SUBJECT: Discussion of Trip to Philco Corporation, Philadelphia, Pa., July 7, 1959

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SUMMARY:

After reviewing previous trip reports (attached) by W. Rublack dated June 1957 and notes taken at the Philco meeting, it is concluded that no significant tube or circuit developments have been made over the past two years which would substantially modify our original cost estimates of the Apple System. Changes have been made in tube processing and circuitry with improved quality and increased reliability, but considering the optimism of the original shrinkage and cost figures, these improvements have already been included in the book ("An Evaluation of Color Television Display Systems") presented to management in June 1957.

The Apple project, currently in the hands of the Research Group at Philadelphia, is undergoing a "paper study" of tube processing and receiver circuitry with the aim being an Apple manufacturing cost equal to twice that of monochrome (the current relationship is about 3.3 to 1). This is the same as our projected figure (the above book), but falls short of the 1.5 to 1 G.E. color objective. It was not clear as to the number of man hours or the money that would be expended to carry out this program when finally formulated.

Basically our discussion involved:

1. The disdavantages of the secondary emission system.

2. The photoelectric 3/2 index system
   (a) Predictor circuit

3. Long range goals
   (a) Electron optics - wide angle tubes
   (b) Tube processing
      1. Modification of sub-master system for improving line width control.
      2. Study of phosphor reclamation
      3. Use of frit panels

4. Blue Sky
   (a) Use of decal screens

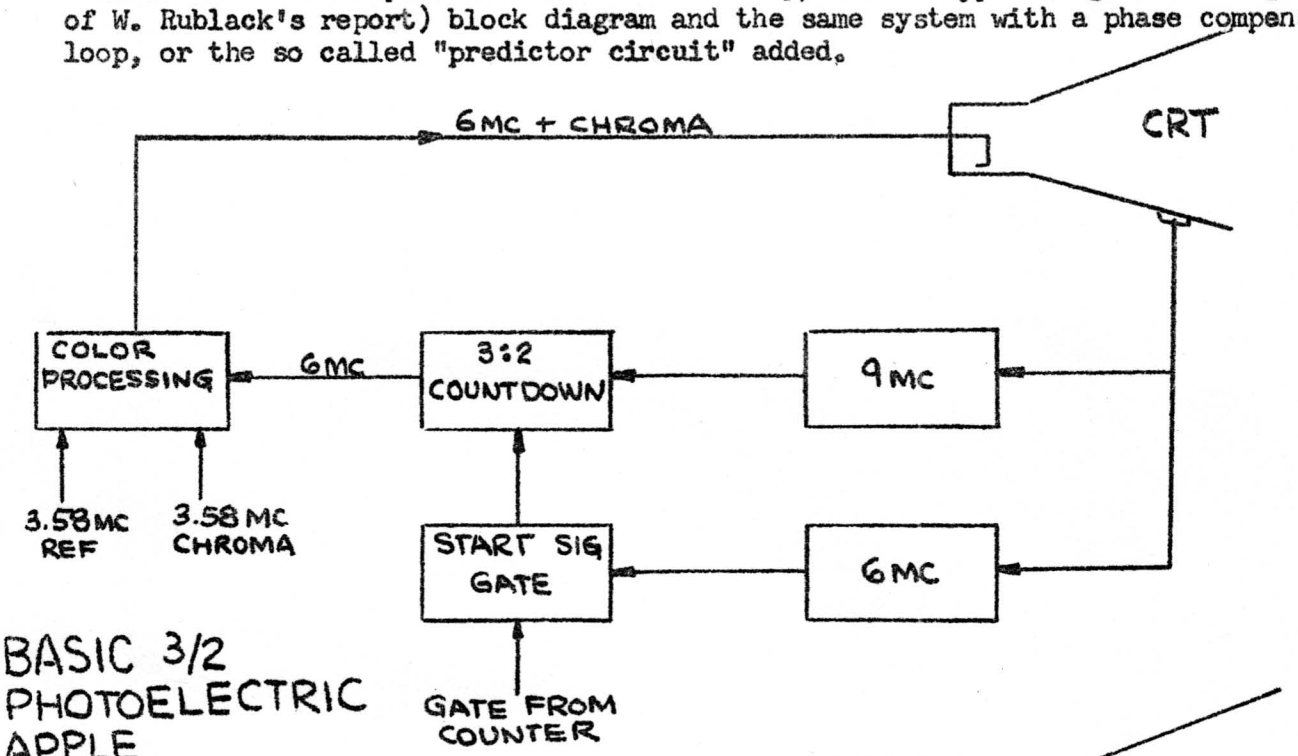
5. Comparative cost data of color systems

