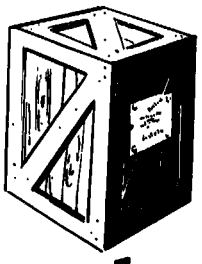

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Heat-Reflecting Filters in Carbon-Arc Projection Systems

By RUDOLF FISCHER and MARTIN PLOKE

A paper submitted for, but not read at, the Society's Convention at Los Angeles, October 1956, by Rudolf Fischer and Martin Ploke, Zeiss Ikon AG., Kiel Wik, Mecklenburgerstr. 32-36 West Germany. Assistance with the translation of this paper was kindly given by Walter Beyer, Motion Picture Research Council, 6660 Santa Monica Blvd., Hollywood 38.

THE HIGHER amperages required to satisfy screen-brightness standards in wide-screen projection have caused increased heating of film and projector head. In order to obtain highest pictorial quality, each frame should be flat in the projector gate during the projection cycle and not buckled by the heat from the light beam and the hot metallic parts in and around the aperture. Reduction of heat from the arc thus becomes an urgent problem.

Heat filters may be inserted in the light beam at a point where the light cone is still relatively large, so that the specific heat load on the filter area is kept at a minimum. Two types of filters are used, involving different basic principles in their heat-absorbing properties. The older type of filters, once the only kind available, have a slight greenish tint and run very hot since they reduce the heat from the light beam by absorption. They are generally made in strips to avoid cracking due to expansion, and additional air cooling is needed.

Among the more recently developed heat-reflecting filters[1] there are some which absorb no heat, require no cooling, and can be inserted in the light beam like any ordinary lens. Heat-reflecting filters can be made completely colorless or with any color tint desired without affecting the light transmission. An example of the latter type would be heat-reflecting filters made for low-intensity carbon-arc illumination where a bluish-green filter factor is added in order to avoid the bothering orange tone present in the light of low-intensity carbons, which affects the reproduction of color films. As indicated by their name, these filters reflect the invisible heat, which is present in the light beam, back to the light source. This is made possible by means of a special coating

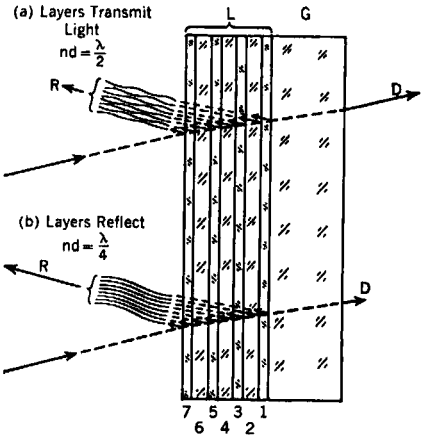

Fig. 1. Cross section of a 7-layer interference filter. L, coating; G, glass support; R, reflected radiation; D, transmitted radiation; nd, optical thickness of each coating.

applied to a glass base. The coating consists of a multiplicity of transparent layers having alternating high and low indexes of refraction.[2]

The effect is based upon the reflection of light on the surfaces of the different layers, which is also accompanied by an interference effect. On this account they are sometimes called interference filters. These filters use the same principle as that of heat-transmitting mirrors.[3,4] Such mirrors have a reflective surface consisting of a coating of layers with interference properties. In general, the layers are much thinner here, but the number used for "cold mirrors" is much greater.

Such mirrors have a high transmission for heat rays, and at the same time have high reflective properties for visible light. Heat-reflecting filters, on the contrary, show excellent transmission for the visible light and a high reflection characteristic for the infrared rays adjacent to the visible spectrum. This is one reason why such heat-reflecting filters are often called infrared mirrors. This basic difference in the operation of cold mirrors and heat-reflecting filters makes it clear that although the coating functions in essentially the same way in both cases, it must be applied in each case with the specific purpose in view for which it is intended.

The relationships between filter and reflection effect are shown in Fig. 1. This is a schematic drawing of an interference coating consisting of seven nonabsorptive layers. The layers with the high index of refraction are marked 1, 3, 5 and 7. The layers with the low index of refraction are marked 2, 4 and 6. Those with the higher index of refraction are thinner than those with the lower index. The reason for this is that to achieve correct optical quality the product of the thickness of the layer, (n), multiplied by the refractive index, d, must be the same for all layers.

If the product nd is about half the mean wavelength of the visible light, for which we will assume the value $\lambda = 0.525\ \mu$, the reflected waves of the visible light will cancel each other, and the coating is transmittant for this wavelength. This is indicated as (a) in Fig. 1.

