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Design and Construction of an Edge Exposure Apparatus

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DESIGN AND CONSTRUCTION
OF AN
EDGE EXPOSURE APPARATUS

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ABSTRACT

A means of producing photographic edges using visible radiation is often a requirement for evaluating some of the image characteristics of a photographic emulsion. The method of producing edges described uses a high quality razor blade for the knife edge held at a small angle to the film plane. The instrument is detailed and elaborates on the major features of the constructed apparatus. These features are a vacuum surface to insure film flattness; the knife edge held by a jaw-clamp assembly that pivots to allow for contrast control of the image; and exposure through a tungston-halogen lamp and an electronic shutter which has a separate timer.

INTRODUCTION

It is sometimes desired to make photographic images which have an edge which is as sharp as possible, and often with the added requirement that the density across that image be as uniform as possible. When visible light is used to expose the photographic emulsion, the sharpest images are formed by pressing a small light source at a distance rather than by forming the image of a slit on the film with a lens. These edge images are useful in image evaluation for acutance measurements, evaluating adjacency effects, and for producing modulation transfer function curves in lieu of sine wave targets.[1]

Since the demand in image evaluation for the image of a sharp edge often arises, then it seemed relevant that a device should be available for making photographic edges. A review of the literature indicated that when an apparatus is needed for knife edge exposures, organizations construct a device within its facilities to meet their specific requirements.[2] The usual method is to use two devices with separate types of exposing radiation in a primary and secondary system of imaging edges on photographic emulsions. The first apparatus uses the short wavelengths of x-ray exposures to minimize defraction and produce a high quality photographic edge using a very fine grain emulsion. This is considered the primary edge and is the edge used to make the secondary or working edges in routine analysis of emulsions. These secondary edges are generally made by using visible radiation from the primary photographic edge to evaluate some of the image characteristics of the film in question.

This means that in order to produce edges for even the simplest edge analysis of a film, a device should be designed and constructed to fit the particular needs of the laboratory. Since demands do occur in the Photographic Science Department, here at Rochester Institute of Technology, for knife edge images that can be readily and easily made, with a degree of high quality, the proposal to design and build such an apparatus was made. The intent of the reasearch was to produce an edge exposure apparatus with which the operator could produce a knife edge image of high quality and yet do so with a minimal amount of time and effort.

project

DESIGN CONCEPTS

The fundamental objectives for the design of the edge exposure apparatus were based on the method of contact of the knife edge with the film. The basic concept was to build a device in which the knife edge is held at a small angle to the exposure plane.[3] The knife edge would be in intimate contact with the film at an angle such that only the point of the edge touches the emulsion. Previous testing and research has shown that a knife edge which lies in contact and totaly parallel to the film produces more defraction and surface reflections than is desired. By being held flat on the film, visible light will defract around the edge, and radiation will reflect rays back and forth between the knife edge and the surface of the film. These rays will continue to reflect until they are inhibited and will also be aided by the inner reflections

Not really. Contact changes the surface reflection characteristics of film.

Complicated and partially wrong

in the emulsion which will increase the image spread where it is not desired. These surface reflections can result in severe degradations of the final edge image. But one method of minimizing the defraction and eliminating the image degradation, is to keep the amount of contact between the knife edge and the film as ~~little~~ small as possible. In order to do this, the objective was to keep the angle of the knife edge small yet large enough so that only the pointed edge touched the film.

Not really

knife

Another consideration before the design could be initiated was the type of knife edge that would be used. An investigation of commercially available razor blades was made to determine if technology had progressed to the state where their use in edge imaging could be considered. A razor blade was also proposed for reasons such as their ease of availability if it became necessary to replace them, and also because it was thought that a razor blade would make mechanical construction somewhat easier.

The initial razor blade investigation was made by examining eight different types under a microscope. The types differed according to their construction, single or double edge, and the type of metal they consisted of. The blade edges were studied at 430X magnification, using transmitted and reflected illumination, for the edge sharpness and degradations. The results of the survey were that razor blade technology has produced some high quality knife edges. The best blade had a chromium-steel edge and its largest nick in the edge was a 5 ~~micron~~ meter indentation, and after taking the magnification into account, its actual size is 12 nanometers. below the microscope resolution limits

The data indicated that this razor blade was of sufficient quality to warrant its use in the design of the exposure apparatus.