It should be pointed out that little of what Philco disclosed was new or novel. Their tube processing cost reduction program, for example, was under scrutiny by CRT Engineering in 1957. Despite this, however, if the Apple system is to be competitive, progress must be made along the above lines.

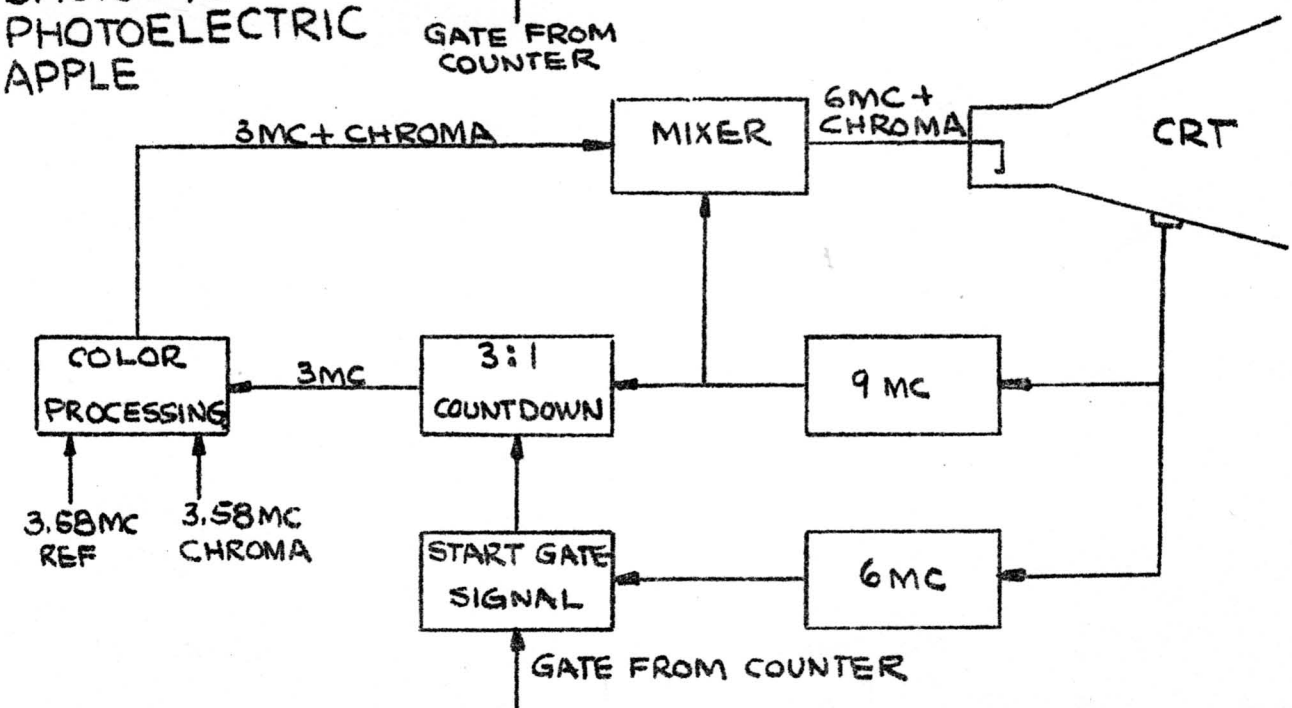
DISCUSSION:

Basic 3/2 Photoelectric Apple

The advantages of the photoelectric 3/2 index system over the MgO (secondary emission) system are discussed in the attached report (pages 2, 3) by W. Rublack. Redrawn here for simplification is the basic 3/2 Photo Apple (Figure 1 - Figure 2 of W. Rublack's report) block diagram and the same system with a phase compensated loop, or the so called "predictor circuit" added.



