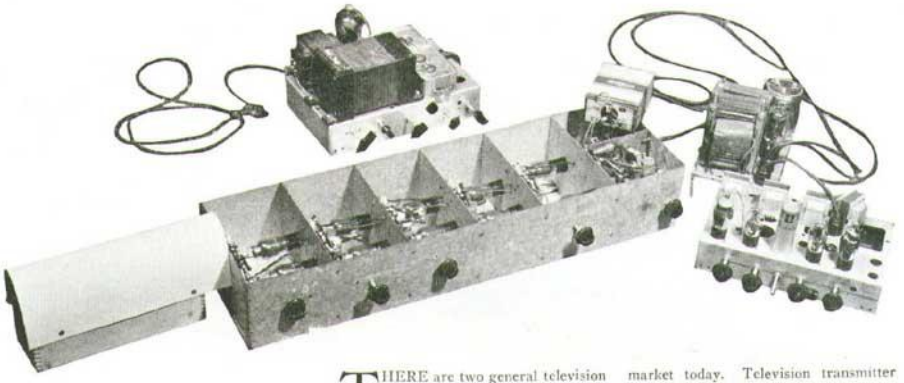
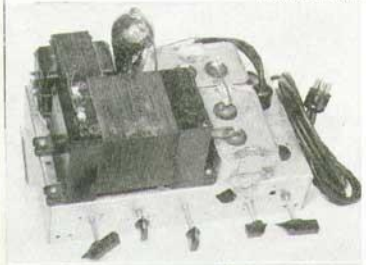
An AMATEUR'S TELEVISION



The complete Video Section hooked up ready to transmit a picture. The radio frequency section is not shown.

Black Box Fotos



(Top) The Cathode Ray tube high voltage power supply with its 866.

(Middle) The Cathode Ray sweep circuit low voltage and filament supplies.

(Bottom) The complete Video amplifier section. Modulators and drivers not shown.

THERE are two general television transmission systems in use today. First, is by means of the whirling disk and the second by means of tubes. The second classification is divided between the Iconoscope, used by RCA, and the Dissector, used by Farnsworth on the West Coast. Neither of these latter tubes are available to the amateur.

There were three of us who became interested in the subject of television; George Sharp of Sioux City, Iowa; Ernest Kokoska of Cicero, Illinois; and myself. We discussed the designing of an experimental wired television system that would operate on the same basis as the commercial. Later put it on the air. However, we knew that we were not able to obtain an Iconoscope and that is where our difficulties began.

Close inspection of the Iconoscope revealed that it is in effect a cathode ray tube with a metal plate placed in such a manner that it will be scanned by the electron ray. The ordinary cathode tube shoots the electron ray up against a coated glass screen at the end of the tube and the ray, when hitting the screen, heats it to a sufficient extent to make it luminous. Our problem, therefore, was to construct either an Iconoscope or a tube which could be used in its place. We soon gave up the tube construction idea and concentrated on using the available tubes that are on the market today. Television transmitter described below is the result of our experiment. While it will not televise a living person, it will transmit pictures from film negatives or it could be used to transmit motion picture film.

The system of transmission of the negative is quite unique in that it incorporates the cathode ray tube as the heart. The difference between our system and the Iconoscope was that while the Iconoscope scans an image inside of the tube, we were able to scan an image outside of the cathode ray screen This was done by placing a negative flat against the end of the cathode ray tube and transmitting the ray through the glass and the film, collecting it in an Eby cell upon which it had been focused by means of a series of lenses. This then would be our "Iconoscope." The lens we used was an ordinary photographic convex type which can be purchased in any supply store. Our system had one drawback. There was not enough light hitting the Eby cell to operate the modulator for the ordinary speech input.

Our second big problem, therefore, was to design an amplifier which would amplify the very small amount of energy obtained from the Eby cell sufficient to modulate a small transmitter.

A lot of different things had to be taken into consideration. Firstly, the amplifier had to pass a very wide range of frequencies, from 20 to 1,500,000 cycles with a constant output over the entire frequency rate. We determined we had to have at least a 60-volt output from the amplifier in order to adequately excite the drivers and the modulators of the transmitter.

In order to avoid distortion, the ca-

TRANSMITTER

by ANTHONY KOWALEWSKI, W9VCU

Without whirling disks, Iconoscope or Dissector, the author has designed a television transmitter which works. Radio News is first to publish a complete circuit diagram. The Amateur again leads the way . . . . . .

pacity of all of the parts had to be very small. The amplifier had to be hum-free, and each stage would have to be shielded so that there would be no interaction between them.

