

Jan. 24, 1939.

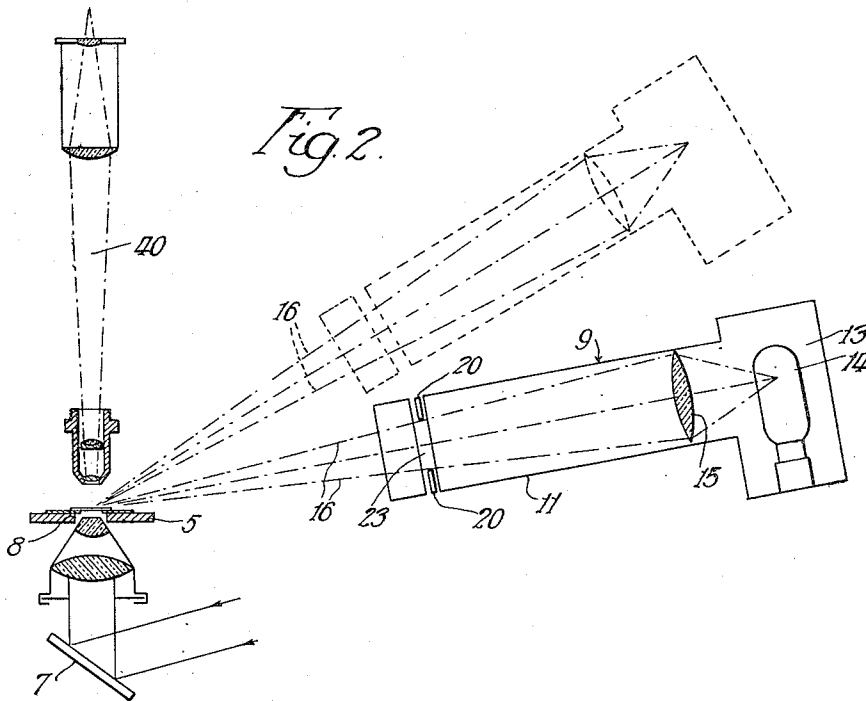
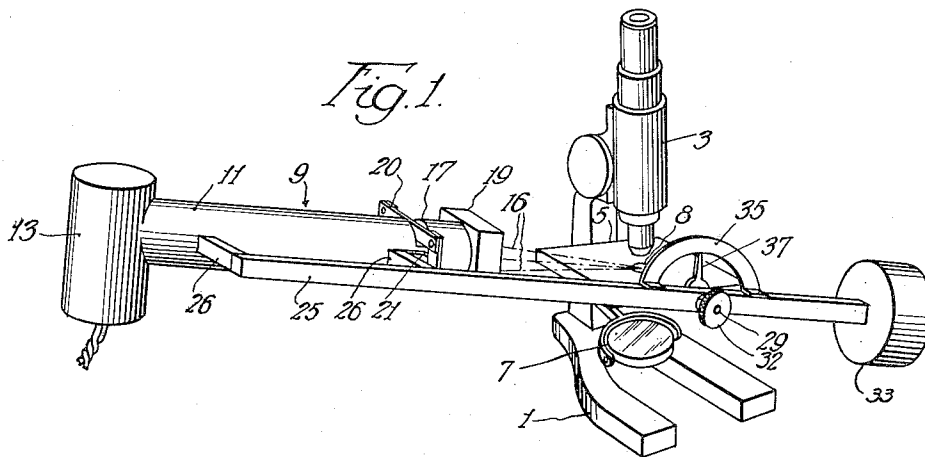
J. H. GRAFF

2,144,653

ILLUMINATOR

Filed Dec. 24, 1936

2 Sheets-Sheet 1



Inventor
John H. Graff

By: Fisher Clapp Seams & Pond
Attys.

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2 Sheets-Sheet 2

Fig. 3.

