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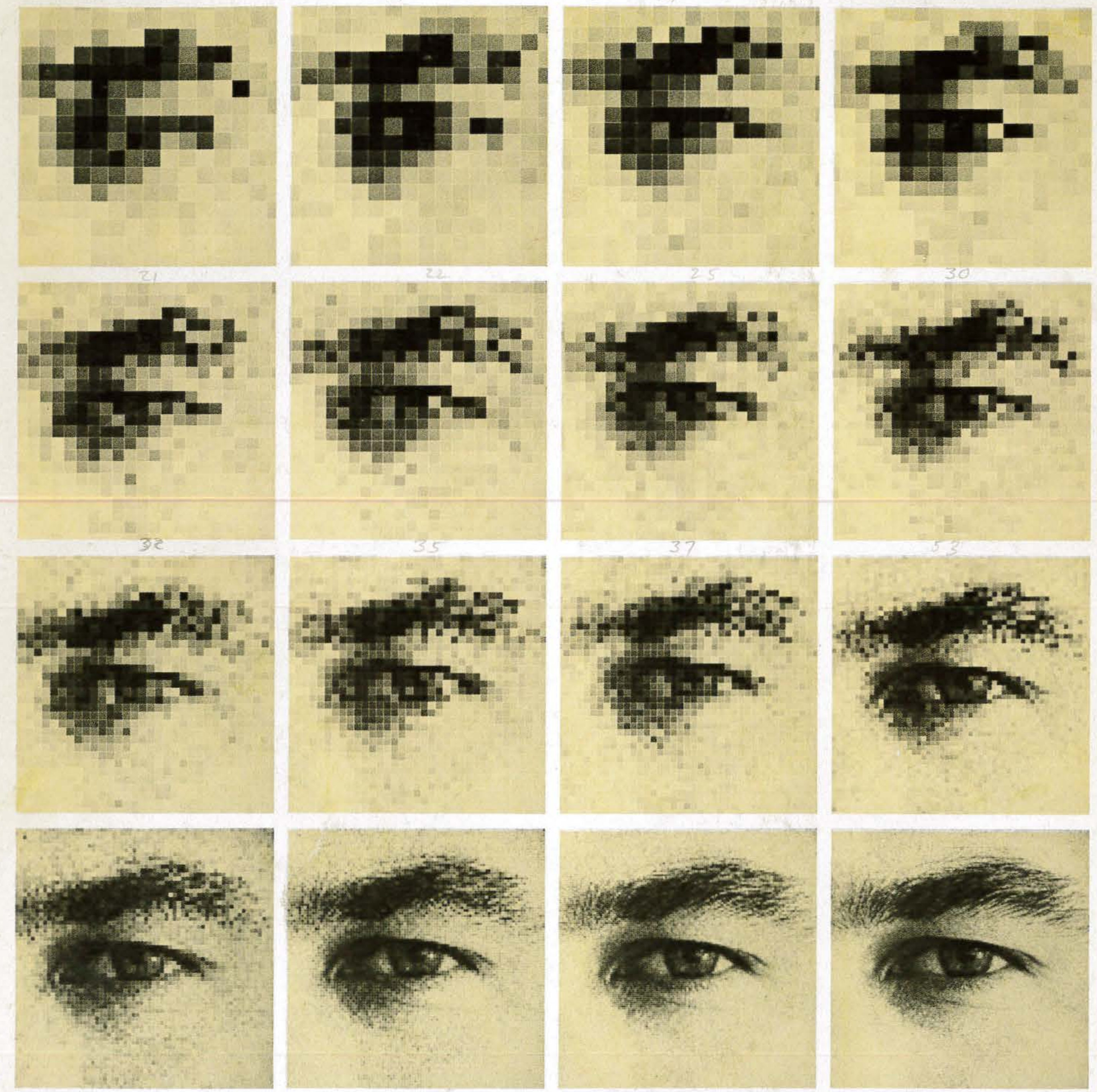

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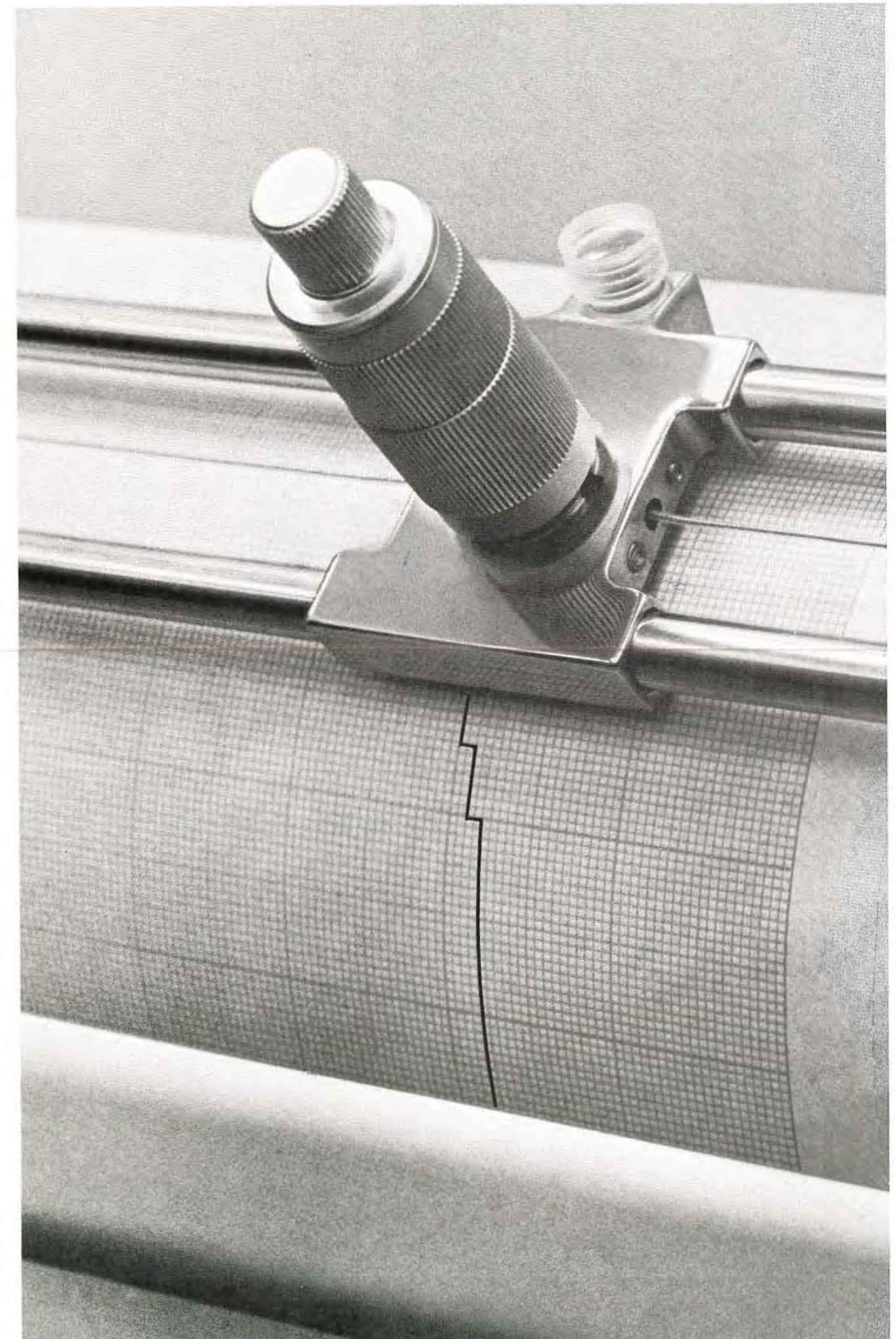

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The Journal of Data Display Technology

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The Cover

A snapshot of the human eye was digitized on a programmable film reader (PFR), to convert it from visual to electronic stimuli. The data was processed with a special picture program and then rerecorded in a mosaic sequence of increasing resolution. Courtesy of Information International, Los Angeles, Calif.

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Editorial

On Olympiads and Large-Screen Displays

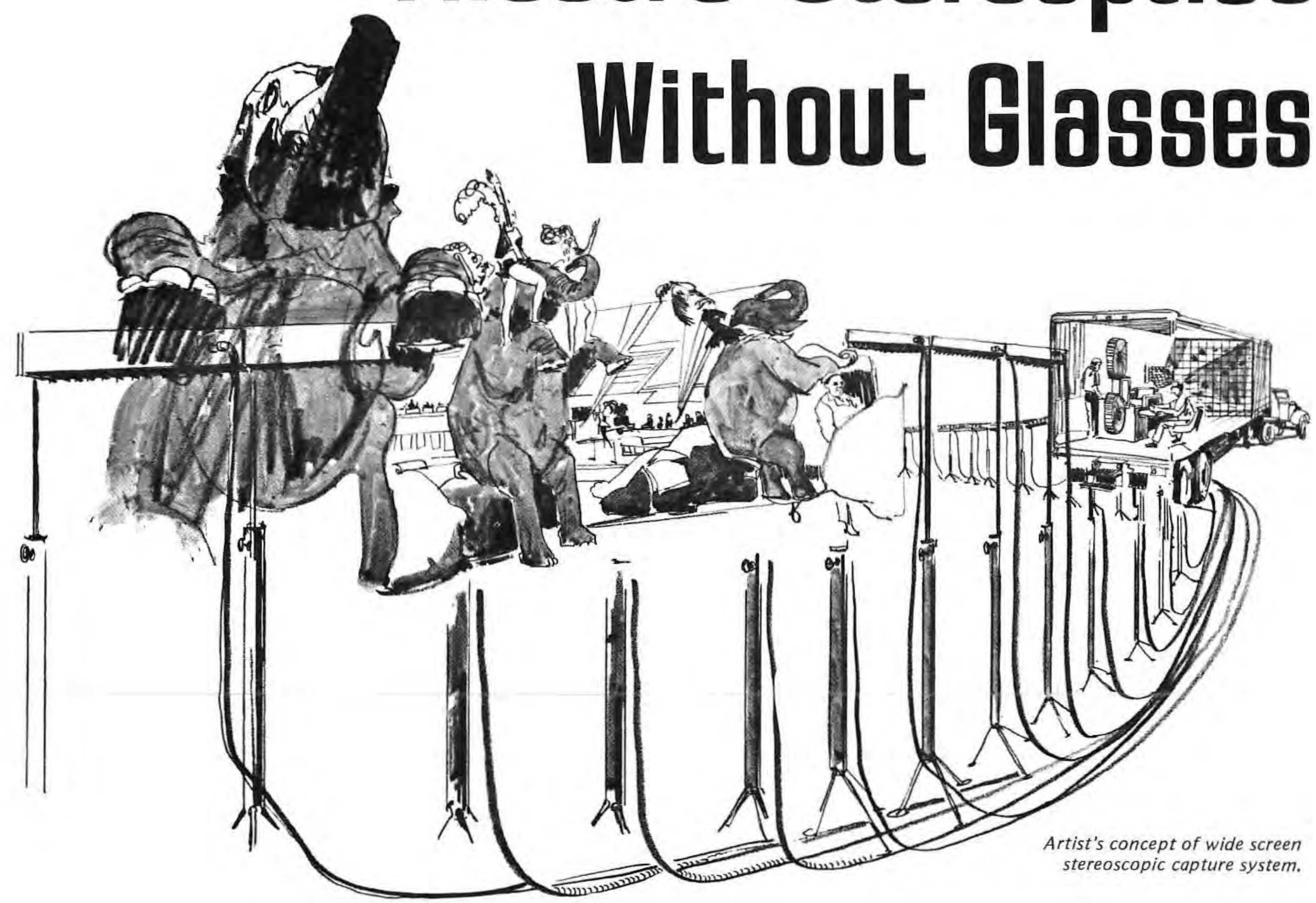
In the time that has elapsed since the 1972 Summer Olympiad, many second thoughts have been expressed concerning that most highly instrumented athletic event in history. It has been estimated that over one billion television viewers throughout the world observed some portion of the Olympic Games. An audience of such size is an exciting prospect for the members of the display field. More specifically our interest was aroused by the computer-controlled scoreboards on which the stadium spectators could observe and follow the progress of events.

