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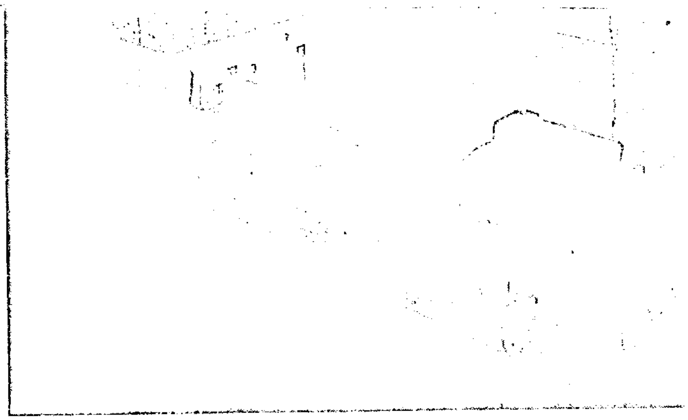
A New Field for the Experimenter



Over-all view of the color television system. The bottom unit on the left is the flying spot scanner which was made from a discarded TV set. The color slide to be transmitted is fastened to the face of the cathode-ray tube and is visible just beneath the upper chassis. In the center of the picture is the photocell chassis with three photomultiplier tubes equipped with red, blue and green filters facing the scanner. On the right is the sync and blanking generator. This, too, was made from a salvaged TV receiver, and is also part of the author's black and white television system. The coaxial cables from the photocell chassis carry the red, blue and green channels to the color unit, the upper chassis on the left. This is the heart of the system and contains a matrix for converting the three color signals to standard black and white, "I" and "Q" signals, plus the 3.58-Mc. color carrier oscillator, the color modulators and the burst signal generator.

Amateur Color Television

BY MELVIN H. SHADBOLT,* WØKYQ

Those who feel that regular black and white TV is on the far fringe of ham experimentation had better catch their breath. WØKYQ has built a color television system which transmits slide pictures and drawings with excellent quality. So far as we know, this is the first amateur color TV to be put on the air, at least in the United States. The signal is very similar to the NTSC standard for commercial broadcasters and can be viewed on a standard color set with a 420-Mc. converter. It is also compatible with regular black and white receivers. By using junk-box parts and sections of two give-away TV sets, the author kept the cost of the system to $175.

With amateur television on its way to becoming a popular phase of ham radio, it was only natural that some experimenting should be done in color. Since color TV has been confined primarily to commercial broadcast use, a great deal of planning and gathering of information was necessary before undertaking such a project. Such questions as what type pickup source would be desirable, could good color quality be obtained, what types of color filters should be used, and could junk-box parts be made to work had to be answered. After studying all of the facts and drawing up some circuits that would be satisfactory for amateur purposes, it was decided that it would be practical to go ahead with the project. Fig. 1 shows a block diagram of the system that was finally decided on and constructed.

Type of Pickup

Cost was a prime factor, and since this was an experimental project I decided to use the "flying spot scanner" type of pickup to transmit color pictures put on glass plates about 3¼ × 4 inches. These slides have been made with water colors, drawing inks, colored cellophane and transparency film. Briefly, the flying spot scanner depends upon a light source that is capable of scanning the color slide at the proper rate. The light at any one instant will depend on the density of the slide at that point. If the slide is in color the light will also be filtered as it passes through the slide.

Assume now that the beam of light is passing through a red portion of the color slide. This simply means that the red dye in the slide absorbs all the colors except red. Therefore, this is the only color that will pass through the slide at this instant. If a photocell is now placed in front of the slide with a filter in front of it so that only red light will be allowed to pass through, then a voltage that is proportional to the light passing through the slide at that point will be developed by the cell. Now, if we have a second cell with a filter that will pass only blue light in front of it, and a third cell with a green filter, we will be able to produce every color of the rainbow, including white, simply by proper mixing of the three basic colors.