If, on the other hand, the thickness of each layer and therefore the product nd is

only half of the above value, or $\frac{1}{4}$ of the mean wavelength, the reflected light will consist of waves of equal phase, and therefore the coating will act as a mirror for $\lambda = 0.525\ \mu$ ((b) in Fig.1). It is thus possible to calculate the characteristic of reflection of such a system in relation to the wavelengths of light.[5,6] If a figure reciprocal to the wavelength, for instance the light frequency, is chosen as an independent variable, a periodical curve with several main reflection maxima, R_1, R_2, etc., will be obtained. These maxima alternate with transmission sections D_0, D_1 and D_2. This is shown in Fig. 2.

If the coating is to act as a filter, the thickness of the individual layers must be such that the transmission section D_1 is shifted into the visible light. In the case of the mirrors, the thickness of the layers must permit the main reflection maximum R_1 to be located in the range of the visible light. Figure 1 indicates what is involved in the composition of such coatings in respect to the number, thickness and refractive index of the layers.

In order to obtain a high degree of light transmission in the case of a filter, the principal concern is to ensure the disappearance of the troublesome band structure in the transmission section D_1. Furthermore, the reflection band R_1 must be extended close to the edge of the visible light. In the case of a mirror, one has mainly to aim for a sufficient height and width of the reflection band R_1, together with adequate elimination of the band structure in the transmission sector D_0. Heat-reflecting filters with a transmission factor of 95% for visible light have been successfully made. These eliminate 50% of the heat rays from the arc lamp. With respect to the total radiant energy of the arc lamp, including the energy of the visible light, and depending on the type of carbons and amperage used, filters give up to 37% effectiveness.

Figure 3 shows the spectral characteristics for two types of such filters as manufactured by Zeiss-Ikon. Curve A represents the clear white Ernotherm filter, and curve B the Ernocolor filter, which has a slight blue-green tint. Both filters are manufactured in the form of disks of 4-in. diameter and 0.118-in. thickness. The manufacture of heat-reflecting filters for use in motion-picture theaters involves not only the dimensions of the individual layers, as described above, but also presents a technological problem. As a carrier or base for the heat-reflecting coating, a heat-resistant glass is generally used, while quartz may be used in special cases. Great care has to be taken in selecting the materials for the interference layers. Most of the known materials will result in relatively soft coatings, which are insufficiently resistant to heat and moisture.

Filters manufactured from such materials can be used only under specific conditions and with adequate precautions. Considerable demands are made on the adhesion of the coating to the glass, since the temperature close to the arc may rise to several hundred degrees during the showing of a reel. During the pause between reels, there is a tendency for condensation of moisture and other atmospheric conditions which tend to deteriorate the coating. Heat may cause pores to form in the layers into which moisture will enter during the cooling cycle.

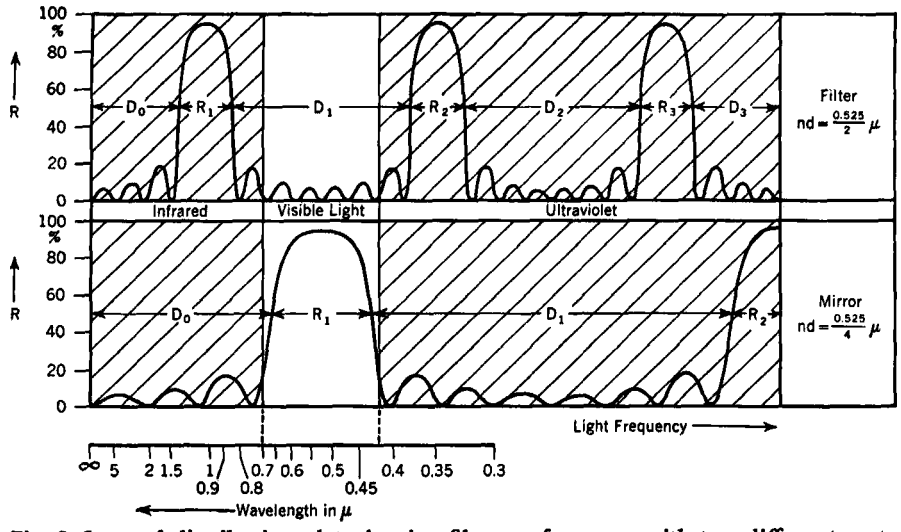

Fig. 2. Spectral distribution plot, showing filter performance with two different coating thicknesses.

When the filter is reheated there is danger of blisters forming, due to the rapid evaporation of the moisture in the pores, and the layer must be destroyed. It is, therefore, essential that these layers should be carefully tested during the manufacturing process for their heat and moisture resistance.

