

QCX  
Avro  
CF105 ANALYZE  
Ext. 2-  
A47-A.C.MAN-2

Classification cancelled / Changed to **UNCLASS**  
**SECRET** EXTRACT 2 **AVR5** A.C. MAN./2  
By authority of  
Date **27 Sept 56**  
**PLANE MANOEUVRES AT MAXIMUM** **AVR5**  
**SIGNATURE** FOR THE CF-105  
Unit / Rank / Appointment **AVR55**  
T. F. Potts **SECRET** April 1957



A. V. ROE CANADA LIMITED  
MALTON - ONTARIO

ANALYZED

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: CF-105

EXTRACT 2

REPORT NO. - A47/A.C. Man./2

FILE NO.

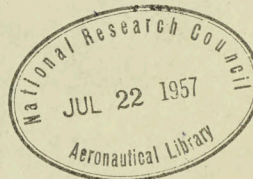
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TITLE:

Classification cancelled / Changed to UNCLASS  
By authority of AVRS  
Date 27 Sept 56  
Signature RB ce  
Unit / Rank / Appointment AVRS

PLANE MANOEUVRES AT MAXIMUM 'g' FOR THE CF-105



PREPARED BY T. F. Potts DATE April 1957  
CHECKED BY T. F. P. R. R. Carley DATE April 1957  
SUPERVISED BY [Signature] DATE  
APPROVED BY [Signature] DATE

ISSUE NO	REVISION NO	REVISED BY	APPROVED BY	DATE	REMARKS

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AIRCRAFT:

CF-105

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DATE

T. F. Potts

April 1957

CHECKED BY

DATE

R. R. Carley

April 1957

PLANE MANOEUVRES AT MAXIMUM 'g' FOR THE CF-105

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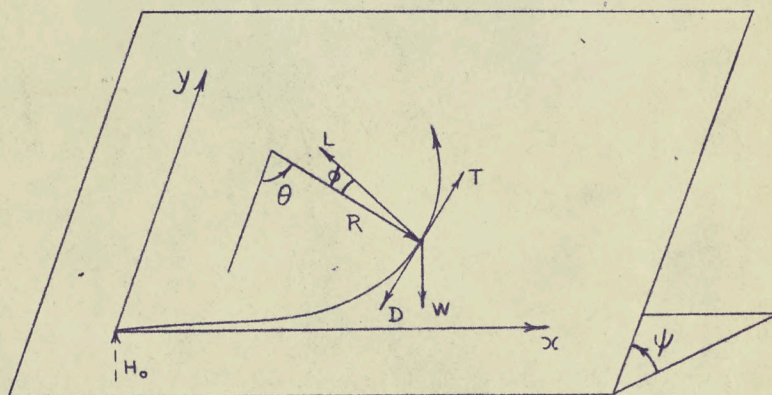
R. R. Carley

April 1957

PLANE MANOEUVRES AT MAXIMUM 'G' FOR THE CF-105

This report is the first of a series to be prepared on Dynamic Manoeuvres for the CF-105, and its purpose is to investigate manoeuvring capabilities of the aircraft in maximum 'g' turns confined to a plane, for various altitudes and speeds.

GEOMETRY AND EQUATIONS OF MOTION:-



- (1) 
$$\frac{dM}{dt} = \frac{g}{aW} \left\{ 2 \frac{F_N^*}{F_N} \cdot \frac{F_N}{F_N} - p \left[ K_1 \left( \frac{n}{p} \cdot W \times 10^{-4} - 2.11 \right)^2 + \frac{D_{MIN}}{p} \right] \right\} - \frac{g}{a} \sin \psi \sin \theta$$
- (2) 
$$\frac{d\theta}{dt} = \frac{57.3g}{M} \left( p \cdot \frac{n}{p} \cos \theta - \sin \psi \cos \theta \right)$$
- (3) 
$$p \cdot \frac{n}{p} \sin \theta = \cos \psi$$
- (4) 
$$\frac{dx}{dt} = aM \cos \theta$$
- (5) 
$$\frac{dy}{dt} = aM \sin \theta$$
- (6) 
$$H = H_0 + y \sin \psi$$
- (7) 
$$V = aM$$



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SYMBOLS USED:-

- D - Total aircraft drag (lb.)
- $D_{MIN}$  - Fictitious minimum drag, used in the mechanization of the drag function
- $F_N$  - Net thrust of one engine with maximum afterburner. (lb.)
- $\frac{F_N^*}{F_N}$  { - Functions of Mach number and altitude used in thrust mechanization
- $\frac{F_N}{F_N^*}$  {
- H - altitude (ft.)
- $K_1$  - Function of Mach number, used in drag mechanization
- L - Total aircraft lift (lb.)
- M - Mach number
- V - Aircraft speed (ft./sec.)
- W - Aircraft weight (lb.)
- a - Speed of sound (ft./sec.)
- g - Acceleration due to gravity (ft./sec.<sup>2</sup>)
- n - Total normal acceleration ('g' unite)
- p - Ambient static pressure (lb./in.<sup>2</sup>abs)
- t - Time (sec.)
- x { - Rectangular Cartesian coordinates
- y { - in the plane of the manoeuvre (ft.)
- $\theta$  - Angle turned (deg.)
- $\phi$  - Angle of bank relative to manoeuvre plane (deg.)
- $\psi$  - Angle of inclination of manoeuvre plane (deg.)
- Subscript 0 - Initial conditions.



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MECHANIZATION OF THRUST, DRAG AND NORMAL ACCELERATION:-

In the expression  $2F_N^*$ ,  $\frac{F_N^*}{F_N}$ ,  $2F_N^*$  and  $\frac{F_N}{F_N}$

are functions of Mach number and altitude respectively, whose product yields maximum thrust for two PS - 13 engines with afterburners. The values of  $2F_N^*$  given by this mechanization are everywhere within 2% of the values given by the carpet, and over most of the range the error is considerably less than this value.

The expression  $p \left( K_1 \left( \frac{n}{p} \cdot W \times 10^{-4} - 2.11 \right)^2 + \frac{D_{MIN}}{p} \right)$

is the mechanization for the carpet of total trimmed drag with 40° up aileron deflection. The values of drag given by this mechanization are everywhere within 2% of the values given by the carpet, and over most of the range the error is considerably less than this value.

Although the ailerons will only be deflected above 45,000', and the carpet for undeflected ailerons should be used below this altitude, lack of computing equipment makes this impossible at the moment. The one set of data was therefore used throughout.

Normal acceleration 'n' is obtained from the product  $p \cdot \left( \frac{n}{p} \right)_{MAX}$  where  $\left( \frac{n}{p} \right)_{MAX}$  is a function of

Mach number. Maximum 'n' is limited by buffet for M 1.08 and by available trim for M 1.08. Hinge



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moment limitation is not considered serious at these altitudes and Mach numbers, and its effects, have been ignored. In the simulation, the value of  $n_{MAX}$  has been limited to 5.5 'g', corresponding to the damper command limit. A lag of  $\frac{1}{1 + .5S}$  has been introduced in  $\frac{n}{p}$  in the simulation, to allow for the response of the aircraft in pitch.

The data for these mechanizations was obtained from Messrs. J. Cohen and T. Roberts of Performance Group.



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CASES STUDIED:-

Initial altitudes and Mach numbers, and angles of plane inclination studied are as follows;

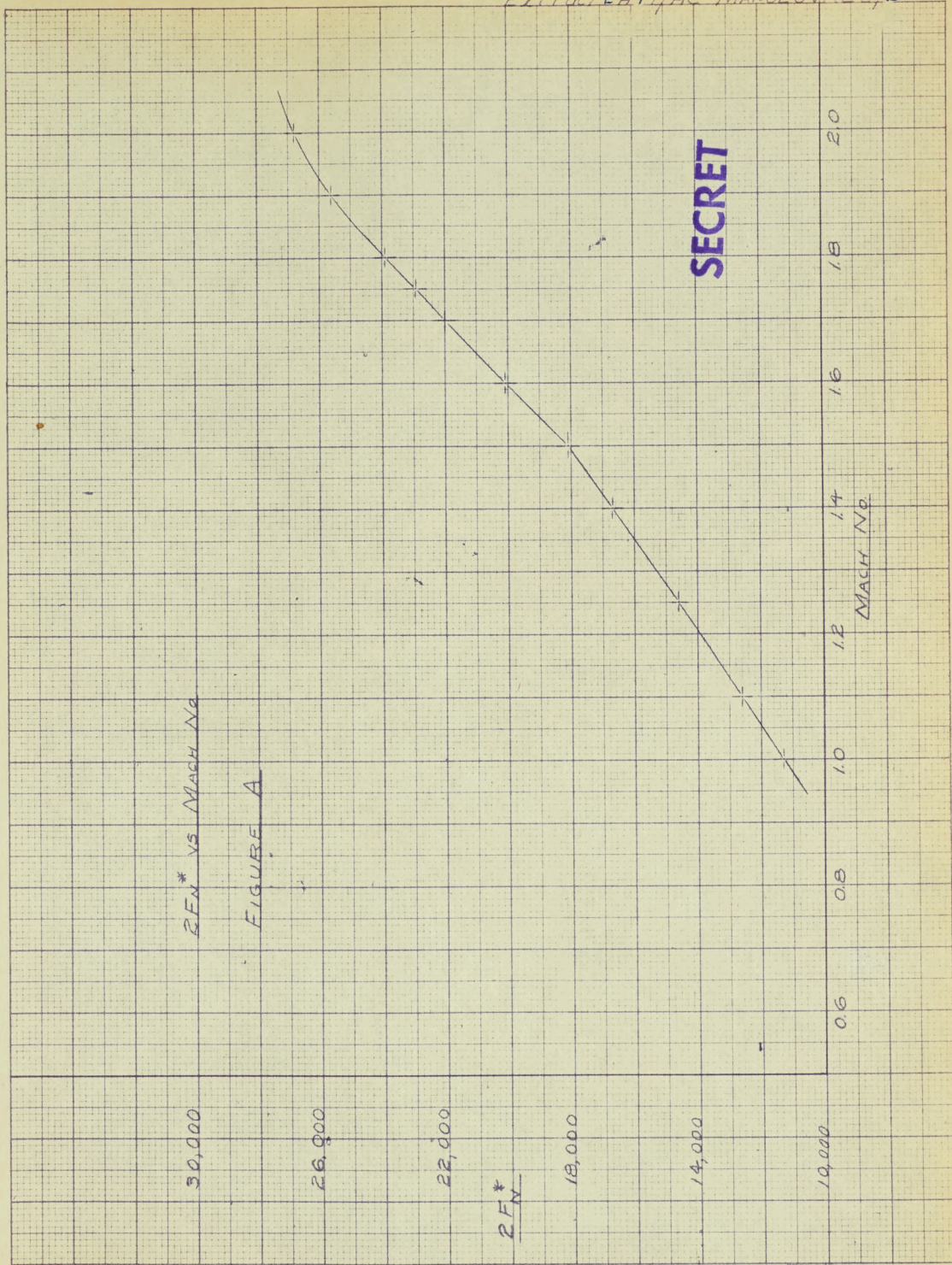
$H_0 = 36,000'$ ;  $M_0 = 2.0, 1.75, 1.50$ ;  $\psi = 90^\circ, 0$   
 $H_0 = 40,000'$ ;  $M_0 = 2.0, 1.75, 1.50$ ;  $\psi = 90^\circ, 0$   
 $H_0 = 50,000'$ ;  $M_0 = 2.0, 1.75, 1.50$ ;  $\psi = 90^\circ, 0, -90^\circ$   
 $H_0 = 60,000'$ ;  $M_0 = 2.0, 1.75, 1.50$ ;  $\psi = 90^\circ, 0, -90^\circ$   
 $H_0 = 70,000'$ ;  $M_0 = 2.0, 1.75, 1.50$ ;  $\psi = 0, -90^\circ$

The solutions are valid for  $H \geq 36,000'$ ,  $M \geq 1.0$  and  $\theta \leq 180^\circ$ .

The weight of the aircraft was taken as 51,000 lbs. and the speed of sound was taken to be constant at 968.5 ft./sec.

Solutions are presented as curves of  $M$ ,  $\theta$ , and  $n$  vs.  $t$ , and  $y$  vs.  $x$ . In addition, composite curves of  $y$  vs.  $x$  for the different plane inclinations are given, with time intervals and Mach number noted along the curves.

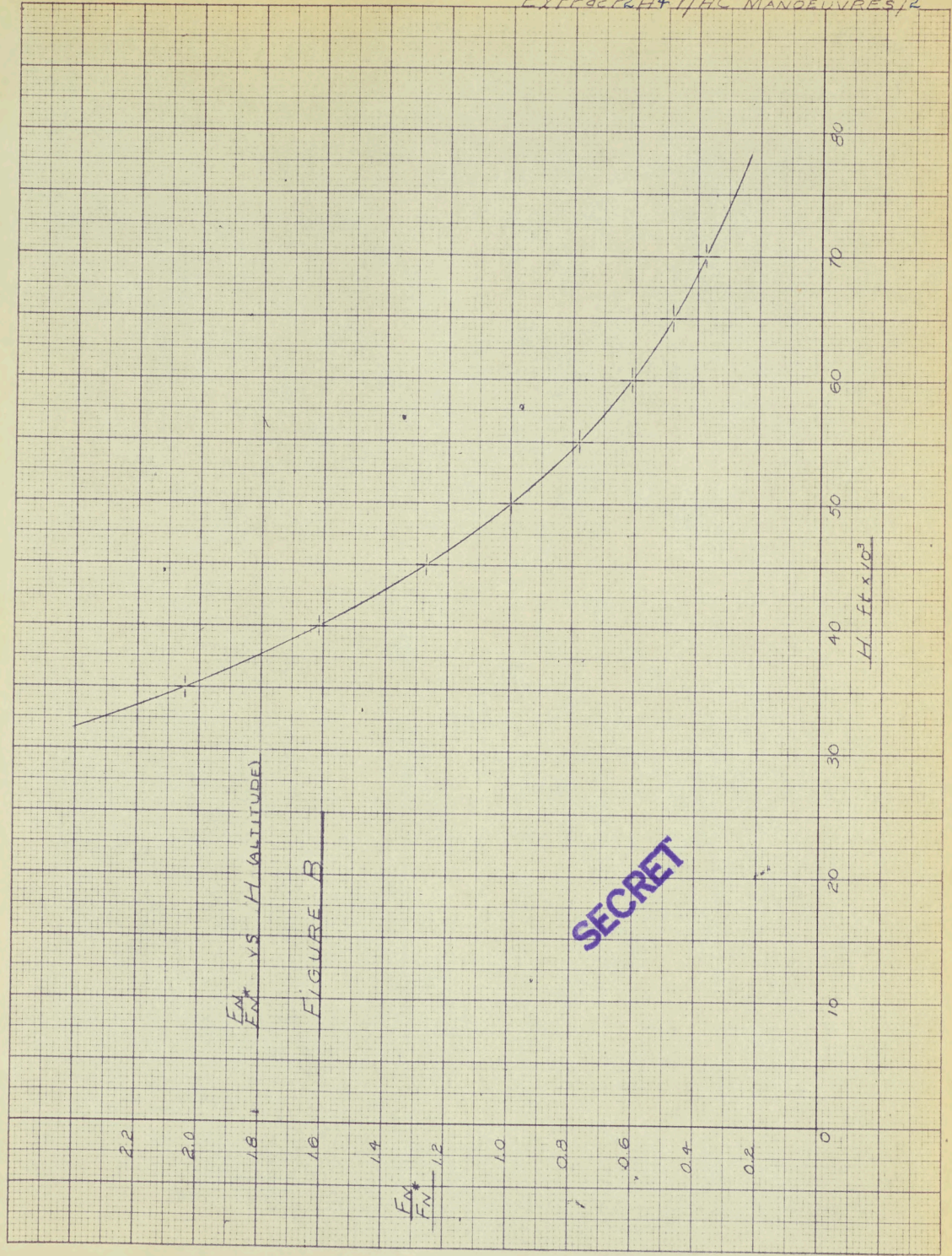
Hand calculated check solutions for the cases  $H_0 = 40,000'$ ,  $M_0 = 2.0$ ,  $\psi = 0$  and  $H_0 = 60,000'$ ,  $M_0 = 2.0$ ,  $\psi = 0$  are given for comparison.



