Receiving Television Signals at Ultra Short Waves

TELEVISION has moved to ultra short waves from pure necessity. The channel occupied by one reasonably good picture is so wide that operation anywhere else is out of the question; kilocycles are too scarce in the standard wave region. The photographs show this point clearly.

Having moved to ultra short waves television automatically becomes, for the moment, a local affair serving only a single city area over which signals can be sprayed from an elevated antenna. We now turn to an outstanding example of a single city television transmitter, namely that in New York City. With modifications the discussion applies to others. The text following is quoted from Modern Radio. The German apparatus photographs are due to Radio World.

"There is far to be had from "looking in on" the so-called 5-meter radio talkies from Al's place, officially called the Empire State Building. These radio transmissions have a whale of a signal over a wide area, days, nights and Chinese holidays, without any of the usual horrible television fading, and with no very serious shadows behind hills—all of which agrees with amateur 5-meter experience of other years but fits poorly into the "quasi-optical" argument. One can also prophesy that very soon these signals will be heard trans-continentally and trans-oceanically, just as amateur 5-meter signals have been. Even now a California observer has been troubled by hearing a 5-meter station which transmitted some NBC material and then degenerated into "a lot of fool noises"—exactly a description of W2XK when it switches from WEAF to the soundtrack of a Mickey Mouse film just been fed into the W2XK sight-transmitter. Incidentally, on sunny days, the signal isn't too bad at Hartford, although 90 miles is well into the skipped distance for anything but a very good signal.

All this, plus the good quality of the pictures seen by various "lookers," makes one take Empire State seriously.

At the left, detail of television picture as compared to number of picture points, indicated at lower left of each. At upper right, a German television receiver chassis with neon tube and scanning wheel. Next below the same in its cabinet. At lower right, a cathode ray receiver showing zig-zag path of ray much opened out.
Dr. D. McFarlan Moore, who years ago devised glow-discharge tubes containing neon and other gases. The ability of these lamps to follow extremely fast changes in the current supplied to them has made possible some of the best sound-on-film recording, and around them have grown up most of the present television receivers. Will the cathode-ray tube replace them?

Admittedly this is a New York affair at the moment. Note, however, that the transmissions are from sound-film which is quickly made and transported after an event. Thus the received transmissions may be a substitute for direct-pickup, or else an attack against movies. The latter is quite possible, for RCA now has the film sources and through its RKO affiliation has become a rival of the Warner brothers. While wearing Mr. Gernsback's cloak of prophecy one may as well continue and guess that the grandiloquently named "Radio City" may serve as a point of origin for sound-sound programs to be sent about in film form to cities where

perience shows local program sources to be sufficient. Whether the actual film is sent, or some method of instant relaying is devised, is not to be guessed now. The weak spot is that America does not go to the talkies for their own sake — but rather to be going somewhere.

The Transmitter

The transmitter at Empire State is some ways (280 feet?) from the antenna. The transmission line between, after many headaches, appears to be subdued, and no longer mangles the pictures. The grapevine telegraph bureau reports that electrical and mechanical scanning have been used, but normal receivers seem to fit the scanning order. As to power one may guess. The license says 5 kilowatts, rumor says 15 and the signal sounds like 90. The receiver is the main interest anyway.

The Receiver

Over most of New York reception with a neon lamp and scanning disc seems possible with no more than a detector followed by two audio stages with the high-quality couplings described in the free-circulor of International Resistance Co. The 120 hole disc is not easily made but until commercial ones appear folks are making their own or using the commercial 60-hole two-turn-fast disc which ruin the picture by cutting it up and shifting it but allow the parts to remain nearly undamaged and thus permit other problems to be studied. The sound receiver and sight receiver are no easy job, but the sight one is vastly the tougher because of the big frequency range. The first rush toward super-regeneration has given way to a variety of double and triple detection receivers with flat intermediate-frequency amplifiers using coupling which combine reactance capacity with inductance. It is also found that signal-frequency gains are possible with normal screen-grid tubes.

