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The Todd-AO System: A Projector For Both 70- and 35-mm Film

By JAMES MORRIS

The American Optical Co. and Philips of Eindhoven cooperated to design this versatile projector. The system is an example of the new trend toward "roadshow" motion picture exhibition.

TODD-AO, which is probably the most ambitious single-projector motion picture system ever devised, was unveiled to the industry on the 12th of this month when the new film, "Oklahoma," opened at the Rivoli Theatre in New York City. Since IP went to press before this premiere, it is impossible to give any evaluation of the screen image obtained with the 70-mm Todd-AO equipment, or the audience reaction to its giant-sized, deeply-curved picture. That will have to wait for next month.

However, fairly detailed information is now available on the equipment used in the Todd-AO setup, and projectionists will want to know about this equipment as soon as possible. The Todd-AO system is a prime example of the new "roadshow" trend in the American motion picture business.

As of now, it seems likely that within a few years American indoor theatres will be divided into two categories. One group will include a number of de luxe houses equipped with projection machinery of the Todd-AO variety for roadshow (two-a-day) presentation of special and elaborate films. The other group, which will remain the vast majority, will continue to use 35-mm projection equipment of substantially the same character as that now available.

For 70- and 35-mm film

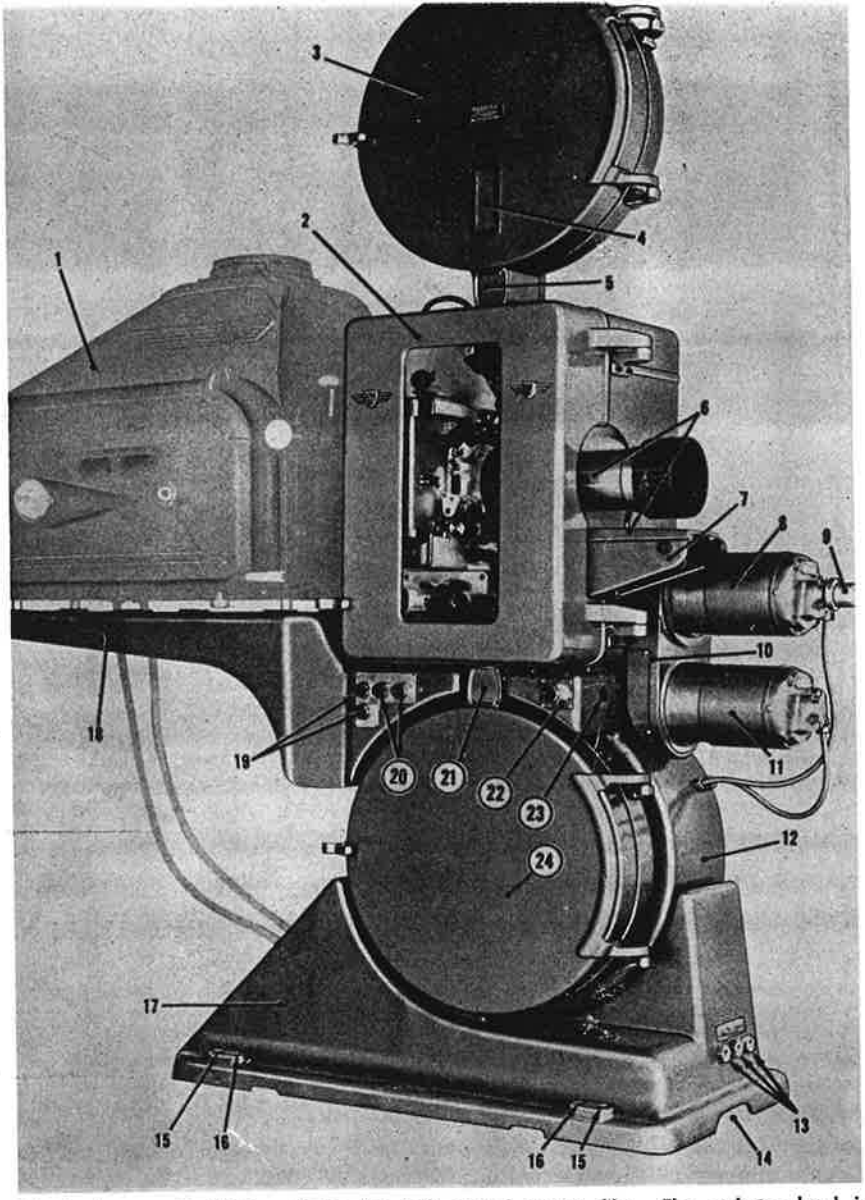
The Todd-AO projector is designed for 35- as well as 70-mm film. By switching a few parts in the projector head, it can be made to accept 35-mm prints and pick up either standard optical sound or CinemaScope magnetic sound. It will not only equip de luxe theatres to show films in a spectacular way, but also in just about any way that a desirable picture happens to be printed.

