ploying an extremely strong source of light or by using proper arrangements to concentrate light on the object. This difficulty increases when the depth of focus has to be improved by choosing a small diaphragm.

The main problem in taking pictures of this kind is therefore the question of the source of light. One may use for this purpose the "Edison Mazda Photoflash Lamp," which has recently appeared on the market. This is a glass bulb in the same shape as an electric light bulb, filled with oxygen and furnished with an aluminum foil. The aluminum may be ignited by an electric current and burns within the bulb, giving a very strong and fairly short flash (according to the statement of the manufacturers about 1/50 second).

A camera of the type of vertical cameras for microphotography has been used (Fig. 1, C). Such a

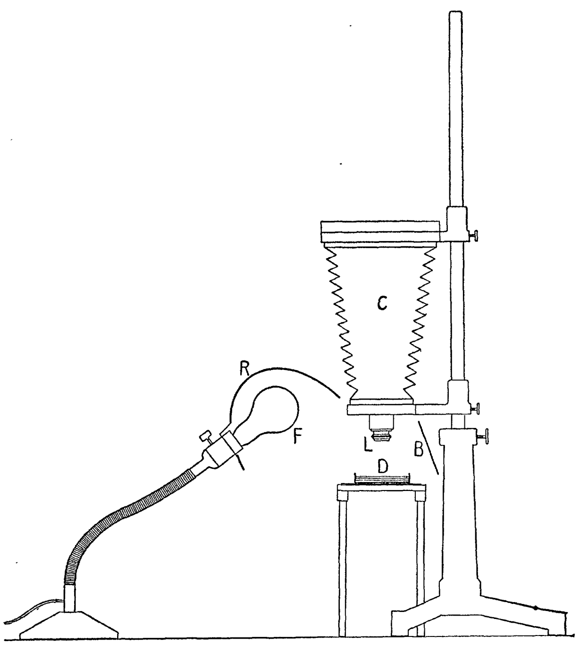

FIG. 1. Diagram of the arrangement of apparatus for taking pictures of small animals. (B) White cardboard for reflecting light; (C) camera; (D) Petri dish containing animals; (F) flash-bulb; (L) photographic lens; (R) reflector.

camera is kept in most of the biological laboratories. It combines two advantages: it allows great variation in the length of the bellows and takes pictures in a horizontal plane. Any other camera with similar characteristics will, of course, work the same way. The lower opening of the camera, which in microphotographic work is set on the eyepiece of a microscope, is closed with a photographic lens (L) with short focal length (about 5 cm). The animals are put into a shallow dish (D), *e.g.*, a Petri dish, and placed under the lens at the proper distance. The picture is focused on the ground-glass plate with the lens entirely open. It is necessary to mark the field of vision of the ground-glass plate on the Petri dish. That may be done by putting under the dish a sheet of dark paper with a properly shaped opening. Then a flash-bulb (F) is placed close to the dish (it may be as close as 15 cm), so that its light will fall on the object obliquely from above. Care must be taken that no light falls directly on the lens or is reflected to it from the water surface. The illumination is improved by a reflector (R) fixed behind the bulb. One may use a common table lamp with a reflector, substituting the flash-bulb for the light bulb. A sheet of white cardboard (B) on the opposite side of the object may be used to increase the lighting by diffuse reflection.

After these preparations the diaphragm is adjusted in order to obtain a proper depth of focus. In an enlargement of five times and in employing ordinary double-coated plates with fine grain (and therefore with only mediocre speed) a diaphragm with an opening of F/16 is permissible. The ground-glass plate is changed for the photographic plate. It is convenient to work in a room with dim artificial light. Then the lens may stay open for quite a while without the plate being affected by the incident light. No high-speed shutter is necessary.

The picture is taken when an animal is moving over the marked space in the dish in proper position and shape (planarians may to a certain extent be directed in their moving by a weak source of light). The exposure is made by igniting the flash bulb by turning an electric switch.

It is often advisable to photograph a small scale with the animal. Thus one may later check the magnification in the pictures.

