<u>Some notes on early experiments with frequencies above 30 MHz:</u>

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March 1933 Proceedings of the IRE (Volume 21, # 3) contained four papers (totaling 144 pages; a virtual textbook of all that was known, or suspected, in 1933) detailing various long term tests done at frequencies as high as 435 Mc/s although the majority of the transmission testing was done between 30 and 100 Mc/s.

a/ "**A Study of the Propagation of Wavelengths Between Three and Eight Meters**" (L.F. Jones; RCA Victor Company, Inc., Camden, N.J.); pages 349-386

b/ "**Notes on Propagation of Waves Below Ten Meters in Length**" (Berthram Trevor, P.S. Carter; RCA Communications, Inc., Riverhead, L.I., N.Y.); pages 387-426

c/ "**Ultra-Short-Wave Propagation**" (J.C. Schelling, C.R. Burrows, E.B. Ferrell; Bell Telephone Laboratories, Inc., New York City); pages 427-463

d/ "**Some Results of a Study of Ultra-Short-Wave Transmission Phenomena**" (Carl L. Englund, Arthur B. Crawford, William W. Mumford; Bell Telephone Laboratories, New York City); pages 464-493.

Just to hang a 'date-stamp' at this point, on March 4, 1933 FDR was sworn in as the 32nd President of the United States and the world was "*in the nadir of the worst depression in history*".

Proceedings of the Institute of Radio Engineers
Volume 21, Number 3 — *March, 1933*

TECHNICAL PAPERS

A STUDY OF THE PROPAGATION OF WAVELENGTHS BETWEEN THREE AND EIGHT METERS*

BY

L. F. JONES

(RCA Victor Company, Inc., Camden, New Jersey)

Summary—A description is given of the equipments used in an airplane, dirigible, automobile, and indoors to measure the propagation characteristics of wavelengths between about three and eight meters. The majority of observations were of television transmissions from the Empire State building.

The absorption of ultra-short-waves traveling through or around large buildings is shown to be in terms of amplitude about 50 per cent every 500 feet for seven meters and 50 per cent every 200 feet for three meters. A number of reflection phenomena are discussed and the influence of interference patterns on receiving conditions is emphasized. It is shown that any modulation frequency is partly or completely suppressed if propagation to the receiver takes place over two paths differing in length by half of the hypothetical radio wavelength of the modulation frequency. For a good television picture this corresponds to a difference of about 500 feet.

Various types of interference are mentioned. There are maps of the interference patterns measured in a typical residential room. The manner in which traffic movements cause severe fluctuations in ultra-short-wave field strengths at certain indoor points is shown by recorded field strengths.

It is shown that the service range of the Empire State transmitters includes most of the urban and suburban areas of New York, and that the interference range is approximately 100 miles. Variations of field strength with altitude, beyond line of sight, are shown. Observations made at a distance of 280 miles are described.

An empirical ultra-short-wave propagation formula is proposed. Curves are then calculated showing the relations between wavelength, power, range, attenuation, and antenna height.

Any circuit (transmission or reception) that functioned without full-time technical monitoring above 30 Mc/s in 1930 was a laboratory curiosity. Yet both RCA and Bell Labs were developing extremely good technical quality hardware and precision reception measurement and recording systems. At RCA the driving force was creation of a stable wideband modulated system which could mature into television broadcasting; at Bell Labs, while television was of interest, much greater interest revolved around creating point-to-point relay systems to allow simplex, duplex and wideband telephone circuits to expand into areas where 'open wire lines' (the predecessor to cable including coaxial) could not reach economically. Transmission power levels in the range of 100 watts utilizing horizontally polarized dipoles or vertical (base loaded) half wave radiators were established by RCA and Bell for testing that ranged from near-ground level transmission to heights of 300 meters (from Empire State Building, NYC see "Fig. 3"). Reception testing involved thousands of individual measurements at ground level, at slightly elevated heights (4 meters being one example), in boats/ships, aeroplanes, dirigibles and in-motion automobiles. Early in the tests conducted by RCA, they came to a tentative conclusion that as long as there existed 'LOS' (line of sight) transmission height was significantly more important than transmission power levels (tests with as little as 1 watt led to this conclusion; see "Fig. 5"/pg. 3 and "Fig. 6"). Bell Labs tests did not directly agree with RCA's pre-1933 summaries; they found ("**Ultra-Short-Wave Propagation**") that because of "leading wavefront edge bending" the actual range was not limited by line of sight but rather could be calculated as 1.33 times the distance from transmission antenna to the visual horizon (the so-called "*4/3rds earth*" theory). In fact 1.33 was an 'average' as Bell measured changes between summer and winter from 1.37 to 1.31 (thus leading to the well known falling off of beyond-LOS signal levels during colder months and the influence of location with respect to air temperatures and moisture content) (see "Fig. 16"; pg.4). The depth and detail of all four papers is extraordinary and would have been so if they had first been published in 1943 or even 1953. Technology historians seldom connect such equipment design and measurement skills to prior-to-WWII. In fact RCA and Bell both

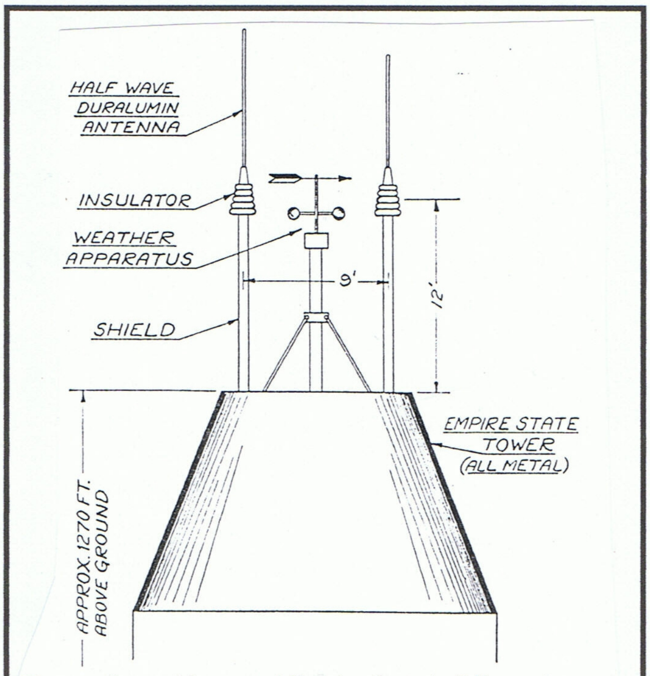

Fig. 3—General layout of Empire State building antennas.

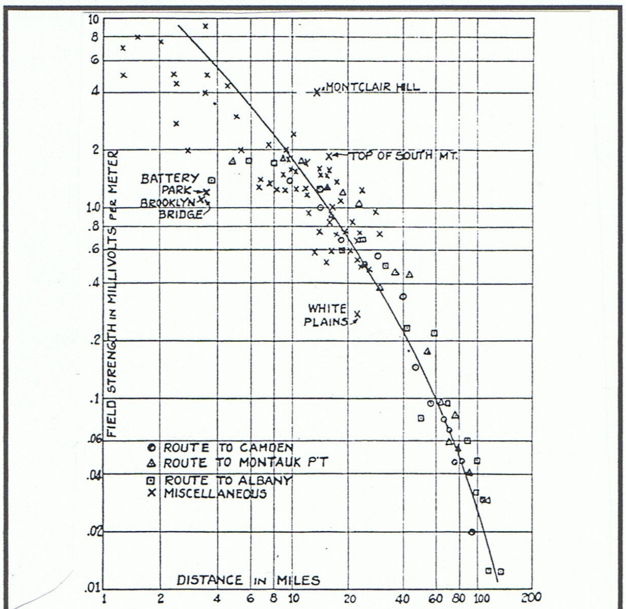

Fig. 6—Attenuation of 44-megacycle signals from Empire State building.

built on an even older foundation dating from 1926. There are two aspects to this pre-1930 era history: first the hardware required to even conduct such testing appearing so soon after the very first serious discoveries were made in the 2-18 Mc/s region. Less than ten years prior to the above papers appearing,

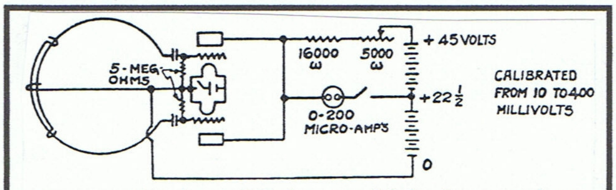

Fig. 5—Circuit used in low sensitivity loop receiver.

