

HOW TO USE THE SLIDE TUBE.

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## CONGRATULATIONS!

Congratulations upon becoming the owner of a new Slide Tube. The Slide Tube is an expansion of the concept of the slide rule and, being a new product, you are among a select few who will learn to enjoy the time-saving uses of this remarkable instrument. The Slide Tube is a new tool for experienced users of the slide rule. It is a slide rule with a dimension added, allowing the user to perform multiplication, division, proportions, composites, squares, square roots, cubes, and cube roots of functions of three variables. For the scientist, engineer, architect, pilot or any of the countless professionals who perform multiple calculations with frequently-encountered functions, the Slide Tube has one obvious advantage over the slide rule - it is a great time-saver. The slide rule is sufficiently accurate for all but the most precise applications and is perfect for rapid multiple approximations.

If you are familiar with the operation of a circular slide rule, you will find the operation of the Slide Tube an easy skill you will never regret having acquired. This instruction booklet covers the major operations which may be performed on the Slide Tube. While this coverage is complete and thorough, it is necessarily terse. If you are learning to use the Slide Tube for the first time (as is extremely probably) you may find this manual rather brief. For additional explanations and practice problems, it is suggested that the beginner purchase our book, The Slide Tube Manual. These are available through your Slide Tube dealer. However, this instruction booklet does cover all the topics necessary for you to make complete use of your Slide Tube.

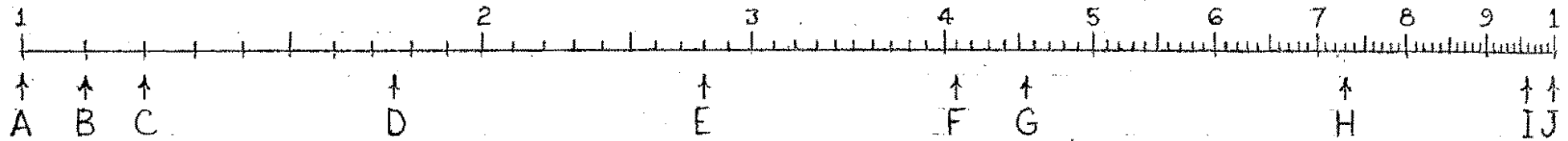
## INTRODUCTION

Upon inspecting your Slide Tube, you will find that it consists of four concentric acrylic cylinders. You will notice that the outer cylinder consists of two sections. The clear ring at the right is called the "cursor". On the cursor is a thin, red hairline which is used to align various vertical settings of the Slide Tube. The remainder of the first cylinder is a case which serves to contain the other three.

The second and third cylinders are double-walled and are the equivalent of the D and C scales on a slide rule. These are called the "D" and "C lamina", respectively. Each lamina has a thumb index.

The most inner cylinder is called the "transport". On the transport is a thin, red hairline which is used to align various horizontal settings. The interior of the transport is used to hold "inserts", carbon and scribe. An insert is that part of the lamina which is removable. In practice, this thin transparent plastic sheet

# READING THE SCALES



A. 1.00

B. 1.10

C. 1.20

D. 1.75

E. 2.80

F. 4.10

G. 4.55

H. 7.30

I. 9.60

J. 10.0

of graphing paper is folded into a tube and carefully inserted between the walls of its respective lamina. This property of the lamina allows the user of the Slide Tube to program a given function using the scribe and carbon.

### READING THE SCALES

After inserting the inserts in their respective laminae, hold the Slide Tube so that you are looking at the horizontal hairline on the transport. Carefully align lamina C by holding the transport in the left hand and turning lamina C in the right, until the index line matches the hairline. Now align lamina D with lamina C by holding lamina C in the left hand and turning lamina D with the right hand until the index lines match. (Insertion and removal of the insert will be easier if the index lines are on the thumb indices.) At this point slide the cursor to the left until the hairline matches the vertical index line of lamina D.

Your Slide Tube is designed so that all the index lines and both hairlines may be simultaneously aligned. This is one test you can apply to insure that your hairlines and laminae are properly aligned. See Fig. 1.

Learning to read the scales correctly is the first step in using your Slide Tube. All the scales are graduated into decimal parts. This means that all major divisions are divided into equal parts of ten so that each mark stands for one-tenth (.1), two-tenths (.2), or five-tenths (.5), of the whole unit. Since the C and D scales are the most used scales of the Slide Tube, we'll use them to demonstrate the reading of the scales.

Locate the C and D scales on your Slide Tube. If the index lines are properly aligned, you'll note that these two scales are identical. Keep them aligned in this manner as we cover their readings in this section. Just to the left of the letters C or D, you will see the large division mark which is labeled "1". This line is called the "index" and marks the beginning and end of each scale. On the C and D scales it represents the numeral 1.00 (Fig. 2). Now slide the cursor to the right to the next large division which is marked "11". Think of this as marking the value 1.10. The next large mark of 12 would then be 1.20 (Fig. 3). Between 1.10 and 1.20 there are ten divisions; each consecutive space is counted as one, two, three...and so on. The corresponding page demonstrates various readings of the C or D scale. Be sure you are able to justify these answers before you go on to the next section.

### PLACING THE DECIMAL POINT

The reading of the scales of the Slide Tube has made you aware that the digits resulting from Slide Tube calculation give you no hint

as to the placement of the decimal point in the answer. A variety of rules can be developed to aid in placing the decimal point, but only three will be mentioned here.

1. Common Sense Placement. If you are working a familiar problem, you know about the magnitude of the answer to expect, and you can place the decimal point accordingly.

2. The Rounded-off Calculation. This system gives you the order of magnitude of the answer, and the more precise calculation gives you the digits to place in your answer. This is an easy system to use for relatively short problems. You must round-off the numbers involved in your problem until only one significant figure remains in each of the numbers.

3. Scientific Notation. This is certainly the best manner of keeping track of the decimal point, no matter how involved or protracted a particular calculation may be. It is in widespread use and is described in most science and mathematics textbooks. Its use is strongly recommended.

Further information concerning the placement of the decimal will become apparent in the following section.

#### FUNCTION ANALYSIS AND PROGRAMMING

The Slide Tube is designed to deal with the mathematics of functions of specific forms. In using your Slide Tube, you will be able to perform many operations involving functions of three variables. There are three general forms which functions to be used in the Slide Tube may take. These are as follows:

$$1. mx^r y^s = z^t$$

$$2. mr^x s^y = z^t$$

$$3. mr^x y^s = z^t$$

(where x, y, and z are variables)

Functions of form one (1.) are programmed (or graphed) using the two logarithmic inserts. Those of the form two (2.) use semi-logarithmic inserts. Finally, functions of form three (3.) should be programmed using one logarithmic insert and one semi-logarithmic insert.

The first step in programming the function is to analyze it. Decide which of the three forms the function fits. Then separate the two variables on the left arbitrarily. These two variables will form two "partial functions", each to be programmed on separate inserts. If the choice of insert is correct, the partial function will plot as a straight line and therefore requires only two points and a straightedge to program.

Partial functions of the form  $mx^r$  plot as straight lines on logarithmic inserts. In such a case the constant  $m$  provides the first point  $(1,m)$ . The constant  $r$  provides a statement of the slope of the line function.

Partial functions of the form  $mr^x$  plot as straight lines on semi-logarithmic inserts. The  $m$  again provides the first point  $(0,m)$ . The constant  $mr$  provides the second point  $(1,mr)$ .

You will notice that the inserts are one cycle only. However, as shown in Fig. 4, they may be extended to cover as many cycles as are necessary for practical use. Fig. 5 (a) shows the first cycle of  $x^3$ . Fig. 5 (b) shows the second cycle which has the same slope as the first cycle. The horizontal intercept is both the end of the first cycle and the beginning of the second. Fig. 5 (c) shows the third and last cycle. As can be seen, the third cycle was formed in the same manner as the first. Fig. 6 (a) shows the first cycle of  $3^x$ . Having chosen a desired range of numerical operation for the value of  $x$  (zero to ten), these values are written in along the horizontal axis in the spaces provided as shown. Fig. 6(b) shows the remaining cycles filled in, much in the same way as in Fig. 5, until the sequence of  $x$  is filled.

Each additional cycle represents an exponential increase of  $10^1$  over the previous cycle with relation to the value of the partial function. This rule is extremely important in placing the decimal in the result.

From this section it is easily understood that to use the Slide Tube to solve a single problem corresponding to a given form would be wasteful. For this reason we wish to point out that the vertical scales (Fig. 7) may be used as an ordinary circular slide rule should single problems arise. However, should you find yourself faced with numerous problems, each of which use the same equation, it will be a time-saving instrument.

## MULTIPLICATION

Multiplication is the logarithmic addition of the partial functions to arrive at the resultant  $z$ . This addition is accomplished by means of a diagonal transformation of the laminae. The first step is to align the laminae, placing lamina D over lamina C.