Although it has many new optical, mechanical and electronic features, the Todd-AO system used for "Oklahoma" relies basically on the big film image for its effectiveness. There is nothing new about this idea. It was used back in the Twenties for the Grandeur process. The VistaVision horizontal projector, introduced last year by Paramount Pictures and the Century Projector Corp., obtains a greatly-enlarged film image by turning a 35-mm film strip on its side and pulling it sidewise through the special projector.

It has been clear for the last two years that a screen image of the highest quality is difficult to obtain on very large indoor screens because of the tremendous magnification required of the 35-mm film frame. This is true not only with the cropped widescreen aperture for non-anamorphic pictures, but also of the larger CinemaScope aperture. Consequently, 20th Century-Fox is now making 55-mm prints of some CinemaScope features scheduled for roadshow presentation.

High-quality 35-mm projection equipment can give good results on screens up to as much as 50 feet in width, but this equipment is just not up to the job of providing quality performance on screens of this size or larger in indoor theatres.

One of the most interesting refinements of the Todd-AO system is a distortion-correcting printing process developed by Dr. Brian O'Brien, of the American Optical Co. (This is where the AO in Todd-AO comes from.) The corrective-printing proc-



This is the new Todd-AO projector for both 70-and 35-mm film. The projector head is manufactured by Philips of Eindhoven, in Holland, and the rest of the machine and the special lenses required for the Todd-AO system are produced in the United States by the American Optical Co. Features of the new projector, indicated by number, are as follows: (1) arclamp; (2) projector head; (3) upper magazine; (4) window; (5) upper fire trap; (6) CineApergon objective lens and mount; (7) lens mount bracket; (8) upper motor; (9) inching knob; (10) belt housing; (11) lower motor; (12) upper base; (13) water line connections; (14) cutout for electrical leads; (15) hold-down screws; (16) leveling screws; (17) lower base; (18) arclamp bracket; (19) arclamp push button switches; (20) motor push botton switches; (21) lower fire trap; (22) motor selector switch; (23) connector hole, optical sound cable, and (24) lower magazine.

ess, which is roughly described in an accompanying illustration, is asserted to eliminate image distortion that would otherwise be present on a giant, deeply curved screen when projection is from a steep angle. According to a recent American Optical Co. announcement, it basically employs an optical method of distorting the print in processing so that the optical distortion inherent in the type of projection mentioned above is counterbalanced.

Three types of distortion will be corrected, it was stated — keystone distortion, distortion resulting from a deeply-curved screen, and distortion resulting from the use of extreme wide-angle lenses in both photography and projection. Two classes of prints will be processed. One class will be corrected for projection angles of from 10 to 15 degrees, and the second for still higher projection angles.

The Todd-AO projector is an unusual machine designed to handle multi-channel sound for Todd-AO, 35-mm magnetic sound for CinemaScope, or conventional optical sound. All three types of sound pickup are provided for inside the projector head. The only action that need be taken when changing from one type of sound to another is to thread the film through the desired soundhead. Even scund on separate film can be used by means of a selsyn synchronizer which is available on an optional basis.

The Peerless Hy-Candescent condenser arclamp, manufactured by the J. E. McAuley Co., of Chicago, is used with the Todd-AO projectors at the Rivoli Theatre in New York. These lamps are equipped with a new type of water-cooled jacket for the positive carbons. These jackets are made by the Hal I. Huff Co., of Los Angeles.

The projector is said to be adaptable to a wide variety of arclamps, but only certain high-powered lamps are recommended at present. The tilting mechanism of the projector rotates at a high point so that there is only a slight change in the center of gravity when it is tilted up or down. Projection angles as far down as 28 degrees and, for drive-ins, as far up as 20 degrees can be reached.