Forgetting for the moment the video or transmission of television signals, we concentrated on the design of an amplifier suitable for our purpose. Before going into the actual construction itself, it might be well to state a few axioms of television. The simple basis of comparison with television is the ordinary broadcast transmission and reception. An ideal broadcast or phone transmitter is one which can follow transmitted variations in one ten-thousandth part of a second. This will not do for television. In picture transmission it is necessary that the transmitter follow a variation from light to dark in almost a millionth part of a second.

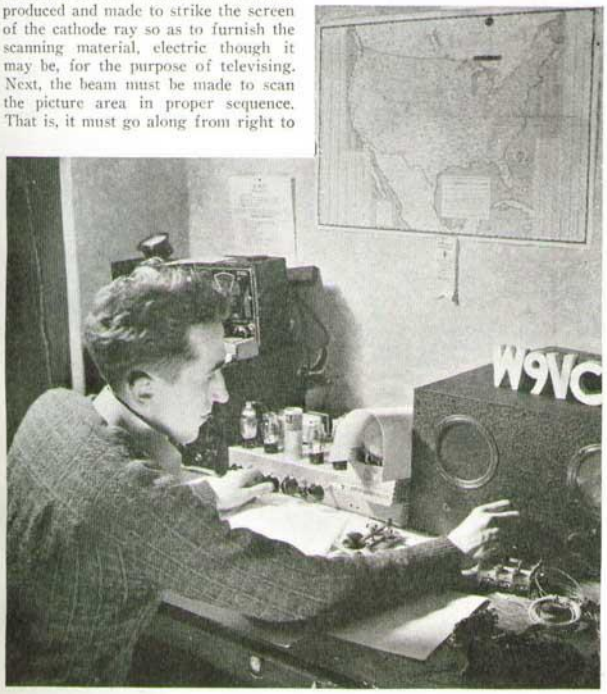
In order to televize a picture properly, a number of conditions must be satisfied. A beam of electrons must be produced and made to strike the screen of the cathode ray so as to furnish the scanning material, electric though it may be, for the purpose of televising. Next, the beam must be made to scan the picture area in proper sequence. That is, it must go along from right to left in the proper order so that the received signal at the other end will also come out exactly as transmitted. The density of the beam must be variable, at the rate of one million times per second. Ordinary television transmission contains, also, in addition to the above, DC modulation, vision modulation, synchronizing modulation, line synchronizing signals, and frame synchronizing signals.

At the onset, it seemed almost hopeless for us to produce all of these things in one small amateur transmitter, and as we worked along the problems more or less solved themselves. The picture brightness is transmitted as amplitude modulation so that definite carrier value can be associated with definite brightness. This is the DC modulation mentioned and has no fixed value of average carrier. The average carrier varies with the picture brightness. The term "visual modulation" is modulation applied in the direction which represents the increase in carrier corresponding to the increase in picture brightness. Vision signals occupy values between 30% and 100% of the total modulation of the total speech carrier.

All of the signals transmitted below 30% of the speech carrier represent the synchronizing modulation signals. Line synchronizing signals are those which are transmitted to permit the beam to fly back so as to start scanning the next line. Frame synchronizing signals are those signals which are transmitted which cause the line to scan downward and not to repeat over the same line previously scanned.

In our transmitter the total numbers of lines in the complete picture was 240 scanned sequentially, and horizontally 24 picture transversals per second or 24 complete frames per second. The line frequency of our transmitter then was 5,760 cycles horizontal deflection, and frame frequency of 24 pictures per second. Later we were able to push out scanning lines up to 300 with some distortion and our horizontal deflection ran 7,200 cycles. This distortion was noticeable and not pleasing to the eye.

Before commencing the construction of the amplifier it would be better to construct the oscilliscope and its associated circuits. If two 908 oscilliscope tubes are available, one may be used with which to transmit, and the other one to check the entire system by receiving the image. They may be hooked



