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Early Electronic TV

W6XAO - Los Angeles

One of the most interesting stories in the history of early television is that of Don Lee Broadcasting. Don Lee was a Cadillac dealer in Los Angeles who entered the broadcasting business in 1926 with the purchase of a radio station. In November, 1930, Don Lee engaged the services of 24-year-old [Harry R. Lubcke](#), B.S., University of California, an electrical engineer, and gave him the title of Director of Television of the Don Lee Broadcasting, and applied for a construction permit for the first television station on the west coast, W6XAO.

On December 23, 1931, W6XAO went on the air from the eighth-floor transmitter at Seventh and Bixel streets, Los Angeles, at 44 1/2 megacycles, to broadcast one hour daily except Sundays. This was one of the first VHF stations to go on the air in the United States.

Lee also had a license for W6XS, which broadcast on a frequency of 2100-2200 kHz, using a mechanical camera that worked only with film. The picture had 80 lines and 20 frames per second. Since there were few commercially available TV receivers at the time, Lubcke prepared and distributed [plans for construction of mechanical receiving sets](#) to many amateurs in the area of Los Angeles. The 80 line picture was transmitted on both W6XS and W6XAO.

In the early 30s Lubcke started experimenting with all electronic television. By 1932 Lubcke had developed a CRT receiver with self synchronization. He even demonstrated television reception in an airplane (see below). Because Los Angeles had both 50 and 60 Hz electric power, and to facilitate use of CRT receivers, synchronizing pulses were included in the video signal.

W2XS and W6AXO broadcast the same 80 line images until 1936, when W6XS went off the air. On June 4, 1936 W6XAO began a [month-long public demonstration](#) of its new system, using 300 lines and 24 frames per second. The camera was a mechanical flying spot scanner type. One source describes it having "some sort of sine wave vibrating mirror and a Nipkow disk", while the description from F. Alton Everest below describes a camera with a large disk. Only filmed material was telecast.

As early as 1931 Lubcke had been providing instructions to amateurs to [build their own electronic receivers](#), and kit sets were available from [Allied Radio](#). There were many articles in radio magazines about people [building their own sets](#).

DuMont Iconoscope cameras were obtained in late 1938 or early 1939, and the standard was changed to 441 lines and 30 frames per second, in line with the RCA system. Three [sets built by Lubcke](#) in the late 30s survive today. Radio News published an [article](#) about Don Lee in 1939.

In 1941 the station changed to 525 lines, and broadcast through World War Two with a limited schedule to the handful of sets in the area.

On May 6, 1948, the station was granted full commercial status. On becoming a full commercial operation the station adopted the call letters KTSL-TV. It was acquired by the Columbia Broadcasting System January 1, 1951, and ten months later, the call letters were changed to KNXT to coincide with CBS Radio Station KNX.

The pictures below and their captions were generously provided by Steve Dichter. More on Don Lee can be found in the Robert L. Pickerings article titled [Eight Years of Television in California](#).

Here is a description of the station from the book "The Great Television Race" by Joseph H. Udelson:

In the Los Angeles area, Don Lee, who owned several California radio outlets and headed a regional broadcast network, began operating W6XS near Gardena in 1931, on the 2100-2200-kHz. channel. In the

spring of 1932 the station was moved to the Don Lee Broadcasting System headquarters at 7th and Bixel, in Los Angeles, where in December this video facility, operating in synchronization with radio station KHJ, initiated a regular telecasting schedule from 6:00 to 7:00 p.m. Using a 1000 watt transmitter, an 80-line picture, 20 frames per second, was telecast. The programming consisted of filmed action and closups of motion picture stars.

After reading this account of the history of W6XAO, [Ed Reitan](#) provided the following information. If you have comments or corrections, please contact Ed.

Don Lee, a Cadillac dealer, and owner of KHJ, was always in competition with Earl C. Anthony, a Packard dealer, and owner of mighty KFI. Don Lee's KHJ became famous as the flag station of the West Coast Columbia and later Mutual "Don Lee Network".

Don Lee saw television as a way to excel over his competitor.

After the station's near-downtown 7th and Bixel location (on the eighth floor of the Cadillac agency) , it moved in 1939 to the top of "Mt. Lee" above Hollywood. An art moderne studio and transmitter building, complete with swimming pool and television tower, was constructed at the top of the mountain. The site is still used today as a Los Angeles emergency communications complex. Its many towers are visible in many picture-postcard views of the illuminated Hollywood Sign in the hills below it.

As Don Lee died (from choking in a restaurant) in 1934, the W6XAO effort continued to be supported through the 1930's and 1940's by his son, Thomas S. Lee.

