The results obtainable with this arrangement are illustrated in Fig. 2a, which represents the photograph of a stationary ultracentrifuge cell filled with water so as to leave a small air space, and in Fig. 2b, a flash image of the same cell, recorded by a single discharge at approximately 10,000 r.p.m. The air-water meniscus, which is curved in the stationary

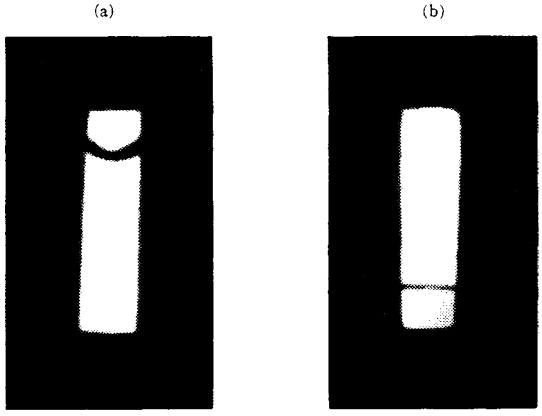

FIG. 2. Flash photographs of centrifuge fluid cell at rest (a) and in motion (b).

picture, becomes practically a straight line. The slight blur at the trailing edge of the cell sector image is probably due to an afterglow phenomenon in the discharge tube.

Images of macroscopic objects during flight may be recorded without appreciable distortion. Fig. 3a is the picture of a stationary, star-shaped object which was attached to the outside of a clear plastic plug inserted in the opaque rotor.

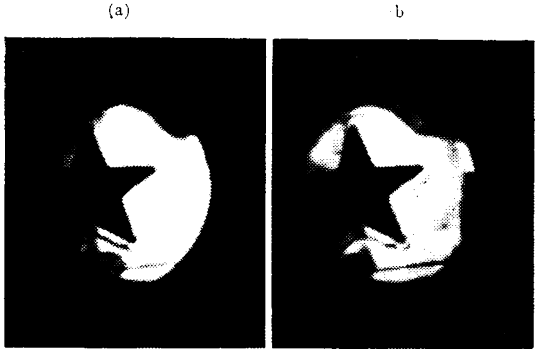

FIG. 3. Flash photographs of star-shaped object at rest (a), and in flight (b).

Fig. 3b represents the image of the same object, photographed with a single flash during rotation at about 4,000 r.p.m. The sedimenting boundary of tobacco mosaic virus protein has been photographed by the schlieren method with the aid of single light flashes.

It is evident that the arrangement here outlined lends itself, in principle, to other applications, e.g. the photomicrography of small objects, such as individual cells, and to studies of photoelastic stress patterns in polarized light. A full report of this work will be published elsewhere.

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An Apparatus for the Determination of the Tensile Strength of Healing Wounds

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The role of nutrition in wound healing has been the subject of few quantitative studies. Harvey and Howes, in their studies on the effect of nutritional state on the rate of healing of wounds, used tensile strength as a measure of repair (*1*, *2*).

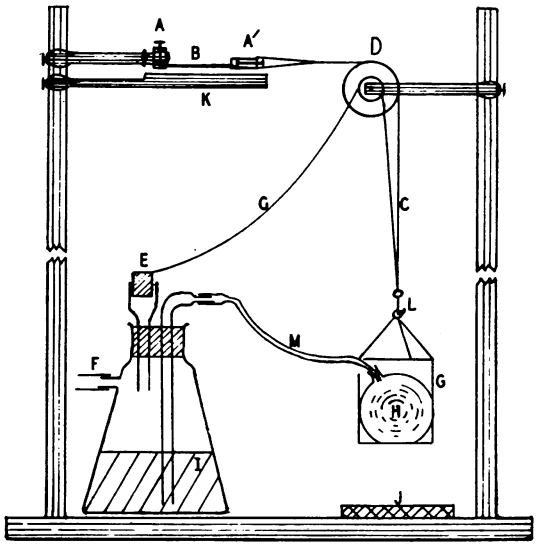

FIG. 1. Arrangement of apparatus: A-A', screw clamps; B, strip of skin to be tested; C, braided nylon cord; D, pulley; E, rubber stopper; F, compressed air line; G, cardboard container; H, rubber balloon; I, mercury; J, cushion; K, support plate; L, hook; M, rubber tubing.

In the course of our work on the role of protein nutrition in wound healing, a simple, semiautomatic apparatus for measuring the breaking strength of skin wounds was devised.

[1] The authors wish to thank Miss Lois H. Henneberger and Miss Mary A. Lord for their technical assistance.

The apparatus allows a uniform rate of loading, can be constructed easily with ordinary laboratory equipment, and is simple and rapid in operation.

