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TELEVISION STATION W2XAX

Part I—Transmitter

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EARLY IN 1936 a search was started for suitable space to house a new high-power television transmitter for Station W2XAX.

In order to obtain reliable coverage within a radius of about 40 miles the antenna had to be located not less than, roughly, 1,000 feet above ground, according to the formula $h = d^2/1.5$ where "h" is the height of the antenna location in feet and "d" the distance from the antenna to the horizon in miles. Of course, receiving antennas beyond the horizon located above ground would still be in the path of direct waves depending on their elevation.

Another requirement was sufficient space at that height to house the entire transmitter equipment, weighing more than 100,000 lbs. Each unit of the transmitter and its associated equipment will have to be replaceable within the shortest period of time.

The need for complying with building regulations, floor loadings and electrical and mechanical requirements for efficient and safe transmitter operation narrowed considerably the choice of buildings. After exhaustive study the top floors of the Chrysler Building, located at Lexington Avenue and 42nd Street in New York City, were chosen as the space which came closest to meeting our requirements.

However, there was not a surplus of electric power available for proper transmitter operations, particularly if one or two feeders should be taken out of service. Though the total power input for both video and audio transmitters and the auxiliary equipment amounts roughly to 250 kw, sufficient tolerance had to be allowed for future expansion, as well as to insure a minimum of voltage variation. The installation now under way will provide three transformer banks each of which consists of three transformers and is connected on the primary side to a 60-cycle, 13,000-volt feeder. The three high-voltage feeders will permit uninterrupted transmitter operations even on a second contingency, that is, when two feeders are out of service. The secondaries of all nine transformers are connected in parallel and yield a total power of 1,500 kw distributed over three 208-volt phases.

The next problem was to design an antenna system which could be mounted around the highest portion of the Chrysler Tower and have at the same time the desired electrical characteristics. Consequently the manufacturer

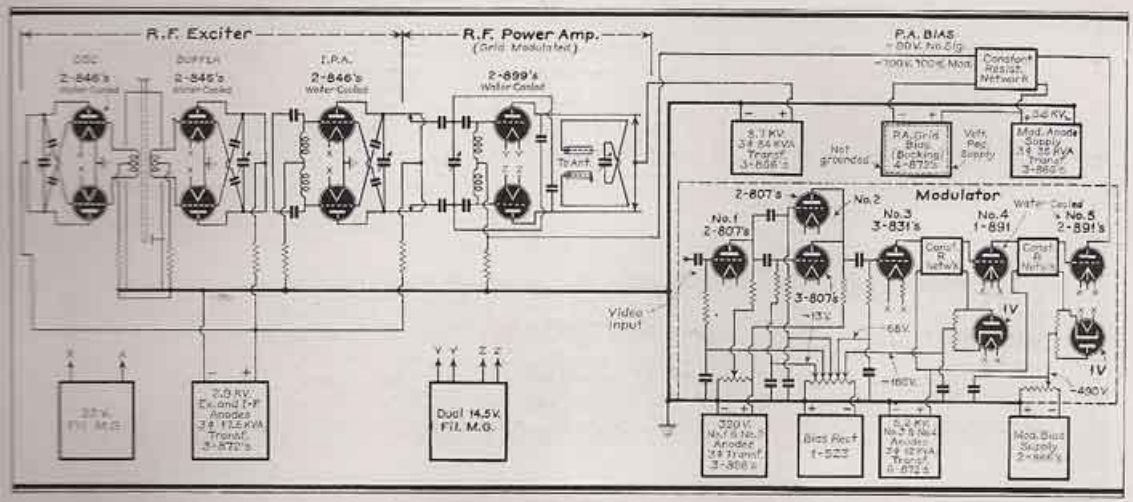


Fig. 1. Block diagram of the video transmitter.

of the transmitter was authorized to build a full-scale model of that portion of the Chrysler Tower around which the antenna would be located. This model was constructed of wood and covered with wire mesh, except where windows are located in the actual tower. On this electrical model, which was erected in the middle of a large field, many types of antennas were tested. The impedance and phase characteristics as well as field-strength diagrams of the various combinations were determined. Eventually an antenna system was arrived at which showed a substantially flat impedance between 50-56 mcs and had a peak power gain of about 4:1 over crossed dipoles without the field-strength pattern deviating appreciably from a circle in the horizontal plane.