Intensive research and development have now made available heat-reflecting filters which are extremely heat and moisture resistant. Experience in theaters throughout Europe has shown that the Ernotherm and Ernocolor filters fulfill all practical requirements, without need for additional cooling during use. As far as cleaning and maintenance is concerned, no more care is needed than is required for the usual cleaning of optics with antireflective coatings. The Ernotherm colorless filter has done an excellent job in connection with all high-intensity carbon arcs and has contributed notably to the reduction of film buckling due to heat absorption, thus increasing the lifetime of the prints. Such filters can also be used successfully at lower amperages of about 70 amp, at which level noticeable film buckling and flutter can already be observed, tending to produce in-and-out-of focus of the projected image, particularly with short focal-length and high-speed projection lenses. With these filters a steady image with good detail is obtained.

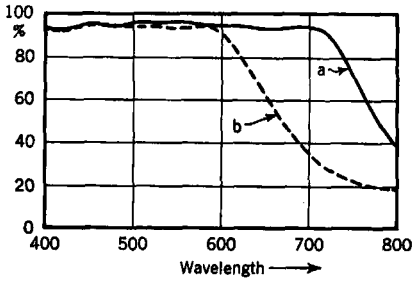

Fig. 3. Transmission curves of heat-reflecting filters; a, Ernotherm filter; b, Ernocolor filter.

Besides the clear white Ernotherm filter, there is also a demand in certain cases for Ernocolor filters with their bluish-green tint. These are used, for example, with low-intensity carbon-arc lamps. Such lamps give orange light which upsets the color balance in the showing of color films.

The transmission characteristic of the Ernocolor filter is shown in curve B of Fig. 3. It has been designed so as to eliminate the disturbing color tint from the low-intensity carbon-arc light. The filter action inherent in the Ernocolor filter does not cause any reduction in its excellent heat-absorption characteristic. Loss or reduction of the visible light has been kept to a minimum.

The effectiveness of this Ernocolor filter in improving color reproduction can best be demonstrated by putting a filter in half the light beam, so that half the image is directly exposed to the low-intensity carbon-arc light, while the other half is projected with light which goes through the filter. The part of the image which is projected by filtered light will show an appreciable improvement in color reproduction, apparent particularly in the white and green colors as reproduced on the screen. Black-and-white films gain as well when projected with light through the Ernocolor filter, because the elimination of the orange color from the light beam causes an apparent increase in contrast on the screen. A loss in screen brightness is hardly noticeable, since light richer in blue-green is physiologically more effective.

In general, it may be concluded that the above heat-reflection filters, with their specially designed transmission curves, will provide screen illumination at a uniform color temperature even with the use of different light sources.

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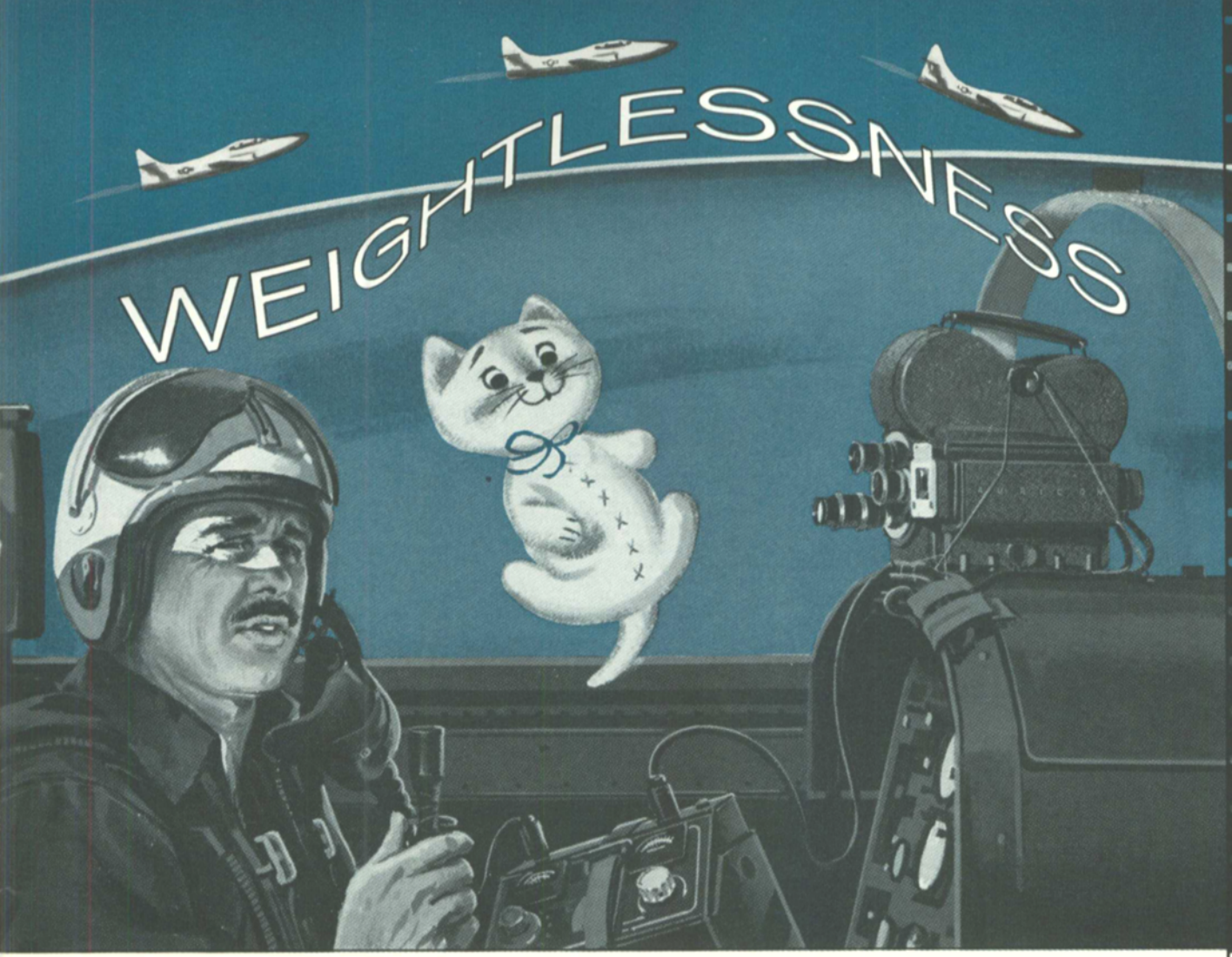

