Dental Photography: Its Application to Clinical Orthodontics

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Photography has played only a minor role in orthodontics up to the present time. Yet seldom is the orthodontist offered a medium through which he may accomplish so much. The eye can grasp an idea many times faster than the ear and in general retain it far longer. Pictures are the best means of visual education. Essays, clinics and patient records should be supplemented by good photography. In addition, much information that is normally lost during the course of treatment can be recorded from the mouth by photography and these pictures become valuable records.

The purpose of this article will be to describe a photographic technique and the equipment necessary to take 35mm color transparencies, from head and shoulder size down to a single tooth, and to show their usefulness in clinical orthodontics. The primary thought in choosing and designing the camera equipment was to be able to take pictures of first quality and to do so in as direct and simple a manner as possible.

We will speak only of 35 mm colored transparencies because, when color photography is understood, black and white photography comes easily. Furthermore, color film is much more desirable for dental photography. If, for any reason, black and white pictures are desired, they may be taken from a color transparency. When we use the term "dental photography" it will have reference to picture sizes from a full head and shoulder down to a single tooth. We will exclude routine profile and full face record pictures. It is felt that pictures in this latter category should be taken in black and white with a separate camera and head holder which are specially designed to take pictures oriented in the correct planes.

Dental photography must be accomplished quickly, accurately and with a minimum of discomfort to the patient and effort by the dentist. A technique must allow the picture to be taken under practically any condition with speed, precision and ease. It must permit rapid photographing of any subject desired, from any angle of approach, and with the subject properly framed.

First, I will describe in detail a camera and its base that was designed especially for dental photography. Second, I will outline step by step a procedure for determining correct field sizes, lighting and exposures. And then it will be shown how these colored transparencies can be of help in clinical orthodontics.

The camera must meet the following requirements:

1. *It must be a top quality instrument.* Being such it will have a critically sharp lens and a dependable shutter. It is better to purchase a used camera of top quality than to buy a new camera of lesser quality.

2. *It should be a single lens reflex type.* The advantage here in close-up photography lies in the fact that optimum focus may be readily obtained by a direct view through the camera lens, thereby permitting extreme accuracy of focus, eliminating the consideration of parallax and the necessity for using a set-distance focusing device, or a sliding or hinging focusing attachment.

3. *It should be compact.* A compact camera is easier to manipulate and less likely to arouse apprehension than a bulky type.

4. *It should be versatile.* This requires a wide range of shutter speeds, and F/ openings, and the ability to easily accommodate auxiliary lenses or extension tubes. Also, it should be adaptable for flash and stroboscopic lighting.

One camera that meets all of these requirements is the Kine Exakta.

The camera base or standard to be used must also meet certain specifications. These are the following:

1. *It must hold the camera steady.* There can be no vibration or movement during the exposures which are necessarily long in most cases.

2. *It must allow complete freedom of movement and ease of adjustment.* This permits rapid positioning of the camera and the establishment of accurate focus almost instantaneously with a minimum of discomfort to the patient.

3. *It should be light but strong.* To facilitate handling, strong, light-weight metals are used whenever possible in the construction.

4. *It should be easy to operate.* The dentist should be able to position the camera quickly and easily wherever necessary to obtain proper framing.

5. *It should be able to accommodate a movie camera.* If properly designed, the base can hold a movie camera in the same manner that it supports a 35mm camera.

A base that attaches firmly to the chair arm (or any other solid object), operates with two ball and socket joints connected by a telescoping arm and constructed of light-weight metal, meets these requirements.

A Kine Exakta camera mounted on the base described is shown in Figure 1. This combination has proven to be very succesful for use in dental photography. Each part is numbered and will be described in detail.

