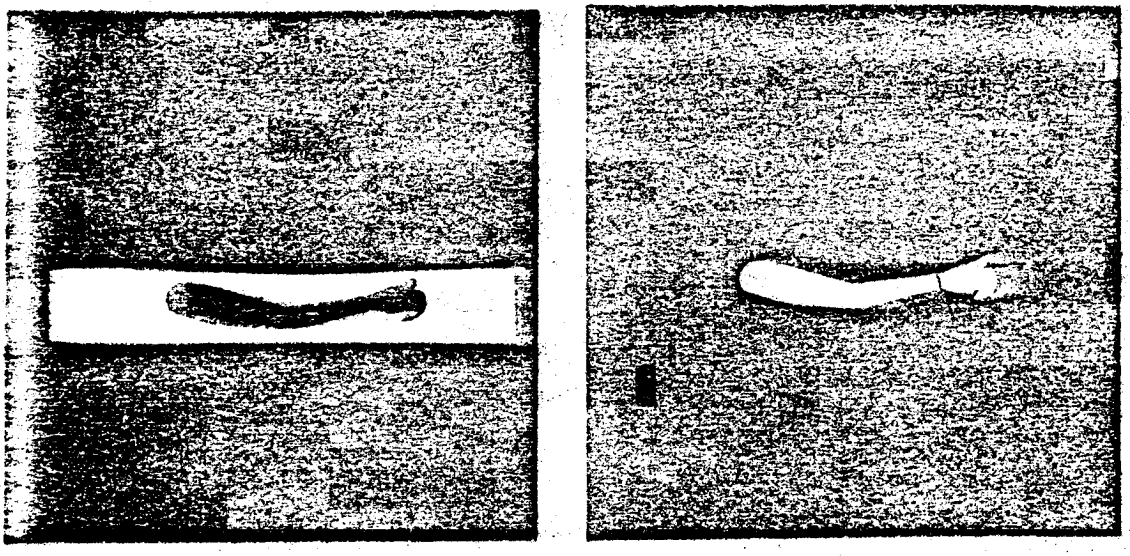
CAESAR is the name of an electronic animation system that utilizes digital computer, analog computer and television technology. These technologies are combined in a unique manner so that an artist or an animator can use the power of a hybrid computer in combination with his artistic talents to produce animation. An artist can use his drawing skill to create the characters and then his sense of motion to direct the character's movement.

CAESAR animation is based on the concept of mapping surfaces. The operation of a television broadcasting system is also based on mapping surfaces. The surface of the target on the image tube in the camera is mapped onto the surface of the Cathode Ray Tube (CRT), in the receiver. In the case of television the desirable mapping function is unity, that is, the two surfaces are identical. Then the image on the receiver is a faithful reproduction of the image picked up by the camera. Sometimes due to problems in the receiver or interference with the broadcast signal the mapping function is different from unity. Then the television image appears torn, it appears to roll or it looks distorted. The scene in front of the camera has not changed but the image on the television receiver has changed due to the change in the mapping function.

