THE CONSTRUCTION AND OPERATION OF THE JENKINS TELEVISION LABORATORY AT WHEATON, MD.

A thesis prepared by Pledge

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4/17/31 Date?

DR. C.FRANCIS JENKINS

SUMMARY

The history of the Jenkins Television Laboratories at Wheaton,Md, began on the evening of July 2,1928. On this date, Dr.Jenkins began his first of a series of regular broadcasts of television signals,from his experimental laboratory at 1519 Conn. Avenue,N.W.,Washington,D.C. Encouraged by his early success, Dr.Jenkins continued to broadcast, until he was forced to search for a location further away from the residential section,in which he was situated, because of the interference caused by his experimenting.

At this point,the location of the present station at Wheaton was determined, and construction began in February, 1929. With the conscientious aid of his fine staff, Dr. Jenkins was able to broadcast the initial program from this newer and more powerful station in April,1929. Silhouettes formed the first program features, but developments took place rapidly, so that the first half-tones were sent over the air in November,1930.

Broqdcasts are now done entirely from the face of film,on a regular schedule, but soon pictures taken from living figures will be transmitted. Since the time of the transmission of the first half-tones, progress at the station has been very rapid. Even at the present writing, the power of the station is undergoing the process of change. Consequently, any apparatus discussed in this report,or even the present theory of television is liable to be rendered obsolete and discarded in a very short time.

HISTORY AND BACKGROUND OF THE LABORATORY

The story of the construction of the Jenkins laboratory at Wheaton ,Md., is a short one. It is necessary to delve further into the history of television to learn the purpose for which it was erected.

One who might be called the father of television in the United States is Dr. C.Francis Jenkins,born of Quaker parents at Dayton,Ohio in 1868. He is the outstanding pioneer in this new industry, and has probably done more in practical experimental work than any other man in America.

His discoveries and inventions relating to television were made in 1923 and 1924. Previous to this time,he had been working with the problems of the transmission and accuracy in reception of radio pictures of still objects. This art he brought to a high degree of perfection through the use of his invention of the prismatic ring for scanning the pistures or objects transmitted. Television,however,brought newer and more difficult problems.

Dr. Jenkins was fully aware of the value of the American amateur in developing the perfection of radio transmission,especially in the short wave range to which television signals are restricted. It was with the idea of obtaining the valuable assistance of the amateur that the Jenkins Laboratories began the first broadcast as a licensed station on July2,1928.This date inaugurated the beginning of the transmission of television signals on a regular schedule.

The initial broadcasts were especially for the benefit of the members of the Amateur Radio Relay League of which the Jenkins Laboratories are members.This first broadcast was through the station W3XK, located at 1519 Connecticut Ave.,N.W.,Washington,D.C. on a frequency of 6420 kilocycles,for distant receivers ,with a wave length of 47 meters, and 1605 kilocycles with a wave length of 186 meters for the benefit of Washington listeners and amateurs of the surrounding territory. The power of this station was 50 watts.

THE FIRST HOME OF STATION W3XK ON THE SECOND FLOOR OF THE MARMON BUILDING AT 1519 CONN.AVE.

Distinguished visitors on the occasion of the inauguration by the Jenkins Laboratories of the first regular scheduled broadcasts of Radiomovies July 2, 1928. Left to right: Capt. S. C. Hooper, Navy; C. Francis Jenkins; Gen. George O. Squire; Capt. Guy Hill, Signal Corps, Army; Commissioner Harold A. LaFont; Commissioner Judge Ira E. Robinson; Commissioner Sam Pickard; and Carl Butman, Secretary Radio Commission (in rear).

Their first broadcasts consisted only of silhouette movies in the black and white and transmitted from the face of a film. The program lasted for an hour on the evenings of Monday, Wednesday and Friday. The reason for broadcasting silhouettes was that such pictures were simpler, covered a narrower frequency band, and were therefore simpler for the amateur to pickup and adjust his receiver to. Short subjects were first used, and more elaborate stories were gradually worked into the program which was transmitted. Reports were immediately forthcoming from the listening amateurs, showing the interest of the American radio fan in the new invention.