Measuiring 90 ft x 30 ft and installed at each end of the stadium, the displays were the first fully computer-controlled scoreboards to be used both in the Olympics and in Europe. Each main display consisted of an array of 24,000 25-W lamps. There, in the midst of the most sophisticated assemblage of instruments, data processors and broadcasting systems, stood the display mastodons consuming electricity at rates calculated to bring joy to the hearts of electric utility stockholders. We must give credit where it is due, however. The engineering accomplishment which produced such computer-driven displays is indeed awesome, for the existing technology most certainly constrained the available design choices.

Once again, we are forcefully reminded of the similarity of large-screen displays to the fountain of youth, neither of which has yet been found. We seem to be always skirting the perimeter, not quite able to find the breakthrough that appears to be needed. Perhaps the need is not yet great enough to warrant the investment and concerted effort that produced such developments as color kinescopes, cameras, video recording and other small miracles. On the other hand, the applications for new devices frequently increase phenomenally after their introduction. Let us hope, then, that the 20th Summer Olympiad will light a fire under the research efforts to produce a large screen display which is consistent with the state-of-the-art of the environment within which it must operate.

R.L. Kuehn

Standard Theatre Stereoptics Without Glasses



Artist's concept of wide screen stereoscopic capture system.

PART II

ROBERT B. COLLENDER

Abstract

A new concept of geometry and suggested implementation is presented, which allows single point projection from existing theatre projection booths, and the utilization of the existing present seating arrangement (with changes required only in a special complexed screen and a projector using a single strip of continuously moving special film).

The picture is photographed with the aid of an extended array of electronic imaging camera tubes, whose signals are gathered in a nearby mobile processing truck, and the total information is recorded on a single film in real time. A positive copy of this film is used by a special stationary high speed projector to project the 3-D picture in a standard theatre. The information is time and space multiplexed to satisfy each person in the theatre with a separate perspective for his point of view. The field of view available to the audience is 180°.

The screen can be as large, or larger, than conventional wide screens, and is constructed of vertically dispersive direct reflective mirror type full screen height elements which are multi-faceted and rotate at a slow constant speed. These elements are pre-set in their phase relationship only once during the projection equipment set up and alignment procedure.

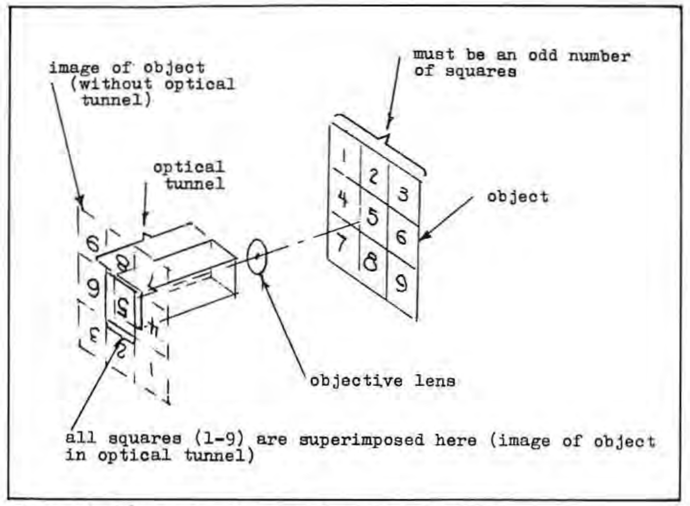


Figure 12: Perspective of optical tunnel in operation.

Processor System Implementation

The processing system is conveniently contained in a mobile unit that moves where the 3-D pictures are being photographed. The camera array of 48 cells is directly connected through cabling to the mobile unit.

The purpose of the processor is to centralize the recording from 722 widely dispersed electronic imaging cameras. It also provides a means to retrieve all of the motion picture data in real time and on a single piece of special film, while simultaneously applying sync control pulses to the film for synchronizing the rotating screen elements on the theatre projection screen to the picture presented at any given time.

In order to understand the real time operation of the processor, it will be necessary to review the operation of the optical tunnel.

The purpose of using the optical tunnel in the processor is to allow an extremely rapid scan of the entire array of 722 sequential frames captured by the cameras in parallel. These frames will be placed into a matrix of storage tubes arranged in a square. There will be an odd number of storage tube monitors along each side of the square matrix. Each monitor storage tube will be optically scanned by the optical tunnel and the rapidly changing pictures (e.g. 722 times faster than normal) will be recorded by image dissection photography on continuously moving spherical lenticular film.

Figure 12 shows the optical tunnel in operation with only nine monitor storage tubes (object) for simplicity. As will be seen later, the matrix selected for the processor is actually constructed of 361 (e.g. 19 x 19) tubes.

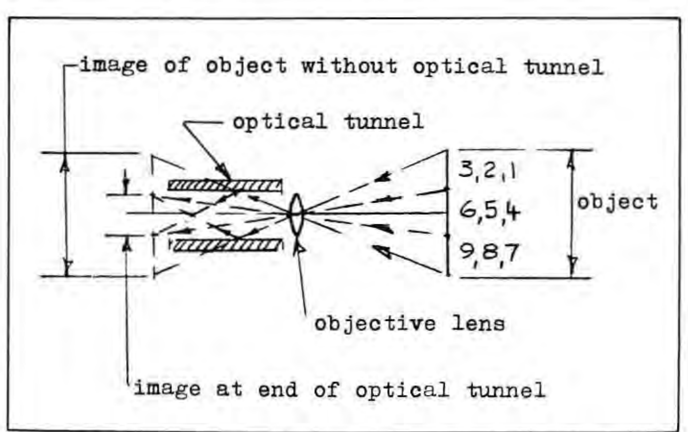


Figure 13: Elevation view of optical tunnel showing image construction.

The object would normally be imaged as in the dotted image of the figure, but four mirrors making a 90^{o} angle with each other and arranged as in a tunnel with their reflective surfaces on the inside, serve to reflect the matrix numbers so that they all tend to fall on the position for number 5 in the figure.

A glass block, which is accurately ground flat with perpendicular sides, can replace the mirrors, thus eliminating critical mirror alignment problems. The tunnel creates an aerial image at the number 5 position, which can be viewed through a field lens by the high speed image dissection camera.

In Figure 13, the same arrangement is shown as an elevation view where the reflections from the optical tunnel are traced out for a simplified case.

The final orientation of each of the matrix squares is a function of the number of reflections encountered in the tunnel. This is predetermined, and the storage tube monitor's yokes are wired to make all images at the aerial image plane of the same total orientation.

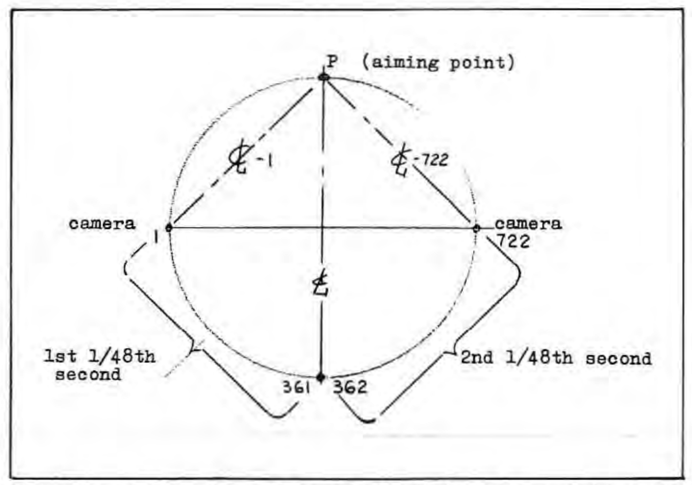


Figure 14: Division of capture cameras to eliminate processor hardware.

The multiple reflections especially encountered by extreme off-axis points in the object matrix, result in images of low brightness as taken from these remote areas. Here again, the brightness can be adjusted electronically in bias once in the monitor tubes to compensate for all matrix squares.

The 5000 vertical scan lines on each of the storage tubes are corrected in length by the mathematical relationship derived in the mathematical analysis section. This function is always identical for any particluar monitor tube correction, but different for each of the monitor tubes. The present design simplifies the hardware by splitting the required monitors by a factor of two, compared to a case where one monitor would be required for one camera. Also, the quantity of corrective functions can be reduced by noting that the corrective functions applied as a result of the left half of the camera array is a mirror image of the correction applied as a result of the right half of the camera array.

The time to scan the 722 pictures from cameras 1 through 722 is taken at 1/24 s so as to provide a flicker free picture to the audience.

Figure 14 shows how the camera division of 1-361 and 362-722 allows each half of the array to be scanned in 1/48 s.

Figure 15 shows a perspective view of the processor and the optics required. The first aerial image of the matrix array object of 361 storage tubes is formed by the first objective lens, and is viewed through the first field lens by the second objective lens and optical tunnel combination to form a second aerial image of any matrix square that is uncovered by the rotating picture selector. The picture selector sequentially uncovers the first aerial image squares. The second aerial image becomes the high speed changing picture (17,300 pictures per second), as viewed by the image dissection camera through the second field lens. This camera is discussed in some detail in the July/August 1968 article. The film, spiral disc picture selector and the main picture selector shutter, all move in a synchronous relationship with the electronic switch timing of the storage tubes. As the film is sequentially recording the scenes (e.g. 1-722 and back to 1 continuously), a sync pattern is simultaneously recorded on the film so that the start of key frames is always known for purposes of synchronizing the rotating screen elemental reflectors (the elemental reflectors are discussed in the playback system implementation section). The film, in this system, is without sprocket holes and moves continuously at an estimated velocity of approximately 10 ft/s.