The RCA receivers are reputed to center about a cathode-ray tube built in the large Corning Glass envelope, which admits a 4.9 inches screen, on which appears the picture of ordinary sound-film proportion — height 758, width 878, or about 6 x inches. The auxiliary equipment is discouraging. Merely to produce the electron jet and center it to produce a bright light point about 1/16 inch across at the center of the screen requires: low filament voltage, focusing cylinder voltage around 300 (there are other ways) and accelerating disc voltage around 2000. Then the jet must be wiggled one way 24 times per second, and transversely 120 times as fast. The wiggling waves, which are applied to the detection plate, must be of correct frequency, phase and WAVE FORM and run the form e one touching to raise the light in a radio receiver. Accordingly one has asserted plate supplies, two special oscillators with odd wave forms, and a variety of shields and filters. The special oscillators provide only low voltages and must be amplified, or else one must use a two-stage cathode ray tube, first deflecting a low-speed jet and then speeding it up to secure enough impact to make the screen glow brightly. The distortion possibilities are many.

Even now one has but a woolen rectangle of light, painted by the wiggling electron jet. Next the jet speed must be modulated in accord with the scene on the distant movie film. This requires superimposing the output of the receiver on some electrode of the tube, perhaps through a high-ma 100 volt tube with indirectly heated cathode to prevent filament-ripple overlays. (An 841 serves experimentally.)

Again — all speed changes involve a focus change — the dot changes size as well as brilliance. Additional devices
The mechanism of a cathode-ray tube minus the focusing electrode and modulating electrode. At left, wave form shown on screen of tube.

The vital machinery at the small end. Electrons from the filament focused by the surrounding tube, are attracted to the accelerating disc and slide through the central aperture, then between the two pairs of deflection plates to which the deflection-frequency a.c. voltages are connected. The wriggling ray cross-hatches the screen with fluorescent lines, the intensity changing as the jet speed is modulated in accordance with the light seen by the distant electric eye as it scans through the scanning equipment of the moving film.

fact one of those receivers is readily modified for the purpose. For sound alone nice work has been done with an JV-7 superheterodyne with the detector tuned circuit cut down and the oscillator run at 3 or 4 times the signal frequency. Naturally the i.f. selectively spells the picture. In any case the household antenna can be coupled inductively or capacitively, avoiding over-close coupling. Ranges are checked by oscillating the detector and using a General Radio wavemeter in the familiar Judson method. Recall, though, that the circuit is detuned greatly with the oscillation control and work near the no-oscillation point.

Following Schedule Changes

While RCA will certainly welcome reports from observers, they will probably be unable to advise of all transmission changes, hence the "looker-in" should use his ingenuity in following changes of wavelength, picture frequency and number of scan lines. The following is a method used by Mr. Boyd Phelps with invariable success in quick analysis of television signals. Receivers based on the information gained have invariably worked.

High precision is not needed. The "whine frequency" of the signal is first determined by comparison with any available audio standard—crystal-controlled beat-oscillator as first choice but ranging on down to the family mandolin or piano. A piano is really a very decent frequency standard. In the case of the Empire State signals the whine is at 2880 cycles, which is the product of scan-lines times pictures-per-second. One might, at great cost, in time and $$$ make many crowds and

An engineer's nightmare—waveform such as used by cathode-ray deflection plates, and readily created by nearby radio devices.
the reed which beats easily with such
notes as it has strong harmonics. A
fairly decent curve is obtained. In Mr.
Phelps' work check-points were wanted.
The local power system wanders as to
frequency, hence a 60 cycle point was
obtained by feeding a neon lamp from a
radio receiver tuned to an amateur
station with a strong plate-supply ripple
due to a network known to serve many
electric clocks—and therefore probably
fairly correct. The reed was adjusted
to "stand still" by this lamp, its length
measured, and the point marked on the
curve.
An amateur movie projector without
film then had its motor speed adjusted
so that when aimed at the motor disc
its flickering light caused 2, 3 and 4
spokes to appear—corresponding to 30,
20 and 15 shutter-openings per second.
In each case the reed was held in the
flickering beam and the length adjusted
to "stand still"—the motor speed
being meanwhile checked against the
distant station's neon light. The points
all fell nearly on the original curve.
In the case of the Empire State
transmissions 24 came out as the picture rate
and 2800/24 is the scan-line number of
120.
If such a measurement as this gives
accurate results such as 120,3 lines,
there should be no difficulty in the mind
of anyone able to unravel amateur radio-
grams, or listen to shortwave broadcast-
ing with enjoyment."

