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TELEVISION KIT CONSTRUCTION HELPS TO UNDERSTAND VIDEO page 42

The TELEVISION KIT

A better understanding of video components and behavior of the circuits results from the actual construction of a TV set.

By MARK FLOMENHOFT

A home-constructed unit can achieve a "professional" look when housed in a specially built cabinet. Unit at right has built-in magnifier lens.

IT SHOULD be especially timely to pause at this still early stage in the growth of the television industry in order to take inventory of the design practices that are at last crystallizing in the kit field. There are, of course, other reasons to justify a study of trends in over-all kit design. Consideration of kits offers a picture of the industry as a whole since, in basic principle at least, differences between factory and home-constructed sets are quite superficial. More to the point, however, is the fact that many people still believe that a layman cannot build a good instrument, and so an authoritative discussion of problems actually uncovered by what is now more than a year of experience may serve to end prejudices that are caused by the absence of concrete information. By the same token, the dealer himself should be capable of more forceful and intelligent sales arguments if he is familiar with the inside story behind the procedures of the television kit he distributes.

Because specific examples and illustrations often hasten an understanding of general principles, material supplied by *Transvision, Incorporated,* New Rochelle, New York, has been used to illustrate the subject matter.

A representative milestone of progress in television design is to be found in the deflection circuits currently in vogue. It may be recalled that the first kits to appear on the market featured seven inch kinescopes that employed electrostatic deflection. Consequently, simple capacity charging circuits with timing controlled by equally simple multivibrators were employed for the generation of deflection voltages. (See horizontal and vertical oscillators of Fig. 2.) But consistent with the inescapable American attitude in such matters, the passage of time has occasioned an insistence for larger pictures that even now is progressively restricting the applications for which smaller tubes are deemed acceptable. A by-product of this eagerness for large pictures, is the growing popularity of the "blow-up" lens.

EDITOR'S NOTE: *The increasing popularity of television kits is due, largely, to intelligent engineering and practical construction approach of these kits.*

The Editors of this magazine have preached the gospel of "learn by doing" for a long time. Realizing that one of the best ways to get acquainted to TV circuits is to build up a set from scratch, we considered total cost of components plus labor (not to mention the messy job of chassis fabrication) and pre-tuning problems and compared this figure to equivalent manufactured sets.

It didn't take long to make the decision in favor of the "kit" idea. Many months of engineering go into a TV kit. Drawings of elaborate proportions are simplified to the extent that almost anybody can produce a set that compares favorably with many production receivers. As a result, a kit has the advantage of being an instrument of instruction as it develops into a finished article capable of providing endless hours of entertainment.

But taking this demand for large pictures as a starting point, let us recapitulate the straightforward—in fact, obvious—steps that have led to the more elaborate deflection circuits of Fig. 1.

First of all, what kind of deflection should be used in a larger picture tube? The answer—electromagnetic, of course. There are many reasons. The electromagnetic tube is better and cheaper to manufacture, for one thing. It is better because it permits a greater concentration of the beam, and this fact, in turn, provides superior definition and brilliance. It is cheaper to manufacture because the absence of deflecting plates removes many causes for "shrinkage" (rejects) in addition to eliminating numerous operations in the assembly of the tube. By no means trivial is the smaller size of the electromagnetic tube, a property that facilitates cabinet design appreciably. From a design standpoint, furthermore, the larger electrostatic cathode-ray tubes require deflection voltages in excess of 600, while sweep circuits for similar electromagnetic tubes can function satisfactorily with the conventional 350 volts. Perhaps of lesser importance is the somewhat greater illusion of realism imparted by the flat faces of electromagnetic tubes.

The next decision to be made concerns the selection of an impulse generator. Fig. 1 discloses that blocking oscillators have replaced the multivibrators of Fig. 2, and to avoid what

