A NEW LABORATORY PROJECTION APPARATUS

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WITH 10 FIGURES.

The projection apparatus was designed to meet the requirements of the anatomical laboratory of the Wistar Institute where, in nearly every research, photographic processes, outline drawings from the projected objects or Born's method of reconstructing microscopic objects are employed. It is essentially a fixed apparatus and not designed for lecture

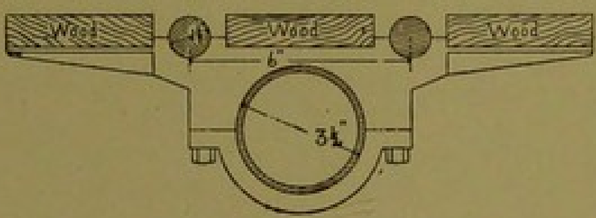

FIG. 1.

purposes. Its parts are all heavy to avoid vibration and that they may remain in place without fastenings. The base or optical bench differs from other forms of projection apparatus in consisting of one piece. Other differences are found in the mechanical stage, in the cooling cells, in the focusing apparatus, in the lantern, and in some other minor points. The camera presents a number of new features, but as it is not yet completed no further mention will be made of it at this time, except to say that it is to be applied to the same optical bench and the same lantern, condensers, mechanical stage, and focusing device are to be used.

The apparatus is a result of a series of experiments with crudely constructed apparatus to ascertain the exact requirements. I am indebted to Dr. H. D. Senior and Dr. G. L. Streeter for their assistance in developing the plans and to Mr. S. Noble, the Institute's mechanician, for the skillful mechanical work.

The Optical Bench consists of an iron frame approximately ten feet long. It is made up of a central steel tube 3½" in diameter bearing eight saddles or transverse castings placed equidistant upon this tube. The tube furnishes rigid support for the transverse bars which in turn bear two parallel round steel shafts or ways each $1\frac{1}{8}''$ in diameter and 10′ long and set 6″ from centre to centre. Between the two steel ways and on both outer sides are strips of wood $4'' \times \frac{7}{8}''$ secured to the saddles forming a flat table surface. The central strip bears a T slot which may be used to secure apparatus to the bench. See Fig. 1.

Accurate alignment of all the optical parts is secured by turning and grinding to a perfectly true cylinder the supporting $3\frac{1}{2}''$ tube; milling all the saddles on a jig so that they are exactly alike and using turned and ground shafting for the ways.

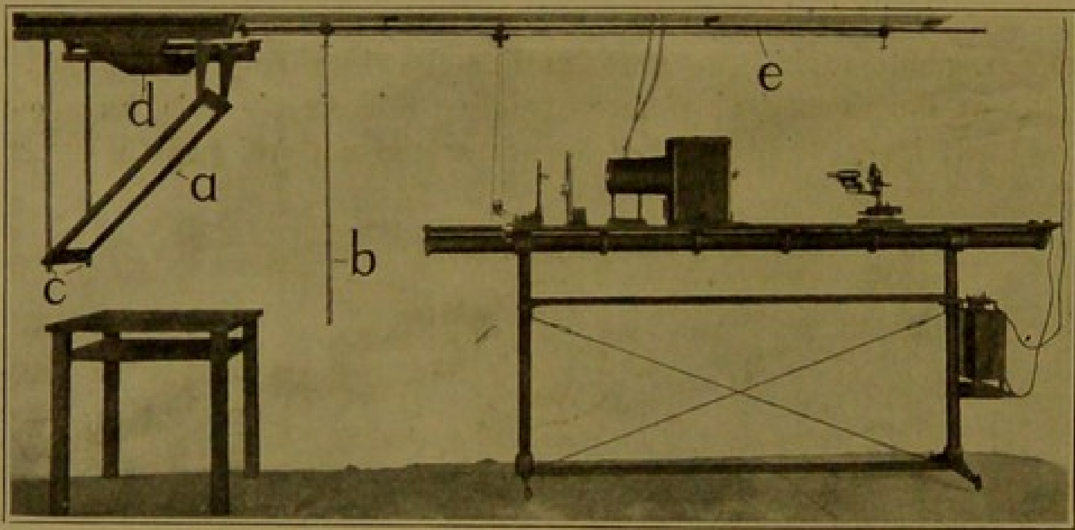

FIG. 2.