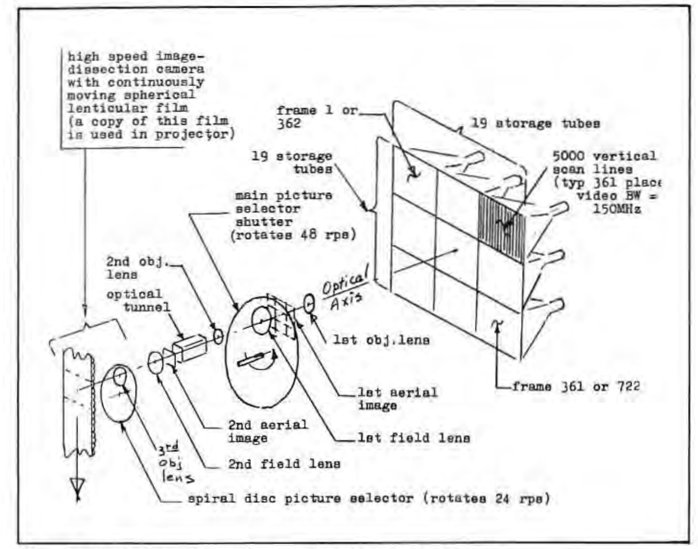


Figure 15: Processor system major components.

The film would like to see entire frames at one time in order that the pictures can be projected one complete frame at a time. If this is accomplished, the observers will always be assured of seeing a complete picture with each of his eye positions, as a complete picture would be available during the 57.7 μs frame "on-time," which occurs to each of his eyes separately every 1/24 s. This duty cycle is a worst case condition and applies to the rear seats in the theatre. If only a single line portion of the frame was available at any instant (zero time) the light loss would be increased.

A matrix of storage tubes was selected in place of conventional CRT's, as a storage tube can present a constant intensity raster at any instant in time where a scanned CRT will have dark areas and scan line intensity degradation due to phosphor decay rates.

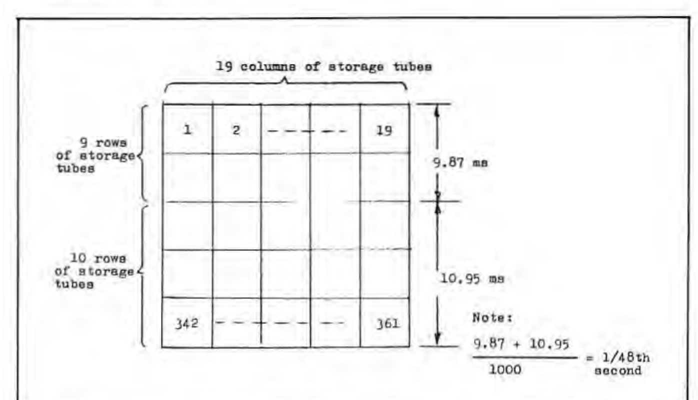


Figure 16: Storage tube matrix timing division (19 x 19 tubes).

Operation of Processor

The scanner looks at each picture in the matrix in sequence, (e.g. 1-361) so that the optical tunnel shows one at a time (each 57.7 μs) to the image dissection camera.

With reference to Figure 16, when the top portion of the matrix (containing nine rows or 171 storage tubes scanned in 9.87 ms) has been sampled, and the bottom portion of the matrix (containing 10 rows or 190 storage tubes scanned in 10.95 ms) is being sampled in sequence, the top half is erased and the next pictures (e.g. 362 through 533) are written in parallel. When the bottom half is sampled, the scanner immediately starts with 362 which is on the same storage tube as number 1 previously. During the sampling of the top half, (e.g. 362 through 533) the bottom half is erased and the next block of 534 through 722 are written. This process continues utilizing all of the electronic imaging camera readouts (e.g. 1 through 722) sequentially and continuously.

Timing Step	Function
Part of D	Write 1-171
A	Sample top (1-171) and erase bottom and write (172-361)
B	Sample bottom (172-361) and erase top and write (362-533)
C	Sample top (362-533) and erase bottom and write (534-722)
D	Sample bottom (534-722) and erase top and write (1-171)
	Repeat

Table I: Cycle timing operation.

From Table I, the total time to sample A (1-171) through B (172-361) is 1/48 s = 20.8 ms. During the fastest sample time of a portion of the storage tube matrix (e.g. the top portion sample time equals 9.87 ms), the bottom portion must be erased and a new series of frames written in parallel. This sets a requirement on the fastest erase time required for the storage tube.

Since the optical tunnel images all frames simultaneously onto an aerial image position, ideally the pictures should be presented one at a time with zero time lapse between pictures. Two adjacent pictures should not be uncovered on the matrix at any time unless they could be complementary portions (e.g. the left side of picture 1 and the right side of picture 2 as appears in Figure 16). Since the matrix frames are not commonly oriented, this cannot be done.

Figure 17 shows what would happen if parts of two adjacent matrix squares were uncovered at the same time. The right side of the "right side up" frame and the left side of the "right side up-sideways reversal" adjacent frame would present the same half of two adjacent matrix squares in the aerial image and hence cause superposition of pictures to be recorded and later projected onto the screen.

Although Figure 15 shows a rotating picture select disc, the suggested implementation method of alternate matrix storage tube picture selection, is a form of electro-optical shutter matrix placed directly in front of the storage tube matrix or at the first aerial image.

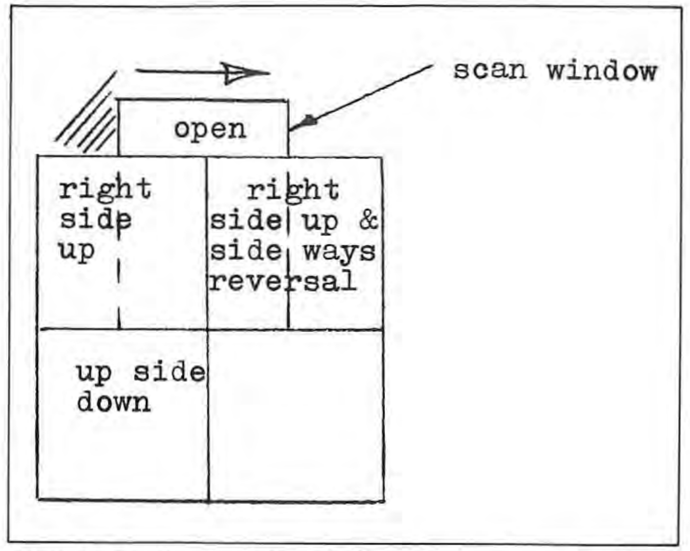


Figure 17: Random orientation of adjacent matrix squares in order to achieve erect and common optical tunnel output.

Playback System Implementation

The field angle of all 722 cameras was set at 90° in order that a maximum viewing angle of the scene is presented to the audience. Since the projection point occupies the position of the 361st camera half way around a semicircle, and the playback-image to capture-object ratio is unity, then the projection extremities will intersect the circle at two points which determine the circle diameter. Therefore, the screen includes an angle of 180°.

In order for an observer to see all 180° of the scene playback, he would have to be located at the center of curvature of the screen. The smallest included angle he would see would be 90° for a position within the circle and located along the periphery. If the observer is outside the circle periphery, he would see progressively smaller included angles of view.

Theatre size and shape constraints may prevent the full 180° screen installation, but information is recorded and available to fill either the full 180° screen or any portion of it. Deletion of some portion of the screen does not affect the remainder of the 3-D picture on the screen.

From an analysis of picture resolution and acuity of the eye, screen element diameter has been set at 1/4 in. and the space between elements at 3/8 in. in order to provide sufficient clearance for adjacent element rotation and the interleaving of antireflector baffles. This spacing between elements and the 100 ft diameter screen, calls for 5000 elements in a 180° screen. This accounts for the 5000 vertical scan lines required in the electronic cameras and the same resolution processing capability. Three-eighths in. subtends 1.07 min of arc at a 100 ft distance.

Figure 18 shows a simplified plan view of the screen with a radius of 50 ft and containing 5000 rotating elements, each element having eight highly reflective sides, and vertically corrugated to cause the required vertical dispersion of incident light. These elements are shown rotating at a common speed of 3 r/s and in the same direction. A positive belt drive connected to a small synchronous motor and several elements in a group (e.g. approximately 60) causes the motor's angular rotation to be transferred to all of the elements in the group. The synchronous motor is driven by control signals derived from the film sync track as it travels through the projector, and is also phase keyed to the projected picture (e.g. 1-722 projection picture sequence) on the same sync track of the film.

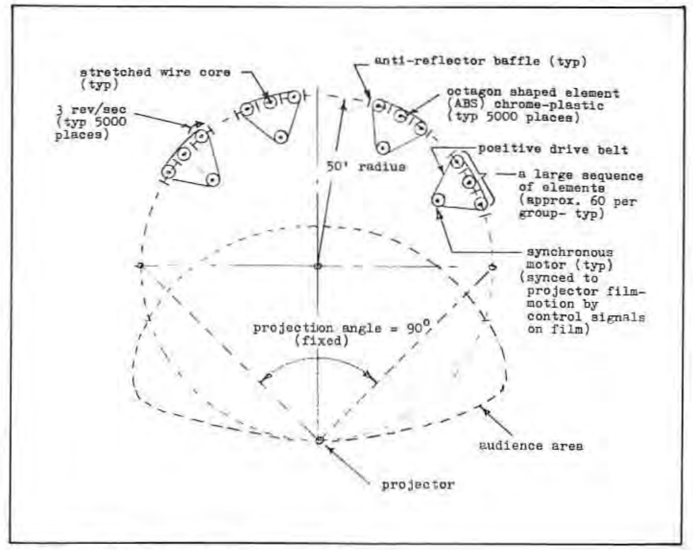


Figure 18: Simplified plan view of theatre.

If the film is spliced at any time, the coded sync track assures that the phase and rotation rate of the screen elements will always match the pictures projected at any given time.

Theoretically, all of the screen's rotating elements could be turned through the agency of a single timing belt and synchronous motor. However, nonlinear belt length changes due to environmental conditions would cause large phase errors in the element positions.

The antireflection baffle is placed between each of the revolving octagon cross section elements in order to block the tendency for side reflections to other elements. Figure 19 shows this tendency.

A practical length for the reflective octagon shaped rotating screen segment is taken at 2 ft. Figure 20 shows a detailed design of this segment constructed of ABS plastics. The segments are formed by an injection molding process and nickle-chrome plated.

The writer investigated the manufacturing feasibility of these segments by contacting Plastic Molded Products Co. in Downey, California. For a screen height of 26 ft, 65,000 segments are required for the total screen. The 13 segments required per element, contain steel tubing cores and are threaded onto a wire under tension. The screen would contain 5000 wires. This company quoted $33,000 for a four cavity mold, which would include the R&D for a one cavity shrinkage test. They would turn out 5000 segments per day or 1 million per year. They could work to an accuracy of 0.0002 in.

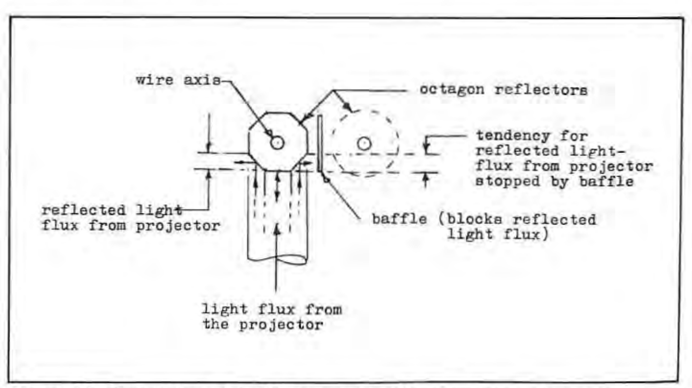


Figure 19: Operation of baffle between adjacent screen elements.