Noted documenter and television author Donald Fink said W6XAO should be given credit as the one that started the first regular television program service in the United States (long before NBC in New York). [This is written in Chester Porterfield's book]

As I wrote in my IEEE paper, Don Lee initially used 300 line, 24 frames per seconds for its all-electronic telecasts because "half of Los Angeles was on 50 cycle power and the other half was on 60 cycle power". And we today think 720p (progressive) HDTV is so wonderful when W6XAO was using "300p" in 1936.

Harry Lubcke gave me the engineering notebook for his-built first iconoscope camera - I believe it was the first such built iconoscope camera OUTSIDE of RCA. How in the world he got that pickup tube from RCA is unknown. Sadly, upon his death his widow quickly threw out all his engineering notebooks (why is it that women hate our clutter and paper so much?).

There is a great technical paper in the SMPE (earlier name of SMPTE) Journal on Lubcke's telecast of the first Rose Parade on January 1, 1940. He used RCA supplied Iconoscope Field Cameras, mounted on the top balcony of the Elk's Club Building on Colorado Blvd. NBC originated its first color Rose Parade coverage (in 1954 and many years continuing) from the same location on Colorado Boulevard. The Telecast was on a rare rainy day, so the iconoscopes would have had sensitivity problems. The man who sold me my RCA RR-359B Mirror Lid set said that set was used to bring in his neighbors for viewing of that 1940 Rose Parade.

The SMPE technical paper describes the RCA pickup equipment used and the elaborate radio relay link that sent the imagery from Pasadena over the hills back to the station transmitter at 7th and Bixel.

Later W6XAO purchased a RCA ORTHICON camera. Harry once told me all the early equipment was sold and sent to an early station in Mexico.

Three Lubcke receivers survive, the blonde direct view and mahogany mirror lid - both at UCLA, and the set pictured in the "Los Angeles Flyover". I also have the engineering notebook for the blonde direct view receiver. I also never determined from Lubcke where the CRTs came from for the "Los Angeles Flyover" receiver - RCA did not supply its "Kinescopes" too readily to others. Lubcke had initially worked for Farnsworth, so a CRT may have come from there.

I know the cabinet for the "Los Angeles Flyover" receiver came from Gilfillan Brothers, as S.W. Gilfillan supported Lubcke's work with electronics parts and that cabinet. The later blonde direct view set used an electrostatic deflection CRT, so I assume it was English or DuMont in origin.

The following description of W6XAO as it was in 1942 is from Al Germond:

There's a fairly complete description of W6XAO in the 1942 "Radio Daily Annual" [pp 903-4] excerpted as follows:

"KTSL, established 1931, sight freq: 51,250 kc; sound: 55,750kc. Sight power 4000 watts; sound 2000 watts, effective signal radiated (ESR): 5600. Operated by Don Lee Broadcasting System, 3800 Mount Lee Drive, phone HOLLYWOOD 8255. Time on the air: 4-5 p.m., 8 to 11 p.m. Thomas S. Lee, president; Lewis Allen Weiss, v.p. and general manager; Harry R. Lubcke, director of television. Other listed personnel include an assistant television director, four engineers, two cameramen, a producer and a building superintendent.

System in Use: 525 line, 30/60 frame FCC standard, all-electronic cathode ray. Horizontal polarization. Studio cameras and film equipment. Complete 100 ft. square two story television building housing one 100 ft. x 60 ft. x 30 ft. television stage, one 46 ft. x 26 ft. x 16 ft stage, monitor, film, transmitter, makeup and lounge rooms, offices, shop, transformer vaults, etc. 300 ft. tower, antenna elevation 2000 ft. W6XDU (experimental television relay station operating with KTSL) operates on 324 megacycles and is a beam relay type television transmitter used for outside pickups.

Developments of 1941: W6XAO (experimental call letters of KTSL) operated 590 hours. Sixty seven remote programs scheduled and broadcast. Studio shows are mentioned along with various film presentations.

Remote television pickups included the professional boxing and wrestling matches from the Hollywood American Legion Stadium twice weekly until Nov. 1941; thereafter the same program from the Olympic Auditorium in downtown LA. The pickup of the Hollywood Stars Coast Baseball League twice weekly was also another remote of great interest to our television lookers. The Easter Sunrise service at the Hollywood Bowl, the Easter Promenade and auto races from Southern Ascot speedway were also telecast.

Receivers: There are between 400 and 500 television receivers in the service area of W6XAO, some as far as Pomona at 35 miles away, a number in Long Beach at 25 miles away and many in cities at lesser distances. The predominant commercially manufactured television receiver is the TRK12 or 120 of RCA. There are some RCA TRK9 and approximately 50 TT5 RCA television receivers. A number of the latter are operating satisfactorily in Long Beach at 25 miles from W6XAO. Other commercially manufactured television receivers are the local Gilfillan G12 which is an equivalent to the RCA TRK12 and utilizes a 12 inch cathode ray tube, some DuMont 12 and 20 inch tube television receivers, the General Electric 12's and 9-inch receivers and the Stromberg-Carlson and Stewart-Warner 12 and 9-inch receivers.