The optical bench is borne upon two upright tubes or standards $2\frac{1}{4}''$ in diameter mounted in cast iron feet and of the proper length to bring the top of the bench 48″ from the floor. This frame is made rigid by a $1\frac{1}{2}''$ channel from foot to foot and two diagonal tie rods with turnbuckles. Just beneath the optical bench is a shelf 10″ wide. Upon a bracket on one standard is mounted the Rheostat (10 to 25 amperes). Upon the two steel ways the lantern, condensing system, mechanical stage, microscope, and other accessories are movable from end to end of the bench.

At the proper distance from this apparatus is placed the mirror and drawing table. The mirror 24″ x 36″ (Fig. 2 a) is suspended at an angle of 45° from a wooden framework by strips of steel, one pair of which has binding screws and slots at the lower ends (c) in order that the miror may be accurately adjusted at 45°. The wooden framework carrying the mirror is 36″ x 33″; the central cross bar (d) is blocked down at each end in order to pass beneath the apparatus secured to the ceiling. This frame is suspended from the ceiling of the projection room by means of a steel track such as is used for sliding doors in house construction. This makes it possible to move the mirror nearer to or farther from the projection apparatus according to the magnification desired. The drawing table is of ordinary construction with a shelf just beneath the top to carry paper or wax plates. Suspended by a universal joint

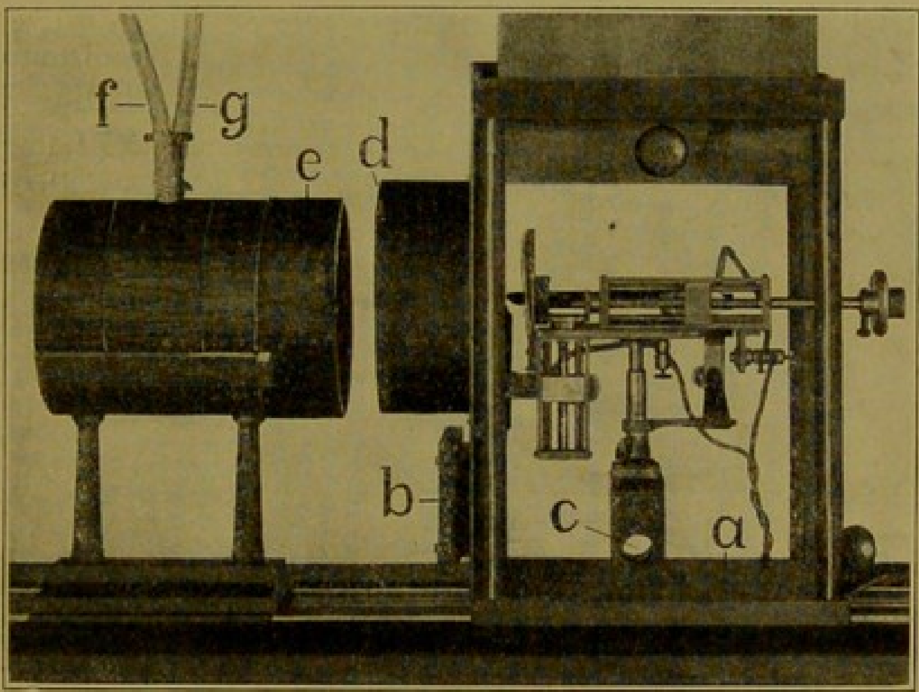

FIG. 3.

conveniently near the drawing table is the focusing rod (b) which is also movable from end to end of the projection room. Secured to the ceiling by brackets are two parallel steel rods (e) $\frac{1}{2}$″ in diameter and $2\frac{1}{2}$″ apart. These rods extend from end to end of the projection room directly above the apparatus. They carry the pulleys of the focusing apparatus and make it possible to have the microscope at any point of the optical bench and focus it while working at any other point in the room. Projecting from the ceiling, at convenient intervals over the optical bench are three pairs of water supply ($\frac{3}{8}$″) and waste pipes ($\frac{1}{2}$″) (not shown in the figure) to furnish water circulation for the cooling cell.

Each piece of apparatus to be used on the bench has a cast iron base, the bottom of which has a V-shaped groove on one side and a flat surface on the other side. The V-groove fits over one way or shaft of the optical bench and keeps the apparatus in line while the flat surface rests on the other shaft giving the necessary support.