The quoted price breakdown including the plating costs is: 1000 parts – $5000; 10,000 parts – $10,000; 100,000 parts – $80,000; and 1,000,000 parts – $750,000. The total screen cost is estimated at about $150,000. This includes the structure, wire, segments and driving equipment.

The total weight of 65,000 ABS elements plus steel cores is 1.72 t. The steel core makes up 13% of the total segment weight.

Figure 21 shows an elevation view of the segments interlinked along a wire under tension. If only one end of the 26 ft array was driven, noticeable torsion might result, which would be evidenced by adverse deviation of reflected light from the projector. It is therefore proposed to drive each end of each element group to eliminate the tendency for torsion.

The segments are interlinked by tongue and groove, and contain concentric steel tubing that allows rotation of each segment around the wire central core with a low friction factor. The total motor torque required to drive an element at both ends would be quite small.

To begin the screen element phase alignment procedure, a control signal simulating the film code track picture 361, is sent to all synchronous motors to drive them to a position representing the phase relation for the 361st picture. At that point, all the motor shafts are locked and the individual segment phase alignment begins.

The screen element phase alignment method consists of projecting open aperture light flux from the projector in the projection booth and slipping the phase of each individual element, using a light meter to measure the reflected light returned to the projection booth for each element. During this alignment procedure, only the element being phase aligned to the projector is uncovered. Provision must be made to mask those elements not being phased at that time.

The projector is located in a fixed position in the projection booth (e.g. similar to the existing theatre method) and is capable of providing controlled synchronous information to the rotating screen elements as extracted from the sync track on the film. The projector must also be able to project at a rate of 17,300 frames/s and provide sufficient light flux to the rotating reflective segment screen whose resultant "effective-gain" is 1.67 (see 3-D projection screen gain section).

In order to achieve the high projection rate and conserve film transit velocity through the projector, an image dissection technique must be employed. The film taken from the mobile processing unit is ready (after any editing that may be required) for projection in the special image dissection high speed projector.

Within a few years, it may be feasible to achieve the required light flux to the screen with advanced image dissection projectors and laser beams. At present the image dissector projector functions with approximately an f/45 effective projection lens.

Multiple picture overlap on a linear film strip while maintaining high resolution (using holographic techniques) is coming to the front in industrial development today and may find a practical application to the 3-D system proposed in this paper.

System Alignment Requirements

Both the capture and playback systems have to be initially set up within certain mechanical tolerances, which, if exceeded during the operation cycle of either system, would result in the presentation of a 3-D scene with disjointed visual characteristics. The human eye is quite critical in the wide panorama scene of nature it is accustomed to viewing. The eye expects to see continuity and proper depth cues for all objects in its field of view whether near or far.

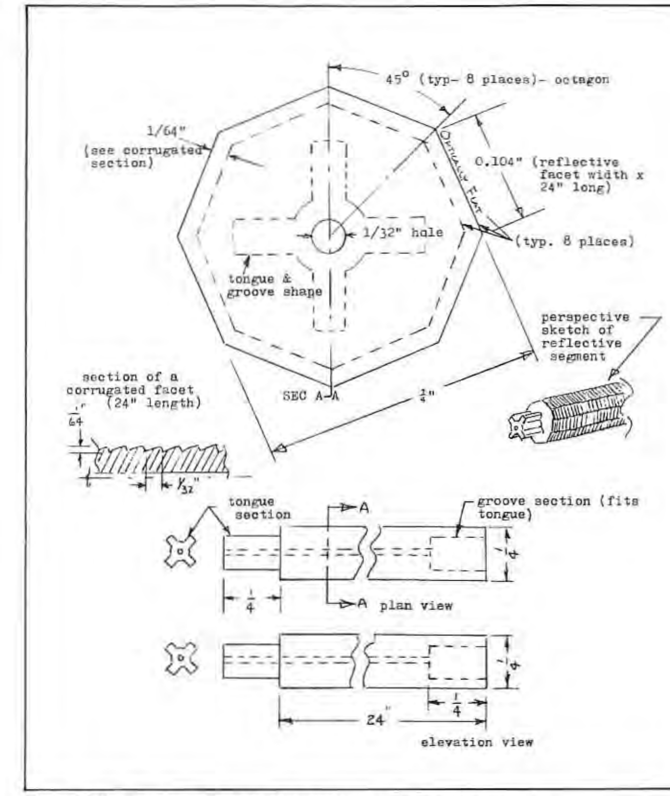


Figure 20: Design of reflective octagon shaped segment.

In the proposed 3-D motion picture concept presented in this paper, a very wide angle of view (similar to natural viewing) is presented in a special coded manner of temporal and spatial dissection. This is not natural compared with reality, but synthesizes the 3-D view for each and every observer differently – without lateral distortion – regardless of his position. Unless the maze of visual intelligence acquired is ac-

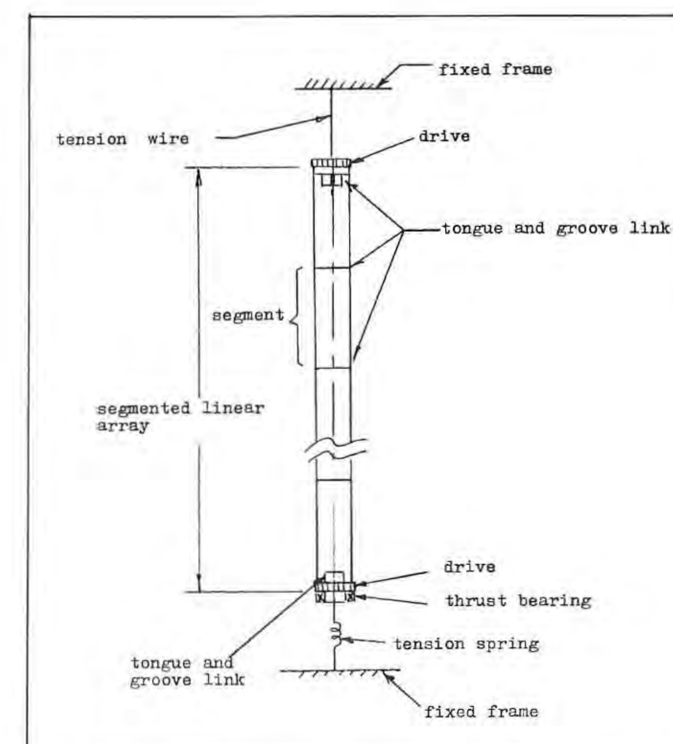


Figure 21: Screen element assembly (elevation view).

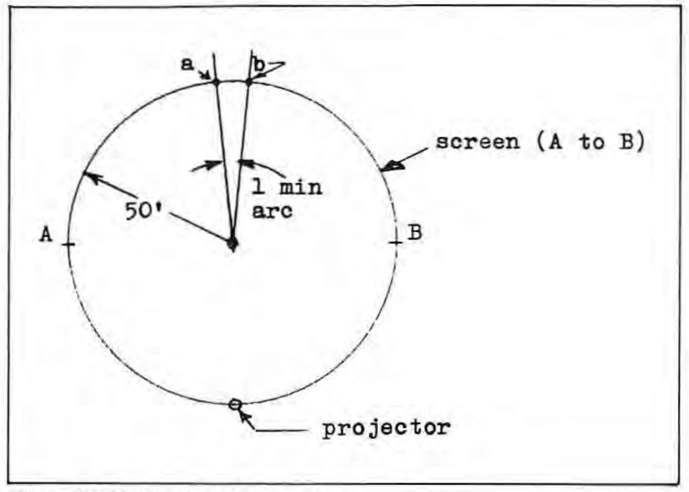


Figure 22: Playback picture acuity.

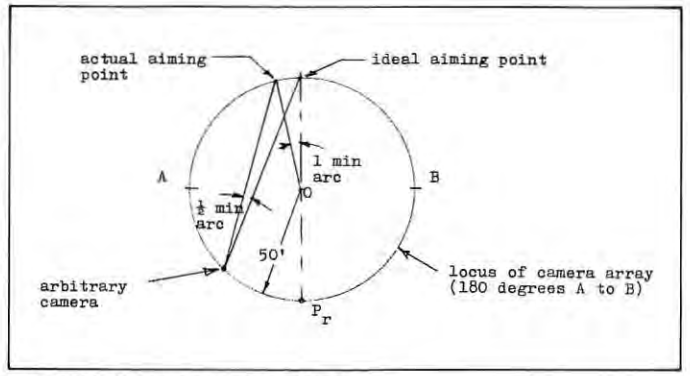


Figure 23: Capture accuracy criteria.

curately connected in the playback view area within the frame period of 1/24 s, the eye will detect some sort of misalignment without the observer realizing how it came to pass.

There are at least two critical alignment problem areas in both the capture and playback systems.

Capture Alignment Problems

1. The 15 cameras permanently connected to a cell can be aligned once with respect to the cell; then any one camera need not be aligned again.
2. The 48 cells can be aligned with respect to the aiming point at each capture set up procedure prior to photographing the scene.

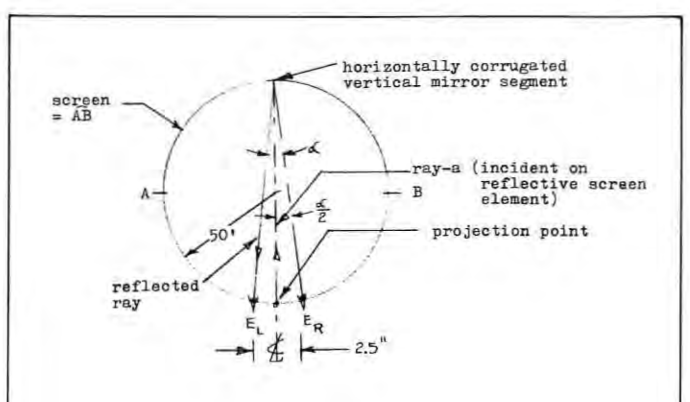


Figure 24: Maximum element torsion and relative phasing accuracy of revolving elements.

Prealigning the 15 cameras per cell (e.g. using transit techniques) before the capture system is ever put into use, allows the camera groups or cells, to be considered as building blocks to construct the 180° array of cameras at the capture site. This reduces the total number of alignments that the camera crew must make per scene set up by a factor of 15.

Figures 22 and 23 show the criteria for determining the capture system optical axis aiming accuracy. In Figure 22, two adjacent vertical lines (e.g. a and b on the screen) in a given 3-D scene reproduction, are shown at the merging angle as viewed from the nearest expected point. This view point is taken at the screen's center "0." The reasons for not allowing observers to move in closer to the screen is due to resultant vertical distortion (note that horizontal or "lateral" distortion is zero for all positions of the observer as discussed in the 1968 issues of *Information Display*) and also the increasing angle subtended at the observer's eye by the screen segments.