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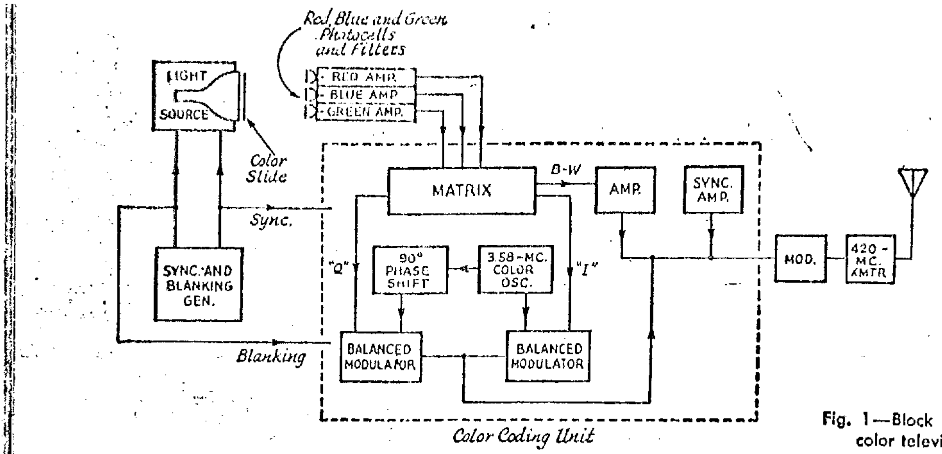

Fig. 1—Block diagram of the color television system.

For example, assume it is desired to produce yellow. Red and green when mixed in the proper proportion will produce this color. Therefore as the light beam is passing through a yellow portion of the slide, the red cell will see red information and the green cell will see green information. When these two separate signals are recombined, the original yellow will be reproduced. Let's take one more example. If we want to reproduce white light, which is actually a mixture of all colors, it will be found that the red photocell will see about 30 per cent of the light, the blue cell will see about 11 per cent, and the green cell will see about 59 per cent. When these three signals are added together, the original white will be reproduced.

The amount of light actually reaching the photocells after passing through the color slide and the selective filters is very small, so sensitive photomultiplier tubes were used. The green and blue channels use 931-As and the red channel uses a 1P22. These photocells are presently on the surplus market for about $5 each. The filters that were used in front of the red, blue and green photocells were Kodak Wratten filters Nos. 25, 47B, and 58, respectively. Each of the photocells is followed by a three-stage video amplifier employing 6AK5s. This unit was built on a separate chassis along with its own electronically-regulated power supply.

Light Source

Readily-available used television receivers at giveaway prices solve the problem of a scanning light source. In this instance, an old RCA KCS 28 chassis was obtained for $5. All of its front-end tubes were removed, leaving only the sync, video amplifier and deflection circuits intact. Another rectifier tube was added in parallel with the one that was already in the set, since it was desired to use this power supply to run the remainder of the color unit. Provisions were also made to feed in blanking and sync pulses to control the scanning.

For the light, a 5AXP4 picture tube was used. This is a TV serviceman's 5-inch substitution type tube. When selecting a tube to be used for color television, it must always be kept in mind that the light transmitted by the tube must have sufficient amounts of the three basic colors. If this condition is not met it will be impossible to obtain a satisfactory signal on all colors. Red is the hardest color to reproduce from the standpoint of both the photocell and the light source since each is down in output at this frequency.

Matrix

The real problem is still to come. The red, blue and green signals must now be prepared in such a manner that all their information can be put on one carrier and also produce a signal which is compatible with standard black and white receivers. This is the job of the matrix. Its first function is to produce a black and white signal from the three color signals. This is simply a matter of mixing the color signals together in the right proportions. The black and white signal will also be used in color reception as a mixing signal.

By properly adding and subtracting the red,

Close-up of the photocell pickup unit showing the end which normally faces the scanner. The red, blue and green photomultiplier tubes are mounted front and center with their respective color filters wrapped around them. The gain controls on the front panel are for balancing the three channels. Behind the photomultiplier tubes are the red, blue and green three-stage video preamplifiers, and at the rear of the chassis is an electronically-regulated power supply. The coaxial cables on the right carry the three color signals to the matrix.