For equations of any general form, first determine the value of the partial function on lamina D for the value of  $x$ . Fig. 8 shows this value ( $x=2$ ) for the partial function  $mx^3$  where  $m=1$ . Find the value of the partial function on lamina C for the value of  $y$ . Fig. 9 shows this value ( $y=2$ ) for the partial function  $y^2$ . Place the origin of lamina D on the point located in Fig. 9 as shown in Fig. 10. Referring to Fig. 11 and reading horizontally from the value shown in Fig. 8 to the C scale of lamina C, we read the value of  $z$ .

## DIVISION

Division is the logarithmic subtraction of a partial function from a resultant  $z$  to derive the remainder partial function. This subtraction is performed diagonally for equations of any general form.

First, determine the value of  $z$  ( $mx^3y^2=32$ ) on the C scale of lamina C, Fig. 12. Next, determine the value of the partial function on lamina D for the value of  $x$  ( $x=2$ , Fig. 13). Our objective is the value of  $y$ . Place the origin of lamina D on the partial function  $y^2$  (Fig. 14) at the point (1,1). Slide the origin of lamina D along the graph of  $y^2$  until the value shown in Fig. 15 is aligned horizontally with the chosen value of  $z$ . Now reading vertically from the origin of lamina D (Fig. 16) to the horizontal axis on lamina C we read the value of  $y$  ( $y=2$ ).

## PROPORTIONS

Given two exponential functions,  $f(x)$  and  $g(y)$ , such that  $f(x) \div g(y)$  is equivalent to some constant  $k$ , we wish to find the set of all points  $(x,y)$  with a given value of  $x$  or  $y$ . First, program  $f(x)$  on lamina C and the inverse of  $g(x)$  on lamina D (see Fig. 16). Place the origin of lamina D (Fig. 17) on  $f(x)$ . Locate the value of  $k$  on the C scale of lamina C (Fig. 18). By sliding the origin of lamina D along  $f(x)$  we may choose a given value of  $x$  by reading vertically from the origin of lamina D to the horizontal axis of lamina C. The corresponding value of  $y$  is then read vertically from the value of  $k$  on the horizontal axis of lamina D (Fig. 19).

## COMPOSITES

Given the two exponential functions  $f(x)$  and  $g(y)$  programmed on laminae C and D, respectively, we wish to find  $g[f(x)]$ . Using the example  $f(x)=mx^3$  and  $g(y)=y^2$  the result will be  $(mx^3)^2$  which is  $m^2x^6$ . First align laminae C and D (Fig. 20). Slide the origin of lamina D along the horizontal axis of lamina C until it coincides with the value of  $x$  ( $x=2$ ) as shown in Fig. 21. You will notice as you do so that  $g(y)$  and  $f(x)$  intersect at one point. Reading horizontally from this point to the D scale of lamina D (or the C scale of lamina C) is the value of  $g[f(x)]$  - Fig. 22.

## SQUARES AND SQUARE ROOTS

By the use of the A scale along the vertical readout,  $z^t$  may be read as  $z^{\frac{1}{2}}$  or  $z^2$ . If you wish to read out  $z^2$  then in plotting the partial functions use the A scale instead of the D or C scales as shown in Fig. 23. If you wish to read out  $z^{\frac{1}{2}}$ , read out  $z$  on the A scale after performing calculations as usual (Fig. 24).



## CUBES AND CUBE ROOTS

The K scale along the vertical readout is used to read  $z^t$  as  $z^{1/3}$  or  $z^3$ . In order to read out  $z^3$  plot the partial functions using the K scale instead of the D or C scales (Fig. 25). If you wish to read out  $z^{1/3}$ , read out  $z$  on the K scale after performing operations as usual on the D and C scales (Fig. 26).

## GAUGE MARKS

Four different gauge marks have been printed on the D and C scales. These marks make the setting of particular values or constants easy in order to facilitate your calculations.

The pi gauge mark is found on both the C and D laminae to facilitate the rapid setting of the value of pi as 3.1416 as it may occur in your calculations. The rho gauge mark is found only on the C lamina and is used for the conversion of degrees to radians and vice-versa. The value of rho is approximately 57.5. The M gauge mark is found at .434 on the C lamina and is used to approximate the conversions of logarithms to the base ten to logarithms to the base e. found at 2.218 is the constant e. On those Slide Tubes designed for scientists and engineers, the following constants are provided: mass-energy relation, gravitational constant, Plank's constant and the electron charge-to-mass ratio.

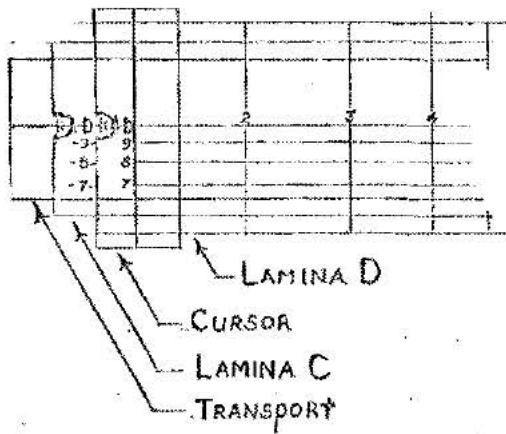


Fig. 1

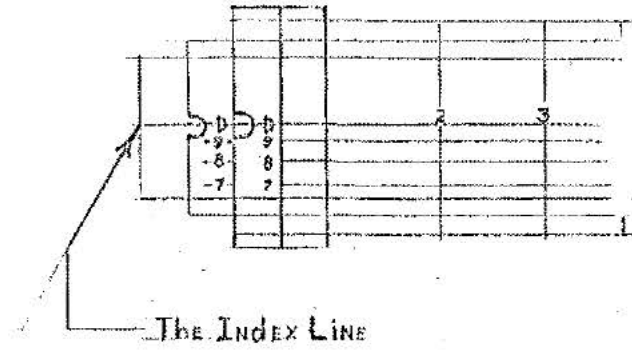


Fig. 2

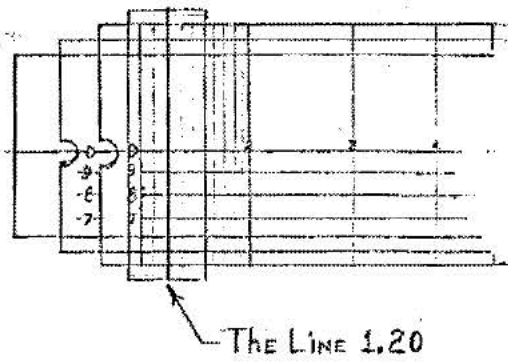


Fig. 3

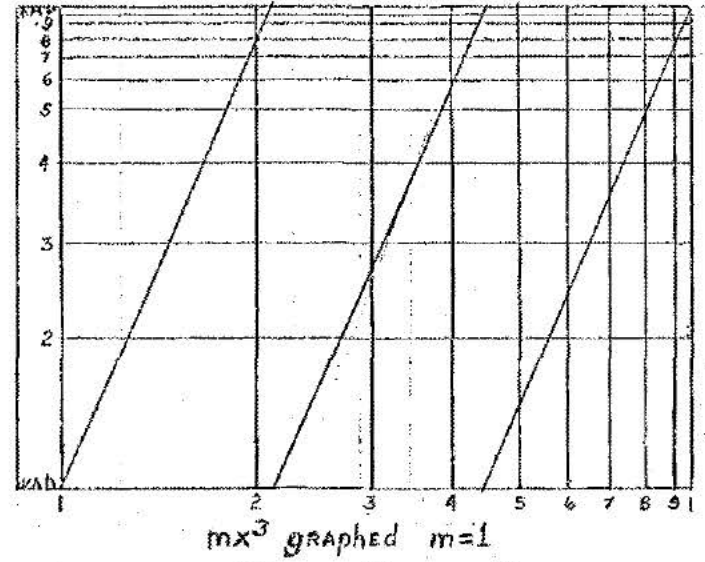
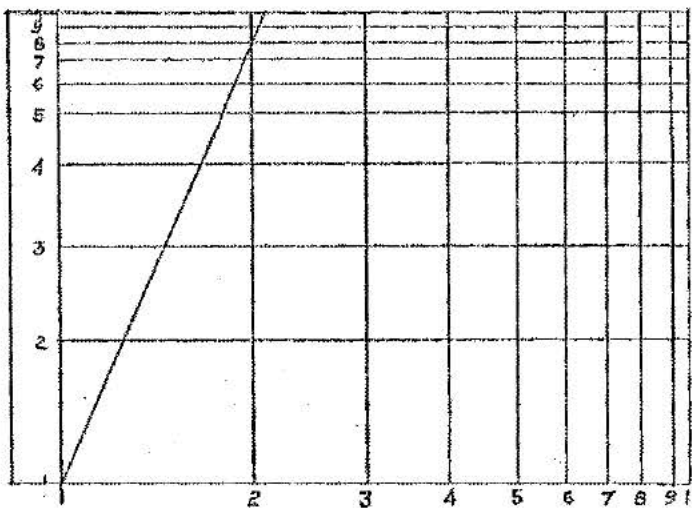


Fig. 4



← Fig. 5(a)