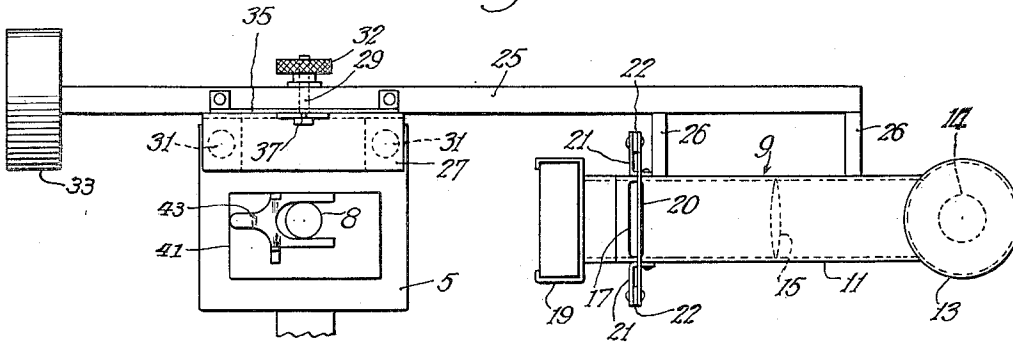


Fig. 4.

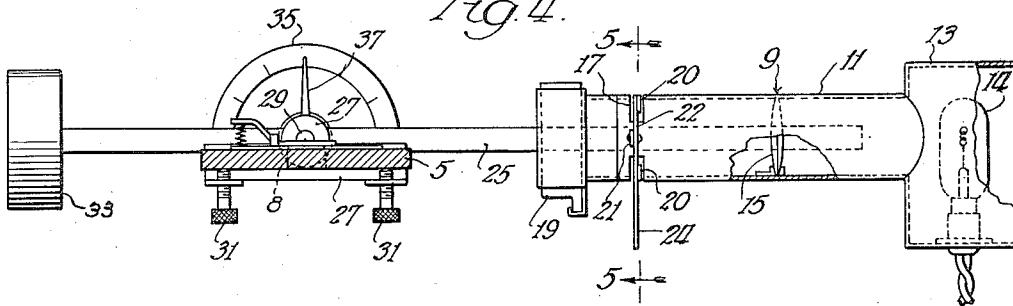


Fig. 5.

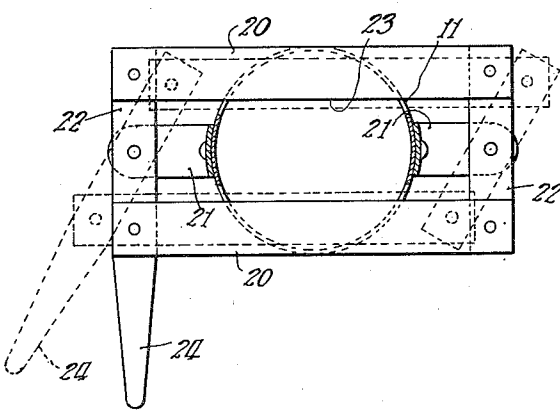


Fig. 7.

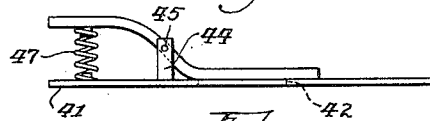
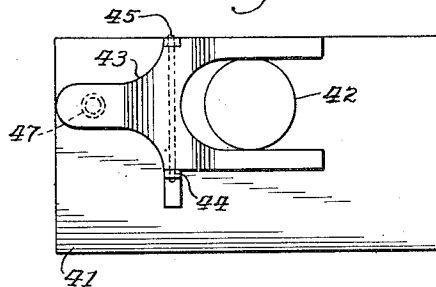


Fig. 6.



Inventor
John H. Graff

By Fisher, Clapp, Seams & Pond
Attys.

UNITED STATES PATENT OFFICE

2,144,653

ILLUMINATOR

John H. Graff, Appleton, Wis., assignor to The
Institute of Paper Chemistry, Appleton, Wis.,
a corporation of Wisconsin

Application December 24, 1936, Serial No. 117,553

4 Claims. (Cl. 88—40)

My invention relates to illuminating apparatus, and particularly to apparatus for use in the examination and comparison of materials, such as paper, cloth, intaglio printing plates, and the like, having a surface texture which may or may not have a directional characteristic.

The principal objects of the present invention are to provide illuminating apparatus whereby the surface texture of materials may be studied under light directed thereon at selected different angles of incidence, and to provide illuminating apparatus for such study which when used with materials having a one directional texture or finish shall permit the illumination to be applied perpendicularly to the directional characteristic of the surface being examined.