The third factor that was researched for the design considerations was the method and type of exposure. Visible light had to be considered as the only means for the source because of the safety problems associated with the use of x-rays. Although x-rays have advantages, as stated previously, the ultimate use of this instrument will be primarily in producing a quick but high quality edge image for image evaluation. Thus visible light will be an acceptable source. The other exposure related factor was the method. This method consists of a timed exposure control and keeping the light source at a distance so it could be considered a point light source rather than using optics to collimate the radiation. The exposure control would be through a shutter and filtration. The other control that had to be allowed for in the design is a method of controlling the contrast at the image edge. A means of exposure had to be made so that the operator could vary the density difference between the light struck and nonlight struck areas.

INSTRUMENT DESCRIPTION

After taking into account all of the fundamental objectives in the design of the edge exposure apparatus, drawings were made (attached as an appendix) and the instrument was constructed. The following is an attempt to describe the apparatus and its operation while only mentioning aspects such as dimensions and types of materials when relevant. (References can be made to the drawings in the appendix.)

The film is placed on the base plate of the instrument which contains a vacuum surface. One of the requirements of producing a good edge image is to have the film as flat as possible. The vacuum surface is created by the pan under the base plate which can be connected to a vacuum pump. The dimensions of the vacuum area is 2" by 4". If it is necessary to increase the amount of suction, and a film sample is less than 2 inches wide, then a simple frame can be attached to the film to stop the flow of air and increase the holding power the film sample. A frame should not become necessary if the vacuum pump is regulated so that enough force is created to hold down the film, yet not so much that it is drawn through the holes on the surface. A laterally adjusting film guide is also on the base plate so that the film can be placed in the correct position under total darkness conditions.

The razor blade is held in a jaw type assembly which pivots on a shaft to a vertical position before coming to a stop. The original razor blade has been trimmed down so that only a 5 millimeter legth of the blade is to be held in place. This minimal section of the knife edge is what protrudes from the jaw clamp for the exposure to produce a 5 millimeter image of an edge. This small section of the knife edge is used because of parallelism problems between the knife edge and the film. Because good and even contact is necessary across the width of the knife edge to produce a high quality edge image, the smaller the portion of the razor blade that is used, the less of a problem there will be in trying to insure even contact along the blade.

The jaw assembly, which holds the knife edge, is a simple clamp which operates by a thumb screw to tighten the razor blade in place. This jaw-clamp has a shaft in it which enables the assembly to be rotated. The operator can place the knife edge assembly in the up position and make an initial overall exposure if contrast control is desired. Then the assembly can be easily pivoted into contact with the film (at an angle of 24^{o}) to make the edge exposure.

The exposing light source is enclosed in a light-tight lamp housing at a distance of 58 centimeters from the film plane. This Distance was used in the design in order to have a point light source. (The ratio of the lamp diameter to the distance from the exposure plane is 52:1.) The lamp is a 45 watt, 7 volt, Quartzline tungston-halogen lamp which operates on alternating current that hasbeen circuited through a voltage stabilizer and then transformed to the operating voltage of the lamp. The lamp is turned on by the operator so that exposures can be timed by an electronic shutter attached to the bottom of the lamp housing. The Ilex electronic shutter is a five bladed, iris shutter with an aperture opening that can be set at any opening from 25.4 millimeters to 0.3 millimeters. The shutter is attached to a separate timer on which ten shutter speeds can be selected. These times range from 4 seconds to 1/125 of a second with the option of keeping the shutter open for longer exposures. A bracket is attached so that it hangs just below the shutter for holding neutral density filters for further exposure control.