There are over 100 owner constructed television receivers fabricated from Meissner and other kits as well as completely according to the owner's design, A number of the latter give excellent operation, some utilizing 12 inch cathode ray tubes giving actually superior superior images at 15 and 20 miles from W6XAO than would be expected from commercially manufactured models.

Public Demonstrations: Television receivers have been maintained by the Don Lee Broadcasting System at the following public places: Wilshire Brown Derby, Kiefer's Pine Knot Drive-In, Vine St. Brown Derby, Griffith Planetarium, Miramar Hotel (Santa Monica), Hollywood Roosevelt Hotel and The Town House on Wilshire Blvd."

And also from Al Germond, this article (condensed) from the November 1993 "SCARS Bulletin". It describes a mechanical film camera with 300 scanning lines and 24 fps being used as late as 1936:

"W6XAO, A Pioneering Television Station by F. Alton Everest.

Several decades before commercial television 'rounded the corner', the Don Lee Broadcasting System was actively broadcasting television images. This work started in 1930 and by November 1931, the television transmitter W6XAO was on the air from the Don Lee Building, 7th and Bixel Streets, Los Angeles [1062 West 7th to be exact].

On May 21st, 1932, the first television motion picture was reproduced on a cathode-ray receiver in an airplane. [Lubcke subsequently wrote this up in a paper reproduced in the IRE Journal]

On May 14, 1933 [sic] filmed scenes of the Long Beach Earthquake were broadcast a few hours after the event [actually, the LB Temblor was on March 10, 1933].

The year 1936 marked my arrival on Harry R. Lubcke's television research and development staff in the Don Lee Building. The display of Cadillac and LaSalle motor cars on the first floor gave no hint of what was going on upstairs. The KHJ transmitter and television activity of 3 or 4 workers shared the eighth floor. [at the time, KHJ was on 900 kc utilizing a horizontal antenna strung between two self-supporting towers anchored to the roof. KHJ later moved to a two tower DA site on Venice Blvd.]

As my graduate work at Stanford was drawing to a close, Dr. Frederick E. Terman, my close professor mentioned an opening at the Don Lee television laboratory and asked if I was interested. A recommendation by Terman to Harry Lubcke sealed the job for me.

My first job was the design and construction of a sine-wave oscillator covering 50 to 1000 kHz with 400 volt peak-to-peak amplitude primarily for transmitter testing. Other jobs covered receiver and transmitter design, adjustment and testing. My work with Lubcke lasted only four months because of an opportunity to join the Electrical Engineering faculty at Oregon State University.

Lubcke (1905-1991) received his degree in electrical engineering from the University of California in 1929. Even before his graduation, he worked in Philo T. Farnsworth's television laboratory in San Francisco. While there, he built, operated and patented the first all-electric synchronizing, scanning and blanking-pulse generator. He joined the Don Lee system on December 31st 1931 [1930 ?]. During his later years he was a prominent patent attorney in Los Angeles.

Don Lee television in 1936 was built around a disc scanning system for motion picture film, the sole program source. Figure 1 is a photograph of the film scanning equipment and Figure 2 is a schematic of the system. The film traveling at a constant rate of speed is sequentially scanned by light through the holes of the scanning disc. The video signal from the photo electric cell is amplified and passed on to the transmitter. The holes in the disc (#80 drill) were not in a spiral but at a constant distance from the center. The effect of the spiral was achieved by constant film motion which provided the movement from line to line. The light from the arc lamp fell on the disc at an angle, reduced the effective spot size and giving a modest improvement in image quality. The demotionizing lens directed at the spot of light from a single spot on the photo-sensitive surface of the photo cell to minimize the effect of irregularities over the emission surface.