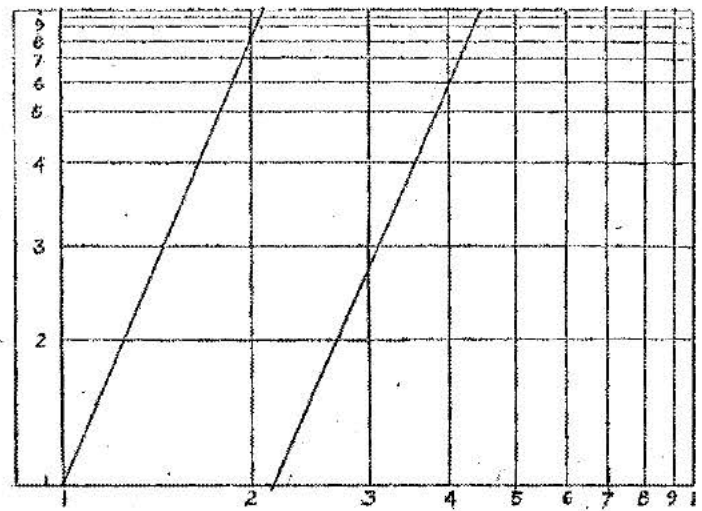


Fig. 5(b) →

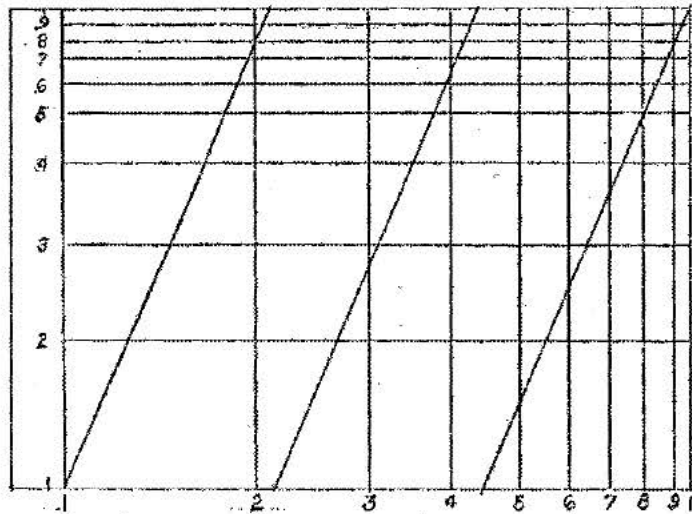


Fig. 5(c)

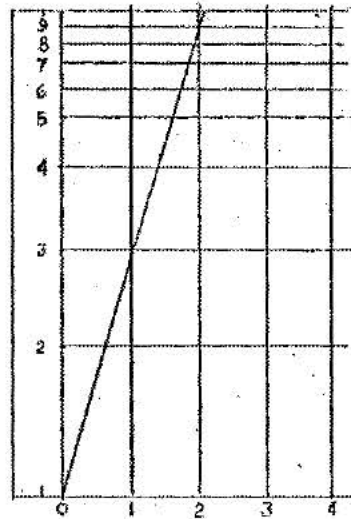


Fig. 6(a)

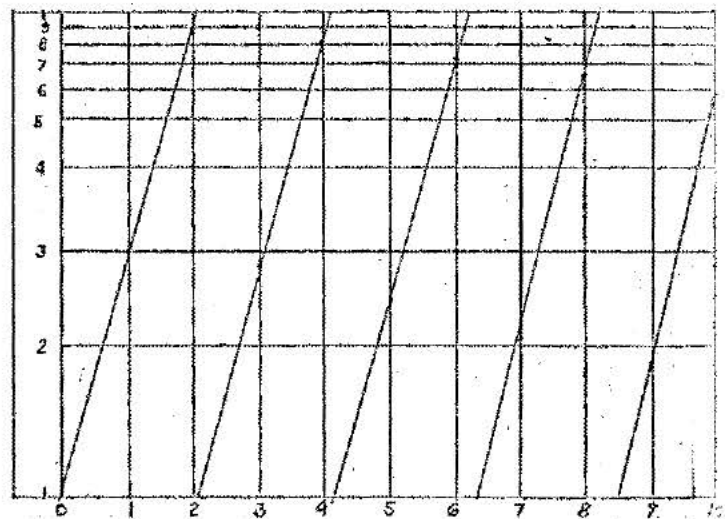
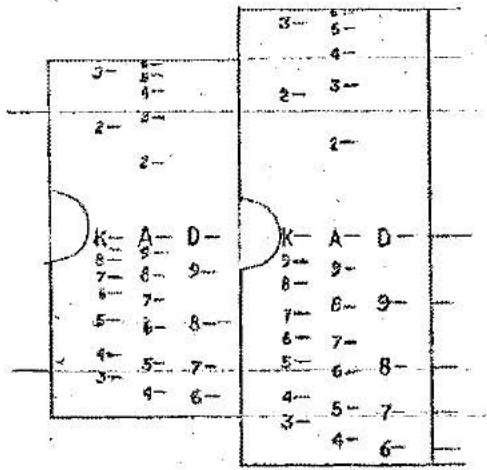


Fig. 6(b)