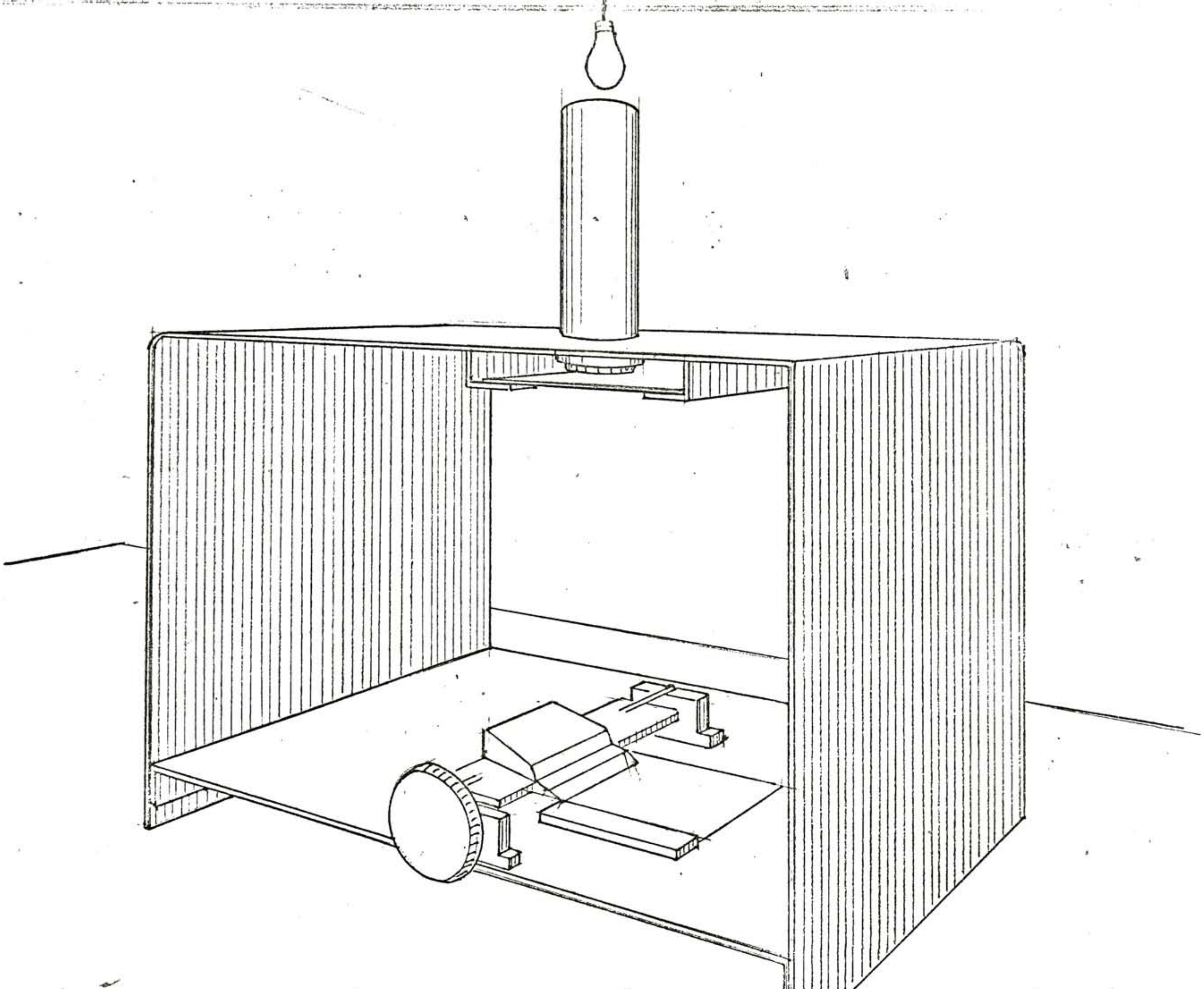
RECOMMENDATIONS

Future research and testing should be completed on this apparatus. One mechanical feature that should be added to the base plate should be a means of covering the unexposed portions of the film. This would be a convienient means of making a seris of images so that an exposure or contrast seris could be made. Testing of the instrument should be made with actual images and traced on a microdensitometer to evaluate the image spread. Time limitations at this point have prevented any data collection. Another consideration might be the conversion of the lamp from alternating to direct current. Alternating current may produce anomalies in the exposure using 60 cycle current.