1. Camera: The camera is a 35mm single lens, reflex Kine Exakta, with a 50mm Zeiss Tessar F/ 3.5 coated lens of top quality. Extension tubes and a plus 3d portrait lens are the only camera auxiliaries needed for dental photography. This camera is compact, but versatile, being able to take pictures from 12 seconds to 1/1000 of a second with a reliable shutter. It has an aperture that ranges from F/3.5 to F/22. It is able to accommodate any number of auxiliaries, such as supplementary lenses and extension tubes. It has an ingenious mirror system whereby the image is directed through the single lens of the camera onto the ground glass viewer. When the picture is snapped, the mirror system shifts and focuses the image on the film. Thus, when extension tubes are used, the image seen on the viewer is the identical one that will be recorded on the film. There is no chance for the patient or camera to move after focusing because there is no time lapse between viewing the subject and tripping the shutter.

2. A tripod and titler base[1]* to which is attached the camera, the photo-floods, operating handle and a steel measuring tape with a center-of-field pointer for a movie camera. It is constructed of light-weight sturdy metal.

3. Plastic adapter to permit a 35mm camera to fit on the tripod and titler base. The dimensions are one inch, by one and a quarter inches, by one-quarter inch.

4. Aluminum support for photo-floods which attaches beneath tripod and titler base. There is a slot three inches long in the center of the support to allow the photo-floods to be offset for light modeling effect.

5. No. 1 photo-flood with chrome re-

*See Manufacturers' list appended.

