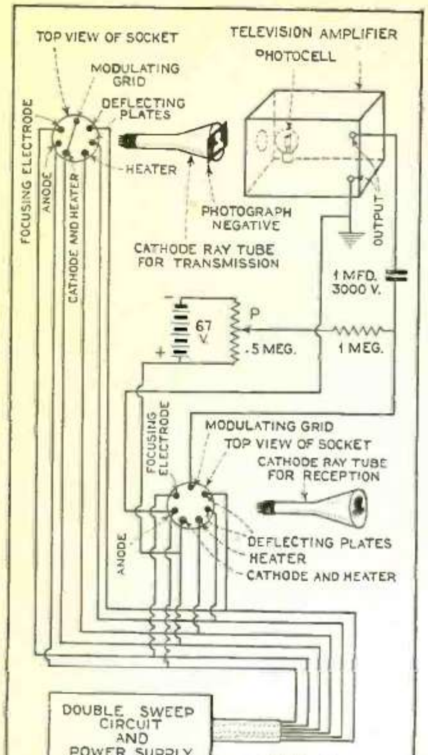


FIG. 1

TELEVISION APPLICATIONS OF CATHODE RAY TUBES

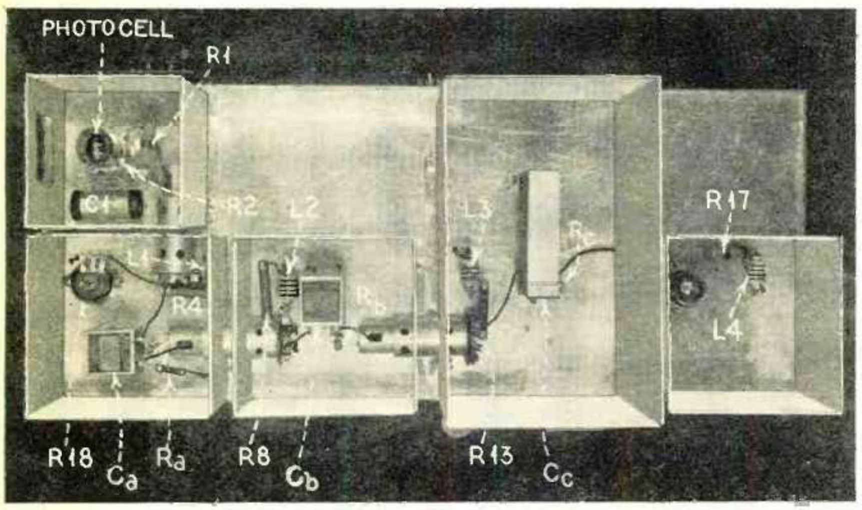
In this, the fifth, article the authors describe an amplifier with an unusually flat frequency characteristic ranging from 1/4 cycle to 250 kc.

J. M. Hollywood, M. P. Wilder

IT is probable that cathode-ray tube reception of television pictures will become important in the future, because they can be made suitable for pictures of any number of lines and degree of definition, up to 400 lines at least. It would be difficult to make mechanical scanners to handle such high scanning speeds, but there are no moving parts in the cathode-ray tube and no limit as to its scanning speed. The degree of detail in pictures than can be obtained depends upon the size of the spot of light produced on the screen as compared to the size of the screen. Apart from this, picture detail in cathode-ray television is limited more by the apparatus associated with the tube than by the tube itself.

Accordingly, it may be of interest to describe an amplifier which can handle a sufficiently wide frequency range to permit pictures of 120 lines, recurring 20 times a second. This amplifier has a calculated gain of over 100 db. and is shown in the accompanying photographs, its circuit being given in Figure 2. This amplifier was used in sending television pictures over a short wire line. This experiment can be duplicated by anyone sufficiently interested, without too great expense. The arrangement is shown in Figure 1.