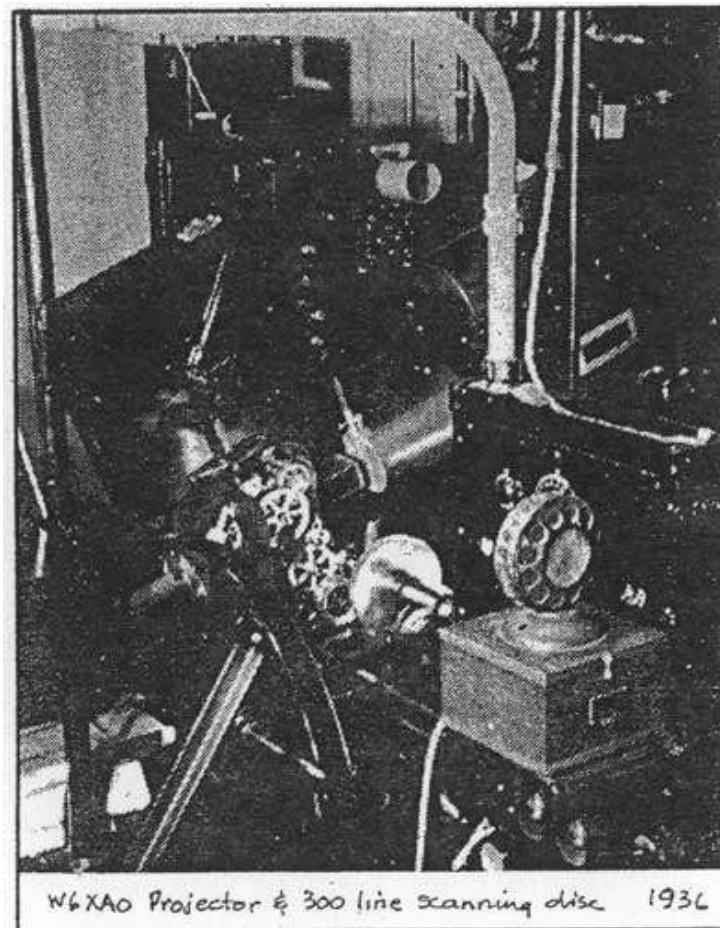


Fig 1

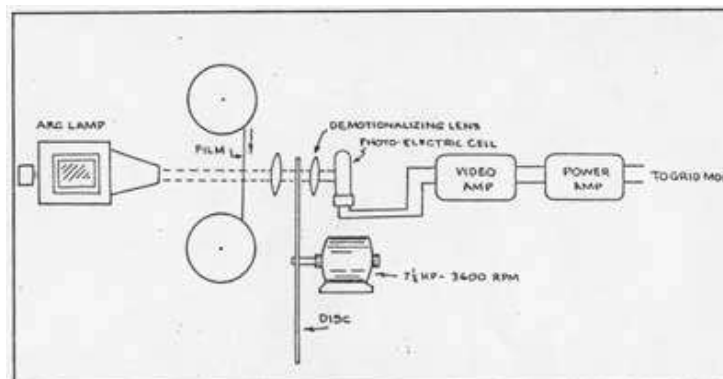


Fig 2

It took 5-7 minutes to bring the sync motor up to 3600 rpm speed upon application of standard voltage. When hunting began, double voltage was briefly applied to pull it into step, after which the standard voltage was applied. When the motor was turned off, it took about 18 minutes for it to come to rest. I remember turning the equipment off after an evening broadcast, going down the elevator and walking [east] to Figueroa Street before the motor whine became inaudible.

The pulses for synchronization were modulated upon the carrier along with the video signal. During the frame interval a synchronizing pulse is transmitted to stabilize the 24hz sawtooth generator of the receiver. This pulse was obtained by the arrangement of Figure 3.

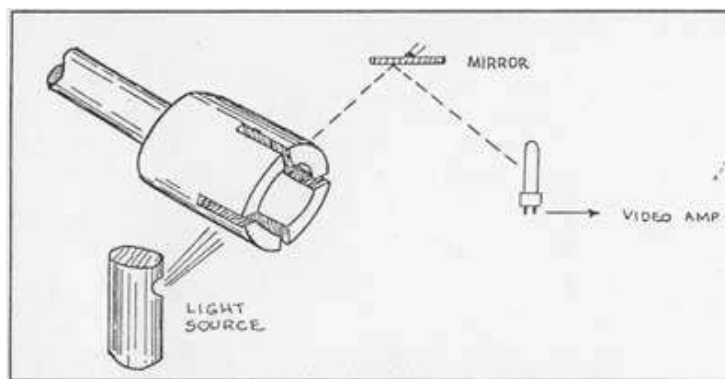


Fig 3

The slotted drum was driven from the film drive train so that the two slots lined up with the light beam every time a frame line passed.

The line synch pulses were obtained by directing a beam of light onto holes a short distance from the point where the picture light falls. The over-all composite video signal (the rectified carrier) looked something like the idealized sketch of Figure 4. The frame pulses were 24/sec and the line synch pulses were 7,200/sec (300 lines x 24 frames).

