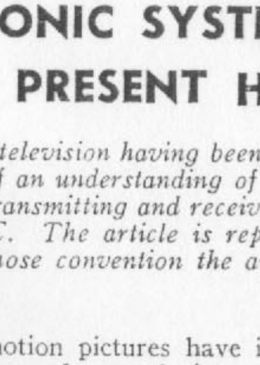
FROM NOTHING MUCH TO SOMETHING GOOD IN TELEVISION

By Ralph R. Beal
Research Supervisor,
Radio Corporation of America

THE ELECTRONIC SYSTEM TRACED FROM CRUDE START TO PRESENT HIGH-DEFINITION PICTURE

Mechanical systems of television having been eclipsed by electronic methods, the following article lays a substantial basis of an understanding of television "with no moving parts." The author is in charge of the television transmitting and receiving experiments of RCA, performed in conjunction with the subsidiary NBC. The article is reprinted from the "Journal" of the Society of Motion Picture Engineers, to whose convention the author in person addressed his remarks in Hollywood.
—EDITOR.

TELEVISION and motion pictures have in common the objective of reproducing on a viewing screen images which, to the eye, appear to have uninterrupted motion. While some of the fundamentals through which this objective is attained in the two arts may be closely related, others are widely different. Objectively and to some extent technically, the problems parallel in the illumination of the subject, in creating the illusion of motion, in realizing an acceptable standard of definition and in obtaining appropriate brightness and size of reproduced image on the viewing screen. An outstanding difference appears in the system by which the reflected light from a subject is transmitted to the viewing screen.



RALPH R. BEAL

In motion pictures, the reflected light from a subject is converted to a film record. Transmission from the film record to the viewing screen is effected through the agency of light. In television, transmission is effected through the agency of electricity. Reflected light from a subject is converted into electrical impulses. These may be transmitted by radio or by special cables from the point at which a subject is located to a point far removed from that locality, and then reconverted into light images on the viewing screen. The reproduced image may originate from a subject or from a film record of a subject.

The development of a television system by which images of high definition may be transmitted electrically and reproduced on a viewing screen has required intensive research by RCA for more than ten years. This research has passed through many stages, beginning with early mechanical arrangements and advancing to the present all-electronic system which is now under field test in the New York City area.

Some of the requirements of a high definition system may be indicated by a brief description of a system patterned after a suggestion made by Carey about 1875. The elements of this system are illustrated in Fig. 1. A pickup area is

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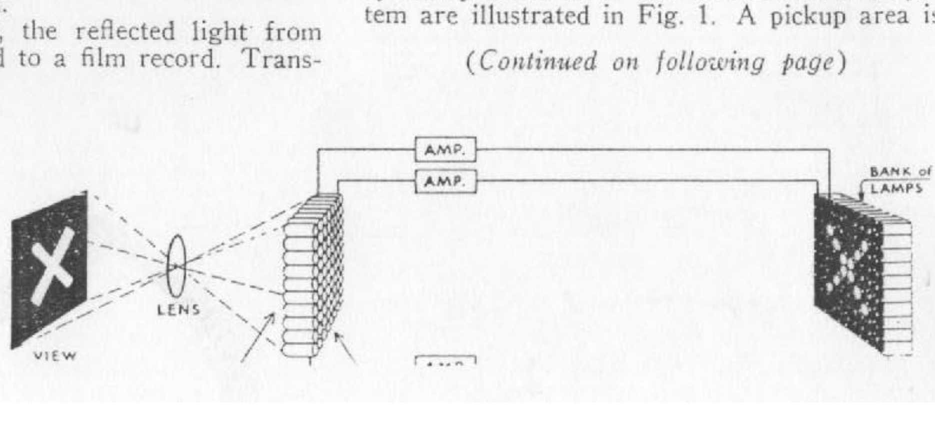
FIG. 1
The elements of an electronic system suggested about 1875 by Carey. The object is the cross-field at left. A lens projects the image on a photo-cell bank. Each cell has its am-



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ıstructed of a bank of photoelectric cells and viewing screen of a like number of incandes-ıt lamps. Each photocell in the bank is con-cted by an electric circuit through an ampli-r to the correspondingly positioned lamp in e viewing screen. The light image to be ınsmitted is focussed on the bank of photo-lls. Electric current then will flow through e circuits connecting those of the photocells hich receive light to the corresponding lamps the viewing screen. A reproduction of the ıbject will appear as an illuminated picture.

A LIMITED SYSTEM

In this system, the amount of detail which ın be transmitted is limited by the physical mensions of the individual photocells in the ckup area. Each photocell represents an ele-ent of picture area and the details in any area the picture smaller than the area of the

tive mosaic in a highly evacuated glass enve-lope. The electron gun produces a fine pencil or beam of electrons which is focused to a spot on the mosaic. This beam is moved horizon-tally and vertically and so caused to scan the mosaic. The motion of the scanning beam is produced by appropriately applied electromag-netic fields.

CONSTITUTION OF MOSAIC

The mosaic consists of a vast number of tiny electrically isolated photosensitized silver globules. These cover one side of a thin sheet of mica. The other side of the mica is covered with a conducting film, and this film is con-nected to a single lead. The mosaic may be thought of as a very large number of minute photocells, each of these shunted by an elec-trical condenser which couples it to the common signal lead. When the mosaic is illuminated, these condensers are charged positive with re-

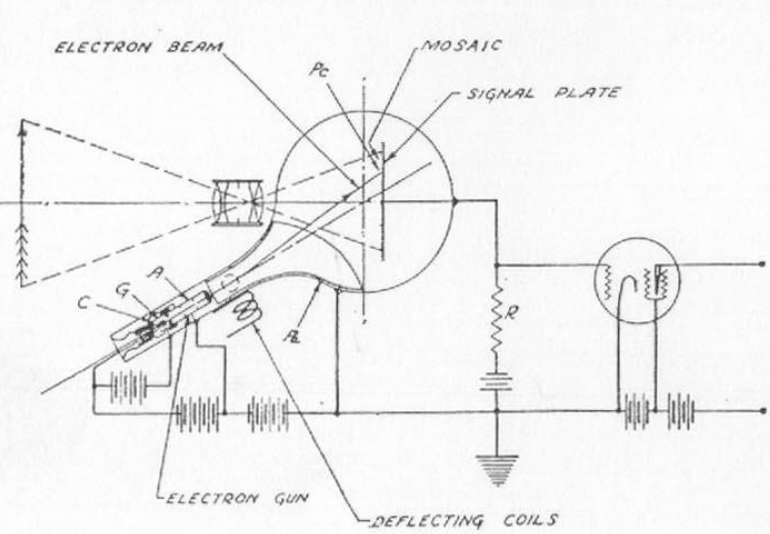

FIG. 2

The Iconoscope consists of an electron gun and a photo-sensitive mosaic in a highly-evacuated glass envelope. The electron beam is focussed to a spot moved horizontally and vertically to scan the mosaic. Electro-magnetic fields impart the motion to the beam.

hotocell cannot be transmitted. An electrical ircuit is required to transmit information con-erning the brightness of each element of pic-ure area. As the amount of detail increases, he number of electrical circuits increases. Such multiple circuit method is not practicable for ransmitting images electrically over long dis-ances. A single channel must be employed for his purpose. This requires methods which in-olve dividing the light into elements, convert-ng the illumination on each element into elec-rical impulses, transmitting these impulses in ırderly sequence and reconverting them into ıppropriately positioned light on the viewing creen.