In order to determine the strength of a wound, a 0.50-cm. strip of skin is cut out at right angles to the wound. The ends of the strip are fastened to clamps A-A′, the support plate K facilitating manipulation of the strip. The apparatus is arranged as shown in Fig. 1, and compressed air is turned on at F, driving mercury into the balloon, H, at 900–1,100 grams/minute. When the limit of strength of the skin strip is attained, it breaks and container G falls, pulling out stopper E and automatically halting the flow of mercury. Container G is then weighed without detaching from the apparatus.

The reproducibility of the results obtained is indicated by determinations of the breaking strength of similar 0.50-cm. strips of freshly dissected, unwounded rat skin. Determination on 10 rats (135–190 grams in weight) gave values ranging from 1,410 to 1,990 grams; the average value was 1,710 grams, and the average deviation, 170 grams.

An experiment demonstrating the possibilities of this approach to the study of wound healing was set up as follows:

Young male rats (140–160 grams) were divided into two groups and fed ad libitum diets containing 6 per cent and 22 per cent casein. The percentage composition of the diet for each group is given below:

	Group I	Group II
Casein	6	22
Dextrose	73	57
Salt mixture No. II (SMA)	4	4
Crisco	15	15
Cod liver oil	2	2

The rats were given a daily supplement of thiamine, pyridoxine, riboflavin, calcium pantothenate, and choline chloride and were supplemented weekly with vitamins A, D, and E.

After 7 days on diet, the rats were anesthetized with nembutal and ether, and the hair in the area of the shoulder blades removed with a pair of clippers. A slit wound (approximately 1 cm. in length) was made longitudinally through the entire thickness of the skin with a scalpel. The edges of the wound were pressed together, and a strip of adhesive tape applied directly to the wound. The edges of the tape were cemented to the skin with a methacrylate polymer mixture consisting of: hydroabietyl alcohol, 20 grams; dibutyl phthalate, 15 grams; isobutyl methacrylate polymer, 50 grams; isobutyl-N butyl methacrylate interpolymer, 40 grams; and toluene, 150 ml.[2]

The hind paws of the rat were incased in test-tube ends filled with plaster of Paris in order to prevent the animal from scratching at the wound. (Further experience has shown that this precaution is unnecessary.) The dressing adhered for approximately 10 days, after which the wound had healed sufficiently to render protection unnecessary. With this technique close proximation of the wound edges was obtained; infection and scabbing rarely occurred.

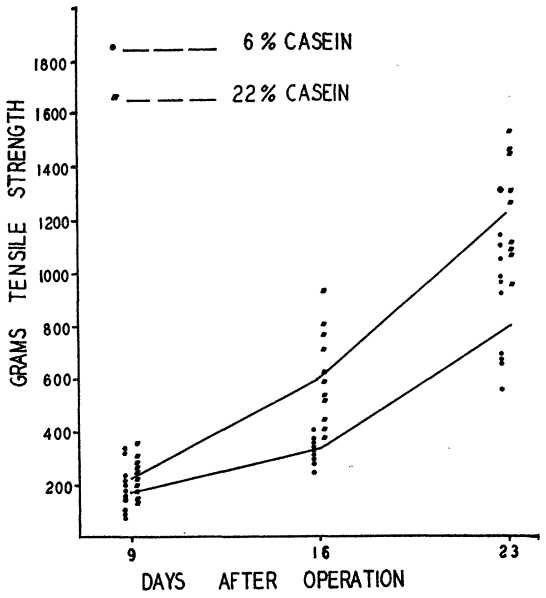

FIG. 2.

After 9, 16, and 23 days, the animals were sacrificed and wound strength determined (Fig. 2). The average error and calculations of significance of each group of rats are given in Table 1.

The data shown in Fig. 2 and Table 1 demonstrate the unfavorable effect of suboptimal dietary protein level on the rate of healing of skin wounds in the rat. This has been confirmed by several repeat experiments using the same technique and apparatus. The data serve to confirm the report of Harvey and Howes on the beneficial effect of high protein diets on the healing of experimental wounds.

TABLE 1

RELATIONSHIP BETWEEN DIETARY PROTEIN LEVEL AND BREAKING STRENGTH OF SKIN WOUNDS

	6% Casein		22% Casein		Critical ratio (3) $\left(\frac{x}{\sigma}\right)$	Probability of significance (3)
9 days	10 rats	178 ± 67 grams	10 rats	229 ± 47 grams	1.5	6 to 1
16 "	9 "	314 ± 36 "	11 "	602 ± 135 "	5.2	2×10^6 to 1
23 "	11 "	800 ± 223 "	9 "	1,222 ± 264 "	4.0	1.5×10^4 to 1

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[2] The methacrylate polymers were supplied by E. I. du Pont de Nemours and Company, Wilmington, Delaware.