The lantern consists of a cast iron base (Fig. 3a) 10¾" x 8". The corner supports are ⅞" turned rods into which grooves are sawn 1/16" wide by 3/16" deep. In these grooves the sides of the lantern slide. Any side may be drawn out as shown in Fig. 3. The top of the lantern is open, yet made light proof by a series of Z-shaped sheets of metal. Through the base at (b) and at (c) are air inlets. At (d) is a double tube or light lock secured to the front of the lantern into which an extension of the condensing system (e) fits loosely so that the distance from the arc to the condensing lens may be varied without allowing light to escape. The lamp which we use is a Thompson Hand Feed Lamp. The screws for adjusting the carbons extend through the rear of the lantern

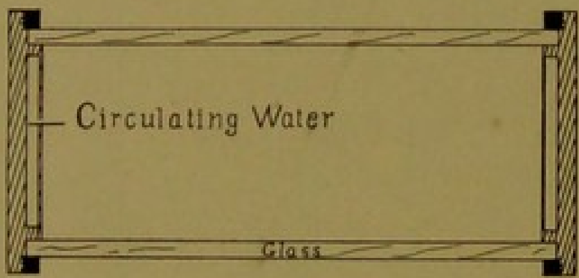

Fig. 4.

and by means of a strip of steel held in grooves in the rear plate render the adjustment of the lamp easy and without the escape of light. The electric wires enter the lantern through two small holes extending 3" into the base and then turning upward into the lantern. The optic axis is fixed at 9" from the top of the ways of the bench.

The condensing system consists of two 6" plano-convex lenses in extra heavy brass mountings with a cooling cell fitted snugly between to absorb the maximum amount of heat. The cooling cell differs from other forms known to me in having a hollow or jacketed wall through which cold water, from any source, keeps the temperature down. The water does not enter the cell itself. The water flows into one opening (f) passes almost entirely around the cell and out another opening (g). The construction is shown by the section Fig. 4. Water connections are made with the before mentioned outlets in the ceiling of the projection room by means of rubber or flexible metal tubes with screw fittings. This device keeps the lens mountings cool and renders the rays practically free from heat. In cases where extra light is needed or where objects must be kept cold a second cell is attached to the stage. For this improvement I am indebted to Professor Simon H. Gage, of Cornell University, who discovered that when a microscope slide under an intense light, bearing heat rays, was placed upon a cold surface the heat was more rapidly conducted out of the slide than it was absorbed from the rays by merely passing through a cold fluid. The glass surface of the cooling cell is therefore the stage proper. Behind the cell is a brass plate carrying an iris dia-

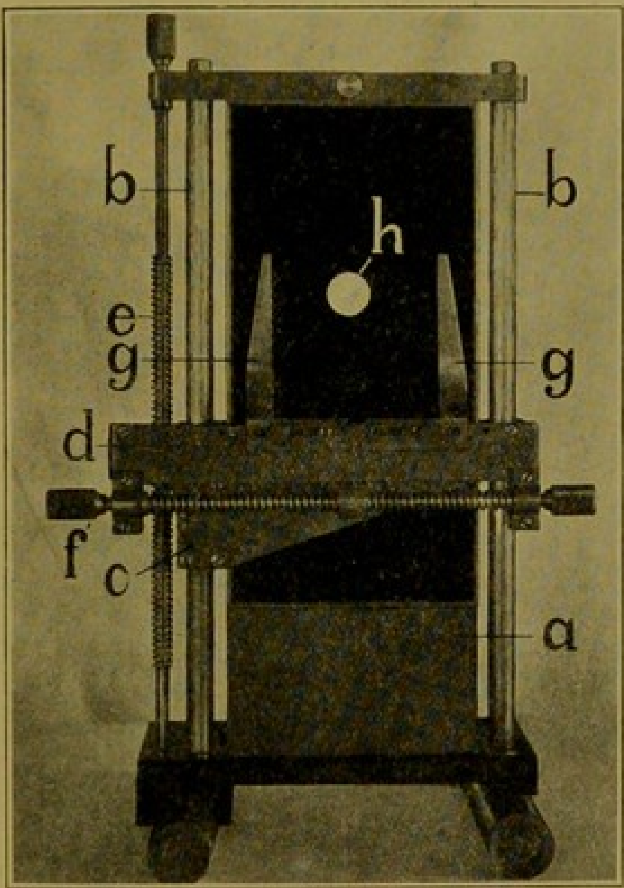

FIG. 5.

phragm. When the cooling cell is not needed the brass plate is brought forward to serve as the stage proper. The cooling cell is 4½″ wide, 9″ high, and 1½″ thick.

The mechanical stage differs from others in its capacity. An ordinary 1″ x 3″ or a 7½ x 5½″ slide are equally easily manipulated. The screws, especially made for the apparatus, give a moderately rapid movement of the carrier in either direction. Referring to Fig. 5, (a) is a heavy cast block to give stability without the necessity of fastening it to the bench.