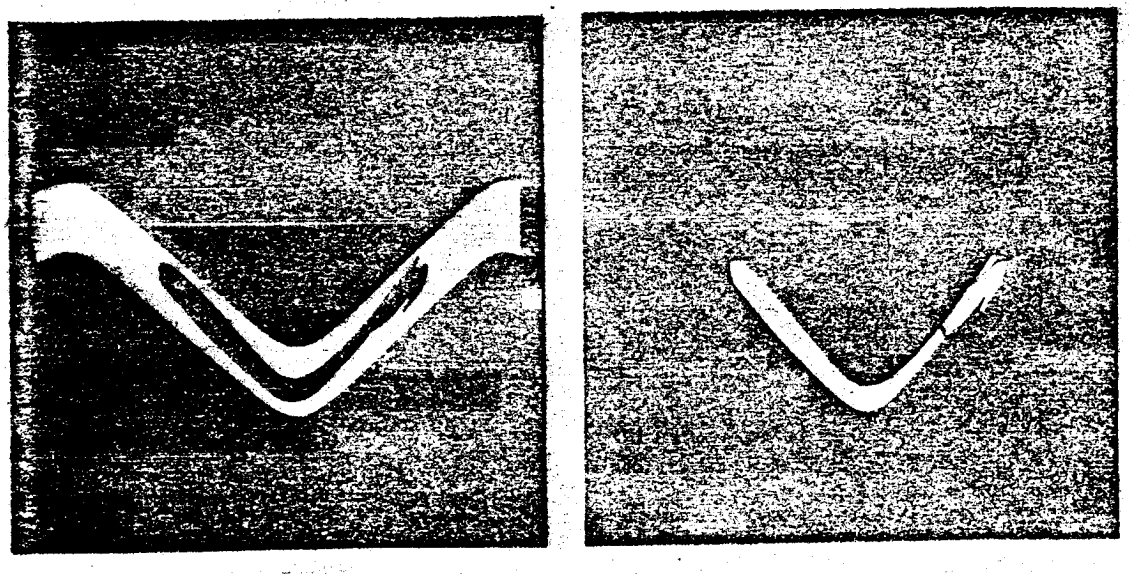
CAESAR produces animation by mapping the input artwork onto an output plane whose shape is precisely controlled. The image plane can be divided into as many as 8 different sections. Each section encompasses a horizontal slice of the input artwork. Viewed on the output plane, each section can have an arbitrary shape, orientation and position. These characteristics are controlled by the operator specifying about 20 different parameters for each section. The parameters are horizontal and vertical size; horizontal and vertical axis rotation; frequency, phase and amplitude of the section shaping function; rotation, horizontal and vertical position; depth and finally an overall horizontal and vertical position that affects all 8 sections.

Let us define a character as any object to be animated that has multiple moving parts. It can be a Donald Duck, a trapeze artist or a graphic symbol. An artist wishing to animate a character with the CAESAR system first must draw the character as it appears in each scene. From this the input artwork is prepared drawing each portion of the character that must move independently on a separate section. For example if the character is a man that will be animated to walk then the input artwork would probably have his body, head, front leg, back leg, front arm and back arm on separate sections. Several examples of an input artwork configuration and the types of output images that can be produced are demonstrated.



(a) (b)

Artwork of Arm With no Bend
(a) Negative of Artwork on Raster
(b) Positive of Artwork



(a) (b)

90 Degree Bend With Vertical Translation Operator Only
(a) Negative
(b) Positive

Graphic symbols such as company logotypes and objects like automobiles or buildings can also be manipulated or animated. The important factor to remember is that each portion of the image that is to move independently must be located on a separate section of the input artwork. This means that 8 independent image components can be controlled by the animator.

Many different kinds of artwork manipulations are possible with the CAESAR system. Manipulations that can be applied to each section individually shall be described first. Perhaps the simplest operation is that of translation. Each section can be moved to any location on screen or off. Size can be changed by varying horizontal size and vertical size, either independently or both together. The ~~attitude~~ angle of each section can be controlled by the rotation parameter. ~~Each section can be positioned at any angle in 0.7 degree steps~~. Also controllable is the center of rotation, that point about which the section rotates. Horizontal axis and vertical axis parameters can position the center of rotation to be any point on the section or to most points off.

The ability to control the shape of the output plane is very important. As many as two bends can be arbitrarily positioned on the section, with their amplitudes independently controllable. Other shapes, too numerous to describe in detail, are possible. All of the shaping effects are controlled by the

operator selecting the waveform, frequency, phase and amplitude of the shaping function generator that best produce the desired image.

Multiple views of the same element can be located side by side on a section. All of the views except one can be blanked and the one to be unblanked can be changed at completely controllable increments of time. Therefore, faces containing different expressions or numbers that need to change can be drawn on the same section and only the desired one is used to produce the output image.