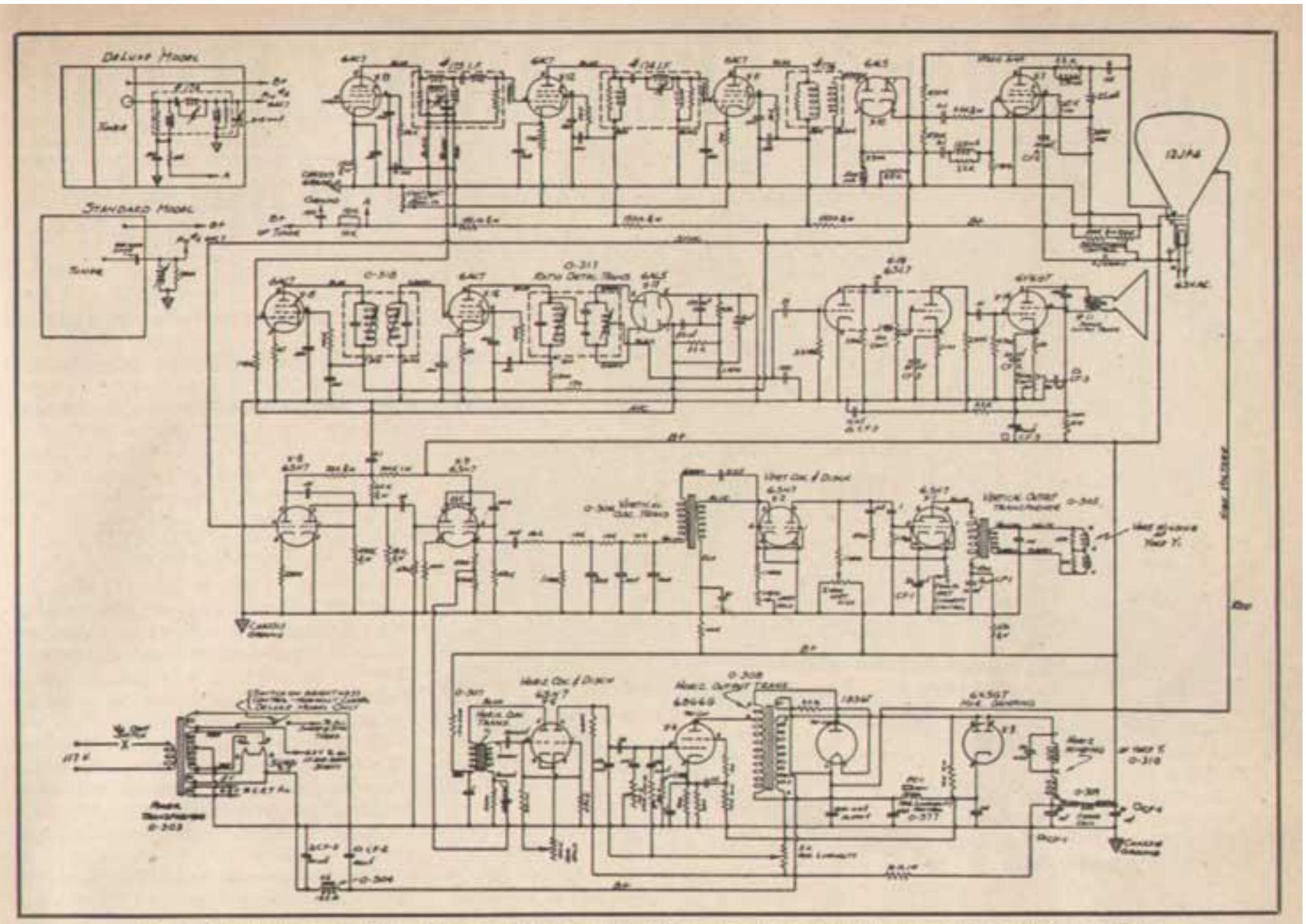

Fig. 1. Circuit diagram of Transvision's deluxe model receiver. An electromagnetic picture tube is used in this kit.

would now be an outmoded debate of virtues offered by these methods, let us make two brief observations.

1. Experience has definitely verified the superiority of the blocking oscillator for both stability (e.g., resistance against misfiring, an occurrence that the spectator interprets as "tearing") and what is really a smaller dose of the same problem, constancy of the triggering point (e.g., the point on the deflection waveform at which triggering occurs, a circuit property that enables the picture to appear sharper to the spectator).

2. The feasible price and performance of blocking oscillator transformers make their use a virtual "must."

At this point it is necessary to settle the issue of high voltage. By elimination we choose the "fly-back" circuit. Here we find that by utilizing the enormous inductive "kick" generated during the brief retrace time of the horizontal scanning cycle, the desired voltages can be obtained both economically and conveniently. Some shielding precautions, or at least a favorable arrangement of parts, must still be observed to prevent harmonics of the 15,750 cycle fundamental in the horizontal oscillator from interfering with nearby AM radios.

