July 6, 1948. D. CROCKWELL 2,444,729

METHOD OF PRODUCING ANIMATED MOTION PICTURES

Filed March 16, 1944

2 Sheets-Sheet 1

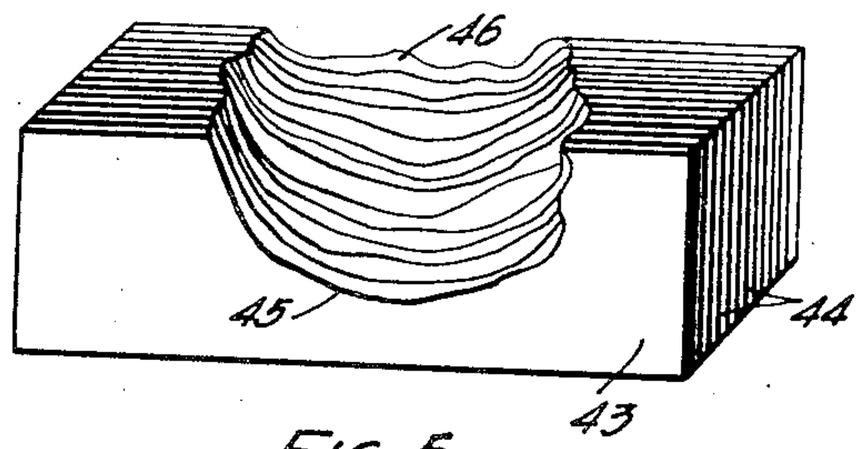

FIG. 5

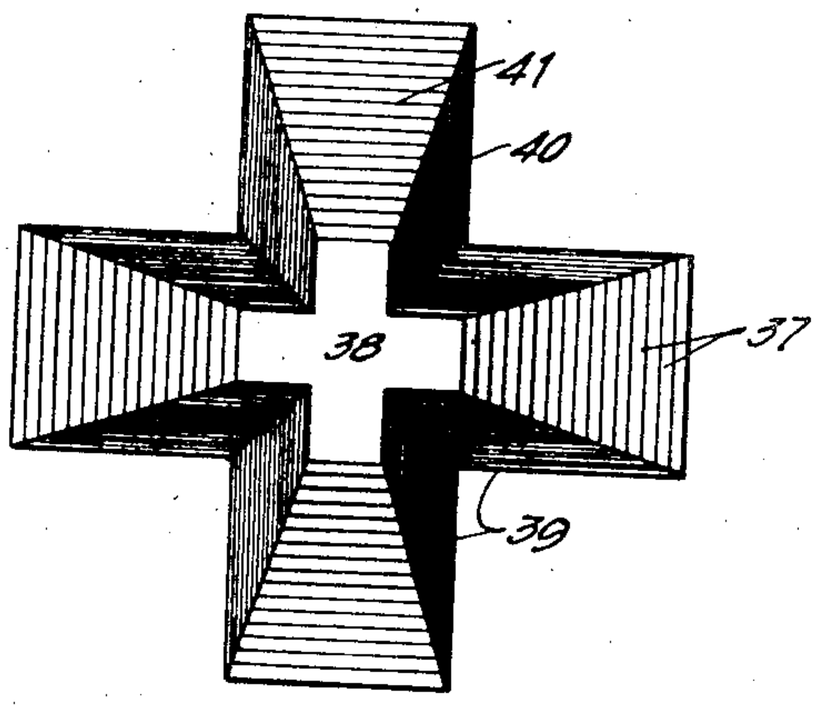

FIG. 2

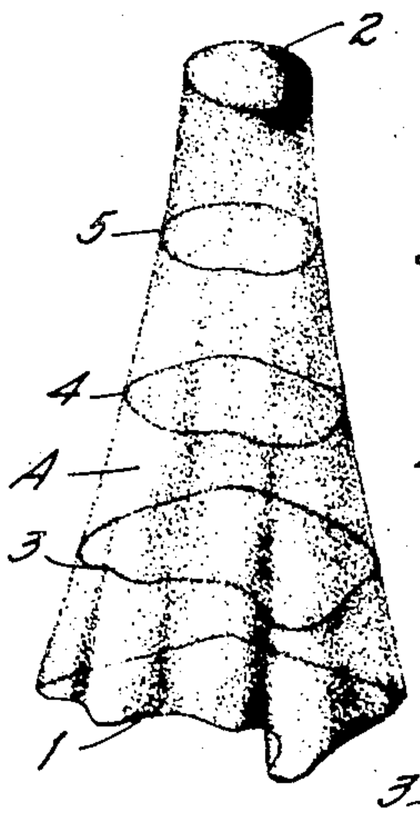

FIG. 1

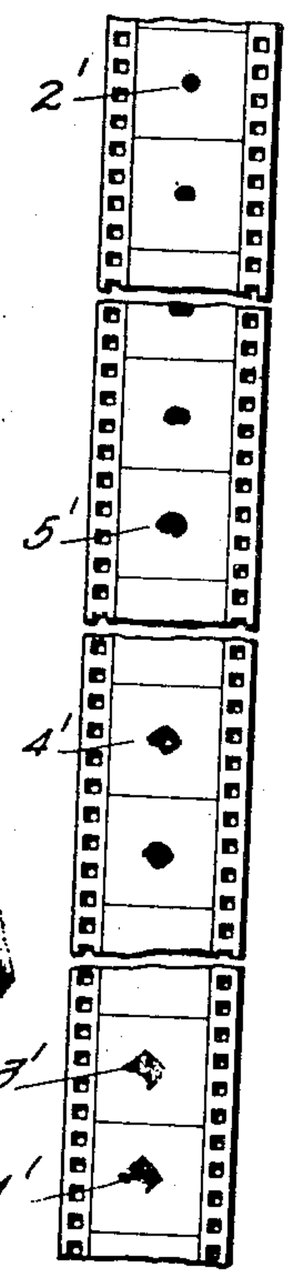

FIG. 6

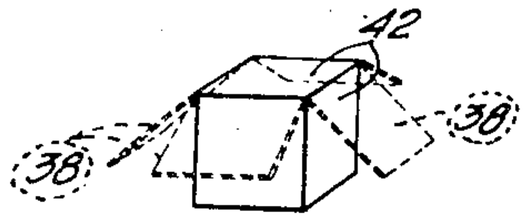

FIG. 4

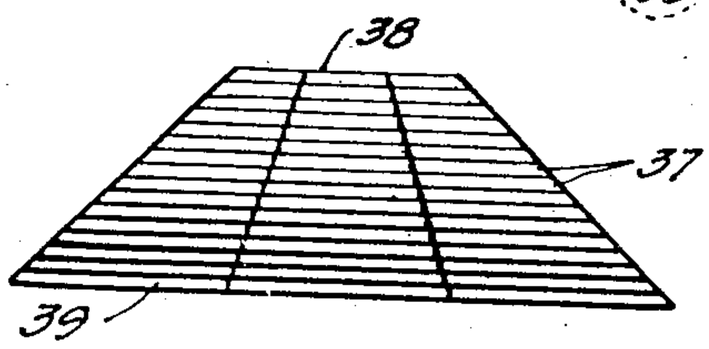

FIG. 3

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2 Sheets-Sheet 2

