Kenyon C. Rosenberg

DICTIONARY OF LIBRARY AND EDUCATIONAL TECHNOLOGY

SECOND EDITION
Revised and Expanded

Dictionary
of
Library and Educational Technology

2nd Edition, Revised and Expanded

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The first edition was published under the title *Media Equipment: A Guide and Dictionary*, by Kenyon C. Rosenberg and John S. Doskey (1976).

Preface to
First Edition

Most persons involved professionally in the field of educational media must usually possess at least a rudimentary knowledge of principles and demonstrate skill in handling basic types of audiovisual equipment. The work of a somewhat smaller number of such persons requires more comprehensive familiarity with the technicalities of media equipment. As the list of media devices grows longer and more complex, both groups are likely to experience problems of communication and a need to be more capable and precise in their use of the technical vocabulary that accompanies them.

Because the field of instructional technology and educational media is now undergoing the expansion of scope and numbers that it is, these problems of communication are compounded. Nowhere is this more evident than in the processes of examining, testing, and purchasing items of media equipment required to support educational, information, and training programs of schools, colleges and universities, public libraries, industrial and business organizations, religious institutions, and myriad other agencies throughout the country. In all such units, and in the absence of a suitable consumer's guide for the purpose, media professionals continue to organize competitive demonstrations and tryouts of audiovisual equipment and to recommend for purchase those that match locally imposed technical criteria and financial constraints. In doing this, they must read (and understand) numbers of specifications, claims, and counter-claims; and they must obtain as much credible information as possible about comparative strengths and weaknesses of competing items and brands. In all such cases, exactness of meanings of technical terms encountered is an obvious essential.

In writing this book, Kenyon C. Rosenberg and John S. Doskey have presented us with a useful tool for improving our ability to carry out such tasks. Written in a manner that is both exact and understandable, and broad in its coverage, this book should be valued by all who work to achieve systematization and improvement of media equipment selection and evaluation and to develop better equipment maintenance programs. Media professionals will find it a valuable source of explanations and definitions of the technical data needed to prepare equipment bid requests, to read and compare technical specifications "on paper" before engaging in "hands-on" testing, to develop media hardware service contracts, or to carry out other necessary tasks.

Perhaps the book will be best used in conjunction with other helpful publications. Among these are the *Audio-Visual Equipment Directory* (National Audio-Visual Association, 3150 Spring St., Fairfax, VA. 22030); certain of the *EPIE*

Reports (Educational Products Information Exchange, Inc., 463 West St., New York City, 10014); *Educator's Purchasing Guide* (North American Publishing Co., 134 No. 13th St., Philadelphia, Pa. 10107); *Library Technology Reports*; and the media hardware reviews contained in *Audiovisual Instruction.*

The authors' credentials for producing this book are well worth citing. Rosenberg's long years of experience in the electronics and engineering information fields, as well as in library and information science, enabled him to serve regularly as column editor (Hardware Reviews) of *Previews* magazine. Doskey's experience in instructional technology and teaching has given him the background to understand and appreciate the practicing educator's need for the assistance that this book provides.

1976   James W. Brown

Introduction and Acknowledgments

The work in hand constitutes the second edition of *Media Equipment: A Guide and Dictionary*, by Kenyon C. Rosenberg and John S. Doskey (Littleton, Colo.: Libraries Unlimited, 1976). This edition has been completely revised and updated to include technical terms appropriate to the fields of reprography, micrographics, communications, and computers. The number of terms herein defined is virtually double that in the previous work.

Libraries and schools have, in the last fifteen years, been thrust (and sometimes dragged) into that unknown area — color it gray — of "technology." Many library and education practitioners have had to learn a goodly amount regarding the selection, use, and care and feeding of such diverse equipment as phonographs, tape recorders, projection devices, video tape players, copying machines, microform readers and printers, and computers.

Not only has the working professional not had available, in one vade mecum, descriptions of how these things worked and some comprehensible definitions of some of the most often encountered terms, but neither has the student had — written, insofar as possible, in non-technical terms — access to this information. It is this lack which the author hopes to rectify.