IRE published "**Some Measurements of Short Wave Transmission**" (R.A. Heising, J.C Schelleng, G.C. Southworth - all associated with AT&T or Bell Labs); June 1923. It was here the first detailed, solid evidence appeared connecting the effects of solar activity on propagation paths; the charts and tables are labeled with such phrases as "sun sets" and "sun rises" marking points where ionosphere pathways closed and opened to distant locales. And subsequent updates (as late as February 1926) refined the initial reports. There was a "glass ceiling" on these early studies created by the actual hardware limitations; a technology that struggled in 1921 to create the first 500-1500-kc radio equipment was finding 18 Mc/s a challenge even in 1925-26. Anything higher than 30 Mc/s was labeled "*The Ultra Highs*" and where essentially most equipment designs and hardware was pressed at 20 Mc/s, something as high as 40 or 80 was simply not doable.

Proceedings of the Institute of Radio Engineers
Volume 21, Number 3 *March, 1933*

ULTRA-SHORT-WAVE PROPAGATION*

BY

J. C. SCHELLENG, C. R. BURROWS, AND E. B. FERRELL

(Bell Telephone Laboratories, Inc., New York City)

Summary—*Part I of this paper first describes a method of measuring attenuation and field strength in the ultra-short-wave range. A résumé of some of the quantitative experiments carried out in the range between 17 megacycles (17 meters) and 80 megacycles (3.75 meters) and with distances up to 100 kilometers is then given. Two cases are included: (1) "Optical" paths over sea water and (2) "Nonoptical" paths over level and hilly country. An outstanding result is that the absolute values of the fields measured were always less than the inverse distance value. Over sea water, the fields decreased as the frequency increased from 34 megacycles (8.7 meters) to 80 megacycles (3.75 meters), while the opposite trend was found over land. As a rule, the signals received were very steady, but some evidence of slow fading was obtained for certain cases when the attenuation was much greater than that for free space.*

Part II gives a discussion of reflection, diffraction, and refraction as applied to ultra-short-wave transmission. It is shown, (1) that regular reflection is of importance even in the case of fairly rough terrain, (2) that diffraction considerations are of prime importance in the case of nonoptical paths, and (3) that refraction by the lower atmosphere can be taken into account by assuming a fictitious radius of the earth. This radius is ordinarily equal to about four thirds the actual radius.

The experiments over sea water are found to be consistent with the simple assumption of a direct and a reflected wave except for distances so great that the curvature of the earth requires a more fundamental solution. It is shown that the trend with frequency to be expected in the results for a nonoptical path over land is the same as that actually observed, and that in one specific case, which is particularly amenable to calculation, the absolute values also check reasonably well. It is found both from experiment and from theory that nonoptical paths do not suffer from so great a disadvantage as has usually been supposed.

Several trends with respect to frequency are pointed out, two of which, the "conductivity" and the "diffraction" trends, give decreased efficiency with increased frequency, and another of which, the "negative reflection" trend, gives increased efficiency with increased frequency under the conditions usually encountered.

The existence of optimum frequencies is pointed out, and it is emphasized that they depend on the topography of the particular paths, and that different paths may therefore have widely different optimum frequencies. Thus, among the particular cases mentioned, the lowest optimum values vary from frequencies which are well below the ultra-high-frequency range up to 1200 megacycles (25 centimeters). For other paths the lowest optimum frequency may be still higher.

Or so most thought.But despite the total lack of prior technological pathways, zero initial appreciation how differently circuits behaved beyond 30 Mc/s, and using component parts including tubes that had major deficiencies even at 20 Mc/s, Bell and RCA (with a handful of others) managed to create transmitter power levels as great as 1,000 watts at frequencies as "short" as 100 Mc/s (3 meters). And, once the equipment functioned in a laboratory there followed a rush to determine where and how these brand new never previously traveled electronic pathways might lead. Which will lead us indirectly back to the March 1933 Proceedings of the IRE.

<u>But first ...</u>

The "Magnetron". Today there are an estimated 500 million magnetrons in use (think microwave oven). Most magnetron history recitations begin with 1940 and a British design (Randall and Boot) which many credit with reversing the tide of Germany's destruction of Europe. Think radar, or more specifically "3cm radar", which remained only one step "less secret" during the war than the development of the Atomic bomb.

Historians credit the "cavity magnetron" with "turning the tide of the war" (this included both Europe and the Pacific but emphasis is usually on radar's application against Germany); the key word here being "cavity". It is 1926 and a group called the "Third Pan-Pacific Science Congress" meets in Tokyo; Pearl Harbor is 15 years into the unforeseeable future. Eighteen months following the Tokyo conclave copies of various papers presented by Japanese engineers find their way, with English translations (January 1928), to the Institute of Radio Engineers (IRE).

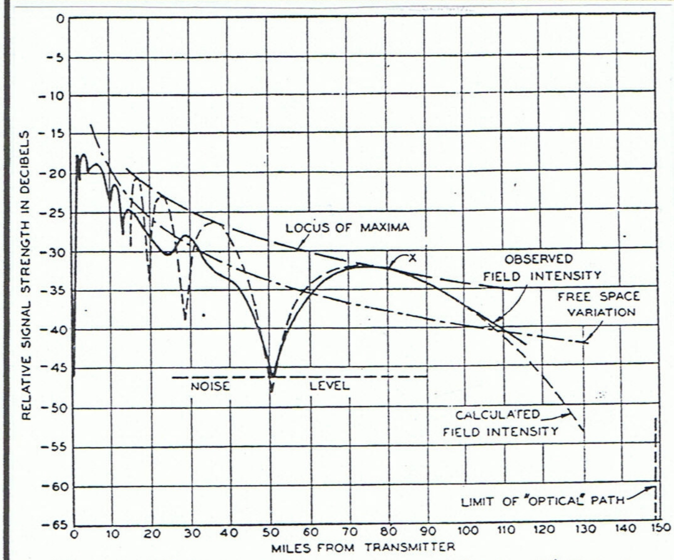

Fig. 16—Flight toward transmitter. Altitude—8000 feet; wavelength—4.3 meters, June 24, 1931.

One titled "**Beam Transmission of Ultra Short Waves**" is credited to Hidetsugu Yagi with support from assistant professors at Tohoku Imperial University; K. Okabe and S. Uda. A synopsis of the Yagi paper by J.H. Dellinger (Chief, Radio Division, Bureau of Standards, Washington) succinctly sets the stage for all to follow.

"Professor Yagi's remarkable work stimulates some thought of a radical order. Radio communication is to a large extent done the wrong way today. Ideally, radio transmissions should be broadcast in every direction only when intended for reception in every direction, and should be sent as nearly as possible in one line when intended for reception by one receiver. Now Professor Yagi has shown us that one of the ways to accomplish the directive function is to use a string of absolutely automatic relay stations, viz, the simple devices he calls directors. His work has included not only this development of wave projectors but also outstanding contributions to the technique of generating and using the shortest of radio waves (with) the development of the magnetron. I would like to say that I have never listened to a paper that I felt so sure was destined to be a classic."

Magnetron? In 1926? Wait; it gets better.

Radio, the technique and technology, began life at exceptionally low frequencies with wavelengths measured in miles or kilometers. Marconi's creation and those that followed were forced to construct multiple multi-hundred foot tall towers just to suspend "aerials" for transmission (and reception).

BEAM TRANSMISSION OF ULTRA SHORT WAVES

By

Hidetsugu Yagi

(College of Engineering, Tohoku Imperial University, Sendai, Japan)

Summary—Part I of this paper is devoted to a description of various experiments performed at wavelengths below 200 cm. Curves are given to show the effect of the earth and various types of inductively excited antennas called "wave directors." Part I is concluded with a discussion of beam and horizontally polarized radiation.

Part II is devoted chiefly to the magnetron tubes used for the production of very short wavelengths (as low as 12 cm.) and the circuit arrangements employed. It is shown that the geometry of the tube and its external connections are of great importance.

The effect of variation of plate voltage, magnetic field strength and other factors on the high-frequency output, is described.

And as Dellinger so correctly notes, "*Before 1920 radio was all wrong; the only use was for communication between two points and it was always done by broadcasting in every direction*". His point? Professor Yagi and his team had mastered very narrow transmission beams which with proper design could connect two points and only those two points.