BASIC 3/2 PHOTOELECTRIC APPLE



3/2 PHOTOELECTRIC APPLE WITH "PREDICTOR LOOP"

The so called "predictor loop" takes care of horizontal sweep deflection errors and mechanical misregistration of the index stripes by delaying video information so that position and video information correlate. Prior to this circuit innovation triplet crossing time had to be controlled within 1%. The "predictor" reduces this by a factor of ten thus permitting the reduction of tolerances in both tube and sweep circuits. It is reported that the circuit functions well for frequency changes of ± 5% but deteriorations beyond that do occur.

Wide Angle Tubes

The feasibility of wide angle tubes was discussed briefly. Their electron optics people felt that 90° tubes were possible but that 110° tubes were questionable at this time because of inadequate gun spot size. They define a gun figure of merit as:

Spot Size x Beam Angle = FM (1)

with an improved gun having the lower figure of merit. Experiments are being carried on to reduce space charge and consequently spot size by using elliptical control grid apertures. The tube they demonstrated had an elliptical aperture with a 4:1 aspect ratio. Reference was made to an IRE article by P. Gleichauf of our Electronics Laboratory to support their ideas. They are working toward an elliptical aperture having a 10:1 aspect ratio so as to give a 3:1 elliptical spot at the screen. Of particular interest was an automatic electron trajectory plotter which they displayed. The electrolytic tank size permitted a 50X magnification of conventional immersion lenses.

Tube Processing

Tube processing has been simplified to an extent by the introduction of the photoelectric system. A single gun is used along with a constant final anode potential which permits a single aluminizing. However, phosphor screening remains a problem; Philco engineers feel that:

a. Exposure time is too long.
b. Too much phosphor is used.
c. Positioning of masters is too critical.
d. Light distribution of projected image is not suitable for good line width control.

The current thoughts revolve around the use of two piece bulbs (separated at the panel skirt) and phosphor deposition using sub-masters in semi-contact with the panel face. They expect exposure time between 10-15 seconds instead of 2-3 minutes and better light distribution yielding better line width control. If line width control is obtained other effects, such as increased resolution and brightness, could be had. To make up for the red phosphor efficiency, the red stripes could be widened; to improve resolution, line widths could be decreased. In addition, screening processes will be evaluated to avoid double printing and minimize phosphor losses. The dusting, settling and sensitize slurry processes will be investigated.

Blue Sky

The use of decal screens came up in the discussion. The basic idea is to print phosphor stripes on a membrane which will not stretch, which can be

transferred to a tube, and which will not leave a residue when the screen is baked out. The thought is interesting and, although known for years, no one has been able to develop a workable system. At the time of our talks, one of the Philco Engineers was investigating the use of plastic materials.

Other ideas revolved around the elimination of the black oxide strips so as to reduce the total number of screen processing steps. However, it was apparent that little thought had been given to this subject since the black stripes are largely responsible for the color purity, brightness, and ambient light protection of the present Apple tube. From our discussions, one might conclude that there were no "tricks in the bag".

Comparative Cost Data of Color Systems

The Philco research objective is aimed at providing an Apple system with a manufacturing cost of 2:1 compared to monochrome. They base this on the feeling that the picture quality demonstrated and the expected field reliability is adequate for consumer use. They do not pretend to know or imply that a color market will exist at this price, but prefer to let the marketing people decide this.

The cost figures provided are given in Figure 3. The units are arbitrary and were said to apply to "works only". It was not clear as to the labor content, return tubes, overhead, etc., that went into these figures. It was definitely stated that cabinets were not included.

	CRT	CIR	CRT ASSLY	
Monochrome	100	180	25	= 305
Apple Research	200	390	40	= 630
1958 Apple	365	565	75	= 1000
RCA Shadow Mask	415	445	135	= 995

The Apple Research Tube (200) was said to be a $40 tube.

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Attachments
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September 10, 1959

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Syracuse - June 12, 1957

H. F. DeLong
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Subject: Visit to Philco Corporation, Philadelphia, Pa.
June 7, 1957

Having recognized that the secondary emission (S.E.) structure of the Apple tube will not permit the attainment of uniform white or color fields, the Philco personnel have abandoned the S. E. system. In its place a photo-electric (P.E.) index system has been developed. Considering the state of the development at this time the new product was quite successfully demonstrated.