Other objects of the invention are to provide an illuminating device in accordance with either or both of the above stated objects which shall produce a concentrated, high intensity beam of light, preferably of knife edge form, and which shall permit the angle of incidence of the beam of light upon the surface illuminated thereby to be readily varied from an angle at which the beam shall be parallel to and grazing the surface to be examined, i. e. a 90° angle of incidence, to an angle approaching zero incidence; to provide a surface illuminator of the class described which may be conveniently adapted for use in conjunction with existing types of microscopes, the illuminator to be preferably of such design that the microscope can be used in either the vertical or the horizontal position, and to be so arranged that the illuminator may be used in conjunction with transmitted illumination; to provide a variable angle surface illuminator of the class described which is so arranged that the optical center of the light beam produced by the illuminator shall intersect the optical axis of the microscope, preferably at a single point such as the top surface of the object or sample being examined by the microscope, for all possible angles of incidence of the illuminating beam; to provide a variable angle surface illuminator of such design that the intensity of the light on the surface being examined shall, under all possible angles of incidence, be sufficiently high to permit the taking of photomicrographs with relatively short exposures; to provide an instrument and method by means of which it is possible to measure the relative depth of the roughness of the surface texture of a material by comparing the degrees of incidence of the light with which the hills and valleys of material are evenly illumi-

nated and the distance between such hills and valleys by the use of a micrometer scale in the eye piece of the microscope; to provide an improved apparatus for holding a sample of material in position upon a microscope so as to make possible the most effective utilization of an illuminator in accordance with the previously stated objects; and generally, to provide an improved illuminator particularly adapted for use in conjunction with microscopes.

These and other objects of my invention will be made more apparent by reference to the accompanying specification and the drawings, wherein—

Figure 1 is a perspective view of a microscope equipped with an illuminator in accordance with my invention;

Figure 2 is a schematic view showing the optical system of the illuminator and microscope illustrated more completely in Figure 1;

Figure 3 is a plan view of the illuminator and the stage of the microscope illustrated in Figure 1;

Figure 4 is an elevational view similar to Figure 3;

Figure 5 is an enlarged fragmentary view showing the features of the knife edge diaphragm forming a part of the illuminator illustrated more completely in Figures 3 and 4;

Figure 6 is a plan view of the specimen holder used in conjunction with the illuminator of my invention; and

Figure 7 is an elevational view of the specimen holder shown in Figure 6.

The illuminator of the present invention, as has been mentioned previously, is intended particularly for use in conjunction with a microscope, and is shown as applied to such an instrument in the drawings. The particular microscope illustrated in Figure 1 includes a heavy U-shaped base 1 of the conventional type upon which the tube 3 of the instrument and the stage 5 are pivotally supported as an integral unit, in order that the instrument may be used in either the horizontal or the vertical position. A reflector 7 of conventional type is adjustably supported beneath the stage 5. The stage is of the usual platform type and comprises a rectangular metallic plate having a suitable opening 8 therein for admitting light from the reflector 7 to the sample.

The illuminator 9, as is illustrated particularly in Figures 1, 3, and 4, includes an elongated light tube 11 preferably formed of sheet metal. A generally cylindrical lamp housing 13 is arranged

at one end of this tube 11, the other end thereof being normally open, and a light bulb 14 is positioned within this housing with the filament thereof coincident with the axis of the light tube 11. In one embodiment of the invention, I have utilized most successfully an 8 volt 2 ampere bulb having a single coil filament mounted perpendicularly to the axis thereof, the filament coil being .0236 inch in diameter and having a length of .234 inch. Such bulbs are sold under the trade number of J-8.

A double convex condensing lens 15 of the ordinary type is mounted within the light tube 11 in such position that the light given off in the bulb 14 will be concentrated into a beam having the general form illustrated by the dash lines 16 in Figures 1 and 2. A slot 17 is provided in the wall of the light tube 11 adjacent the open end thereof for receiving filters or similar equipment, and a generally U-shaped support 18 for a cooling cell or the like is adjustably supported upon the light tube 11 adjacent the open end thereof.