THE VERTICAL SCALES

Fig. 7

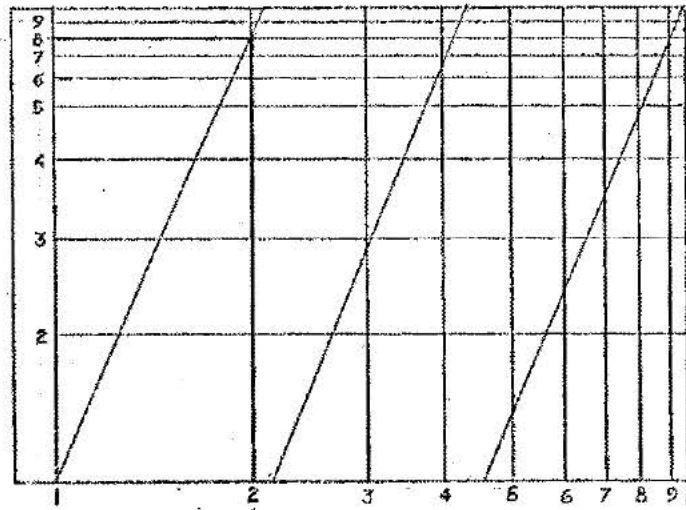


Fig. 8

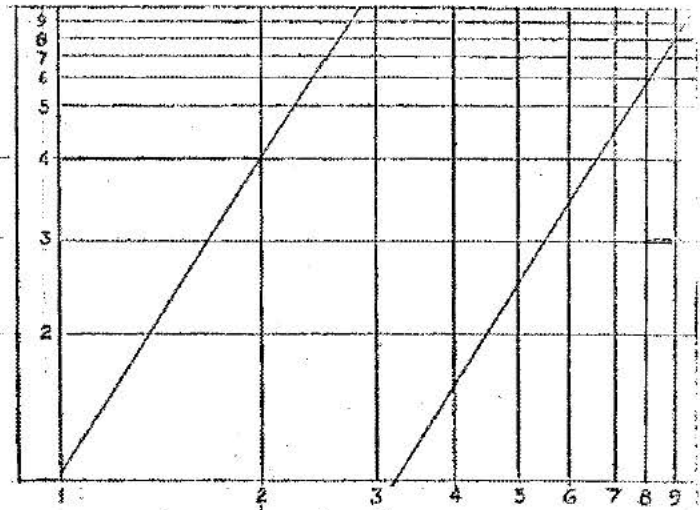


Fig. 9

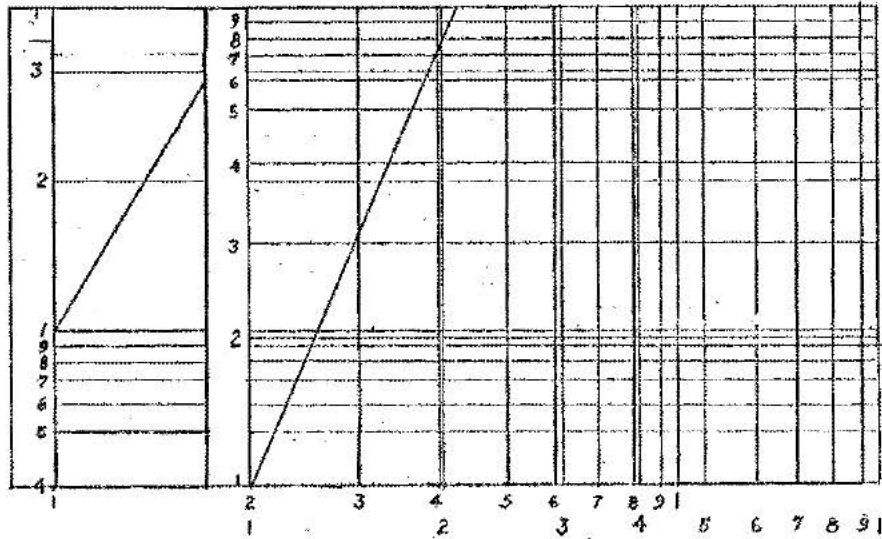


Fig. 10

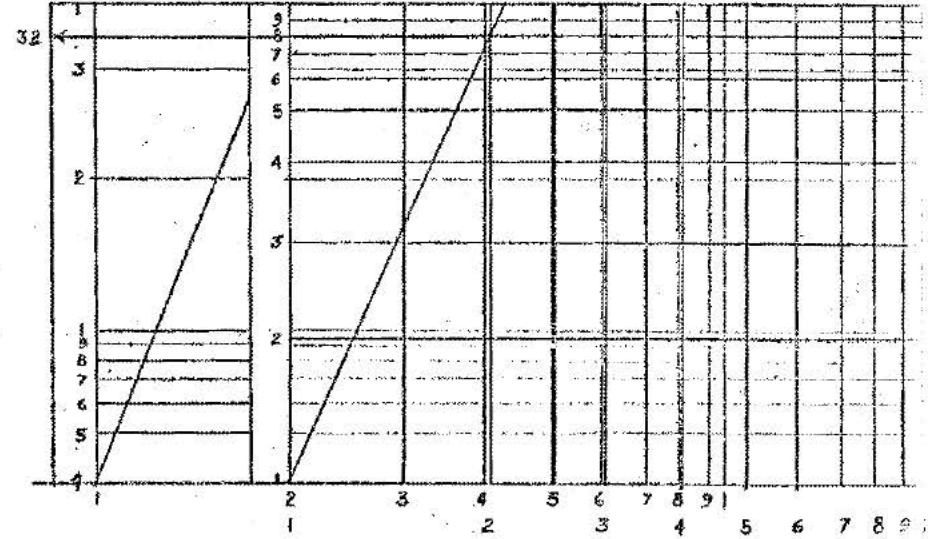
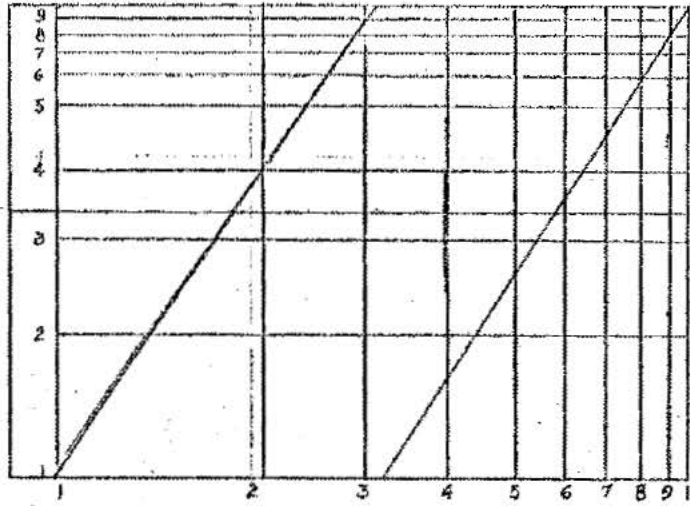