In the RCA high definition television sys-em, the first step in this process occurs in the 'Iconoscope," which converts the light image nto electrical impulses. The final step takes ılace in the "Kinescope," which transforms the lectrical impulses into a light image on the

spect to their equilibrium potential, due to the emission of photoelectrons. This positive charge is proportional to the quantity of light received.

The electron beam as it scans the mosaic from left to right drives to equilibrium the ele-ments over which it passes and thus releases the charges and induces current impulses in the signal lead. The train of current impulses thus generated constitutes the picture signal output of the "Iconoscope." These current im-pulses will appear in orderly sequence as the electron beam scans the area of the mosaic, one horizontal line at a time from top to bottom. It is in this order that the current impulses are transmitted as television signals. Fig. 3 is a photograph of a representative "Iconoscope."

In the "Iconoscope," the charging process in any specific element of the mosaic continues for a time equal to the picture repetition interval; that is until the beam, in the process of scan-ning, returns to that element. The electrical

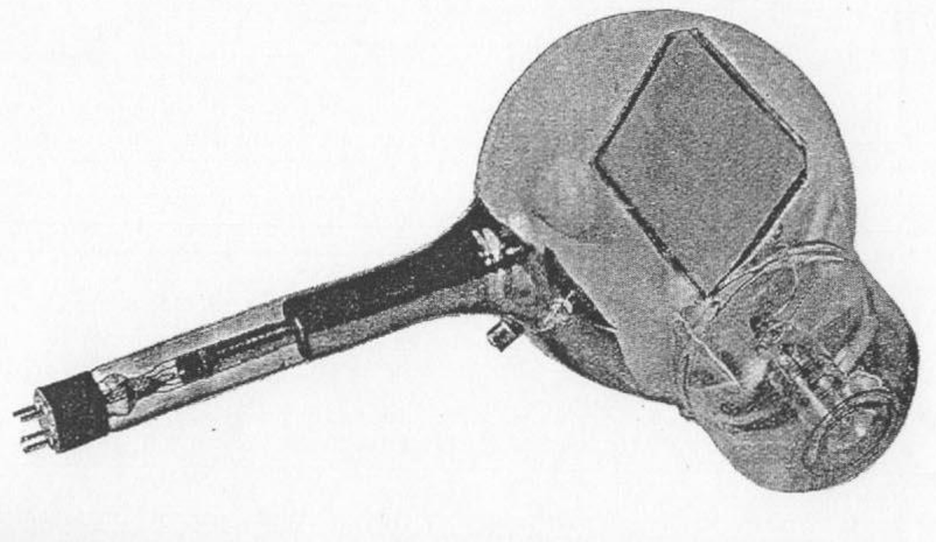

FIG. 3

A representative Iconoscope. The terminals are located at the base and also at heads on the glass envelope. The tilted mosaic on which the electron stream from cathode plays is in practice reflected on a mirror on a console receiver.

induced in the signal lead. This storage principle makes the "Iconoscope" a very effective pickup device for television.

NOW AS SENSITIVE AS FILM

The sensitivity of the "Iconoscope" is of great importance in picking up a wide variety of scenes, both indoors and out, under practical lighting conditions. This sensitivity, at the present stage of development, is about the same as that of ordinary negative film. Research in progress is disclosing methods by which it may be possible greatly to increase the sensitivity.

The color response of an "Iconoscope" depends upon the activation schedule used in producing the mosaic and upon the composition of the photosensitive material. The color response characteristic may be varied over a range comparable with that covered by photographic emulsions available for motion picture work. The color response characteristic of a representative "Iconoscope" is shown in Fig. 4.

The "Iconoscope" and its associated optical parts, correspond, in the RCA Television system, to the camera in motion pictures. This unit of equipment is called the "Iconoscope" camera. "Iconoscope" cameras having the same elements but differing in physical form are used for direct pickup of indoor and outdoor scenes and for the transmission of motion picture film material.

A photograph of an "Iconoscope" camera for use in indoor studios is shown as Fig. 5. The camera may be moved about the studio during a performance; it is raised and lowered by a motion driven mechanism; the usual provisions are made for following the motion and action of the scene; it is silent in operation. The "Iconoscope" moasic is about 4" x 5" or about six times larger than one 35-mm. motion picture frame. Therefore the "Iconoscope" camera lenses are of greater focal depth than those employed in motion picture cameras. Present "Iconoscope" cameras are equipped with lenses of 6.5" or 18" focal length. Fig. 6 shows this camera with the housing raised. The picture signals and the necessary power supply currents are carried by a cable which connects the camera

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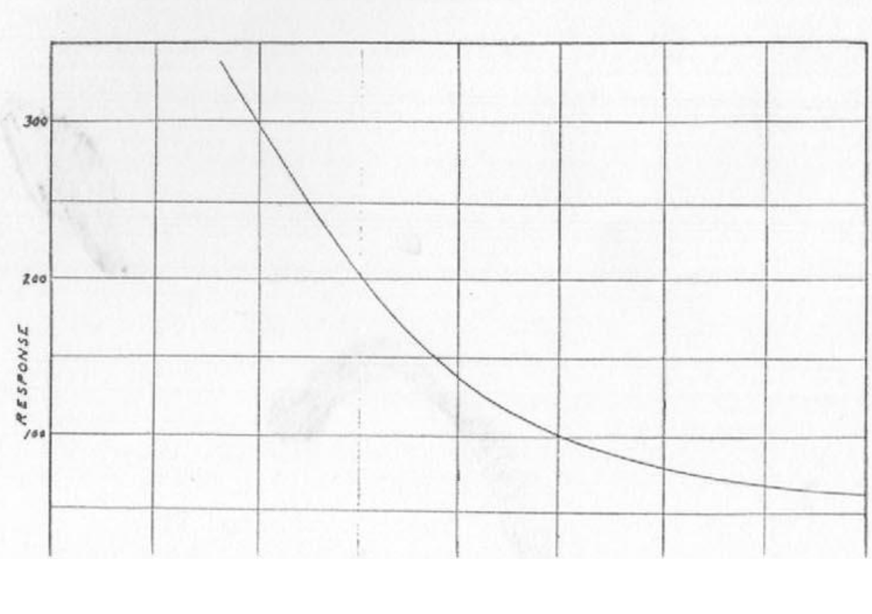

FIG. 4

The 454 Iconoscope has an inverse characteristic with frequency—most sensitive around 5,000 angstroms, and least around 8,000.