With the shower of reports from the amateurs also came letters of complaints. The Jenkins Laboratories at 1519 Conn. Ave. are in the very center of the city of Washington, consequently, a great deal of interference was caused by the operation of the station at this point. Dr. Jenkins was therefore forced to look elsewhere for a position to place his station such that no interference might be caused.

Frames taken from early (1928) Radiomovies broadcasts from W3XK. The Jenkins Laboratories, Washington, D. C.

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CONSTRUCTION OF THE STATION AT WHEATON,MD.

A place which filled Dr.Jenkins requirements was located on the estate of one of his friends,at Wheaton,Md. This position was very desirable from the point of causing interference,as comparatively few residences were near it. Arrangements were completed and construction operations begun at this point in February,1929.

The panels for the transmitter units were built by Messeurs Knight and Link of Passaic,New Jersey. Instruments for the station were built and put into operation by members of the Jenkins Laboratory Staff. According to Dr. Jenkins, the members of his staff who erected the station deserve particular praise for their inventive genious shown in the skillfull manner in which they designed and erected the apparatus of the station which was of a higher power and different frequency than the one at Conn.Ave. The first broadcast from this station took place in April,1929.

STATION W3XK AT WHEATON,MD.

The station is now situated in a small, five-room bungalow which is shown. Overhead are the two,large steel skeleton towers,one hundred twenty-five feet tall. In this one house are situated two transmitters,one known as W3XK and the other as W3XJ. Both operate on short wavelength. Station W3XK is used mainly for the transmission of the television pictures on a wave length of 146 meters,while station W3XJ is used primarily for the transmission of voice on a wave lengthof 186 meters.

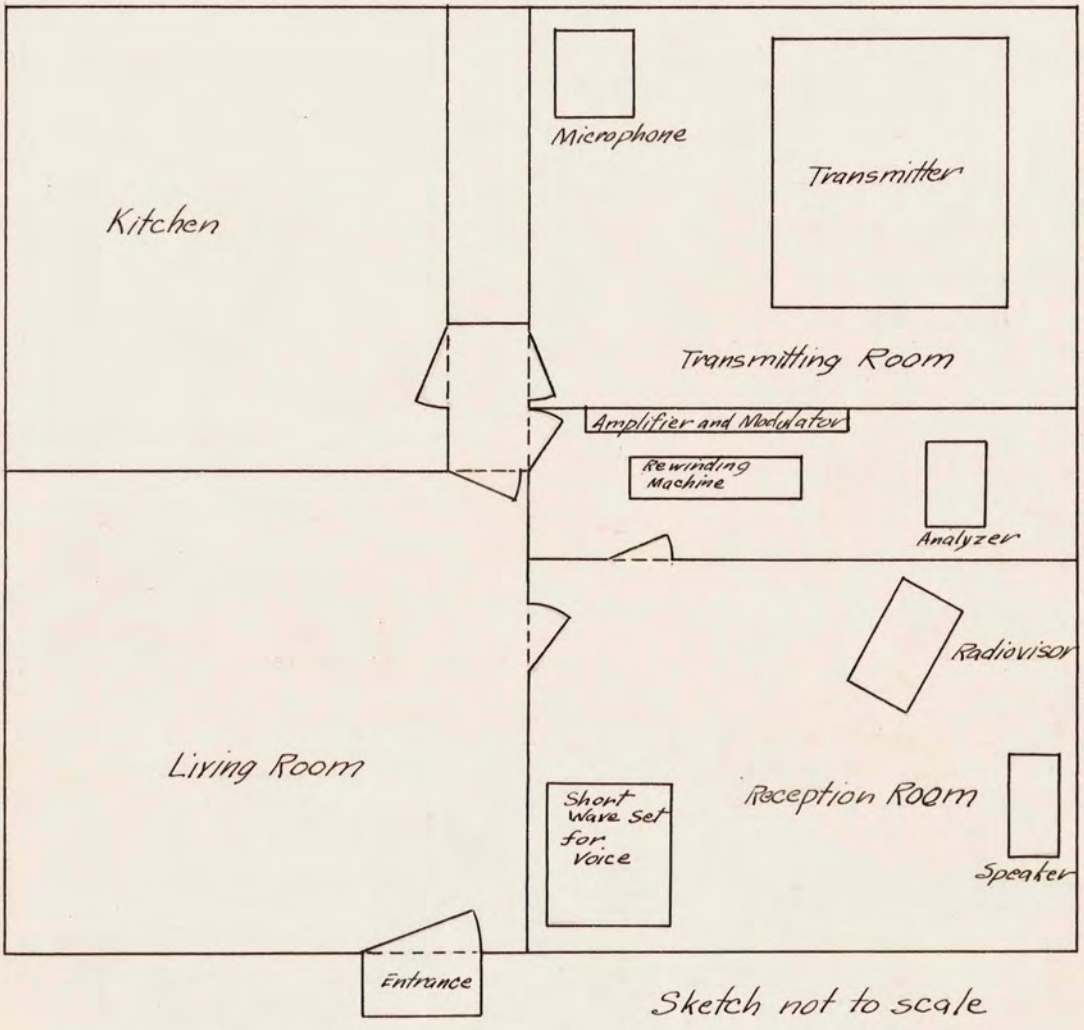
Pictures are broadcast from these stations directly from film in a manner somewhat similar to the broadcast from the Conn.Ave. laboratories. Each set of pictures are preceded by an announcement of the film about to be presented, by the station W3XK. The film is then transmitted over station W3XK and the voice station,W3XJ, describes the events depicted by the pictures. The film is completed by the word "END", prominently displayed.