This work comprises three sections. The first is a set of descriptions and, where possible, groups of selection criteria specific to the type of equipment under consideration. No such list can be all inclusive; this one should be construed as a kind of selection guide for those who have little or no knowledge about the types of equipment which they may have to select or purchase.

The second, and larger section, is an alphabetically arranged (with abbreviations and acronyms at the beginning of each letter) dictionary of almost 800 terms, organizational names, specifications, etc., found in connection with the types of equipment mentioned above. Obviously, when an author does not set out to create a work that is comprehensive (especially a lexicographical work), readers may come across terms, etc., not to be found between the covers of that work. For that, please accept, in advance, the author's humblest apologies. The terms included here have been selected as thoughtfully and carefully as possible, and many of those omitted were found to be (A) admirably defined in the usual, general English language dictionaries; (B) so specific as to interest only the specialist; (C) not encountered often enough.

Following the dictionary is a selective bibliography, arranged by type of equipment. This should prove helpful to those who wish, or require, additional readings.

Readers are thanked in advance for their indulgence and patience regarding any errors (or obvious omissions) they may discover, and for any suggestions for future editions.

To my friend, John S. Doskey (my previous co-author, and eminent William Maclure scholar): thanks for the technical and moral support.

Last, to my wife, Jane: again, thanks for making everything better and easier.

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Criteria for Equipment Selection

This section provides information about the evaluation of various types of media equipment. In considering the purchase of a particular piece of equipment, the considerations mentioned in the Criteria section should be kept in mind. For purposes of comparison, other information about media equipment may be found in publications of the Educational Products Information Exchange (EPIE) Institute and in the National Audio-Visual Association's (NAVA) *Audio-Visual Equipment Directory*.

PROJECTORS

Motion Picture Projectors

In almost all schools, libraries, and media centers in the United States, the first choice element with respect to **motion picture projectors*** is the size of the **film** to be used. These are essentially two: 16mm (the most popular) and Super 8mm. (There is a standard 8mm film, but it is fast becoming obsolete.) The size designation of each film relates to its width. Super 8, devised by Kodak in 1965-66, offers 50 percent larger **frame** size than the old 8mm, while utilizing the same width film. (The Super 8 frame is three-eighths the size of 16mm, while the regular 8mm frame is one-fourth the size of 16mm.) Both types of film are designed for projectors with **sprocket** wheel drives.

The general description that follows is appropriate to both 16mm and 8mm motion picture sound projectors. Both such units are made up of three related systems, each of which will be treated separately.

The Mechanical System

The function of the mechanical system of the motion picture projector is to move the film from one **reel** to another. To do this well, it must move it at a predetermined rate, which is expressed in **frames-per-second (fps)**, and with minimum inconsistency. The hallmarks of a good motion picture mechanical system are consistency of speed, quiet operation, and gentle film handling (i.e., does not damage sprocket holes or break the film). This last function can be tested simply by running new film through the machine, then checking for scratches and broken sprocket holes. Also, the projector should be able to handle old or damaged film without malfunctioning.

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*Terms defined in the Dictionary within this book appear in boldface the first time they occur in a section.

Naturally, a mechanical system, which must accomplish many things at once, will create some **noise**. Therefore, a good test of this system is to operate the projector in a quiet room, with the sound turned off, while sitting close to the device as it runs. If it is objectionably loud under these conditions (the noise level should be forty-four **decibels** or less, as measured with a simple sound-pressure-level meter), try turning up the sound and see whether, at a normal listening level, the sound sufficiently masks the noise produced by the mechanical system.

The mechanical system of a good projector will not damage the film. However, the threading process should be clear and simple enough to prevent misthreading and consequent film damage. Also, if the projector is designed for automatic threading, it is advantageous if it can also be manually threaded, and/or unthreaded before the film is completely finished.

Some good projectors do not have sprocketed (geared or toothed) wheels to drive the film, but instead use rubber wheels that grip the edges of the film and drive it frictionally. Unfortunately, many of these types of projectors do not drive the film with the consistency of speed that can be achieved by the sprocket system.

The Optical System

The components of the optical system of the projector are usually a light source or **projection lamp**, a lens (or lenses), a "framing" device, a fan to cool the light source (driven by the motor of the mechanical system), and a **shutter**, which "blacks out" the **screen** between frames. The function of this system is to direct a focused beam of light through the film as it moves by the film **gate**, and then to pass this **image** through the projection lens and project it upon the screen in a viewable size.