The Cathode Ray Tube in Action
If the experimenter wishes to use a
cathode-ray tube he must learn the
useful of that device to some extent.
It obviously cannot be set down here
and the following is offered merely as a
preliminary explanation of the fashion
in which the ray follows the voltages fed
to the tube. This should simplify the
understanding of its use in television.

1. Sensitivity: An average tube re-
quires a potential of about 45 volts to
swing the spot across the screen. For
many tests it is desirable to do this with
less voltage, to eliminate the need for
amplifiers.
2. Brilliance: Brilliance is mainly due
to the type of fluorescent salt used
as screen coating and to the anode
gap.
3. Accuracy: The movement of the
spot should be directly proportional to
the applied voltages to the deflection
plates, at any portion of the screen, and
for any frequency.
4. Life: The life of a tube depends
(with most designs) on the active life
of the cathode.
5. Focusing: In many tubes this can
be done with an accurate adjustment
of the filament current and anode
potential. In other tubes an auxiliary
electrode is provided for this

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Timing

In the ordinary vibrating-mirror oscilloscope or oscillograph, a time scale is produced by a synchronous motor driving a rotating mirror. In the cathode-ray tube many tests are made with the wave-to-be-investigated applied to one pair of deflection plates (see illustrations) while a "timing wave" of known wave form is applied to the other pair of deflection plates. In any oscilloscope the effect of a timing device is to show on the same screen successive sections of the curve produced by the voltage (or voltages) being investigated.

Imagine that this curve is somehow marked or printed on a long transparent film — the length of course being due to time. If this long picture is to be gotten into the limited area of the oscilloscope screen, several possible schemes occur to condense it. One method would be (A) to wrap the film around and around a glass cylinder, and then to look through the whole thing in that form. Another way (B) is to hold it up in a zigzag by crossing at regular intervals whereby every second section is reversed as to direction in the finished pile. A third scheme would be to (C) cut the film into short sections and place them all up.

In the cathode-ray tube we do not have a long film, but we do have a curve which is ELECTRICALLY folded so as to get all parts on the screen. The folding is done automatically by the timing oscillator as already suggested and it is such an action which permits the ray to paint many pictures per second on the television screen.

Effect of different timing-waves. If sine-wave a.c. is connected to one pair of the tube's deflection plates the curves shown in each column can be produced by connecting to the other pair a timing wave of the same frequency, and of the shape shown above the dashed line.

A is a stepped wave and produces the "thigh up" effect (see text).

B is a saw-tooth wave and gives the zig-zag folding (see text).

C is a saw-back wave and produces the cut and pile effect, with the straight snap-back line added.

A and C are the most useful.

The mechanical equivalent of each folding method is shown at the bottom of the column.

A simple form of "projection" televiser. The neon crater lamp is a strong point-source (almost) of light modulated in accord with the received signal. Its flickering light passes thru the lens and diaphragm to the mirror-wheel which causes the light-pencil to wipe across the screen once for the passage of each of the mirror-faces. Each mirror has a slightly different tilt so that successive strips of the light-pencil fall at different heights on the screen, corresponding to the successive scan-lines, just as do the holes of the ordinary spirally-pierced Nipkow disc. The advantage is in the greater optical efficiency and in the smaller size of the rotating member.

A portable cathode-ray oscilloscope with power supply. The potentiometer at the left controls the potential on the anode, to make the tube more brilliant (right) or more sensitive (left). The right-hand knob controls the focusing field.