Fig. 11



← Fig. 12

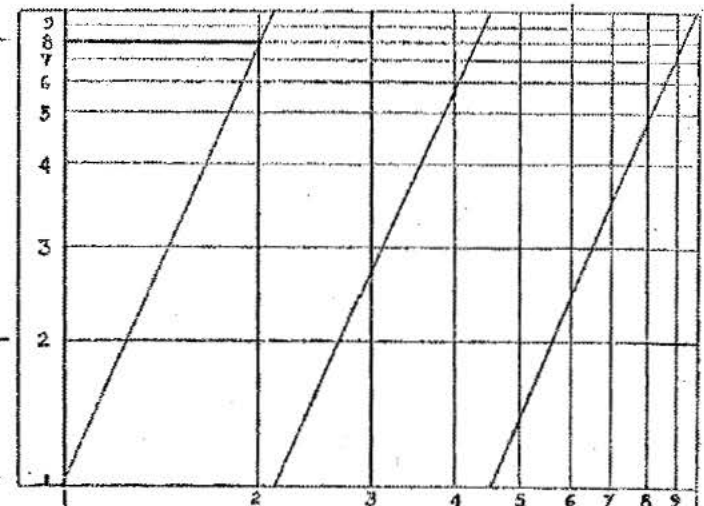


Fig. 13 →

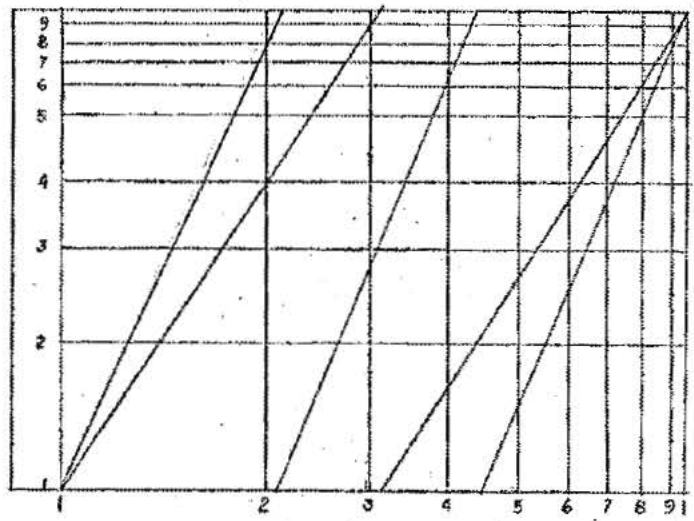


Fig. 14

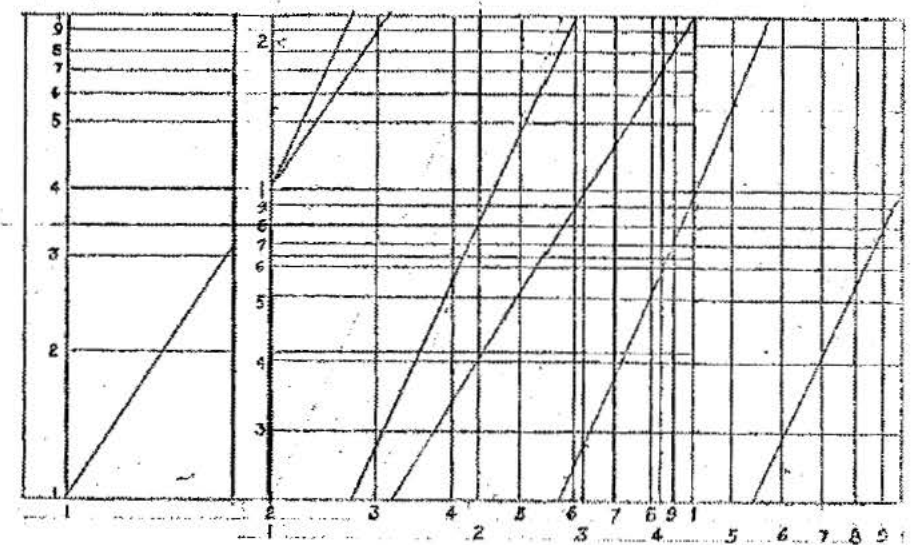


Fig. 15

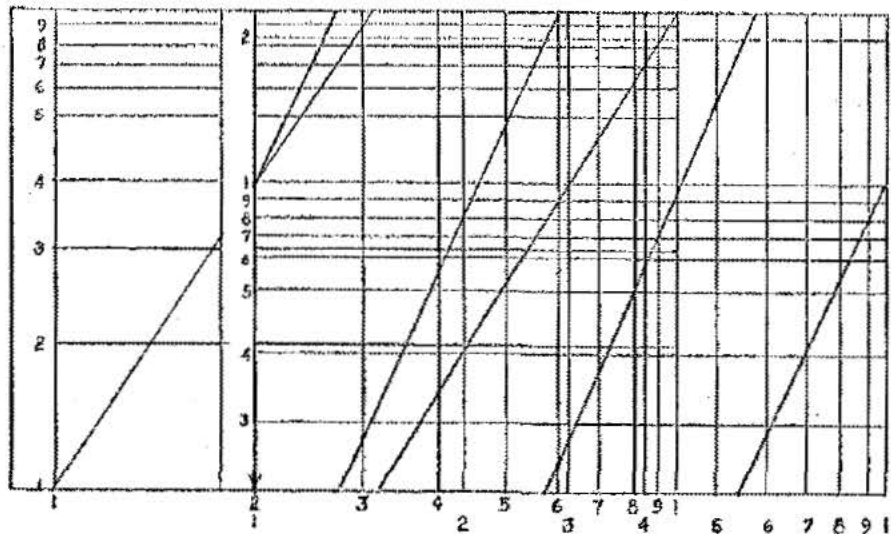


Fig. 16

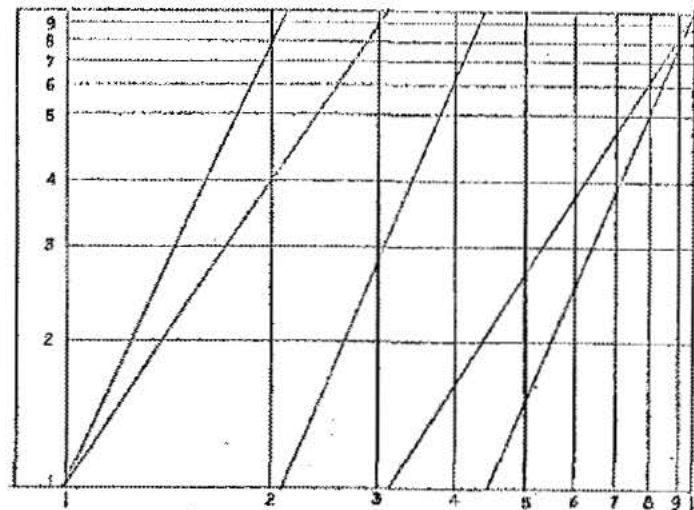


Fig. 17

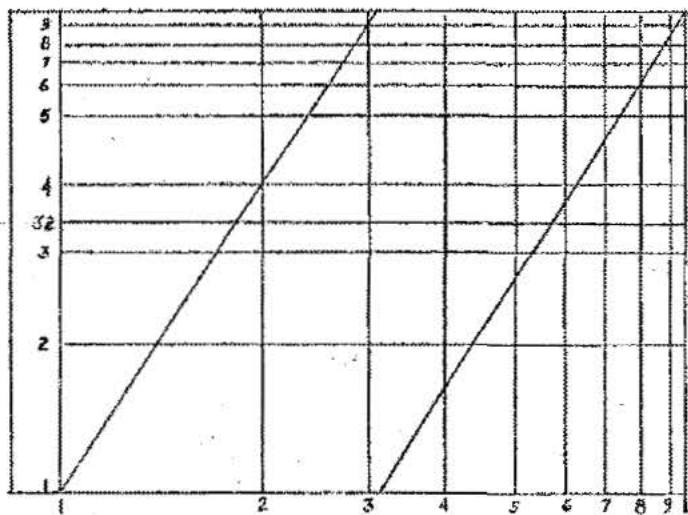


Fig. 18

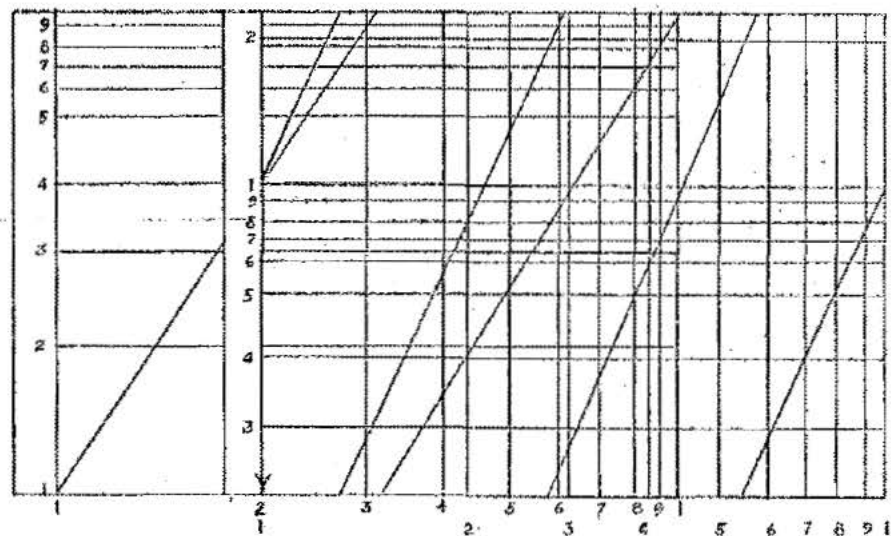


Fig. 19

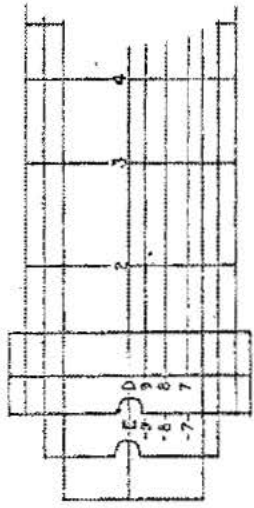


Fig. 20

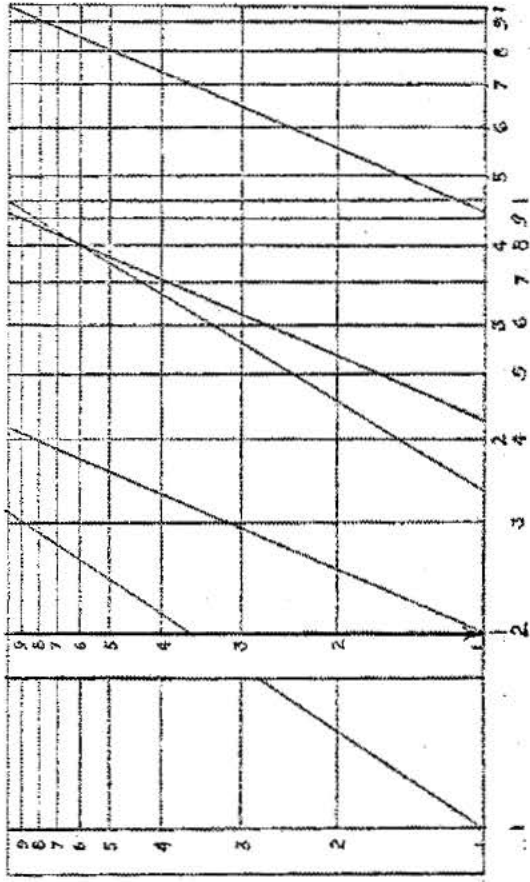


Fig. 21

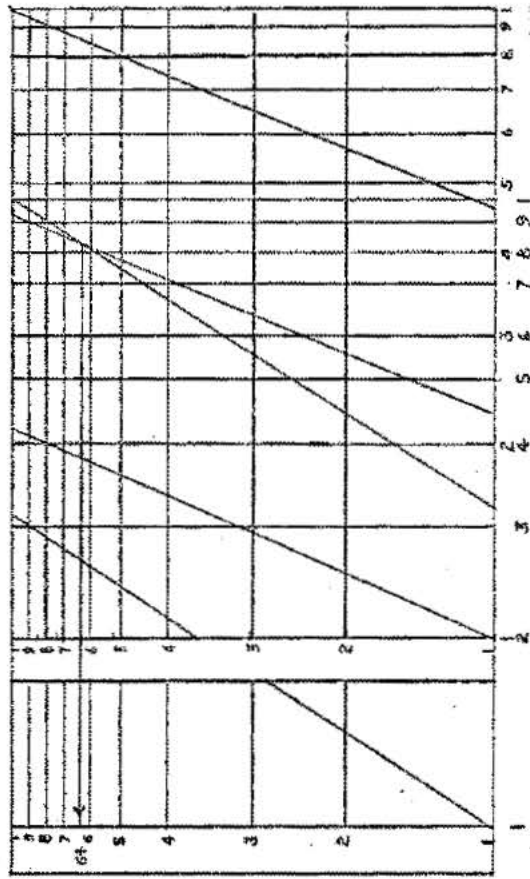


Fig. 22

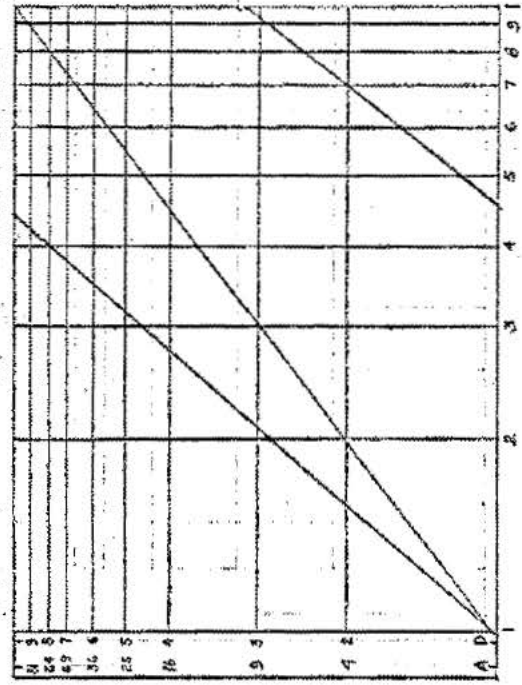


Fig. 23

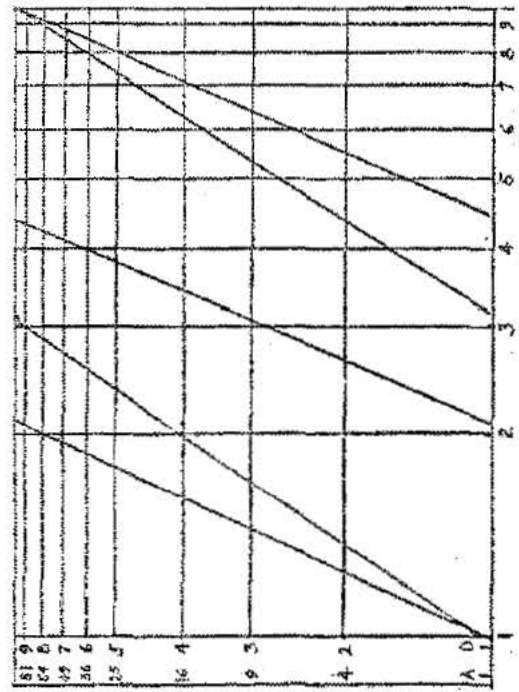


Fig. 24

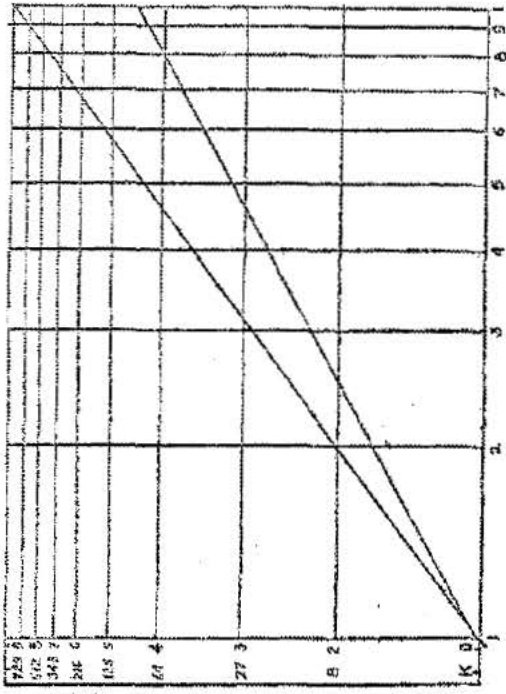


Fig. 25

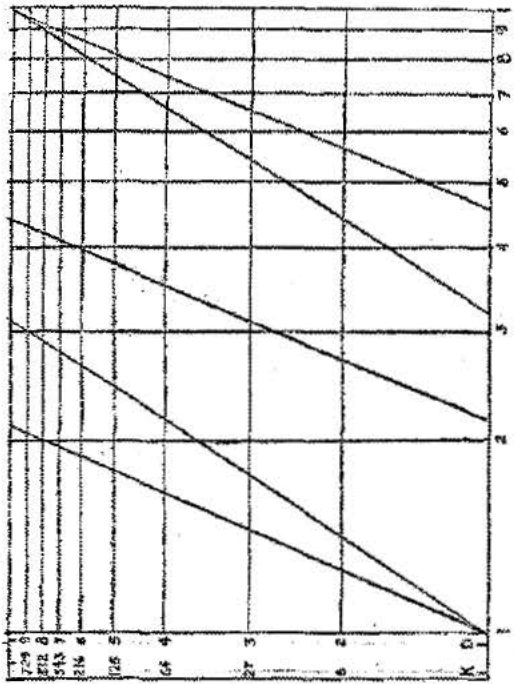


Fig. 26



### PROTOTYPE DESCRIPTION

PART	LENGHT	I.D.	O.D..
1. CASE	8-7/8 in.	2-3/4 in.	3 in.
2. LAMINA D	8-7/8 in.	2-1/4 in.	2-3/4 in.