The accepted criteria for proper viewing of adjacent merging vertical lines, is that they are separated by one min of arc for 20/20 observers. From Figure 23, it is seen that any arbitrary camera must have its optical axis pointed at the aiming point within an angle of 1/2 min of arc.

Playback Alignment Problems

1. The screen's rotating reflective segments are interlinked and span a height of 26 ft. There is a limit to the allowed total twist angle from the top to the bottom of any given screen element.
2. All of the screen elements theoretically rotate at the same speed and have a constant phase relationship to one another. Due to mechanical imperfections in the construction of these screen components and the belt stretch in the driving equipment, phase errors tend to be prevalent.

Figure 24 shows the right and left eyes of an observer at the maximum expected viewing distance from the screen. A ray-a is shown leaving the projector and returning to the left eye via reflection from a screen element. If the horizontal dispersion is kept within $\alpha/2$ degrees, and the torsional angle over the entire element height is kept within $\alpha/4$, due to the double angle incurred at the element reflective surface, then the receiving eye (e.g. E_L) will see the entire picture height taken from a single projected scene. $\alpha/4$ equals 1.8 min of arc. Hence, the total torsional error allowance is less than or equal to ±1.8 min of arc.

Any screen reflective element's phase relationship to all other elements in the screen must be held to $\pm\alpha/4$ degrees or ±1.8 min of arc. With this relationship, any eye stationed along the circular arc of 50 ft radius, will see all vertical segments of a given scene projected at one time, as all of the screen's elements return the single projected scene perspective to the given eye. At some eye location between the circular periphery and the center of the circle, the eye will derive its perspective from several different but grouped sequentially projected pictures.

3-D Projection Screen Gain

There are two opposite reacting prime factors which are prevalent in this 3-D system that tend to cancel each other while retaining a total calculated screen gain of 1.67. The negative factor is the very short duty cycle of screen illumination to the observer's eye, and the positive factor is the highly concentrated light available from the semispecular rotating screen elements.

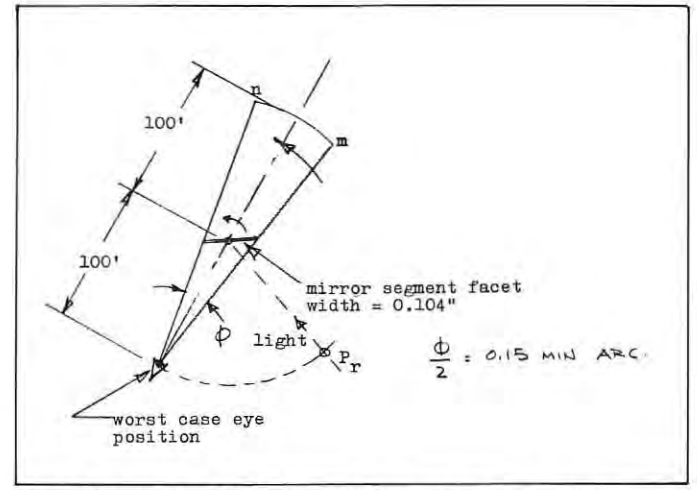


Figure 25: Projected light duty cycle for worst case eye position.

Figure 25 shows the projector source light reflective from a screen element facet whose distance is 100 ft from the projector position. The facet width equals 0.104 in. The angle ϕ is calculated at 0.3 min of arc. This represents, by a sweep angle of view analogy, the total minimum (or worst case viewing) illumination duration of reflected light from projector P_r. The total angle during which the reflected light is not seen by this eye position along the circle containing P_r, is 90°. Arc nm is the locus of P_r as seen by the eye as the mirror segment rotates. The ratio of on to off angles is 5.56×10^{-5}, or the projection light "loss" factor due to the on to off duty cycle of reflected light of the projector output diverted to the worst case observer position by an arbitrary screen revolving and horizontally reflective element.

The positive factor which contributes to a reasonable total screen gain by cancelling the effects of a low duty cycle of viewable illumination, is a high semispecular screen gain possible through concentrating the reflective distribution of incident screen illumination to 40° of vertical dispersion and 0.15 min of arc in horizontal dispersion.

The serration cross section of an arbitrary screen rotating segment, is shown in the projection section – Figure 20 – and is determined as shown in Figure 26. Using screen gain criteria as outlined in the October 1968 *Journal of SMPTE* (i.e., Eastman Kodak's charts on high brightness projection ideal reflective screen gain), a 40° half angle screen with a 1° half angle in the transverse direction results in a screen gain of 75. The requirements for the total horizontal dispersion angle of the reflective screen in this paper, however, is 400 times narrower (i.e. a 0.15 min arc horizontal half angle is required instead of a 1° angle). The extrapolated screen "gain" is then $400 \times 75 = 0.3 \times 10^{+5}$.

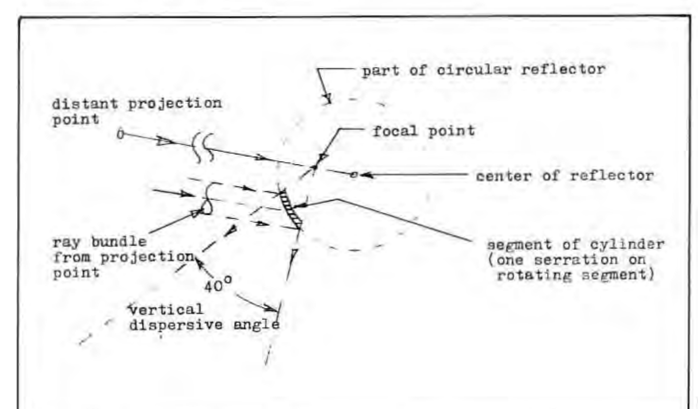


Figure 26: Controlled vertical light despersion during projection.

When the positive light gain factor of $0.3 \times 10^{+5}$ is multiplied by the negative low duty cycle loss factor of 5.56×10^{-5}, the resultant screen gain is 1.67.

Conclusions

To the author's knowledge, no wide screen autostereoscopic movie system exists in publication or in fabrication, that permits installation in standard theatres where only the screen and projector need to be changed.

The technical growth curve in this area can be extrapolated to show the projected availability of state of the art hardware by circa 1975. Developments needed to assure completion of this project are: electronic imaging camera tubes capable of 5000 lines of resolution and 150 MHz bandwidth; storage tubes with 5000 lines of resolution, 10 ms erase time and 150 MHz bandwidth; low f/number image dissection or equivalent projection equipment or alternately, a very high efficiency projection light source (with low heat generation).

The capture and playback geometry presented in this paper is ideal for 3-D without glasses. The practicality of synchronizing the screen to the film offers film splicing possibilities and eliminates the need for multiple picture integration at each eye through the agency of electronically operated shutters.

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Robert B. Collender received his B.S. degree in Electronic Engineering from the University of California at Los Angeles. He has spent 15 years in the aerospace and aircraft fields, mostly working on multiplexing and readout methods in ground support, airborne and space vehicles. In parallel, research and development with laboratory investigation of 3-D effects has been pursued. Early work (1949) involved 3-D drawing machines in an attempt to give more freedom of expression to artists. He is currently employed by Lockheed California Company in Burbank, California, as a design specialist assigned to an ASW Display Group where CRT multipurpose displays are designated with computer and special sensing equipment interfaces.

Color Telefilm Recording

STEPHEN P. ROBINSON

Introduction

The need to record television signals became apparent from the earliest days of television broadcasting. This need was filled by transferring the television image to film using a regular kinescope display and film camera. This system was complex and difficult to control. Thus, the advent of the video tape machine was hailed with heartfelt thanks by recording engineers as being the end of the need to kinescope. However, this was not to be. If anything, the availability of video tape equipment gave new purpose to film recording. While video tape is ideal for storage of program material for subsequent replay into networks, the cost of duplicating video tape and the logistic problems of disseminating programs on tape inhibited its use in many areas. Thus, film recording grew as a method of dissemination of programs and was made a more tractable system by the new found ability to work off line with the ever present safety factor of a video taped copy of the program.

It has become apparent that the needs of broadcasting and transfer studios for a film transfer system are not met unless the system is so designed as to be foolproof and to eliminate the need for expert knowledge of film transfer processing by the operator. In the past, the need for transfer equipment was met by the studios developing their own hardware. This was then used by the personnel who did the development work. Thus, the operator's knowledge was of a high degree; this knowledge alleviated the need for proper systems design. It was decided, therefore, that we would not only engineer a film transfer system using the latest technology available, but also carry out systems and human factors studies which would allow this equipment to eliminate many of the pitfalls that similar equipment had previously incorporated, thereby allowing the use of a lower level of skill to carry out this transfer process.

Review of TV Displays

Since by its very nature a telefilm transfer system must first image the incoming television signal, the most urgent decision was related to the type of TV display to be used. There are a variety of different methods of displaying a color TV signal. Apart from the standard shadow mask tube, it is possible to display a color picture using three monochrome tubes and combining the light output from these. It is possible to scan and modulate a laser beam or more accurately three laser beams to create a color image and there are available forms of Eidophors, also called light valves, which modulate incoming white light to generate a color TV display. This last approach

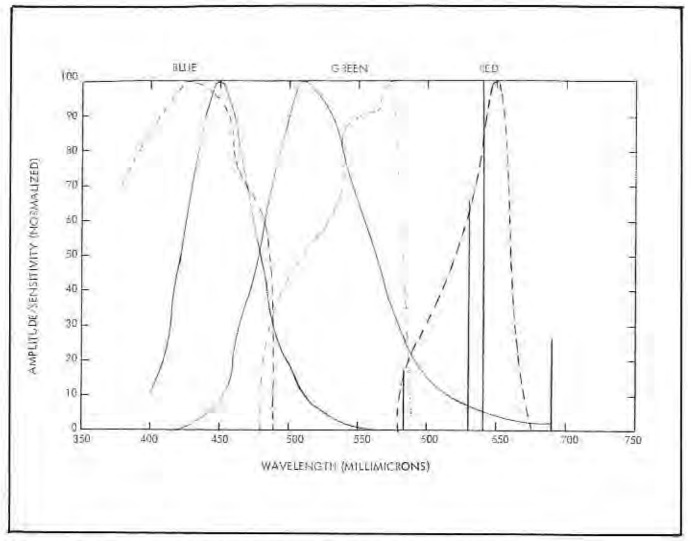


Figure 1: Film sensitivity related to phosphor output.

appears at first to be very attractive. However, it suffers from a major drawback. A light valve has an extremely long decay time (in the order of ten TV frames). While this is normally acceptable for use by observers, it causes severe lag problems when it is used for recording purposes. This problem is compounded by the fact that the decay time differs for different colors.