To transmit from these two stations,two antennas are required.The antenna used by the picture station,W3XK, is strung between the two radio masts,and has a length of 226 feet The antenna for the voice station,W3XJ, is stung on a slant, running from the top of one of the masts to the ground.

With the erection of this higher powered station the frequencies were also changed. Through the courtesy of the Federal Radio Commission, television stations all over the country were granted a frequency band of a width of 100 kilocycles. This greatly increased the range of frequencies obtainable in broadcast,in contrast to the ten kilocycles band which was formerly available.

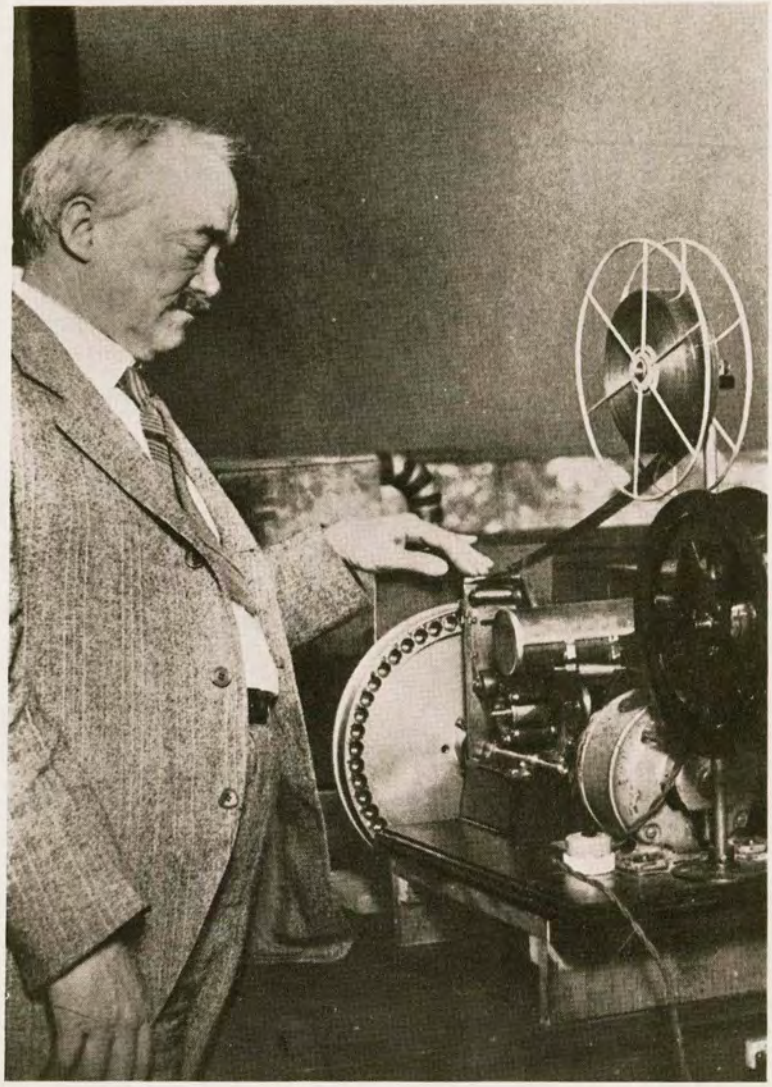
The kilocycle channel now broadcast from the Jenkins stations at Wheaton is now 2850 to 2950 for distant listeners, and 2000 to 2100 for local receivers. With this increase of power and broader frequency band, clearer pictures are broadcast than were formerly possible.