Both the video and audio transmitter as well as the power-supply transformer vaults, the shielded room for the input equipment, the power distribution panels, control desk, etc., had all to be placed on the 74 floor which is only 50 feet square and the center of which is occupied by the fire-tower and stairway. Additional equipment consisting of transformers, reactors, pumps, motor generators, etc., had to be placed on the floor below which already appeared to be completely filled with existing building facilities, such as water tanks, ducts, pumps, elevator machinery.

Throughout the entire planning stage a great number of problems arose which could not be solved by leaning on past experience because there were no precedents. They had to be tackled one by one, consuming more than half a year of continuous study.

The video and audio transmitters now being installed will operate in the band between 50-56 mcs. The carrier of the audio transmitter will be 55.75 mcs and when unmodulated will have a power of 7.5 kw. The video transmitter will be modulated between 50 and approximately 55.5 mcs with a peak power of approximately 15 kw. Of course, at these two limits either the modulated input or the r-f carrier must be attenuated to an adequately high degree in order to prevent interference with the sound carrier of the lower television band or with our own sound carrier.

For double-sideband transmission the carrier would be located at 52.5 mcs and for single-sideband transmission, in the neighborhood of 51 mcs. In the latter case the lower sideband will be attenuated by suitable electrical filter networks following the r-f power-amplifier output circuits.

A block diagram of the video transmitter is shown in Fig. 1. A master oscillator with a temperature-compensated grid line with two 846's producing the carrier frequency and keeping the frequency constant within ± .02% of its value, is followed by a pair of 846's acting as buffer stage. Another pair of 846's act as intermediate r-f power amplifier and is followed by the grid-modulated r-f power amplifier using two 899 type tubes. These 899's operate with a plate voltage of approximately 9,000 volts and a plate current of 3 amps. per tube.

The plate power supply operates on 3-phase, full-wave, using hot-cathode mercury-vapor rectifiers. The grid bias to the power amplifier is supplied from a regulated voltage supply, floating above ground.

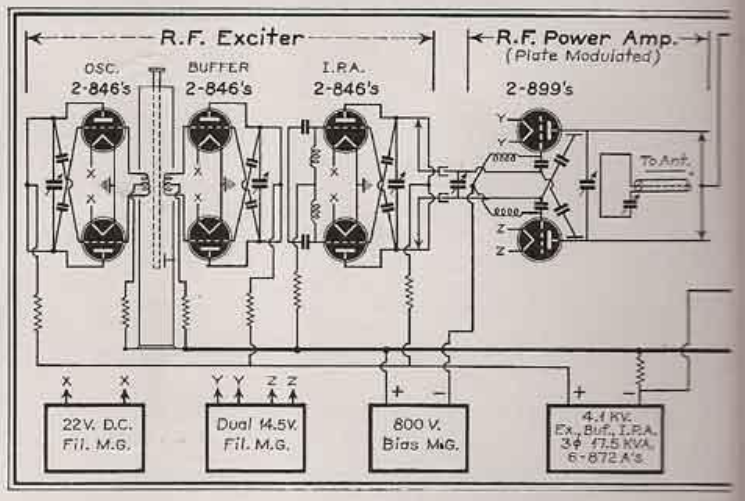
The first stage of the video modulator consists of two 807's in parallel, driving five 807 tubes, the plates of which are all in parallel. The next stage consists of three 831's in parallel. Up to this point these three stages have been capacity-resistance coupled. However, the output of the 831's and the input of the next stage, consisting of one 891 tube which is water-cooled, are coupled by a special constant-resistance network which offers a constant impedance to all frequencies transmitted within the video band. The diode 1-V is connected between the grid and the cathode of the 891 tube and provides for the reinsertion of the picture d-c component (that is, "toeing-up" of the combined video and synchronizing pulses to the same peak level).

The d-c reinsertion diode can be connected to the grid of the 891 tube either with its cathode or anode, depending on whether positive or negative type transmission is desired. Correspondingly the bias to the 891 is to be readjusted for which purpose a switch is provided.

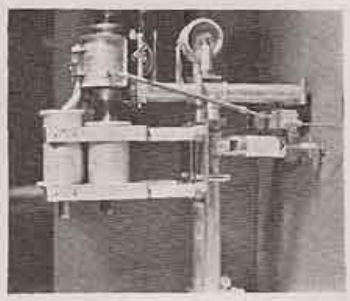
Since the next stage, using two 891's in parallel, is in effect a-c coupled, though through another constant-impedance network, the d-c component has to be reinserted again using the same diode arrangement as before.