The laser display system also looks very attractive. It has ample light output and the scanning systems are inherently linear. Unfortunately, at this time these laser displays are still

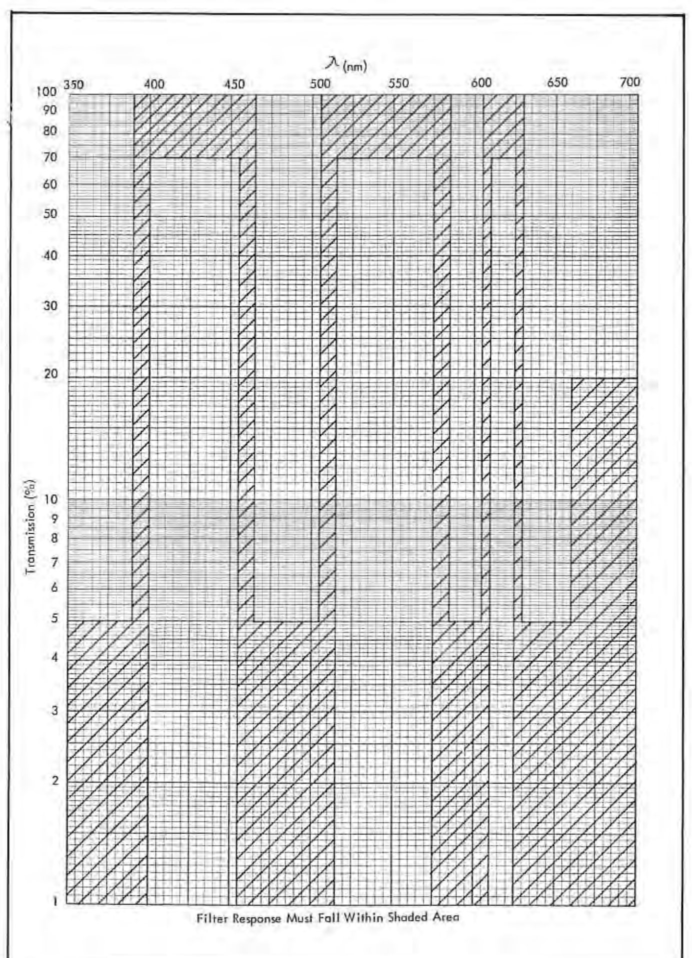


Figure 2: Filter response.

in the laboratory stage and it was felt that the operational drawbacks of this experimental equipment nullified any potential advantage in using this as a display medium for a production hardware such as the television recorder. Thus, we are left with a kinescope type of display system either with three tubes or with the shadow mask. In the past considerable work has been done with three tube systems. The advantages of these systems are that they have greater light output and have no fundamental resolution limitations due to the shadow mask. However, past experience with these systems has shown that the rather complex problems of aligning the optics necessary to combine the imagery would be beyond the average user. We, therefore, reached the conclusion that the shadow mask tube was the only suitable display medium at this time.

A further factor in this decision was that because of the high usage rate of shadow mask tubes in the industry, considerable research has been continued in this area. This has resulted over the past few years alone in an increase by a factor of two of the light output and a comparable increase in resolution.

Optical Analysis

The decision to use a shadow mask tube was not taken on the purely negative grounds discussed above. Analysis of the resolution requirements imposed upon a system by the NTSC 525 line system and comparison of the tubes with the inherent limitations of 16 mm color film, show that the tube is in fact not the weakest link in the transfer process.* The film selected for primary use with the system is Eastman 7252 reversal. This is selected as it is the slowest currently available film with a correspondingly good grain size. It can be calculated that to properly expose this film we need a light output from the tube of 60 footlamberts.+ Investigation of shadow mask tube data sheets and test results show that this light is now available from these tubes. In fact, under certain conditions, 100 footlamberts is obtainable.

Investigation of the resolution capability of the shadow mask tube shows that the resolution limitations of the tube are not inherently due to the shadow mask. For example, a 19 inch tube underscanned demonstrates an availability of 544 picture elements per horizontal sweep. This compares favorably with the NTSC requirements of 220 elements.± Thus, providing a small spot size can be maintained within the tube, resolution is adequate on a shadow mask to record the NTSC color signal.

Spectral Interface Problems

Consideration should now be given to the color imagery of the transfer process. Since we are constrained to use readily available production hardware for the shadow mask tube and, of course, we must design around readily available film, the comparison of the spectral responses of these two items is in order. This comparison demonstrates that the light output of the phosphor used in a standard shadow mask tube does not coincide with the sensitivity of the film. For example, the green phosphor of the shadow mask tube will tend to expose not only the green sensitive layer of the film but to some extent it will expose the red and blue layers also. (See Figure 1.) This "crosscoupling" effect means that desaturation will occur during the transfer process. Two methods of correcting this desaturation were investigated.

*See Appendix 1 +See Appendix 2 ±See Appendix 3

The most obvious method is to eliminate those parts of the light output from the tube which expose the wrong layers of the film. This can be done by the use of optical filters and we did indeed develop a theoretical mask of this nature. (See Figure 2.) However, discussion with various glass coating experts brought to light weaknesses in this approach. Although this type of interference filter should have no insertion loss in the pass band, in practice approximately 20% of the light is lost. In addition, the slopes of the transfer function required to properly correct for desaturation are still beyond the current state of the art for optical filter manufacture. We thus regretfully shelved this approach.

The alternative approach is to predistort the color signal prior to the display to correct for this crosscoupling effect. To take a simple example, if the green gun by itself exposes the green sensitive film 100%, the red sensitive film 10% and the blue 20%, it is possible to electronically subtract 10% of the green signal from the red channel and 20% of the green signal from the blue channel. This will in most cases give the correct result. Limitations in this approach are obvious. Since the negative exposures are not feasible, this system can only work if some exposure is expected for all three colors. Thus, fully saturated signals such as color bars cannot be perfectly recorded. However, most real life pictures do exhibit some element of desaturation and can, therefore, be corrected in this manner. Also, since some exposure is required on the film even for "TV black" signals, there is still some exposure even at TV black levels from which can be subtracted the correction signals.

Electronics Design

At this point we have a system capable of recording TV information on film when it is presented as three standard signals (red, green and blue). For normal use it is still necessary to decode the NTSC signal. Currently available hardware does not present an accurate method for this decoding since most decoders rely on a notch filter approach to separate the chrominance from the luminance information on the incoming signal. A more accurate decoding method is to use a comb filter which removes all the chroma signals from the luminance channel and all the luminance from the chroma channel. The luminance signal may then be aperture corrected over its full bandwidth before being passed to a standard ring decoder in which the red, green and blue primaries are developed.

Camera

The above discussion defines the basic hardware required to present a color signal so that it may be recorded on film leaving only the selection of a film transport mechanism. Fortunately, the choice of a camera presents no problems. For many years we have been building the DBM-64 camera system which is capable of transporting film during the vertical interval of the TV signal and then holding the film sufficiently steady so that no interlace problems occur when the two subsequent fields of the TV signal are recorded. Some additional constraints were placed upon the camera during the design of this equipment, due to the nature of the tube from which we will be recording. A normal kinescope recording tube is designed to have a very short persistence so that information presented during the one field is not stored and thus recorded on subsequent fields.

The phosphor decay in the color tube employed is somewhat longer than this ideal case. Thus, we can no longer consider the exposure of any point on the film to be instantaneous. It is now a summation of the exposures due to the initial brightness of the spot plus the decaying brightness over a period of time. This presents no problems except when we consider the manner in which the film is transported in relation to the timing of the TV signal. During this transfer process, a correction in frame rate has to be made between the TV signal of 60 fields (30 frames) and the film standard of 24 frames per second. This is done by eliminating every fifth field of the TV signal by interrupting the optical path with a mechanical shutter. To obtain symmetry of the film motion of the camera, the film is thus pulled down at one time immediately after a field has been "written" allowing one microsecond for film stabilization and the alternate pulldown occurs in the middle of the unused field. Thus, exposure of the film is stopped in one case by the initial transportation of the film at pulldown and in the other case by the shuttering action of the mechanical shutter. To avoid any flicker effects, it is necessary to carefully "phase" the shutter timing with the pulldown timing of the camera. This constraint is not normally applicable to monochrome recording. Since this is so critical, a vernier system was developed to allow accuracy of this timing on a day-to-day basis.

Operational Considerations

Apart from the mechanics of transferring the telefilm signal to film, we should consider the constraints placed upon this process by operational considerations relating to the type of program material to be transferred, available personnel and the chemistry of the film processing. The major parameter that must be controlled in order to make color telefilm recording an operationally practicable process is the quality control method used by the printing laboratory. It has been found necessary to conduct close liaison with the printing laboratory to insure that no attempt is made by them to correct for color balances on the film. If this is not done, a situation can develop whereby both the telefilm transfer operator and the printing labs are "fighting" each other to achieve the same result. Obviously, quality control of the processing of the film is equally necessary and currently we are relying solely upon Eastman Kodak's abilities in this area to achieve repeatable results.

Although the equipment described above is capable of transferring "good" video tape programs onto film it has been our experience that very few video tape programs meet the high standards of color balance and signal level control that are expected when the results are viewed in a critical cinema atmosphere. It has been found that very often a TV program is acceptable for a single transmission when it would not be acceptable as a release film. This is usually due to constraints imposed upon the TV studio during shooting such as available light, time to adjust color balance, etc. Thus, in many cases further correction of the television signal is required between the video tape replay equipment and the telefilm transfer unit. Fortunately, a large proportion of this correction can be carried out using available hardware. Obviously, the video tape replay processing amplifier has controls for pedestal and gain, and it is possible to purchase a color correction unit which will allow for independent adjustment of gamma, gain and pedestal of each of the three colors. This unit can be incorporated in the transfer chain between video tape machine and the telefilm recorder. Unfortunately, the use of this equipment once more causes the telefilm transfer operation to rely upon the skill and judgment of an operator. However, it has been found in practice that the use of this equipment does not degrade the image