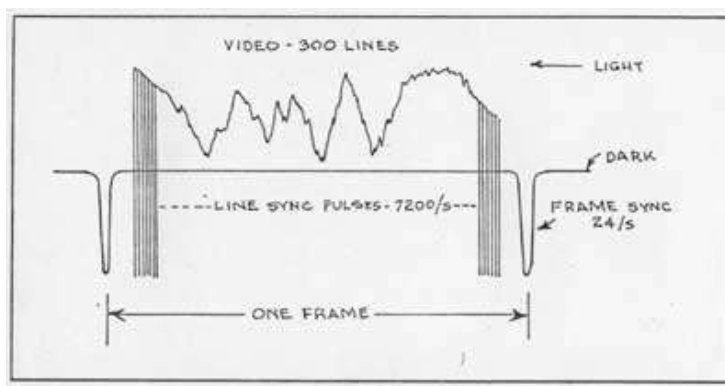


Fig 4

A photograph of the 1936 television transmitter is shown in Figure 5. It was grid modulated with an output power of 150 watts and operated on a frequency of 45 MHz. The image was transmitted as negative for greater linearity. Modest distortion of the synch pulses by the saturated bend of the grid-modulation characteristic had negligible effect. By adjusting the number of stages in the receiver the negative picture was made positive... [description of amateurs, Don Lee TV set plans, etc. omitted]

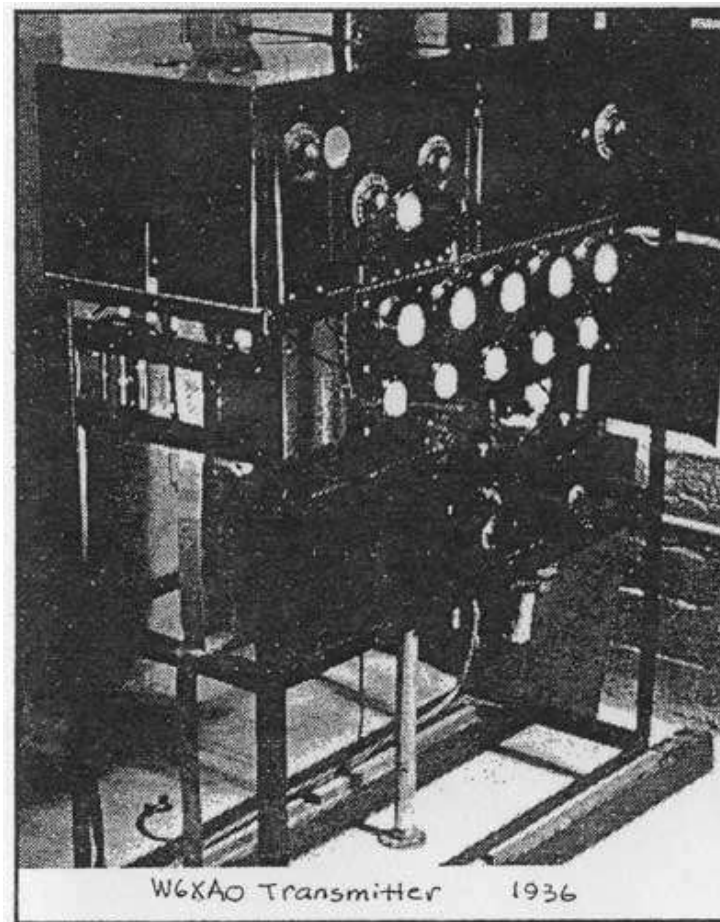


Fig 5

A well-publicized demonstration for the general public was held in June 1936, shortly before my departure. Long lines of people patiently waited to view the wonder of 'pictures by radio' [several years later, off air TV reception would be demonstrated at the Griffith Planetarium].

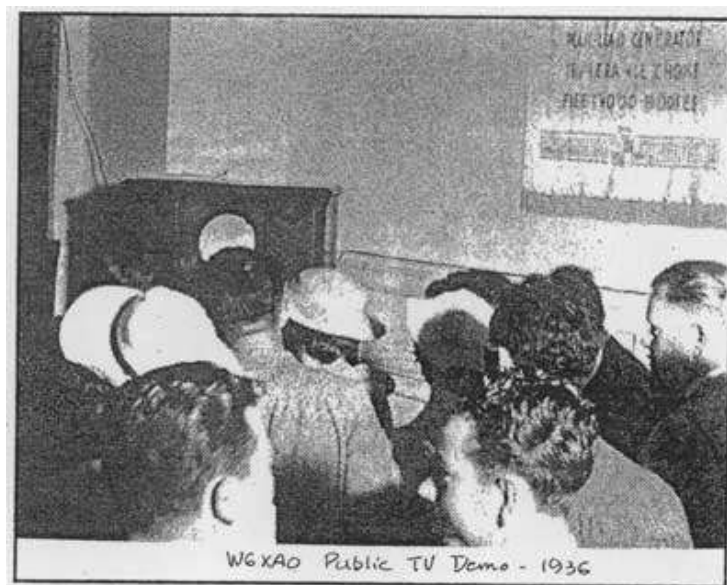


Fig 7

Figure 7 shows people straining to get a good view of the 9-inch cathode-ray image (about 5x7 inch picture). The transmitting antenna outside the eighth floor window which sent the picture signal to the first-floor demonstration is shown in Figure 8.