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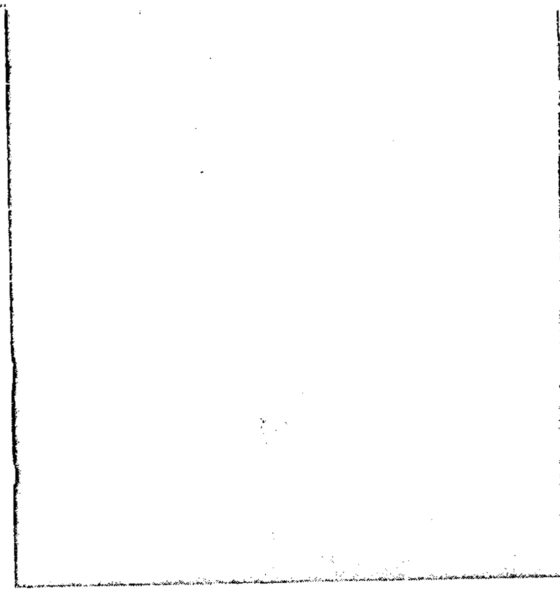

And here (don't laugh, now!) is the transmitter. The inverted socket at the right holds a 12AT7 parallel line oscillator for 420 Mc. Shown above the chassis are the plate and cathode lines and the heater r.f. chokes. On the left is a 6CL6 modulator. It and the 12AT7 are connected in series across the plate supply, and video drive is applied to the 6CL6 grid. WØKYQ admits the irony of such a simple rig for so complex a system, but points out that TV signals are wideband and that the little 5-watter does fine for local work. A 420-Mc. converter and standard color (or black and white) set are used for reception

blue, and green signals electronically, all the information they contain can be condensed into two signals if the black and white signal is properly mixed with these two signals at the receiver. The two new signals that take the place of the red, blue and green information are called "I" and "Q."

Now we can make use of a very special type of modulation called "quadrature modulation." This is a system whereby two signals can modulate one carrier by making one signal always lag behind the other signal by 90 degrees. The color modulators operate on the standard color frequency of approximately 3.58 Mc. and are of the balanced-modulator type. Effectively, we put all the color information on a single carrier and then suppress the carrier so that we are sending all the color information by d.s.b. Next, we mix this color signal with our black and white signal and with the standard sync pulses.

Sync and Blanking

Another cheap TV receiver was obtained to generate the sync pulses. This receiver was left intact and is adjusted to receive a local station. The sync can then be taken from the sync circuit in the receiver without any additional equipment being required. By obtaining the sync in this manner a superior pulse can be had with the minimum of cost. The blanking generator is built as a subchassis on this same unit. It is a group of multivibrators and clippers which effectively produce a pulse that will turn out the light source during the retrace period of the electron beam.

The only thing left now is to produce a pulse which will initiate a reference signal for the color receiver to lock on so that the proper colors will be reproduced. This signal is called a burst signal and is sent only during the period of time when no picture information is being transmitted.

By making good use of the junk box the complete project cost a total of about $175. The results have been very satisfactory. Colors are true and brilliant. All colors have been faithfully reproduced, including some of the hardest, flesh tones.

There is a great deal of fun to be had in exploring this new phase of amateur radio, and I am sure that we will begin to hear a considerable amount from now on about experiments in amateur color television. Unlimited ideas and methods are waiting to be tried out, and many systems like mine can be built out of readily-available parts. There are many different ways of producing color TV and this is only one of them. So let's go color — there's nothing quite like it in amateur radio. QST

Note: Practical circuit diagrams have been left out of this article intentionally. Anyone experimenting with color TV would have to acquire enough knowledge of the subject to devise his own, based on current commercial practice and standards if regular receivers are to be used. For more information, consult texts such as *Introduction to Color TV, 2nd Edition* by Kaufman and Thomas, published by Rider. — *Editor.*

25 Years Ago this month

September 1935

. . . The editorial 25 years ago was a plea to amateurs to cooperate in cutting down QRM by three simple methods: using the proper bands to avoid jamming DX with local rag-chewing, trimming power to just that necessary for the QSO in progress, and ceasing to test on radiating antennas, using dummy antennas instead.