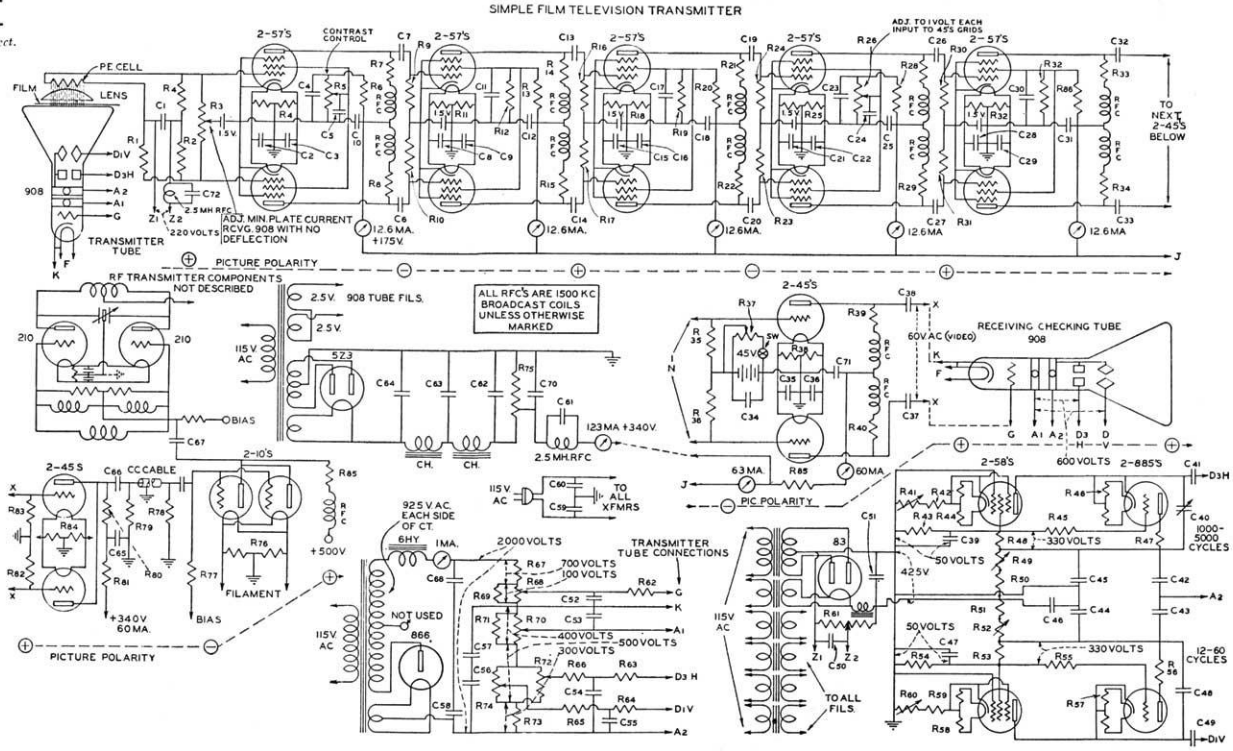
The author seated at the controls of his television station W9VCU.

(Below) The modest home in which the author made his far-reaching experiments.

Black Box Fotos

Components

C1—8 mfd. 300 v. elect.
C2—.05 mfd paper
C3—.05 mfd paper
C4—.25 mfd paper
C5—.25 mfd paper
C6—1 mfd paper
C7—1 mfd paper
C8—.05 mfd paper
C9—.05 mfd paper
C10—.25 mfd paper
C11—.25 mfd paper
C12—.25 mfd paper
C13—1 mfd paper
C14—1 mfd paper
C15—.05 mfd paper
C16—.05 mfd paper
C17—.25 mfd paper
C18—.25 mfd paper
C19—1 mfd paper
C20—1 mfd paper
C21—.05 mfd paper
C22—.05 mfd paper
C23—.25 mfd paper
C24—.25 mfd paper
C25—.25 mfd paper
C26—1 mfd paper
C27—1 mfd paper
C28—.05 mfd paper
C29—.05 mfd paper
C30—.25 mfd paper
C31—.25 mfd paper
C32—2 mfd paper
C33—2 mfd paper
C34—2 mfd paper
C35—.05 mfd paper
C36—.05 mfd paper
C37—1 mfd paper
C38—1 mfd paper
C39—8 mfd. elect.
C40—.0001 mfd. var.
C41—.1 mfd paper
C42—.1 mfd paper
C43—.1 mfd paper
C44—8 mfd. elect.
C45—8 mfd. elect.
C46—8 mfd. elect.
C47—8 mfd. elect.
C48—.1 mfd paper
C49—.1 mfd paper
C50—8 mfd. elect.
C51—8 mfd. elect.
C52—.75 mfd paper
C53—.1 mfd paper
C54—.1 mfd paper
C55—.1 mfd paper
C56—.25 mfd paper
C57—.25 mfd paper
C58—4 mfd. 2000v.
C59—2mfd. 500v.
C60—2 mfd. 500v.
C61—.0053 mfd. mica
C62—4 mfd. 500v.
C63—4 mfd. 500v.
C64—4 mfd. 500v.
C65—1000 mfd. 400v.
C66—1000 mfd. 400v.
C67—1000 mfd. 500v.
C68—4 mfd. 2000v.
Input to modulators,