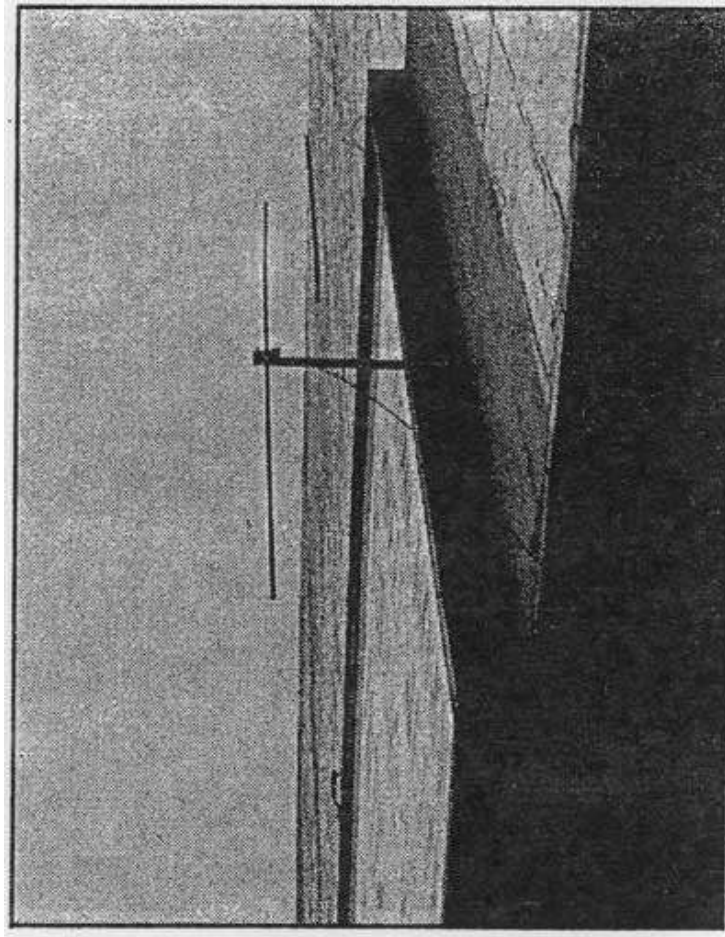
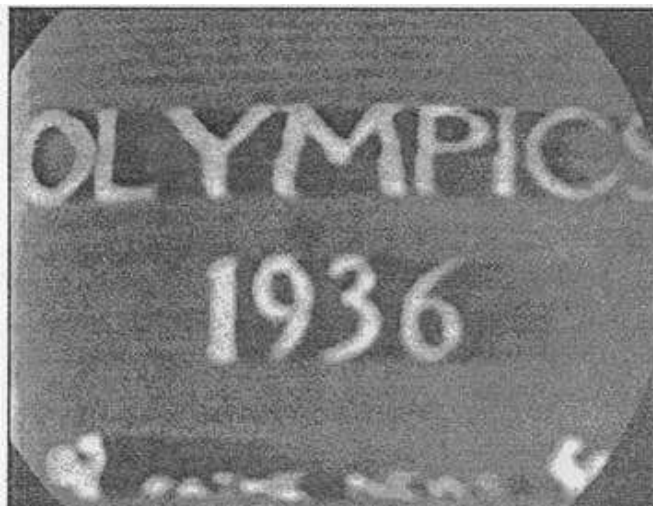


Fig 8

In the waiting lines, I spotted William S. Klein, a fellow EE graduate of Oregon State. Bill applied for my job and was hired. After the television work faded he became a KHJ network and transmitter engineer until retirement.

Many other demonstrations were conducted on an invitational basis from Lubcke's home in the Silver Lake District, 3-1/2 miles from the transmitter. Old newsreels provided much of the programming for W6XAO because the motion picture industry was extremely wary about the future legal implications. I remember one historical film, 'The Train Wreck' which always lost frame hold as the train went in and out of a tunnel.



Screen shots of 300 line image

... During 1939, grandiose plans were presented at the Los Angeles Planning Commission for a Mutual-Don Lee Television Center on a hill to the rear pf and above the Hollywood sign overlooking the heart of Hollywood. This project was later abandoned [sic]."

Au contraire relative to the site atop Mt. Lee.

From the above information, we can conclude that the camera worked as follows: The disk spun at 3600 rpm, or 60 rps. To get the rate of 7200 lines per second (24 fps x 300), 120 holes would be required in the disk. As the article says, the holes were all the same distance from the center of the disk. It is not possible to determine the diameter of the disk from the photo, but since it was driven by a 7 1/2 hp motor it must have been quite large. Assuming a disk diameter of 6 feet, the circumference would have been 226 inches. With 120 holes, the holes would have been 1.88 inches apart. The article says that the holes were #80, which are .0135 inches in diameter. That would allow about 135 hole diameters in the 1.88 inch space, which would roughly translate into the horizontal resolution of the camera. The article mentions that the resolution was improved by aiming the light through the holes at an angle. The screen shots look like about 150 line resolution.