Two $\frac{5}{8}''$ steel rods (b b) carry the movable parts (c-d). The vertical movement is accomplished by the screw (e) while the bar (d) is moved horizontally upon (c) by the screw (f). Two adjustable clips (g g) hold by means of beveled edges the glass slides against the stage. These clips may be moved to accommodate any length of slide up to $7\frac{1}{2}''$. At (h) is the iris diaphragm, which is placed on the radiant side of the cooling-cell. The device carrying the objective consists of a heavy cast iron base (Fig. 6) (a) carrying a sliding top (b); secured to this sliding top by stud bolt (c) is the objective carrier (d) resting upon three adjusting screws (e e e) The objective carrier consists of a large brass disc to which a bellows or other apparatus may be secured. This disc is bored and threaded for our

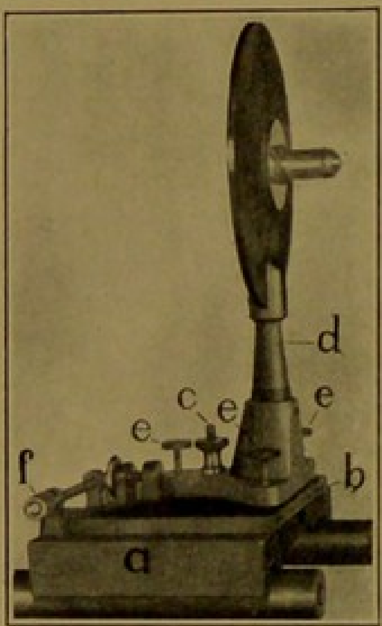

Fig. 6.

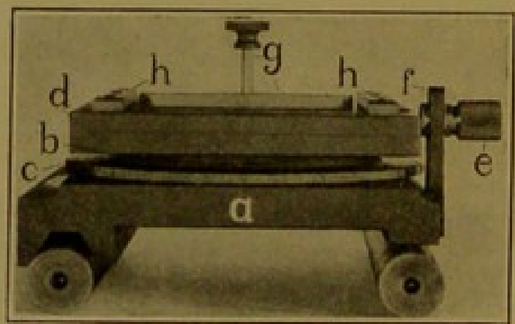

Fig. 7.

largest photographic lens and has a series of bushings for other lenses down to the society screw for microscopic objectives.

The fine adjustment is accomplished by the milled head (f) which actuates, through a bevel gear, the sliding plate (b). This simple stand is used for all low powers. When high power objectives are to be used the compound microscope is substituted and mounted on an adjustable table shown in Fig. 7. This table consists of a base (a) through which a 5″ hole admits the threaded extension of the table proper (b). The large brass nut (c) projecting slightly on each side is turned to raise or lower the table. The upper portion of the table (d) slides between two beveled guides secured to the lower portion of the table and the lateral adjustment of the miscroscope is thus accomplished by the milled nut (e) which fits into a groove in the upright (f). The microscope is held in place by the clamp and screw (g) between the guides (h).

The focusing device is shown in position in Fig. 2. The focusing rod (b) hangs from the ceiling and is easily moved from one end of the room to the other, likewise the wheel and jointed arm which actuates the fine adjustment of the microscope may be placed at any point on the optical bench. For the details of the focusing device, Fig. 8 shows a clamp (a) which may be secured to any point along the optical bench by the screw (b); this clamp carries the rod (c) which is adjustable vertically and transversely to the bench by means of the screw (d). At (e) another thumb screw permits the pulley (f) to be adjusted at any

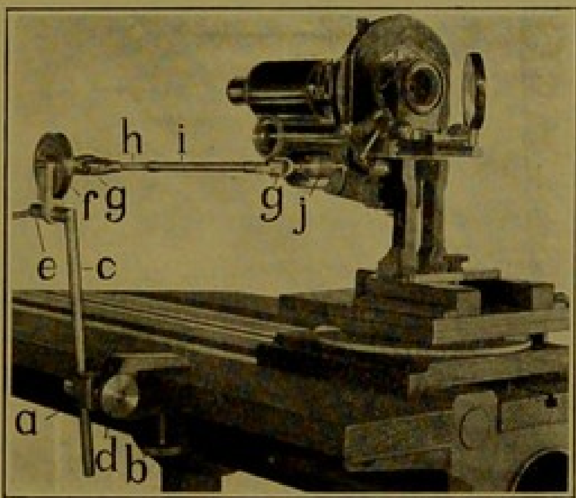

Fig. 8.