REFERENCES

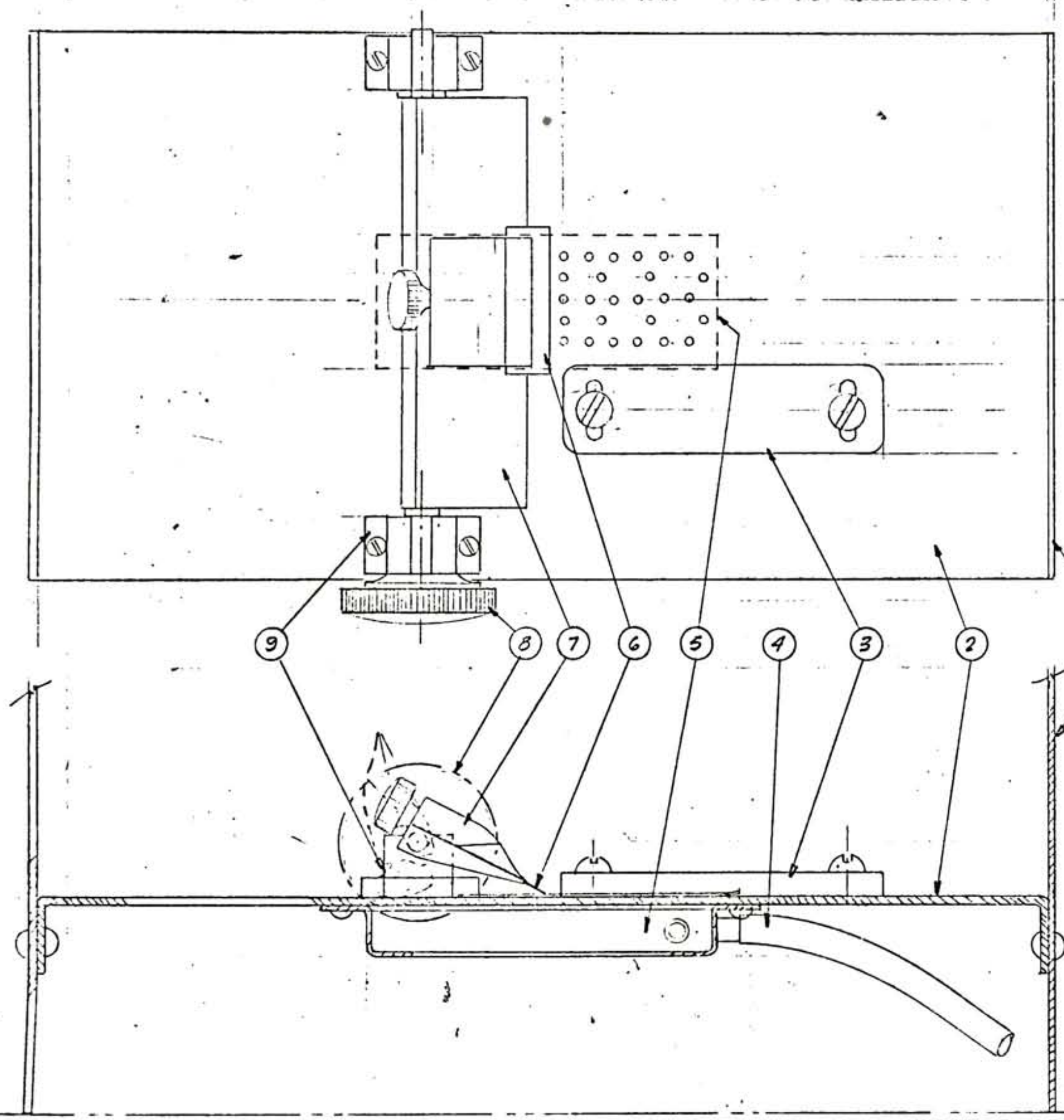
1. F. Scott et al, Phot. Sci. Eng., 2: 345 (1963)
2. H.F. Sherwood, Rev. Sci. Instr., 38: 1619 (1967)
3. G. Schumann, personal communication