The critical aspects of the optical system are as follows: the light source should not overheat (and burn) the film; the shutter should operate properly and quietly; the lens should cast a sharp, clear image of appropriate size.

The lens is a key factor in achieving good motion picture projection. It should have at least a two-inch **focal length** (50mm is standard), and a **lens speed** of between f/1.3 and f/1.6. The lenses of most modern sound projectors should have a **resolving power** (clarity of the projected image) of between 50 and 80 lines/mm. Less than 50 lines/mm will result in a markedly fuzzy image. When selecting a projector, check the projected image not only in the center, but also around the edges and corners. Because of the necessary convexity of the front of the lens, uniform resolution is virtually impossible to achieve. Center resolution should average about 180 lines/mm, and high is 200 lines/mm or better. Corner resolution should be at least 50-80 lines/mm when the lens is focused, and 150 lines/mm is excellent.

Some projectors are equipped with, or have as an option, a **zoom lens**. This can be very useful for projecting an image of appropriate size at various distances from the screen. However, if the projector is to be used in one room, at a fixed distance from the screen, the zoom lens is not needed.

The quality of illumination (brightness) of the optical system may be measured with a **photometer** (light meter). The degree of brightness depends on the type of lens used and the light power of the bulb or lamp. The light output should be at least 416 **lumens** or more. A coated lens usually presents a brighter image than an uncoated one. Very even brightness occurs when corners are at

least two-thirds as bright as the center; one-half as bright is fair. With respect to the light source, a low-voltage tungsten-halogen lamp usually provides the longest life and maximum brilliance. Using a 250-watt tungsten-halogen lamp, you can expect a minimum of twenty-five hours of use on high output. The cooler the light source is kept, the less chance there is of damaging the film and, as a by-product, the longer the bulb will last.

The best type of fan for cooling the light source seems to be the type called the "squirrel cage." It moves considerably more air than the bladed type, and it is usually quieter. A quick and simple way to check the fan's efficiency is to run the projector for about ten minutes and then place one's hand near the ventilation grill. Air being expelled should be noticeably warmer than the ambient air in the room. This means that the bulb is losing heat effectively. A further test of the effectiveness of the cooling system is to check the temperature in the film gate area. It should be between 100 and 110 degrees Fahrenheit; 118 degrees or more is unacceptable.

If the projector has the capability of "freeze framing" (that is, **stop-motion**), some apparatus (usually a glass plate) should be interposed between the bulb and the lens to prevent the film from burning. Also, the bulb voltage should drop automatically. Try this function for about three or four minutes to check for any noticeable degradation of either the film or the image.

The Sound System

In older motion picture projectors, this is exclusively an **optical sound track** system. The sound is converted into optical impulses and laid down, as a "sound track," alongside the frames. In the projector, a light beam from the **exciter lamp** passes through the film sound track and is projected onto a **photoelectric cell** in the sound drum (on which the film is moving). The cell changes the varying light impulses to electrical impulses, which are then amplified, and these electrical impulses activate the projector's **loudspeaker** system.

A number of factors should be considered when evaluating the sound system of a motion picture projector. Is the speed of the film over the sound drum sufficiently constant? (The answer to this question depends on the consistency of speed with which the mechanical system runs.) Is the speaker large enough, and of sufficient quality, to reproduce the sound for the desired room size or audience? Is there provision for plugging in an extra speaker—or a **microphone**? Finally, is the **power output** of the **amplifier** adequate for the room or auditorium size in which the projector will be used?

Although most 16mm sound motion picture projectors use optically recorded sound, virtually all 8mm types use **magnetic recording** in the form of a **stripe** (which is exactly the same system used in all tape recording). Many newer 16mm sound projectors are equipped to handle both types of sound recording, while some offer only the magnetic type. Not all projectors that can use magnetically recorded sound, however, can also record. Some have playback devices only, while the more flexible ones allow for recording also. These are more flexible in that one can change the sound track at one's pleasure. The most sophisticated of the projectors that use magnetic recording not only permit simple recording from a microphone, but also allow for "line and mike mixing." This means that the microphone and another sound source (**phonograph, tape recorder**, etc.) can be mixed together in a controlled **volume** blend to produce

both sources on a film. The magnetic recording system, generally, when used properly, produces better and cleaner sound. Its major disadvantage lies in the possibility that one may inadvertently erase the existing **program**.