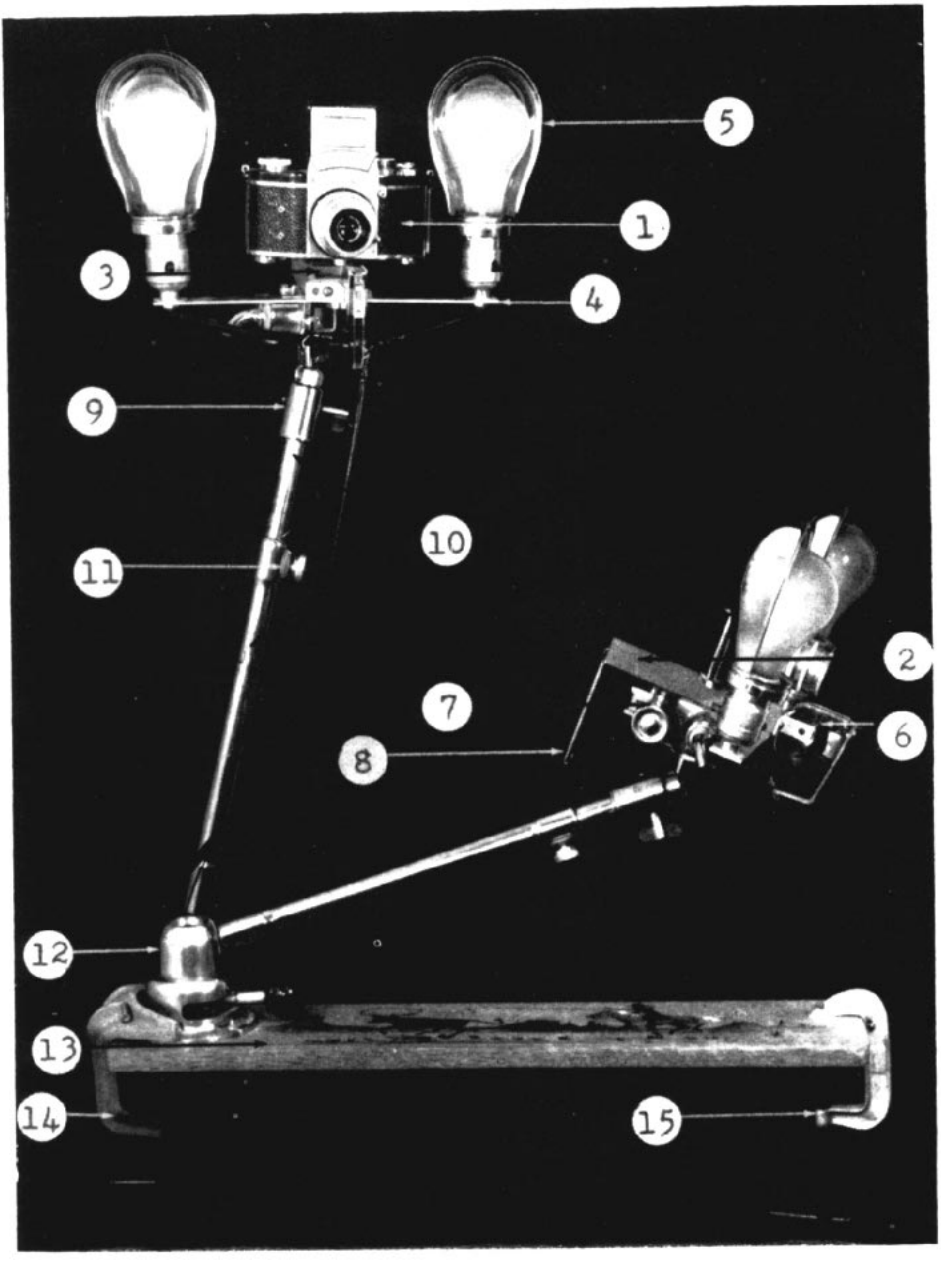

Fig. 1 Detail of camera and base. For description see text.

flector mounted in ordinary light socket which attaches to aluminum cross-piece or support.

6. Steel tape measure with plastic pointer that establishes center of field and correct focus for the movie camera.

7. Rack and pinion[2] to allow critical focusing. This device allows both the

camera and the photo-floods to move in unison while focusing and this makes it easier to predetermine field sizes with their correct exposure. It also eliminates the necessity for calculating exposure factors.

8. Handle to manipulate base and camera.

9. Ball and socket joint[3] which allows great mobility. It is small, but very strong, and locks tightly with just a slight finger pressure.

10. Two twelve-inch lengths of chrome plated, brass tubing. The dimensions of the outer tube are: outside diameter 22½mm, inside diameter 19$\frac{1}{10}$mm. The inside tube dimensions are: outside diameter 19mm, inside diameter 17mm.

11. Set screw to grip telescoping tubing. This screw should be at least ¼ inch in diameter to function satisfactorily.

12. Ball and socket positioner.[4] This positioner, plus the ball and socket joint and telescoping tubing, give a maximum of mobility to the camera. Slight finger pressure easily locks the positioner.

13. Hardwood board two feet, by five inches, by two-thirds of an inch that lies across the chair arms and fastens to them with two clamps. The positioner is attached to the upper surface of the board.

14. Clamp[5] designed to hold positioner to chair arms.

15. Auxiliary "C" clamp to steady opposite end of hardwood board.

After the various parts of the camera base are procured, a machine shop can make the alterations necessary for assembling.

Figure 2 (*above*) shows the camera in position and ready for taking an intra-oral photograph. Figure 2 (*below*) shows camera in position to photograph miscellaneous objects.

Now that we have a camera and suitable base, we are ready to predetermine the size fields we will want to use together with their correct camera settings for distance and exposure. This procedure will help our pictures to be uniformly accurate and will save us much chair time later on. Also, it will serve to familiarize those who are not adept at photography with their new equipment.