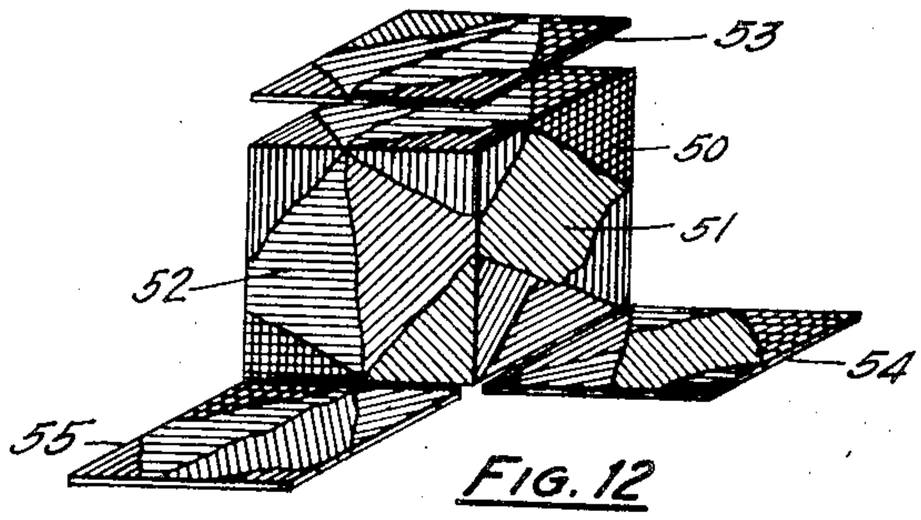

FIG. 12

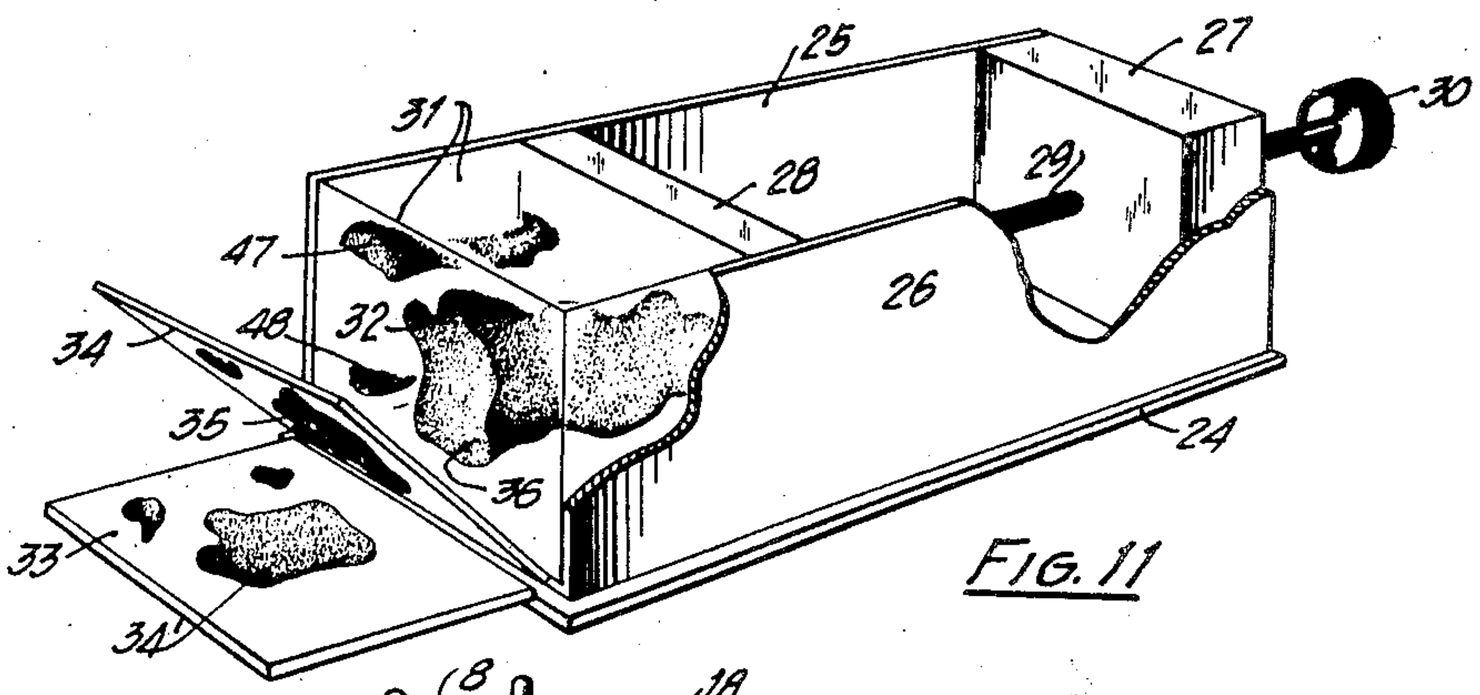

FIG. 11

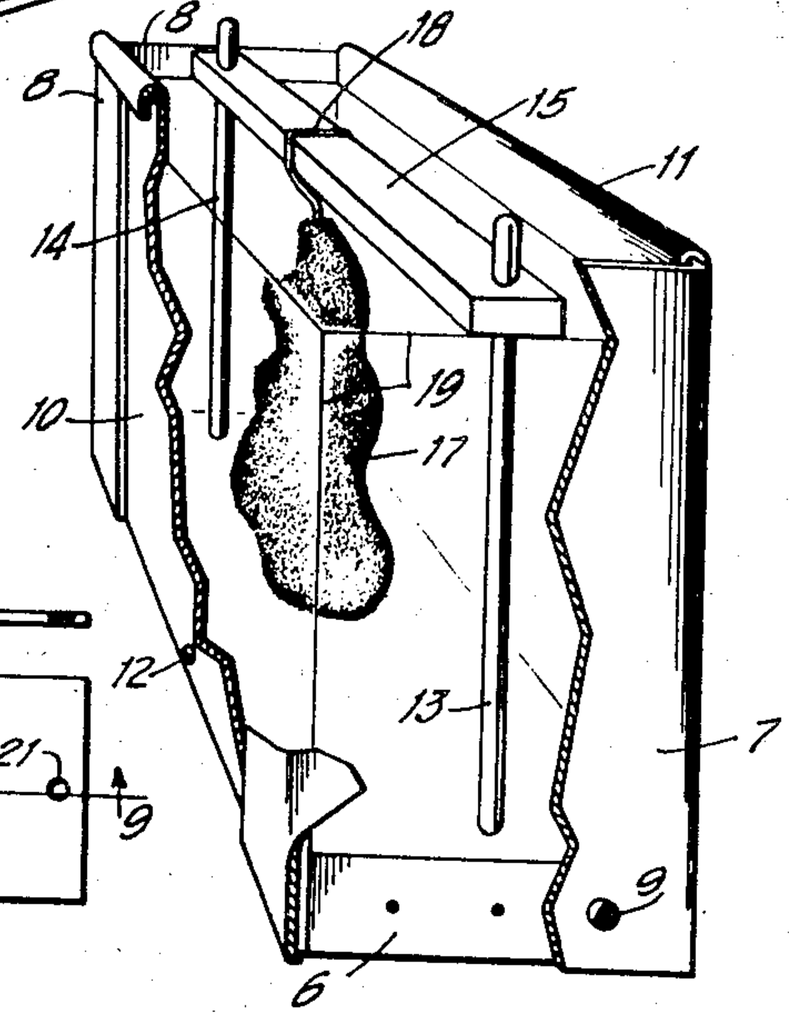

FIG. 7

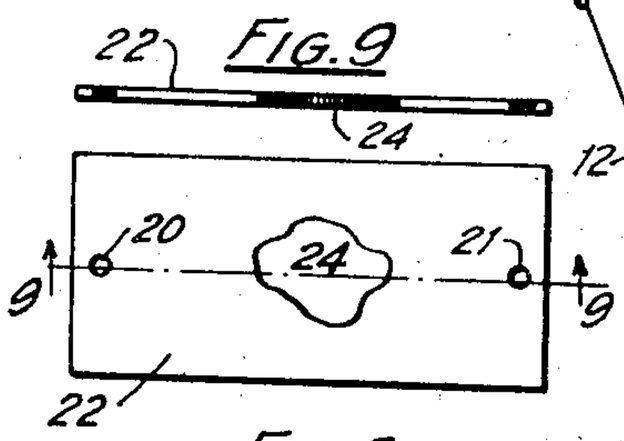

FIG. 9

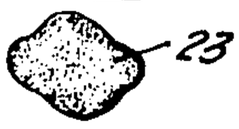

FIG. 8

FIG. 10

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UNITED STATES PATENT OFFICE

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METHOD OF PRODUCING ANIMATED MOTION PICTURES

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Application March 16, 1944, Serial No. 526,770

6 Claims. (Cl. 88—16)

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My invention relates to animated motion pictures and particularly to a new method of producing such pictures whereby a precise yet fluid transition between separated frames of an animated sequence is attained.

The principal object of my invention is to provide a novel method of procedure whereby drawings or other representations may be made of a selected subject in such a way that, when photographed in sequence and projected, the subject will be endowed with smooth, precise movements as it changes from one phase to another. Another object is to provide a method of procedure which will permit a series of pictures having elements thereof differing slightly but progressively in degree and representing time spaced variations in phase to be prepared more expeditiously and with greater fluidity than is possible by present methods.