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ie system. A wide band pre-amplifier for ifying the picture signal produced by the ıoscope" is included in the camera.

MODULATION AS TO SOUND

ıe picture signals generated by the "Icono-e" in the camera are amplified and deliv- to the radio transmitter. These signals caused to modulate the carrier wave of transmitter in a manner analagous to that oyed in sound broadcasting. The radio il thus produced is picked up at the dis- point by the receiving antenna and deliv- to the television receiver. Here it is re-ed to its original form as a train of im-

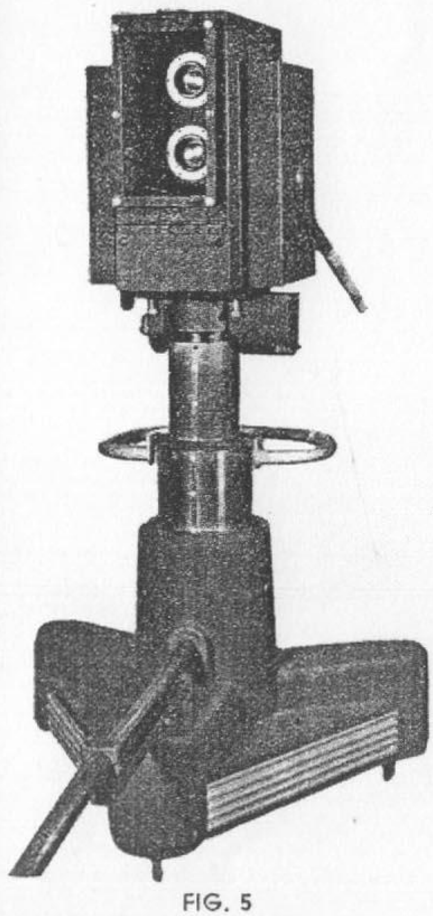


FIG. 5

ıor type Iconoscope camera. It may be moved ut, raised and lowered, and follow the move-its of the character in the usual "pursuit" fashion.

ses. These impulses are fed through ampli-s to the "Kinescope" which transforms them a light image on the viewing screen.

he "Kinescope" is an evacuated glass enve- which contains, as the essential elements, electron gun and a luminescent screen. The tron gun produces an electron beam similar but of greater current carrying capacity n, the gun in the "Iconoscope." Light is duced when the electron beam bombards the inescent screen. The amount of light thus luced is proportional to the current in the viewing screen by appropriately applied electromagnetic fields.

The scanning beams in the "Iconoscope" and the "Kinescope" are accurately synchronized. The team beams are on corresponding points of the mosaic of the "Iconoscope" and of the luminescent screen of the "Kinescope," at any instant. The brightness of a point on the luminescent screen is proportional to the current in the bombarding beam. This current is produced by voltages related to the picture signals generated by the "Iconoscope."

SYNCHRONIZATION OF BEAMS

These picture signals represent, by electrical impulses, information concerning the brightness of each picture element. Since the electron beam in the "Iconoscope" and "Kinescope" are in exact synchronism, the brightness of any point on the "Kinescope" screen will be a function of the brightness of the corresponding point on the mosaic of the "Iconoscope." Thus the image projected as the mosaic of the "Iconoscope" will be reproduced with exactness on the viewing screen of the "Kinescope."

The electron beams in the "Iconoscope" and "Kinescope" are synchronized by transmitting synchronizing impulses at the end of each scanning line and at the end of each picture or frame. A synchronizing amplifier in the receiver separates the synchronizing signals from the composite signal by amplitude selection, separates horizontal and vertical synchronizing signals from each other by frequency selection and delivers the impulses to the respective deflecting oscillators in proper amplitude and polarity for synchronization. The requirement of accurate synchronization between the scanning beams at the transmitting and receiving ends of the circuit is one of the important factors necessitating a uniform standard for all television systems to be used in broadcasting services in this country.

As in motion pictures, the degree of technical perfection of the reproduced image may be measured in part by the detail it contains. To produce a system which will transmit and reproduce pictures of acceptable detail has presented one of the most severe problems in television. The solution was found in the all-electronic system.

NUMBER OF ELEMENTS IMPORTANT

The amount of detail which can be transmitted by a television system depends upon the number of picture elements resulting from the scanning process. The number of picture elements depends upon the number of lines by which a complete picture is scanned. A picture element has a height equal to the distance between the centers of adjacent scanning lines, that is, the scanning line pitch, and a length of 56% greater than its height, for equal horizontal and vertical resolution in the picture. The number of picture elements, hence the amount of detail, increases with the number of scanning lines. In a system which employs the "Iconoscope" and other electronic devices the number of scanning lines, hence the picture detail, may