Referring to the horizontal oscillator, let us assume that initially the left-hand section of the 6SN7 (X-6) is cut off. Now suppose a positive pulse is conveyed from the right-hand cathode section of X-9 to the point marked "yellow" on the diagram. For successful triggering the magnitude of this pip must raise the grid voltage by an amount that permits conduction. This current flow and the ensuing drop in the transformer winding sharply drops the voltage at the point marked

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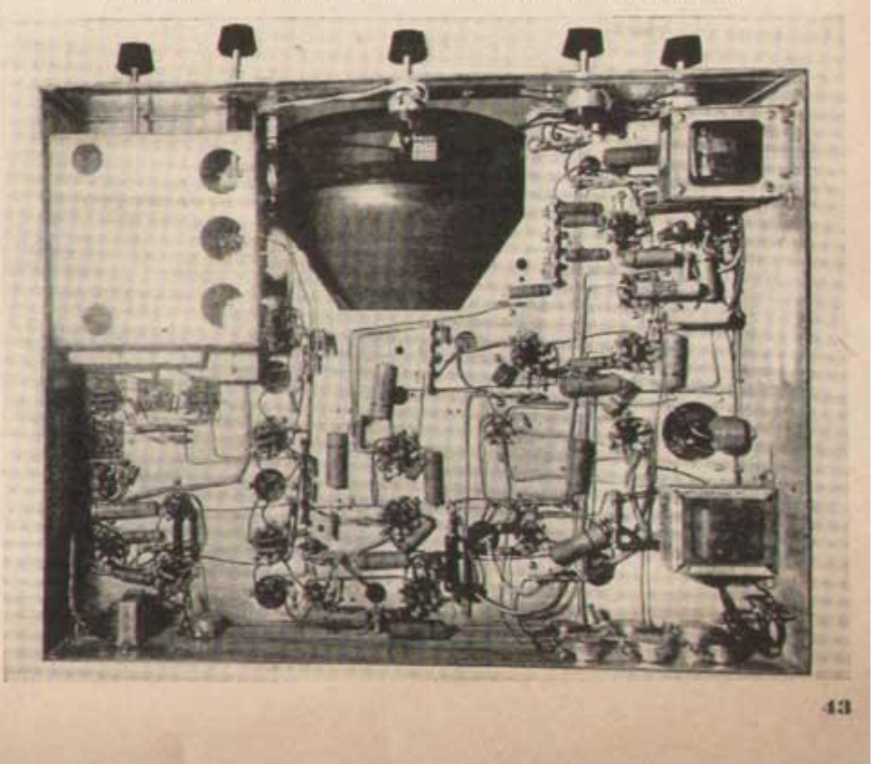
Under chassis view of video receiver constructed from Transvision kit.



The Television Kit

(Continued from page 43)

and the transformer connec-
re such that a large positive
now appears on grid "4" to
ate the process. Note, however,
is action charges the 500 μμfd.
ser in a manner that places its
e side on the grid.

while, the positive voltage is
directly to the other grid so
is triode also conducts heavily
pidly discharges the 1000 μμfd.
ser in series with the 100,000
otentiometer. Presently a re-
ction begins, for when the or-
triode saturates, its plate
can drop no further. Conse-
, only the negative voltage ap-
y the 500 μμfd. condenser as it
ges through its grid leak is left
ar on the two grids, cutting off
bes until the next positive pip
in a new cycle, and permitting
harging of the 1000 μμfd. con-
previously mentioned.

ntrast to the saw-tooth volt-
quired for electrostatic de-
, modifications must now be
ced so that the currents flow-
he deflection coils will increase
nstant rate, the condition for
deflection in electromagnetic
s.

coil did not contain resistance,
tage across it would be *L* (its
nce) multiplied by the rate at
ts current changed, and a con-
hange of current would there-
duce a constant voltage across
terminals. In other words, if
red current is that of curve *A*
3, the corresponding voltage is
y *B*.