RFN\* VS MACH No

FIGURE A

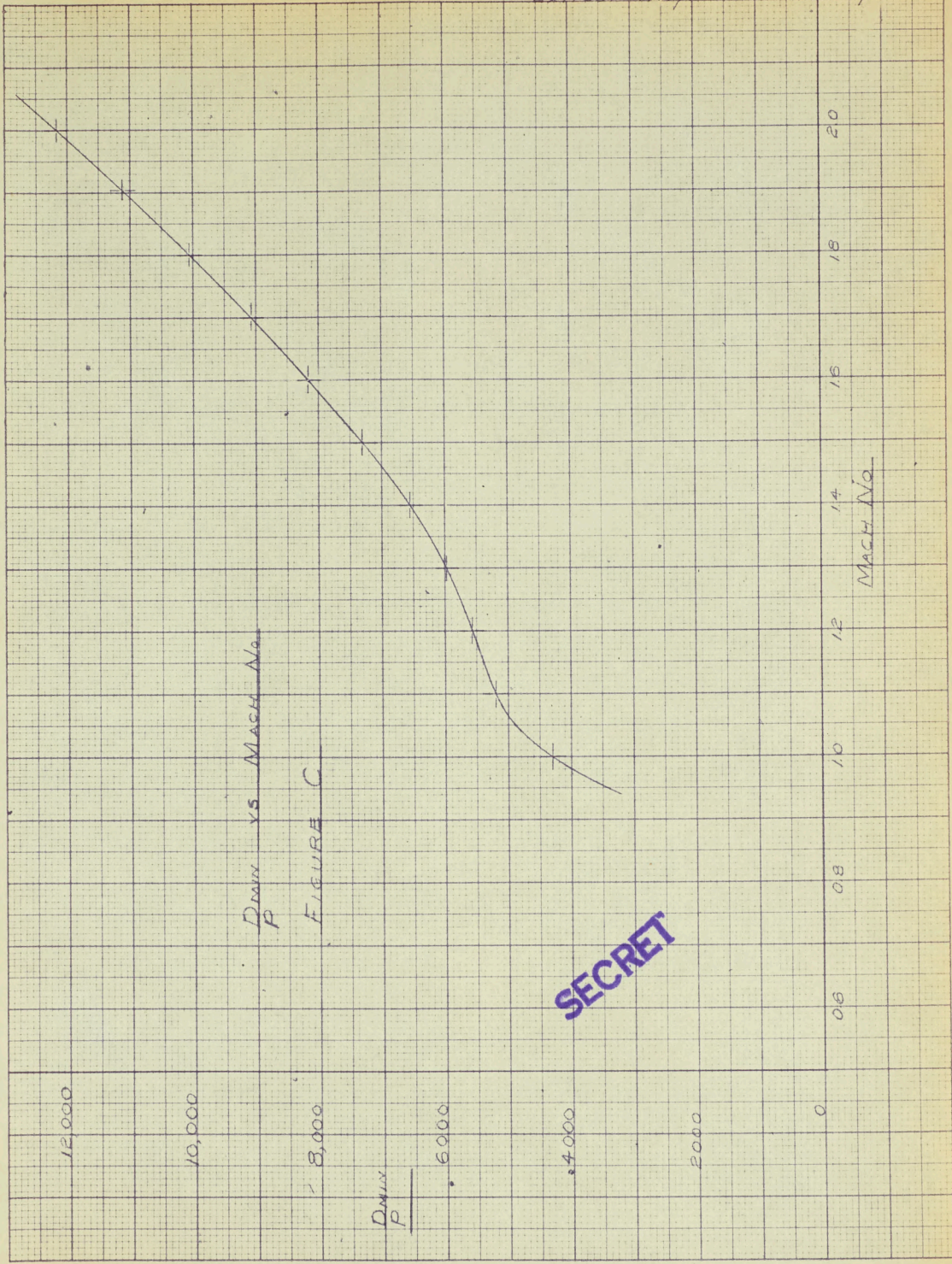
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$\frac{F_A}{F_N}$  VS  $H$  (ALTITUDE)

FIGURE B

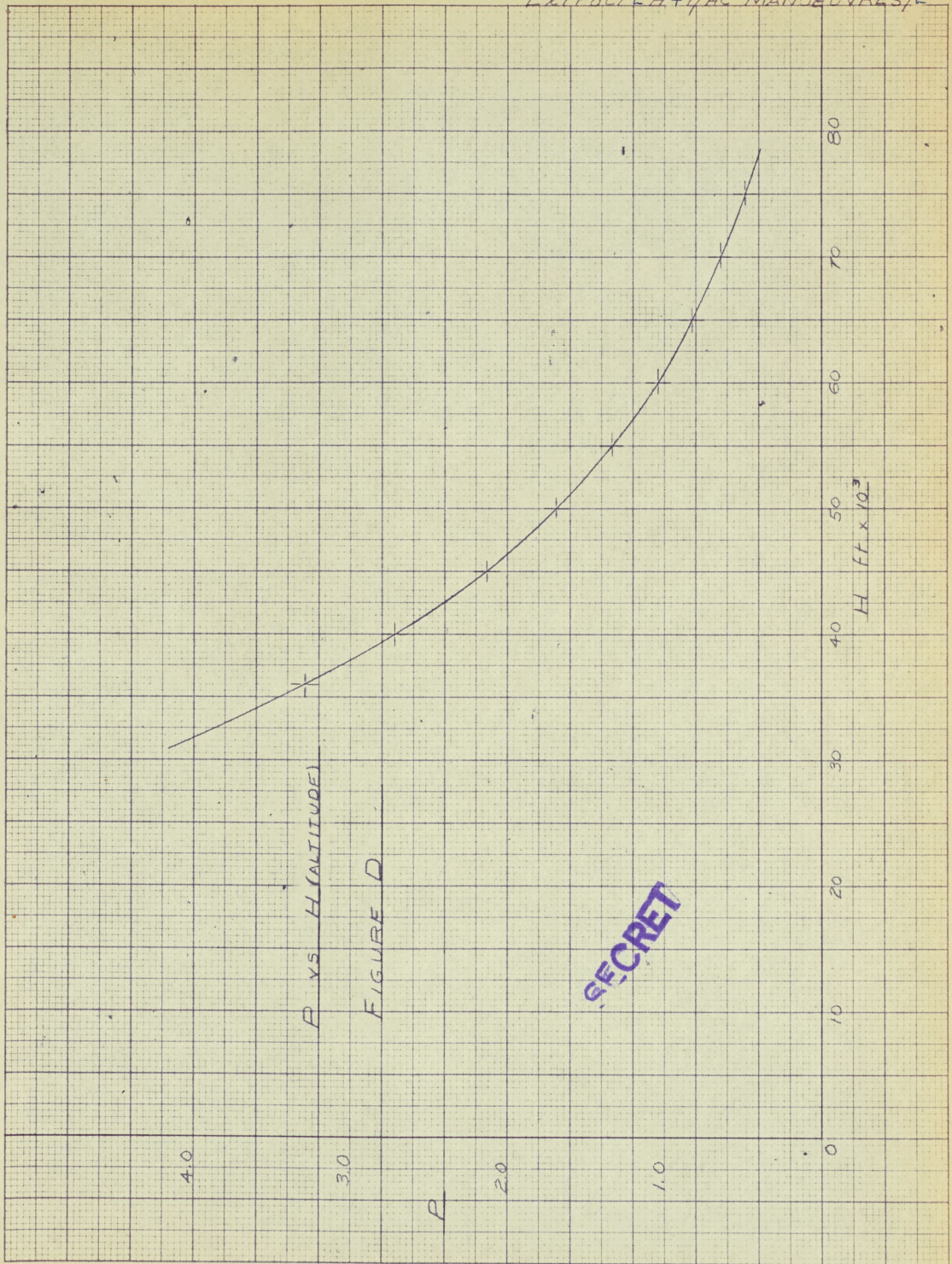
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$D_{max}$  vs MACH No.

FIGURE C

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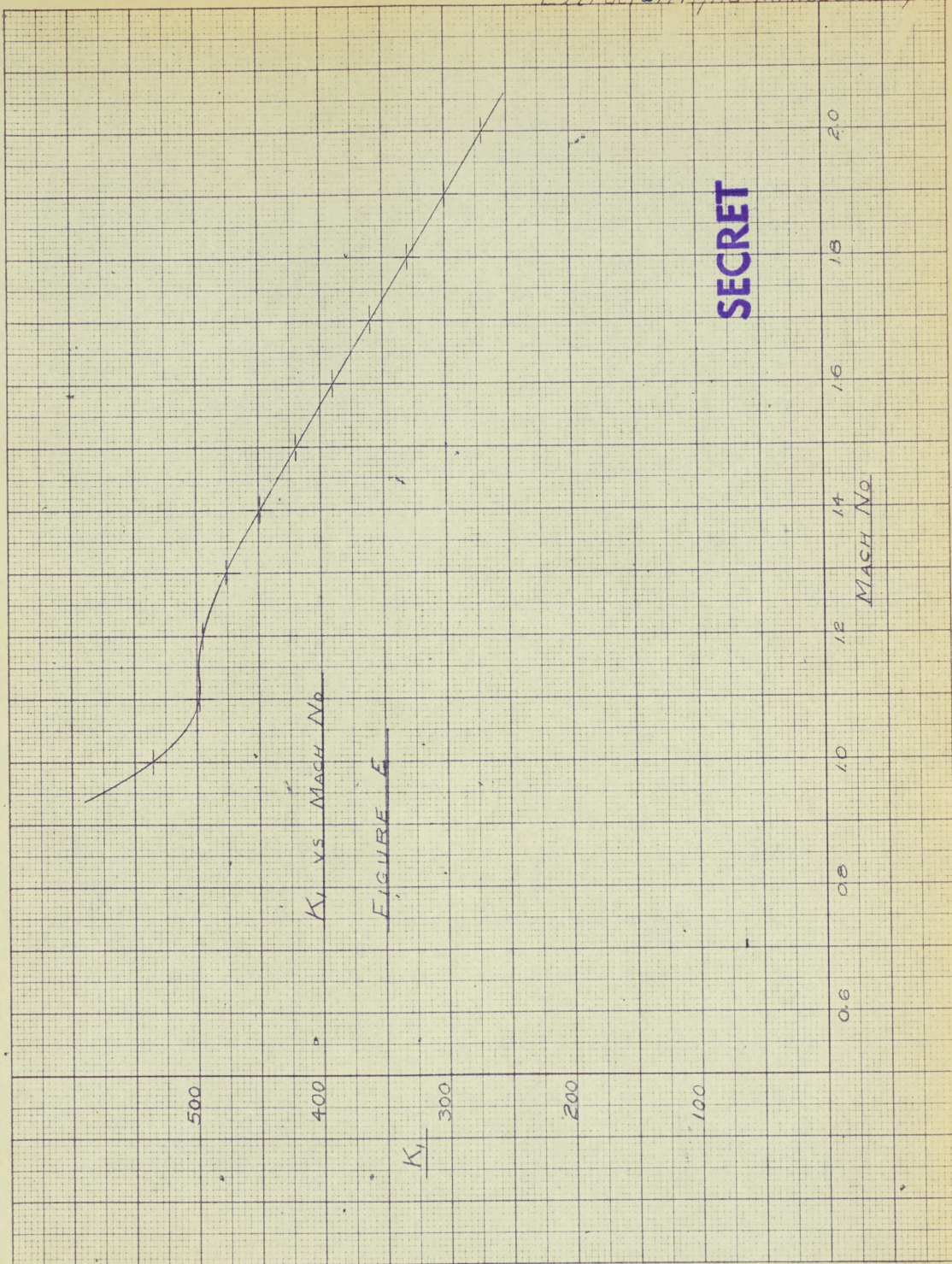
P vs H (ALTITUDE)

FIGURE D

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G9-12  
10 X 10 TO THE 1/2 INCH  
MADE IN CANADA