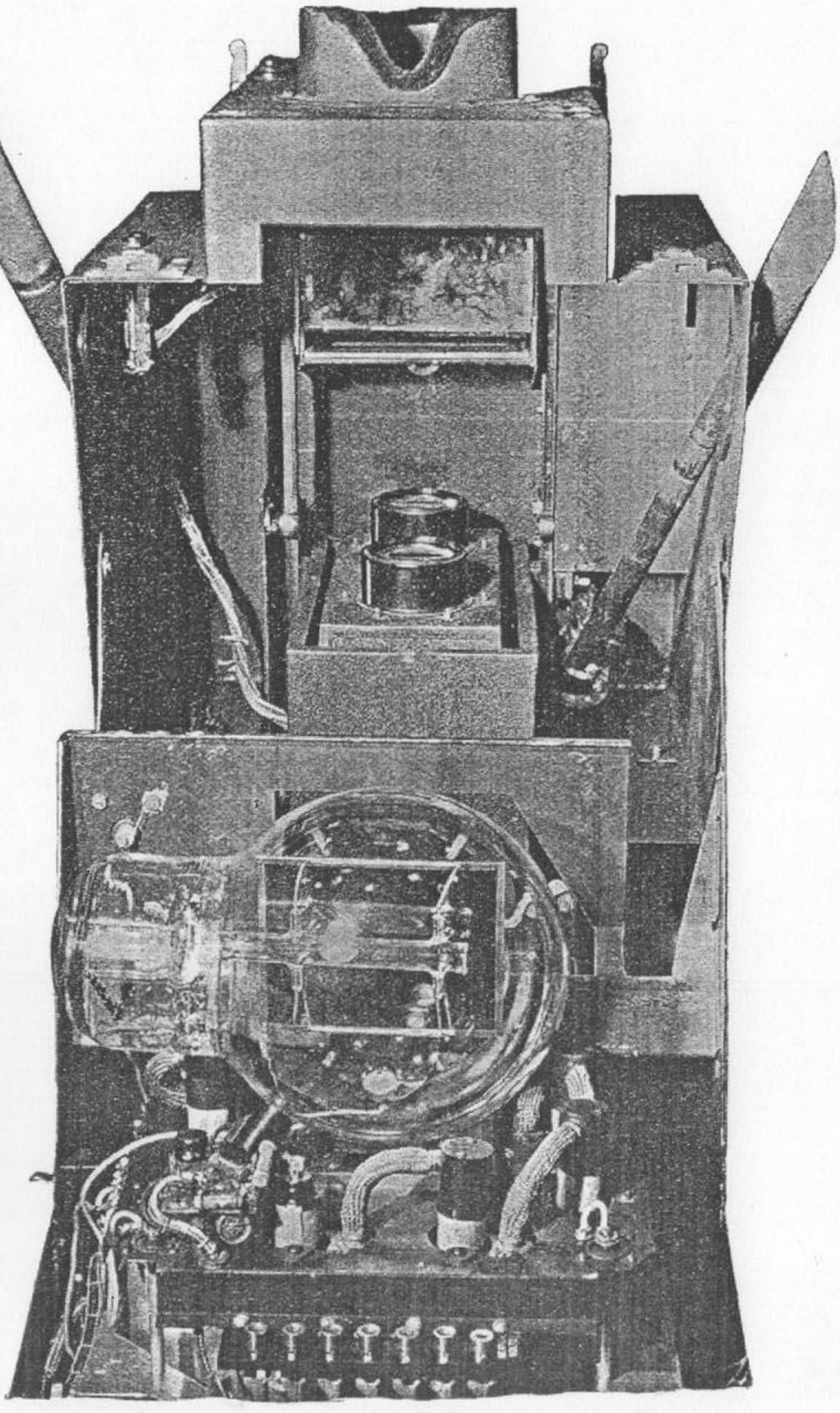


FIG. 6

The Iconoscope camera with the housing raised. A cable carries power and picture signals to the instrument.

mosaic does not limit the detail because many of the tiny photosensitive elements in the mosaic contribute to a single picture element.

The detail which may be obtained by differ-veloped in the course of the studies of the subject. Pictures of less than 60 lines were used in early experimental systems. The electronic system embodying the "Iconoscope" and other

FIG. 7A
e 60-line scanning of the early mechanical sys-ns yielded a result like this. The subject is a Mickey Mouse cartoon.

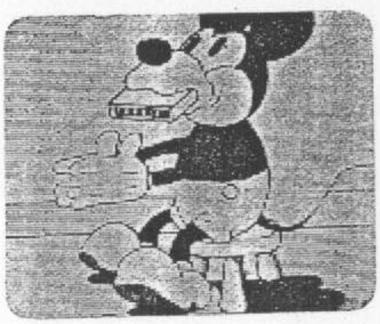


FIG. 7B
ubling the scanning lines improves detail and definition. This is an electronic result.

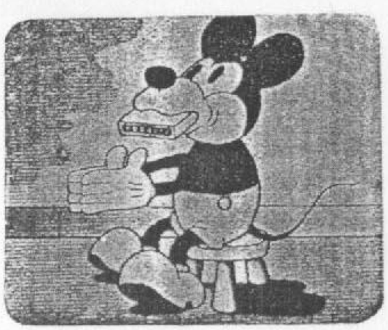
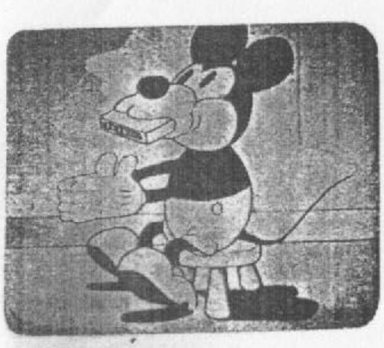


FIG. 7C
180 lines the separate lines begin to be in-ible at reasonable distance from the screen.



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tory detail with 441 scanning lines. This amount of detail corresponds approximately to that obtained with 16 mm. motion picture film. A photograph of an actual 441 line television picture is shown as Fig. 8. This is a photograph of an image on the viewing screen of the "Kinescope." The picture was transmitted by the RCA system now under test in the New York City area.

NATURALNESS AND NO FLICKER

In television, as in motion pictures, two considerations are involved in determining the rate at which the scanning operation must be repeated. The rate of repetition must be great enough to give the appearance of reasonably continuous and natural motion in the reproduced scene and it must be great enough to minimize unsteadiness or flicker in the reproduced picture. Continuity of motion is maintained with a repetition rate of 16 pictures or frames per second. At least 48 frames per second are required, however, to minimize flicker unless some artifice is employed. Motion pictures are projected at the rate of 24 frames

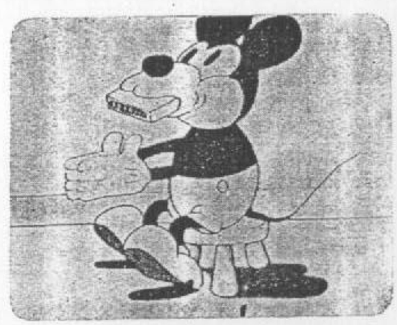

FIG. 7E

A photographic enlargement of the cartoon, where foreground definition alone is retained.

per second and the artifice to reduce flicker takes the form of an extra blade on the shutter which interrupts the light while the film is being pulled down from one frame to the next. Thus, as far as flicker is concerned, the projection is, in effect, at the rate of 48 frames per second.

Such an artifice is not applicable in television. Some other method must be devised. Interlaced scanning is employed in the RCA system. This provides satisfactory freedom from flicker. In interlaced scanning, instead of scanning the picture in adjacent lines from top to bottom, alternate lines covering the entire area of the picture are first scanned and then the beam returns and scans the omitted lines. The entire picture is scanned 30 times per second, but the picture area is covered in alternate lines 60 times per second.

Another requirement for consideration in television is the relation which should exist between the frequency of the power supply to the transmitter and receiver and the repetition rate. It

FIG. 8

Naturalness and no flicker are the results of 441 lines and interlaced scanning. The camera faced the mirror of the experimental receiver when this photograph was taken of the televised image of Betty Goodwin, television announcer.

necessary to minimize certain synchronous interference effects which otherwise might be detrimental to the picture. The television transmitter and receivers of the RCA field test system operate from a 60 cycle power supply. Hence a repetition rate of 30 frames per second fulfills the requirements.

WIDE BAND NEEDED

It should be noted that although the scanning beams of the "Iconoscope" and the "Kinescope" must be in exact synchronism, it is not necessary for the frequencies of the power supplies to the transmitter and the receiver to be synchronous, that is, interconnected, provided they have the same nominal frequency and both systems are regulated in frequency accurately enough for the operation of electric clocks.