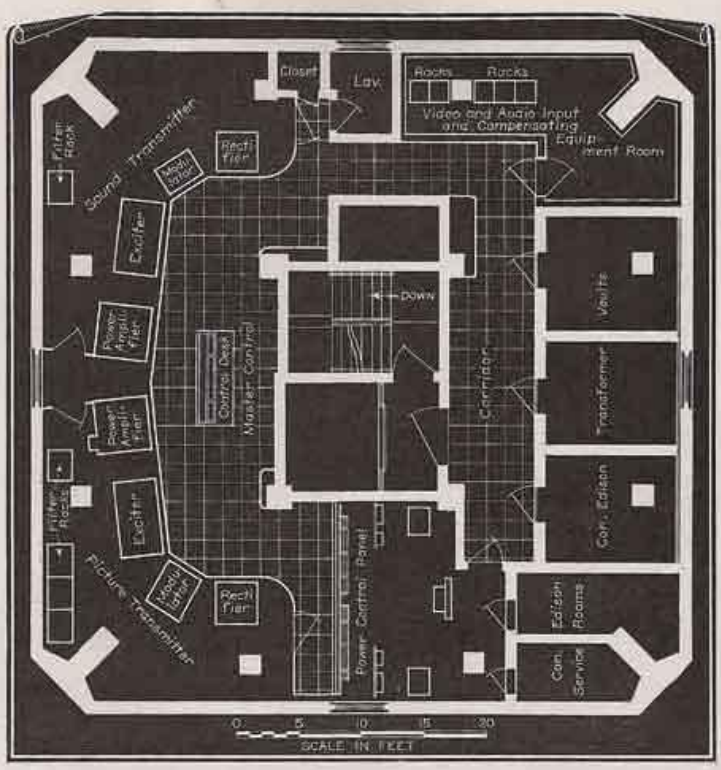
From here on the picture background value is maintained through a combination of a constant-resistance network and direct coupling to the grids of the r-f power amplifiers. For this reason the bias supply of the 899 tubes had to be kept above ground potential.

Figs. 2 and 3 show the side and top views of the tuning and coupling arrangement of the power-amplifier stages. The neutralizing, plate tuning and trans-

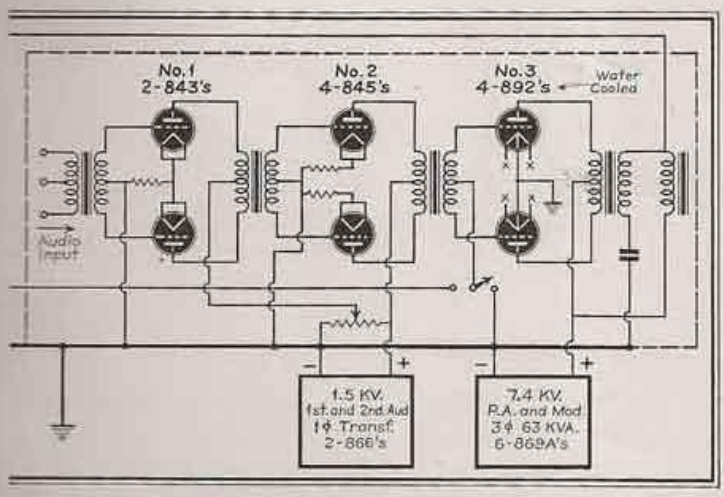


Below: Side (Fig. 2) and top (Fig. 3) views of tuning and coupling arrangement of power-amplifier stages.





Above: Fig. 8. The 74th floor plan.



Left: Fig. 6. Diagram of audio transmitter.

emicient-line tuning condensers can be plainly seen, as well as the beginning of the transmission line which is inductively coupled to the plate tank circuit. Fig. 4 shows the complete power-amplifier rack assembled, while Fig. 5 shows the video master-oscillator unit.

The r-f portion of the audio transmitter is very similar to that of the video section, except, of course, that the master oscillator produces a 55.75 mcs carrier and the power amplifiers have a grounded bias supply. The 899's are Class B operated while high-level modulation is employed. The block diagram in Fig. 6 of the audio transmitter shows that the modulator stages are designed in standard fashion.