This could only be practical at "ultra high frequencies" but until Yagi and Uda's creation of a functional magnetron and their marriage of this ultra short wave signal creation device to the invention we still honor in their name, "the directive array", it was simply not possible (the original HF adopters in the 30s correctly referred to multiple element in-line directive arrays as 'The Yagi-Uda' design. Over time Uda's name was forgotten.) (See "Figs. 6, 17-18/ pg. 6 and 25/pg. 7")

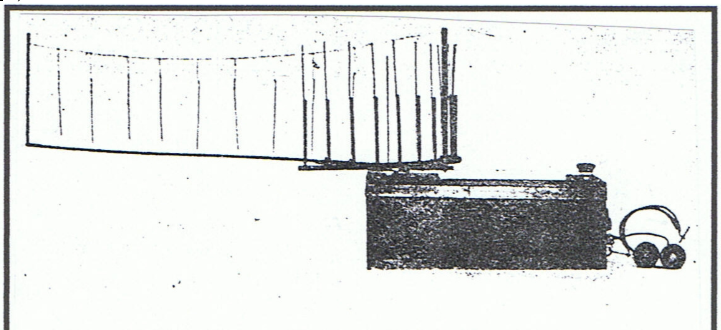

Fig. 6—Fifty-cm wave receiver with shielded box.

Magnetron? It was the predecessor to the later and far more useful "cavity magnetron" created in England and turned into a war tool by the Radiation Laboratory at MIT. Until the Yagi-Uda-Okaba version came along, generating any useful amount of transmission power even at 3 meters (100 Mc/s) was limited to amounts of ten watts or less and fraught with reliability challenges (an unstable transmitter that turned itself off or went into self-oscillation on an unknown and unplanned new frequency was hardly suitable for day-in, day-out propagation path testing). Uda in particular proved it possible to generate stable transmission sources on wavelengths as short as 2cm (18,000 Mc/s); June 1930 Proceedings of IRE (see "Fig. 29" and "Fig. 31/pg. 8"). Uda focused his attention on the 40-50cm region (600-700 Mc/s) creating reliable point-to-point pathways of 10km and more. His receivers were very elemental; a crystal diode followed by several stages of audio amplification (as RCA and the Germans would later also adopt, Uda modulated his carrier with an audio tone – typically-1 kc - and 'measured' the volume level at the receiver to quantify reception signal strength). But his association with Professor Yagi resulted in what we would today label as "very long Yagi antennas" - at both ends. His 1930 (IRE) paper described one of 40+ "directors" (he called this a "chain") along a 7 meter length boom (which at 600 Mc/s works out to a 14 'wavelength' antenna) (see "Figs. 34-35-37/pg. 9").

The Japanese magnetron was a glass envelope tube of unusual design and in fact had origins at Schenectady's GE Research Lab in 1920. Inventor Albert Hull, stymied by the original Lee De Forest patents on "electrostatic control" which his employer wished to circumvent, stumbled quite by accident on what might be called "a two-pole magnetron". At the time of invention it did nothing to assist GE in end-running De Forest so it was packed away in a technical paper few noticed or read. But Czech Physicist August Zacek and coincidentally German Erich Habann thought they saw something of value. Both, independently during 1924, created functional two-pole devices capable of generating sizable amounts of stable RF between 100 and 1,000 Mc/s. Zacek's work at the Technical Physical Institute in Jena was quickly picked up by Abraham Esau and Walter M. Hahnemann at the research laboratories of C. Lorens Aktiengesellschaft (Berlin) under the oversight of the Bavarian Post Authority. A 100 watt output (dual anode) magnetron transmitter operating at 3.2 meters/100 Mc/s was positioned on top of Brocken (an elevated site at 1142 meters); it was 1925 and therefore ahead of the later Japanese work (1926-8). What the German-Czech pioneering lacked was Professor Yagi's contribution; directional, high gain, antennas for reception (or transmission). Still, with nothing more than a tuned vertical dipole at the transmitter and a receiver consisting of a "sensitive detector with silicon and metal whisker", distances greater than 80km were carefully recorded under varying weather conditions (including having lightning strike within meters of the reception antenna!). The Germans apparently recognized the value in this new technology building numerous transmitters (including one of 1.2 kw), equipping several airplanes with receivers and methodically plotting coverage paths in a carefully selected variety of terrain (flat, hilly, mountainous). One Juken F13 plane, equipped with a 2 watt transmitter in the 100 Mc/s region(see German "Fig. 6"/pg. 11), transmitted voice, telegraphy and even television images to ground receivers. Scientists Esau and Hahnemann, detailing their work as (later) published in the IRE

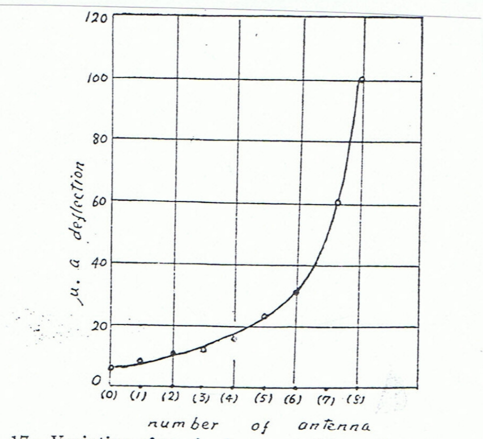

Fig. 17—Variation of received energy with number of antenna.

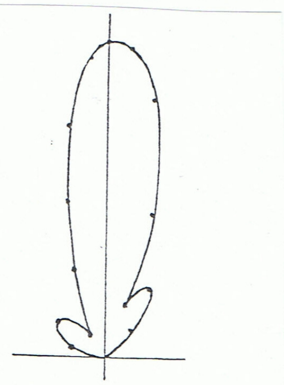
Fig. 18—Polar curve in horizontal plane.

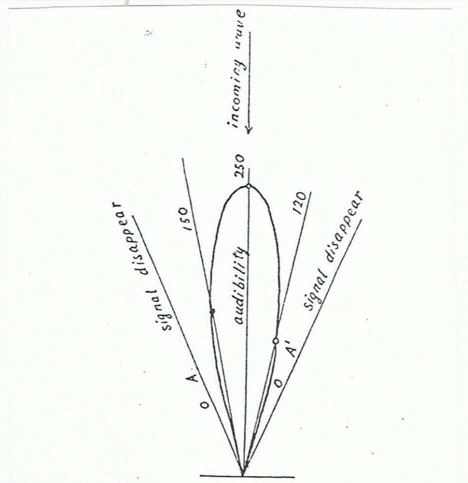

Fig. 25—Audibility curve of detected signals at 10 km.

(March 1930) spoke volumes with a near-closing paragraph:
"*As the ultra-short waves may readily be modulated with a very large width of television transmission, they may perhaps some day lead to the practical solution of television transmission.*"

Proceedings of the Institute of Radio Engineers
Volume 18, Number 6 *June, 1930*

RADIOTELEGRAPHY AND RADIOTELEPHONY ON HALF-METER WAVES*

BY

SHINTARO UDA

(College of Engineering, Tohoku Imperial University, Sendai, Japan)

Summary —Communication tests in radiotelegraphy and radiotelephony on half-meter waves are described. The first section of the paper is devoted to the description of a new type of receiver for 40–80-cm waves. Experimental results are given to show the action of this receiver. It is pointed out that a sort of regenerative amplifying accompanies the detection of such extremely short waves, and a brief explanation of this action is given.

The next section of the paper contains the results of experiments on a half-meter transmitter, with special regard to the modulation system.

In the latter portion of the paper, actual tests of communication to the distance from 10 to 30 km are described. The possible application of our wave collecting system to direction finding with such extremely short waves is pointed out.