4. LAMINA C	9-2/8 in.	1-3/4 in.	2-1/4 in.
5. TRANSPORT	10 in.	1-1/2 in.	1-3/4 in.
3. CURSOR	1 in.	2-3/4 in.	3 in.

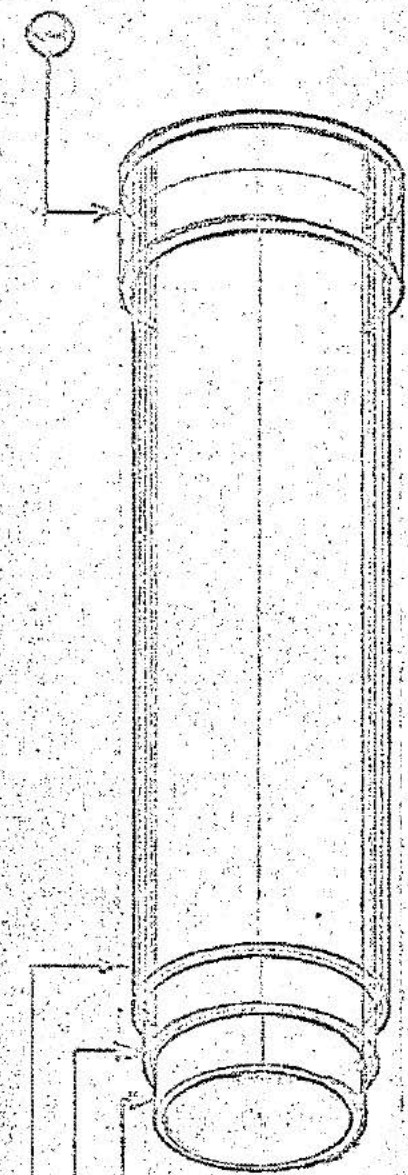
**INSERTS:**

LAMINA D 8-3/4 in. x 7-7/8 in.  
thickness - .003 in.

LAMINA C 9 in. x 6-1/4 in.  
thickness - .003 in.

**SPECIFICATIONS:**

The case and transport are made of white plastic while the remaining tubes are clear, and they are capped at one end. Laminae D and C are double walled tubes allowing insertion and removal of the inserts. A red hairline extends the length of the transport and circumscribes the cursor.



$D^3$   
 DIMENSION  
 SLIDE TUBE

ILLINOIS

- ① CURSOR
- ② LAMINA D
- ③ LAMINA C
- ④ LAMINA B
- ⑤ CASE

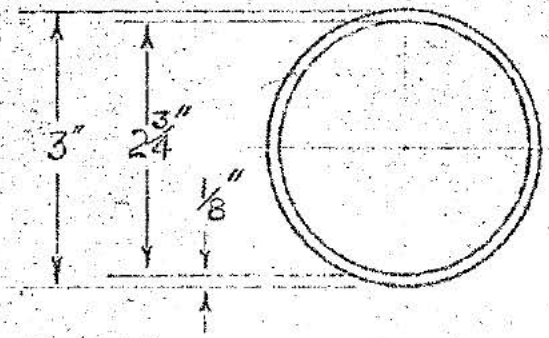
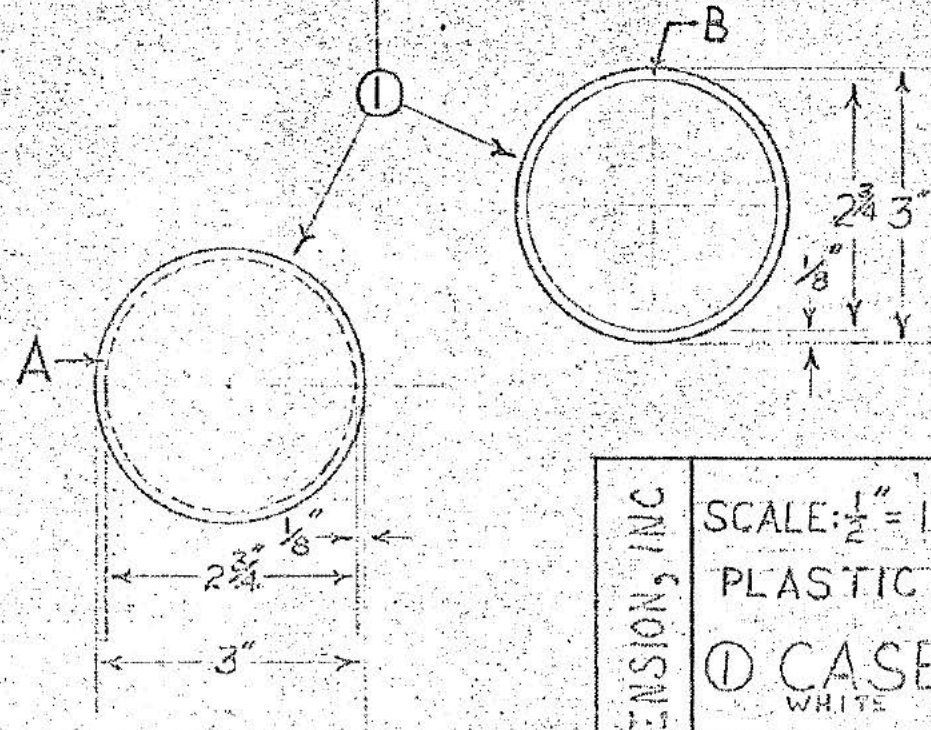
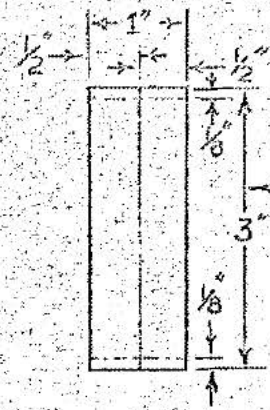
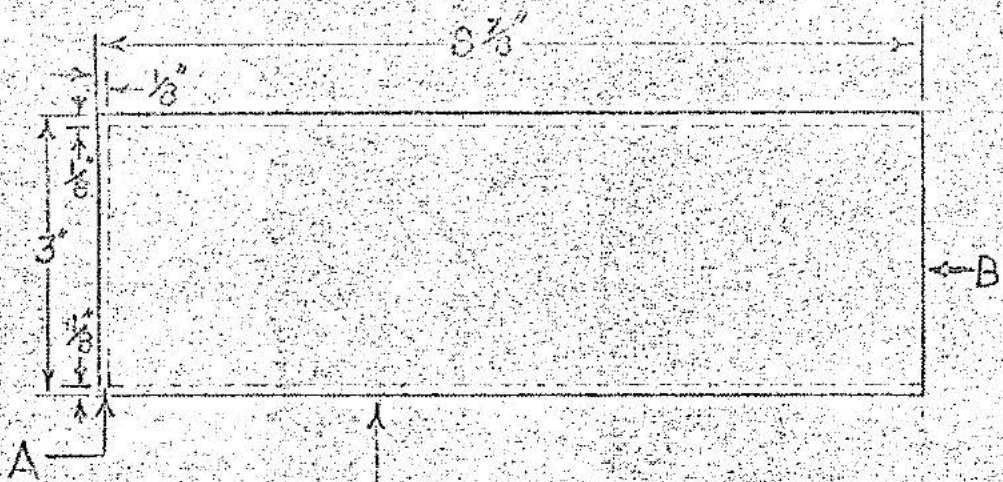
SCALE: 1" = 2"