Two cathode-ray tubes are used. The deflecting plates of both tubes are connected together and to a common sweep circuit. In this way, the spots of light on both screens are automatically moved in synchronism while scanning the screen area. The tube at the sending end is used to scan a photographic negative with the moving spot of light, the negative being held tightly against the screen. The light is then passed on to the photo-cell and amplifier, where changes in voltage occur in accordance with changes in light as the spot passes over darker and brighter parts of the negative. These voltage changes are amplified and applied to the modulating grid of the cathode-ray tube used for reception. The amplifier, photo-cell and cathode-ray tube are connected so that a decrease of light on the photo-cell causes an increase of brightness of the



INSIDE VIEW OF AMPLIFIER

Extraordinarily thorough shielding is employed. Note the horizontal mounting of the tubes. The resistance-capacity filters are under the chassis

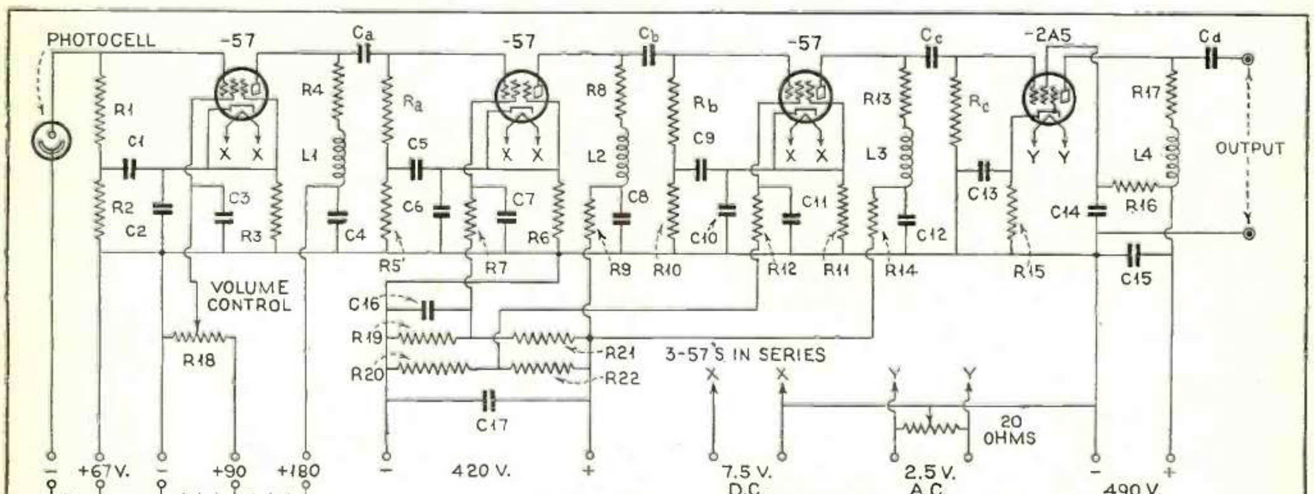


FIG. 2

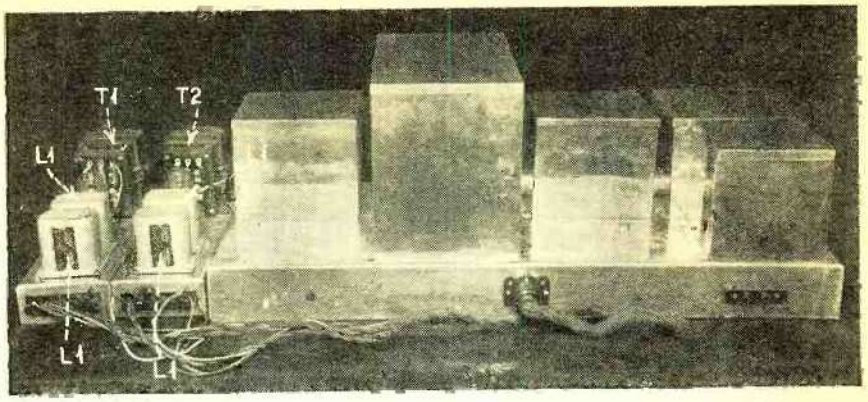
spot on the screen of the cathode-ray tube. Consequently, a positive picture is traced out on the end of the receiving tube as the negative is scanned at the sending end.

The power supply and sweep circuit can be similar to that shown in the second article of this series, in the December issue of RADIO NEWS. Instead of one sweep circuit, however, two must be used, one for deflecting the spot of light horizontally across the screen about 2400 times a second, and the other for deflecting the spot vertically about 20 times a second. The combination of the two linear deflections causes the spot to trace out scanning patterns of about 120 lines. The pattern will be repeated 20 times a second, which will not give much flicker.