Their prophecy did not end there for they also foretold:

"*If it becomes possible to reduce the wavelength somewhat more (down to 0.5 m) while maintaining as much as possible the transmission energy, and the sensitivity of reception obtained for the 3-m wavelength, then still more applications of the ultra-short waves will become possible by the fact that for these shorter wavelengths, reflectors may be used whose dimensions are large as compared with the wavelength. In such cases, however, it will be possible to obtain beams of waves with a directive sharpness similar to that of a beam of rays emitted by a searchlight. The consequences of a development of this kind cannot be foreseen at present.*" "(a)t present" was in fact late in 1926 although the IRE publication did not occur for more than 3 additional years. As for, "*...possible to reduce the wavelength somewhat more (down to 0.5 m)*", well, Uda was already doing that and much more. The Yagi and Uda IRE papers were published in 1930 as well virtually eliminating the likelihood the German and Japanese work "cross pollinated" as of the time when the respective papers were created. One final note on this subset: the Esau and Hahnemann text included numerous photographs of their equipment for both receiving and transmitting with one especially powerful photo. It appears on page 481 with this caption: "Fig. 8 - Picture transmitted from airplane with wavelength of 3 m." Yes, television from air to ground in 1926. Oh yes - the photograph, while an office machine copy from an IRE issue now 81 years

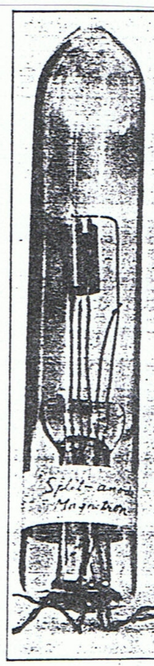

Fig. 29—Split-Anode Magnetron; 2-segment type.

mature and yellowing, looks suspiciously like an image from a CRT (cathode ray tube). The image itself (approximating 120 line definition) consists of what appears to be a sheet of paper with various numbers and diagrams (see German“Fig 8”/pg. 10) or - perhaps - the airplane was equipped with a "monoscope" imaging device and the image formed was actually drawn with the 1926 equivalent of a "marking pen" on the CRT phosphor; we will perhaps never know. Functional monoscopes in 1926?

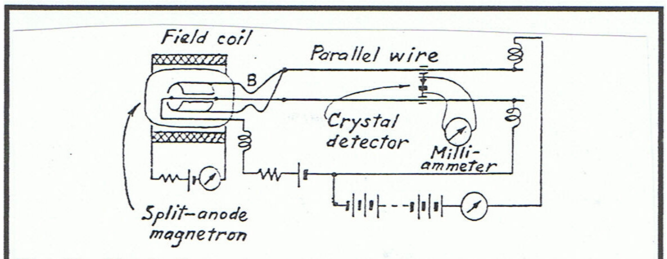

Fig. 31—Circuit Connection for Short Wave Oscillating Magnetron.

RCA 'invented' television

Everyone has been told this and if you stop after the first paragraph of any technology 'history treatise' that statement is probably good enough. But it is very far from accurate and any serious investigation of the period 1925-1941 must arrive at a different 'summation'. Let us be more precise and then investigate the facts.

"*RCA did more to develop and create commercial television broadcasting than any other single firm.*" There; that is it. And it is a bit generous erring towards RCA.

There allegedly was television being broadcast (well, images connected to a transmission device and thence into the ether) as early as 1923. There were two major and countless almost-major unresolved technical challenges, however; - lead by the pictures were (by even 1950 standards) terrible! First and foremost was "bandwidth" - or enough spectrum space to allow a modulated waveform to contain enough data bits to form an acceptable image on a display system. In 1928 television had been allocated (by the FRC or Federal Radio Commission) a 950 kilocycle slice around 2.5 megacycles (with individual 'channels' 100 kilocycles wide). We'll return to this shortly.Secondly, the bandwidth - wherever it might end up being - had to provide suitable 'coverage' - as Dellinger (Chief of Bureau of Standards) wrote (in 1928),

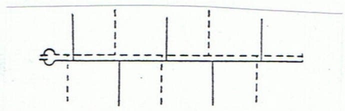
Fig. 34—Directive Antenna, 40 cm.

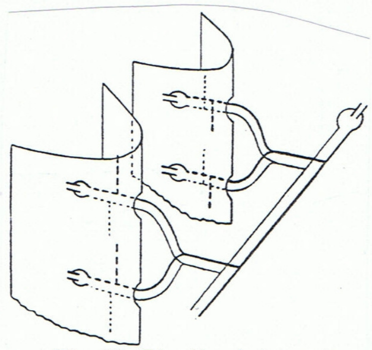
Fig. 35—Directive Antennas.

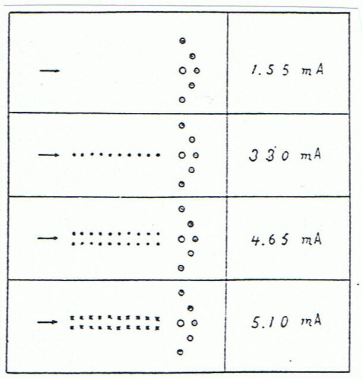

Fig. 37—Reception with a Collector and Wave Canals.

"*It was not until 1920 that we had the advent of broadcasting as such, transmission intended for reception by a large number of receivers*". These were the two major challenges.

Heading the "almost-major" was some device which would produce imagery which as a design goal approximated the movie theater experience. Creating an image capable of transmission to a distant point (even if the distance was very short), without a direct 'wire' connection between the source and the display, was first proposed in 1884 by another German chap; last name Nipkow. However Paul Gottlieb Nipkow was unable to actually demonstrate his theoretical 'spinning disc' technique (lacking electricity and rudimentary motors would have been a first level hurdle) and popular lore has him witnessing his invention (patented for the period 1884-1899) for the very first time at a German science exhibit in 1928. Baird (UK), Jenkins (US) and others (including GE) toyed with the use of a mechanical scanner through the mid-20s and well into the 30s. Baird actually managed to transmit across the Atlantic via 2 Mc/s short-wave the image of a human head in February, 1928 to an American (ham or amateur) receiving station while Jenkins created and sold hundreds of his 'Radiovision' receiver kits to a technology craving American consumer base. Where all of this led was ultimately 'nowhere' although in fact 'television stations' (starting with Jenkins' original FCC licensed W3XK which was superseded in April, 1931 by more elaborate - read expensive - New York 5th Avenue studios for his W2XCR) by 1931 were actually operating to preplanned schedules.. The images transmitted were deficient for several reasons: (1) the resolution was seldom greater than 60 lines per image, (2) the accompanying audio/sound (if in fact there was any - usually it was image only) was transmitted separately by an affiliated (AM) radio station, (3) The transmission frequency (in the 2 Mc/s region) was subject to significant interference, rapid variation in received signal level as the ionosphere changed status, and, (4) on a 1930 scale with a depression running rampant, investing money in 'radiovision' seemed like very foolish use of one's funds (Jenkins is an interesting sub-study as he held a patent on a technique (Phantoscope) to create color motion pictures in 1895 and through fascinating circumstances this patent ended up in the hands of Thomas Edison who renamed the technique 'Vitascope' and launched the earliest motion picture industry).

It was against this background that one of the most unexpected papers ever to appear in The Proceedings of the IRE was published (September 1929); **"The Selection of Standards for Commercial Radio Television"** (Julius Weinberger,

Proceedings of the Institute of Radio Engineers
Volume 18, Number 3 *March, 1930*

REPORT ON EXPERIMENTS WITH ELECTRIC WAVES OF ABOUT 3 METERS: THEIR PROPAGATION AND USE*

BY

ABRAHAM ESAU AND WALTER M. HAHNEMANN
(C. Lorenz-Aktiengesellschaft, Berlin-Tempelhof, Germany)

Summary—After means became available for generating sufficient power at wavelengths of about 3 meters, and with the development of suitable methods of reception, experiments were carried out with regard to the character of propagation of these waves. Directive devices, in the form of parabolic reflectors, were also used successfully.

Some preliminary experiments upon the maximum range were first made by the Technical-Physical Institute at Jena, and following these, similar experiments were made from Herzogstand jointly by the Institute and the Bavarian Postal authorities. Later more thorough experiments were conducted by the laboratories of the C. Lorenz Aktiengesellschaft, Berlin, in co-operation with the Jena Institute, from airplanes and from the top of the Brocken (1142 meters above sea-level).

These experiments are described and brief explanations are given concerning the apparatus and methods used in each case. The results have clarified the phenomena of propagation of these wavelengths and indicate the possibility of their practical application as a means of signaling over short ranges, and, particularly as a means for transmitting signals in a fog for marine and aerial navigation, and as a possible means for transmission of television in the future.

Theodore A. Smith and George Rowdin; Research Department, Radio Corporation of America, New York). It read as though RCA either ignored the years-earlier work of the Japanese and Germans, or nobody on staff read any language but English. "*The basis of a system of television standards suitable for commercial television...*" is how the summary begins.

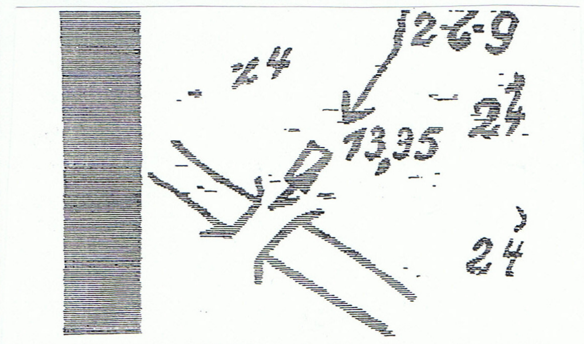

Fig. 8—Picture transmitted from airplane with wavelength of 3 m.