Other features include a centrifical switch to drop the dowser if the film speed is too low, a water flow switch to cut off the arc if the water-cooling equipment fails, and stop switches on both sides of the chassis. The optical preamplifier is of a special plug-in design so that a new unit can be substituted quickly in case of breakdown.

Mechanism Water Cooled

The projector is water-cooled, but it contains no air cooling other than the fanning action generated by the shutter. The film gate is slightly curved above and below the aperture for the purpose of counteracting the tendency of film to buckle under heat.

A single-bladed shutter revolves twice through the film path for every frame of film. Todd-AO engineers claim for it a light-transmission efficiency of over 50%. Two separate motors are provided to drive the mechanism at 30 and 24 frames per second, depending on whether 70-mm or 35-mm film is being projected. For reasons to be given later in this article, a speed of 30 frames per second is used for 70-mm film. Two motors are employed, rather than one plus gears, because this arrangement is said to provide quieter operation with a minimum of gear complexity.

The projector mechanism is manu-

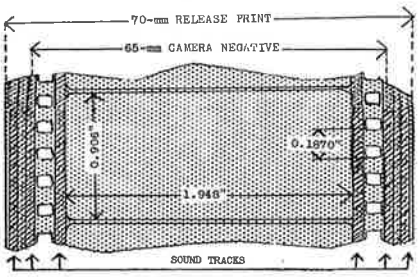
factured by Philips of Eindhoven, in Holland, but the rest of the unit, including lenses, base, magazines and other parts, are produced in the United States by the American Optical Co. Both companies cooperated in the design of the projector.

Screen Design Problems

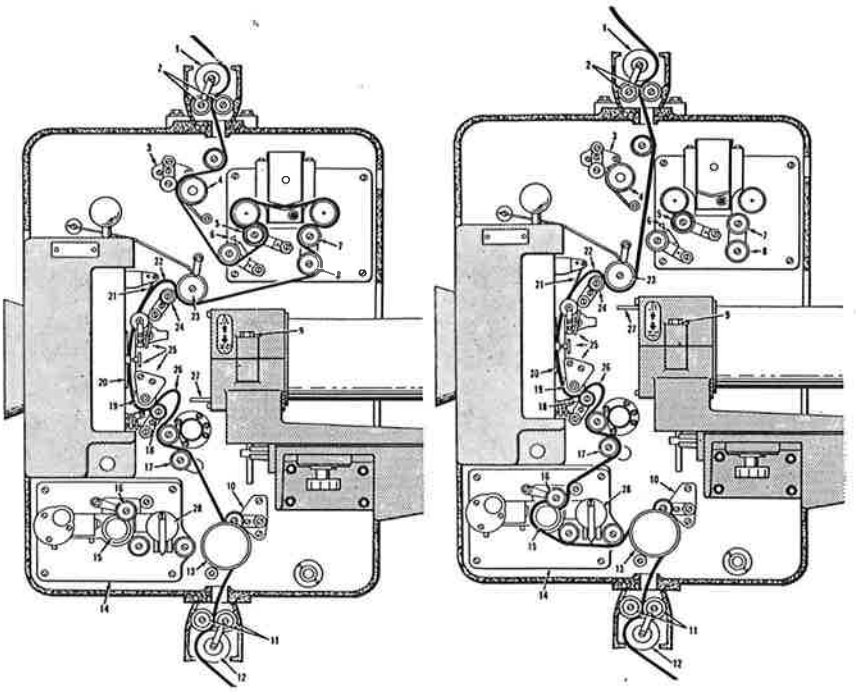
The screen specified for the system is deeply curved and large. According to Todd-AO engineers, use of such a screen posed two problems — re-illumination, and maintaining an adequate level of screen brightness. They use the word re-illumination to describe what happens when light shining on one section of a deeply-curved screen scatters to another part, merging colors and reducing contrast. The brightness problem was felt to be partly solved by the large Todd-AO aperture.

The screen selected has a moulded plastic surface with differently angled lenticulations along its width. The screen is coated overall with aluminum. The lenticulations, or concave reflecting surfaces, are so designed as to reflect light striking any portion of the screen's curvature so that it is reflected only to the auditorium and not to the other side of the screen, it is reported. To accomplish this, the lenticulations must have a different reflective angle at the sides of the screen compared with those near the center.