The transmission electrically of high definition images over a single channel requires very wide frequency band apparatus and circuits. This is occasioned by the rate at which information must be transmitted concerning the brightness of a very large number of picture elements. A 441 line picture with an aspect ratio of 4 to 3, as transmitted by the RCA system, will con-

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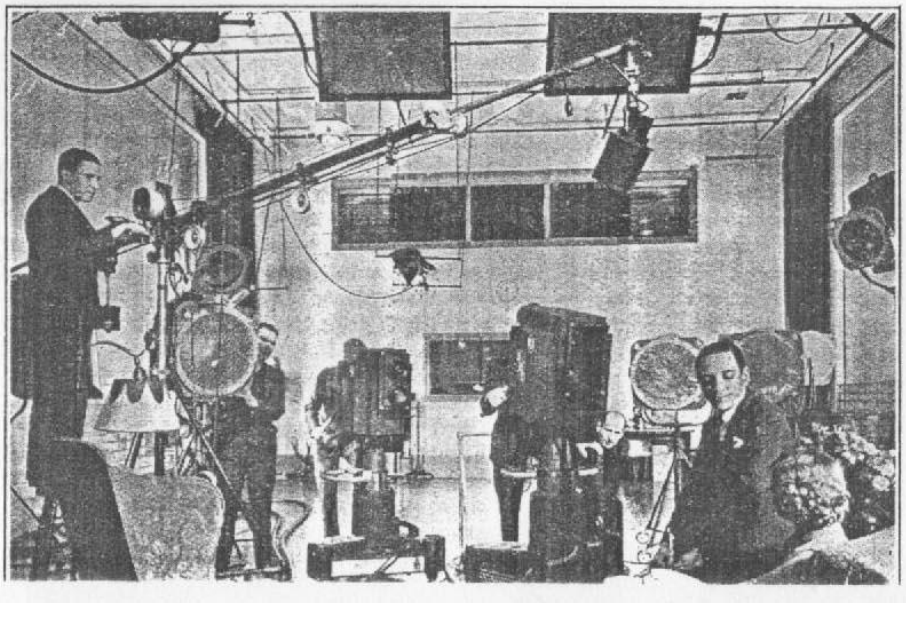

FIG. 9

The equipment in th Radio City televis ion studio as use for program worl The Iconoscope carr eras, of which tw are plainly visibl in center, pick u scenes in sequence by being suitabl switched in as de sired. At left a operator is guidin a standard veloc ity microphone su pended from th end of the boom

FIG. 10

The control room. This adjoins the studio and occupies an elevated position. From this room the different cameras are switched in, in fact all sound and sight monitoring is performed here.

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n 165,957 picture elements, for equal resolu-n horizontally and vetically. This is derived om the product of the square of the number formation must be transmitted concerning the brightness of 30 × 165,957 or 4,978,710 picture elements each second. One cycle of the picture signal provides such information for two pic-

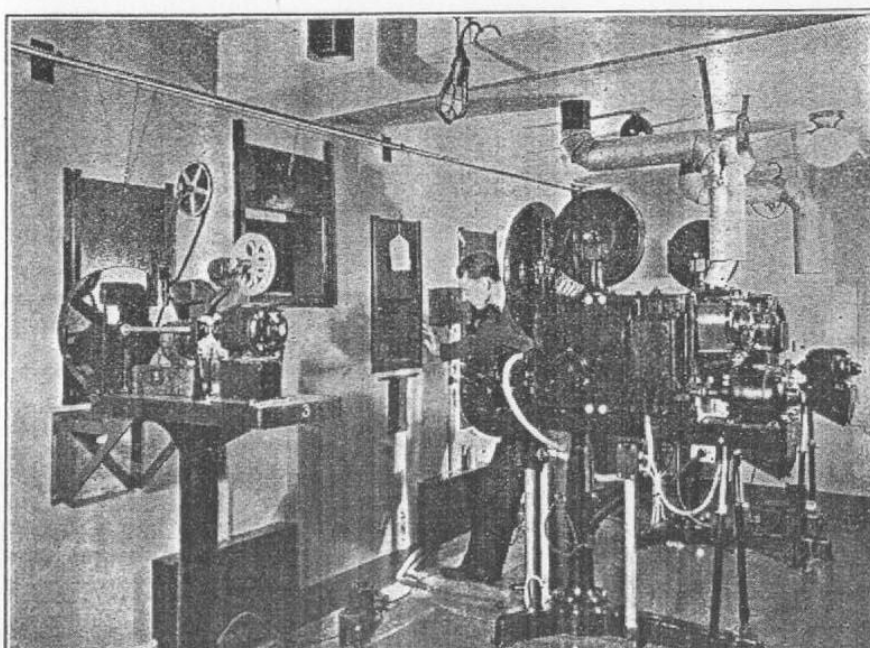

FIG. 11
The film projector equipment.

scanning lines and the aspect ratio, divided 1.56, the dimension of the picture element ... of scanning line pitch.

ture elements; hence the total frequency band required for transmitting a picture as above described is about 2,500,000 cycles. This is the ... of the frequency band which must be cuits in the system. It is the frequency band by which the carrier wave of the radio transmitter must be modulated. The total radio transmitting channel width will be 5,000,000 cycles when the carrier is modulated by the picture signal. This is equal to the combined widths of 500 sound broadcasting channels of 10,000 cycles each.

WHEN THE ULTRAS ARE USED

Channels of such great width are not available in the frequency spectrum now used for radio services. For this and other reasons related to technical requirements, the ultra high frequencies or ultra short waves are used, for television. Frequencies above 30 megacycles (wavelengths of less than 10 meters) are employed. Ultra short waves have quasi-optical properties in propagation. The range over which satisfactory high definition television pictures may be reliably transmitted by ultra short waves is limited practically to the distance of the horizon from the height at which the transmitting antenna is placed. Under some abnormal conditions, pictures may be received over greater distances for periods of very short duration, but primarily television stations will serve local areas. The signals from the stations in these local areas will be stable and will have about the same intensity during the day and night hours, and during the seasons of the year.

Television networks for the simultaneous distribution of programs originating at one point will consist of interconnected local stations. The circuits which interconnect these stations must be capable of transmitting the very wide frequency band required for high definition television. Existing circuits, either wire or radio, cannot fulfill this requirement. New facilities nically, to provide them for extensive, nationwide networks becomes an economic problem of magnitude.

NEW METHODS FOUND

The development of a high definition television system has required technical advances over a broad front. Fundamental research in the field of electronics was very important. Extensive research in an unexplored portion of the radio frequency spectrum was required to determine the laws of propagation of ultra short waves and to produce methods and devices by which they may be applied. Entirely new methods and apparatus had to be produced for picking up images, and converting them into electrical impulses for transmission. New methods and devices were required for amplifying, transmitting and receiving the very wide frequency bands on ultra short waves. The fundamental character of the work and its extensiveness constitute practically the development of a new art.