A valuable source of test films for 16mm sound motion picture projectors is The Society of Motion Picture and Television Engineers (862 Scarsdale Ave., New York, N.Y. 10583). These films may be used to test comparative performance of 16mm projectors with respect to such factors as amplifier and speaker response to low and high frequencies, steadiness of screen image, relative distribution of light at various points on the screen, intelligibility of dialogue, reproduction of music without **wow, flutter**, etc. It should be emphasized that all tests of competitive projectors must be made under the same conditions and with the same films.

Super 8mm Loop Projectors

The 1960s saw the development of the Super 8mm continuous-loop **film cartridge**. In this type of system, one simply inserts the cartridge into a slot in the projector and the machine is turned on. No threading or rewinding is necessary. Some such projectors are even prefocused and, when the **film** has been shown, turn themselves off, leaving the cartridge rewound for the next showing. Other special characteristics that have been incorporated by some manufacturers are: built-in projection **screens, zoom lenses**, and recording capability.

Many of the criteria used to evaluate 16mm **motion picture projectors** are also applicable to the Super 8mm loop projectors. However, special problems are sometimes encountered in loop projectors, such as difficulty in retrieving either broken film or film pulled off the cartridge hub, bulb changing, and film jamming. The only way to test for these problems is to run the loop projector for a number of hours (at least fifteen) using different films — some short and some long — to see how well it handles these varying lengths. Another point to consider is that, as yet, there are fewer films available in the cartridge format.

Slide Projectors

In general use today is the "miniature" or 2x2-inch **slide** in which is mounted a single **frame** of transparent 35mm **film**. These are termed "miniature" because, earlier in this century, the "regular" lantern slide had dimensions of 3¼x4-inches. Since the advent of the popular 35mm camera, the 2x2-inch slide has virtually supplanted the larger size.

A **slide projector** generally consists of two principal systems: a mechanical system for moving the slides and an optical system for projecting the slide **image**. The purpose of the mechanical system is to move the slide from its carrier or container (the latter may be either a circular or a cube-like tray) to a position in the optical system from where it may be projected. There are two basic systems for accomplishing this. The older one is the "mechanical feed" type, in which the slide is manually pushed or pulled into the optical system by means of the carrier. In the newer system, the so-called "gravity feed" (developed by Kodak in its Carousel projectors), the slide is allowed to drop (hence "gravity") into the optical system from its tray; when the viewing time has elapsed, it is mechanically pushed back into the tray. Both systems have good and bad points. The gravity system reduces physical handling by half, and slides seem to suffer less wear. The major

problem with gravity systems is that if the projector is tilted, sometimes the slide does not drop.

A number of standards must be considered when evaluating the mechanical aspects of a slide projector; these standards are applicable to both manual and automatic machines. Will the slide carrier or container accept both paper-mounted and glass-covered slides? In the case of automatic projectors, does the container accept the number and types of slides you desire? Are the containers reasonably priced? May they also serve as storage units? Is there a locking device to prevent accidental spilling of the slides? Does the projector have an adequate framing device? Does it have an adequate elevation mechanism to adjust the image up and down on the **screen**?

Many of the newer gravity feed slide projectors are automatic in that they can be set to show slides in a prearranged time sequence. Also, one of the most useful options available with currently produced slide projectors is a remote control unit which provides for both forward and reverse motion, plus adjustment of focus. This allows the projectionist some freedom of movement or position, and it means that he can hear audience questions that he could not hear if he were sitting next to a projector with a noisy fan.

The slide projector and the **motion picture projector** have an optical system whose purpose is the same, i.e., to produce a well-defined image on the screen. It is apparent that the optical system of the slide projector has characteristics similar to those of the motion picture projector. However, since the slide produces a still picture that the audience views in detail and for a greater duration, the lens of the slide projector should have greater **resolving power** (60-100 lines/mm) than that of a film projector. Some manufacturers offer a selection of projector lenses of varying **focal length**s and **lens speed**s (f/ratings) to allow the projector to be used with different sized audiences, rooms, etc. Since the purchase price of these extra lenses may be prohibitive, a **zoom lens** is a very useful and important feature to consider when buying a slide projector.