SLIDE TUBE

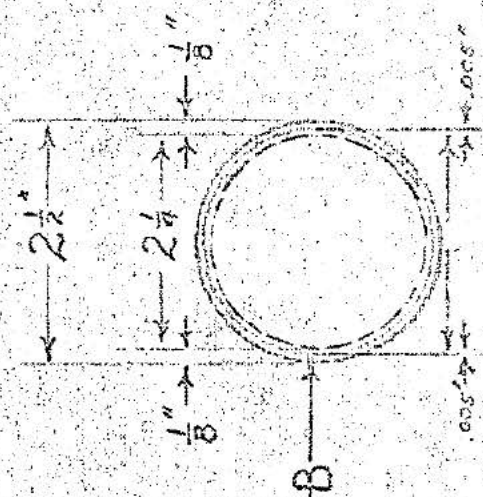
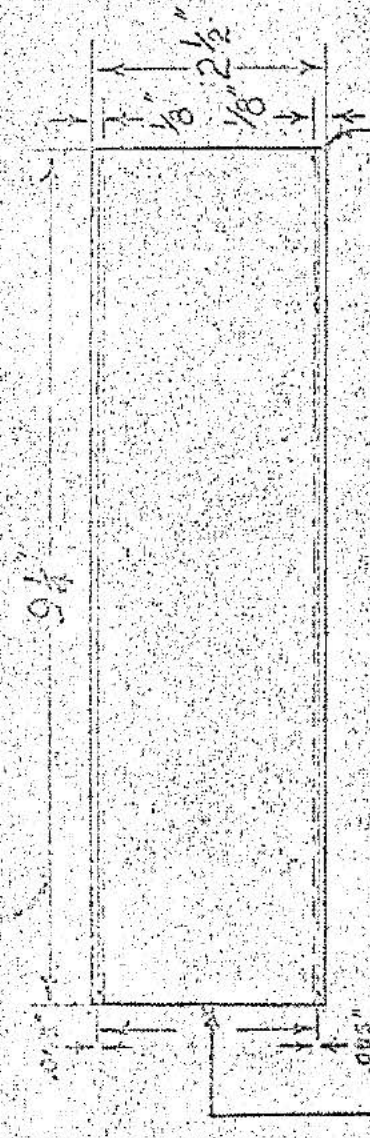
PICTORIAL - NO INSERTS

DRAWN BY D. MCGOVERAN

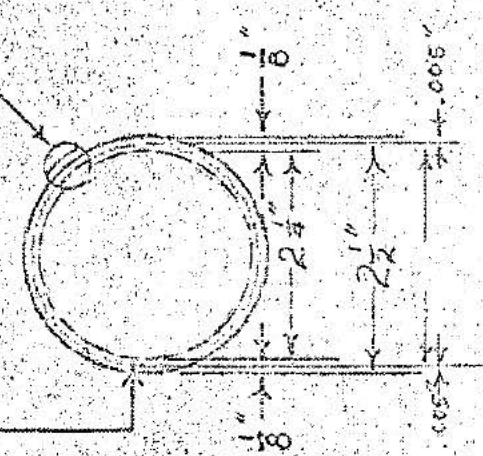
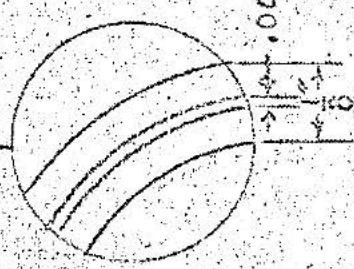
NO. 1



DIMENSION, INC	SCALE: $\frac{1}{2}$ " = 1"	SLIDE TUBE CASE & CURSOR	
	PLASTIC	DRAWN BY D. McGOVERAN	
	① CASE WHITE	DRAWING NUMBER 1	SHEET NO. 1
	② CURSOR CLEAR		



MAG. SCALE: 2" = 5"



DIMENSIONING

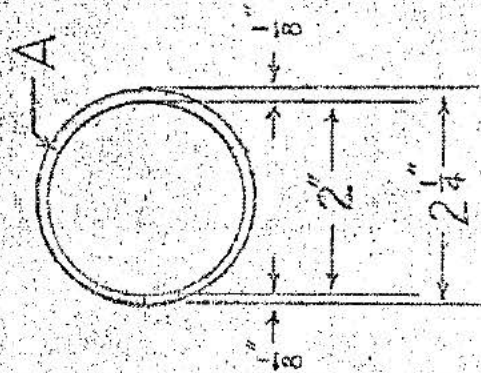
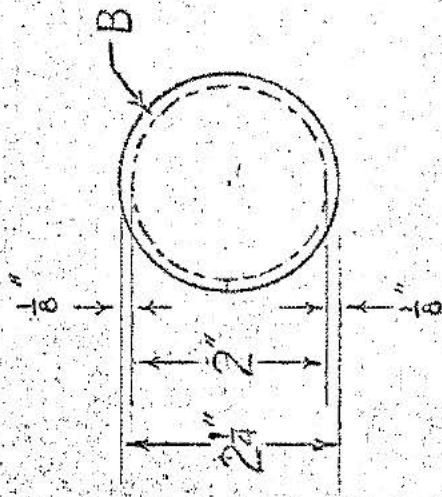
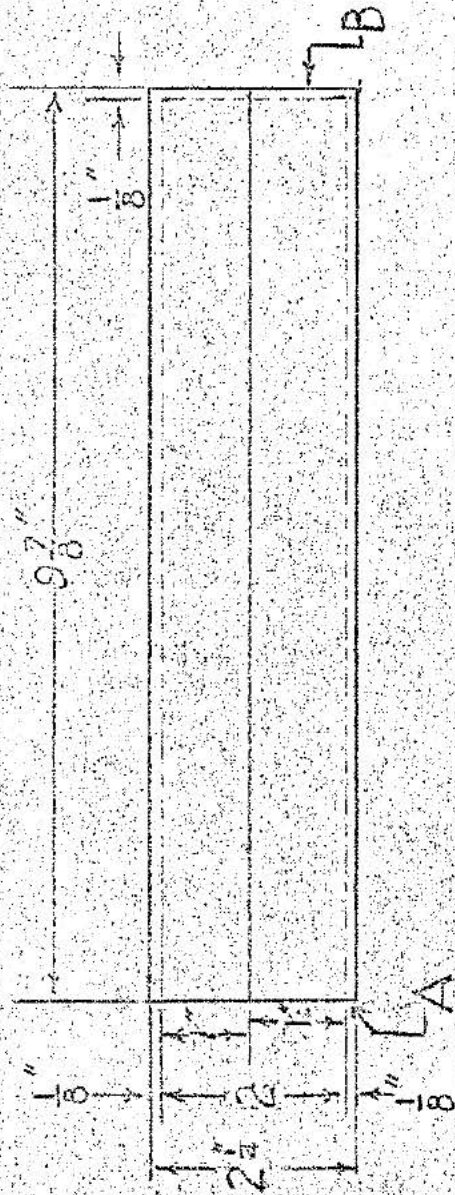
SCALE: 1/2" = 1"  
PLASTIC

COLOR: NONE  
PLUS LINE REPRESENT

SLIDE TUBE  
LAMINA C

DRAWN BY D. McGOVERAN

DRAWING NO. 3 SHEET NO. 3



DIMENSION, INC.