Peter Yanczer commented on the above:

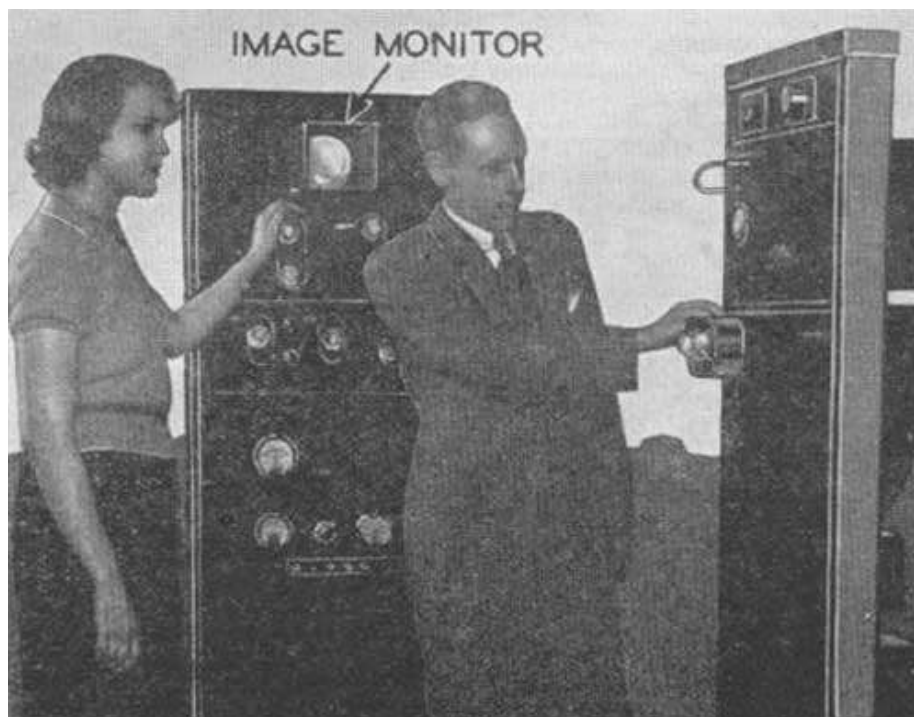
If it were 6 feet... think about it. The disk circumference of about 19 feet would be rotating 24 times per sec., therefore moving at about 450 feet per sec. This is a little over 300 miles an hour. This gives one an idea of the windage there would be. No doubt this would require an evacuated housing, able to resist the atmospheric pressure on two 6 foot+ diameter surfaces. Air pressure is around a ton per square foot, so you're looking at about 60 tons total on the housing. Maybe I screwed up here? But I wouldn't go this route.

It was common practice on cameras to use smaller disks, operating at higher than normal speeds in evacuated housings. if you double the disk speed, the spacing between the holes doubles. On 240L/25P, using a drum, Baird was running them as high as 6000 RPM. The same principal would apply to scanning disks.

As for how Lubeck accomplished it, Possibly he also had some optical techniques as well. There are ways.

I also wonder about this business of running the light source on a slant to improve resolution. With a scanning disk, that to me seems to present problems. Yes, I have to wonder.

Actually, the disk would be rotating at 60 times per second, making the speed at the edge about 1150 fps, approaching the speed of sound.



Harry Lubcke with monitor equipment (ca 1937)