There is a feature called "overlap" that keeps elements of a character that are located behind other elements from showing through them. Therefore an arm of a character can pass in front of its face and the arm will obscure the face. Which element is nearer the viewing plane than another is controlled by positioning of the input artwork.

Colors are also controlled by the operator. Areas that are a certain shade of grey can be transformed to an arbitrary color at the output plane. There may be as many as four different colors on a character plus one other color for the background of an image. All of these colors can be made to change during a scene. Any image existing as a color television signal can be substituted for the background color. As an example, the signal could come from a color television camera that is viewing a piece of color artwork.

However, to produce animation the section parameters must change with respect to time so that each succeeding image is slightly different from the preceding one.

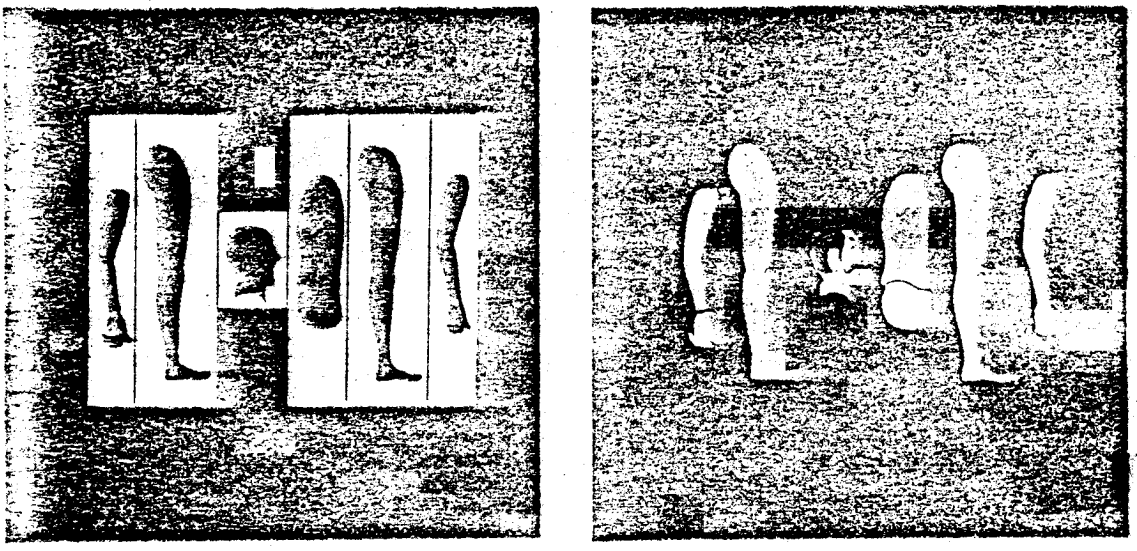
It is possible to produce a wide variety of output images from the one piece of input artwork by selecting appropriate values for all of the animation parameters for each section. These parameters are either selected by the operator or calculated by the computer in the animation procedure. The operator adjusts the parameters to produce the desired "key" frames. He also selects the number of frames between each key frame which controls the timing of the animation. Then the digital computer portion of CAESAR calculates the parameters for each of the "in between" frames according to the selected fairing function.

Parameter values are controlled by the operator pushing the appropriate push buttons to select the parameter and then rotating a knob to adjust the parameter's value. The operator uses visual feedback, which is available since response is instantaneous, to decide what parameter value is best. One knob can control any of the parameters, but three identical knobs are available so that three different parameters' values can be varied simultaneously. Thus it is possible to try various combinations of related parameters' values to help choose those that produce the desired effect.

Two different types of artwork are used by CAESAR. If the background is to consist of a full color scene, then that full color scene must be supplied. A color camera converts the color artwork to a television signal and it can then be combined with the animated character.