Its foreword: "*It is now generally recognized that radio television and audible broadcasting differ in one extremely important respect, in that there are certain fixed elements in a television receiver which must possess constants identical with those of similar elements at the transmitting station, while in audible broadcasting receivers such a requirement does not exist.*"

The original paper was presented to IRE's Fourth Annual Convention (May 14, 1929) and focused on a newly recognized need that television, unlike radio, could only be displayed/received and used if the transmitted waveform and the receiver were 'in lock'; synchronized. Which got readers to RCA's plan for establishing standards.

It is the detail of the mid-1929 'standards' proposal that attracts our interest.

"1. In the image to be reproduced, the total number of picture elements and their distribution (vertically and horizontally), together with the method of scanning.

"2. The number of picture repetitions per second.

"3. Phase of the transmitter modulation with respect to the original object.

"4. The synchronizing frequency or method to be employed for maintaining the transmitting and receiving scanner devices in synchronism." All very sensible and the authors noted "*...before television can become a national service, there must be some degree of standardization of these elements among those who desire to operate television transmitting stations and those who propose to manufacture television receiving equipment.*" The paper proposed a number of technical 'standards'

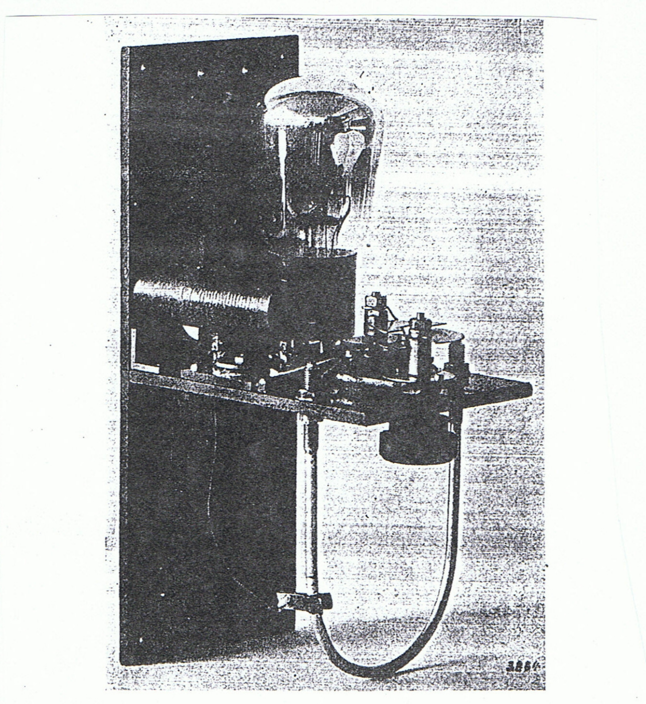

Fig. 6—High-frequency part of transmitter by C. Lorenz, 3 m, 1 to 2 watts.

Proceedings of the Institute of Radio Engineers
Volume 17, Number 9 September, 1929

THE SELECTION OF STANDARDS FOR COMMERCIAL RADIO TELEVISION*

By

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Summary—*The basis of a system of television standards suitable for commercial television service, with specific standards, is discussed. The elements considered in this paper are the following: picture proportions, number of scanning elements, number of picture repetitions per second, scanning method and direction, phase of transmitted current.*

Synchronizing is considered, with possible methods, and also various arrangements for utilizing the television channel.

for use in the (then) existing 2 Mc/s developmental television 'channels' (each 100-kc in width). In fairness, it also noted, "T*he authors wish to make it clear that the specific standards which are discussed in the following do not in any way involve the present practice or possible future procedure of the Radio Corporation of America.*" Well, that slid RCA off the hook if not the three employees.

Television in 1929 was experimental, using Nipkow mechanical scanning discs for image generation imposed onto silicon cells, to which the paper refers. The 'debate' then underway revolved around one question: what *quality* of image would be required for the launch of "*commercial* television". The National Electrical Manufacturers' Association had drawn a line in the sand and their official position was this:

"*Commercial television is the radio transmission and reception of visual images of moving subjects comprising a sufficient proportion of the field of view of the human eye to include large and small objects, persons and groups of persons, the reproduction of which at the receiving point is of such size and fidelity as to possess genuine educational and entertainment value and accomplished so as to give the impression of smooth motion, by an instrument requiring no special skill in operation, having simple means of locating the received image and automatic means of maintaining its framing.*"

Ninety-five words; perhaps the first attempt at defining what television would be, must-be, before "*commercial* status" could begin. Looking into the crystal ball, it would be May, 1941 before FCC mandated 'standards' would actually become regulatory 'law'. And it would not involve 2 Mc/s channels of 100-kc width (experimental television was assigned specific spectrum between 2.0 and 2.950 Mc/s).

There is the possibility that RCA management authorized this paper with the intent publication would drive a nail through the then pervasive optimism many held for 2 Mc/s "commercial" operation. It is difficult, as we shall perhaps see, to digest the paper without coming to the conclusion "this will *never* be a commercial technology". The paper closed with a different suggestion, however:

"*It will be gathered from the discussion contained in the paper that a close study of all of the problems of television is essential before definite working standards can be proposed or adopted.*"

In the paper's research the author's relied upon then-existing motion picture creation technology for 'minimum acceptable' techniques. It was the 'downsizing' assumptions which doomed the exercise from the beginning; the unproven optimism "educational and entertainment value" could be commercial with images as small as 2" in diameter with as few as 60 scanning lines and a total number of picture elements ('pixels' in today's parlance) of around 4,000. Any 'standard' had to be defined so as to 'fit' within the FRC's 100-kc established 'channels' and based upon laws of physics then (and now - or at least until digital compression) imposed, that bandwidth was simply not enough to do much more than create a postage-stamp image of limited resolution. But such was the optimism and energy behind "television NOW!" that mere laws of physics were seldom a throttle to publicity which created intense interest for the common man.

There was some cause for public optimism; magazines published puff stories which were seldom restrained by fact, publications renamed themselves ("Short-wave and Television" for example), a half-dozen radio stations (WGBS was the 'audio' portion of Jenkins' experimental W2XCR) actually created television studios and daily 'TV Schedules' appeared in prominent newspapers ("Chicago Daily News" for example). And for millions of American homes, they had 'proof' in the parlor; a magnificent wooden piece of sculptured furniture from which the voices of 'Amos and Andy' and President Hoover, Kate Smith and Rudy Vallee (joined by hundreds more) literally compressed the world into their lives. By 1930 innovative radio set manufacturers were feeding this frenzy by placing (on the set's rear apron) 2 or 3 or 4 hole 'sockets' mysteriously labeled 'Television' which of course allowed sales messages akin to "This set ready for television!". President Herbert Clark Hoover had promised (1928 election campaign) "a chicken in every pot" while RCA and others were hinting at "a television set in every parlor".

Perhaps the one event that saved America from a very premature headlong stampede into postage stamp television was the stock market crash (Black Friday: October 29, 1929) and the rapid spiral into depression that followed. With 1 worker in 4 jobless (a national average which rose to 1 in 3 in many areas), the hype took a deep breath and in the intervening years through 1935 technology finally caught up with promise.

Fig. 1—Equivalent detail of 60×72 picture; semi close-up. Fig. 2—Equivalent detail of 60×72 picture; view of single person. Fig. 3—Equivalent detail of 48×48 picture.

The RCA trio reached 1929 conclusions (coincidentally, IRE publication was less than two months prior to Black Friday): "1. In the image to be reproduced, the total number of picture elements and their distribution (vertically and horizontally), together with the method of scanning.

"2. The number of picture repetitions per second."