GROUND PLAN OF THE STATION AT WHEATON, MD.



The layout of the station is shown in a diagrammatic sketch. In the central portion of the southern part of the house is a room about five feet wide and about ten feet long. This room contains the first elements of the television system.Here is the analyzer and the two amplifier and modulator units. The next room on the right is the transmitter room, containing the transmitter units and the microphone for the announcements. On the northeast corner of the house is a room which seems to be arranged as a kitchen. Diagonally opposite is the receiving room, containing two receiving sets by which the transmitted signals are closely observed and checked for clarity, flicker and other details. Directly north of this room is situated the small,but comfortable living room, tastely decorated, furnished with several chairs and another radio of a commercial model. On the table in the center of the room is the list where visitors to this station are requested to register their identity. This list holds the names of many important and famous people. Visitors are always welcome and are very cordially received.

To return to the broadcasting equipment,consider first the analyzer, as this is the beginning of the transmission of pictures. An idea of the appearanceof this machine may be obtained from the picture inclosed, showing Dr. Jenkins standing by the apparatus formerly used to transmit pictures from the Conn. Ave Station.(Note: It was not permissible to take pictures of the broadcasting equipment,so the machinery is being described from photographs of equipment now obsolete, corrections being noted inthe description.



The Jenkins Lens-disc Radiomovies transmitter of 1928.
Lenses arranged in a circle; film moves continuously.

This piece of apparatus is so arranged that the film to be analyzed is supported on a framework and moves vertically between the sides of a small sleeve, in amanner similar to the construction of a motion picture projector. The film to be shown is of the standard motion picture size with the usual holes placed along the side. Into these holes fit knoblike projections, arranged circumferentially on a small cylinrical drum, about one inch in diameter. This drum draws the film from the lower reel to the upper. The shaft by which this drum is driven is geared to a second shaft which in turn is driven, by a second set of gears , by a small, 60 cycle synchronous motor, which is running at 1800 R.P.M. On th same shaft to which the drum is geared, is directly attached a thin, metal disc, about eighteen inches in diameter. This corresponds to the disc appearing in the photograph of the analyzer. In the photograph, the disc is shown studded with forty-eight tiny lenses, but inthe present apparatus, which is considerably more recent than the one shown, the lenses are replaced by narrow slits, about one-sixteenth inch in width and one-half inch long.

The gears mentioned are so arranged that as the motor rotates at 1800 R.P.M., the film moves at a rate of 900 pictures per minute, and the disc rotates at a speed of 900 R.P.M. Therefore, for every picture frame, ther is a correspond ing complete revolution of the disc. This disc is placed in behind of the moving film. In front of the film is a very strong source of light which is focused on a narrow horizontal

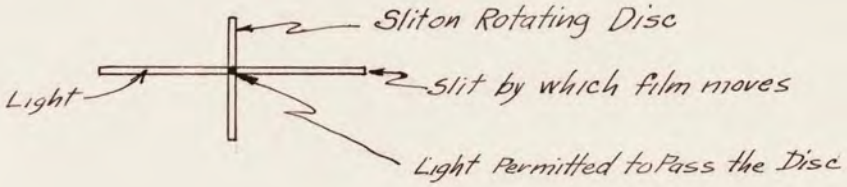
slit in the metal sleeve through which the film moves.The focusing power consists of three lenses,namely: a plano-convex, double-convex and a plano-convex.