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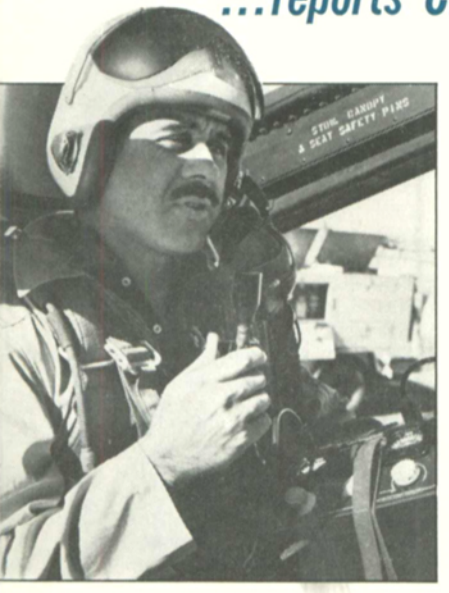

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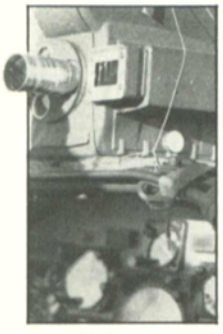

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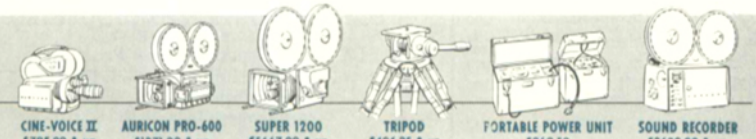

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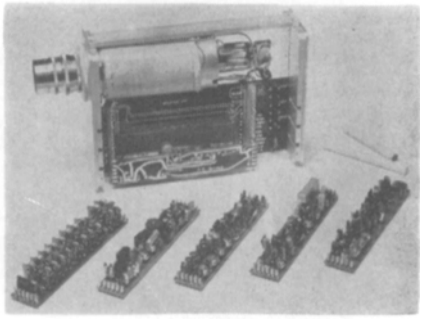


A miniature TV camera described as "the world's smallest" has been announced by Dage Television Div., Thompson Products Inc., Michigan City, Ind., measuring 2⅜ by 5⅜ by 7¾ in. and weighing about four lb. The camera is completely transistorized and makes extensive use of printed circuits. It is said to equal in performance high-definition TV systems weighing several hundred pounds. Separate potted, plug-in modules handle the six basic camera functions: video amplifier, sweep amplifiers, synchronizing generators, binary strip, power supply and oscillator strip.