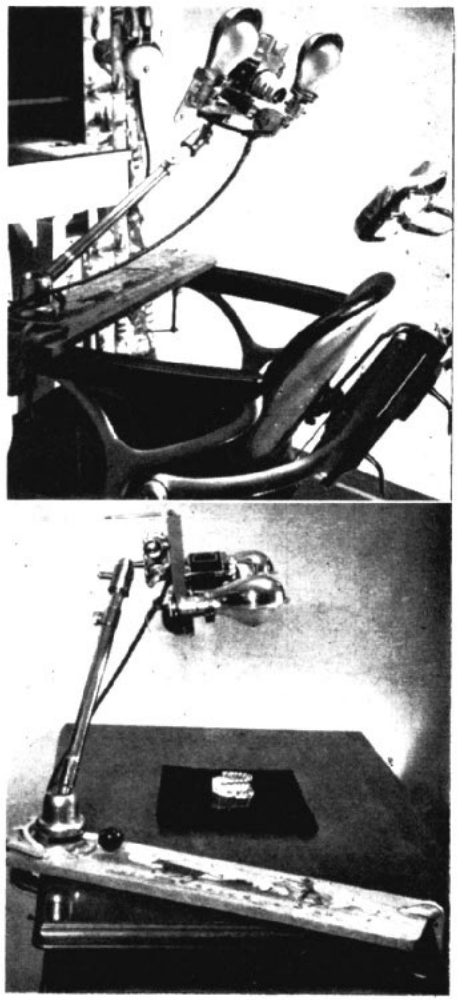

Fig. 2 *Above,* camera and base in position to take intra-oral picture; full head and shoulder picture may be taken by extending the tubes. *Below,* camera and base attached to desk in position to photograph miscellaneous objects.

The following method of field size and exposure predetermination will be outlined employing the Exakta camera. The same method, however, may be used for any 35mm camera which has a detachable lens assembly for which a copying attachment is available.

The first step is to determine the range of field sizes offered by our camera with its extension tubes and plus 3d lens, or the new small extension ring for the Kine Exakta. Then we can choose from these the ones we will wish to use most often.

Place a sheet of paper approximately two feet square on the wall and secure the camera base to a solid object so that the camera directly faces an 'X' drawn in the center of paper. Remove the lens, place all three extension tubes on the camera and then re-attach lens to the tubes. Set the F/ opening at 3.5. Set distance scale at infinity. Focus on the 'X' by moving the camera toward and away from the paper. Obtain critical focus with rack and pinion. When 'X' is in sharp focus, lock the camera in position and measure the size of the field seen in the viewer by placing two rulers, one vertically and the other horizontally, across the field. Draw a rectangle of these dimensions on a separate piece of paper. This will be the smallest sized field. Number it "one."

By following this procedure with every possible combination of the extension tubes and then by using distance readings of 0.7m, 1.2m and infinity, with the adaptor rings minus the tubes, the full range of field sizes possible with the tubes and rings may be determined. These sizes range from ½ inch by $^{10}/_{16}$ inch to 4¾ inches by 3⅛ inches on the Exakta, with the German extension tube set.

In order to obtain field sizes from 4¾ inches by 3⅛ inches to 12¾ by 8⅛ (the latter being the smallest field size possible without extension tubes or auxiliary lenses), it is necessary to use a plus 3d lens on the 50mm lens with no extension tubes. Set distance scale for 0.7m, 1.2m, and infinity, respectively for each measurement. After these fields are determined, remove the plus 3d lens and with distance reading set just below 0.7m, at 0.7m and 1.0m, we obtain field sizes up to 22 by 14 inches which is full head and shoulder size.

We now have a series of concentric rectangles that represent a rather complete selection of field sizes from a single tooth to a full head and shoulder. Of course, many other fields could be added to the selection by using other readings on the distance scale. For practical purposes, we will use only about seven of these for taking most of our pictures. So our next step will be to predetermine the exposures needed for photographing the objects for which these seven fields have been selected. The method for determining exposures is identical for each field. To explain this method, we will use field No. 5 which is the size most commonly employed in photographing a full complement of teeth.