The width of the slot through which the light passes is approximately equal to one forty-eighth of the length of the picture.Immediately behind the film is a second set of two plano convex lens which focus the light coming through the film on to the revolving disc. After passing through the slots of the disc,the light again is focused through a series of two plano-convex lenses.From these, the pinpoint of light impinges on a photo-electic cell.

PRINCIPLE OF THE ANALYZER

To understand the principle involved,it would to start again at the beginning of the analyzer apparatus. Powerful, focused light is allowed to fall on a narrow slit, past which the film moves,which is about to be analyzed. It then falls on the rapidly moving disc. Now this disc is moving at such a rate that it revolves once for every picture frame passing by the horizontal slit. The result ,then, is the same as would be obtained by keeping the film stationary and drawing 48 horizontal lines of light across the film, each below the preceding one,and each composed of tiny pinpoints of light for as each slit moves across the horizontal line formed by the horizontal slit, it allows only a small portion, the width of the slit in the disc,to pass through.Hence,as the disc rotates, each slit allows a series of pinpoints (or a line) of light to pass through. As one slit passes beyond the edge of the film,

a second begins at the opposite edge of the film,only slightly lower. At any given instant, only a pinpoint of light is passing through the disc and is determined by the slit in front of the film and the slit in the disc,thus:



It is evident why this machine is termed an analyzer for it actually breaks up the pisture into its component values of light and darkness,just as a half-tone picture produced by the screen method,for use in newspapers and magazines, is broken up into dots of varying intensities of light.

The light from the analyzed picture now strikes on the photo-electric cell. This is,in reality,a form of generator. It consists of a glass bulb with the rear wall coated with a layer of silver. Over this coating is placed a layer of potassium. One electrode is formed by the potassium and a second by a loop of wire projecting from the cell. The bulb is filled with hydrogen. As light strikes the potassium,it emits elect--rons. This tiny electric current is directly proportional to the amount of light on the cell. It is obvious,the,that the value of the current from the cell corresponds ,at any instant to a light intensity at a point in the analyzed picture.

This minute current,which is of audible frequency, is very much to small for broadcact purposes,and must be amplified greatly. This is accomplished by passing the current

through four stages of amplification followed by four more stages of power amplifier. The frequency of the impulses from the cell are modulated to radio frequencies in a two stage modulator.

The next stage of the system is the transmitter. This is entirely too complicated to discuss adequately in the space here alotted, but it might be said that the frequencies are controlled by a quartz crystal as in voice broadcasts. The system is completed by sending out the impulses over the radiating antennae.

The chief difficulty encountered in television transmission seems to be that the frequencies from pictures run into about thirty and forty thousand cycles per second, about three times that of voice broadcasts.

THE RECEIVER SYSTEM AT STATION W3XK

Another important unit in the system of the Jenkins station is the receiving set which is used to check up on the quality of the pictures broadcasted. This consists of a set which is sold commercially by the Jenkins Corporation, and which is known as a "Radiovisor". It is composed of two short wave receivers,one to be used for voice and the other, for the television signals,so that both may be received simult--aneously.

The set for receiving the television pictures consists of a short wave set coupled with a drum scanner.The scanner is the heart of he machine,for it is this piece of apparatus which changes the electrical impulses from the transmitting station into light impulses,and assembles as

them in the proper sequence to form a picture.

THE JENKINS RADIOVISOR

The drum scanner consists of a hollow metal cyl--inder,about seven inches in diameter,three inches long , with a one-sixteenth inch wall. There is a hub on the outside of the drum which slips on the $\frac{1}{2}$" shaft of a small synchronous motor. On the peripheral wall of the cylinder are 48 tiny holes about 1/32" in diameter. These holes are arranged on four helical turns,the turns being $\frac{1}{2}$" apart and the holes spaced 2" apart circumferentially. Inside the drum is a single target cathode-glow neon tube, held stationary by a support above the drum.