TELEVISION IN THE AIR

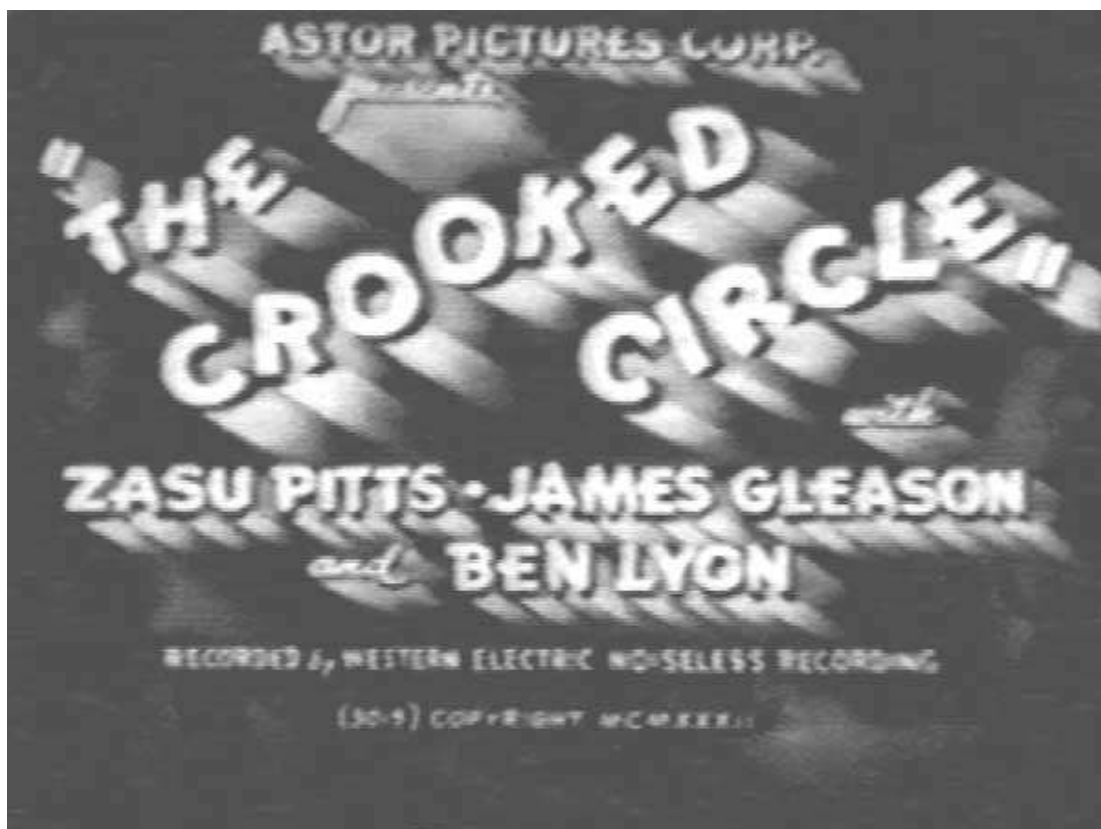


The problems of synchronization hold no terrors for Harry Lubcke, director of television of the Don Lee Broadcasting System, of the Pacific Coast. While flying over Los Angeles recently in a tri-motored plane, he successfully reproduced television images transmitted from station W6XAO, using a cathode ray receiver. He is shown above at the controls of the set in the cabin of the plane.

1932 newspaper article



In 1933 W6XAO, using "rapid process" film development, telecast news footage of the 1933 Long Beach earthquake to L.A. viewers. This is the first documented evidence of television news coverage. Who knows what the received images looked like on the mechanical sets of the era.



March 10, 1933. W6XAO telecasts the first motion picture ever presented on television. "The Crooked Circle". Perhaps 5 L.A. area television receivers received the broadcast.



W6XYZ claimed that their 1943 [remote telecast](#) was the first on the west coast. However, W6XAO was actually first with a live telecast of the Tournament of Roses Parade on January first of 1940.



W6XAO claims to have broadcast the first soap opera, on April 15, 1938, called "Vine Street".



An early Don Lee camera



1939 telecast from the swimming pool located at the new W6XAO studios/transmitter situated on Mt. Lee atop the Hollywood Hills



Telecast from about 1939. The camera was made by RCA.



Rear view of Don Lee camera (ca 1939)

Television Transmission Schedules

THE Don Lee Broadcasting System operating station W6XAO will transmit daily television programs excepting Sunday and Holidays starting at 6:30 P.M., P.C.T. In addition, daylight programs will be transmitted on the following schedules: Monday—9 to 10 A.M. Wednesday—11 to 12 A.M. Saturday—2 to 3 P.M.

The Video signal is transmitted on a frequency of 45 megacycles, and the audio on 54.3 megacycles. The image is 300 lines with a frame repetition frequency of 24 per second. Interlacing is avoided and successful reception can be had on either 50 or 60 cycle electric line power.

According to information at RADIO NEWS office, neither NBC nor CBS maintain regular television schedules. NBC and CBS use a 441 line frequency interlacing every 240 frames.

RADIO NEWS will be interested in receiving reports of television reception of any one of the three systems.



1942 Don Lee Iconoscope camera

1938 Program Schedule



WANTED—"DEAD OR ALIVE"

The battle for the balance of power between Society and Crime went to Society last month when television helped crack down on miscreants. Rogues Gallery pictures of men badly wanted in Chicago and New York, and held before a telly camera in the Don Lee studios in Los Angeles, were instantly observable on all the receivers tuned into the program. At right is Thomas S. Lee, owner of the station. District Attorney Buron Fitts is shown here (and on the cover) holding a photo of John Turteltaub, wanted for felonious assault, carrying a concealed weapon, rioting, and bond jumping in New York State. Television may soon put an end to the 6 years' freedom of this fugitive.

1940 Article



Late 30s test pattern