Instead of making, in the first instance, a separate drawing or painting depicting each increment of change in phase of the subject, I propose, in the simplest embodiment of my invention, to make two outline drawings of the subject to be animated in which the first drawing will show the outline of the subject at a first predetermined instant, and the second drawing will show its outline at a second predetermined instant which will be time-spaced a predetermined interval from the first instant. As a simple example, suppose it is desired to show, in a motion picture, a circle which gradually and smoothly changes its contour to that of a square. Using two fairly stiff patterns conforming, respectively, in outline to the circle and the square, and disposed in spaced, parallel relation to each other (the space between them depending upon the time interval within which the change in shape is to be effected), I propose to model with clay, or other suitable material, an elongated body extending between these patterns as bases, and then so to mold or model the surface of this body that it forms a smooth transition surface between the circular pattern and the square pattern. Thus, the outlines of those transverse cross sections of the molded body parallel to the patterns and in zones adjacent the circular pattern will more closely approximate a circle than a square, and those adjacent the square pattern will more closely approximate a square than a circle. I then propose to cut the body so formed between the patterns into a multiplicity of slices in the same way that a loaf of bread or a Bologna sausage is cut from end to end, and to photograph or otherwise to utilize the outlines of the slices,

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or of the end of the sliced body, in sequence, in depicting the proper outline of the subject at various instants between said first and second instant. In other words, I propose to determine accurately the precise shape of the outline of the subject as it changes in phase from a circle in the first instance to a square in the second instance. No particular apparatus is required to perform the process but I have illustrated in the drawing several devices which I have found particularly useful or helpful in connection with the general procedure.

In the drawing:

Fig. 1 is a perspective view of a body formed according to my procedure;

Fig. 2 is a plan view of another type of body;

Fig. 3 is an elevation view of Fig. 2;

Fig. 4 is a perspective view of a three dimensional object which may be formed from patterns obtained from the body shown in Figs. 2 and 3;

Fig. 5 is a perspective view of a body illustrating a modified application of the procedure;

Fig. 6 is a plan view of fragmentary portions of a motion picture film;

Fig. 7 is a fragmentary perspective view with portions broken away of a mold;

Fig. 8 is a plan view of a section of the body formed in the mold shown in Fig. 7;

Fig. 9 is a section of Fig. 8 in the plane 9—9;

Fig. 10 is a plan view of the piece which has been removed from the center of the section shown in Fig. 8;

Fig. 11 is a perspective view of a mold from which a body of material may be progressively forced so that slices of uniform thickness may be cut therefrom; and

Fig. 12 is a perspective view of a block formed from a plurality of pieces of variously colored plastic and showing slices cut from three sides thereof.

Referring first to Fig. 1 of the drawings, assume that it is desired to produce a series of pictures depicting a smooth, fluid change in shape of a plane object from that shown in irregular outline at 1 in the base of Fig. 1 to the circle or ellipse shown at 2 at the top Fig. 1. An outline pattern, preferably of rigid sheet material, is made to conform to the outline 1 and a second pattern of similar material is made to conform to the outline 2. These patterns are then arranged in spaced relation to each other, the spacing depending upon the time interval within which the shape of the object as depicted by pattern 1 changes to the shape depicted by pattern 2, and a mass of moldable material A is

then placed between the spaced patterns. The surface of this mass is then smoothly modeled to form a transition surface between said bases. If necessary or desirable, other patterns such as 3, 4 and 5, the outlines of which correspond to assumed outlines of the subject at various time-spaced intervals in the phase change from that shown in outline 1 to that shown in outline 2 may be made and arranged in properly time-spaced relation to the patterns 1 and 2 to facilitate the surface modeling. While I have shown in Fig. 1 a progressive diminution in size of the object as it changes in shape from 1 to 2 it is to be understood that the sections intermediate 1 and 2 may be of any size and shape and that by modeling the material between each of the adjacent sections an elongated body is produced in which any transverse cross-section thereof will represent the precise outline of the object at any desired time-spaced interval from base 1.

In practice, the moving design may be drawn on thin, stiff, three-ply paper in various stages a predetermined number of frames apart and cut along the outlines thereof to form patterns. "Plastelina," or other moldable material rolled into a sheet, say one-half inch in thickness, may be cut into cooky-like sections a little larger than the patterns, and the sections superimposed on each other, with the patterns therebetween to form a stack. The stack or elongated body of "Plastelina" thus formed is then modeled to form a surface of transition between adjacent patterns. If necessary, one or two stiff wires may be pushed through the center to hold the stacked sections in alignment. When the correct shape has been attained the patterns may be removed and the various sections pressed firmly together.