Extract 2A47/AC MANOEUVRES/2 10

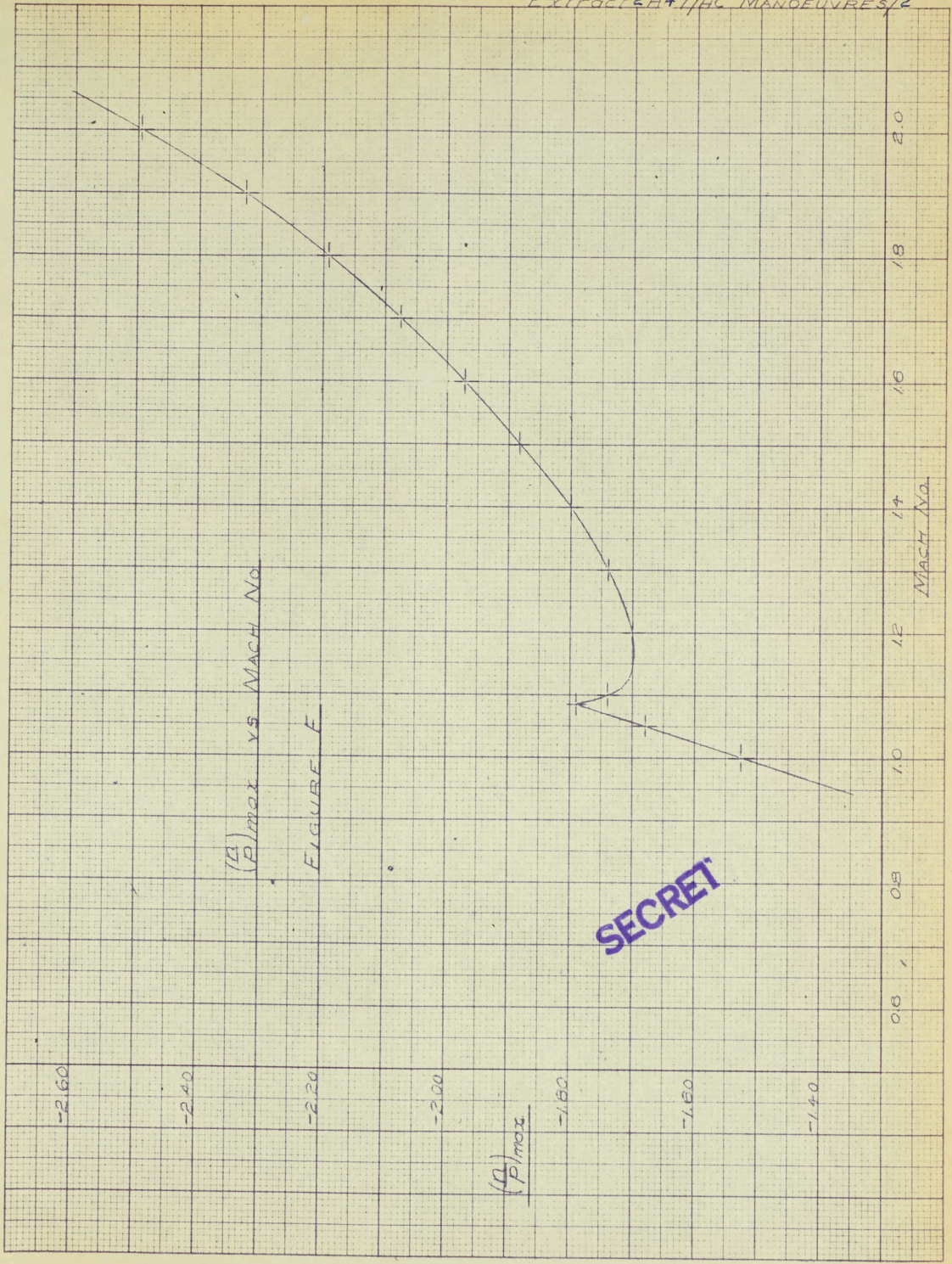


$K_1$  vs MACH No

FIGURE 5

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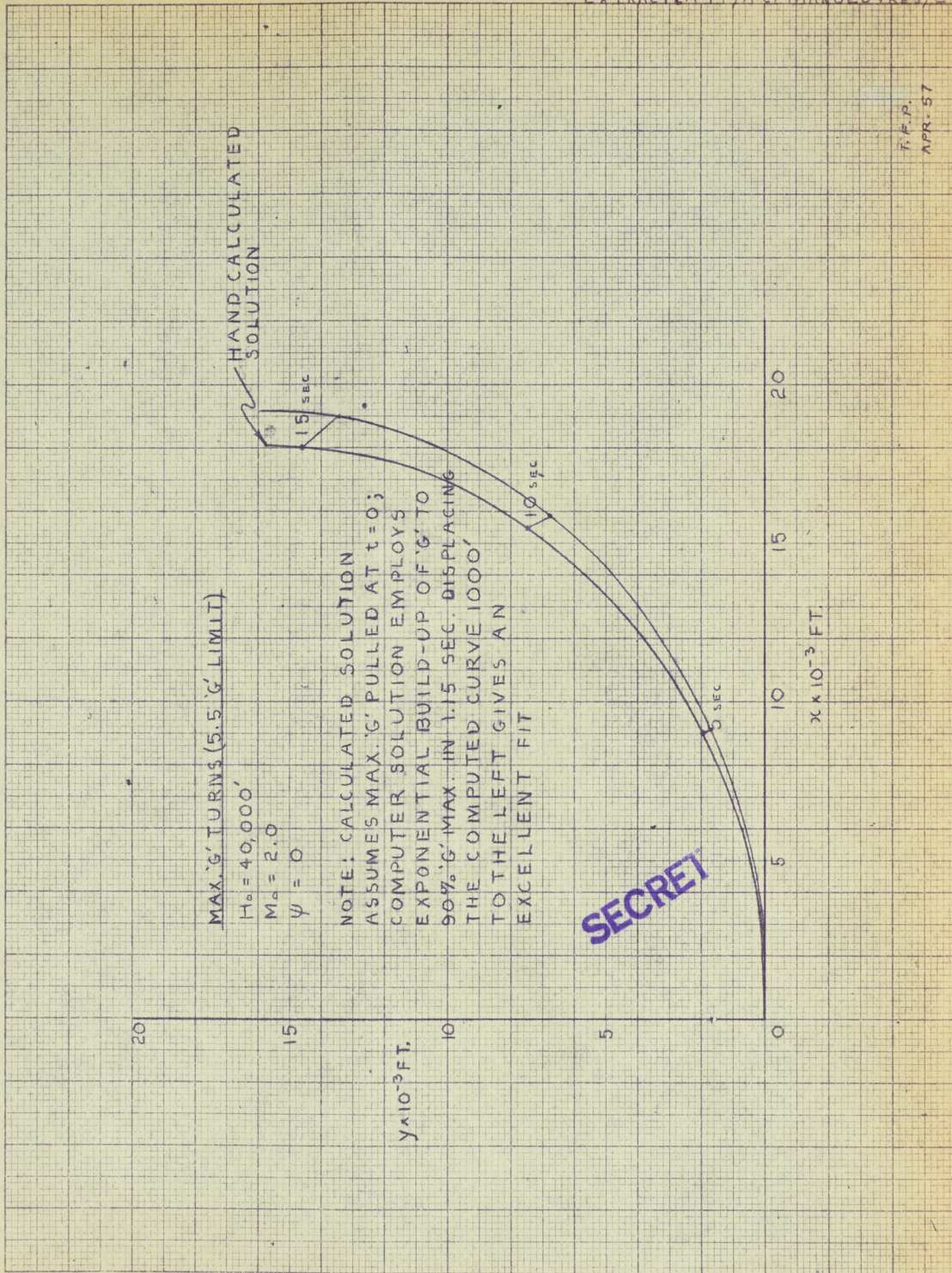
G9-12  
10 X 10 TO THE 1/2 INCH  
MADE IN CANADA



(P)max vs MACH No.

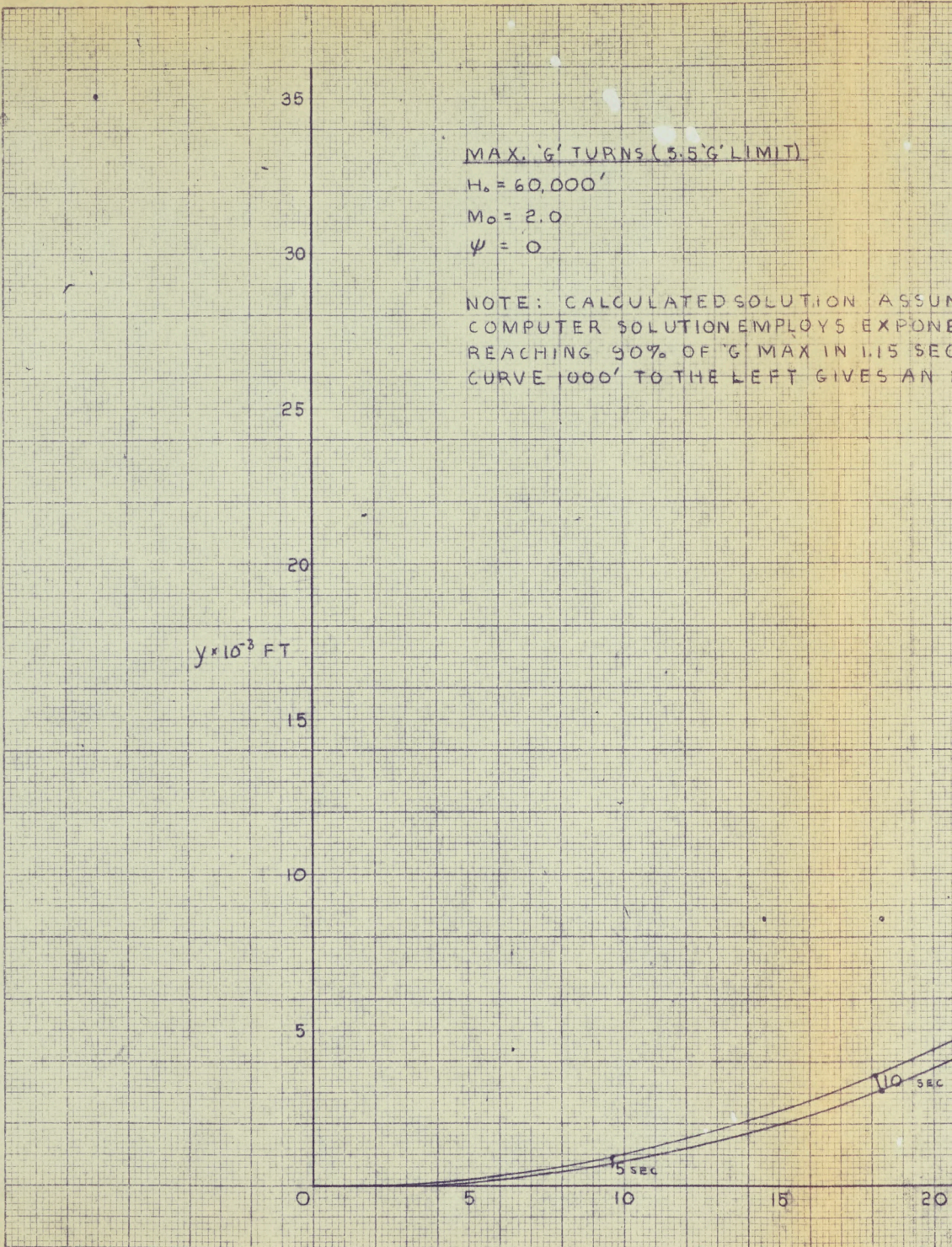
FIGURE F

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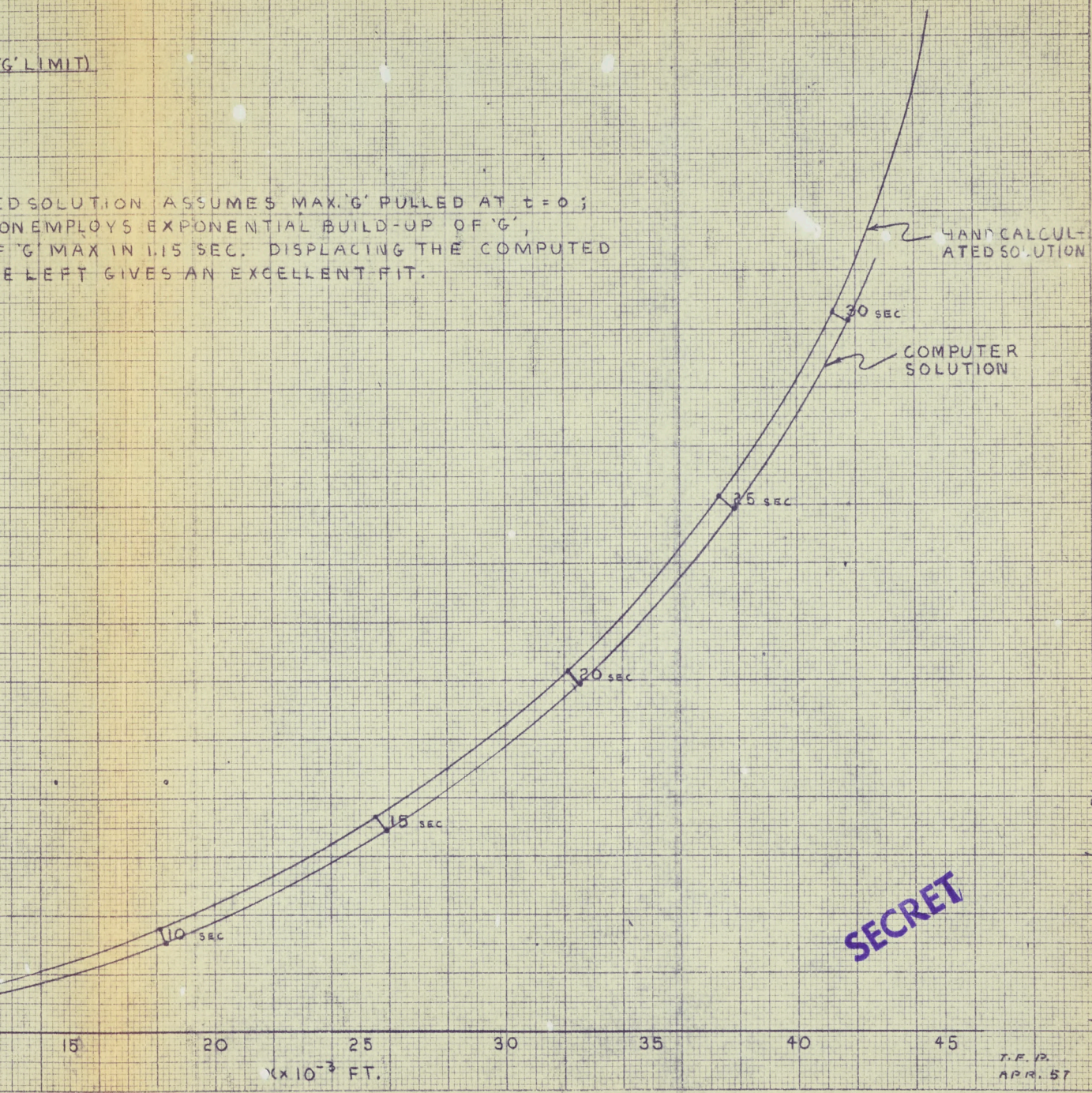
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K&E 10 X 10 TO THE 1/2 INCH 359-11L MADE IN U.S.A. KEUFFEL & ESSER CO.