. . . The magazine served a pot pourri of technical fare including articles on plate modulation of pentodes . . . an all-purpose s.s. superhet with turret-type automatic coil changing . . . a new type u.h.f. transmitter . . . a frequency-lock multi-vider . . . a flexible e.c.-controlled transmitter . . . plus technical topics and three pages of hints for the experimenter.

. . . The seventh international DX contest was hailed as "the greatest in the history of amateur radio." The winner was W3SI who rolled up 40,803 points in contacting 56 countries on all continents. "Breath-taking!!" said *QST*.

. . . The third annual Field Day was hailed as best yet — the United Radio Amateur Club of Wilmington, Calif. took top honors with 1116 points.

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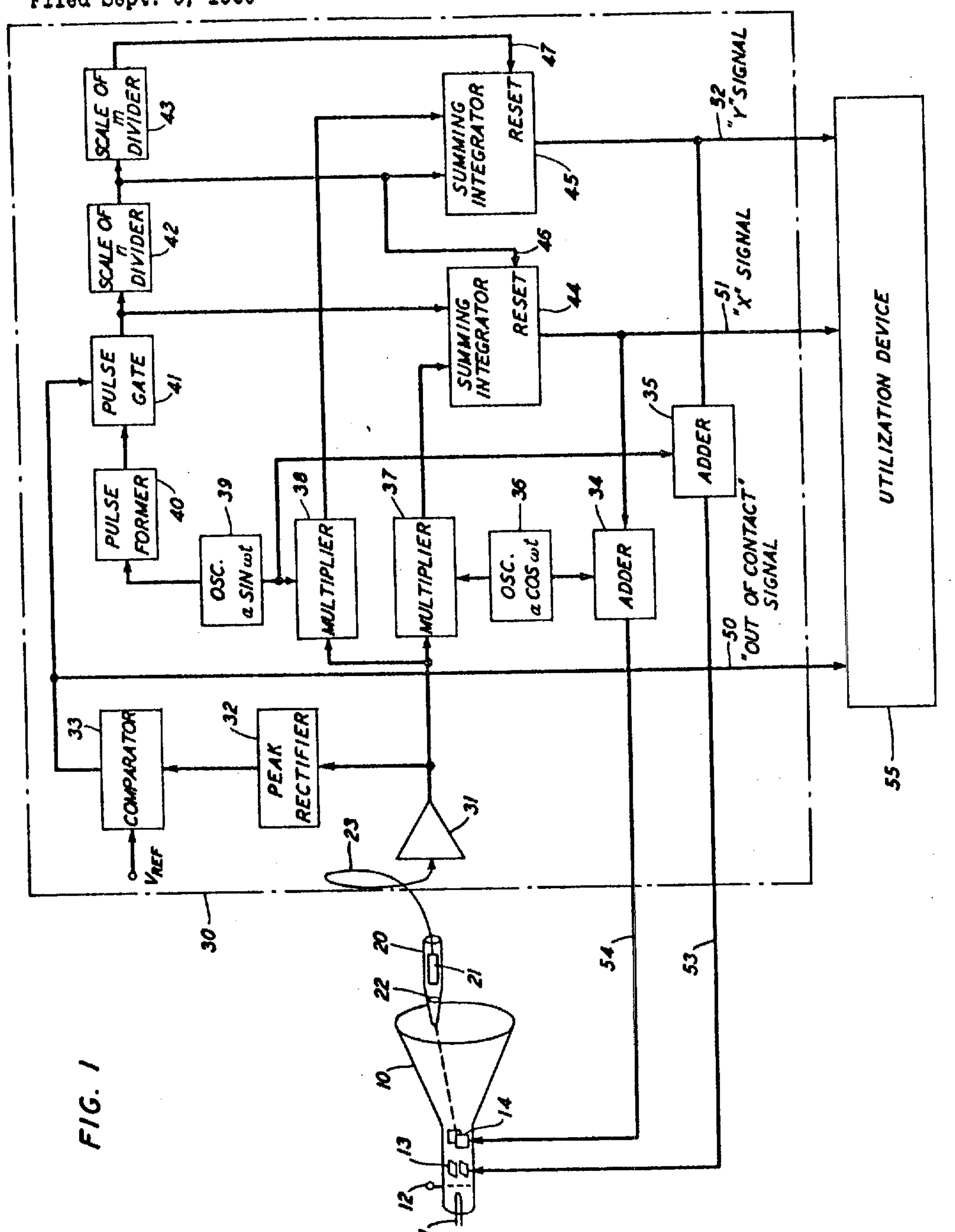