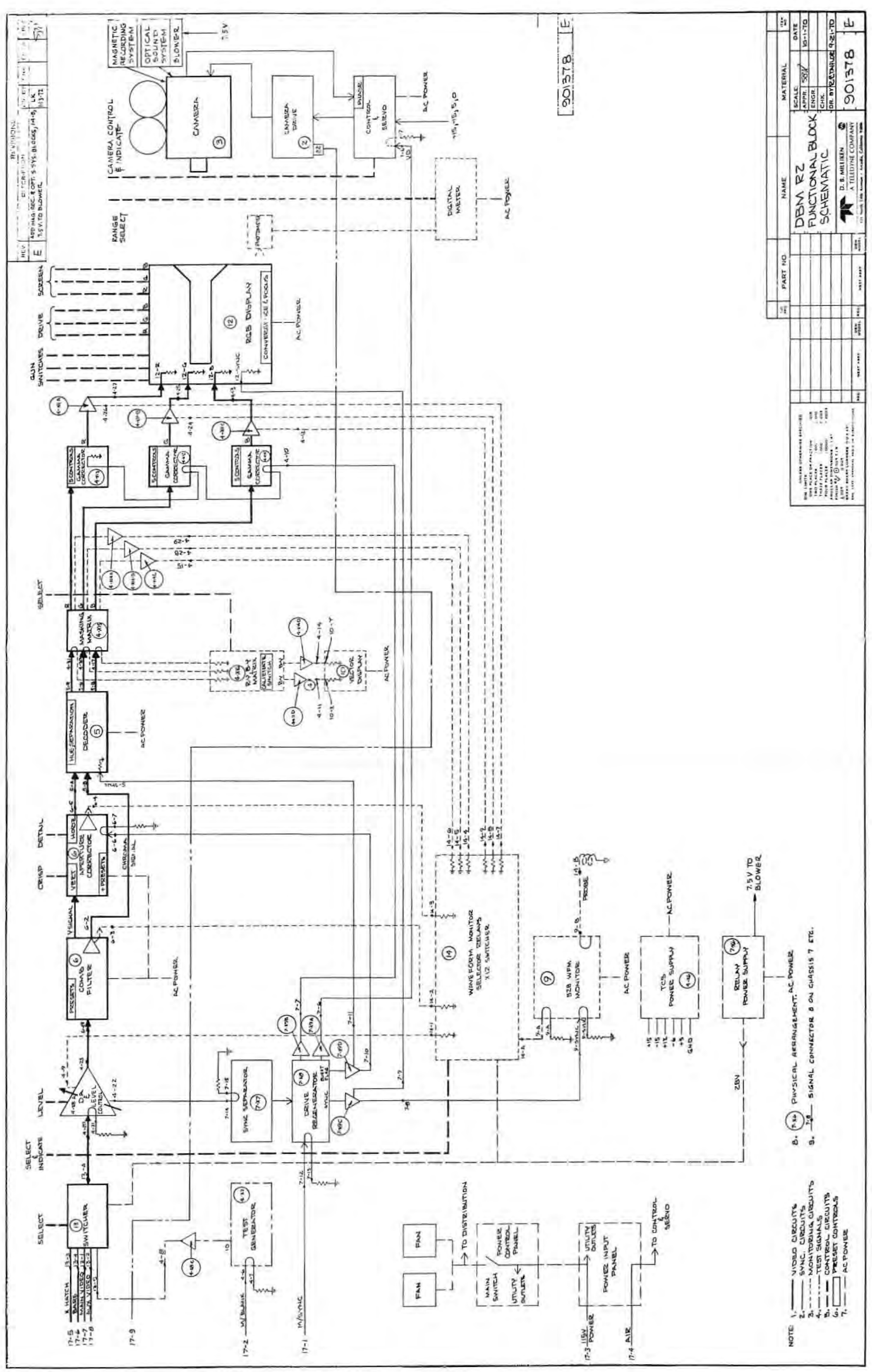


Figure 3: Functional block schematic.

and in some cases can "rescue" an otherwise unusable TV program.

The use of color correction equipment requires a subjective judgment for picture quality by the operator. It is thus necessary for the operator to view a high quality image of the signal being transferred. If daylight balanced film is being used in the telefilm unit, it is possible to view the recording display. This is not recommended, however, as the light levels used in this display are high and are liable to cause misjudgments by the operator. In addition, if a film balance for tungsten light is used, the color presented on the recording display will be far from that which the operator is used to. An alternative approach is to supply a color display television from the same decoder as the recording display but adjusted to a normal white light and to a level which will be acceptable to the observer. He may then predistort the incoming signal using the color correction to maintain a pleasing picture on his review monitor and the telefilm recorder will record the result of these corrections.

Some consideration should now be given to the human factors involved in the operation of video tape, telefilm and color correction units to avoid a multiplicity of staff. The grouping of the equipment must be such as to allow easy operator access to all three equipments. It is recommended that a central control console be built comprising controls for the video tape machine, telefilm recorder and color correction unit. This console should contain the review monitor, a reference white and a reference flesh tone to aid the operator in his adjustments.

Operational Repeatability

With the equipment defined above it is possible to make high quality color telefilm transfers. However, in order to allow operators to repeatably obtain the optimum results, further hardware is necessary. This hardware is best discussed in reference to a system schematic. (See Figure 3.) A variety of test signals are necessary to insure that the equipment is adjusted to the same parameter for each recording. The source selection system allows 1 of 5 signals to be selected; thus crosshatch signals can be supplied for convergence adjustment to the display, the color bar signal is supplied to allow for correct alignment of the decoder, and the internal test generator supplies a sawtooth signal for matching the gamma amplifier curves and a step signal to be recorded as a test pattern onto the film for subsequent density measurements. Incidentally, this internal test generator also supplies a special two step signal to allow brightness and contrast controls for each gun to be set. The use of this will be discussed later.

An auxiliary input is made available to allow for the recording of a known reference signal such as a color slide. This aids the subjective judgment of the result of the film transfer. The controls for this selection have been grouped to aid the operator in the correct sequence of operations. (See Figure 4.) A series of test signals are also made available within the equipment. These are used in conjunction with a waveform monitor to allow system performance to be checked prior to each recording. Again, the selection panel for these signals is configured in such a way as to encourage the operator to use this facility in a logical manner. (See Figure 5.)

It will be noted from this that analysis of the decoder's performance is possible not only in terms of the correct amplitude response of the three color channels by means of the waveform monitor, but a Vector analysis is made feasible by the use of a special "Vectorscope" type display of the decoded signal. Using this it is possible to initially calibrate the decoder using color bar signal as a source.

Figure 4: Controls for selection of results of film transfer are grouped to aid operator in correct sequence of operations.

The gamma amplifier performance is checked both in terms of input to output gain for each color channel, and in terms of matching of the gamma curves for all three color channels. Once these electronic checks are made on the system the actual light output from the display may be adjusted to insure correct exposure of the film. This is done by selecting the special exposure control signal from the internal test generator and by adjusting the three background controls mounted on the main control panel independently for previously determined figures for each color. The high level signal is then selected and the three gain controls for each channel are adjusted again to obtain previously determined figures for each color channel. The grouping of meter and gun controls with the digital display of the light level from the tube face is made such that the operator may concentrate solely on this area of the control panel while these adjustments are being made. The sensing element for this photometer is built into the unit so that no positioning errors will affect this most important calibration. Once these channel calibration adjustments have been made, the source to be recorded can be selected, and use of the waveform monitor and the Vector display allows this source to be brought in line with the locally generated test signals. This insures that every recording will obtain consistent quality standards. This area of design also is considered to be the most important of the whole system since the best hardware in the world will not give acceptable results if it cannot be operated by the available level of talent in the industry.

Figure 5: Selection panel for test signals allows system performance to be checked prior to recording.

Summary

To summarize, the very nature of a transfer process to film eliminates the possibility of checks being made for the quality of the recording until one or two days later. The equipment design for this process must therefore incorporate every conceivable feature which will insure not only that the mechanics of the recording are correct, but that the operator, as far as is possible with a human being, does not make any mistakes.

It has been our experience that this latter requirement is facilitated when the operator is not asked to use judgment factors at critical times such as when other problems, signal routing, liaison with studio personnel, etc., are detracting from his attention to the equipment. Thus, a film transfer equipment must offer (a) excellent technical performance, and (b) attention to the human factors involved in day-to-day operation in a TV studio.

Appendix 1

Assuming a 16 mm TV format and second generation, i.e. 1 Master and 1 Print.

$$\text{Resolution required} = \frac{\text{System Resolution (H)}}{\text{Image Width (PH 22.96)}}$$

$$\text{Resolution required} = \frac{228}{0.38 \text{ X } 25.4} = 23.6 \text{ cycles/mm}$$

From data available for Ektachrome MS for the Master and Ektachrome R for the Print:

MTF of MS @ 24 cycles/mm = 50%
MTF of R @ 24 cycles/mm = 50%

$\therefore$ System MTF for film = 25%, i.e. -12dB

Compare with shadow mask resolution of 583 elements/picture or equivalent 30 cycles/mm on the film.

Note: The above calculation may be considered a worst case as experience has shown that Ektachrome commercial (7252) film printed onto a high resolution print stock such as 7388, gives subjectively sharper results than the above films. However, data is not available for this print stock in terms of MTF and it is therefore impossible to apply an analysis to this process.

Appendix 2

Light required to expose film is given by:

$$FC = \frac{25 \text{ X } F^2}{E.1. \text{ X } t}$$

where:

FC = footcandles
F = F/stop
E.1 = ASA Index
t = exposure time

When recording from a kinescope tube incedent light in footcandles is numerically equal to the light output in footlamberts:

$\therefore$ as F = 1/1.4
E.1. = 25 (for 7252)
t = 1/30

Note: The real value for t is indeterminate for any given picture element; however, since the measuring technique for the tube light output uses a summing (average) meter – we may also use a summing technique:

$$\therefore F_L = \frac{25 \text{ X } 1.4^2}{25} \text{ X } 30 = 58.8 \text{ footlamberts}$$

Appendix 3

NTSC System Resolution @ 4.2 MHz

Horizontal

$$\text{Active line time} = \frac{0.855}{15734} = 54.34\ \mu\text{sec}$$

$$\therefore \text{Cycles/line} = 4.2 \text{ X } 10^6 \text{ X } 54.34 \text{ X } 10^{-6} = 228.228 = 228 \text{ cycles @ } -3 \text{ dB}$$

Vertical

Active line = 525 X 0.93 = 488

Assuming Kell Factor = 0.7
Resolution = 341 TV lines
= 171 Cycles

Underscanned raster on a 19-inch tube has a 17.5 in. diagonal.

$\therefore$ Picture width = 14 in.

Typical triad spacing = 0.024 in.

$\therefore$ shadow mask elements per picture width = 583, i.e. 1-1/4 times the system limiting resolution.

Thus the shadow mask tube performance is solely a function of the spot size achieved by the gun. ■

Stephen P. Robinson was educated at Cambridge University, where he received his M.A. degree in Electronics Engineering. He was employed by the British Broadcasting Corp. between 1962 and 1967 as an Engineering Group Leader. As such, he had responsibility for the installation and acceptance of video tape and video film recording equipment. During this time he also designed film recording systems to record the American standard 525 line TV signals on 35 mm film. In 1967, he joined Teledyne Camera Systems, Arcadia, Calif., where he is responsible for the development of both airborne and commercial film recording systems.

SHOW COVERAGE

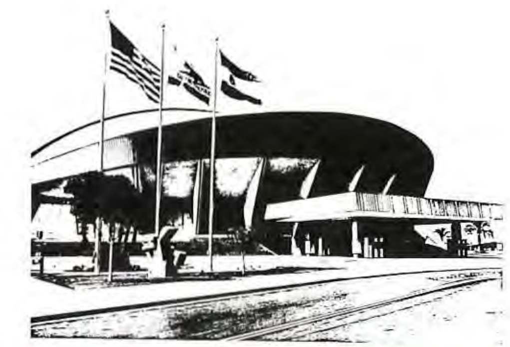
1972 IEEE DISPLAY DEVICES CONFERENCE

United Engineering Center Auditorium
New York City
Oct. 11-12, 1972

The Institute of Electrical and Electronics Engineering Inc. and the Advisory Group on Electron Devices are presenting the 1972 IEEE Conference on Display Devices on Oct. 11-12, 1972, at the United Engineering Center Auditorium in New York City.