angle to the rod (c). At the points (g g) are universal joints, while between them is a shaft (h) carrying a loose sleeve (i). The shaft is grooved on one side and the sleeve carries a key which fits the groove. Thus the arm is freely extensible without clamping screws. The thimble (j) is lined with soft leather and slips over the fine adjustment of the microscope with sufficient grip to turn it. This device is sufficiently flexible in its adjustments and movements as not to bind or jar the microscope while focusing high powers. The pulley (f) is operated by an oiled silk cord or common fishing line coming from the apparatus attached to the ceiling. The details of other parts secured to the ceiling are shown in Fig. 9. Two $\frac{1}{2}''$ steel parallel rods $2\frac{1}{2}''$ apart (a a) are secured to the ceiling above the apparatus by brackets screwed to the rods at the sides (b b) (brackets not shown) so that the clamps (c c) may pass without interference. Each pair of clamps (c c) are grooved to fit the rods and clamped together by the screw (j); screwed to the lower halves of these clamps are the pulleys. Pulleys (f) and (g) are idlers, one is placed at each end of the projection room. They are to keep the cord taut over the other pulleys. The axis of pulley (e) extends

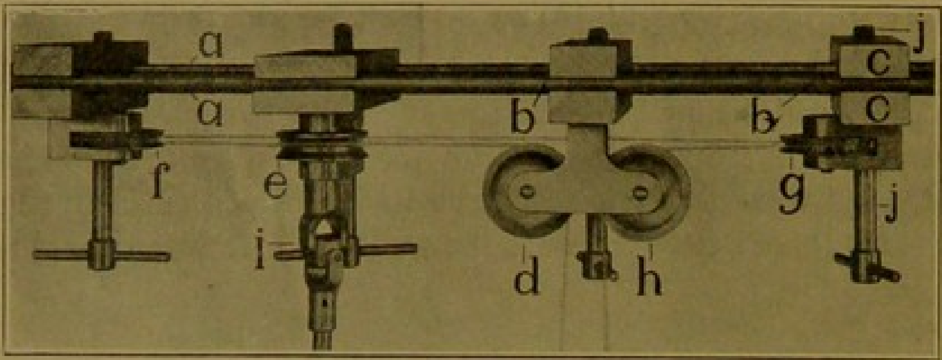

Fig. 9.

downward and carries a universal joint (i) from which the focusing rod is suspended. The cord from the pulley (f) Fig. 8, attached to the optical bench passes over pulley (d) Fig. 9, then to pulley (e) making one complete turn around this pulley, then around pulley (f) and from this point directly to pulley (g) and from (g) over pulley (h) and down to the optical bench again. From the universal joint (i) hangs a wooden

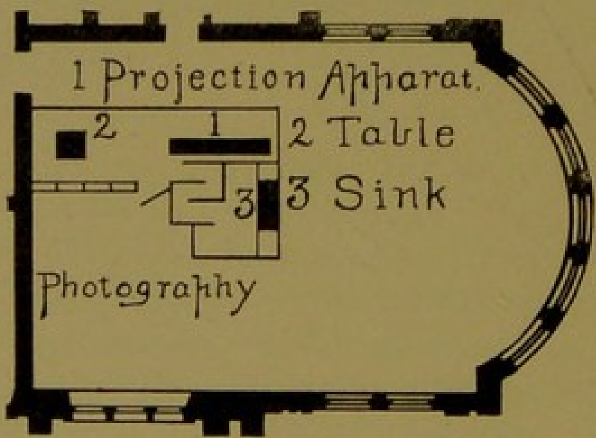

Fig. 10.

rod ¾″ in diameter. This rod has been spoken of as the focusing rod and it will readily be seen that a turn of this rod in either direction proproduces a corresponding movement in the fine adjustment of the microscope. The movement of the focusing apparatus is easy and without jar, so that while drawing at one end of the projection room, the microscope at the opposite end is easily focused. The same focusing device may be used with the photomicrographic camera.

The projection room together with a dark room of light panel work construction is located in one of the large laboratories so that the investigator may turn from his table to the projection apparatus without leaving the laboratory. The ceiling of the projection room is seven feet high. Good ventilation is maintained by means of a small fan and two 24″ light tight openings in the ceiling and one in the side wall.

Fig. 10 is a floor plan of the laboratory which contains the dark room and projection room and shows the location of the apparatus.