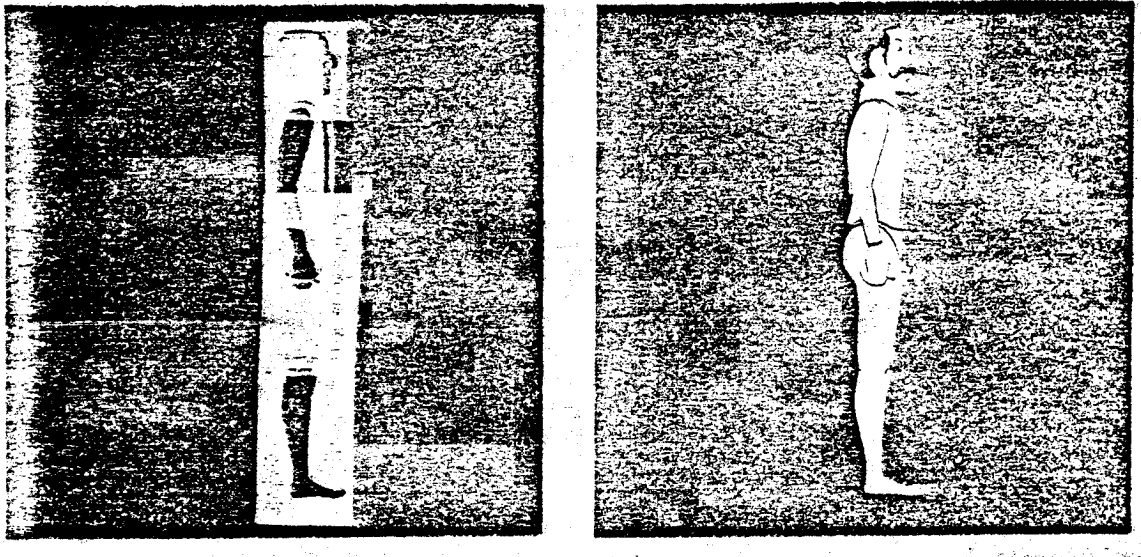
The artwork for the character to be animated is contained on a piece of film containing up to five different areas. Each area that is to be a different color is coded by having a different level of light transmittance. This artwork is backlighted and then has the appearance of being black, clear and three shades of grey. The greys are produced by adding the appropriate type of Letrofilm to clear areas. Examples of input artwork are shown.

Both appropriate artwork in front of the input cameras and digital storage of the section parameters for each frame of the sequence are necessary to produce the character animation. During playback the section parameters specify the changing shape of the output plane while the input artwork is mapped onto this complex, changing output plane. The result is the image of an animated character on a high resolution, random scan monitor which is then scan converted, colorized, keyed into a background scene and presented as a color television signal ready for viewing or recording.



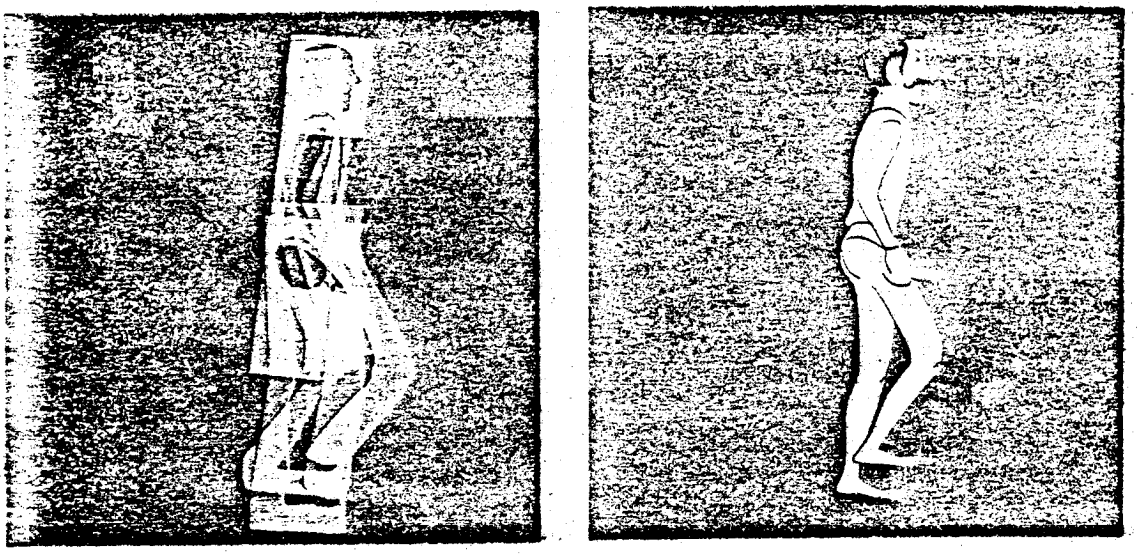
(a) (b)