The unit includes an automatic electronic light adjustment which compensates for light level changes as high as 250 to 1. For higher changes encountered in airborne uses, servo-driven neutral density wedges provide additional compensation as high as 10,000 to 1, at a speed sufficient to protect the camera's vidicon tube when it is pointed directly into the sun. The camera requires no operating controls for adjustments. Adjustments, such as beam current, target voltage, focus and contrast are made automatically. The camera contains what is said to be the world's first completely transistorized sync generator, which develops a standard broadcast quality EIA sync pulse, with more than 4.5-v output. The entire camera, including the sync generator, requires only 8 w of power and can operate on almost any a-c or d-c power source. It delivers a video signal in excess of 1.5 v.

First deliveries have been made to the Army Signal Corps, Fort Monmouth, N.J. The commercial model is priced at $8000.00.

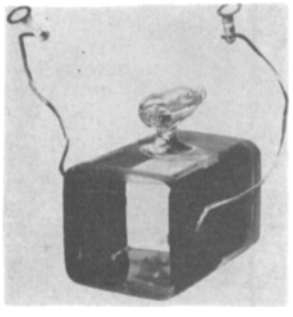
The New York Central Railroad yards at Elkhart, Ind., cover about 675 acres. Thousands of freight cars daily hurtle about over 72 freight classification tracks, but switching is accomplished in considerably less time and is much less hazardous to railroad workers than before the installation of closed-circuit TV.

Following installation of the RCA closed-circuit system and other automated equipment, railroad officials estimated that freight cars can be speeded through the center in about one-third of the time required before the system was installed. With this equipment one operator in the control tower can direct operations on the 72 tracks that handle up to 3540 cars.

A fixed-focus RCA TV camera is located in a raised housing near each of the yard entrances, two miles apart. As each car passes the camera, its picture is relayed over the closed circuit. The cameras, installed for unattended, round-the-clock operation, are pre-set to scan a 20 by 15-

ft area, and are equipped with automatic iris controls and automatic target adapters to permit electronic adjustment for changing light conditions. The system includes video line amplifiers with a suppressor of induced noise, designed to assure a clear picture, unaffected by power lines or other sources of distortion.

Automatic programming equipment designed for a TV station break was demonstrated at the NAB Convention, April 28–May 1, at Los Angeles, by Radio Corp. of America. The system can handle a program consisting of ten events, with a possible expansion to a maximum of 20 events. The system's memory unit employs binary relays and stepping switches to store information, including the time required for the individual program event, the audio or video source (film camera, record turntable or slide projector) and the event number in the program sequence. The relays and switches are mounted in a standard cabinet rack with a timer and the necessary power supplies. The operator sets up the desired program sequence by pressing the proper "event select" buttons. Events of any desired length can be selected by use of a time selector switch. Another switch on the control panel permits the operator to scan the system's memory system for errors or to locate a particular event in which changes are to be made.



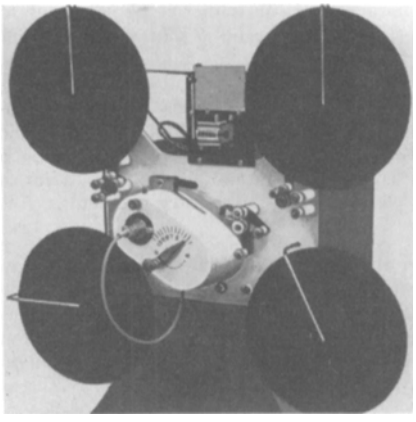
An exposure time of 0.01 μsec is reported achieved with a Kerr cell electrooptical shutter and pulse generator circuit developed by the Research and Advanced Development Div. of Avco Mfg. Corp., 20 S. Union St., Lawrence, Mass., especially for ballistics photography. The pulse generator consists of RG8/U coaxial cable and a specially designed spark gap to provide the required driving signal. The Kerr cell is connected directly across the load resistor on the transmission line and does not require an impedance matching network or pulse transformer.

The electric field needed to produce phase rotation of the electromagnetic light vector as it passes through the nitrobenzene-filled cell lies between 10 to 15 kv/cm. Thus, a pulse generator for a 5-cm. aperture must deliver a pulse of 50 to 75 kv to the Kerr cell plates. Exposure time can be varied from 0.01 to 0.1 μsec by changing the length of the transmission line used in the pulse generator. The waveform for the exposure characteristic is nearly that of a square-wave.

The spark gap used on the pulse generator is designed to minimize effects of corona leakage and atmospheric variations on the trigger characteristic. It may be modified for shadowgraph or schlieren photographs to provide a point light source that is synchronized with the opening of the Kerr cell. Original work on the pulse generator was performed at Los Alamos Scientific Laboratory under the auspices of the Atomic Energy Commission. The shutter has been used in aerodynamic simulation studies of long-range missile re-entry problems.