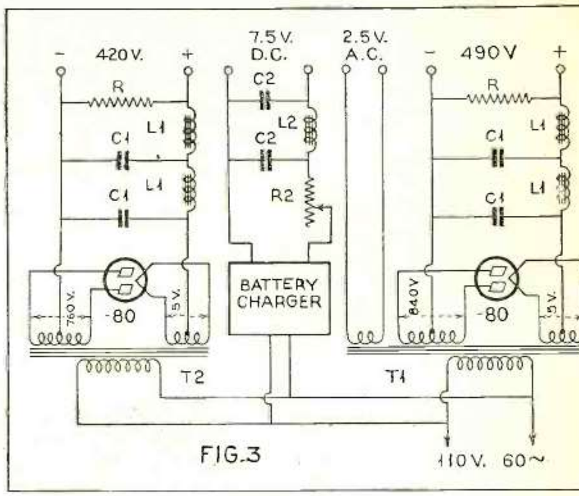
It is to be understood that the socket connections shown are only for a particular make of cathode-ray tube. However, any cathode-ray tubes can be used if the socket connections are changed so that the proper wires go to the proper electrodes in the tubes. The power supply voltage for the focusing electrode may have to be changed by altering the resistance values in the voltage divider in that unit; and the heater voltage may have to be changed by means of a rheostat or a different transformer voltage. This applies to the power supply described in the December issue. Data given by tube manufacturers should indicate what changes, if any, will have to be made in the power supply.

The general light intensity level of the picture can be regulated by varying the grid bias voltage with potentiometer P of Figure 1. This should have an insulating shaft, and it and other apparatus connected to the grid should not be touched, because such points are at high d.c. potential with respect to ground. The degree of contrast in the picture can then be regulated by varying the volume control of the amplifier. If the largest possible output is small, the light intensity will have to be reduced by potentiometer P to obtain good contrast. In any case, the average light intensity should not be made over half the maximum possible value, so that it can increase when a positive voltage is applied to the grid from the television signal.

The amplifier itself is rather interesting. A wide frequency range must be amplified in order to reproduce fine details. For example, if the picture is a checkerboard with 120 squares to a side, when the light spot sweeps over the picture it will be interrupted 60 times per line, 7200 times per picture, and 144,000 times per second. Frequencies at least as high as 144,000 cycles would have to be handled to obtain even a poor reproduction of such a picture. On the other hand, if the top half of the picture is black and the lower half white, the light will be interrupted 20 times a second, requiring frequencies lower than 20 cycles to be passed. When such a picture is shown, the voltage input to the amplifier jumps suddenly to a constant value lasting for a fortieth of a second, then jumps down to another constant value. The output voltage will not follow this action faithfully unless the



coupling condensers Ca, Cb, Cc, discharge slowly through resistors Ra, Rb, Rc, as compared to the time the input voltage remains at one level. A condenser of C mfds. discharging through a resistance of R megohms starts discharging at a rate that would discharge it completely in (CR) seconds. In order to have each condenser discharge only 2.5% while the input remains constant for one fortieth of a second, (CR) was made equal to 1 second in each case. This would make the amplification drop 16% in each stage at one-quarter of a cycle per second; i.e., 50% drop for the entire amplifier and its coupling system to the cathode-ray tube at ¼ cycle.



POWER SUPPLY

Two independent power-supplies are used to insure stability. Any good battery charger which can deliver one ampere is suitable for the filament supply

At high frequencies the amplification is limited by the interelectrode capacities between cathode and grid and between cathode and plate of the tubes, and other stray capacities by-passing the coupling resistors. The coupling condensers are mounted as far from the shielding as possible, but even so the total by-passing capacity is about 20 mmfd. In order to make this by-passing action relatively small, low-resistance coupling must be used. With resistors of 30,000 ohms, the amplification per stage would drop 16% at a frequency of 250 kc., making total drop in amplification about 50%. By using small inductances in series with the coupling resistors as shown, the amplification tends to increase at high frequencies, counteracting to some extent the by-passing action of stray capacitants. Thus it is seen that the amplifier loses 50% of its gain or 6 db. at ¼ cycle and at over 250 kc. Its calculated gain is 110 db. or 300,000 times. With such high gain and such a frequency range, very good shielding is necessary, so all parts are completely enclosed in aluminum shield cans except the photo-cell, for which an opening is cut, protected by a copper screen. Magnetic shielding is unnecessary, since the only inductances used are very small.