As a result, the screen must be constructed of a varying number of vertical sections, the number varying with a particular installation. About 12 are used in New York. Seams of the screen are joined in the rear by Fibreglas tape, and are said to be nearly invisible to the audience and a distinct improvement over those in the vertically-sectioned and lenticulated Miracle Mirror screen manufactured by 20th Century-Fox during the early days of CinemaScope.



Seen here is a drawing of the 70-mm Todd-AO print film. The wider areas of sound striping outside the standard-size sprocket perforations each carry two magnetic sound tracks. The more narrow stripings inside the sprocket holes each carry one track. The total is six sound tracks.



Shown above is the interior of the Todd-AO projector head. At left is shown the film path when 70-mm film is used with Todd-AO magnetic sound. At right the projector is threaded for 35-mm film and optical sound. Components of the machine are identified by number as follows: (1) and (2) upper fire trap guiderollers, (3) upper pad roller, (4) upper feed sprocket, (5) nylon pressure roller, (6) tension indicator, (7) piloting guide roller, (8) adjustable guide roller, (9) lens mount clamping bolt, (10) lower pad roller, (11) and (12) lower fire trap rollers, (13) hold back sprocket, (14) optical sound unit, (15) sound drum, (16) pressure roller, (17) guide roller, (18) lower film gate pad roller, (19) intermittent sprocket, (20) aperture plate, (21) pressure bands, (22) upper loop, (23) intermediate sprocket, (24) upper film gate pad roller, (25) film gate, (26) lower loop, (27) lens mount lever, (28) exciter lamp housing.

Although screen manufacturers regard the lenticulated screen as a very good idea, it has been little used since the Miracle Mirror days. The embossing process was found difficult on a mass production basis, according to one screen manufacturer, and the exact directional reflective quality difficult to guarantee.

The Todd-AO lenticulated screen, which overcomes previous difficulties with this type of screen, is manufactured by the Textileather Division of the General Tire & Rubber Co., Toledo, Ohio. The lenticles of the screen are embossed by means of machinery developed by the American Optical Co. Each lenticle is about 0.50″ high and 0.33″ wide, and they vary in spacing and in angle across the screen.

Special wide-angle projection lenses are required for the Todd-AO process. Manufactured by the American Optical Co. and known as Cine-Apergons, these lenses have specially-designed aspherical surfaces on some of their elements. Without these lenses, it is reported, the optics would have been the weak point in the system.

Ordinarily, a lens is made up of a number of concave or convex elements whose surfaces follow a spherical or truly circular arc. In an aspherical design, a lens may contain elements with surfaces that follow, for instance, an ellipsoid pattern. The purpose of this departure from the usual design is to solve an unusual or difficult optical problem.

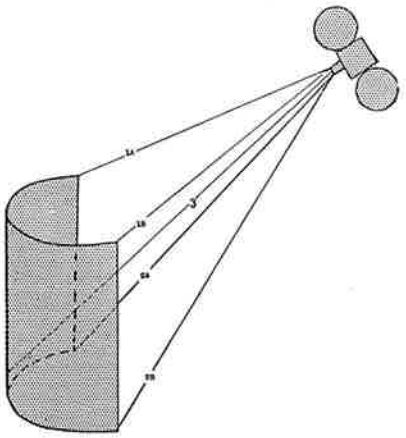
"Oklahoma," the first Todd-AO feature, was photographed on 65-mm Eastman Color negative, and is being shown on 70-mm Eastman Color prints, the extra 5-mm of space on the print is required to make room for the magnetic striping of the 6-channel magnetic sound that is being used.

Film frames are not only larger in the Todd-AO system, but they move faster — at a rate of 30 frames per second. This change was considered

necessary because the human eye is very sensitive to movement and flicker that occur at the edges of a wide field of view. The eye, therefore, is more conscious of flicker that occurs on the edges of a wide screen than it is of flicker at the center of the screen. Flicker also becomes more perceptible as the light level on the screen increases.