While the modeled body, especially if made of hardenable material, may be cut into a multiplicity of slices which may be photographed in sequence as shown at 1', 3', 4', 5', and 2' in Fig. 6, or used as templets to transfer the outlines of the object to a suitable base for photographing, I prefer to embed the body in a mass of material such as gelatine. In order to do this, a mold such as shown in Fig. 7 may be employed. The mold is preferably collapsible and comprises a base 6, ends 7 and 8 which are secured to the base by means of screws, and side plates 10 and 11 which are also secured to the base by means of screws 12. Within the mold and secured to the base 6 are two spaced upright cylindrical rods 13 and 14 which are spaced from but are quite close to the opposite ends of the mold. Adapted to slide down over the rods 13 and 14 but with some frictional resistance so that it may be positioned at any desired elevation is the element 15 which merely provides a means from which the elongated modeled body 17 may be suspended by the wire 18. A liquid gelatine or other composition which will solidify into a fairly firm mass when cool is then poured into the mold. Thus, a solid block 19 is formed within which the body 17 is encased.

A good gelatine composition may be made from the following ingredients:

	Pounds
Gelatine	1
Glycerine	1½
Water	¾
Flour	1
Petroleum jelly	½

The water and glycerine are added to the gelatine and the mixture is heated in a double boiler until the gelatine has melted. The flour and petroleum jelly are mixed together and worked into the melted gelatine. If necessary, additional water may be added and slowly stirred into the mixture to produce a proper pouring consistency. The formation of air bubbles in the mixture should be avoided as far as possible and, where the gelatine is intended to form an impervious mask to be used as hereinafter described, the bubbles should be removed from the mixture by centrifuging just before pouring. After the mold is filled it is refrigerated which definitely stiffens the molded block and facilitates an even slicing thereof.

After the block has hardened the mold may be taken apart, the element 15 pulled from the uprights and the block also pulled therefrom. The uprights 13 and 14 will leave two passages through the block which are preferably plugged lightly with soft clay to keep the edges thereof clear when the block is sliced.

The block is then cut into a multiplicity of thin slices and in a direction transversely of the elongated object encased therein. One of these slices is shown at 22 in Figs. 8 and 9 and has two holes 20 and 21 therein which are used to facilitate precise positioning or registration of successive slices. The "Plastelina" section 23 may be easily removed from each of the slices to leave openings 24 conforming in outline to the outline of the object in that section where the slice is taken, and such slices may be used as masks or stencils for transferring the outlines to a suitable base for photographing. If the "Plastelina" body is coated with talc before the gelatine is poured the removal of the sections 23 is somewhat facilitated.

There is some shrinkage in the gelatine sheets and it is therefore advisable to protect them so as to avoid uneven shrinkage due to uneven loss of moisture. The shrinkage is not so important provided it is maintained uniform and therefore the slices should be subjected to uniform treatment.

In Fig. 11, I have illustrated a device which may be used as a mold and also for facilitating the production of slices of uniform thickness. This comprises a base 24, two side walls 25 and 26, a fixed end wall 27 and a movable plunger 28. The end wall 27 is threaded to receive the rod 29 one end of which is rotatively attached to the plunger 28 and the other end of which is provided with the knurled knob 30. By retracting the plunger 28 so that it is closely adjacent the end wall 27 the space between the plunger 28 and the open end of the mold may, for example, be packed full of "Plastelina" or other variously colored clays 31, 32, 47 and 48 which may be merely twisted or formed into various shapes as shown at 32, or may be preformed to a desired shape or shapes, as described above. By turning the knob 30 in a direction to force the plunger 28 towards the open end of the mold the body of "Plastelina" may gradually and progressively be forced toward the open end of the mold so that it projects slightly therefrom. The projecting portions may be successively cut off to form slices such as shown at 33 and 34. The cross-sections of the body as exposed by each slice will present a mosaic design of various colored inlays as at 34', 35 and 36, or as at 50, 51 etc., in Fig. 12, and, after the removal of each slice, the exposed end of the molded block may be photographed on one or more frames of film. Thus, very beautiful and interesting effects may be produced when such films are projected on the screen.