The output of the video transmitter will be fed into a balanced transmission line, approximately 75 feet long, leading to the video antenna system. The output of the audio transmitter will be fed through a single coaxial transmission line to the audio antenna located above the video radiators. All three transmission lines will have an impedance of 70 ohms. The video antenna as well as the audio antenna will consist of two rows of horizontal dipoles on all four sides of the building, separated in vertical direction by half a wavelength (about 9½ feet). The audio and video antenna arrays are separated by approximately 28 feet. Thus on each side of the building there will be two video and two audio antennas placed above each other. Fig 7 shows the schematic diagram of the elevation and top views of the antenna plan. The antennas on opposite sides of the building are fed out of phase with respect to each other.

Quarter-wave matching sections distributing the r-f current derived from the 70-ohm transmission lines to the eight dipoles through correcting sections will be placed inside the tower at a close level to the antennas. The sixteen independent dipole antennas protruding beyond the tower will be heated from inside and thermostatically controlled so that no ice can accumulate on them. This is necessary to prevent detuning of the antenna and danger to pedestrians from falling icicles.

The 73 floor, that is, the one immediately below the two transmitters proper, will house the tube water-cooling equipment which is a closed system with a total water flow for both transmitters of approximately 180 gallons per minute. A fireproof vault on the same floor will house such units as power-supply reactors, plate transformers, audio modulation transformers, audio-output modulation reactor and Delta-Wye switches.

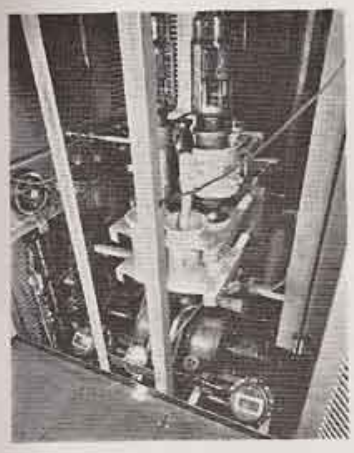
In another section of this floor there will be six motor generators supplying various filament and bias voltages for both transmitters.

On the 75 floor air-conditioning equipment will be installed to supply the transmitter on the floor below with fresh air and exhaust the heat generated by the various units behind the transmitter panel.

On the 74 floor a double-shielded room will contain the video and audio input equipment (see floor plan Fig. 8). The coaxial cable, coming from the studio, will be terminated in this shielded room and the signal derived, after being suitably amplified, will drive a picture monitor as well as the video modulator of the transmitter. The audio input equipment is standard. There will be provision for feeding any signal from the CBS master control

room on Madison Avenue into the W2XAX audio transmitter.

Diode detectors coupled to the video antenna will supply rectified r-f to a



monitor in the shielded room permitting a constant check on the radiated signal.

The following safeguards are provided to prevent operating personnel from coming into contact with high voltages. The two main doors, which provide access to the equipment behind the transmitter panel and the two doors between the video and audio transmitters, each carry an interlock switch so that when the doors are opened the power of that transmitter is instantaneously cut off. The doors to the transformer and reactor vault on the 73 floor carry interlock switches as well. Every filter condenser has a shorting bar operated by gravity so that when power is turned off the charges accumulated in the condensers are neutralized. In addition there are interlocks on each of the eight large units behind the transmitter panel. Further precautions are a number of shorting plugs connected in series, which are placed right near to the door leading behind the transmitter panel. When a man enters that space he takes one of these plugs along, thereby disconnecting the entire transmitting supply circuit. Only after each man has returned and all the plugs are put in their place will the circuit be completed again.

As a further measure of precaution, the entire 74 floor will be covered with

thick rubber tile providing good insulation from the concrete underneath.

The transmitter is entirely remote-controlled from a control desk so that no operation has to be carried out from behind the protective panel.

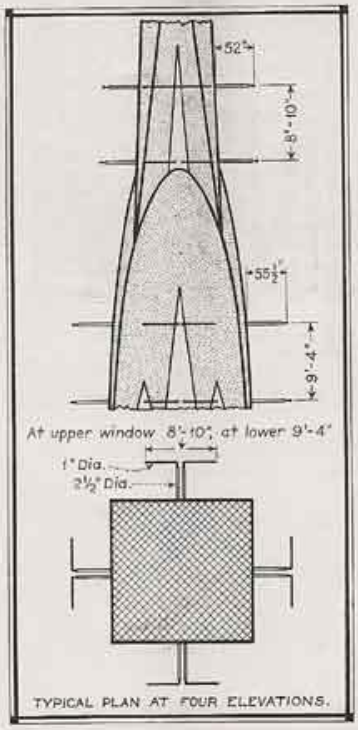
On the control desk, in front of the transmitter panel, there are twenty control lamps indicating whether the interlock switches are open or closed, that is, if men are at work or not. There are forty more control lights to indicate whether the various units are supplied with power and are in good operating condition.