In evaluating the optical system of a slide projector, you should use slides with small details for a sharp focus test; if possible, they should be projected onto a large screen. The image should be clear at the center and edges, and there should be no chromatic **aberration**. Illumination (brightness) readings may be taken with a **photometer** or, if no photometer is available, the evenness of the spread of light and the sharpness of focus may be judged visually.

There are other important factors to evaluate with respect to the light system of a slide projector. Does it accept lamps of sufficiently high or low wattage for the purposes intended? Tungsten lamps are less expensive, but they have a shorter life expectancy and tend to fade. Lower wattage (cooler) quartz lamps provide comparable brilliance with a system of reflectors and mirrors. Although they are more expensive, they will last longer and will not fade. Are there separate switches for lamp and fan, so that the fan can be used to cool the lamp after it has been turned off? This provision will increase bulb life. The effectiveness of the cooling fan can be tested in the same way as that of the film projector fan — by simply holding your hand close to the vent.

One of the main problems pertaining to slide projection is keeping the slides in focus once they are displayed. Unless they are mounted between glass plates, they will "pop" when placed in the optical system: heat from the bulb causes the slide to expand within its mount, forcing it to bulge at the center, and the projected image will then go slightly out of focus. Some projectors ameliorate this phenomenon somewhat by prewarming the three or four slides closest to the

optical system so that when they are displayed, they will be, for the most part, in focus. An option on certain of the newer projectors is an automatic focusing device, which resolves this problem through the use of additional optical equipment.

In recent years "slide-tape" presentations have become increasingly popular. These are achieved by coupling a slide projector with a **tape recorder** or **audio cassette** player; slides in the projector are advanced automatically by an inaudible pulse on one of the **stereophonic** channels, while the second **channel** of the tape presents the **audio** message, narration, or music. There are a number of excellent self-contained machines now available on the market, in addition to individual synchronizers that can be interconnected with stereo tape and slide projector units (also, **filmstrip** projectors). Among the least expensive of these synchronizers are those available from the Edmund Scientific Co. (624 Edscorp Building, Barrington, New Jersey 08007), whose free catalog, by the way, is a browser's delight. One such unit can be used with either of those types of Kodak Carousel or Airequipt slide projectors which are capable of being operated by remote control. This Edmund unit is available with the essential connecting cable for the projector.

When considering the purchase of slide-tape equipment, one should decide whether an integrated unit or separate components would be more useful. But there are other factors to keep in mind when evaluating such equipment. Is the pulse-**programming** easy to use and easy to re-program? Are the pulse frequencies compatible with other sub-systems that might be incorporated into the network? How reliable is the pulsing system? (In testing reliability, determine whether **signals** are ever missed by the projector or see if the system occasionally double-trips the slides.) If the program does go out of **synchronization**, how easily can it be locked back in during the presentation?

Currently, a number of manufacturers do market 2x2-inch slide projectors which are unique in that they eliminate the need for a tape recorder or cassette player to provide sound. The slide (including, usually, its cardboard mount) is mounted in variously designed borders. These borders are possessed of magnetic striping, etc. (depending on the manufacturer's system), upon which can be recorded (usually through a recorder/player built into the projector) a brief message varying in length from ten to thirty seconds. At the end of the message, a pulse can be added so that, in actual use, the audience views the projected image and simultaneously hears the recorded message, at the conclusion of which the next slide is automatically advanced. Once more, the projection portion of the device should be equal to regular projectors, while the recorder/player — since, more often than not, it will be used only for spoken rather than musical material — need not have the **frequency response** capabilities of good, separate audio equipment.