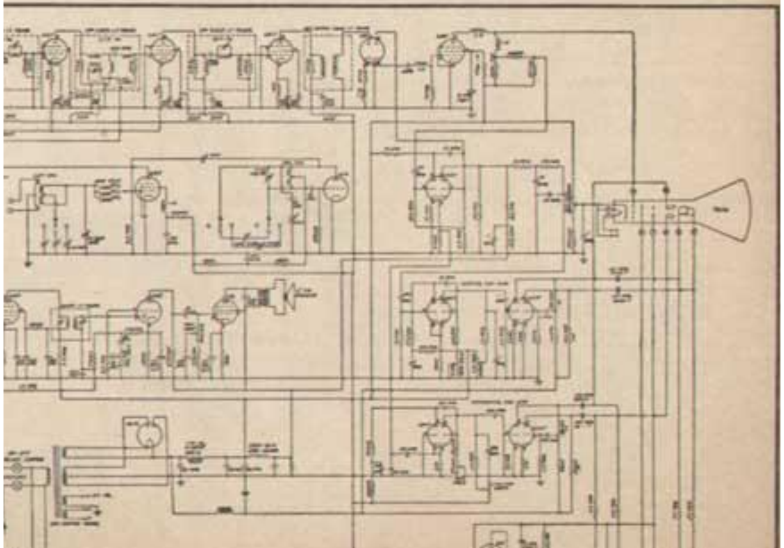
Unfortunately, real coils always possess finite resistance that leads to a further *IR* drop of the form denoted by *C*, and the terminal voltage accordingly becomes the sum of *B* and *C* as shown by curve *D*. Reflection should now disclose that, conversely, if a waveform of the form *D* is generated and impressed across a real coil, the resulting current through it must increase at a constant rate.

As a result we perceive that the linearity of the sweep depends upon how closely we succeed in matching *D*. Luckily, a reasonable approximation can be attained by holding the current flowing into a charging condenser and a series resistor substantially constant. A linear rise of voltage now develops across the condenser during the charging time, while the flood of current during discharge develops an appreciable voltage (V_r on *D*) across the resistor. In this manner, we achieve an acceptable duplication of the desired waveform.

The actual design task involved is tricky, however, leading to the additional components attached to the grid of X-4. Such compensation is generally found by trial, and in the kit field must also permit easy adjustment by the novice. This point illustrates one of the differences between kit and factory assembled receivers. The factory circuit can frequently use less components since trained personnel with access to suitable equipment make all adjustments before shipment. The kit, on the other hand, repeatedly must resort to expedients that offset the inexperience of the lay constructor but which do not sacrifice quality.

The remainder of the horizontal section needs little explanation. The 6BG6G is a straight current amplifier feeding an output transformer serving a dual role. One function performed is simply that of matching the amplifier to the low impedance of the yoke coils, while the other consists of tapping off a portion of the tremendous voltage induced during the retrace interval, with rectification accomplished by the 1B3GT and the 1200 μμfd. condenser in its filament circuit. Finally, the 6X5GT is inserted to damp out the transient oscillations created by discontinuities in the waveform. The tube is connected to conduct when current increases and consequently no lengthening of the retrace time is sustained. Although a factory-built receiver would probably use a heavier tube, careful investigation has vindicated the 6X5GT as completely satisfactory for this application, thus eliminating an extra filament winding.

Fig. 2. Circuit diagram of an early model kit using a 7 inch tube. Since electrostatic deflection was employed capacity charging circuits were used, controlled by simple multivibrators, to generate deflection voltages.



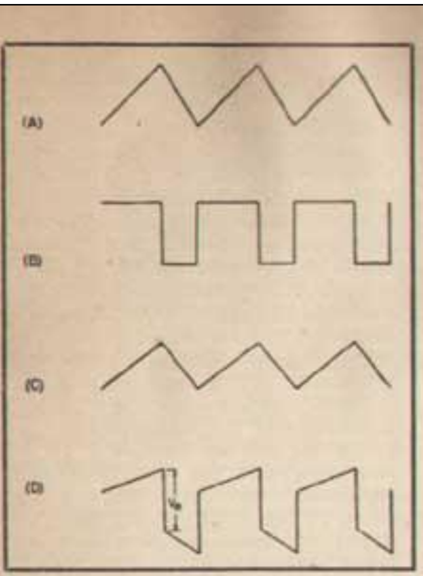


Fig. 3. (A) Current through and (B) voltage across perfect inductance. (C) Voltage across the finite resistance of an actual coil. (D) Combination of (B) and (C) gives required voltage across a real coil to provide a saw-tooth current waveform.

Since the vertical section has to produce a deflection current and nothing more, its design is a simplification of the procedures just discussed and the reader may analyze the circuit at his leisure.