This change introduces a number of new engineering problems but it is significant that this change removes some of the most serious manufacturing difficulties associated with the S.E. system. It is the author's opinion that the new engineering problems will be no more difficult to solve satisfactorily than those which previously required solution in the S.E. system.

The tube is now a single beam, uniform potential device. The screen structure has temporarily reverted to a 50% duty cycle pattern with equal phosphor line widths for all three colors. A fast decay, violet-U.V. emitting phosphor (P-16) is applied in stripes on the gun side of the aluminum film and located only over some of the black guard bands as shown in Figure 1A. For a screen structure having a nominal 6 MC writing rate this index configuration yields a 9 MC position signal. However, a triple ambiguity as to color field exists as shown by Figure 1A. Therefore an unambiguous starting signal is required. A 6 MC starting signal is obtained in addition to the 9 MC position signal by placing P-16 stripes over the blue stripes for 8 - 10 triads at the left of the picture. This requires about 1/2 inch and can be restricted to the non-visible panel skirt. This is shown in Figure 1B.

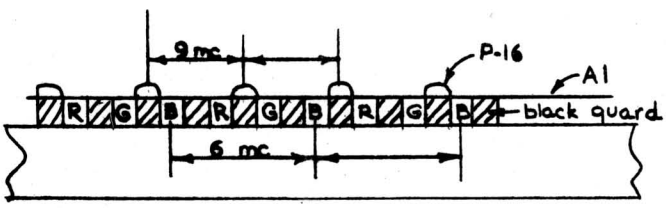

FIGURE 1A

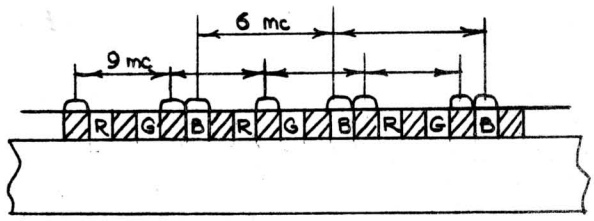

FIGURE 1B

The light pulses emitted by the P-16 are converted to electrical signals by a photomultiplier tube. (At present DuMont 6365, six stages at 150 V/stage) The 6 MC and 9 MC signals are separated by electrical filters and handled by the gating, mixing and frequency doubler circuits as shown in Figure 2. The 6 MC output which contains the position information is fed back and mixed with the 9 MC signal to produce the 3 MC signal which is doubled. Thus, after the starting signal has ceased the circuit acts somewhat as an oscillator. This is one of several possible circuits that could be used.

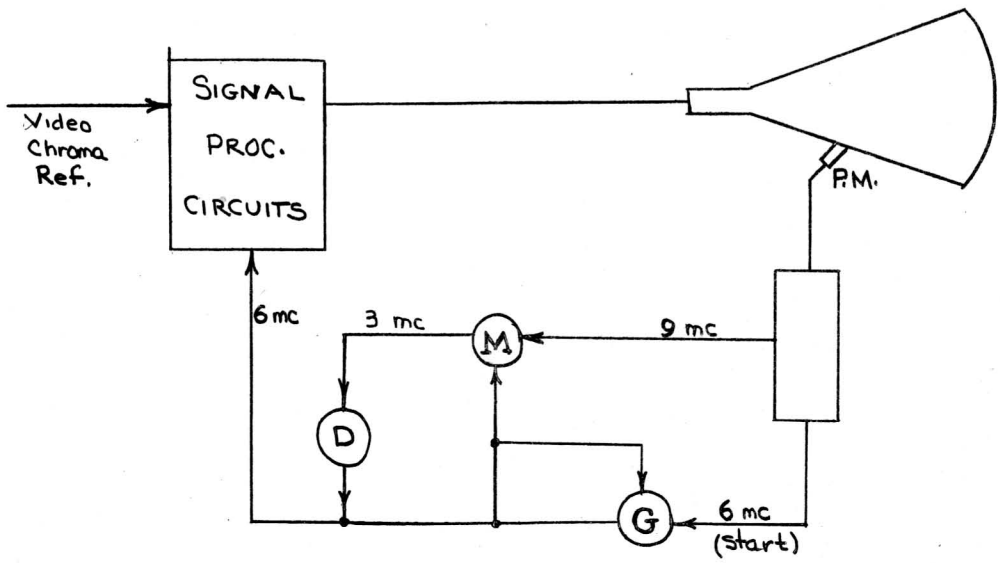

FIGURE 2

It is possible to list a large number of advantages of the P.E. system:

1. Simple triode gun with lower input capacitance and ease of manufacture (see below.)

2. Simple monochrome type bulb except for the hat seal.

3. Simpler exposure machine design since the lens now coincides with the center of deflection in the yoke field. The two potential tube decelerated the electron beam requiring that the bulb be raised up around the lens for screen printing.

4. Methacrylate spray filming (pre-aluminizing) may be used and this eliminates a silicate application and one bakeout operation.

5. No aluminum umbrella shield and clean out are required.

6. Application of chromic oxide resistance paint is not necessary. Due to the precision required to define the fields in the S.E. system this was a diffi-

cult process. (Paint band 1/8" wide and located ± .030").

7. No stray emission problems and wide range of anode voltage possible.

8. P-16 phosphor will be very much simpler to apply than MgO and should yield much less scrap.

9. Single beam gun eliminates convergence, skew and transmu problems.

10. This in turn simplifies the test operation.

11. This tube is not subject to electrical interference. Does not need shielding.

As performance advantages we may cite:

1. Better uniformity of fields

2. Improved saturation

3. Reduction of grid input capacitance with triode gun

These are some disadvantages with the P.E. system:

1. The writing beam must not remain below cutoff for more than two triads. Thus the contrast range is not improved by using the P.E. system but contrast and saturation is since no additional pilot beam is required when video is present.

2. At maximum brightness (1500 - 2000 ua) there is a possible 15° phase error but this is supposedly not noticeable.

3. Video crosstalk contamination will occur but only when high peak current causes index dropout.

A unique gun structure was described which allows a very thin grid element. It is shown in Figure 3. The .001" element is welded to a heavier (.060"±) disk which has a large aperture. The various dimensions have not been fixed at their optimum values yet. It is possible to achieve the same focussed spot size as with the tetrode but only with one-half of the divergence. The present cut-off is approximately -175 volts.

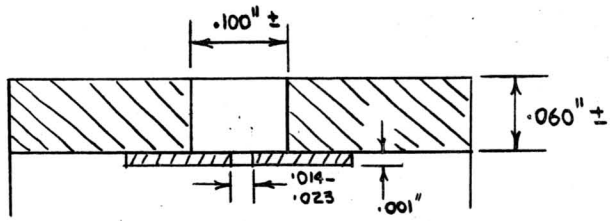

FIGURE 3

Some new processing procedures were discussed. In screening, Philco personnel have adopted a spray technique. The photosensitive film is sprayed on. Following this, a phosphor suspension is also sprayed on and allowed to dry. This is exposed and developed. George Pratt quoted a 4 - 5 minute exposure time which is very surprising for this method. This yields satisfactory coverage as to be expected. One-seventh as much phosphor is required by this method.

The registration in printing has been notably improved by redesigning the master holders using the six-ball (all fixed) principle.

The "triple carbonate in water" cathode mix was applied by electrostatic spraying which yielded very smooth cathodes (and therefore small spot size due to uniform space charge). In some instances this produced excellent cathodes but in other instances there were failures due to unknown causes. This is not yet a production practice.

All details of process and equipment improvements would be best obtained from Lansdale from the people working directly in these fields.

New masters should be produced (for Philco use at least) by July. Index masters in a series of various line widths will be produced to see how narrow an index stripe can be used. This will determine whether the red stripe can be made twice as wide as the blue and green as has been the previous practice. This practice requires the narrowing of some guard stripes and therefore of the index stripes.

Conclusions

Although it appears that the product change has resulted in a set-back (in time), the ultimate product and its potential appears much improved. The material cost for the tube and chassis is probably very little different for the two systems. However the labor cost for the tube should be lower and the scrap levels to be expected should be very much reduced. The chief tube problem now appears to be simply screen printing uniformity and Apple is not alone in this.

Our assistance in this program was asked for, particularly for photomultiplier and index phosphor improvement.

WDR/fmd

Wilfred D. Rublack