A device called Audipage which fits on an instructor's ear has been developed by Philco Corp. to facilitate two-way communication in closed-circuit applications. First used in a demonstration at Perth Amboy General Hospital, Perth Amboy, N. J., as part of an experiment in the use of closed-circuit TV in nursing education, the study was conducted as part of a freshman clinical conference. The student nurses were able to question the instructor as his bedside discussion of a patient's case was presented in the classroom on TV. The questions could be heard by the instructor through the device without being heard by the patient. Personnel and equipment for the experiment were provided without cost to the hospital by Impco Inc., Philco Industrial Television representative in New Jersey, New York and Connecticut, and by Consultant Associates, Inc., Long Branch, N. J.

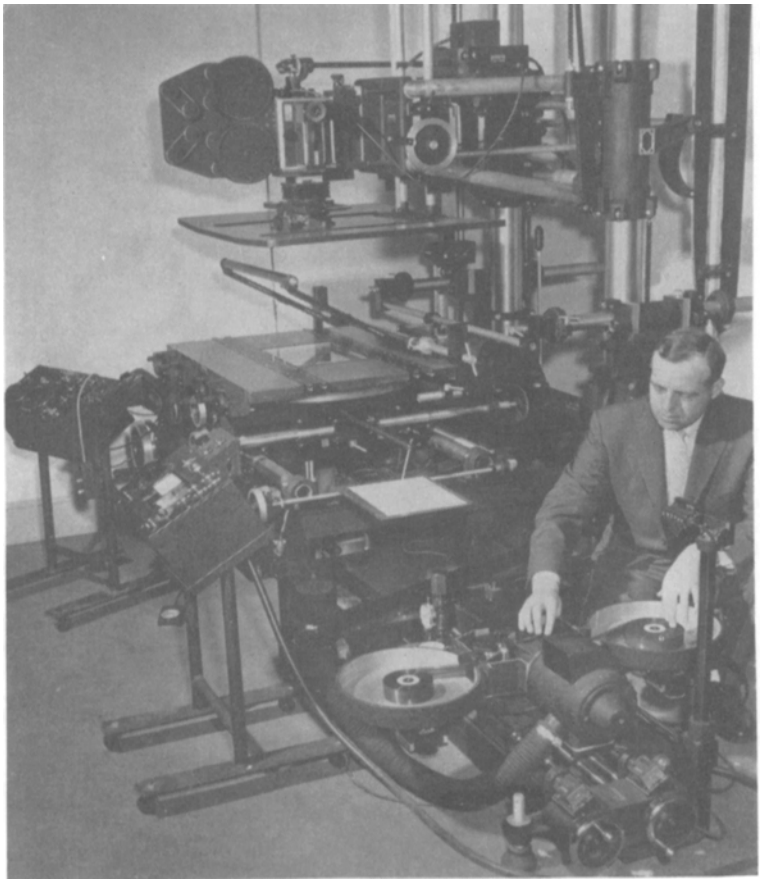
Almost a hundred types of precision wire-wound resistors are listed in the 20-page illustrated catalogue, 14RC, issued by Cinema Engineering, 1100 Chestnut St., Burbank, Calif. Since the last catalogue was issued, certain resistor series have been renumbered to conform with a new specification pattern. Requests for the catalogue should be addressed to the company to the attention of James L. Fouch.



The Tel-Amatic 16mm printer has been announced by S.O.S. Cinema Supply Corp., 602 W. 52 St., New York 19. Features include semiautomatic 13-scene mechanical light change, separate feed and takeup sprockets, and 3-way aperture for sound, picture and composite. The machine has a 1200-ft capacity and a speed of 43 ft/min. It has been designed with a 40-tooth printing sprocket for proper registration. The lamp is 6-v, 4-amp, S.C.B. The lampholder accommodates CC filter for color printing. The printer is supplied ready for bench or table mounting at the price of $1495.00 or mounted on a heavy floor pedestal for $1650.00.

Artiscope, described as "illustration in animation by automation," is an animation technique introduced by Illustrated Films Inc., 8460 Santa Monica Blvd., Hollywood 46, and described briefly as a new film technique in the firm's brochure. The firm explains this method of animation as a process of first photographing a "live action" record of people and props on 35-mm film and then converting the images to inked drawings on celluloid by a series of electrochemical procedures. This method is said to effect fully animated illustrations at a cost lower than that required by conventional animation techniques.