SINGLE TARGET CATHODE-GLOW NEON TUBE

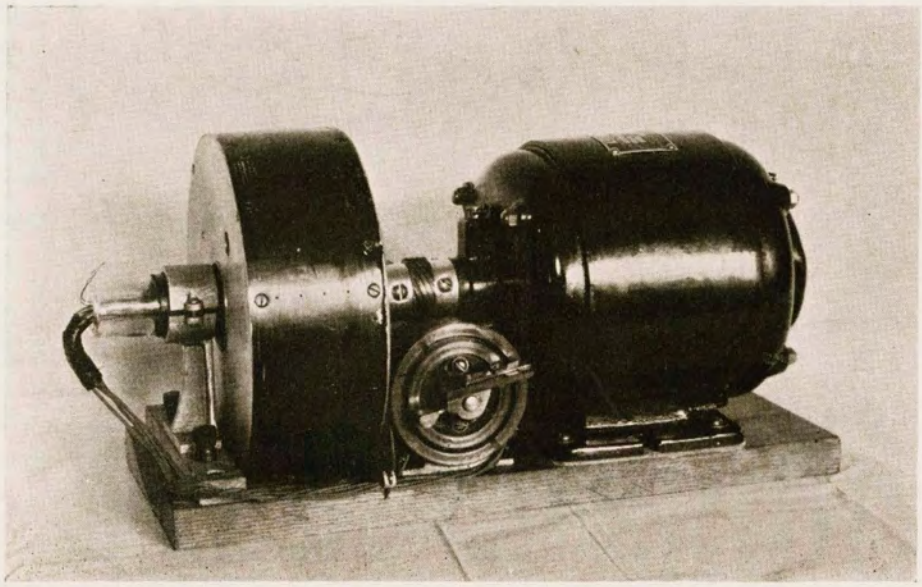
SIMILAR TO ONE USED IN THE JENKINS RADIOVISOR

In front of the drum and geared to the motor which drives the drum, is a flat metal disc with spiral slits cut in it. These slits ars so arranged that as the drum rotates, only one of the 48 holes on the drum shows at a time,and that only as long as it passes across the face of the neon tube target.The result is ,that the top hole of the drum passes

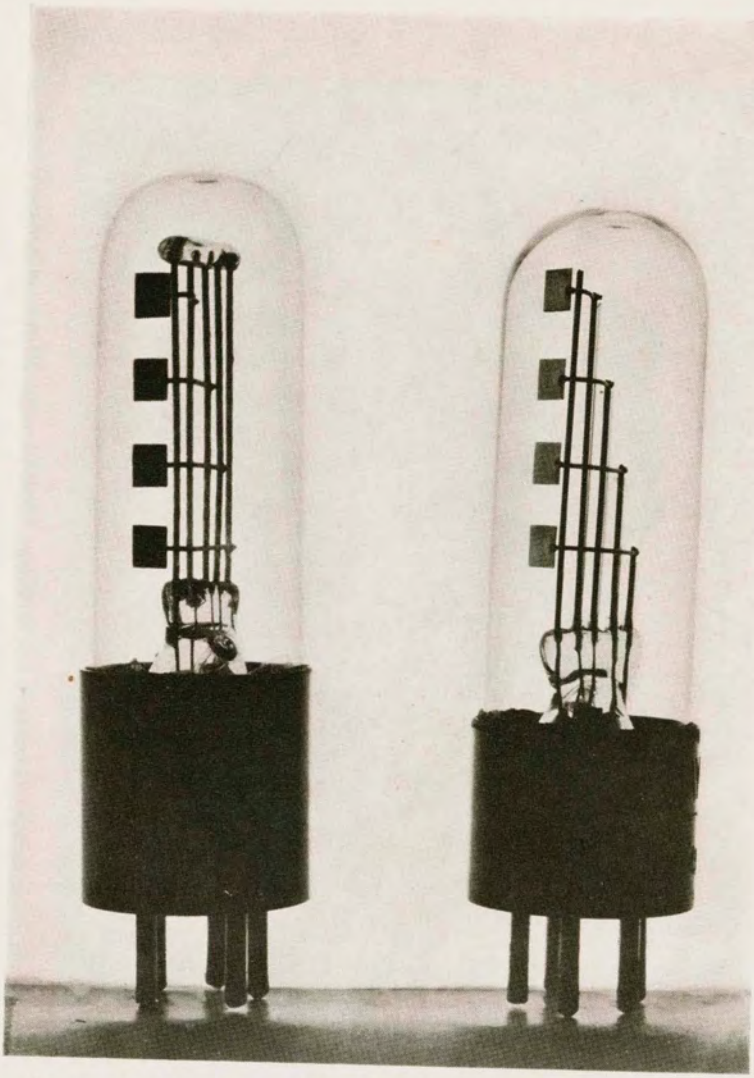
across the face of the target and disappears;next,the hole below the first one repeats the procedure,until finally the whole target is covered with imaginary lines traced by the holes in the drum. It id evident that this is just the reverse process of analyzing. The neon tube target is so hooked up as to glow with different intensities of light corresponding to the impulses from the transmitting station . The glow from the tube is then made into a beam of light by the hole in the drum scanner, and this beam traverses back and forth across the face of the target until the impulses are all arranged in their proper order, so that the picture finally appears as transmitted.The color of the picture is pink and black.