Load camera with Kodachrome type 'A' film. Seat patient and fasten camera base to chair arms. Place extension tube adaptors on camera and attach lens. Set distance scale at 0.7m and F/ opening at 3.5. Place cheek retractors. Free both universal joints, obtain approximate focus and lock. Focus critically with rack and pinion. Turn on photo-floods and take a reading with light meter directly from the mouth at a distance of approximately eight inches. (All of the pictures taken intraorally will be shot at $^1/_5$ of a second, because this is the maximum time a patient can be expected to hold perfectly still. We need as long an exposure as possible in order to be able to use a small aperture and thus have a maximum depth of focus). The meter

should give a reading of approximately F/18 at 1/5 second. So we set the camera accordingly and take a picture at the reading given by the exposure meter. We will consider that the reading is F/18 at 1/5 of a second. Then take two more pictures, one at F/22 (one-half stop above F/18 at 1/5 of a second and the other at F/14 (one-half stop below F/18) at 1/5 second. One of these pictures should be exposed correctly. If they are not, the three pictures will indicate clearly the direction in which the next tests should be made. All exposures (camera settings) and objects photographed should be noted in a book in the order they are taken.

Repeat this procedure for the other six fields, being sure to take your meter readings from the type of object that you will be photographing. For example, if field No. 6 is to be used for photographing plaster models against a green background, take your meter reading for same. Different objects reflect varying amounts of light.

When this test roll is sent in to be developed, ask that it be returned in strip form, so that the exposures will be in the order that you have recorded them. When the test strip is returned, you can pick out the best exposures for each object photographed in its special field and put this information on file for later reference.

On a sheet of clear lucite, 1/16 inch thick and 13 inches square, scratch the selected field sizes in concentric rectangles. Fill scratches with different colored ink for each field. Number rectangles according to field sizes, number one being the smallest and number seven largest. Then at the base of the lucite square make notations of objects photographed and their correct camera settings opposite the number indicating that particular field. When we wish to photograph part of an appliance, for example, we can choose the field which best frames it, set our camera by the reading noted opposite its number, and take the shot with a minimum amount of effort.

Figure 3 shows two charts: the upper one gives us the general range of field sizes available; the lower shows us the seven fields arbitrarily selected for the lucite guide.

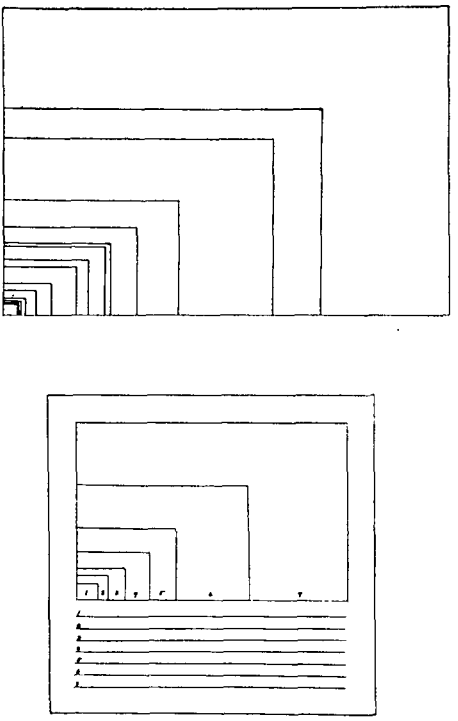

Fig. 3 *Above*: chart showing general range of field sizes available. *Below*: chart showing field sizes chosen for the lucite guide. For measurements see text. Scale 1"—6.1".

All of the groundwork has been laid and we are ready to take any dental picture that is desired. To illustrate the ease with which a dental photograph may be taken, let us suppose that a patient presents with an inlocked upper lateral and we wish a transparency of

this for our records. The assistant brings the camera and locks the base to the chair arms. Referring to the lucite chart, field No. 5 frames the area best and the footnote opposite the field number gives all camera settings for an intra-oral shot. Set camera accordingly, focus with F/ opening at 3.5 to allow clear vision, and lock in position when the lateral is properly framed in sharp focus. Close F/ opening to indicated setting, turn on photo-floods and trip shutter. The picture is taken, correctly framed and exposed and in sharp focus.