In order to permit convenient control of the intensity of the light beam, the illuminator 9 is equipped with a knife edge diaphragm, the features of which are illustrated particularly in Figure 5. Essentially, this diaphragm comprises two sets of link members 20 and 22 pivotally connected to each other to form a parallel bar linkage which is supported upon the light tube 11 by means of a pair of L-shaped brackets 21. The link members 20 are movable within the slot 17 formed in the walls of the light tube 11 and serve to define a rectangular slot aperture 23 of adjustable area. The separation of the link members 20, and hence the area of the aperture 23, is readily adjustable by means of an extension 24 on one end of one of the shorter link members 22. A second position of the diaphragm is indicated by the dotted lines of Figure 5.

The light tube 11 and the associated structural elements are supported as a unit upon an elongated, relatively rigid support arm 25 through the agency of a pair of short time members 26. To permit angular adjustment of the illuminator during use, the elongated support arm 25 is pivotally connected to a U-shaped bracket 27 through the agency of a suitable pivot pin 28, the bracket 27 being adapted to be clamped to the stage 5 of the microscope with which the illuminator is used by means of a pair of thumb screws 31. The pivot pin 28 is threaded at its outer end and provided with a locking nut 32 in order that the illuminator may be locked in position during use. A counter weight 33 is affixed to the outboard end of the elongated support arm 25 for balancing the illuminator and thereby aiding in accomplishing convenient adjustment thereof during use.

In order that the illuminator of the present invention may be used to the best advantage, it is desirable that some means be available whereby the angle of incidence of the beam upon the surface of the sample or object being examined may be conveniently and accurately measured. One satisfactory arrangement of this type is illustrated in the drawings, and includes a scale 35 affixed to the upper surface of the main support arm 25 and adapted to move therewith. A pointer 37 rigidly supported upon the upper portion of the bracket member 27 cooperates with this scale so that the relative angular relationship of the microscope stage 5 and the light beam of the illuminator may be conveniently measured.

As will be noted from inspection of Figure 4, when the illuminator is clamped in position the axis of rotation of the support arm 25, i. e. the axis of pin 28, lies in a plane substantially coincident with the plane of the stage 5, and during the clamping operation this axis may be easily adjusted to coincide with the optical axis of the microscope with which it is used. Thus, when the sample under observation is a flat sheet of paper or cloth or has a surface coincident with the plane of the stage, the scale readings are an exact measure of the angle of incidence of the illuminator beam upon the surface of the sample, and when other types of objects or samples are being examined, suitable correction may be easily made.

The optical constants of the condensing lens 15 are such that the beam produced by the illuminator is focused substantially at the axis of rotation of the illuminator, which axis when the apparatus is properly set up intersects the optical axis of the microscope. Through this arrangement the accuracy of measurements based upon the angle of incidence of the light beam produced by the illuminator is assured. This characteristic of the device is particularly well illustrated in Figure 2, wherein the path of the light beam from the illuminator is indicated by the dash lines 16, and the axis of the microscope is indicated by the line 40. The utility of measurements by this method will be greatly augmented if the eyepiece of the microscope is provided with a micrometer scale.

The relation of the light source, the lens, and the diaphragm of the illuminator are such that a beam of substantially knife edge form is produced during the operation of the illuminator, and the several elements of the illuminator are so correlated that the width of this beam is sufficient at small angles of incidence to give an even illumination of the area covered by the microscope objective being used.

To accomplish the most satisfactory operation of the illuminator, and to derive the maximum benefit from examinations made through the use thereof, it is necessary that the sample holder shall hold every part of the sample perfectly flat, while at the same time being free from any obstructions that would prevent the grazing beam of the illuminator from being directed upon the surface of the sample. A holder capable of meeting these requirements is illustrated particularly in Figures 3, 4, 6, and 7, and, as will be seen by reference to those figures, includes a metallic slide or plate 41 having an opening 42 formed therein which is adapted to coincide with the opening 5 in the stage 5 of the microscope and a generally Y-shaped clip or arm 43 the opposed side portions of which extend along the opening 42 in the center portion of the plate. The clip is pivotally supported upon the plate 41 by means of a pair of upwardly extending bracket members 44 and a pivot pin 45, and the side portions thereof are biased into engagement with the plate by means of a spring 47. It will be apparent that this sample holder will serve to hold a piece of paper, cloth, or other material perfectly flat, while at the same time permitting the light beam to graze the surface of the sample without obstruction.