The designers of the system say that they were presented with a choice between a dim picture without apparent flicker, a bright one with flicker — or a greater frame frequency, which would permit a bright picture without flicker. The last was chosen even though it meant a considerable departure from conventional design for a theatre projector. The 30-frame-per-second speed also has the advantage of making action on the screen smoother during fast movement.

A sound reproduction system which is both complicated and versatile has been designed to reproduce the six magnetic tracks used in the Todd-AO system. This equipment will also accept any type of 35-mm sound system now in use.



The above diagram shows why a distortion-correcting printing process, one of the features of the Todd-AO System, was felt to be required. This printing method will counterbalance the distortions inherent in projection on a deeply-curved screen from steep projection angles. 1A, 1B, 2A and 2B indicate portions of the image striking the four corners of the screen. The lines at bottom must travel further and will therefore spread more than the lines at the top, causing the familiar keystone distortion. Observing line 3 will show that this distortion is even further compounded by the fact that portions of the image striking the center of the screen will always hit lower than portions striking the edge. By means of simple test patterns, an accompanying diagram shows how this distortion looks on the screen and how the Todd-AO people plan to correct it.

Sound for the performances at the Rivoli Theatre in New York City is obtained from a separate sound film which contains six tracks and is synchronized to the projector by means of a selsyn interlock. However, the Altec Service Co. is now beginning delivery of a switching-relay-equalizer rack designed for the Todd-AO system which will enable the projector to handle sound-on-film reproduction of the 6-track Todd-AO system plus the sound carried on all magnetic and optical prints. Orders for this relay rack have been received for 50 theatres throughout the country.

How Altec Panel Functions

The Altec panel provides individual equalization and level balancing controls — screw-driver operated — for 20 magnetic tracks. On a two-projector installation, the facilities allow setting the six Todd-AO channels on each projector for identical quality; likewise the four CinemaScope channels on each machine. In addition, a compact equalizer is provided for adjusting the Perspecta-optical channel response. For a third projector, a somewhat similar panel appears lower on the rack.

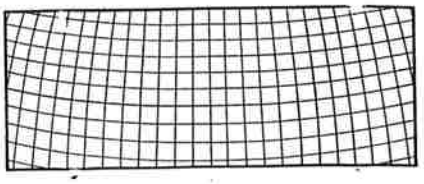
The system thus becomes fully compatible with any of the present-day regular theatre sound systems, capable of reproducing, in conjunction with the Todd-AO projector, all regular release prints.

The Altec-Todd-AO SRE rack contains seven separate panels, with the entire assembly housed in a ventilated heavy steel cabinet. Providing quick and easy access to tubes, fuses, and other components is a heavy door, with air vents top and bottom. The door protects against accident or tampering, and allows for concealed wiring and cabling.

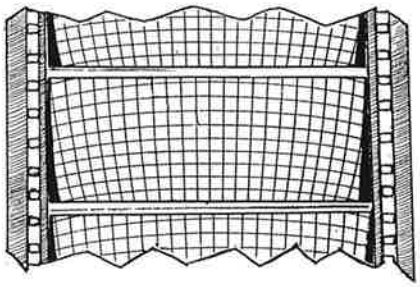
The foregoing was a summary of the information available at press time on the equipment used in the Todd-AO system. As was said at the beginning of this article, no critical evaluation of the process can be given until it is possible to view "Oklahoma" on the screen and judge the performance of the equipment under regular operating conditions.

There is, however, one question about the Todd-AO system that can be raised now because it relates to a doubt voiced by IP over the last two years — this question is on the value

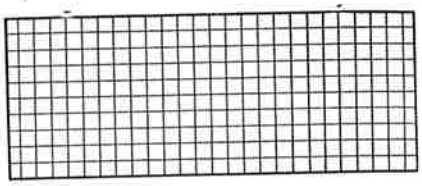
Distorted Screen Image



Distortion-Correcting Print



Corrected Screen Image



The top section of this drawing shows how straight horizontal and vertical lines are distorted by keystone and screen curvature. Distorting a print in processing so that vertical and horizontal lines would take the shape shown in the film strip at center could counterbalance this distortion and provide straight lines on the screen shown at bottom even though that screen be curved. These diagrams are not meant to be an exact description of the Todd-AO corrective printing process. Their purpose is to explain in simple language how it works. In addition to the two types of distortion mentioned above, the Todd-AO method also corrects a print for distortion caused by the use of extreme wide-angle lenses in photography.

of a deeply curved screen. The screen used at the Rivoli Theatre in New York is 63 feet wide, 27 feet high and curves to a depth of 13.3 feet. The chord of the screen (the distance from one edge to the other) is just over 50 feet, presenting viewers with an effective aspect ratio of approximately 2/1.