APPENDIX



EDGE EXPOSURE APPARATUS

R.I.T. FEB. 15, 1976

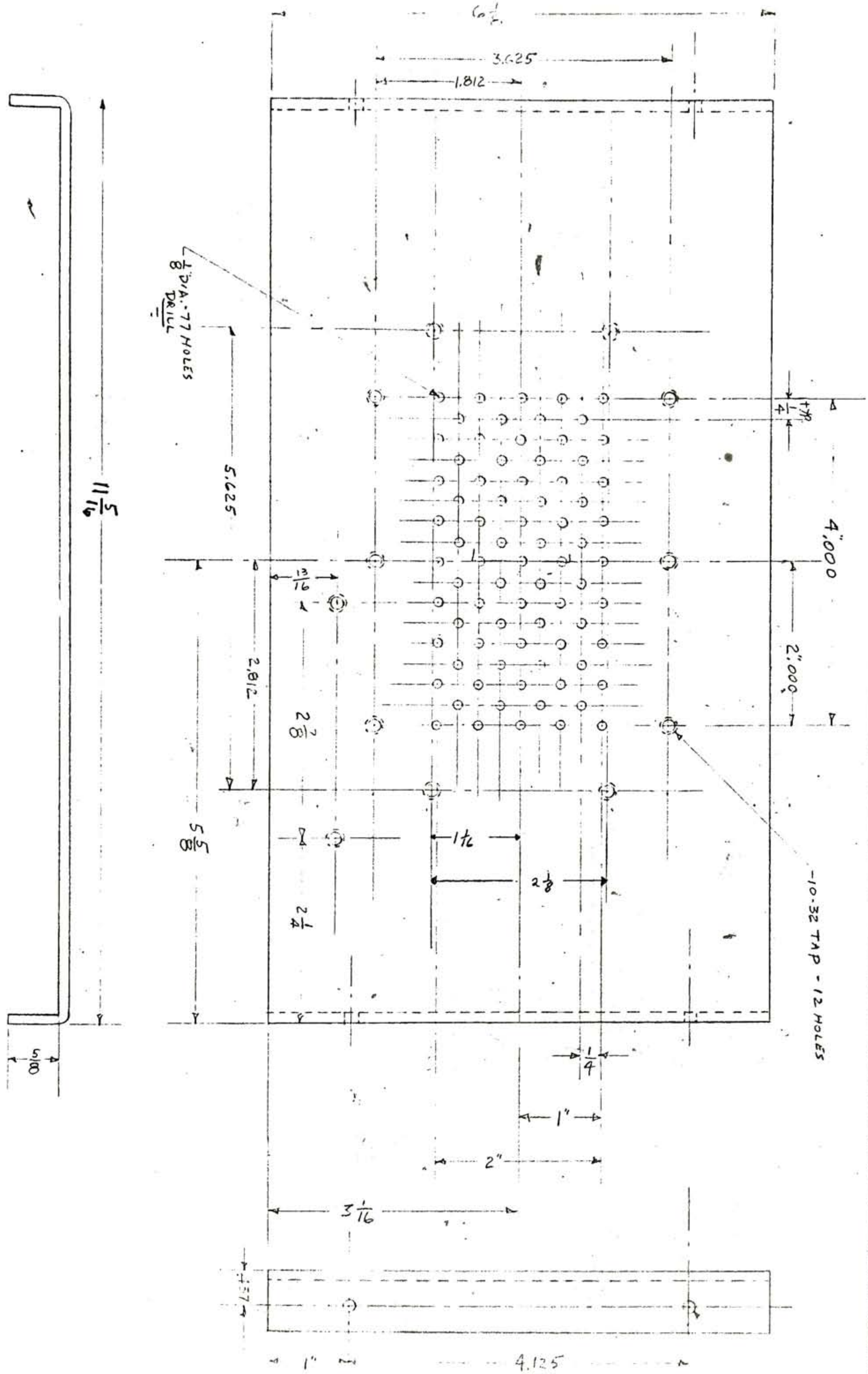


ITEM	DESCRIPTION
1	HOOD - SHEET ALUMINUM
2	BASE - SHEET STEEL
3	ADJ. GUIDE - STEEL
4	VACUUM HOSE
5	VACUUM TANK
6	KNIFE EDGE - STEEL - CHROME.
7	BLADE HOLDER - MODEL 966
8	PIVOT KNOB
9	SHAFT SUPPORT

EDGE EXPOSURE APPARATUS

R.I.T FEB. 15, 1976

FULL SCALE - MICHAEL G. BENSON



6 1/2
3.625
1.812
1/8 DIA. - 77 HOLES
#77 DRILL
5.625
11 5/16
4.000
13/16
2.812
2 7/8
2.000
5 5/8
1 1/16
2 1/8
2 1/4
-10-32 TAP - 12 HOLES
5/8
1/4
1"
2"
3 1/16
.37
1"
4.125