Input Artwork Configuration for Pierre
(a) Negative of Artwork on Raster
(b) Positive of Artwork



(a) (b)

Pierre as Assembled
(a) Negative
(b) Positive

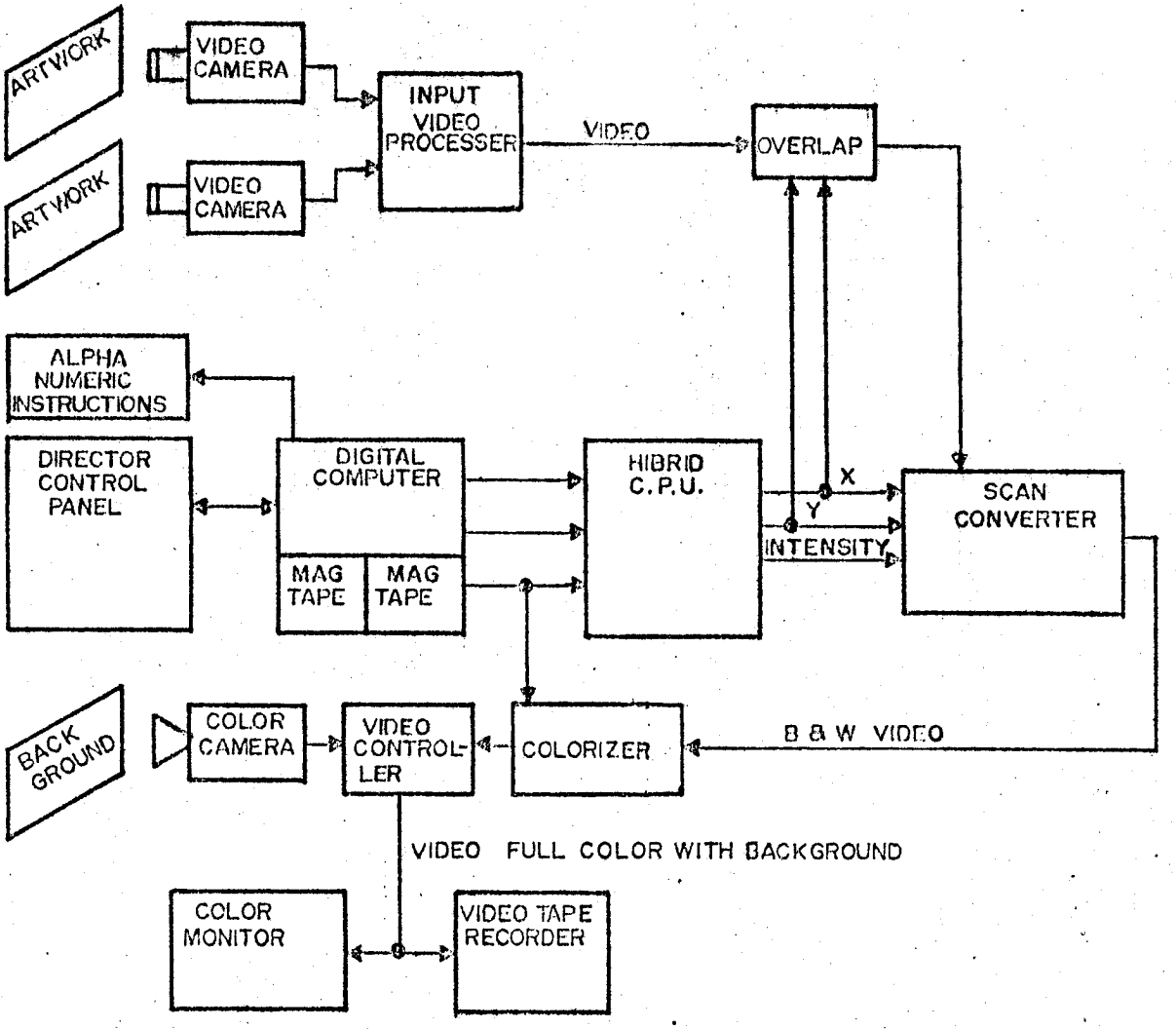


(a) (b)

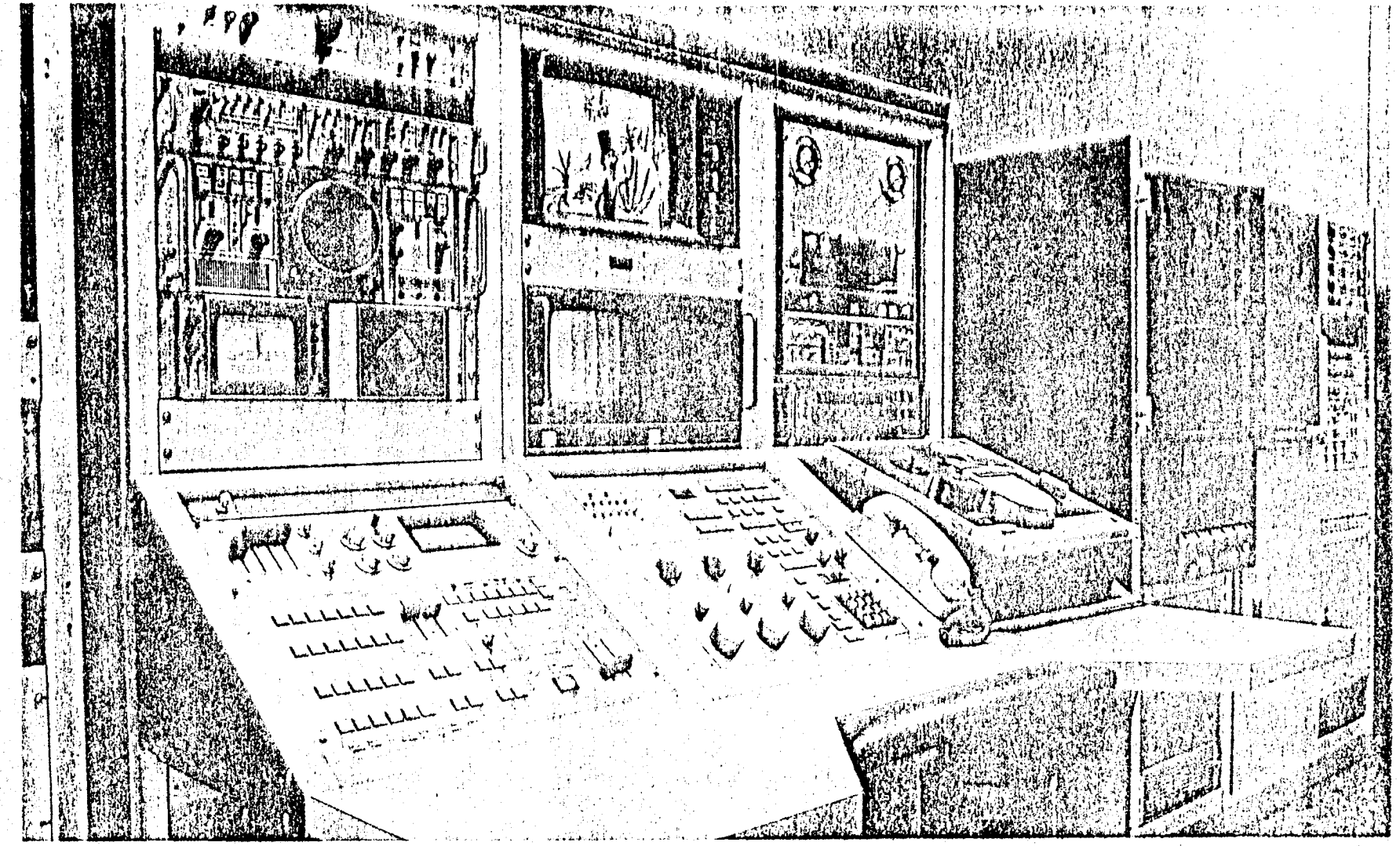
First Key Frame of a Walk Cycle
(a) Negative
(b) Positive