We have described in some detail the equipment and technique needed for taking good transparencies. We should mention briefly the equipment necessary for displaying the transparencies to their best advantage.

A good transparency must be displayed with good equipment or it loses quality.

For storing slides in such a way that they can be readily viewed and easily found, a Multiplex[6] slide filing cabinet is recommended. The transparencies are set in sliding trays which allow one hundred to be viewed at one time, if so desired.

For showing slides in the office, a large table viewer with a strong light is recommended. It will show a good-sized image which is bright enough to be viewed easily in a partially lighted room.

For showing transparencies in a lecture hall, a 750 to 1000 watt projector is highly recommended, because there will always be enough light to project your slides clearly even though some outside light is present.

Now we have chosen a camera and base to satisfy all of the requirements for dental photography. We have predetermined the size fields that will be used most often, and the camera settings required for them, so that any picture can be taken quickly and accurately. We have reviewed the best ways to show our pictures. It remains to be shown how dental photography is applied to clinical orthodontics.

Photography is an excellent medium for visual education. Colored transparencies can be used to illustrate many aspects of clinical importance such as mouth hygiene, treatment procedure, habits, etc. There is no limit to the number of photographic opportunities encountered in one's practice.

Photography is a method of taking records. Certain records taken photographically will save many hours of work and much storage room. For example, transparencies may substitute for progress models. An occlusal view of the whole upper or lower arch can be taken with the help of a mirror.

Photography is a valuable aid in diagnosis. If we have a series of slides taken progressively while treating difficult or unusual cases, we can refer to these when deciding how to deal with similar cases in the future.

In any situation where clinical photographs are desired, it is most advantageous to be able to make your own slides. The orthodontist is fully aware of the exact picture he desires and sometimes it is difficult to make this understood to a professional photographer. Then too, the camera and base we have is specially designed for this type of work and it will take the best possible picture of the subjects desired. The following are some general suggestions that will be helpful in clinical photography.

In all clinical photography the main point of interest should be so positioned in the ground glass that it is the center of attraction. Extraneous objects should be avoided. For example, use clear acrylic cheek retractors when taking intra-oral pictures. They serve to "dress-up" a picture and, more important, they do not detract from the center of interest. They can be constructed by your dental laboratory.

Use clear acrylic bite-blocks, if it is

desired to take a picture with the jaws apart, such as a mirror shot. These do not detract from the point of interest, and they serve to hold the jaw wide open, yet immobile, during exposure.

A cable type shutter release is desirable to prevent movement of the assembly while making exposures.

Many areas within the oral cavity can be photographed only with mirrors. The new surface coated mouth mirrors are most suitable.

Always dry teeth with air or cotton to remove saliva before taking exposures.

Use a light green terry-cloth material as a background when photographing models and for full head shots. It is a pleasing color and it will not reflect high-lights.

When it is desired to photograph either an X-ray or a transparency, use a piece of black cardboard with windows cut in it, slightly smaller than the X-rays or slide. Secure these over the opening with Scotch tape. Use a #1 photo-flood behind a diffusing glass or screen against the back side of the cardboard as a light source. Take meter readings directly against the X-rays or transparencies, or use your predetermined reading that is noted on plastic square opposite the appropriate size field.

The light output from the photo-floods should be checked occasionally. To do this, purchase a grey sheet of cardboard, sold by Eastman for this purpose. Place it ten inches directly in front of the camera lens, with no extension tubes. Turn on the two photo-floods (new ones must be used) and take a meter reading from the cardboard and note. As the photo-floods grow older, they should be tested in the same manner periodically, using the same cardboard and distance to lens. If the exposure meter readings vary even slightly, the photo-floods should be replaced.

Always keep the lens absolutely clean.

Do not allow excessive daylight to fall on subject in order that you may be sure of color uniformity.

Keep complete records of each exposure in order to correct any errors made in the past.