Formerly, the neon tube had four targets for producing a 2" picture,such as is made by the single target tube of today.These targets each lighted a separate helical turn and the disc in front of the scanner was not necessary.There was a hollow drum inside the scanner and holes corresponding to the holes on the outside wall.These two sets of holes were connected together by hollow quartz rods to make a more efficient transmission of light to the exterior of the drum,but this has proven impractical in commercial use,so that it was done away with and the single tube substuted together with the elimin--ation of the quartz rods.

EARLY TYPE OF SCANNER USED IN THE JENKINS RADIOVISOR



The mechanism of the Jenkins Radiovisor. Motor rotates the drum for scanning the picture.



Four-cathode lamp used in the Drum-scanner of the Jenkins Radiovisor (2-inch square picture, unmagnified).

As there are four helical turns on the drum, it takes four turns to make a complete picture. The speed of the drum must therefore be four times the speed in R.P.M. of the analyzer speed in pictures per minute or 3600 R.P.M. In front of the scanner is a large plano-convex lense which magnifies the picture until it is about six inches square, so that five people can watch it comfortably. Because the synchronous motor runs from the same supply as the transmitter and analyzer, the pictures are always stationary. The speed of the pictures received and those transmitted must always be in exact synchronism. There is a switch on the machine, however, for bringing the pictures into frame to compensate for a slight tendency of the motor to "hunt".

This receiver gets its impulses by wire. There is however, a receiver, taking its signals from the ether which is used to check up on the voice quality from the transmitter.

The two young expert members of Dr. Jenkins staff who assisted in assembling the apparatus of this station when it was first constructed, also now maintain it. They are Mr . Theodore Delote and Mr Paul Thomsen.

Until just recently, the accepted American Television method of scanning was from left to right and top to bottom, at a speed of fifteen pictures per second and 48 lines per picture. The Jenkins station conformed to this standard, but it is being changed to meet the newer standard of 20 pictures per second and sixty lines per picture. It is expected that this will produce pictures of much greater clarity than before obtainable. The power of this station is also being increased. Because

this is a transitory type of station,being in the amateur stage,no apparatus blueprints were available.

The station now broadcasts from 7P.M. to8 P.M. Eastern Standard Time every evening except Sunday,using both transmitters. From 8 P.M. to 9 P.M.,station W3XK carries on the broadcasts, W3XJ being required by law to sign off in order to allow a station in New York to transmit without interference.

The world is about to witness the birth of a new art , television. Very soon in the near future, it will hail this art as the highest acheivement of the inventive genius of men,all over the face of the globe, who are striving to make the world a better more interesting place in which to live. One of these men is Dr. Jenkins , and his laboratory at Wheaton,Md., is an important,integral part in the development of this great invention to the high degree of perfection which it truly deserves.

BIBLIOGRAPHY

Vision by Radio, Radio Photographs and Photograms published by the Jenkins Laboratories, Inc., 1925.

Radio Movies, Radio Vision, Television published by the Jenkins Laboratories, Inc. 1929

Television: The World's First Television Journal, published in England. Now discontiued.

(Note):

Practically all of the material used in this thesis was obtained from personal interviews with Dr. Jenkins, Mr. Stuart Jenks, one of Dr. Jenkins staff members; Mr. Paul Thomsen and Mr. Theodore Delote at the Wheaton Station.

The writer is deeply indebted to them for the help which they have so generously profered and wishes to here express his gratitude for their assistance.

EARLY HISTORY

of the

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