During the Wednesday sessions, papers presented will include: "Recent Developments in Three-Color Plasma Display Panels," H.J. Hoehn and R.A. Martel; "Tubular ac Plasma Panels," W.N. Mayer and R.V. Bonin; "Panaplex II, a Low-Cost Digital Display," T.C. Maloney; "An All-Thick Film ac Plasma Line Display," W.E. Coleman, J.P. Gaur, J.H. Hoskinson, J.L. Janning and R.C. Smith; "Light Addressed Light Valves," E.I. Gordon; "Three-Axis Matrix Display Addressing Techniques," S. Sherr; "Electrophoretic Display Device," I. Ota, J. Ohnishi and M. Yoshiyama; "Electroluminescence in Mn-Implanted ZnS Thin Films," T. Takagi and I. Yamada; "Linear Planar Processed Green GaP:N Led Arrays," H. Allen, S. Fisk and J. Walker; "Recent Progress in a Real-Time 3-D Display," G.G. Goetz, R.K. Mueller, D.M. Shupe; and "Characteristics of an Electrically-Controlled Fluorescent Dye Panel," D.P. Hamblen and J.R. Clarke.

Featured at the Thursday sessions will be: "A 160x256 Element Alphanumeric/Graphic Display," J.E. Lang, W.F. Goede and J.E. Playter; "A CRT-Thermochromic Display with VO_2," J.R. Trimmier and L.T. McConnell; "Nucleation Media/Electron Beam Recorder Near-Real-Time Display System," P.A. Sullivan and D.B. Learish; "Rare Earth Oxysulfide Films: High Brightness, Multicolor CRT Screens," R.V. Alves, R.A. Buchanan and T.G. Maple; "The Gain in the Definition of a Color CRT Image Display By the Aperture-Grille, In-Line Electron Beam Arrangement," H. Machida and Y. Fuse; "Development in CRT for the Schmidt Projector," N.W. Patrick; "Liquid-Crystal Display Prospects in Perspective," A.R. Kmetz; "Nematic Liquid-Crystal Displays: Properties and Limitations," U. Bonne and J.P. Cummings; "Design Considerations of Liquid-Crystal Displays," R.E. Adrich and R.B. Lauer; "A Large, Flexible, Liquid-Crystal Display Cell," J. Wargin, P. Herczfeld, T. Matcovich, R. Fischl, Z. Turski and W. DaCosta; "Thermo-Optic Effects and Two New Liquid-Crystal Information Display Devices," A. Sasaki, K. Kurahashi and T. Takagi; and "Liquid-Crystal Graphic Displays Thermally Addressed by Infrared Laser Beams," D. Maydan, H. Melchior and F.J. Kahn. For further information, contact Thomas Henion, IEEE secretary, Palisades Institute, 201 Varick St., New York, N.Y. 10014.



FALL JOINT COMPUTER CONFERENCE

Anaheim Convention Center
Anaheim, Calif.
Dec. 5-7, 1972

More than 20,000 computer specialists, users of data processing equipment and services, government officials, administrators, corporate executives and educators are expected to attend the 1972 Fall Joint Computer Conference, Dec. 5-7, 1972, at the Anaheim Convention Center in Anaheim, Calif.

Featured at the conference will be six sessions on the measurement of computer systems. The sessions will be directed to users of EDP systems and will look at the measurement of computer systems in the following areas: executive viewpoint, system performance, software performance, useful approaches, techniques and applications and case studies.

In addition, a major exhibition will be held as part of the conference. The exhibition will enable those attending to evaluate and compare the latest products and services of approximately 200 organizations.

At a special seminar on Dec. 5, computers in banking and the changing electronic payments mechanism will be analyzed. The seminar will be addressed to operators and users of advanced banking and related systems and to the developers of computer systems involved in the changing electronic payments mechanism. Further information regarding the conference may be obtained by writing to: 72 FJCC, c/o AFIPS, 210 Summit Ave., Montvale, N.J. 07645; or phoning (201) 391-9810.

On the Move

R. Joseph Dorcy appointed product marketing manager-cathode ray tubes for the Electronics Components Group of GTE Sylvania Inc., New York, N.Y., a subsidiary of General Telephone and Electronics Corp.

Dorcy

Mallery

Guy Mallery has joined Incoterm, Marlborough, Mass., as director of sales.

J.C.R. Licklider named chairman of the Data Communications Advisory Group of the American Federation of Information Processing Societies (AFIPS), Montvale, N.J.

Westinghouse Electric Corp., Pittsburgh, Pa., has announced *William A. Coates* as its general manager of the electronic tube division.

J.L. Moll, PhD, was awarded the J.J. Ebers Award by the Electron Devices Group of the Institute of Electrical and Electronic Engineers Inc., New York City.

Herman A. Rubin named sales manager of McDonnell Douglas Automation Co., Detroit, Mich.

In Oak Ridge, Tenn., *Robert J. Pratt*, sales administrator with Tennecomp Systems Inc., has been promoted to the newly-created post of assistant sales manager.

Don M. Avedon named technical director of National Microfilm Assoc., Silver Spring, Md.

University Computing Co., Dallas, Tex., names *Dean D. Thornton* vice president-finance and administration.

Dialight Corp. Inc., Brooklyn, N.Y., announced the appointment of *Sanford Roth* as its first new product applications manager, and *Joseph Pardo* as export manager.

Roth

Pardo

Elbert (Matt) Mathews has been appointed to the newly-created position of vice president-operations of Sycor Inc., Ann Arbor, Mich.

TeleMation Inc., Los Angeles, has announced the appointment of *Harold C. Blakeslees* as marketing specialist for a new product, the TMM-500 Information Display Channel.

Blakeslee

Pinder

Sanders Associates Inc., Nashua, N.H., has named *Richard S. Pinder* manager of its Data Systems Div. office in Atlanta.

William N. Moody named general manager of the Dumont Electron Tubes Div. of Fairchild Camera and Instrument Corp., Clifton, N.J.

The Gerber Scientific Instrument Co., Windsor, Conn., appointed *Augustus T. Ashton* vice president of marketing, and *Thomas P. Lydon* general sales manager.

Eldorado Electrodata Corp., Concord, Calif., appoints *Norman W. Brown* manager of manufacturing.

Richard E. Kaylor named president of Informatics Inc. Computing Technology Co., River Edge, N.J.

ID Readout

Digital Driving

Sometime in the near future drivers will utilize direct digital-readout dashboards for all vital driving statistics. As shown in the Monsanto Co. mock-up, the dashboard will tell the driver exactly how many gallons of gasoline he has left, miles per hour, cumulative miles driven, exact time, elapsed time, and the status of his seatbelts, doors and hand brake.

Additionally, instead of the old fashioned clock-type tachometer, a series of mini-diodes will light to indicate engine speed at a glance. The power requirements for the diodes, some of which are no larger than a grain of rice, will be no more than that of a small transistor radio and, because of their near 100-year life capacity, they will never require replacement.

Totalscope Display

Totalscope, a Motorola display combining radar data and tactical management modes, has been selected for a major role in the Air Force's new Position Location, Reporting, and Control of Tactical Aircraft (PLRACTA) system.

Motorola Government Electronics Div. developed the display, AN/USA-26(V)2, which was procured by the Rome Air Development Center and is being evaluated by the Mitre Corp. under the direction of the Air Force System Command's Electronic Systems Div. (ESD).

PLRACTA is an ESD advanced development program designed to demonstrate a new command and control concept. Under this approach, all users in the synchronized tactical network are provided time slots for digital two-way communications.

Alfred S. Hume, Director of Radar Operations for the Motorola division, said the display provides the vital link between tactical users and the welter of communications and information generated under battlefield conditions. Through Totalscope the user, whether he is an aircraft maintenance officer or the tactical commander, can select the specific data he needs to perform a given task without having to sort vital information from the total amount generated. With the PLRACTA system, for example, Air Force commanders can rapidly assess an entire aircraft availability situation. Position locating is an added benefit, the accuracy of which is enhanced by computer processing.

ID Products

Recorder

Alden Electronic & Impulse Recording Equipment Co. Inc., Westboro, Mass., introduces the "Main Frame" recorder for graphically reproducing a variety of electrical phenomena such as permanent hard copy records. Alden states recording applications include computer line printers, ultrasonic and infrared flaw detection, hard copy readout of scanning electron microscopes, oceanographic sub-bottom profiling, geological seismic profiling, biological studies and medical research in such applications as scanning for early detection of cancer and real-time hard copy contourograph recording of the R, S, T and P waves of the heart beat.

Circle Reader Service Card No. 10

Front End Processor

Incoterm Corp., Natick, Mass., has developed a remote front end processor using the configuration of the SPD 10/20 Intelligent CRT display. Designed to reduce the polling requirements of central computing systems with on-line communications networks, the remote front end processor provides for remote and automatic polling of downstream terminal devices having reduced access requirements, according to Incoterm. In airline reservation networks the front end processor is to relieve the workload of the central site and to allow automatic polling at remote locations without affecting the central site software or hardware configuration.

Circle Reader Service Card No. 11

Lighted Push Button

A lighted push button is in production at the Switching Devices Div. of Gordos Corp., Bloomfield, N.J. According to Gordos, the switch has a life expectancy (at rated resistive load) of 10 million operations. The push button can be P.C. or panel mounted, and it features solutions to problems such as marginal lamp contact, complex lamp extraction and replacement and difficult keytop alignment. It is compatible with the Gordos Feathertouch push button and has tool-less lamp installation and ejection features as well.

Circle Reader Service Card No. 12

Plotter Systems

California Computer Products Inc., Anaheim, Calif., announces two plotter systems utilizing CalComp flatbed plotters. Model 7800 and Model 7900 include controller, magnetic tape drive and software as well as a flatbed plotter. Model 7800 features a 31 x 34 in. single pen flatbed plotter; Model 7900 is built around a 48 x 72 in. plotter with four program-selectable pens, according to CalComp. Applications for the systems include mapping, integrated and printed circuit artwork production, schematic drawing preparation and general-purpose drafting.

Circle Reader Service Card No. 13

Driver/Decoder

The development of a standard hybrid driver/decoder to be used with their 0010 rear projection readout has been announced by Industrial Electronic Engineers Inc., Van Nuys, Calif. The driver/decoder features a drive capability of up to 300 mA @ 30 V, the company says, and provides 12 different message positions with message areas capable of projecting numbers, colors, symbols, designs and anything that is photographically reproducible.

Circle Reader Service Card No. 14

Ramp Generator

Celco, Mahwah, N.J., manufactures a dual ramp generator for producing ramp output signal periods from 10μs to 100 ms each channel with 0.05% linearity. The ramp period is determined by the four-position range switch and adjustable period control, according to Celco. The RG-116 enables rasters to be seen on an oscilloscope as generated by flying spot scanners, line scan systems and CRT displays. The output signals can be offset ±5 V about ground with continuously adjustable dc bias controls, with 10 V peak-to-peak from each channel.

Circle Reader Service Card No. 15

Collet Knobs

Christel Co. of Calabasas, Calif., introduces collet knobs that feature miniature size, plug-in components and color coding. Six knob sizes are available from 0.350-1.41 in. diam serving shaft sizes 1/8-1/4 in. Knob configurations include plain, lined, wing knob and lined wing knob in colors gray, black and red. Knob design includes provision to accept plug-in nut covers, pointers or figure dials as well as the ability to be assembled in two-stage concentric combinations, according to Christel.

Circle Reader Service Card No. 16

Advertisers

Circle Reader Service Card No. 4