In a recent announcement, the Todd-AO Corp. stated as follows:

"Another aspect of the deeply curved screen is its freedom from squeezed images. Most theatre-goers are familiar with the strange elongated narrow figures that are seen from the side seats in the front row. This effect

(Continued on page 34)

it happens that sudden, although small, speed changes are usually involved. Each change of speed produces a perceptible pulse of flicker which is frequently mistaken for sputtering of the carbon arc.

It is very desirable to minimize hunting of the shutter by replacing all gears and bearings responsible for excessive backlash. In certain older machines, the framing slide and associated lever and spring should be checked for tightness, and end-play removed. Looseness of the spiral drive gear on its flat-faced drive shaft is especially troublesome.

[CONCLUSION]

SMPTE DRIVE-IN SURVEY

(Continued from page 14)

factors are completely different.

The Screen Brightness Committee and the Society of Motion Picture and Television Engineers have had outstanding cooperation from a great many people in the conduct of this survey. Theatre projectionists and their organization, the IATSE, and the theatre managers have been most cooperative in permitting this survey and in assisting Committee members

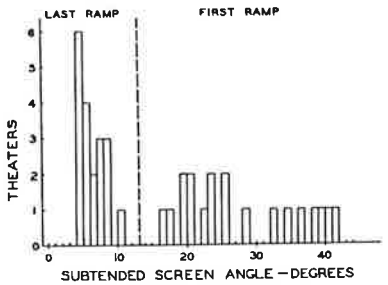


FIG. 10. Maximum and minimum subtended screen angles. Maximum angles for the theatres surveyed were measured from the center of the front ramp, minimum angles from the center of the back ramp.

in obtaining the data. It has been most heartening to observe that all those directly associated with the presentation of drive-in motion pictures have been extremely anxious to help improve the quality of this form of entertainment.

The Committee is particularly appreciative also of the assistance of C. E. Heppberger and others of the

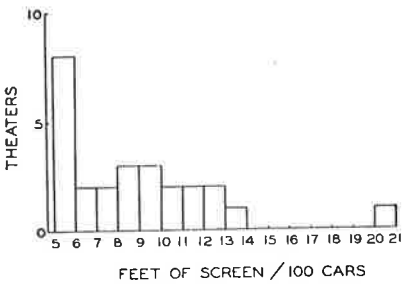


FIG. 11. The relationship of screen width to theatre size is shown. Figures at bottom show the number of feet of screen width for each 100 cars of capacity. It is an indication of past ideas on the size screen appropriate to theatre size.

National Carbon Co. and of the assistance of many members of the Eastman Kodak Co. in carrying out the survey in different areas of the U.S. and in analyzing the information.

THE TODD-AO SYSTEM

(Continued from page 10)

which is already objectionable on a conventional movie screen, becomes intolerable on a large flat screen. Scientists at the American Optical Co. conducted a series of careful experiments to see what squeeze could be tolerated without objection when looking at the screen from an angle. They then studied theatres to see how many seats present an objectionably squeezed picture and which seats give a good picture. In the average theatre twice as many orchestra seats are satisfactory with the Todd-AO curved screen than with a flat screen of equivalent width."

Against Deep Curvature

Questioned on this point, one independent projection expert replied:

"Despite what the AO people say, best viewing of Todd-AO, Cinerama, and all other pictures projected upon deeply curved screens is limited to the middle of the auditorium. Viewed from the side, foreshortening effects vary from one side of the screen to the other, actors on the side nearest the observer looking very thin. There is no way out of this dilemma; and I might say that varying degrees of foreshortening in a picture are more objectionable than a uniform degree, as when a flat-screen image is viewed from the side of the auditorium."

This article is not meant to give a critical view of the finished Todd-AO process. Its purpose is to make available to projectionists such information about the system as is now available, and to point out the very difficult problems solved by the engineers who participated in its design.