G' LIMIT)

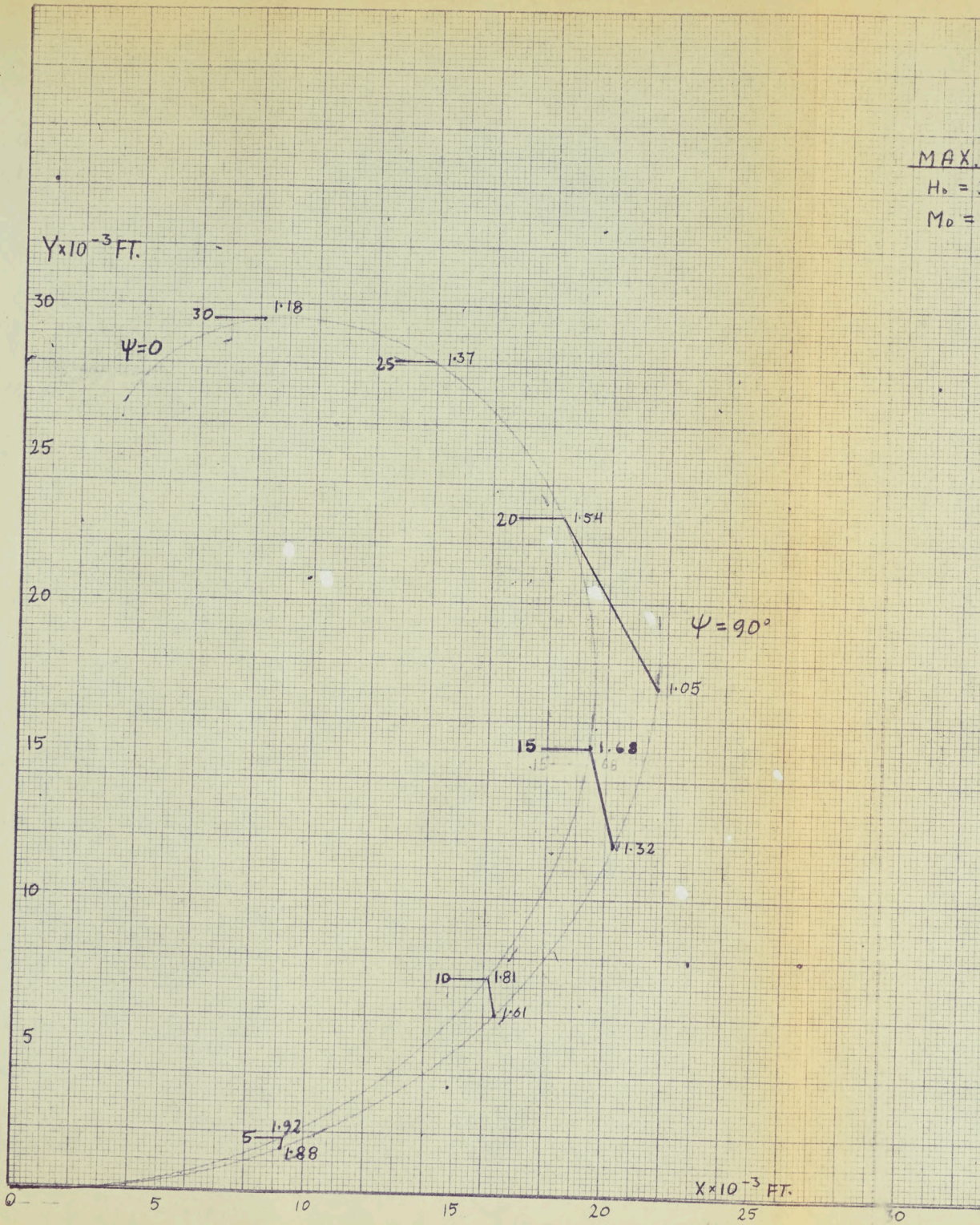
ED SOLUTION ASSUMES MAX. G' PULLED AT t=0 ;  
ON EMPLOYS EXPONENTIAL BUILD-UP OF 'G',  
E 'G' MAX IN 1.15 SEC. DISPLACING THE COMPUTED  
E LEFT GIVES AN EXCELLENT FIT.



EXTRACT 2 A 47 / A.C. MANOEUVRES / 2

T.F. 12  
APR. 57

10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
MADE IN U.S.A.



MAX. G' TURNS (5.5 G' LIMIT)

$H_0 = 36000'$

$M_0 = 2.0$

$\psi = 90^\circ$

05

**SECRET**

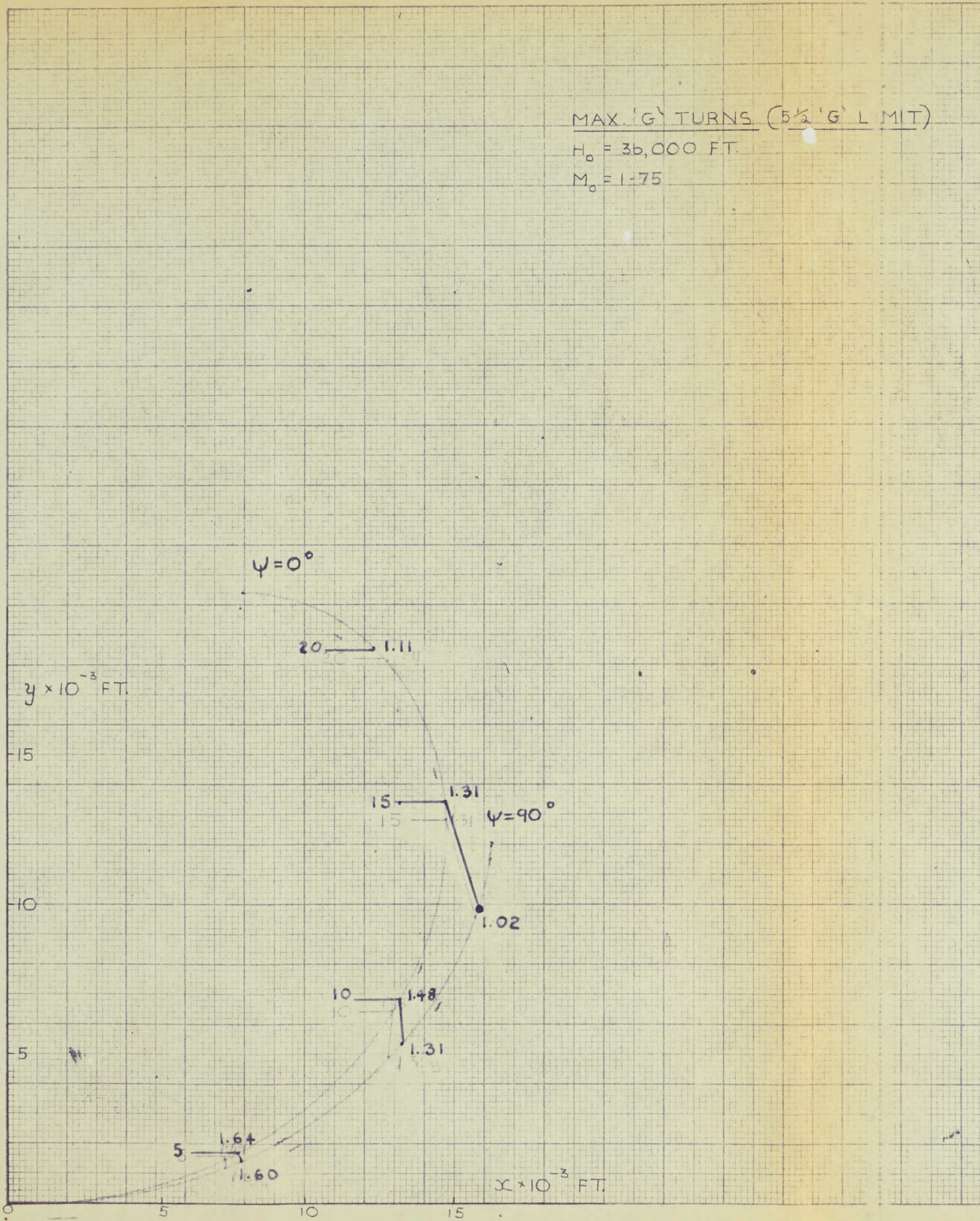
EXTRACT 2 047/A.C. MANOEUVRES/2

$X \times 10^{-3}$  FT.

25

30

K&E 10 X 10 TO THE 1/2 INCH 359-11L  
KEUFFEL & ESSER CO. MADE IN U.S.A.



URNS (5 1/2 'G' L MIT)  
0 FT.

EXTRACT 2, A47/D.C. MPROEUVRES/2

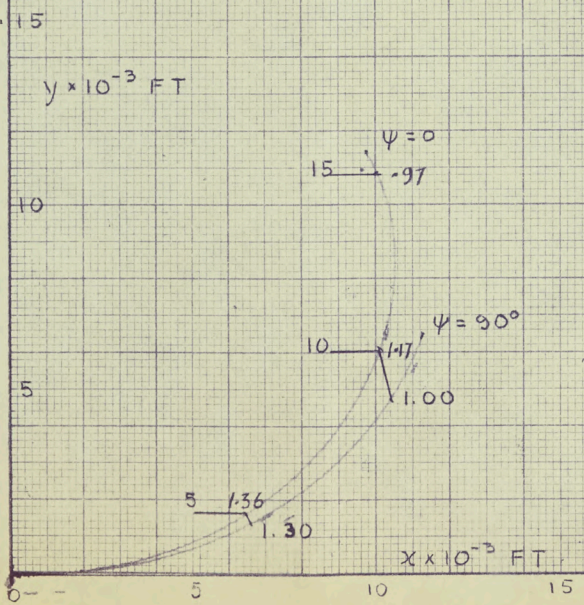
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K&E  
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
359-111L  
MADE IN U.S.A.

MAX 'G' TURNS ( $5\frac{1}{2}$  'G' LIMIT)

$H_0 = 36,000'$

$M_0 = 1.50$



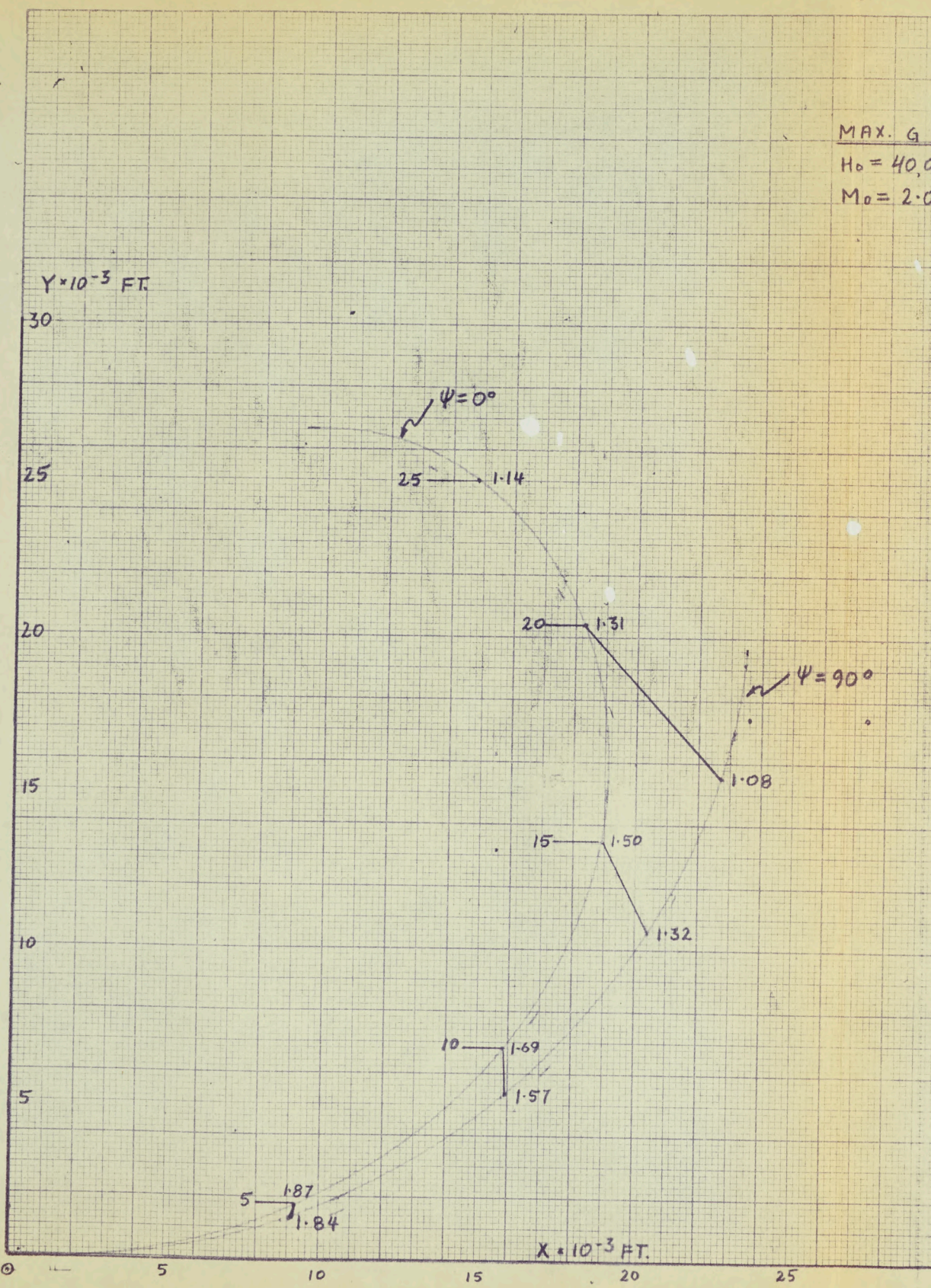
(G' LIMIT)

EXTRACT 2 A47/A.C. MANOEUVRES/2

SECRET

MAX. G  
 $H_0 = 40,0$   
 $M_0 = 2.0$

$Y \times 10^{-3}$  FT.



10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
MADE IN U.S.A.