The fact that the amplifier passes very low frequencies means that trouble may be encountered from slow oscillation or "motorboating," and to prevent this, simple filter circuits are placed in individual grid and plate leads; also the screen-grid leads cannot be connected to a common voltage divider, but must have individual dividers or series resistors. Trouble may also be encountered from fluctuations of the a.c. line voltage; if this is serious, some automatic line voltage or B voltage regulating device may be necessary, or B batteries can be used instead of an a.c.-operated supply from the first stages.

In a receiver for television by radio, much less low-frequency amplification is used, and many of the difficulties encountered in the amplifier become negligible. The fact that such a high-gain amplifier suitable for television can be made shows that the problem of making a receiver that will give sufficient picture detail is by no means insoluble.

Incidentally, the output of the amplifier shown in Figure 1 could be used to modulate a small amateur transmitter for transmission of photographs, pictures of call letters, etc., by radio at small expense, on the proper wavelengths and with the proper license. It would be necessary to provide for synchronization (*Continued on page* 566)

The DX Corner (Broadcast)

(*Continued from page* 545)

767	Gr. Britain, Midland Regional	30
776	Toulouse, France	60
785	Leipzig, Germany	120
804	Gr. Britain, Scottish Regional	50
814	Milan, Italy	50
832	Moscow, Russia	100
859	Strasbourg, France	11.5
877	Gr. Britain, London Regional	50
886	Graz, Austria	7.
922	Brno, Czechoslovakia	36
932	Brussels, Belgium	15
950	Breslau, Germany	60
977	Gr. Britain, West Regional	50
1013	Gr. Britain, North National	50
1031	Heilsberg, Germany	60
1040	Rennes, France	1.3
1050	Gr. Britain, Scottish National	50
1077	Bordeaux, France	13
1131	Horby, Sweden	10
1149	Gr. Britain, London National	50
1195	Frankfort, Germany	17
1222	Trieste, Italy	10
1249	Luxemburg	10
1258	Rome, Italy	50
1411	Bucharest, Roumania	12

New Zealand Changes

Following is a list of New Zealand stations which started operating on new frequencies in December. The old and new frequencies are both given, for convenience:

Call	*Location*	*Old Fre.*	*New Fre.*
1YA	Aukland	820	650
1YX	Aukland*		880
1ZB	Aukland	1420	1190
1ZH	Hamilton	630	770
1ZJ	Aukland	1320	1310
2YA	Wellington	720	570
2YB	New Plymouth	1230	750
2YC	Wellington	1010	840
2ZD	Masterton	1180	1170
2ZF	Palmerston N.	1050	960
2ZH	Napier	1370	820
2ZJ	Gisborne	1150	980
2ZL	Hastings	1400	1240
2ZO	Palmerston N.J	1050	1400
2ZR	Nelson	1360	1110
2ZW	Wellington	1120	1060
3YZ	Christchurch	980	720
3ZR	Greymouth	1300	940
4YA	Dunedin	650	790
4ZB	Dunedin	1080	1050
4ZM	Dunedin	1080	1050
4ZO	Dunedin	1080	1050
4ZP	Invercargil	1160	620
4ZW	Dunedin	1080	1470

*New Station

Canadian Changes and Additions

The Canadian Radio Commission has announced changes in frequency, power or call letters of several Canadian stations. Following are the new listings for these stations:

Call	*Location*	*Freq. Kc.*	*Power Watts*
CFAC	Calgary, Alta.	930	100
CFCO	Chatham, Ont.	600	50
CFRC	Kingston, Ont.	1510	100
CFCT	Victoria, B. C.	1450	50
CHCK	Charlottetown, P. E. I.	1310	50
CHGS	Summerside, P. E. I.	1120	50
CHPR[1]	St. John, N. B.	1370	100
CJAT[2]	Trail, B. C.	1200	100
CJCA	Edmonton, Alta.	730	1000
CJCJ	Calgary, Alta.	690	100
CJKL[1]	Kirkland Lake, Ont.	1310	100
CJLS[2]	Yarmouth, N. S.	1310	100
CJOR	Vancouver, B. C.	600	500
CJRC[1]	Middlechurch, Man.	1390	100
CJRM	Moose Jaw, Sask.	540	1000
CKBI[3]	Prince Albert, Sask.	1200	100
CKCR	Kitchener, Ont.	1510	100
CKGB[1]	Timmins, Ont.	1420	100
CKMC	Cobalt, Ont.	1210	50
CKOC	Hamilton, Ont.	1120	500
CKPC[4]	Brantford, Ont.	930	5
CKPR	Fort Williams, Ont.	780	50
CRCV	Vancouver, B. C.	1100	1000

[1]New stations. [2]CJAT, formerly 10-AT, 1155 kc., 25 watts. [3]CKBI, formerly 10-BI, 1200 kc., 25 watts. [4]CKPC, formerly 10-BQ, 1200 kc., 5 watts.

Special Program from France

The New England Radio Club *DX News*, the bulletin sent out periodically to members of the New England DX Club (135 Highland Street, Worcester, Mass.), contains a note that should be of particular interest to DX fans, especially those along the east coast. It states that the French station, Poste Parisien, announced during a recent broadcast that a special program would be put on, in English, each Sunday from 6 to 6:30 p.m., E.S.T., on 776 kc. This station has a power rating of 60 kw. and on the frequency it employed prior to January 15 was well received in the eastern part of the U. S. and Canada. The proximity of its new frequency to those of WJZ and WBAL may offer complications for listeners in several of the coast states. The DX Corner will be glad to receive reports from readers who hear these programs.

Cathode Tubes in Television

(*Continued from page* 539)

of scanning at the transmitter and receiver, for instance, by using sweep circuits at the two ends with the frequencies "locked" by means of the same a.c. power system.

The last article of this series will show the results of some tests on this amplifier, and will give some further comments on cathode-ray tubes as applied to television by radio, including a suitable double sweep circuit.

Parts Used in Amplifier of Figure 2

Ca, Cb—Aerovox bakelite case or filter condensers, 1 mfd., 400 volts
Cc, Cd—Aerovox filter condensers, 4 mfd., 400 volts
C1, C2, C3, C5, C6, C9, C10—Aerovox electrolytic condensers, 25 mfd., 100 volts
C4, C7, C8, C11, C12, C13, C14, C15, C16, C17—Five Aerovox double electrolytic condensers, 8-8 mfd., 500 volts
L1, L2, L3—Hammarlund r.f. chokes, 8 millihenries
L4—National r.f. choke, 2.5 millihenries
Ra, Rb—IRC metallized resistors, 1 megohm, 1 watt
Rc—IRC metallized resistor, .25 megohm, 2 watts
R1—Aerovox wire-wound resistor, 50,000 ohms, 10 watts
R2—IRC metallized resistor, 50,000 ohms, 2 watts
R3—Aerovox wire-wound resistor, 900 ohms, 5 watts
R4—IRC metallized resistor, 30,000 ohms, 3 watts
R5—IRC metallized resistor, .1 megohm, 2 watts
R6—Aerovox wire-wound resistor, 1,000 ohms, 10 watts
R7—Aerovox wire-wound resistor, 100,000 ohms, 15 watts
R8—IRC metallized resistor, 30,000 ohms, 3 watts
R9—IRC metallized resistor, 85,000 ohms, 3 watts
R10—IRC metallized resistor, .1 megohm, 2 watts
R11—Aerovox wire-wound resistor, 1,000 ohms, 10 watts
R12—Aerovox wire-wound resistor, 100,000 ohms, 15 watts
R13—IRC metallized resistor, 30,000 ohms, 3 watts
R14—IRC metallized resistor, 85,000 ohms, 3 watts
R15—Aerovox wire-wound resistor, 410 ohms, 5 watts
R16—IRC metallized resistor, 37,000 ohms, 3 watts
R17—Aerovox wire-wound resistor, 7000 ohms, 15 watts
R18—Electrad potentiometer, 50,000 ohms
R19, R20, R21, R22—IRC metallized resistors, 50,000 ohms, 2 watts