In the foregoing, I have disclosed the features of a novel illuminating apparatus particularly intended for use in conjunction with microscopes and the like. The illuminator of my invention produces a concentrated beam of light of readily controlled intensity and includes means whereby

that beam may be directed upon the sample under observation at any predetermined angle of incidence. Through this arrangement, it is possible to make measurements of the relative dimensions of the texture or surface of a sample, and the device has proven in actual practice a most valuable adjunct to the art of microscopy.

The illuminator of my invention can be readily applied to existing forms of microscopes, and when so applied may be conveniently adjusted so that the optical center of the illuminating beam will at all times intersect the optical axis of the microscope, if desired, at a fixed point, which point is preferably but not necessarily the surface of the sample under observation. The improved illuminator of my invention is capable of producing sufficient illumination under all angles of incidence to permit the taking of photomicrographs with relatively short exposures. Further, since the illuminator is entirely supported upon the stage of the microscope with which it is used, the microscope may be used in either the vertical or the horizontal position. The design of the illuminator of my invention is such that it may be used in conjunction with illumination by transmitted light. As mentioned previously, the illuminator of my invention greatly extends the useful range of a microscope as a measuring instrument.

Various modifications may be made in illuminators embodying the principles which I have herein disclosed. It is my intention, therefore, that the accompanying claims shall be accorded the broadest reasonable construction consistent with the state of the art.

I claim the following as my invention:

1. In combination, a microscope having a stage, and a variable angle illuminator for illuminating the surface of objects positioned upon said stage, said illuminator including a light tube, a source of illumination and a lens cooperating with said light tube to produce a concentrated beam of light, a frame, means rigidly attaching said frame to said stage, and pivot means supporting said light tube on said frame for rotation about an axis which intersects, and which extends generally transversely to, the axis of said light beam, said pivot means being so positioned relative to said light tube and said frame that the axis of said light beam will at all times intersect the axis of rotation of said light tube and beam at a fixed point.

2. In combination, a microscope having a stage, and a variable angle illuminator for illuminating the surface of objects positioned upon said stage, said illuminator including a light tube, a source of illumination and a lens cooperating with said light tube to produce a concentrated beam of light, a frame which includes an adjustable clamp by which said frame is adjustably affixed to the stage of said microscope, and pivot means sup-

porting said light tube on said frame for rotation about an axis which intersects, and which extends generally transversely to, the axis of said light beam, said pivot support means being so positioned relative to said light tube and said frame that the axis of said light beam will at all times intersect the axis of rotation of said light tube and beam at a fixed point intermediate the microscope objective and said stage, which point may be adjusted by means of said adjustable clamp to coincide with the optical axis of said microscope.

3. In combination, a microscope having a generally flat stage, and a variable angle illuminator for illuminating the surface of objects positioned upon said stage, said illuminator including a light tube, a source of illumination and a lens both disposed within said light tube and cooperating therewith to produce a concentrated beam of light, a frame provided with a clamp by which said frame is adjustably affixed to the stage of said microscope, means pivotally supporting said light tube on said frame for rotation about an axis which intersects, and which extends substantially at right angles to, the axis of said light beam, said support means and said frame being so arranged that the axis of said light beam will at all times intersect the axis of rotation of said light tube and beam at a fixed point, the physical proportions of said frame and clamp and the physical proportions and optical constants of said illuminating means being such that said point of intersection of the axis of said light beam and said axis of rotation may be adjusted by adjustment of said clamp to intersect the optical axis of said microscope at a point coincident with the upper surface of a sample located upon said stage, said support means permitting said light tube to be rotated so that the angle of incidence of said beam relative to the plane of said stage may be varied from 90° to a relatively small angle, and a cooperating scale and indicator means, one of which is supported upon said frame and the other of which is rotatable with said light tube for indicating the angle of incidence of said beam.

4. A variable angle illuminator for a microscope comprising a light tube, a source of illumination and lens means cooperating with said light tube to produce a concentrated beam of light, a frame structure including an adjustable clamp by which said frame structure is adjustably affixed to the stage of the microscope with which said illuminator is used, and means pivotally supporting said light tube on said frame for rotation about an axis extending generally transversely to the axis of said light beam, said support means being so positioned relative to said light tube and said frame that the axis of said light beam means will at all times intersect the axis of rotation of said light tube at a fixed point.

JOHN H. GRAFF.