359-11L

MAX. G TURNS (5.5 G LIMIT)

$H_0 = 40,000'$

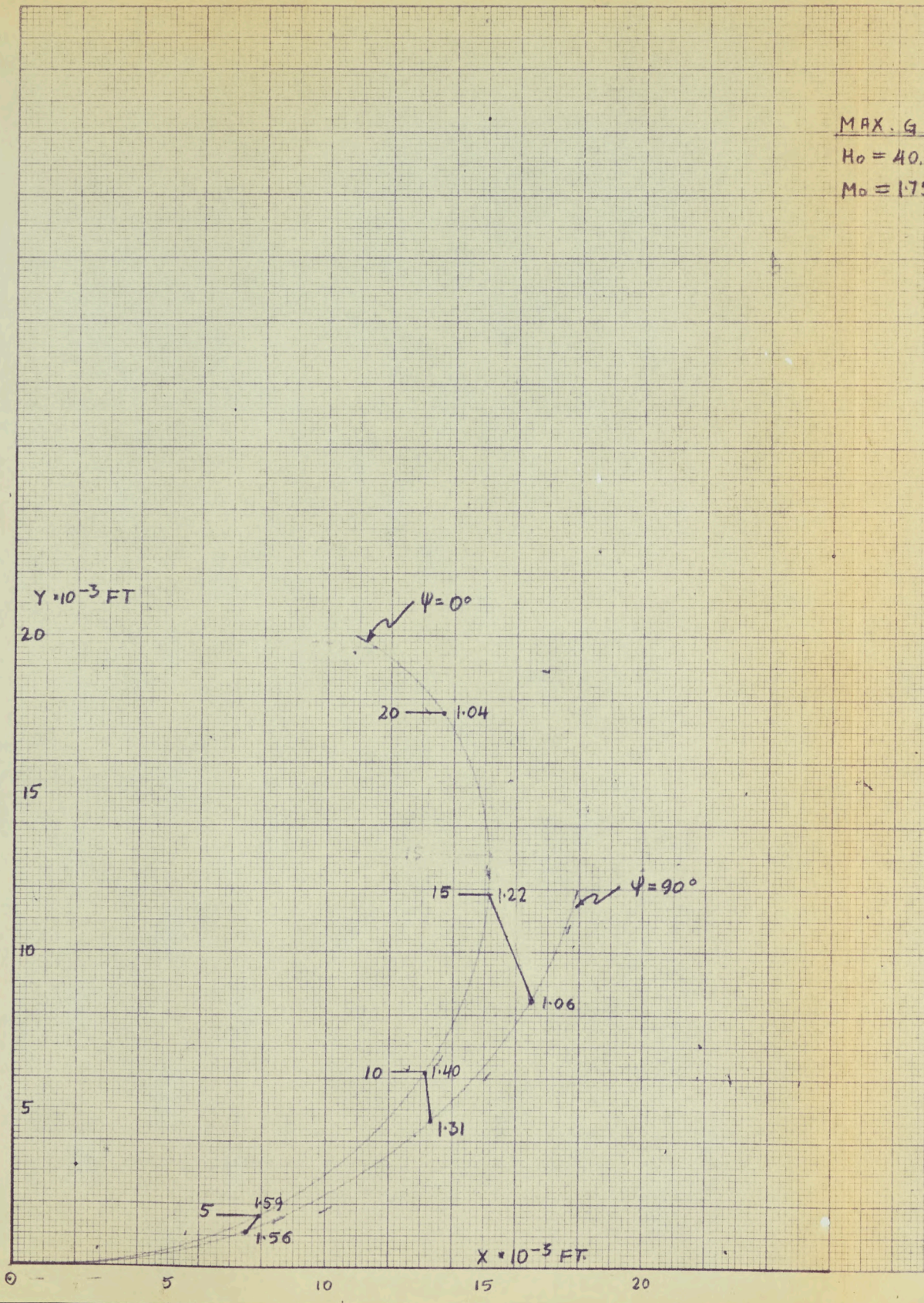
$M_0 = 2.00$

90°

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EXTRACT 2 R471/R.C. MANOEUVRES/2

KE  
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
MADE IN U.S.A.  
359-11L



MAX. G  
H<sub>0</sub> = 40  
M<sub>0</sub> = 1.75

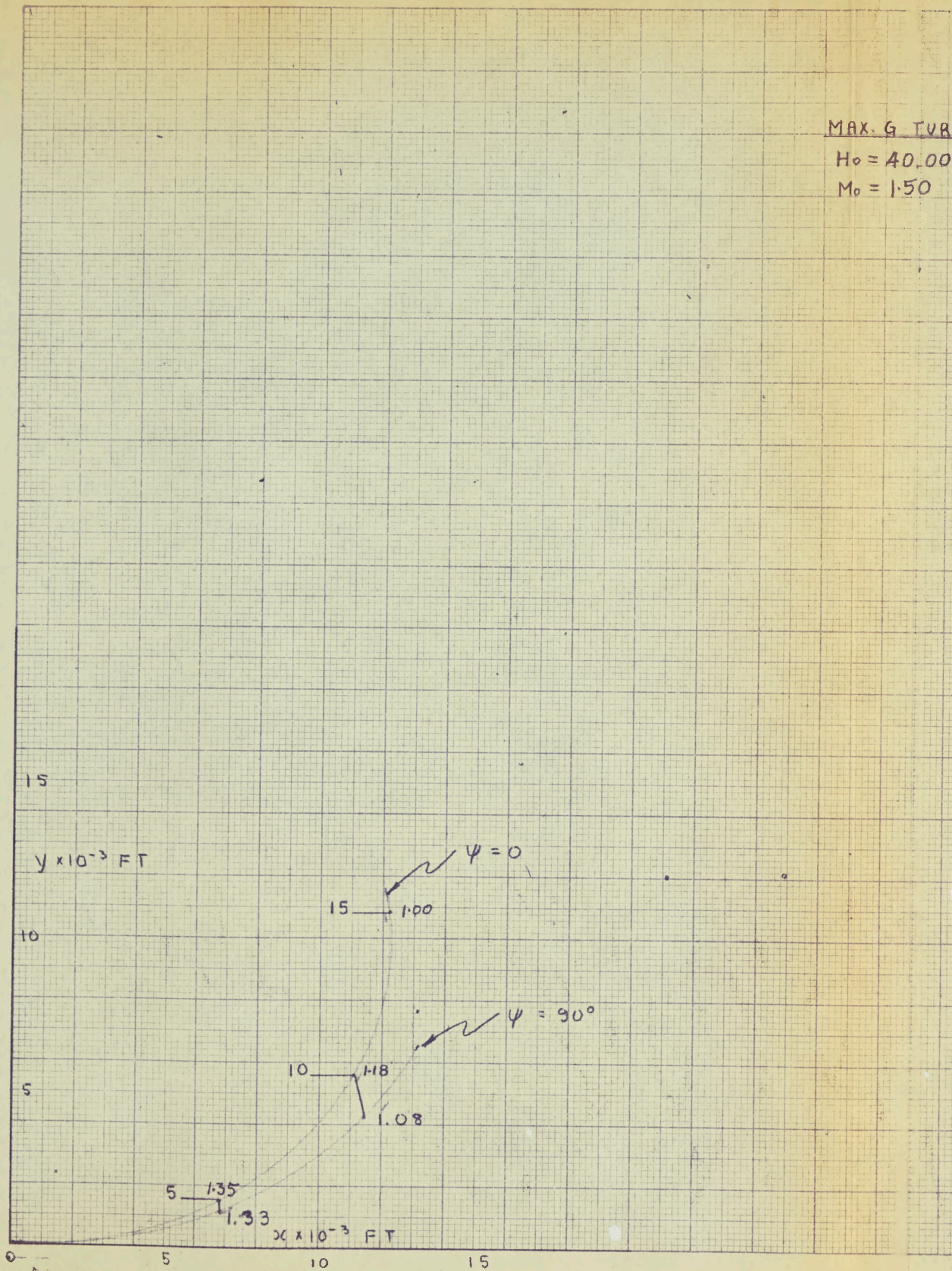
MAX. G TURNS (5.5 G LIMIT)

$H_0 = 40,000'$

$M_0 = 1.75$

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K&E  
10 X 10 TO THE 1/4 INCH  
KEUFFEL & ESSER CO.  
MADE IN U.S.A.



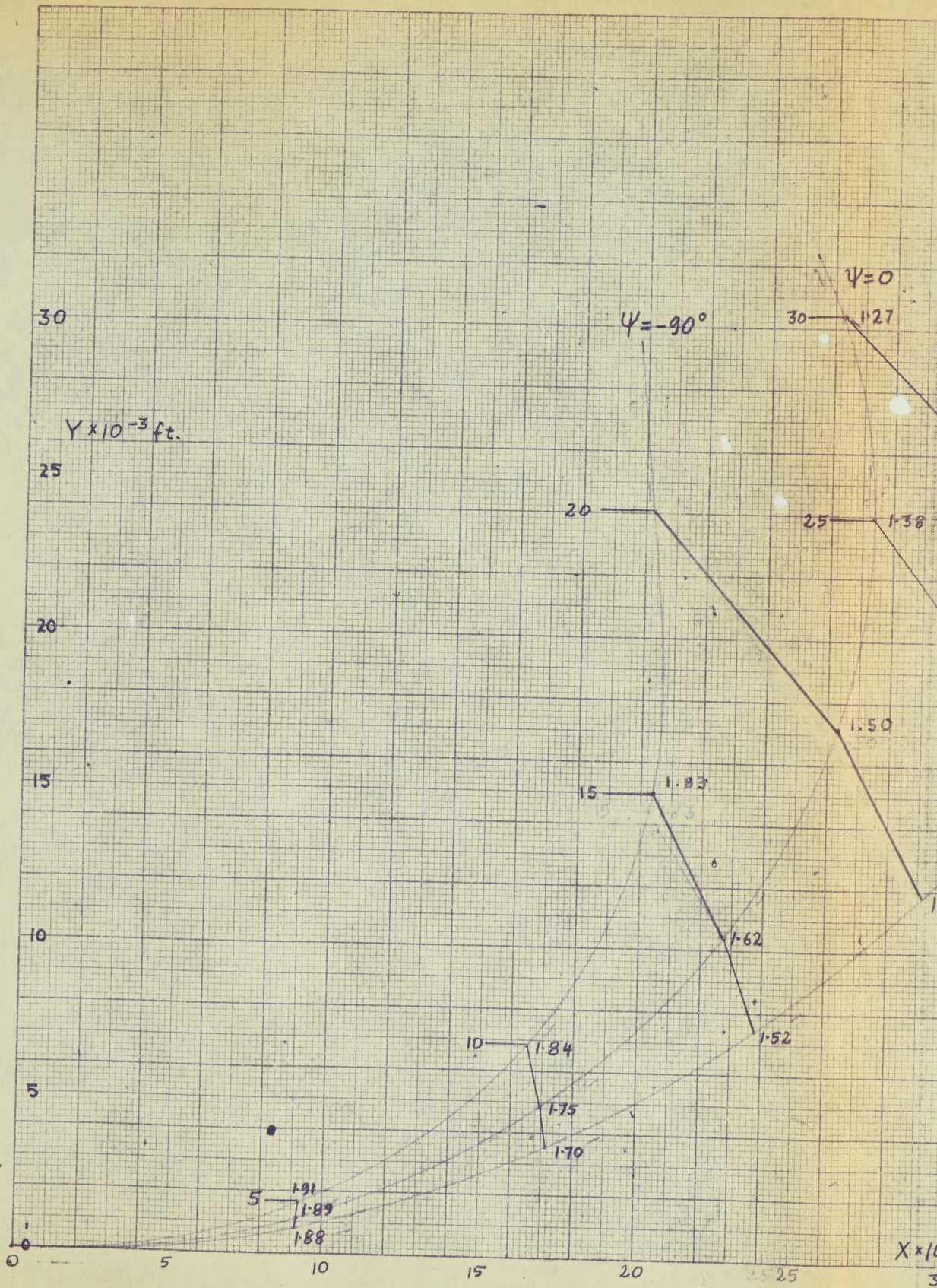
MAX. G TURNS (5.5 G LIMIT)

$H_0 = 40,000'$

$M_0 = 1.50$

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**K&E** 10 X 10 TO THE 1/2 INCH 359-11L  
 KEUFFEL & ESSER CO. MADE IN U.S.A.

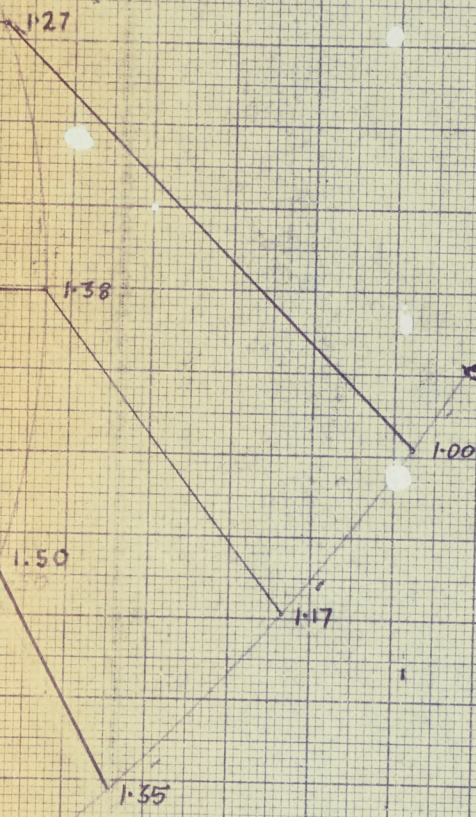


### MAXIMUM "G" TURNS (3.5G LIMIT)

$H_0 = 50000'$

$M_0 = 2.0$

$\psi = 0$



EXTRACT: A47/P.C. MANOEUVRES 12

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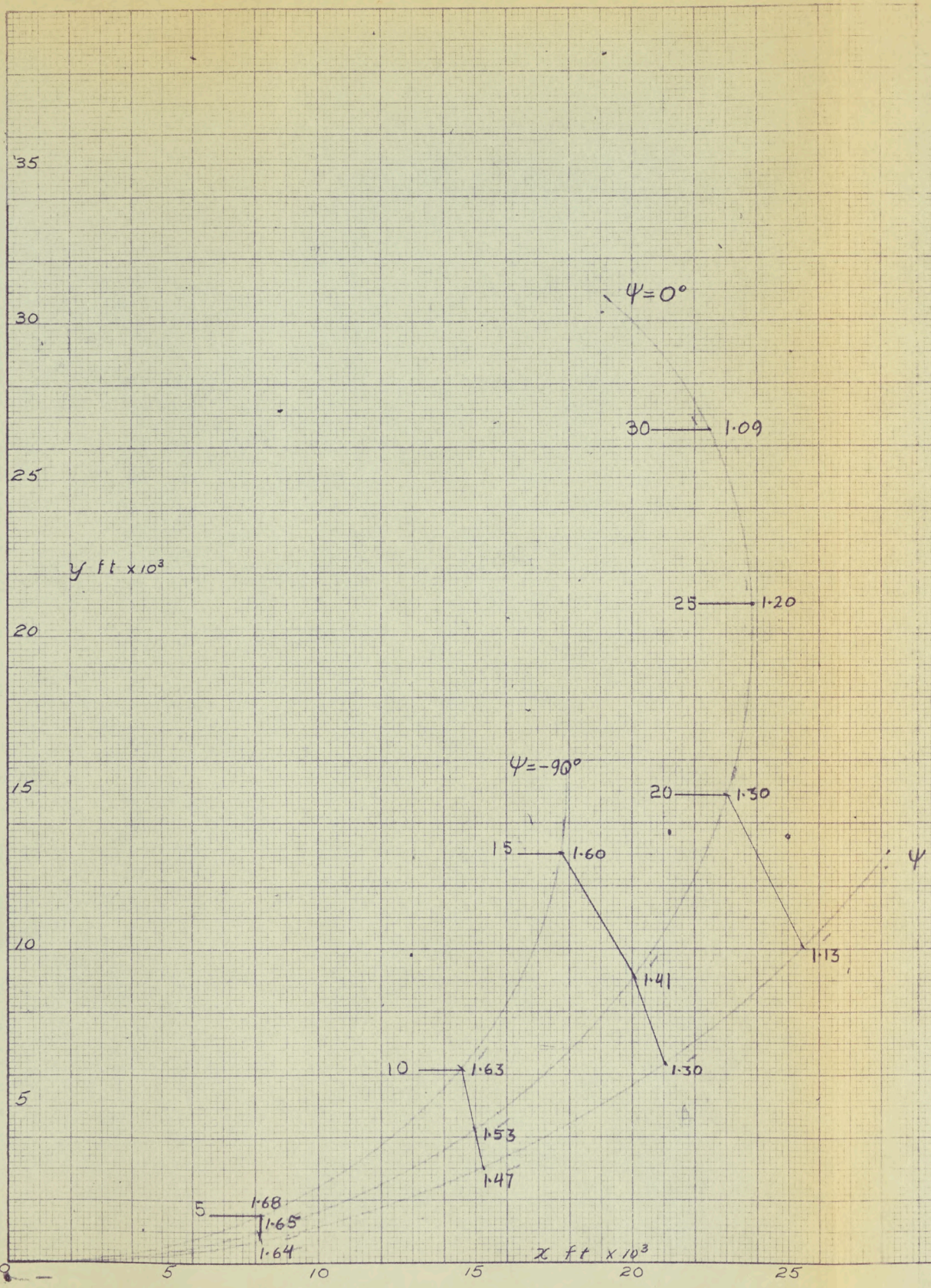
$X \times 10^{-3}$  ft.