FIG. 1

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FIG. 2

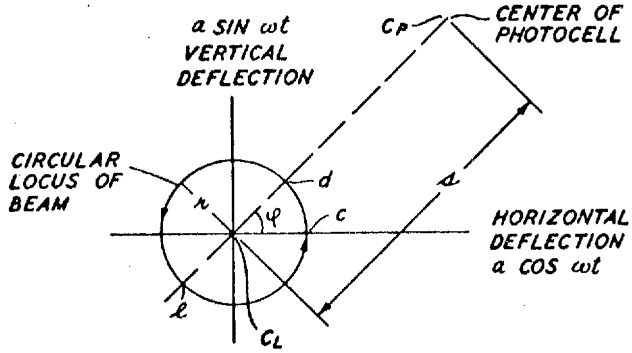


FIG. 3

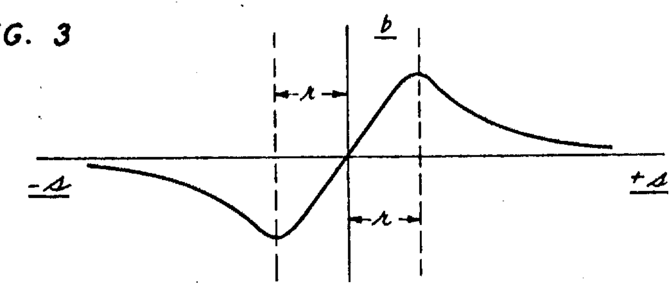
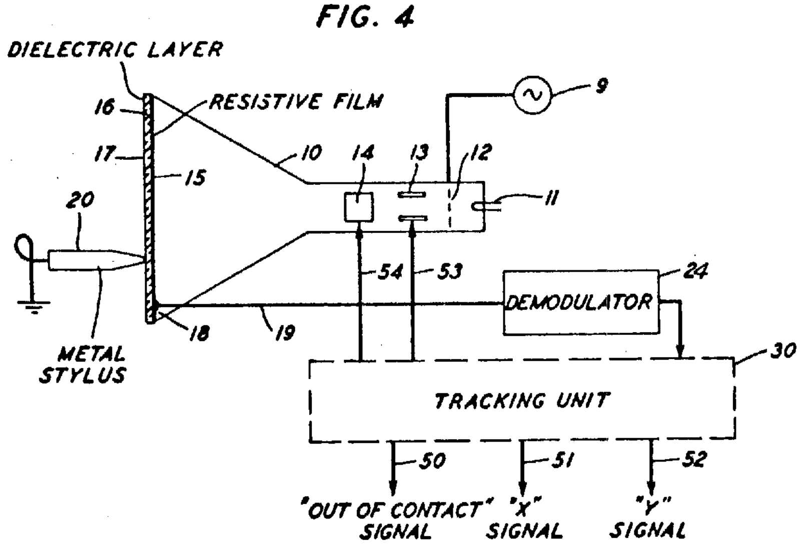


FIG. 4



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