Charles Beseler Co., East Orange, N.J., has purchased Projection Optics Co., Rochester, N.Y., manufacturers of lenses and precision optical equipment, from Fred E. Aufhauser. Operations will continue in the Rochester plant under the direction of Philip Berman, who has been appointed President of the newly purchased firm.



An Oxberry animation stand with a specially designed aerial image rear-projection unit has been purchased by Alpha Film Studio (Pty Ltd.), Johannesburg, South Africa, from Animation Equipment Corp., 38 Hudson St., New Rochelle, N.Y. The aerial image feature converts the equipment into a vertical optical-effects printer. It consists of a projector head, lens mount, stop-motion motor and controls, a flat surface mirror and a large condenser lens system. The stop-motion motor runs continuously forward and reverse and operates independently of the animation camera stop-motion unit, permitting skip-frame work for lengthening or shortening scenes. The unit was built as an integral part of the South African installation, but it can be obtained separately and attached to other Oxberry stands.

Transistor action at a semiconductor/electrolyte interface modulated by an electrical field has been described by Bell Telephone Laboratories in a paper by J. F. Dewald before the American Physical Society. Recent laboratory experiments have demonstrated amplifier operation at 1000 cycles/sec with gain in excess of 15 db.

The experimental device uses a hexagonal rod-like crystal of very pure zinc oxide as the semiconductor, immersed in a highly conducting electrolyte. A platinum electrode placed nearby serves as the grid element. Because zinc oxide is a large-energy-gap semiconductor, it can be operated in a high enrichment condition, with one end of the crystal cathodically biased with respect to the solution, and the other end anodically biased. Somewhere in between is a neutral point which is unbiased, where the energy bands are flat right up to the surface of the crystal. As this neutral point shifts back and forth under the influence of varying biasing grid voltages, the resistance of the crystal changes, passing a current which follows the driving frequency very closely. A fairly extended range of linear response is obtained.

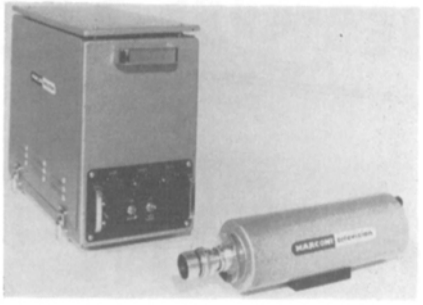
To make electrical contact to the zinc oxide crystal, the two ends are first indium-plated to assure good ohmic contact. They are then copper-plated to allow soldering copper wire leads. The platinized platinum grid completes the assembly. After insulating all wires and connections except the grid, the assembly is immersed in the electrolyte (5% sodium tetraborate and boric acid solution), and hermetically sealed in a small glass tube to avoid electrolyte evaporation.

The Yashica 8, and Turret 8 (Progress Report, *Journal*, May 1958, p. 332) are available in the United States through Jack Gilbert Associates, 1186 Broadway, New York 1, N.Y., at prices of $49.95 and $79.95, respectively. The Turret 8 features a two-lens turret and is available with a normal 13mm, a 3× true 38mm telephoto and a wide-angle 6.5mm lens. The motor has seven running speeds: 8, 12, 16, 32, 48 and 64 frames/sec. The 8 has many similar features but runs at only 16 frames/sec.

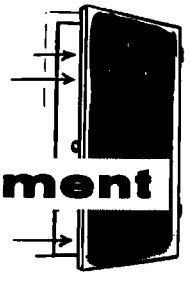
The Magneloop series of continuous-loop magnetic tape recorders-reproducers is described in a 4-page folder available from Amplifier Corp. of America, 398 Broadway, New York 13. Descriptions of 21 basic models available in single or dual speeds and in single, dual and triple channels are included.

A new booklet, *16mm Kodak Movie Films — Data and Selection*, gives advice on loading, film storage, processing, duplicating, use of magnetic sound coating and explains the use of various types of film such as reversal or negative, color or black-and-white. A special data section contains complete exposure information and explains exposure compensation when using filters. It is available without charge from Eastman Kodak Co., Sales Service Div., Rochester 4, N.Y.

An electric slide changer, Model 6800, has been announced by Genarco Inc., 97-04 Sutphin Blvd., Jamaica 35, N.Y. The slide changer accommodates 70 glass-mounted or Polaroid slides, 3¼ by 4-in., and can be mounted on most makes of slide projectors. It operates by pushbutton remote control. It is priced at $285.00.



The Canadian Marconi Co., P.O. Box 1480, Station "O", St. Laurent, Que., Can., has announced a new Industrial Vidicon Camera Channel, Type BD-871. The cylindrical camera head, which is about 4 in. in diameter, has a single lens for a variety of fixed lenses; or a zoom lens and focus can be remotely controlled. This camera chain was described in the Progress Report (*Journal*, p. 322, May 1958) but was inadvertently referred to as the BD-835A which is an earlier, and now obsolete, model of the company's industrial camera chains.