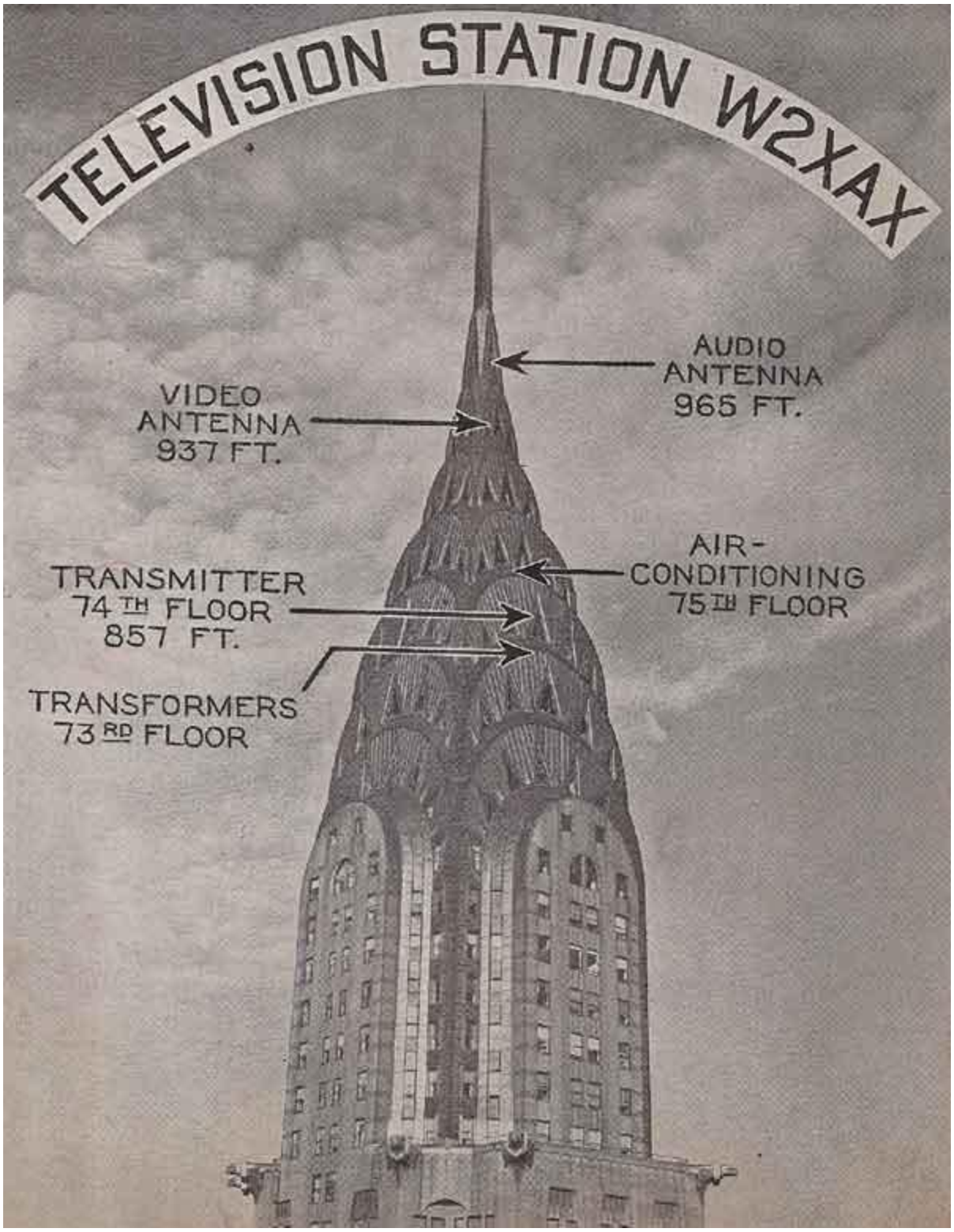
A photograph of the top portion of the Chrysler Building on which the various floors and positions of the antennas are marked, is shown on the front cover of this issue.

Left: Fig. 4. Power amplifier assembly.

Below: Fig. 7. Elevation and top views of antenna plan.

Right: Fig. 5. Video master oscillator.





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