A number of combination filmstrip and 2x2-inch slide projectors are available that permit switching from slides to filmstrips or vice versa. In some of the older model slide projectors (usually manual), the slide carrier is removed and the filmstrip is fed into the optical system from a spool or other device mounted on top of the projector. Quite a few filmstrip projectors have, as an accessory, a slide carrier that converts the machine into a slide projector. Some do not have such an accessory, however, so the slide has to be placed in the optical system manually, usually with a certain amount of fumbling. Thus, it is important to consider whether the projector design facilitates quick, foolproof change from

filmstrip to 2x2-inch slide projection or the reverse. Secondly, do both the slide and the filmstrip carriers have pressure plates or other devices for holding the slide or filmstrip at the focal point? Finally, will the filmstrip carrier accept both single- and double-frame filmstrips?

Filmstrip Projectors

Filmstrips, until recently, were called **slide** films. Essentially, a filmstrip is a group of 35mm transparent **frames** placed in sequence on one piece of **film**. (There are also 16mm and 8mm filmstrips, and they are increasing in use.) Filmstrips are frequently differentiated as being either "silent" or "sound." This is actually an empty distinction, since filmstrips do not have an **optical sound track** or magnetic sound **stripe** on the film itself. Sound filmstrips are intended to be used with a recorded **program,** usually on a **disc** (record) or an **audio cassette** tape. Silent filmstrips are not used with a recording and often have an explanatory or narrative caption on each frame.

The projectors for "silent" filmstrips vary greatly in design but can be divided into two basic groups. The first is what may be termed "semi-automatic" framing projectors. Initially, the filmstrip is inserted into the machine (or carrier) and the focus frame, title, or picture is brought into view for focusing. If the **image** is split between two frames or is not precisely centered in the **aperture,** it may be adjusted with the framing control (see **framing).** This is usually a lever or some other mechanism that is pulled, depressed, or otherwise manually operated. Thus, each subsequent picture or image should be precisely framed as it appears on the **screen.** Although a properly acting semi-automatic framing device is desirable, many of these tend to go out of frame or "half-frame" after a few advances. This means that the operator must repeatedly reframe the film.

A second type of filmstrip projector is the continuous "manual framing" type. With this device, the operator usually rotates a knob to advance the film, and this manual rotation determines proper framing for each picture as it comes into view. For some very inexpensive (read "cheap") projectors, the operator, instead of advancing the film by a rotating, knob-controlled mechanism, pulls it through the projector with his fingers. This type of projector is not recommended because finger marks and dirt may get on the film and because, under certain circumstances, the **sprocket** holes may be damaged.

Although there are two basic types of filmstrip projectors, they use a variety of internal devices that actually move the film. Some have sprocket wheels, which mesh with sprocket holes in the film and act as a driving system. Others use a **pawl-sprocket** mechanism to advance the film. Perhaps one of the best means for moving the filmstrip is found in those projectors which use rubber rollers to grasp the edges of the film gently. Most "semi-automatic" framing projectors rely on either the pawl mechanism, sprocketed wheels, or a combination of the two. But these methods can damage improperly inserted film. Thus, it is apparent that projectors that have manual framing rubber-roller type drives offer the best potential for gently treating what sometimes may be an expensive piece of **software**.

Currently, manufacturers offer two methods of presenting sound filmstrips. One is the coupled disc (record) player and filmstrip projector; the other is the coupled audio cassette recorder/player and filmstrip projector. Both types provide for an appropriate narration for each frame and, in many

instances — equipment permitting — for advancing frames in automatic **synchronization** with the recording. The latter is accomplished with the aid of a pulsed **signal** on the disc or cassette **tape**, which may be either audible or inaudible. At the present time, virtually all professional programs on records are provided with dual recordings: automatic (inaudible pulses) on one side; manual (audible beeps) on the other.

Sound filmstrip projectors should have essentially the same kinds of desirable characteristics they would have if they were not coupled and were to be purchased as separate units. The only exception to this is that since the **audio** units will rarely, if ever, be used simply as music playback systems, their **frequency response**s need be only in the one hundred **hertz** to ten thousand hertz plus or minus four **decibel**s range. What does need testing in such devices is their ability to move the filmstrip properly so that the film is not damaged and to maintain the framing so that partial framing does not occur. If the projector part of these machines can be used as a simple, manual filmstrip projector when needed, this is an additional advantage. Whether one decides to purchase a silent or sound filmstrip projector, or one with semi-automatic or manual framing, the criteria and tests for evaluating the optical and light systems of film and slide projectors are applicable.