In Figs. 2, 3 and 4, I have illustrated how my invention may be utilized to produce a smooth growth or reduction in size of a three dimension object. Thus, if it is desired to depict a cube or a rectangular prism which gradually increases or decreases in size, a laminated block may be built up by adhesively securing together a plurality of laminae 37 of foldable material such, for example, as Bristol board. The laminated block may then be sawed or otherwise cut out so that the configuration thereof at one end corresponds to the developed pattern of the top and sides of the cube or prism when it is in its smallest phase as shown at 38 while the other base of the block is shaped to conform to the developed pattern of the top and sides of the cube in its largest phase, as shown at 39. The surfaces such as 40 and 41, for example, joining the analogous portions of the pattern in its two phases are formed to constitute smooth transition surfaces therebetween. Thereafter the laminae may be separated and folded as shown in Fig. 4 to form the top and sides of a prism 42, or may be used as templets, as described below, to transfer the patterns to a material that can be so folded. These cubes may then be photographed in sequence to depict a prism which progressively and smoothly increases or decreases in size depending on the order in which the pictures are taken.

While I have illustrated this phase of my invention as a method of animating a cube or prism it will be apparent that any developable solid such, for example, as a pyramid or cone may be treated in the same way.

In Fig. 12 I have illustrated a somewhat different method of animating a prism. Here, a plurality of bodies or masses 50, 51, 52 etc., of variously colored plastic are fitted or pressed together in juxtaposed relation to form a prism. By cutting slices 53, 54 and 55 of uniform thickness from three sides having a common corner the proportions of the prism are maintained as it is gradually reduced in size. Very pleasing effects are obtained, due to the variation in the colored areas, by photographing the prism, after each reduction in size, on one or more frames of motion picture film and projecting the images either in the order in which they were taken or in reverse order.

Fig. 5 illustrates a modification of the procedure described above in connection with Figs. 2 and 3 where it is desirable to produce a single outline as it varies between two different phases. Thus, a block 43 may be formed from a plurality of laminae 44. This block may then be tooled to form a recess therein in which the outline 45 is at one end and the outline 46 at the other. By thereafter separating the laminae templets are obtained which may be used in sequence to transfer the changing contour to a suitable base for photographing. Such templets may be used in any sort of machine shaping requiring a series of graduated shapes.

Many variations in the few specific methods of utilizing my invention, which I have described above, will occur to those skilled in the art. Thus, for example, a series of key shapes or outlines of a chosen subject in time-spaced relation to each other may be cut out of colored Celluloid and a solid assembly formed therefrom with a plurality of blanks of transparent Celluloid or other plastic between said shapes and maintaining them in properly spaced relation to each other. By using a transparent soluble cement to hold the laminations together a solid block may be formed the

surface of which may be ground or otherwise tooled to form a surface or surfaces of transition between said key laminae. The laminae may then be separated and the outlines thereof used as templets or stencils, or otherwise, to obtain photographs in sequence which, when projected, will depict the subject in a precise, fluid manner as it changes in phase from key shape to key shape.

By forming a modeled body from white plastic and embedding it, as described above, in a block formed of black material, or by forming the body of black plastic and embedding it in a block of white material, slices cut therefrom (or the end of the block after each slice) will act as a restrictive source of reflected light. If this changing reflective light source is photographed on motion picture film and a print is made from said film, and then these two films are used separately as masks in the printing of a third film, complex wipe effects may be satisfactory obtained.

From the foregoing it will be apparent that the essence of my invention resides in the method whereby it is possible accurately to determine either the natural variations in configuration or other characteristic of an object as it changes from one phase to another, or the variations when the change or transition takes place according to some arbitrary or predetermined rule. In the one case we usually have a smooth, fluid change in the characteristic, while in the other case the change may or may not be smooth. However, in either case a body whose cross-sections conform in their outlines to the outlines of the object in its various phases, or a body such as the prism illustrated in Fig. 12, is so cut, or separated, as to expose these sections for photographic purposes. Sometimes it is desirable to photograph the sections as they are exposed on the body itself after each cut while at other times it is desirable to utilize the cut or separated sections per se in one form or another, as I have described above in connection with Figs. 8 and 9, where the slices may be used as masks for spraying the outlines of the body, as defined by the opening in the mask, on a suitable base for photographing, or in connection with Figs. 2, 3 and 4 where the slices are folded to produce a three dimensional object.