30

35

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K&E 10 X 10 TO THE 1/2 INCH 359-111L KEUFFEL & ESSER CO. MADE IN U.S.A.



MAXIMUM 'G' TURNS (5.5 'G' LIMIT)

$H_0 = 50,000'$

$M_0 = 1.75$

$\psi = 90^\circ$

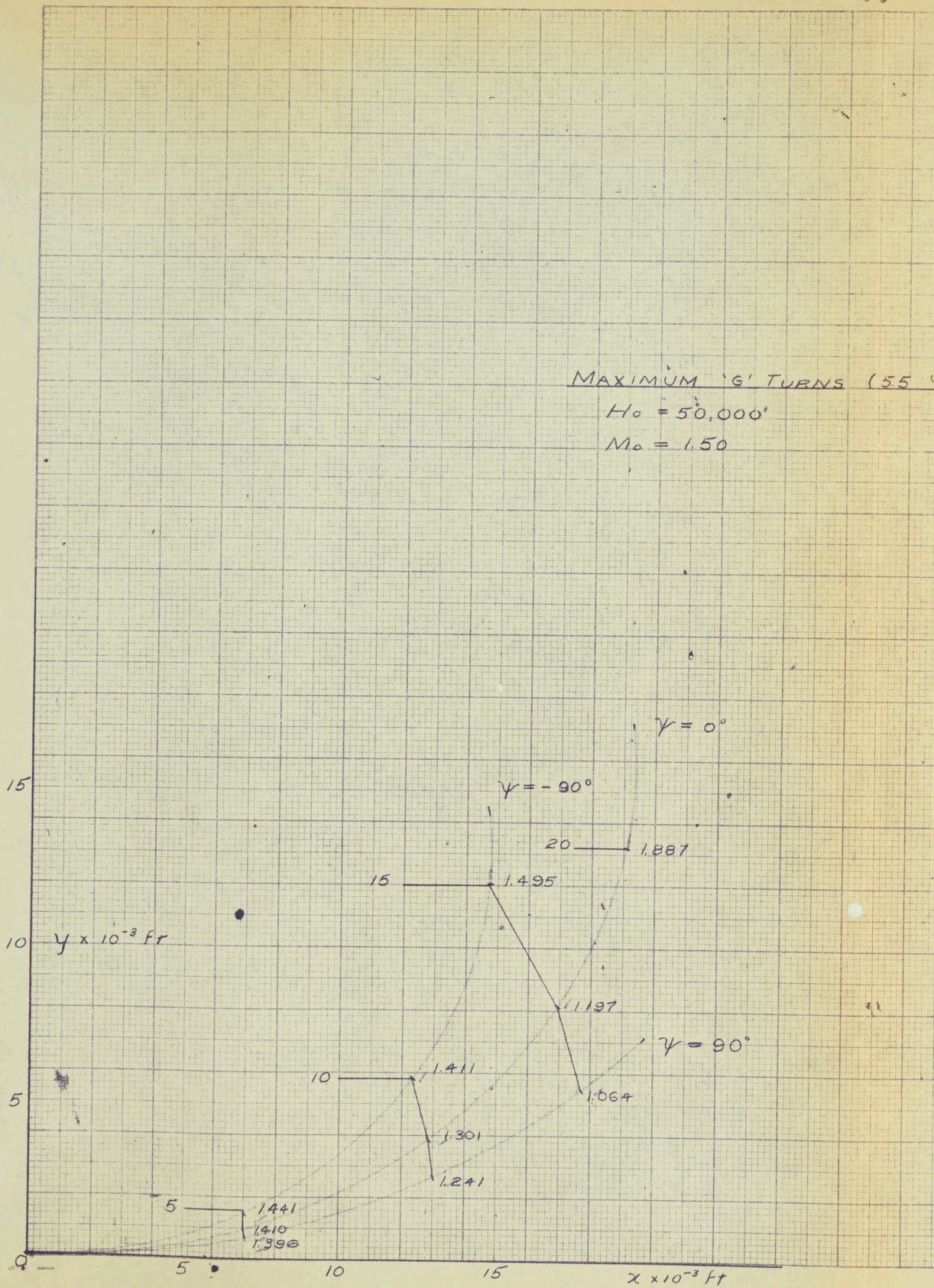
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EXTRACT R47/H.C. MANOEUVRE S/P

10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
MADE IN U.S.A.

K&E



(55 'g' LIMIT)

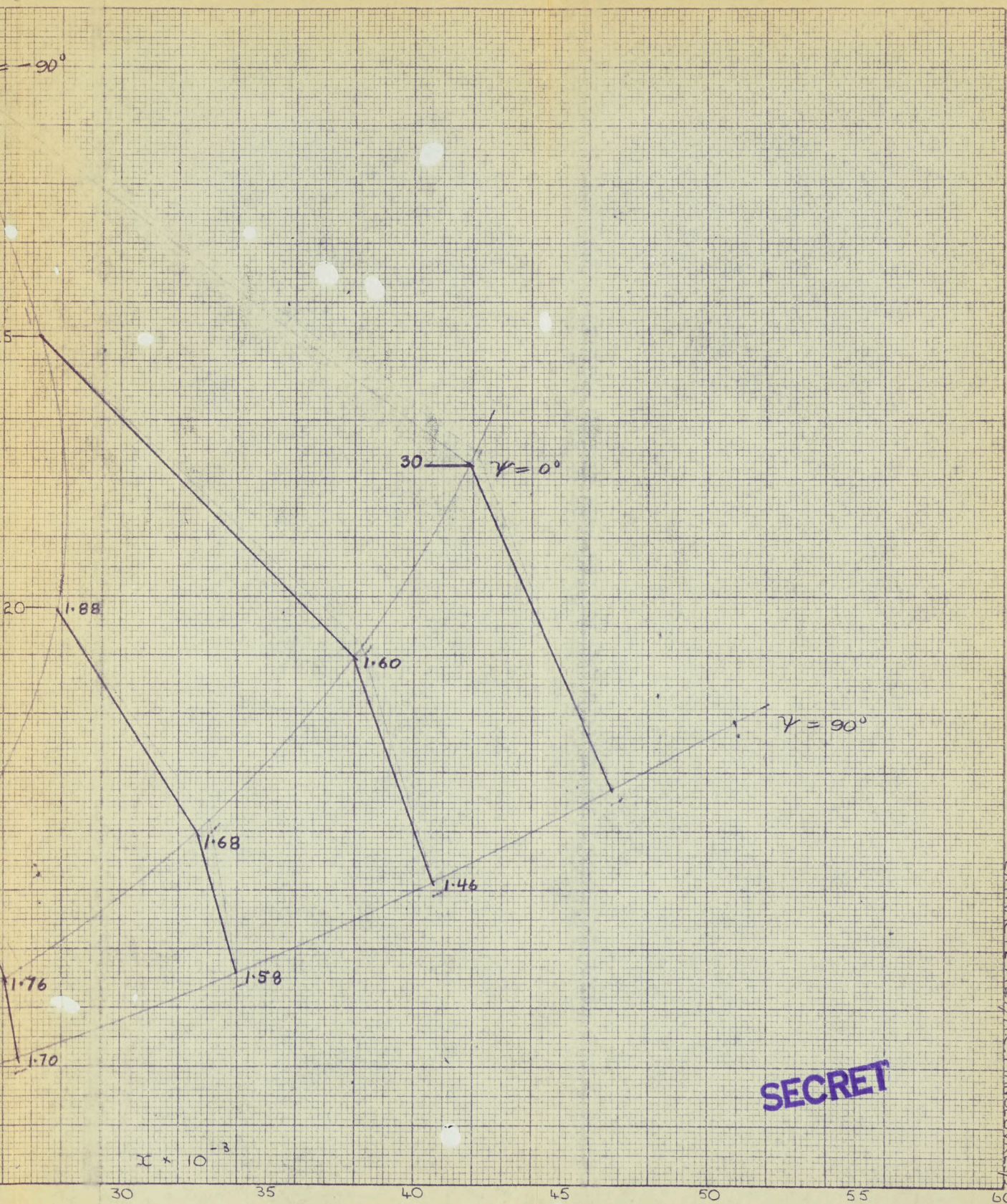
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**SECRET**

EXTRACTS A47/A.C. MANOEUVRES/P

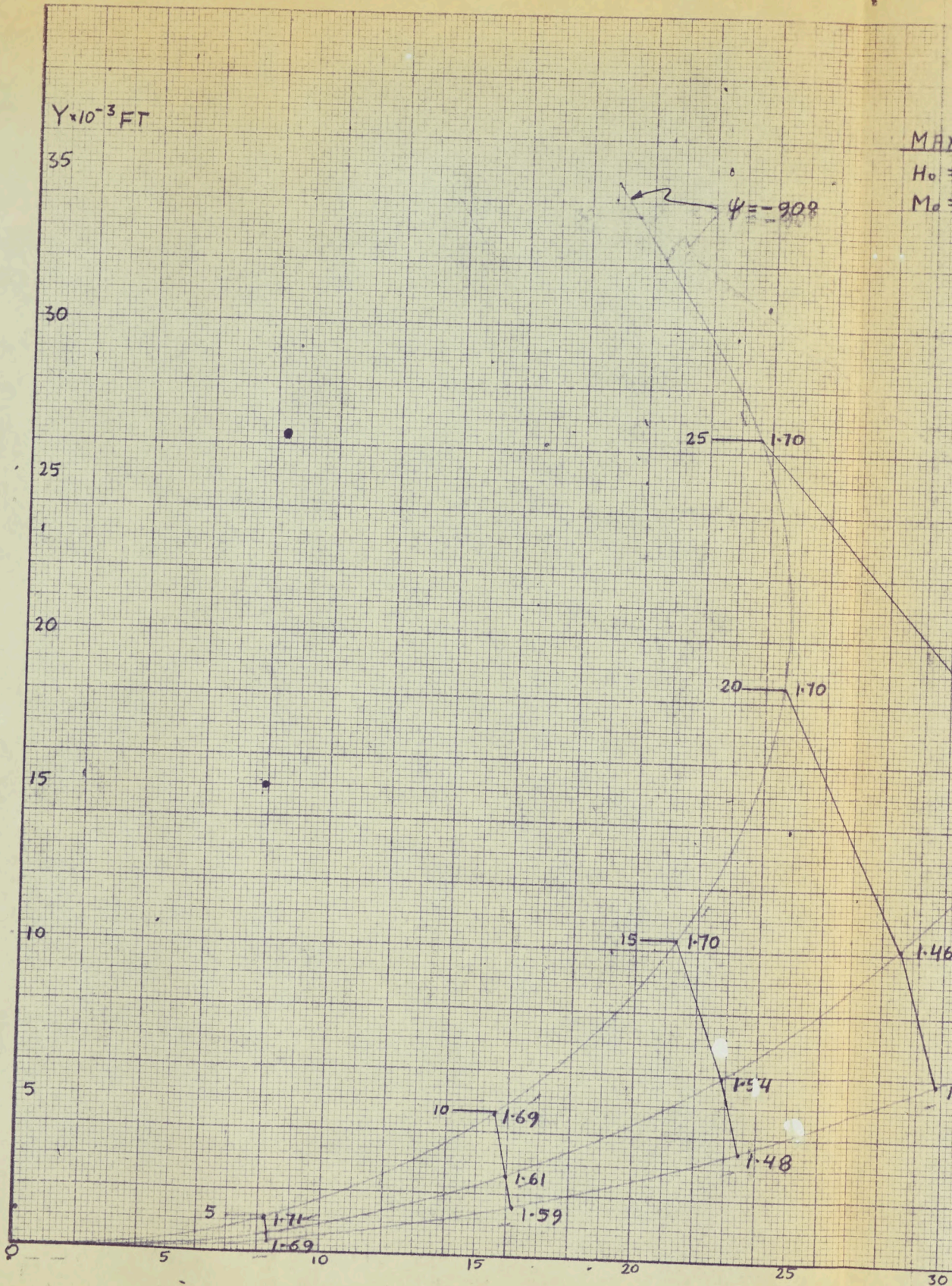
K&W  
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
MADE IN U.S.A.  
359-11L