Overhead Projectors

The overhead **transparency** projector is a quite simple and effective visual teaching device that is easy to use and maintain. It projects an **image** on a **screen** by passing light through a translucent material (usually transparent acetate) which is placed on the projector stage or platform. This stage should be able to accept all standard sizes of masks and transparency areas up to a maximum of 10x10-inches. The light source is located under the stage, and the light, after passing through the transparency, is collected by the head-assembly above, then reflected through a lens to concentrate the light rays on the screen. The projected image should generally be bright enough for viewing in a lighted room.

Focusing of the **overhead projector** is accomplished by moving the head-assembly up or down and by changing the position of the reflector. It is important that the focusing system permit positive stopping at desired points without "drift," which may cause the screen image to slip out of focus. Also one should determine whether the projection and condenser lens system produces a sharp, flat-focus image and an even light distribution over the entire screen area. Again, as with other types of projectors, this judgment can be made visually or with the aid of a **photometer**.

Adequate illumination requires a light source of at least six hundred watts with a quartz lamp or one thousand watts with an incandescent type. Much of the stated wattage may be dissipated in the form of heat. Thus, it is important to note that the **lumen** output (measured by a photometer) of a lower wattage quartz-iodine lamp (which has less heat dissipation) may be greater than that of a higher wattage incandescent **projection lamp**. However, one should be very cautious when moving an overhead projector (usually the portable type) that has a quartz-iodine lamp. If the lamp has not been sufficiently cooled, the slightest jar may cause the filament to break. Whether an overhead projector uses a quartz or an incandescent lamp, it should have an adequate and quiet blower (fan) system with a separate switch (or switch position) to allow cooling the unit without running the projector lamp at the same time.

Overhead projectors come in a variety of sizes to serve different instructional situations. The larger, heavier types are designed for large-group instruction and are more or less permanently situated, or placed on an A-V cart. Some intermediate and less expensive types are easily carried and can be used for instructing either small or large groups. The 3M Company produces such a machine, which is adequate for small groups or the conventional classroom. Some of these machines come equipped with a cellophane roll attachment which allows the operator continuously to write notes, formulate outlines, etc.

All types of overhead projectors are particularly subject to the **keystone effect** (i.e., distortion of the projected image). Keystoning can be eliminated by tilting the screen forward; devices are available that can be attached to wall-mounted screens to serve this purpose.

Opaque Projectors

The **opaque projector** uses the principle of light reflection to create an **image** of flat, printed, or drawn pictures or other materials as well as some three-dimensional objects. Light from a high-intensity **projection lamp** is reflected from the object into a reversing mirror, which then passes it through a lens to the **screen** to create the image. An advantage of this system is that the user need not convert the objects to be projected into any other format — it is a one-step process. The great disadvantage is that since projection is by reflected light, which is much less efficient than transmitted light (the kind used for **slides**, **films**, etc.), successful projection with opaque projectors can be accomplished only in almost total darkness. Also, printed or pictorial material must be kept simple, so that every element, when projected, will be big enough for each viewer to see clearly. Opaque projectors are best used with small groups.

Materials to use with an opaque projector are usually placed on a platen, or platform, which can be raised or lowered to accept them. It is important that there be at least a 10x10-inch opening for reflection of flat pictures, etc. There should also be a heat-resistant glass plate, which will protect projected materials from the heat and hold them flat. Although the opaque projector has its limitations, the same focusing and illumination tests that were suggested for other projectors can be used. In most machines focusing is accomplished by rack-and-pinion gears. There should be a positive stop to prevent the lens from being popped out onto the floor. Some machines are equipped with a built-in light arrow or pointer device, which can be a useful option.

SOUND SYSTEMS

Phonographs

The **phonograph** is one of the most common of all media devices. It is designed to play back the sound encoded on the surface of a phonograph **disc** (or recording). The phonograph is composed of a number of sub-systems or units, of which the most important are the **turntable**, the **tone arm**, a **phono cartridge**, an **amplifier**, and a **loudspeaker**. In a **stereophonic** phonograph, there are two amplifiers and two loudspeakers. In this section, each of the sub-systems of the phonograph is treated separately. However, there are some specific aspects of the phonograph as a whole that ought to be remembered.