Thus, what is eventually utilized for photographing are the outlines of the subject matter as it changes in phase as defined or determined in one way or another from the various cross-sections. Hence, it is to be understood that the phrases "as determined by said slices," or "as determined by said cross sections," are intended to be of such comprehensive scope as to include any of the many ways in which said slices or cross-sections may be employed in preparing the outlines of the subject matter for photographic purposes.

While I have described my invention in its preferred embodiment it is to be understood that the words which I have used are words of description rather than of limitation and that changes within the purview of the appended claims may be made without departing from the true scope and spirit of my invention.

What I claim is:

1. Those steps in the method of producing an animated motion picture of an object which changes in phase during an interval of time which comprise forming a body having spaced, parallel-disposed, transverse cross sections thereof conforming, respectively, in outline to the prede-

termined outline of said object at the beginning and end of said interval and having its exterior forming a desired transition surface between said cross sections, dividing said body transversely between and parallel to said cross sections into a multiplicity of slices to expose the cross sections thereof intermediate the first mentioned sections, and photographing in sequence the outlines of the object as determined by said intermediate cross sections on successive frames of a motion picture film.

2. Those steps in the method of producing an animated motion picture of an object which changes in phase during a predetermined time interval which comprise forming a pattern of the outline of said object as predetermined in each of at least two, time-spaced phases thereof, arranging said patterns in spaced, parallel relation to each other, placing a mass of workable material between said patterns, shaping said material to form a body having a desired surface of transition extending from one pattern to the other, cutting said body between and parallel to said patterns into a plurality of slices; whereby the outlines of said slices will define the outlines of said object as it progressively changes from one of said two phases to the other thereof; and thereafter photographing the outlines of said object as so defined in sequence on successive frames of a motion picture film.

3. Those steps in the method of producing an animated motion picture of an object which changes in phase during an interval of time which comprise forming a pattern of the outline of said object as predetermined in each of several, time-spaced phases thereof, arranging said patterns in spaced, parallel-disposed relation to each other with the spaces therebetween substantially proportional to the respective time intervals between said phases, placing a workable material between each of said patterns and shaping said material between each adjacent pattern to form a body having a surface of transition extending from pattern to pattern, cutting said body between and parallel to said patterns into a plurality of slices; whereby the outlines of said slices will define the outlines of said object as it progressively changes in phase from pattern to pattern; and thereafter photographing the outlines as so defined in sequence on successive frames of a motion picture film.

4. Those steps in the method of producing an animated motion picture of an object which changes in phase during an interval of time which comprise forming an elongated body having spaced, parallel-disposed, transverse cross sections therein having outlines conforming to the predetermined outlines of said object at predetermined time intervals and having its exterior surface forming a smooth transition surface between said cross sections, dividing said body transversely between each of said cross sections and parallel thereto into a plurality of slices to expose the cross sections of said body intermediate said first mentioned cross sections; the number of slices between the various cross sections being substantially proportional, respectively, to the time interval therebetween; and photographing in sequence the outlines of the object as thus exposed on successive frames of a motion picture film.

5. Those steps in the method of producing an animated motion picture of an object which changes in phase during an interval of time which comprise forming an elongated body having spaced, transverse, parallel-disposed cross sections thereof conforming, respectively, in outline to the outline of said object as predetermined at time-spaced intervals, and having its surface forming a desired transition surface from one section to the other, encasing said body in a mass of moldable material, cutting said mass and said body in a direction transversely of said body and between and parallel to said cross sections into a plurality of thin slices, and photographing the outlines of said object as determined by said cuts in sequence on successive frames of a motion picture film.

6. Those steps in the method of producing an animated motion picture of an object which changes in phase during an interval of time which comprise forming an elongated body having spaced, transverse, parallel-disposed cross sections thereof conforming, respectively, in outline to the outline of said object as predetermined at time-spaced intervals, and having its surface forming a desired transition surface from one section to the other, encasing said body in a mass of moldable material, cutting said mass and said body in a direction transversely of said body and between and parallel to said cross section into a plurality of thin slices and removing from said slices the portions of said body to leave openings in said slices conforming in outline to the outlines of the cross section of said object in the respective planes of said slices; whereby to produce a plurality of masks which may be used in sequence to transfer the outlines of said object, as it changes in phase from one section to the other, to a suitable medium for photographing in sequence on successive frames of a motion picture film.

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