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Positions Wanted

Sound man desires position, preferably with educational or technical film producer. 3 yr college, 3 yr technical schooling, 4 yr motion-picture and general sound recording on film, tape, and disk. Experienced in recording, editing, mixing; sound equipment design, installation, repair. Have musical training and experience. Have own tools and test equipment. Age 25, unmarried. Will relocate. For detailed résumé, write: Donald A. Johnson, 700 Prentis, Apt. 403, Detroit 1, Mich.

Sound Recording. Young man, 7 yr specialized experience film recording, scoring, mixing, sound editing; 4 yr intensive musical recording, tape, disc. Wide knowledge of music background material and selection. Prefer NYC location. Address: Sound Recorder, c/o Apt. 2-C, 51 Paulus Blvd., New Brunswick, N.J.

Motion-Picture or TV Studios, Young man (25) acquainted many phases of photography, filmstrip and slide production; 5 yr experience in motion-picture production, employed by Audio-Visual Service USOM/L, c/o American Embassy Beirut, Lebanon, as Program Advisor II. Experience in planning, budgeting, scheduling, purchasing and training. Worked as cameraman-director, editor of educational, documentary training and newsreel films in 16 & 35mm B & W and color. Consider any position along lines of above experience. Write: Hrayr B. Toukhanian, c/o 714 Glenwood Avenue, Syracuse 7, N.Y.; Tel: GRanite 5-4614.

Cameraman-Director-Editor. College background in all phases 16mm production; 2 yrs experience with college film production units. Desires position with commercial or industrial film producer. Will travel or relocate. Single, age 27. Have films, clips, will send resume. Write: E. B. Fleischer, 217 Hillside Ave., Cranford, N. J.

Rhodesian Producer-Cameraman visiting the U. S. October/November to examine latest motion-picture techniques, processes and equipment, offers knowledge gained during 20 yrs experience all branches film making in primitive Africa to interested organisations. Please write air mail to Geoffrey Mangin, Central African Film Unit, P. O. Box 1184, Salisbury, Rhodesia, Africa.

Optical Effects Company owner and operator seeks change. Over 8 years experience in opticals and effects work. Familiar with all phases of processing, editing and production. Have also worked as motion picture theatre manager. Willing to relocate. B.A. in Business Administration. Age 32. Reply to: Occupant, Apt. B-32, 796 Bronx River Rd., Bronxville, N.Y.

Ambitious Photographer, twelve years experience, stills and motion pictures. Three years Audio-Visual Department, San Diego City Schools. Two years news photographer, editor and writer for NBC affiliate television station. Presently employed by small production unit shooting TV commercials, news features, and industrial films. Desires opportunity to do creative quality work with future in production organization, television station or industrial firm. Resume upon request. David Bash, Apt. 2, 2826 Mission Blvd., San Diego 8, Calif.

Motion-Picture and TV Equipment. Presently employed with leading firm supplying equipment and technical service throughout the world; thoroughly familiar with all types of equipment and manufacturers; background as free-lance cameraman. Desire position with active organization supplying equipment or sales representative for manufacturer desiring east coast branch. Available mid-August. Barry Green, 1672 Ocean Pkwy., Brooklyn 23, N. Y. Tel: DEwey 6-2454 after 8 p.m. Mon-Tue-Wed.

Motion-Picture Production. Graduate Brooks Institute, MP course, thoroughly experienced in all phases of camera work, editing, optical and magnetic sound recording, and still photography. Produced industrial and educational films, TV commercials. Familiar with B&W processors. Seeking permanent position or temporary assignments. Free to travel, speak several languages. J. C. Klopping, 312 W. Yanonali St., Santa Barbara, Calif. Tel. WOodland 6-1482.

Cameraman-Editor. Would like to join young progressive film-making organization, foreign expedition or exploration party. Recently discharged from Pictorial Branch, U. S. Army Signal Corps. Experienced in sound recording, laboratory and other phases of the motion-picture field. Age 22, single, free to travel. References and complete resume on request. H. LeRoy Mills, 427 Cherry Ridge, San Antonio, Texas. Tel: DIamond 4-6583.

Studio Engineer. Young man (22), vet., graduate of Studio Training Course—TV Workshop, top scholastic man in class; thoroughly qualified audio engineer, TV cameraman, floor manager, video operator, with knowledge of scenery, special effects, lighting, color TV principles and