This paper would not be complete without some mention of moving pictures and stroboscopic lighting. First, brief mention will be made of moving pictures, since the camera base is designed to accept a movie camera as well as the still camera.

Dental moving pictures are a valuable means of disseminating knowledge to many different groups of people. With a 16mm movie camera (an Eastman will be described with its 25mm lens and two auxillary lenses—a plus 3d and a plus 5d—which substitute for the extension tubes on the Exakta) and the camera base, it is posible for any orthodontist to make his own moving pictures without assistance. With just this limited amount of equipment, we are offered a range of field sizes similar to those available for the 35mm camera. A viewing attachment fits into the moving picture camera which permits the operator to see through the lens and thereby predetermine the camera settings and auxiliary lenses needed for the various size fields. For ease of operation, a plastic pointer on a steel measuring tape has been designed to quickly point out the center of each field and its proper distance from the camera to insure correct focus. This pointer, with the help of the lucite chart showing field sizes, obviates the use of the cumbersome viewing attachment, and it enables us to determine focus, field sizes and camera settings very quickly and accurately. When the exposure is made, the pointer is turned down and the tape retracted. The movie camera attaches to our base when the plastic adaptor for the Exakta

is removed, and the two #1 photo-floods serve for the lighting.

Stroboscopic lighting has come to play an important part in dental photography. Because our camera base is designed to accommodate the lighting tubes used in electronic lighting, this type of illumination will be mentioned briefly.

The stroboscopic lighting equipment consists of a generator which can be located out of the way and one or two gas-filled tubes about the size of radio tubes. The generator sends an impulse of electricity through the tubes which activates the gas to a brilliant light—the flash taking approximaely 1/5000 of a second.

The flash of the tubes and the camera shutter can be synchronized. The intense light allows for a small F/ opening and consequently a great depth of focus. Any movement of camera or patient is nullified by the brief duration of the flash. The intensity of the flash eliminates any interference from outside light.

By simply removing the plate that holds the photo-floods and replacing it with one for stroboscopic tubes, our base is prepared for electronic lighting. The 35mm camera should be coordinated for stroboscopic work by your camera dealer. A Harrison C 1/8 filter in combination with daylight film and two stroboscopic tubes have produced color pictures of high quality. Stroboscopic lighting promises to give us more uniform, sharper exposures, with less effort and patient discomfort.

SUMMARY AND CONCLUSION:

Photography is a valuable adjunct to clinical orthodontics. It plays an important role in visual education and it assists us in the preparation of various records important to our work. To be most effective, pictures must be of top quality. Therefore, the photographic equipment must be suitable and specially designed to take any type of dental picture easily and quickly and to display it to its best advantage. In order to facilitate the technique for both patient and dentist, all of the field sizes and exposure data should be predetermined for all objects that may be photographed and these noted on a special lucite chart for easy reference. Then, never miss an opportunity to take a picture that may be unobtainable at a later date.

Dental photography has a definite place in clinical orthodontics. Its application will assist us in achieving our highest ideals in treatment.

1824 State Street

MANUFACTURERS' LIST

1. Cine Kodak Tripod and Titler base procured through Eastman Kodak Company.
2. Rack and Pinion from Delta Manufacturing Company, 600 E. Vienna Street, Milwaukee, Wisconsin; catalog No. NCS 120—front guide bar; No. NCS 264S represents gauge front block complete (does not include NCS 120).
3. Leitz Ball and Socket joint available at any camera dealer.
4. Powrarm Positioner from Wilton Tool Manufacturing Company, 936 Wrightwood Avenue, Chicago 14, Illinois. This particular model is made specially for cameras.
5. Powrarm Clamp from the Wilton Tool Manufacturing Company.
6. Cabinet No. 41 for 2 x 2 slides from Multiplex Display Fixture Company, 910-920 N. 10th Street, St. Louis, Mo.

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