EXTRACT 2 AL7/A.C. MANOEUVRES/9

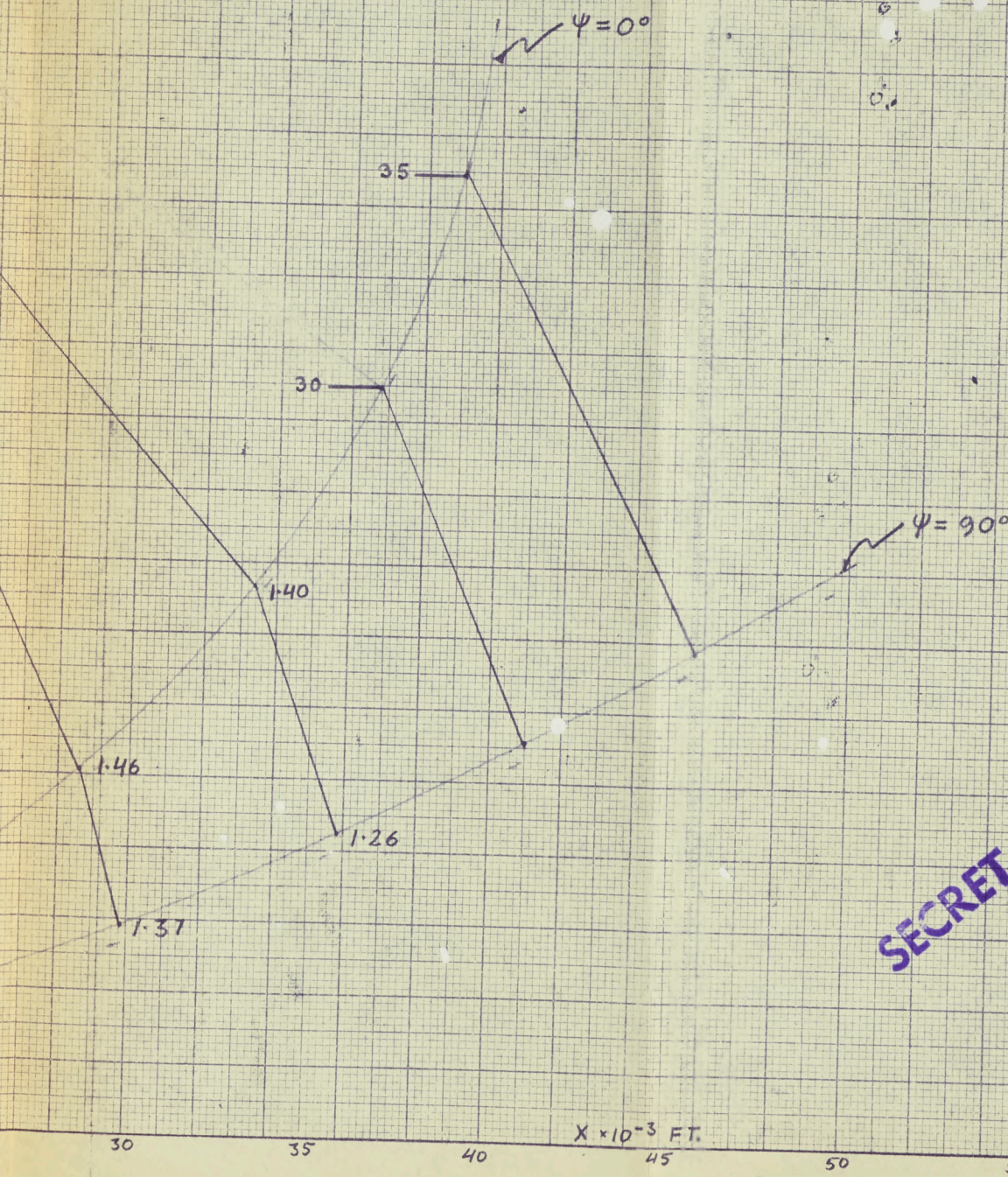
K&E 10 X 10 TO THE 1/2 INCH 339-111  
KEUFFEL & ESSNER CO. MADE IN U.S.A.



MAX. G TURNS (5.5 G LIMIT)

$H_0 = 60,000'$

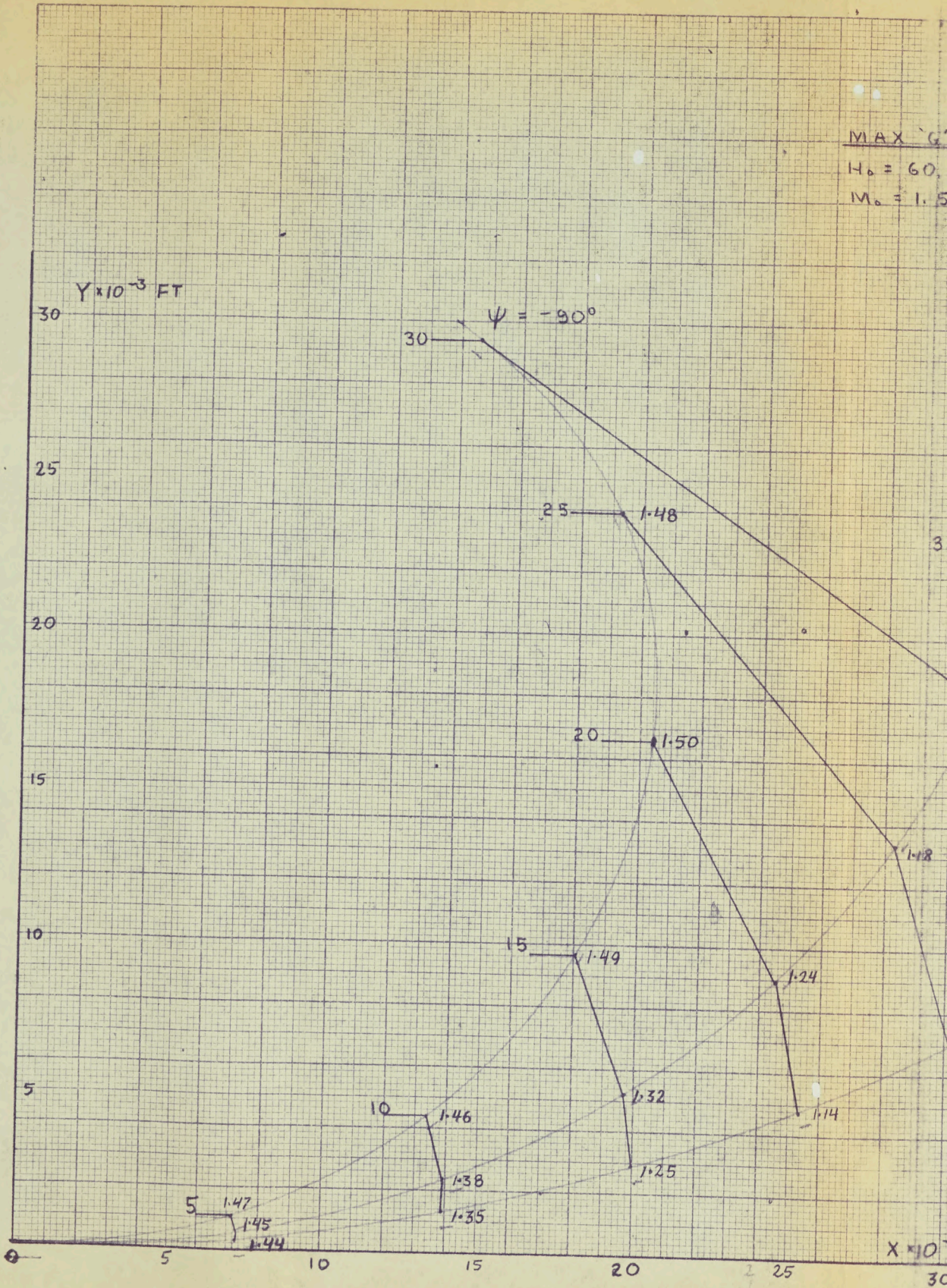
$M_0 = 1.75$



**SECRET**

EXTRACT 2 24719-C. MANOEUVRES/2

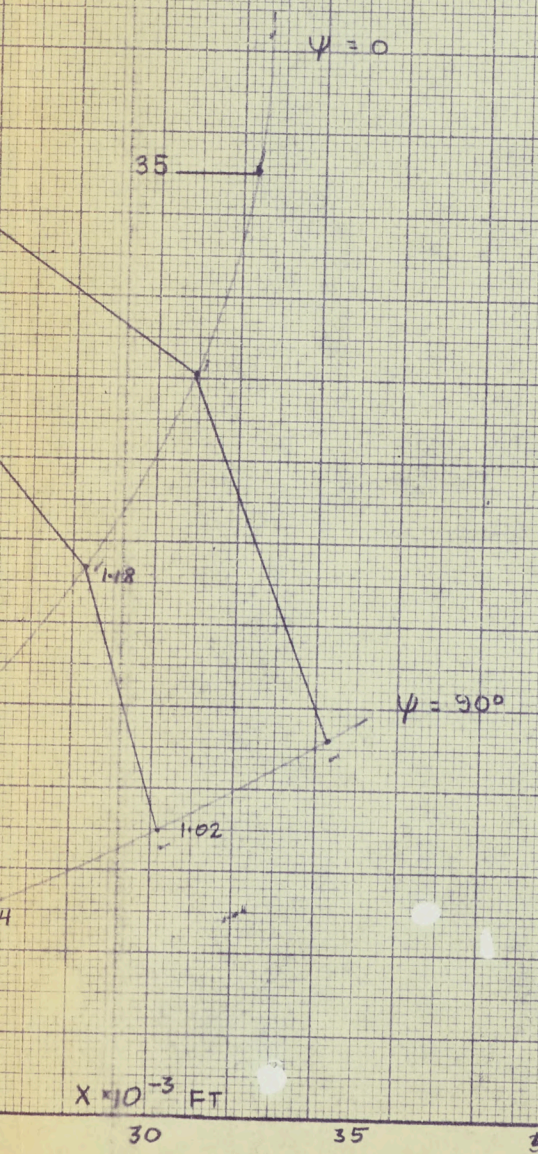
K&E  
10 X 10 TO THE 1/8 INCH  
KEUFFEL & ESSER CO.  
MADE IN U.S.A.



MAX 'G' TURNS (5.5 'G' LIMIT)

H<sub>0</sub> = 60,000'

