flux is applied by a high coercive force magnet operating at its maximum efficiency. Any loss of magnetic flux such as would occur through the shunting effect of a steel panel, prevents the development of the required characteristics. It is best,

[2] A. Van Dyck, "Preferred Numbers", *Proc. I.R.E.*, Vol. 24, pp 159-179 (1936).

therefore, that magnetic materials be kept at least 2 inches away from the center of pointer rotation.

Where the practical situation is encountered in connection with the replacement of an old instrument mounted on a steel panel, (and where it is not practicable to change the panel) a compromise can be effected with only a small error if the panel is not over 1/16" thick. This is accomplished by cutting out the panel below the instrument case as far as possible without extending the hole beyond the face of the instrument.

It is emphasized that the designation of volume in *vu* implies measurement with the new standard instrument with its prescribed dynamic characteristic. Previous types of volume indicators, even though recalibrated to a 1-milliwatt basis, will not usually give indications of program material corresponding to those of the new instrument.

The use of the new term will clarify the terminology used for expressing the performance of a piece of equipment or of an entire system. For example, in the past, it has been the practice to specify the performance of a piece of equipment by stating its (a) input level, (b) output level, (c) gain and (d) signal-to-noise ratio—all in decibels. In the case of (a) and (b) "decibels above a reference volume based on x milliwatts" is implied while in (c) and (d) pure ratios are involved. The use of the new term "vu" for expressing (a) and (b) minimizes the chance of ambiguity since the term immediately implies measurements with the new standard instrument based on a 1 milliwatt calibration.

Thus it should be borne in mind that the term *vu* implies an absolute volume level, and where ratios are involved the term *decibel* is to be used as in the past. For instance, the gain or loss of a system, a program line or a piece of apparatus is expressed in *db* as is a signal-to-noise ratio, or a response-frequency characteristic. Volume levels, on the other hand, are expressed in *vu* since absolute quantities are involved.

The full realization of the advantages of the standardization of volume indicators, of reference levels and of the term "vu" requires the wide adoption and extensive use of the standards.

* * *

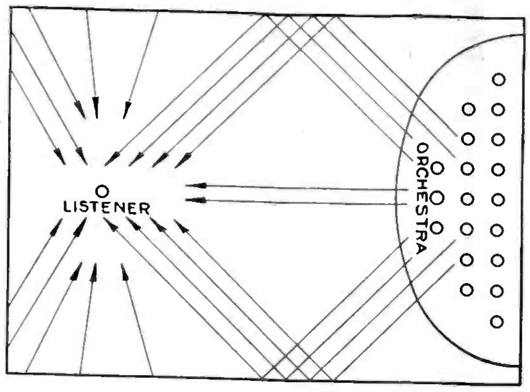
NEELY INCREASES PERSONNEL

Norman B. Neely, technical sales agent with main office in Los Angeles, recently added two sales engineers to his staff. Mr. Bill Stancil takes over field work in the motion picture and recording studio and radio station field. The other new man in the organization is Mr. Richard Hix, who leaves the teaching staff of National Radio and Electrical Schools to join Mr. Neely's organization

The 350-foot Lehigh towers of WGAN, Portland, Me.

SPATIAL EXPANSION

It is well known that a sound reaching a listener's ear in an auditorium is composed of directly-transmitted and reflected energy. As can be seen from Fig. 1, the reflected portion of the sound may constitute high percentage of the total sound energy reaching the ear. It is obvious, then, that there is likely to be a slight difference in the time of

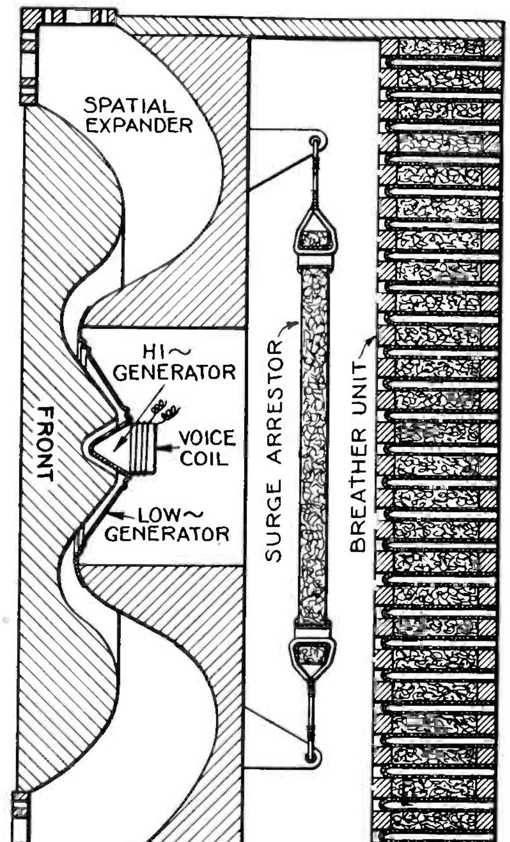


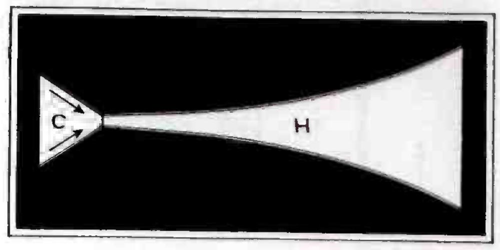
arrival of the reflected and directly transmitted sound. This out-of-phase arrival results in what may be called "spatial effect."