left out, 1000 mfd.
C70—4 mfd, 500v.
C71—.25 mfd paper
C72—.0053 mfd mica
R1—5 meg 1 w.
R2—5 meg 1 w.
R3—2 meg pot.
R4—5 meg 1 w.
R5—.1 meg pot.
R6—40,000 ohms 1 w.
R7—10,000 ohms 1 w.
R8—10,000 ohms 1 w.
R9—1 meg 1 w.
R10—1 meg 1 w.
R11—50 ohms C.T.
R12—1 meg 1 w.
R13—40,000 ohms 1 w.
R14—10,000 ohms 1 w.
R15—10,000 ohms 1 w.
R16—1 meg 1 w.
R17—1 meg 1 w.
R18—50 ohms C. T.
R19—.1 meg. 1 w.
R20—40,000 ohms 1 w.
R21—10,000 ohms 1 w.
R22—10,000 ohms 1 w.
R23—1 meg 1 w.
R24—1 meg 1 w.
R25—50 ohms C. T.
R26—.1 meg pot.
R27—Left out
R28—40,000 ohm 1 w.
R29—10,000 ohms 1 w.
R30—.1 meg 1 w.
R31—.1 meg 1 w.
R32—.1 meg. 1 w.
R33—10,000 ohms 2 w.
R34—10,000 ohms 2 w.
R35—.5 meg 1 w.
R36—.5 meg 1 w.
R37—.1 meg pot.
R38—50 ohms C. T.
R39—5000 ohms 10 w.
R40—5000 ohms 10 w.
R41—50,000 ohms pot.
R42—1500 ohms 10 w.
R43—6000 ohms 1 w.
R44—50 ohms C. T.
R45—300,000 ohms
R46—50 ohms C. T.
R47—1000 ohms 10 w.
R48—38,000 ohms 1 w.
R49—50,000 ohms pot.
R50—7500 ohms 10 w.
R51—7500 ohms 10 w.
R52—50,000 ohms pot.
R53—38,000 ohms 1 w.
R54—6000 ohms 1 w.
R55—300,000 ohms 1w.
R56—1000 ohms 10 w.
R57—50 ohms C.T.
R58—50 ohms C.T.
R59—1500 ohms 10 w.
R60—50,000 ohms pot.
R61—250,000 ohms pot.
R62—1 meg 2 w.
R63—10 meg 2 w.
R64—10 meg 2 w.
R65—1 meg 2 w.
R66—1 meg 2 w.
R67—.7 meg 10 w.
R68—.5 meg pot.
R69—2 meg 5 w.
R70—.5 meg pot.
R71—2 meg 3 w.
R72—1 meg pot
R73—.3 meg 5 w.
R74—1 meg pot.
R75—20,000 ohms adj.
R76—100 ohms C.T.
R77—5000 ohms 10 w.
R78—70 ohms 10 w.
R79—70 ohms 10 w.
R80—10,000 ohm 10 w.
R81—5000 ohm 10 w.
R82—.5 meg 2 w.
R83—.5 meg 2 w.
R84—1331.4 ohms .5 w.
R86—40,000 ohms 1 w.
R1—100 ohms C.T.
marked R4—; 50 ohms
Fil. res. first 57's
marked R32 is 50 ohms
Plates res. opposite R29
unmarked, 10,000 ohms

in parallel insofar as the power circuits go.

High voltage power supply for the cathode tube can be seen directly behind the amplifier in the picture at the top of the page. It uses a single 866 rectifier and operates on the half-wave rectification system. The current drain from this power supply is one milleampere and it will not cause any voltage fluctuation in the power supply when this is used. A full-wave system could be used, but the cost would be exorbitant. The diagram fully explains the component parts and their hook-up. It also gives the necessary voltages for checking.

After the high voltage supply has been completed, the sweep circuits should next be commenced. The cathode ray sweep circuit and its associated power supply is shown. The controls in the front of the panel are from left to right the horizontal amplitude control, the horizontal frequency control, blocking control, frequency control and the verticle amplitude control. This sweep circuit operates the horizontal and vertical amplifiers of the cathode ray oscilliscope. It utilizes two 885 discharge tubes and two '58 tubes. The associated power supply to which it is connected by means of a cable and plug arrangement contains a power transformer a type 5Z3 chokes and the condensers in filter arrangement. Two power supplies are mounted on this chassis, one for the sweep circuits and the other for the amplifier. The transformers are mounted along the rear side of the sweep circuit chassis and 2½ volt filament transformers are used to light all of the heaters in the transmitter.