In photographing water animals one must take care that no dust particles are floating on the surface of the water. These could spoil the picture by forming small depressions on the surface and so destroying the sharpness of the picture locally.

This method of directly photographing small objects at low magnifications may be useful also in other cases where a short exposure of the object is necessary.

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PERMANENT PRESERVATION OF THE HUMAN BODY BY INFILTRATION

A METHOD for preservation of small animals by paraffin infiltration has been previously described by

Dr. G. K. Noble, of the American Museum of Natural History. This note briefly summarizes a method for permanent preservation of the human body by paraffin infiltration.

Four essential steps, well known to all familiar with histological methods, are necessary to preserve a specimen—fixation or embalming, dehydration, clearing and embedding. The different solutions used in the above steps were injected by way of heart and vascular system, and at the same time the specimen was immersed in the solutions.

The embalming fluid which maintained the color of the skin and lips most nearly normal was a solution containing liquor formaldehyde 10 per cent., sodium borate and sodium chloride each 1 per cent. Fixation required about ten days.

Dehydration and hardening was accomplished by gradually increasing strengths of alcohol. Dehydration required about forty-six days.

Xylol containing 5 per cent. of liquid carbolic acid was used as a clearing medium. Clearing required about one week.

Paraffin infiltration was accomplished by means of continued injection of paraffin through the vascular system, together with complete immersion of the body in heated liquid paraffin. Embedding required about one week.

The excess paraffin was removed with xylol and washing under running hot tap water.

In all, experience indicates that adult subjects can be preserved by the above method in about seventy days.

A still-born Negro infant has been successfully infiltrated and embalmed by the technique above described. Unlike mummies of old with their characteristic loss of color, shrinkage, removal of organs, artificial replacements, etc., this infant is preserved *in toto,* retaining its original form and identity in every respect. So natural does it appear that any one would readily mistake it for a living child.

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SPECIAL ARTICLES

GENERAL THEOREMS IN DYNAMICS

I WISH to state some new and simple theorems concerning the motion of a particle in a general field of force. The proofs will be published elsewhere. The results concern the relation between the lines of force and the paths or trajectories. We consider first the case of a particle starting from rest, then a particle projected in the direction of the acting force, then an arbitrary direction.

If a particle starts from rest, it begins to move along the line of force and then deviates from it on account of its acquired velocity. The path and the line of force will, therefore, have the same tangent but different curvatures.

THEOREM I: *The main result is that the curvature of the trajectory obtained by starting from rest is one third the curvature of the line of force.*

A separate discussion is necessary when, at the given point, the curvature of the line of force is zero, as for a point of inflection, for then both curvatures vanish. In this case we consider the ratio of the infinitesimal departures of the two curves from the tangent line. In the main case this ratio would be 1:3; but now it is found to be 1:5, 1:7, 1:9, etc., depending on the order of contact with the tangent line. It is always of the form $1:2n+1$.

THEOREM II: *If the line of force has contact of n-th order with the tangent line, the trajectory produced by starting a particle from rest will also have contact of n-th order; and the ratio of the departure of the trajectory to the departure of the line of force from the common tangent will be* $1:2n+1$.

THEOROM III: If the particle is projected in the direction of the force with a speed different from zero, the initial curvature will be zero and the departure from the common tangent will vary inversely as the square of speed.

It follows, from I and III, that if any dynamical trajectory touches a line of force it will, at that point, either have zero curvature, or else its curvature will be one third that of the line of force.

THEOREM IV: The single infinity of paths obtained by starting at a given point in the force direction with varying speed under the conditions of Theorem II, will have contact of order $n+1$, and will give departures from the common tangent varying inversely as the square of the speed; except for the single path due to zero speed for which case the contact will be of n-th order and the departure ratio will be of the form $1:2n+1$.

These theorems apply to any continuous differentiable positional field of force, conservative or not, in flat or curved spaces of any dimensionality; and therefore can be used, for example, in the gravitational field of an elliptical planet, or in the problem of three bodies, or in the complicated magnetic field of the earth.

If there is a resisting medium, like the air, Theorem I will still be valid. This is true whenever the resistance R_0 due to zero speed vanishes.