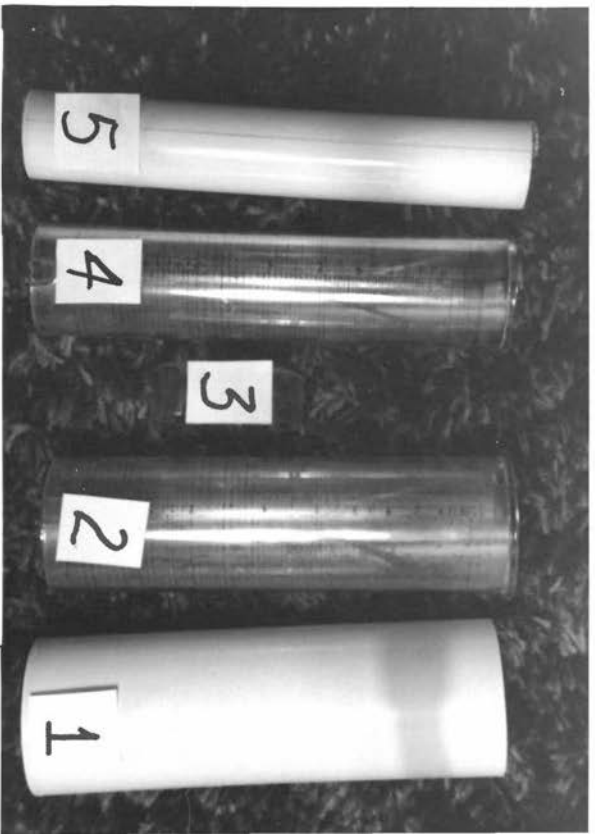
SCALE: 1/2" = 1"  
PLASTIC

COLOR:  
light yellow-  
green

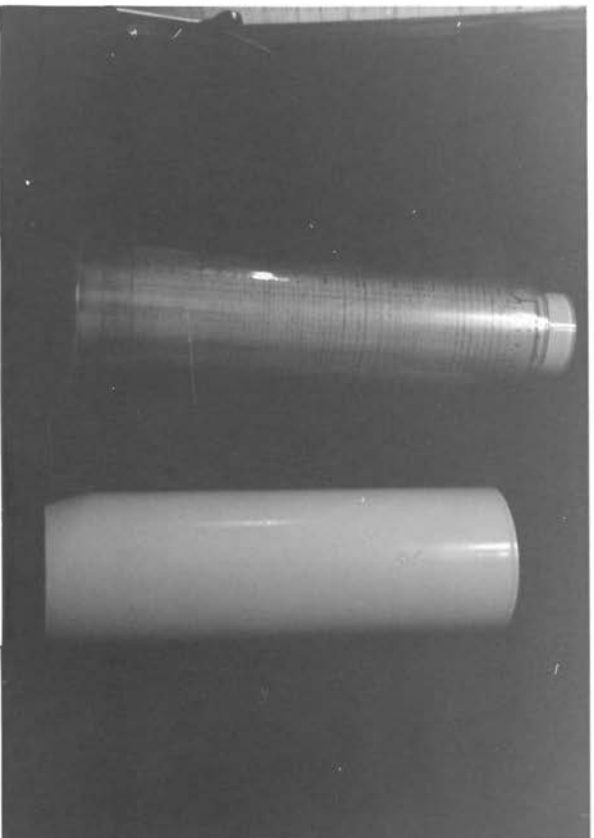
SLIDE TUBE  
TRANSPORT

DRAWN BY D. McGOVERAN

DRAWING NO. 21 SHEET NO. 4



FEB 1972



FEB 1972

# Certificate

FORM 1

## Registration of a Claim to Copyright in a drawing or plastic work of a scientific or technical character

CLASS <b>I</b>	REGISTRATION NO. <b>Iu 16156</b>
DO NOT WRITE HERE	

This is To Certify that the statements set forth on this certificate have been made a part of the records of the Copyright Office. In witness whereof the seal of the Copyright Office is hereto affixed.

*George Slary*  
 Register of Copyrights  
 United States of America



**1. Copyright Claimant(s) and Address(es):**

Name David Ornan McGoveran

Address 2507 1/2 ID Street, Antioch, California

Name \_\_\_\_\_

Address \_\_\_\_\_

**2. Title:** Slide Tube

(Title of the work)

**3. Nature of Work:** DRAWING

(Characterize the general type of artistic or sculptural work involved, as, for example, mechanical drawing, scale model, etc.)

**4. Optional Deposit:**

Basis for claiming option:

Monetary value (retail value per copy) \_\_\_\_\_

Weight (in pounds) \_\_\_\_\_

Size (give dimensions) \_\_\_\_\_

Fragility (give details) \_\_\_\_\_

**5. Author (i.e., Artist):**

Name David Ornan McGoveran - Dave McGoveran

(Give legal name followed by pseudonym if latter appears on the copies)

Citizenship United States

(Name of country)

Domiciled in U.S.A. Yes  No \_\_\_\_\_ Address 2507 1/2 ID Street, Antioch, California

**6. (a) Date of Publication:**

(b) Place of Publication: \_\_\_\_\_ (Month) \_\_\_\_\_ (Day) \_\_\_\_\_ (Year)

**(c) Manufacture Outside United States by Lithographic or Photoengraving Process:**

(Name of country)

**7. Previous Registration or Publication:**

Was work previously registered? Yes \_\_\_\_\_ No \_\_\_\_\_ Date of registration \_\_\_\_\_ Registration number \_\_\_\_\_

Was work previously published? Yes \_\_\_\_\_ No \_\_\_\_\_ Date of publication \_\_\_\_\_ Registration number \_\_\_\_\_

Is there any substantial **NEW MATTER** in this version? Yes \_\_\_\_\_ No \_\_\_\_\_ If your answer is "Yes," give a brief general statement of the nature of the **NEW MATTER** in this version.

EXAMINER <i>[Signature]</i>
--------------------------------

Complete all applicable spaces on next page

**8. Deposit account:**

**9. Send correspondence to:**

Name David Ornan McGoveran Address 2507 1/2 'D' Street, Antioch, Calif.

**10. Send certificate to:**

(Type or print name and address)

Name	<u>David Ornan McGoveran</u>		
Address	<u>2507 1/2 'D' Street</u> (Number and street)		
	<u>Antioch,</u> (City)	<u>California</u> (State)	<u>94509</u> (ZIP Code)

**Information concerning copyright in drawings or plastic works of a scientific or technical character**

*When to Use Form I.* Form I is appropriate for unpublished and published drawings or plastic works of a scientific or technical character.

*What Is a "Drawing or Plastic Work of a Scientific or Technical Character"?* This category (Class I) includes works which have been designed for a scientific or technical use and which contain copyrightable graphic, pictorial, or sculptural material. Examples are diagrams or models illustrating scientific or technical information in linear or plastic form, such as mechanical drawings, anatomical models, blueprints, etc.

*"Plastic" Works.* A work is not registrable in Class I merely because it is formed from one of the synthetic chemical derivatives

known as "plastics." The term "plastic work" refers to three-dimensional works giving the effect of that which is molded or sculptured.

*Ideas, Devices, etc.* It is not possible to secure copyright for ideas, plans, methods, systems, or devices as distinguished from the particular manner in which they are expressed or described in a work.

*Duration of Copyright.* Statutory copyright begins on the date the work was first published, or, if the work was registered for copyright in unpublished form, copyright begins on the date of registration. In either case, copyright lasts for 28 years, and may be renewed for a second 28-year term.

**Unpublished drawings and plastic works**

*How to Register a Claim.* To obtain copyright registration, mail to the Register of Copyrights, Library of Congress, Washington, D.C. 20540, a photograph or other identifying reproduction of the work, an application on Form I, properly completed and signed, and a fee of \$6. Deposits are not returned, so do not send your only copy.

*Procedure to Follow if Work Is Later Published.* If the work is later reproduced in copies and published, it is necessary to make a second registration, following the procedure outlined below. To maintain copyright protection, all copies of the published edition must contain a copyright notice in the required form and position.

**Published drawings and plastic works**

*What Is "Publication"?* Publication, generally, means the sale, placing on sale, or public distribution of copies. Unrestricted public exhibition of a drawing or plastic work may also constitute publication.

*How to Secure Copyright in a Published Drawing or Plastic Work:*

1. Produce copies with copyright notice.
2. Publish the work.
3. Register the copyright claim, following the instructions on page 1 of this form.

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owner, provided the owner's name appears on some accessible part of the copies.

*Universal Copyright Convention Notice.* Use of the symbol © with the name of the copyright owner and the year date of publication may result in securing copyright in countries which are parties to the Universal Copyright Convention, which protection might not be obtained by use of either of the alternative forms of notice. Example: © John Doe 1971.

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NOTE: If copies are published without the required notice, the right to secure copyright is lost and cannot be restored.

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Application received	<u>MAY 26 1972</u>
One copy or reproduction received	<u>24 MAY 1972</u>
Two copies received	
Photographs or reproductions received	
Fee received	<u>135405 9 A APR 1072</u>