Their conclusions:

a/ "*We have found that the improvement in detail gained by increasing the number of scanning elements over approximately 4,000 is not of material advantage...*" (see "Figs 1, 2 and 3").

b/ "*...acceptable detail would just be obtained with an approximately 60-line scanning system...*"

c/ "*Although* (image) *flicker will be apparent on bright television images up to 24 pictures per second, it appears more practical to use a rate not greater than 20 pictures per second (higher rates of scanning result in what are in our opinion unduly wide radio sidebands; if substantially less than 20 pictures per second are scanned the flicker becomes excessively annoying...)*"

d/ "*The frequency band required for transmission with the values now determined will be about 90-kc if both sidebands are transmitted...*".

e/ "*It will be taken for granted that for any unit square area of the picture, the horizontal and vertical detail should be equal; in determining the proportions of the picture, it seems logical to consider the standards of sound motion picture film since it is believed that transmission of sound motion pictures may form a considerable part of television programs. These proportions are in the ratio of 5 to 6 (height to width).*"

"3. Phase of the transmitter modulation with respect to the original object."

a/ "*...the standard method of transmission should be for a television station to transmit a positive picture; that is, maximum amplitude of radio-frequency currents should correspond to light places on the object being transmitted and minimum amplitude to dark places.*"

"4. The synchronizing frequency or method to be employed for maintaining the transmitting and receiving scanner devices in synchronism."

And here is where nobody (at the time) had an answer although without a solution and agreement for a 'standard' there could not be 'commercial television'. The challenge for synchronization (automatic picture locking at the receiver to the image received from the transmitter) was complex.

a/ Problem one: "*If 20 pictures are to be transmitted per second and about 4,000 elements per picture, then about five million impulses will be transmitted each minute. In one hour about three hundred million impulses will be sent. Any slight change in frequency will be seen as a drifting of the picture sideways and if the picture continues to drift it will become 'out of frame' vertically. It may be safely assumed that a drift of one-tenth of the picture width will not be troublesome, but beyond this, details of the picture will be lost. It is assumed that no one would wish to adjust a receiver for framing oftener than once every few minutes.*" (see "Fig. 6")

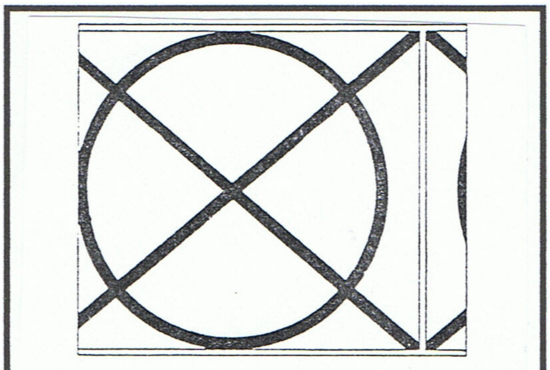


Fig. 6—Image 1/10 out of frame horizontally.

OKay, take a deep breath and ponder what these guys were smoking. Their IRE paper contains three high quality drawings displaying 'drifting images' and even if we consider the very primitive state of broadcasting technology in 1929 (it had been only 9 years from the first broadcast of the 1920 election results that launched the rush-to-radio), well, "*...no one would wish to adjust a receiver...oftener than once every few minutes*"???

b/ Problem two: (to reduce or eliminate adjusting a receiver every few minutes) "*an accuracy in (transmission) frequency greater than one part in seven million is required.*" They give an example: "*a clock which in three months would gain or lose no more than one second*". And, "*The greatest accuracy of a crystal oscillator so far attained is about one part in five million*"; about one part in two million short of what it would take to keep viewers from reaching for the "frame adjust" knob "every few minutes".

c/ Solution one: If the transmission frequency cannot be maintained "within one part in seven million" (it could not in 1929 although today that is hardly a challenge), then perhaps some other "reference frequency" could be used to keep viewers from chasing the picture all over their 2 and 3" display screens?

"*The standard frequency which comes to mind at once is of the electrical power supply, usually 60 cycles per second. This is undoubtedly the simplest and most widely available frequency. However, in order that the frequency at the receiver be identical with that at the transmitter, it is necessary that the power systems supplying the two be interconnected.*"

In other words, 60 cycles in say Hoboken might not be the same as 60 cycles in Bronx if different power sources are in each community. In fact, that was the case; "*Baltimore, Denver, Duluth, Kansas City, Minneapolis-St. Paul, New Orleans, Portland (Maine) and New York have no (external connections) with other power systems at present*" (that would be 1929). So a television station operating from say Manhattan and receivers operating in New Jersey or Long Island would be "out of sync" taking us back to "*no one would wish to adjust a receiver for framing oftener than once every few minutes*".

So even postage-stamp television was in trouble unless viewers became an army of knob turners ("*Honey - last night I had to sit with my hand on that damned knob; tonight it is your turn to turn!*"). There was one more apparent option.

a/ "After the frequency and channel width shall have been decided upon for a commercial television station, the proper sub-division of the available band must be made to allow for the best economic use of the frequencies in the band.

"*The simplest system would provide a single carrier located centrally with respect to the band. All three signals, television, speech and synchronizing, modulate the carrier. Numerous difficulties immediately present themselves with such an arrangement. If the synchronization signal is within the audible range, the speech would be interfered with. In addition, television frequencies would be heard and speech frequencies would produce interfering spots and lines in the reproduced picture. To eliminate this cross-interference, three separate carriers may be considered, one of each of the transmitted signals.* (One more) *possible solution is to attempt to make one of the carriers serve for two signals; one system that has been proposed employs two carriers, the first for the speech and the second for both television and synchronizing*." (see "Fig. 8")

At the time of the paper (submitted to IRE on April 13, 1929), no working solution to marrying speech and/or synchronization to the 4,000 pixel/60 line/20 frames per second postage-stamp size video existed. Black Friday contributed to this problem never being solved and saving thousands, perhaps millions, of households from a nightly 'assignment' to be the 'frame adjuster' individual.

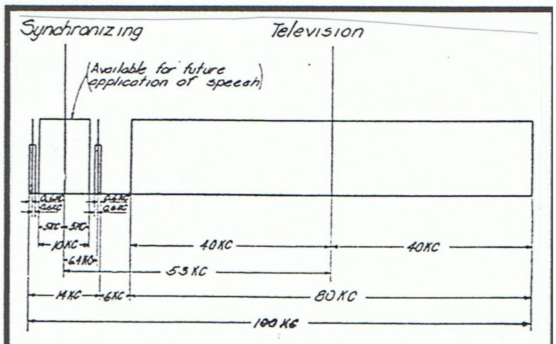


Fig. 8—Spectrum of 100-kc television band.

It would be incomplete to leave this aspect of early television without noting that the FRC's creation of (experimental) television 'channels' in the 2 megacycle spectrum was a non-starter even without the technical problems the RCA trio has highlighted. The missing ingredient? Two megacycles is in the lower 'short wave' spectrum region which simply means there is a huge difference between how far and where transmissions travel during daylight and nighttime hours. From local sun-up to local sun-down a transmitter in this frequency range would have 'coverage' approximating radio stations in the 550-1500 kilocycle region; totally power dependent and distances under 50 miles would be considered normal. But, as the sun begins to disappear (something that varies with location and time of year) those limited-range transmissions suddenly bounce (hop, skip and jump) off-of layers in the ionosphere - the same ionosphere so carefully documented in **"Some Measurements of Short Wave Transmission**" (R.A. Heising, J.C Schelleng, G.C. Southworth - all associated with AT&T or Bell Labs); June 1923. In other words, a TV station in Manhattan would after dark be as strong or stronger in Manhattan, Kansas as a nearby TV station in Kansas City. Unfortunately, this is not only a significant source of interference to distant locales, it is also a nuisance for anyone attempting to 'watch after dark' a distant transmitter. The ionosphere, providing the reflection to distant points, is an unstable and highly unpredictable naturally occurring phenomenon. So even if some bright person did solve all of the problems presented in "**The Selection of Standards for**

Commercial Radio Television" the unruly ionosphere would make all of the efforts a 'commercial shamble'; two megacycles was the wrong place to be for 'commercial' television (and a not very healthy environment for experimental television either).

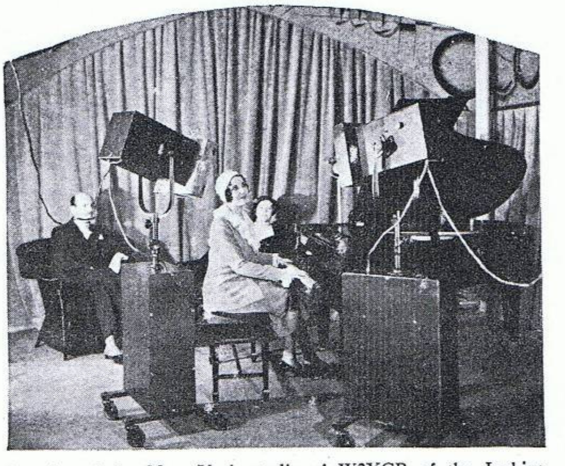
All of this combines to cause you to ponder whether the RCA trio was put up to 'this mischief' in an attempt to bury for all time the entire concept of 'postage-stamp-sized' limited resolution TV service. By engaging in this covert activity, RCA would gain the time - years - required to put their own brand on the TV animal (virtually none of the 1929-1931 'technology' involved RCA or their patents). Whether this surmise is accurate or not is unimportant more than 80 years later because in fact whether by plan or dumb luck this is exactly how the 'TV ranch' turned into (the RCA) NBC's 'Bonanza'.