So far we have learned that the clamor for large picture size is currently making electromagnetic deflection almost standard for kinescopes, causing sweep circuits for both kit and factory-built receivers to be essentially alike. The i.f. section, however, gives us a totally different situation. For one thing, the i.f. channel in this particular kit has remained unchanged in form since its inception for the seven inch tube over a year ago. It also is completely different from i.f. systems appearing in many factory sets where staggered tuning or judiciously coupled stages are feasible. Notable success has been achieved with a double-tuned, trap-coupled innovation that allows the builder to perform i.f. alignment by visual and auditory observation. Examination of either Fig. 1 or 2 will reveal that an inductance resonates with interelectrode and stray capacities in both the plate and grid circuits, with severe damping present to attain wide bandpass. In the second video i.f. transformer (Fig. 2) a tunable resonant circuit traps frequencies immediately surrounding 21.9 mc. and conveys them to the audio stages, while another trap in the third video transformer is set for 27.4 mc. The two preceding sentences explain the term "double-tuned, trap-coupled," features that accept wanted frequencies and reject the undesired ones of adjacent channels. Although large damping resistors diminish gain, the three i.f. stages definitely provide all the amplification a receiver needs, and generally speaking, the factor limiting reception is geography rather than receiver sensitivity.

Detection and video amplification are effected in a conventional manner. Positive signals derived from the cathode of the diode excite a single stage of power amplification characterized by peaking coils in its input and output circuits.

Considerable design latitude is available to the engineer when he tackles the sync limiter-separator. Probably this fact exists because the problem is still one of television's weak links, and until the appearance of a new technique that can really suppress interference effectively, we can expect to find extensive variety in these circuits. Nevertheless, they will all seek to perform the identical function of first responding exclusively to the synchronizing pulses, then transferring the narrow pips to the horizontal oscillator and the serrated pulses to the vertical oscillator.

Several interesting comments can be made about the audio channel. For
one thing, a ratio detector is b
suited for a kit because it is easy
adjust. Low output relative to ot
FM detectors is quite unimportant
cause amplification can be readily
complished. But in this connect
note the somewhat unusual pro
dure of using a high gain duo-tri
ahead of the power tube. This g
could have been furnished just as a
quately by the customary method
another i.f. stage. The 6SL7, howe
dispenses with tuning an extra i.f. c
certainly a desirable simplification
a home-assembled receiver.

There remains only the r.f. unit
consider, and the situation here is
particular interest because of the c
cial importance the tuner bears to
entire receiver. In short, a slips
r.f. unit can nullify completely w
might otherwise be a well-desig
set. Clarity may be impaired, contr
may be reduced, frequency drift
necessitate periodic adjustment
image rejection, already inheren
low, may be lowered still further.
most important of all, the picture n
be badly marred by the incessant pr
ence of "noise" and "snow."

For the uninitiated, "snow" is
advanced case of "noise," and both
marked by the impression of sm
dots swarming chaotically in all dir
tions. Unfortunately, even the m
expensive instruments are plag
somewhat by this defect. Since
occurrence is related to the signal-
noise ratio in the output of the c
verter (the converter, to be sure,
the chief source of noise in any
ceiver), gain becomes secondary to
task of obtaining a high signal-to-no
ratio. Naturally, the problem is
formidable one justifying the full ti
of entire engineering staffs. And
to be overlooked is the vexing mat
of mechanical layout, a problem that is aggravated by the high frequencies of television. Hence, by paying for rigorously designed r.f. units, and by alloting the manufacture of the unit to a sub-contractor, many kit manufacturers succeed in reducing noise to negligible proportions.

Certainly this discussion of design trends would be incomplete if we failed to mention the fundamentals of layout and similar considerations, like shielding the 6BG6G. We are also given an excellent example of how public opinion will make its power felt, as it was consumer reaction that relegated the "hold" controls to the rear of the chassis, leaving the front of the finished model as simple as possible.

The most imperative matter, of course, concerns space. Cramped corners and crowded regions are just out of the question if the beginner is to avoid confusion and if servicing problems are to be simplified. By providing generous space, incidentally, surprisingly neat wiring jobs are made possible.

One result of this consideration is the slightly increased chassis size of the kit compared to the factory product. Nevertheless, attractive cabinet design lends a distinctive and professional appearance to the kit that compares favorably with the factory-produced set.

All in all, the kit industry has unquestionably rendered three noteworthy services. First, it has brought the enjoyment of television to many people who otherwise would not have been able to afford it. Secondly, the use of kits has been a major factor in educating a pool of technically trained men for the industry. Thirdly, and in a humanitarian sense this is the most praiseworthy achievement of all, the kit has been a valuable source of recreational and emotional relief to patients in various hospitals.

EDITOR'S NOTE: *Mr. Flomenhoft's article intrigued us to the extent that we too, assembled and studied a 10BL kit in our labs. Total time from unpacking to viewing WBKB's test pattern was 23 hrs. We weren't disappointed.*

Top chassis view of the completed television receiver.