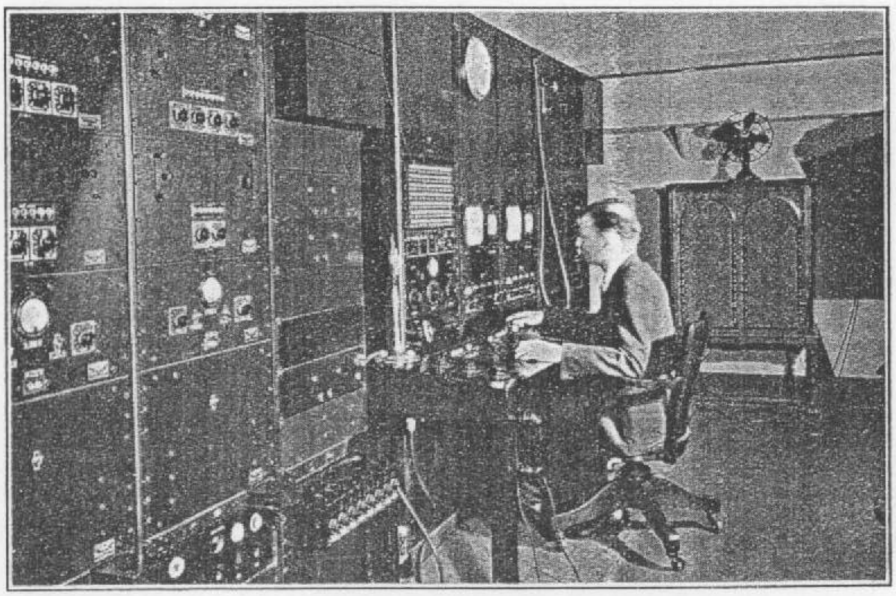

FIG. 12
The film projection room has its own separate control room.

The technical advances made through a step-by-step program of research in the laboratory and practical tests in the field, have been incorporated in the television system RCA now has under experimental test in the New York City area. The equipment provided for this field test is installed under conditions which closely correspond with the requirements of a television broadcasting service. The field tests are comprehensive in scope. They embrace studies of the functioning of the equipment under field conditions, the collecting of engineering information and data related to signal and noise levels within the service area; experiments to develop program technique and observations of receivers in the field by technical personnel.

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: essentials are 441 lines per frame, a frame :quency of 30 per second, a field frequency of per second (interlaced), negative polarity transmission and a video-audio (picture-und) carrier frequency spacing of 3.25 mc. ıe picture signals are transmitted on a fre-ency of 49.5 mc. and the sound at a fre-ency of 52.75 mc.

The studios in which artists perform and the photograph, the "Iconoscope" cameras are employed to pick up scenes to be transmitted in sequence by switching from one camera to the other. The switching operation takes place in the studio control room, which is located in an elevated position at one end of the studio. The sound which accompanies the picture is picked up by a standard velocity microphone equipped with a windshield and attached to a boom.

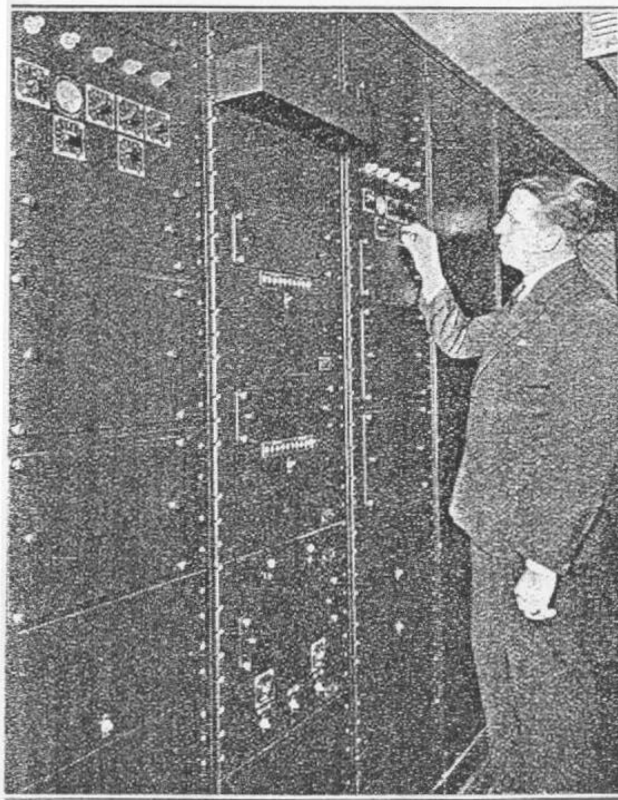

FIG. 13
The synchronizing supply is pictured. The video line amplifiers feed the signal to the Empire State Building.

om which motion picture film is transmitted re located in the RCA Building, Radio City. 'he radio transmitting equipment is installed ı the Empire State Building and the transmit-ng antenna on top of the building. The pic-ıre signals from the Radio City studios are ent to the radio transmitter in the Empire tate Building either by coaxial cable or by ltra short wave radio relay. The accompany-ıg high fidelity sound is carried over special able circuits.

TELEVISION STUDIO

The terminal equipment at Radio City in-ludes three "Iconoscope" cameras for direct ickup in the artists' studio and two motion icture film projectors of special design, each ith its "Iconoscope" camera. This equipment ıcludes the video or picture signal amplifiers nd the deflecting and control apparatus for ach "Iconoscope" camera, the "Kinescope" ıonitors, the synchronizing generators, the line mplifiers and other associated apparatus.

The studio is about 30′ x 50′ with a ceiling height of about 18 ft. It is an NBC studio formerly used for sound broadcasting. The studio is equipped with incandescent lamps of various types, having a total power consumption of more than 50 kw. The lighting equipment is flexible to enable comprehensive studies of a variety of effects in experimental programs. Rifles, floods and focussing spots with ratings between 2 and 5 kw. each are most numerous, although there are several large units of special design. Key lighting and back lighting units are suspended from the ceiling; modeling lights are operated on the studio floor. The present sensitivity of the "Iconoscope" requires an incident light intensity on a set of about 1,000 to 2,000 ft. candles.

STUDIO CONTROL ROOM

Adjoining the studio and at such an elevation that the operating engineers have a clear view of the studio scene, is the studio control room. This control room is shown in Fig. 10. The sound and video signals from the studio produced on the two monitoring "Kinescopes" shown at the left of the photograph. One monitor shows the scene being transmitted and the other the scene picked up by the second "Iconoscope" camera preparatory to transmission. The operating position in the foreground of the photograph controls the sound from the studio. The video controls are at the opposite end of the control board. The racks of equipment behind the engineers include the video amplifiers and the synchronizing and control equipment associated with each "Iconoscope" camera.

FILM STUDIO

Motion picture film material originates in a film studio in another part of the National Broadcasting Company plant. This studio consists of two rooms, in one of which are installed two special 35 mm. motion picture projectors and other supplementary equipment, and in the other, two "Iconoscope" cameras with video and monitoring and control apparatus. The projectors are so designed that standard 24 frame motion picture film is used to produce television pictures at 30 frames per second. In these projectors a changing rate of intermittent drive is used for the picture portion of the film and a constant 24 frame rate of feed for the sound portion. Pictures from the projectors are focussed on the mosaics of the "Iconoscopes" cameras located in the same control room beyond the partition separating the two rooms. The film projector equipment is shown in Fig. 11.

FILM STUDIO CONTROL ROOM

A control room is associated with the film projection room. A view of this room is shown in Fig. 12. The equipment in the film studio control room includes two "Iconoscope" cameras with their video voltage amplifiers and associated synchronizing and control equipment and audio equipment for the control of sound from the film. The two "Iconoscope" cameras are so mounted that they may be shifted from side to side for use with either of the film projectors in the adjacent room.