Errata:

Although postage stamp sized television did not endure, it would be a mistake to ignore the very real efforts and investments which fueled the unfettered interest and optimism between roughly 1926 and 1935. Charles Francis Jenkins (1867-1934) stood out in a small field of wanna-be's, his technology skills equal to Edison, Zworykin and a legion of others. His patents in the then-infant motion picture world are legendary (first film projection system, first color in a projected film, first motion picture sound synchronized with pictures); his legacy includes founding the SMPE (Society of Motion Picture Engineers; now SMPTE where the "T" is for television). On June 30, 1925 Jenkins was granted a patent which all who followed would have to stumble over or run around; "Transmitting Pictures over Wireless"; No. 1,544,156.

What follows appeared in Radio News (July 1931) under the title "**New York Looks-In**"; an overview of Jenkins' final gasp in the 20 frame/ 60 line postage stamp television world (at 2.050 Mc/s). There are two black moments following this "hype piece"; in March 1932 Jenkins Television Corporation liquidated and the assets assumed (for debt owed) by (the) De Forest Radio Corporation. A victim of the depression era itself, by mid-1932 De Forest's firm also filed for bankruptcy. It did not quite end there; the assets of De Forest (and the full studio facility you will read about from Radio News) was then acquired by (why is there no surprise and shock here?) – RCA. The last nail in the coffin department: Jenkins died June 6, 1934, within months of RCA demonstrating the first all-electronic television (as developed by Zworykin)

Pass the baton to RCA ...



Interior of the New York studio of W2XCR of the Jenkins Television Corporation, with sound channel over the General Broadcasting Company's station WGBS, showing method of "picking up" pianist by means of photo cell banks and "flying spot" scanner

New York

Television stepped out of the purely when television station W2XCR New York City for the synchronized on a regular daily

By D. E.

THE question has been asked of me, "How long will it be before we are able to receive television pictures in the home?" That question does not require considerable thought for answering, as a matter of fact it is today possible with apparatus available for the average layman to actually receive sight and sound programs within the confines of his home.

Those of us who have devoted ourselves to television for the past several years have seen the day-by-day progress of the science. So, although the novice may consider the present status but the beginning, I can assure them that present reality was a mere dream not so long ago. Last April we considered television sufficiently advanced to open the first television station ever operated on a regular schedule in New York City, transmitting sight simultaneously with sound signals, the visual transmission being done on television channels and the aural accompaniment on regular broadcasting frequencies.

The Federal Radio Commission has set aside a channel for television broadcasting, the 100-150 meter band. This permits both the experimentation which will lead to perfection and also, through the efforts of such stations as W2XCR in broadcasting programs of real entertainment value, will lead to the popularization of television, the acquisition of an audience, which will in time make television commercially extremely valuable. When that time comes I think we can count on the Federal Radio Commission granting commercial licenses to television broadcasters.

While the Federal Radio Commission has not yet granted authority to operate television stations on a commercial basis, at present we operate on experimental licenses.

Under this arrangement the cost of television broadcasting is defrayed by the experimenters themselves, and consequently, inasmuch as considerable funds are necessary to carry on the development work, the amounts available for programs are somewhat limited. When television stations are established commercially, it will be possible for them to sell time on the air, just as sound broadcasting stations do today. They will have sufficient funds available not only to spend considerably more on the presentation of programs, but have an added source of income to devote to the refinement of technical television.

Television might be said definitely to have been offered for public acceptance last April, when the first radio talking picture studios were inaugurated in New York City. These studios virtually represent my original conception of television when I first began experimentation a number of years ago.

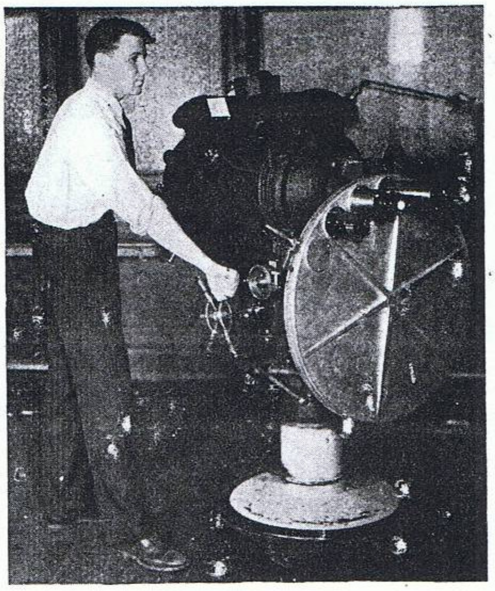
The studios of which I speak are located at 655 Fifth Avenue. Studios, control room, transmitter and reception room, comprising the New York radiovision headquarters of the Jenkins Television Corporation, are housed in several rooms on the sixth and fourth floors of the building, while station WGBS of the General Broadcasting System, located at Astoria, L. I., provides the very essential synchronized sound channel.

The radiovision studios on the sixth floor are a peculiar cross between a broadcasting studio and a motion-picture projection booth, for the reason that both direct pick-up of living subjects and pick-up of film subjects are employed in providing an entertaining program.

The direct pick-up is in the form of the well-known "flying spot." The subject poses before the projector that illuminates it with a sweeping beam of light, for the process known as scanning. The varying reflection of that beam of light by the subject on which it falls serves to actuate a battery of photo-electric cells, which in turn translate the varying light intensities into electrical impulses. By means of several stages of distortionless amplification, the electrical variations are impressed on the powerful radio waves propagated by the television transmitter in the same building. Meanwhile, a microphone placed near the subject picks up the voice or other sound for transmission over the WGBS transmitter. The flying spot apparatus employed in these studios is of the latest type, with a choice of several lenses, permitting close-ups and long shots of the performer without changing the relative positions of the projector on the subject.

The film pick-up apparatus is not unlike the usual motion-picture projector, except that the continuously moving film is projected onto a scanning disc behind which is placed a photo-electric cell. The film may be accompanied by synchronized sound records if desired or by unsynchronized records for incidental music, the sound being transmitted via the sound channel.

The control room adjoining



Direct pick-up television camera of the Jenkins station. Three of the possible five lenses are mounted on the scanning disc housing, the desired lens being moved into position by the handle on the outer rim of the housing. The entire camera may be moved vertically by means of the foot pedal on the base. The operator is holding the wheel which tilts the camera vertically

*Vice President, Jenkins Television Corp.

Looks-In

experimental stage early in April opened its special television studios in broadcasting of radio talking movies program basis

Replogle*

the studios contains a large switchboard with a variety of switches, lights, meters and monitors for the complete control of the sight and the sound channels. The operators not only monitor the sound pick-up, maintaining the desired level, but also monitor the direct or film sight pick-up by following the pictures through the monitor televisor that forms part of the switchboard equipment. Through the glass windows of the control room the operators may observe the artists before the flying spot and microphone, signalling any necessary changes in placement.

The 5,000-watt Jenkins television transmitter is located two floors below the studios, yet sufficiently near to minimize the length of conductors between pick-up and transmitting equipment. The transmitter is licensed for operation on 2050 kilocycles, or approximately 147.5 meters. The television transmitter is connected with its antenna on the roof by means of a radio-frequency transmission line. The transmitter, provided with a five-kilowatt water-cooled DeForest tube for the final or output stage, is of special design to handle the extraordinarily wide range of frequencies required for satisfactory pictorial detail. Station WGBS, on the other hand, operates on 1180 kilocycles or 254 meters, so that signals may be tuned in by the usual broadcast receiver.

The new studios were opened with an inaugural program on April 26th. Every day thereafter, morning, afternoon and evening, television features have been on the air. Elaborate plans are being developed so that the growing audience of lookers and listeners-in may be provided with an endless flow of entertaining programs, through the television transmitter W2XCR and the regular broadcast transmitter WGBS, which will operate jointly during several hours each day in providing radio talkies.