In order to take full advantage of reflection, the sound from the loudspeaker must be truly dispersed. If we could start with a sheet of sound extending from wall to wall and floor to ceiling, the desired result could be accomplished. It was towards this objective that research was undertaken by Maxmillian Weil of the Audak Co.

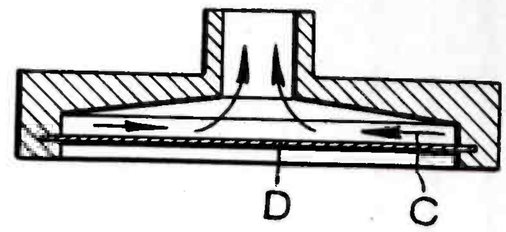
Fig. 2 is a cross-section drawing of the "spatial expander" which, as its name implies, provides essentially the same effect as is obtained from listening, at "listener's distance."

Technically, the cone-speaker is a "free-radiator"—it vibrates and radiates in free air. In the spatial system, the vibrating mechanism is just the reverse of the "free-radiator." It goes back to the principles originally used by Alexander Graham Bell as shown in Fig. 3, in which the vibration of the diaphragm "D" agitates the air in the compression chamber "C." However, in such a device, the sound waves thus generated,





Left: Fig. 1. Above: Fig. 4. Below: Fig. 3.



must travel from an area of larger diameter, toward the center and into a much smaller area. This produces congestion and high acoustic impedance at the small orifice, resulting in distortion.

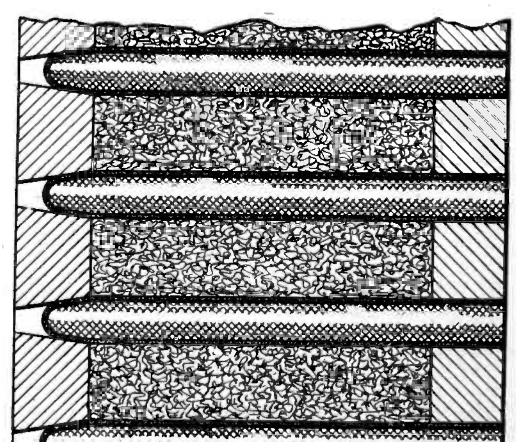
When such a unit is connected to a horn, an effect such as shown in Fig. 4 is obtained.

In the spatial system, the sound generator is so designed as to make possible a compression chamber wherein the propagation of the sound waves takes place in manner approaching the ideal.

To illustrate the action of the unit, let us assume a sound wave being generated by the high-frequency portion of the diaphragm. Keeping in mind that the conventional speaker concentrates high frequencies into a narrow beam, we can immediately see that there cannot possibly be a beam-formation here, as the sound wave, no matter what its frequency, passes through the spatial expander and is discharged into the room from around the complete periphery of the expander.

The walls themselves are punched with some 2000 holes of 3/8" diameter, so located that when the walls are placed in their proper positions the holes are coaxial. Into each of these holes is forced a tube made of fine mesh metal screen.

Left: Fig. 2. Below: Fig. 5.



Index to Advertisers

WITH THE G-R TYPE 775-A FREQUENCY-LIMIT MONITOR

MEET THE F.C.C. FREQUENCY MONITORING RULES

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Relay
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*and other services operating between 1,500 kc and 45 Mc**

Use of this simple-to-operate, easily installed monitor insures compliance with F.C.C. regulations for Police and high-frequency Broadcast stations.

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- Easier to watch than continuously-indicating type of instrument
- No subsequent adjustments needed
- Simple to use . . . lamps out, frequency OK; one lamp lighted, frequency off
- Can be used on one to four channels, selected by a panel switch
- Very compact, requires only 7 inches of relay-rack space
- Entirely a-c operated from built-in supply

TYPE 775-A FREQUENCY-LIMIT MONITOR $240.00
TYPE 376-M QUARTZ PLATES (one required for each channel) $50.00

When ordering, please specify carrier frequency; tolerance; whether frequency deviation limit is 100 to 1,000 cycles or 500 to 3,000 cycles or whether aural monitoring is to be used.

**Although this instrument is designed for operation only up to 45 Mc, with care it can be used at television frequencies between 45 and 108 Mc.*

GENERAL RADIO COMPANY

CAMBRIDGE, MASS. **Branches: New York and Los Angeles**