After the oscilliscope power supply and sweep circuits have been completed it will be well to test them with an oscilliscope. In the event that the sine wave input is not available for test purposes, 60 cycle current may be put upon horizontal or vertical plate through a .002 mfd. mica condenser. If everything is in order, the oscilliscope should operate as is customary.

The amateur is now ready for the construction of the difficult part, the amplifier. Component parts are all listed in the diagram itself. Procure a chassis 35 inches long, 10 inches wide and 6 inches high. Divide this into six compartments, each of approximately 6 x 10 inches in size. The tubes should be mounted in each compartment as is shown in the photograph, making certain that all wiring is as short as possible. Do not purchase anything but the very best parts. Check each resistor at the time of the purchase, and be sure that the values are exact and use the ohmmeter as a reference rather than the printed label upon the part. A few ohms difference in the various resistors might unbalance the amplifier and will make a great deal of difference in the performance of the finished product. Mount the Eby cell on the outside of the chassis to the extreme left and proceed with the wiring and construction as is indicated jointly by the diagram and the photograph.

After the amplifier has been completed tubes should be inserted and it should be checked for hum by turning on all of the filaments and the voltage to each tube. If any hum is present, it will show on the cathode ray tube in the receiving position. Hum must be removed before the amplifier can be put into television operation.

By means of the lenses, focus the beam of the transmitting cathode ray tube upon the Eby cell. If everything is in order, a square frame of light should appear on the receiving tube at the other end of the amplifier. Both cathode ray tubes are connected in parallel as is indicated in the diagram. If the diagrams, pictures and hints herein contained, have been followed, and the apparatus tests ok, a picture can now be televised. Place a sharp contrast negative up against the end of the cathode ray in the transmitting position. Turn on all filaments and tubes. If everything is working right, a positive reproduction should appear on the receiving C. R. tube screen. You are now ready to put the television transmitter on the air.

(Black Box Foto)

Checking transmitter's Video section shows a good, clear picture coming through. Note the typical amateur's mounting. The cover is cardboard.

Because of the wide frequency range of video signals, it is impossible through a transformer plate to modulate any transmitter. Grid modulation, therefore will have to be resorted to. The modulator and driver should now be constructed. We used a pair of 10's as modulators and a pair of 10's as RF final amplifiers.

Feeding the output of the amplifier at points x-x into a pair of 45's in push-pull as is indicated in the diagram, we fed that to 2 10's operating in Class A. Here again the diagram is self-explanatory. The output of the 45 drivers is fed through a low impedance network to the modulators. These, in turn, grid modulate another pair of 10's acting as final RF amplifiers . The crystal and exciter circuit in the RF section has not been drawn since it is well-known to almost every amateur.

In order that amateurs who have different types of receiving sets, as well as any short wave listeners who might be equipped to give you a report, can tune you in, the following procedure is one we adopted with considerable success.

Fire up your regular transmitter, call "CQ Television," or "CQ Video." Do not turn on the Video transmitter. When you make a contact, inform the person receiving, that you wish to transmit a video signal. The person receiving will need the following information. First, the wavelength in KC upon which you expect to transmit your video signal; second, the horizontal scanning frequency, and third, the vertical frequency of the image.

Actually in practice, it works out something like this. W9 . . . calls CQ on 59.9 MC. Receiving a reply, he advised the recipient to watch for the video signal on 58 MC and gave him the horizontal scanning frequency of 5760 cycles and the vertical frequency of 24 cycles. The recipient then tunes his television receiver to 58 MC and set his cathode ray sweep circuit to the horizontal frequency of 5760 cycles and the vertical frequency of 24 cycles. By doing this, the transmitter and the receiver were in synchronization. Transmitted signal and picture came through with considerable clarity. Audio or voice transmission must be at least 1.5 MC removed from the video signal.

The transmitter we described does not transmit any signal of a synchronizing nature, but it does enable the amateur to start on his way with television. As we see it, in the future amateurs will call "CQ Video" and receiving an answer, will transmit their video signals. The receiving amateur will set up the necessary components in his receiving oscilliscope to synchronize with the transmission. Wide variation from 60 cycles on the A.C. line will prevent the picture from being received properly.

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Radio News, April 1938