This is another scene taken in the interior of the Jenkins studio in New York, showing the WGBS "mike" picking up the voice, and, at right and left, the banks of photo cells for image pick-up

In order to receive the sight and sound broadcasts it is necessary to have a receiving set for tuning in the television signals as well as the standard broadcast receiver for reproducing the sound accompaniment. Special receiving sets have been designed for this purpose and consist of a sensitive radio-frequency tuner which operates on the television wave-band, and an audio-amplifier designed especially to reproduce the wide band of frequencies necessary to obtain a clear image.

In addition to this receiving set, it is necessary to have a simple scanning disc and neon tube for reproducing the images in the receiving aperture. The neon tube is connected directly in the output of the short-wave receiving set. The scanning disc consists of a motor-driven disc containing holes drilled concentrically in a spiral about the outer edge. When this disc is rotated at the receiving set in synchronism with a similar disc at the transmitting station, it reconstructs the image being transmitted. A magnifying lens enlarges the image.

To understand the operation of the television receiver, it is necessary to know something of how images are prepared for transmission by television. As stated in a previous paragraph, the radio talkie studio is not unlike the usual broadcasting studio with draperies and other acoustic treatment. However, in addition to microphones, (*Cont'd on page 89*)

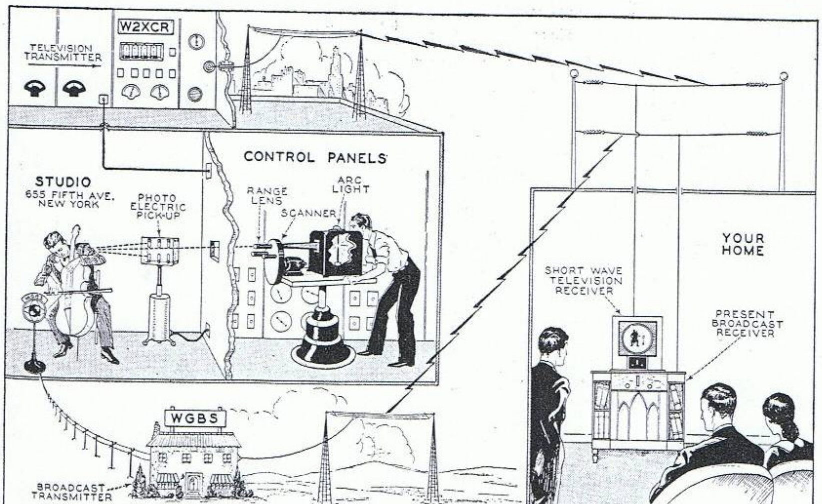


Diagram layout of W2XCR, showing how it is linked with the broadcast transmitter, WGBS

New York Looks-In

(*Continued from page* 31)

the performer faces a sweeping beam of light which scans or analyzes the image to be transmitted. The beam sweeps the subject in sixty parallel, horizontal lines, one following another from top to bottom, then starting at the top again at the rate of twenty complete pictures or frames per second. The reflected light from the image is picked up by a battery of photo-electric or light-sensitive cells, sometimes referred to as "electric eyes," which translate the varying amount of light into corresponding electric terms. Amplified millions of times, the electrical impulses are impressed on the television transmitter which propagates corresponding signals.

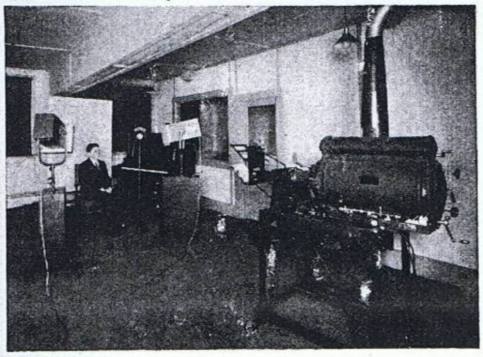
The scanning mechanism comprises a powerful arc light, a scanning disc, three lenses mounted on a turret for ready interchangeability, and a stand which may be moved vertically, horizontally or tilted to follow the performer. The operator can direct the scanning beam by means of lenses picking up a close-up, a half-length or full length of the performer or performers.

Translated into terms of receiving, since at any given instant the subject is illuminated by a single spot of light the reflection from which is picked up by means of the photo-electric cells and subsequently transmitted, while at the receiving end a single dot of corresponding light value appears before the looker-in, it is essential that both dots be exactly at the same point with respect to the entire image. This function is called synchronization, a term which requires more detailed explanation. Where a common alternating-current power station is available the receiving and transmitting scanners are kept in perfect step by means of synchronous motors electrically "geared" together. Where different alternating-current power systems are employed, there are other methods of maintaining the essential synchronism, including a synchronizing feature included in the television signal.

The change from the former forty-eight line, fifteen pictures per second scanning to the present sixty-line, twenty pictures per second scanning systems of W2XCR and other television stations, provides not only greater pictorial detail but also reduces "flicker" to a negligible minimum. The improvement approximates 40 per cent.

While this new station, in the heart of the greatest metropolitan center in the world, is an entirely new venture for television, it does not contain any new and startling development in the art of transmitting vision by radio. The major principles involved in the apparatus utilized are fundamentally those which have been used in other Jenkins stations throughout the country. However the new station does contain all of the latest available refinements of equipment.

While the DeForest station W2XCD in Passaic is experimenting with various technical devices and improving transmission, the Jenkins station W2XCR in New York will attack the problem more from the program end, developing a form of presentation best suited to the maximum entertainment value, using always the finest equipment. To put it differently, W2XCD will use *program material* as a means of testing equipment and results, while W2XCR will use the *equipment* to test program material and presentation technique.



Studio of television station W2XCD, Passaic, N. J. In foreground is the light source with lenses and scanning disc. Microphone and photo-electric cells are in background. Sound is broadcast on 1604 kc.; sight on 2050 kc.

Of course, in any finished whole, equipment and program must compliment each other to the full. And so they shall. But in these early stages of the art, experimentation is the golden rule. Fortunately the Passaic and New York stations see fit to cooperate, to their mutual benefit and that of television as a whole, by each experimenting in its own field. Since the engineering staff and facilities are located in Passaic, W2XCD is in the better position to devise and improve equipment, while the proximity of W2XCR to the entertainment center of the nation, Times Square, permits the testing, by that station, of all forms of talent and the formulation of the principles of television presentation that may well be followed in years to come.

When television broadcasts were first inaugurated from the Jenkins Station W3XK in Washington, D. C., I firmly believed that just as sound broadcasting developed first as an experiment in which radio amateurs took part, so would radio-vision develop best in the hands of amateurs rather than behind the closed doors of the research laboratory.

(*Continued on page* 90)

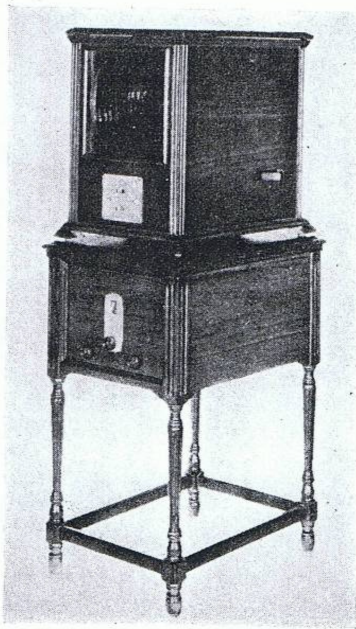
New York Looks-In

(*Continued from page* 89)

When the Washington station was opened radio amateurs all over the country were invited to build experimental radio-vision receivers and tune in the signals.

Since those pioneering days a tremendous transition has taken place. Today, television has reached the stage where it is possible for the layman to obtain apparatus and derive considerable enjoyment from television programs.

While television is still far from perfect, reception has been reduced to its simplest stages, considering our present knowledge of the science. While we eagerly look for new developments and inventions in the not too distant future, changes will probably take the form of continual improvements rather than radical novelties.



Close-up front view of Jenkins televisor

It is in the interest of accelerating the development of television and placing it on an entertainment basis that the Jenkins Television Corporation and the DeForest Radio Company have taken up the broadcasting of television. W3XK is continuing to serve a large portion of the country as the original station. The DeForest Company is continuing its transmissions from station W2XCD at Passaic. Station W2XCR, the new New York transmitter, will be developed along the lines of supplying visual entertainment in the metropolitan area. The best of talent is being secured.

The day has arrived, I believe, when television has passed beyond the laboratory stage and has reached the point of understandability and utility for the average radio listener. With television now being widely accepted throughout the eastern part of the country, perfect vision by radio is soon bound to be the outcome.