(a) (b)

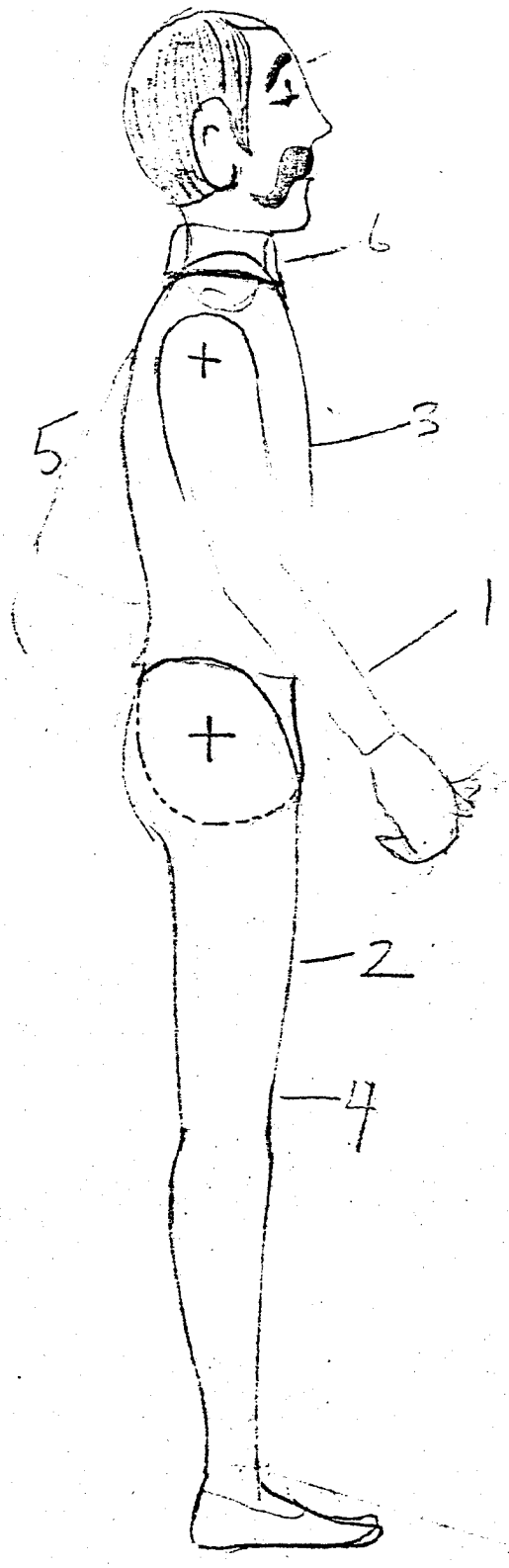
Second Key Frame of a Walk Cycle
(a) Negative
(b) Positive



CAESAR Animation System Block Diagram



Control Console for CAESAR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