SYNCHRONIZING

The panels containing the electronic synchronizing generator equipment, and the video line amplifiers which feed the viedo signal to the Empire State Building are shown in Fig. 13. This equipment is installed in the main equipment room of the National Broadcasting Company plant.

INTER-BUILDING TRANSMISSION

The inter-building ultra short wave radio relay transmitter (Fig. 14) is installed on the 10th floor of the RCA Building. It operates on a frequency of 177 megacycles and has a channel width adequate to carry the full video frequency band. Equipment is provided for monitoring the signal at this point. The transmission distance between the two buildings is approximately .9 mile. The signal obtained at the Empire State Building is free from noise, and pictures transferred by radio relay are as satisfactory as those for which the coaxial cable is used.

EMPIRE STATE BUILDING
CONTROL PANEL

The coaxial cable and radio relay channels, and the channel for the sound accompanying the picture from the studios in Radio City terminate at the Empire State Building control board. (Fig. 15). From left to right the control board consists of the sound channel panel, a video monitoring panel, the radio relay receiver panel and battery and switching panels. The video

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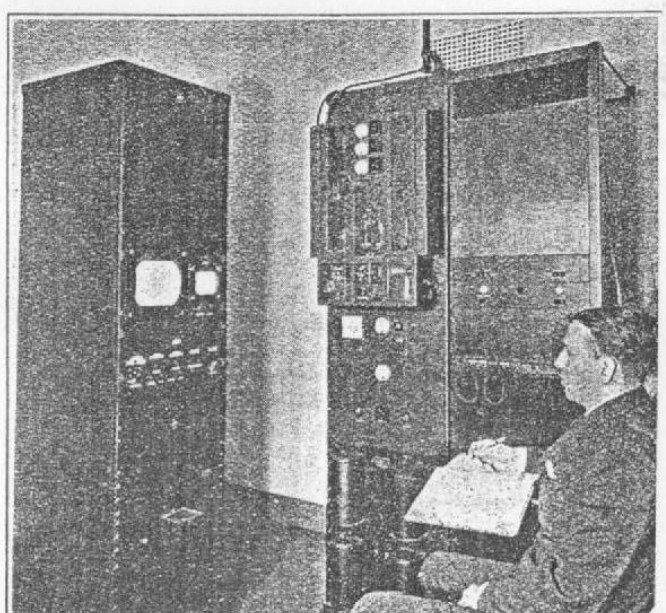

FIG. 14
The inter-building ultra short wave radio relay transmitter.

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tor may be switched either to the radio or the coaxial cable channel.

TRANSMITTERS

ıe video and audio transmitters installed in Empire State Building are shown in Fig.

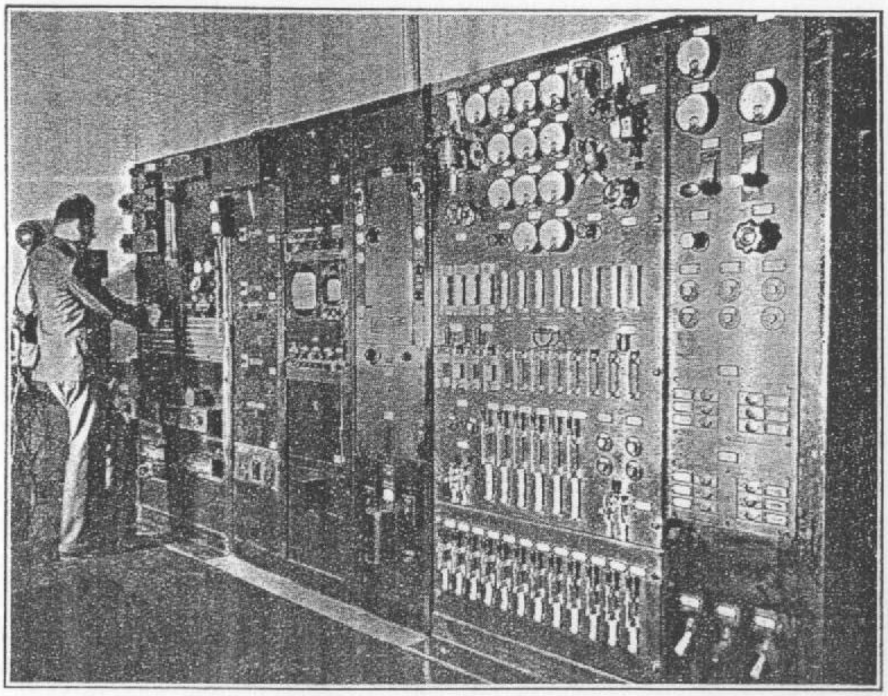

FIG. 15
The coaxial cable and relay channels.

The video and audio transmitters are en- separate and are specially designed for power operation on ultra high frequencies. modulator of the video transmitter is ·le of handling the wide side bands re- d for the video frequencies. Both trans- rs are coupled to a common transmission which is connected to the single antenna p of the building.

ANTENNA

s antenna produces a horizontally polar- field with a pattern essentially circular e horizontal plane. The antenna has a gain in the horizontal plane of about r 3.2 db. as measured with reference to tical dipole. The Empire State Building g a height in the order of 1,250 feet pro- a location from which a maximum trans- g range may be obtained. The distance the antenna to the horizon is approxi- y 43 miles. Fig. 17 shows a view of Empire State Building transmitting an-

RIMENTAL FIELD TEST RECEIVERS

experimental field test receivers resemble earance a console broadcast receiver. Fig.

type and has a tuning range of 40 to 84 megacycles. It receives the picture and the accompanying sound. The "Kinescope" is mounted vertically and the television image is viewed in the mirror mounted inside the cover of the cabinet. Tuning is accomplished by a single knob controlling the radio frequency circuit and the single oscillator which heterodynes both carriers to produce two intermediate frequencies.

Of the seven knobs on the front of the receiver the center knob tunes the picture and the accompanying sound. The three knobs on the right, from top to bottom, are the sound volume control, the treble tone control and the bass tone control. The three knobs on the left, from top to bottom, are the picture contrast control, the detail control and the background brightness control. These receivers operate on the ordinary 110 volt, 60 cycle power supply and draw about 350 watts of power.

These receivers have been used to produce two sizes of pictures. For the first few months of the tests, the picture size was 5¼" x 7½". At the present time most of the receivers have "Kinescopes" which produce pictures 7½" x 10" in size. Fig. 18 shows a 9" Kinescope which produces a 5¼" x 7½" picture. A "Kinescope" about 12½" in diameter is required to produce a 7½" x 10" picture. The shape of the picture, defined by the aspect radio 4 to 3, is the same as that used in motion picture practice.

COLOR AND BRIGHTNESS

lighted room. The color of the "Kinescope" screen depends upon the composition of the fluorescent materials. Many screen colors have been produced. At the present time a slightly greenish yellow screen and a more nearly white screen are being used. The present yellow screen used for the 7½" x 10" picture has a brightness in the high lights of about 4 foot lamberts. This may be compared with the tentatively proposed standards of 7 to 14 foot lamberts for the brightness of motion picture theatre screens.

The optimum viewing distance for a 441 line picture of the 7½" x 10" size is in the order of three to four feet. At this distance the line structure is not resolved by the eye. The screen angle or the angle subtended by the picture at the eye is about 20 degrees. At a viewing distance of 12 feet, the screen angle is about 5 degrees, which in general, is in the order of magnitude of the minimum acceptable screen angle in motion pictures. The size and brightness of the 7½" x 10" picture of 441 lines appears to reasonably satisfy the requirements for pictures to be viewed in the home by the average family group.

PROGRAM MATERIAL

In connection with television program technique, it is too early to accurately predict the technique which ultimately will develop in television programming. It is clear to those who are closely associated in the development of a system that, although some parts of the program technique may parallel the technique of the stage, motion pictures and sound broadcasting, it will be distinctive from any of these. In effect, a new art form must be created.

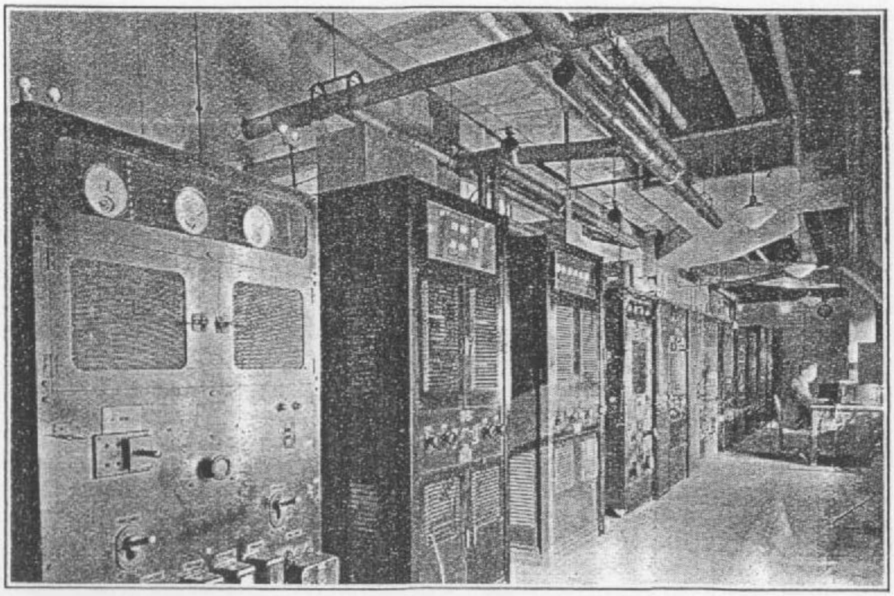

FIG. 16
The video and audio transmitters in the Empire State Building.

other points, outdoor pickups and motion picture film. Spontaneity eventually may be an important element in television programming. The televising of outdoor events as they occur is entirely feasible under the light conditions which prevail during fair weather. Studio programs and motion picture film probably will find liberal use in television programming but here again the requirements peculiar to television will affect the nature and composition of the material.

The field tests in the New York City area are contributing to further technical advances. Pictures of 441 scanning lines have been transmitted and satisfactorily received within a service area having a radius of 30 miles or more from the Empire State Building. Good pictures are regularly received at one observing point in a suburban home over a distance of 45 miles.

MUCH WORK AHEAD

Much remains to be done. When it will be completed cannot be accurately predicted. The engineering information and data collected and the experience gained from operating the system under field conditions are pointing the way toward the realization ultimately of a high definition television broadcasting service.

This new service, just as have many new services in the past, will supplement and not supplant existing services or agencies which represent older arts. The telephone did not supplant the telegraph; it supplemented it. Sound broadcasting did not supplant the theatre and motion picture. On the contrary, it increased public interest and appeal in them and thereby contributed to their advancement and financial profit. And so it will be with

(Continued from preceding page)
ie continually growing list. There will be ome things which television can do that previ-us arts cannot do; a few things which it can o better than they; but there will be many iings which they can continue to do which elevision cannot do. We may therefore welcome the advent of a great new public service, which will come not to displace but to augment our agencies of entertainment and information, thereby making the world a more interesting place in which to live.

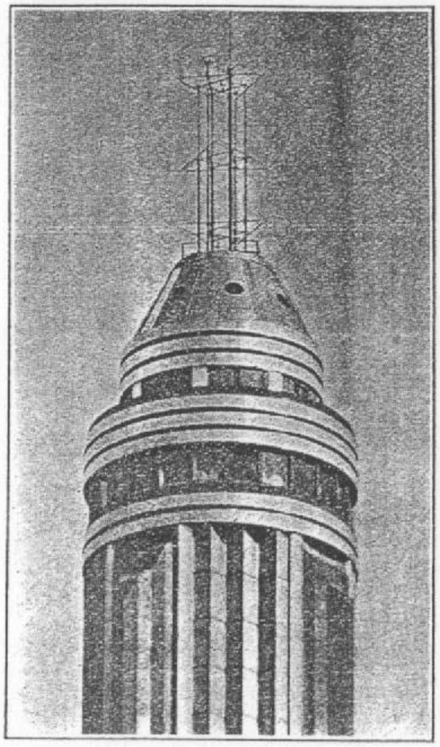

FIG. 17
ower of the Empire State Building, with the television antenna system at top.

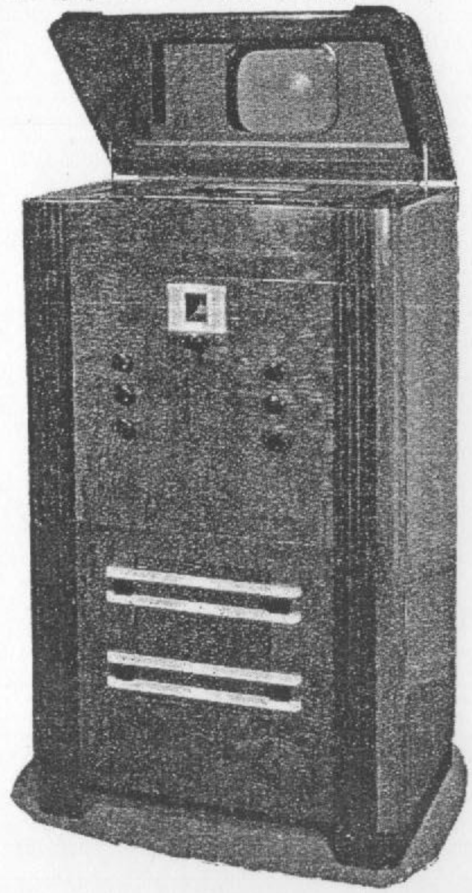

FIG. 18
Experimental television receiver.

Applause

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