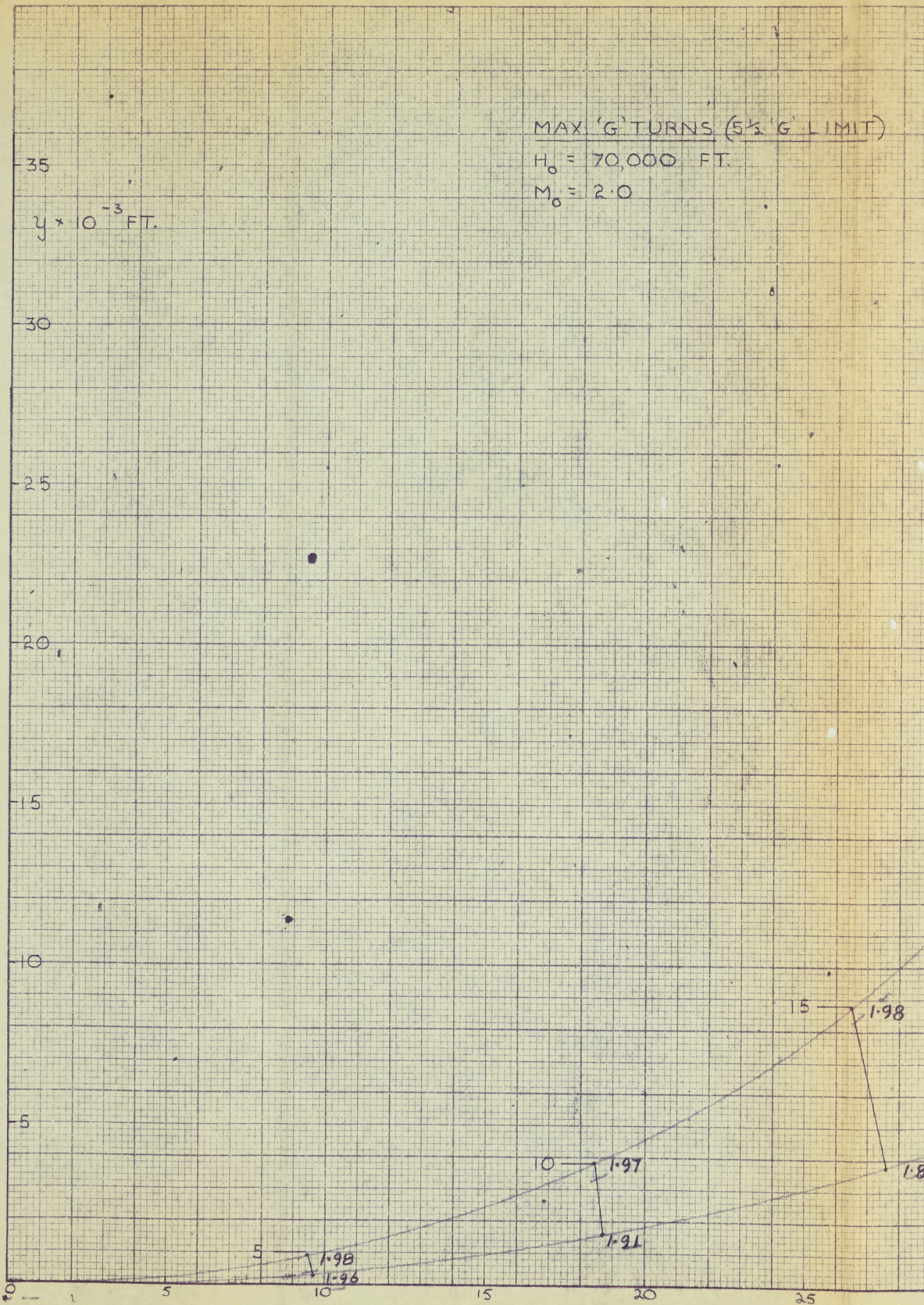
M<sub>0</sub> = 1.50



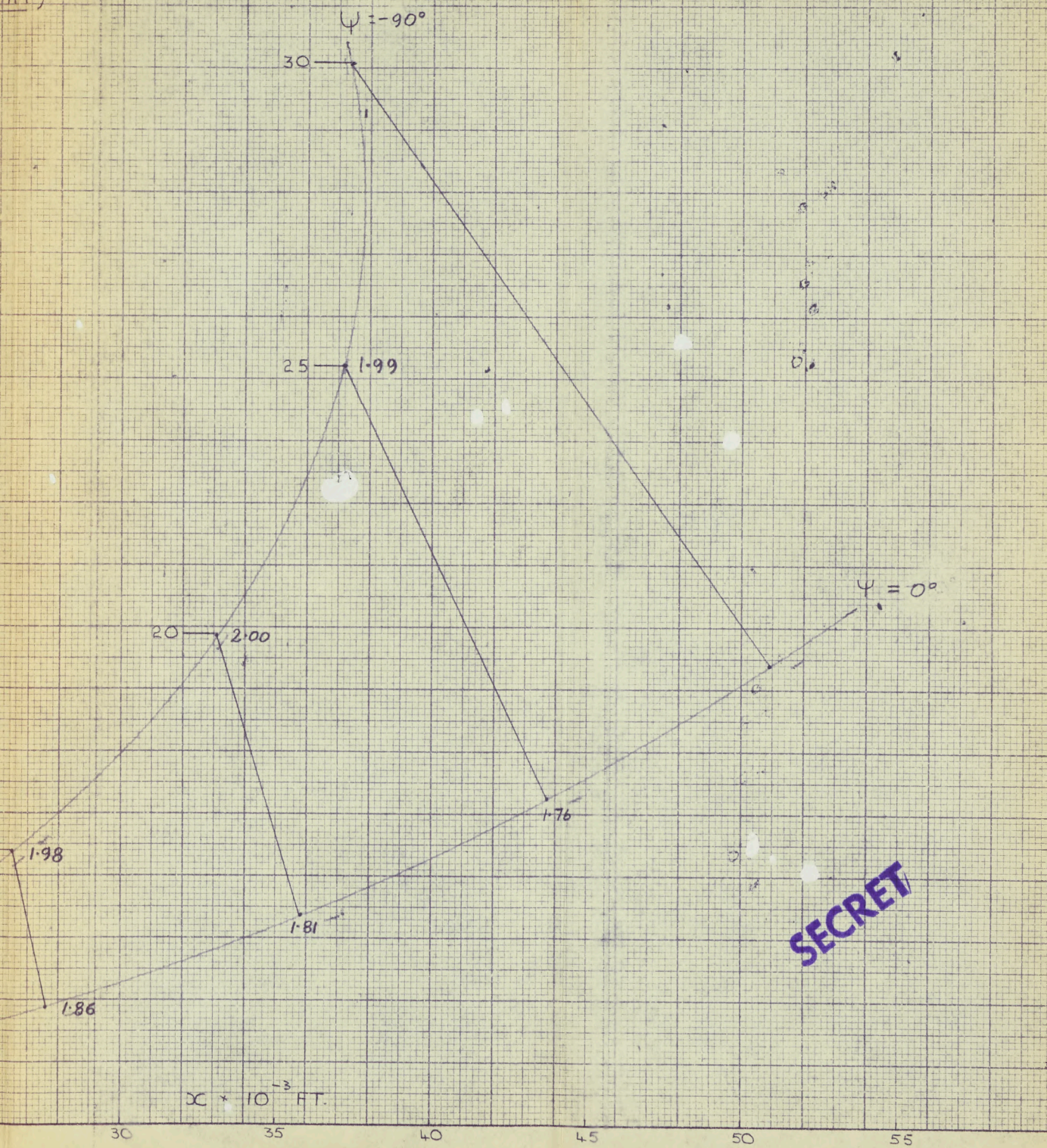
SECRET

EXTRACT 1447/AC, MANOEUVRES/2

K&E  
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
MADE IN U.S.A.  
359-111



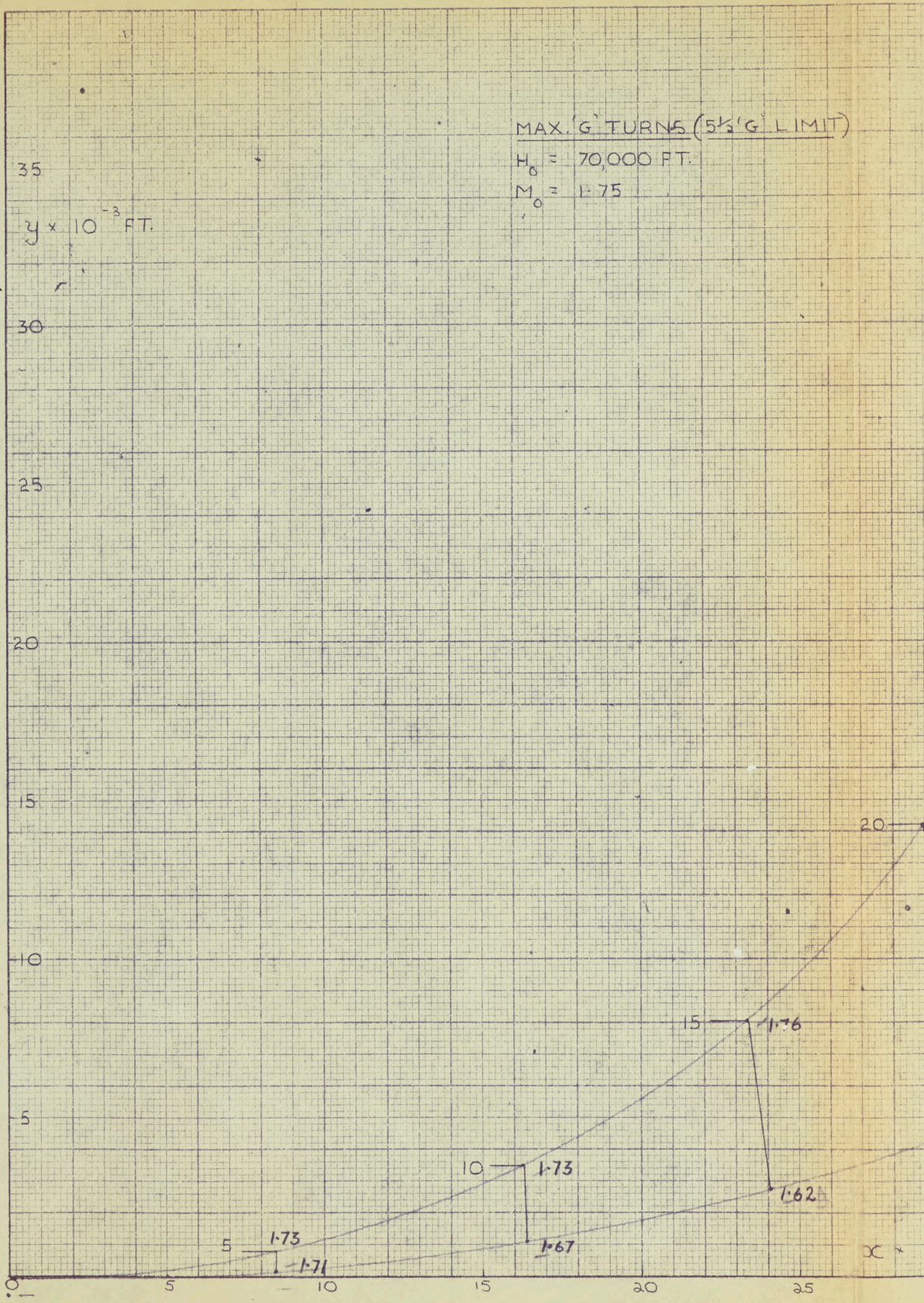
MIT)

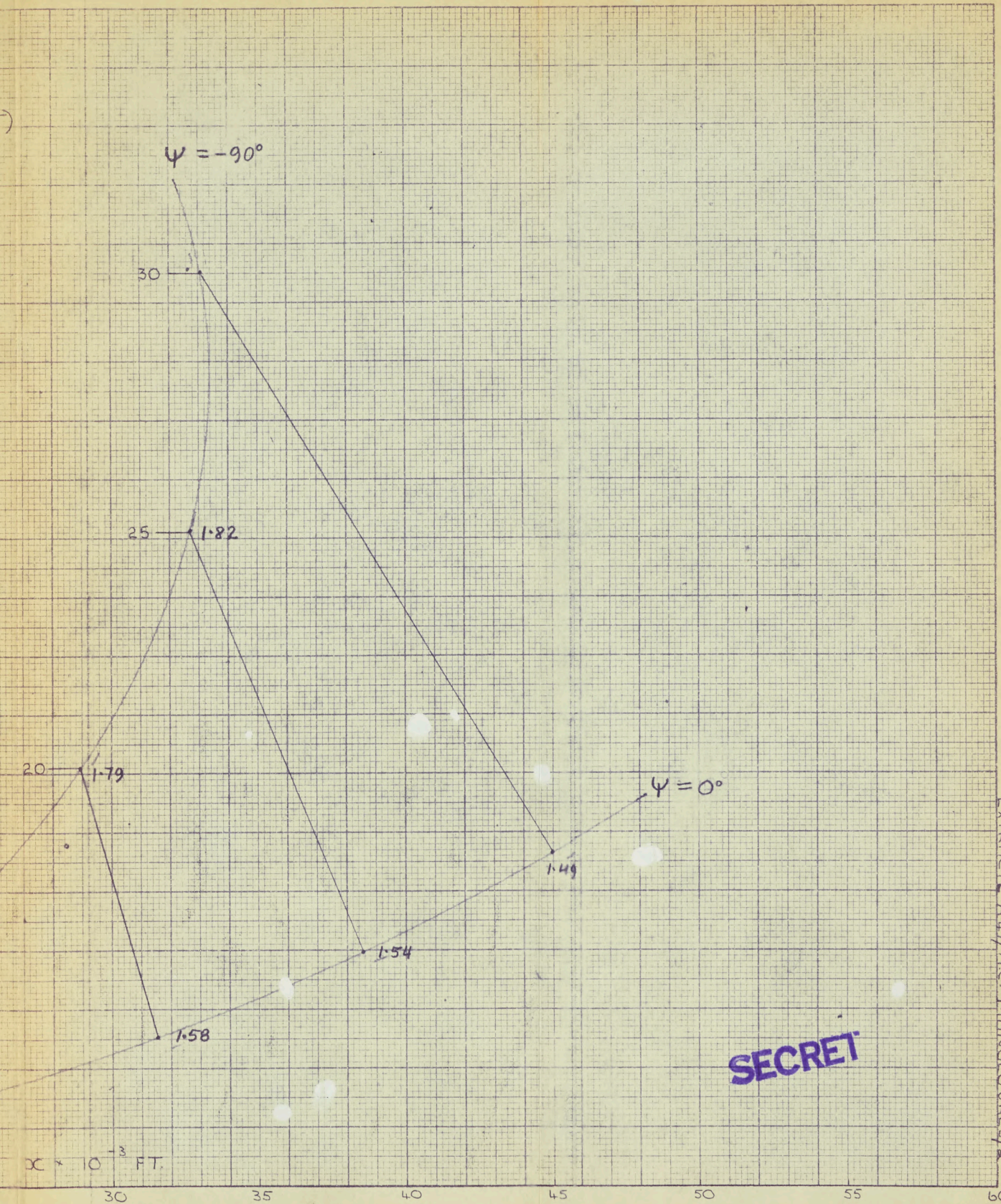


**SECRET**

EXTRACT 47/A.C. MANOEUVRES/2

K&W  
10 X 10 TO THE 1/4 INCH  
KEUFFEL & ESSER CO.  
359-11L  
MADE IN U.S.A.

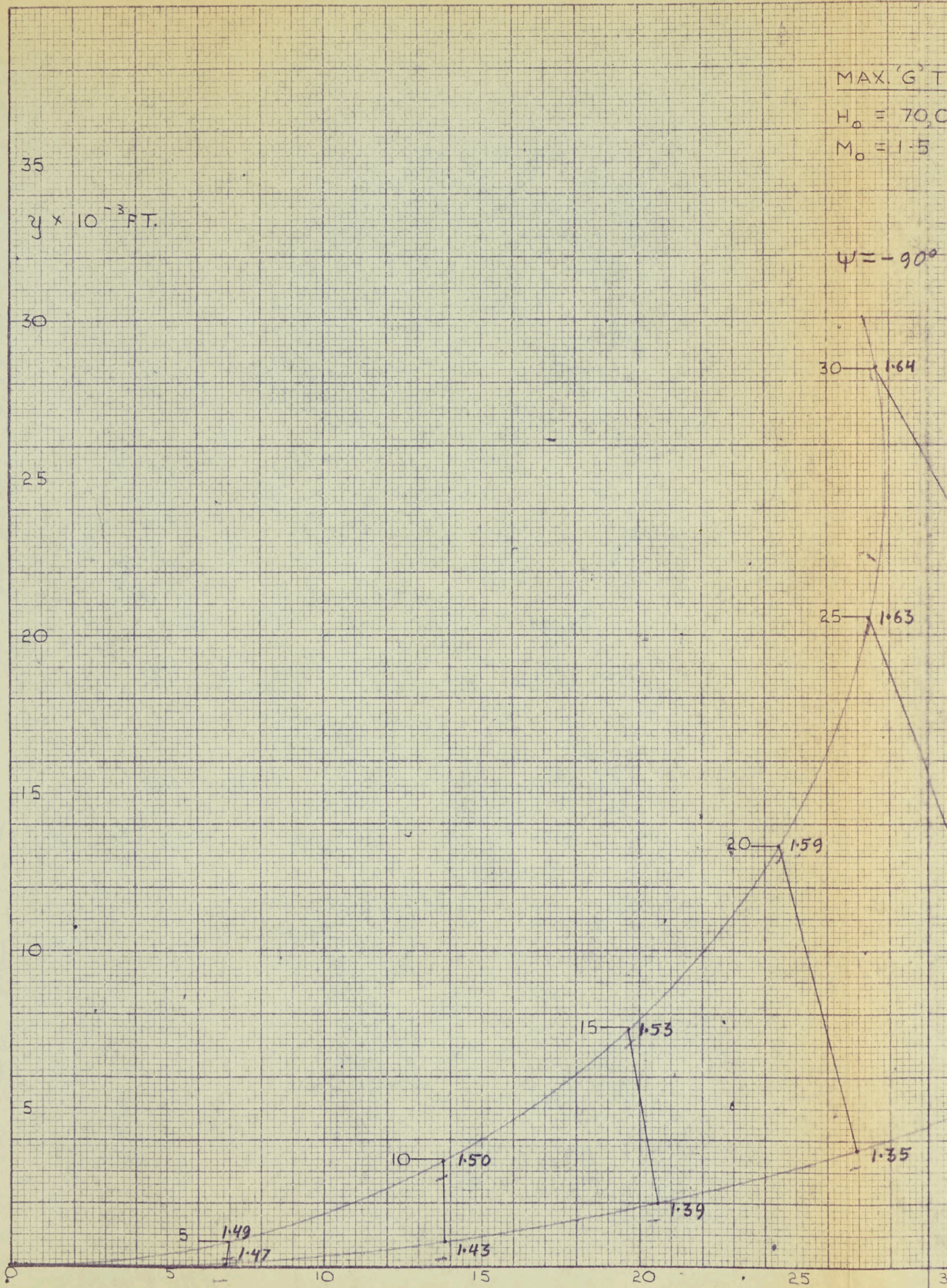




EXTRACT 2 A17/AS. MANOEUVRES/2

**SECRET**

K&E 10 X 10 TO THE 1/2 INCH KEUFFEL & ESSER CO. MADE IN U.S.A. 359-111L

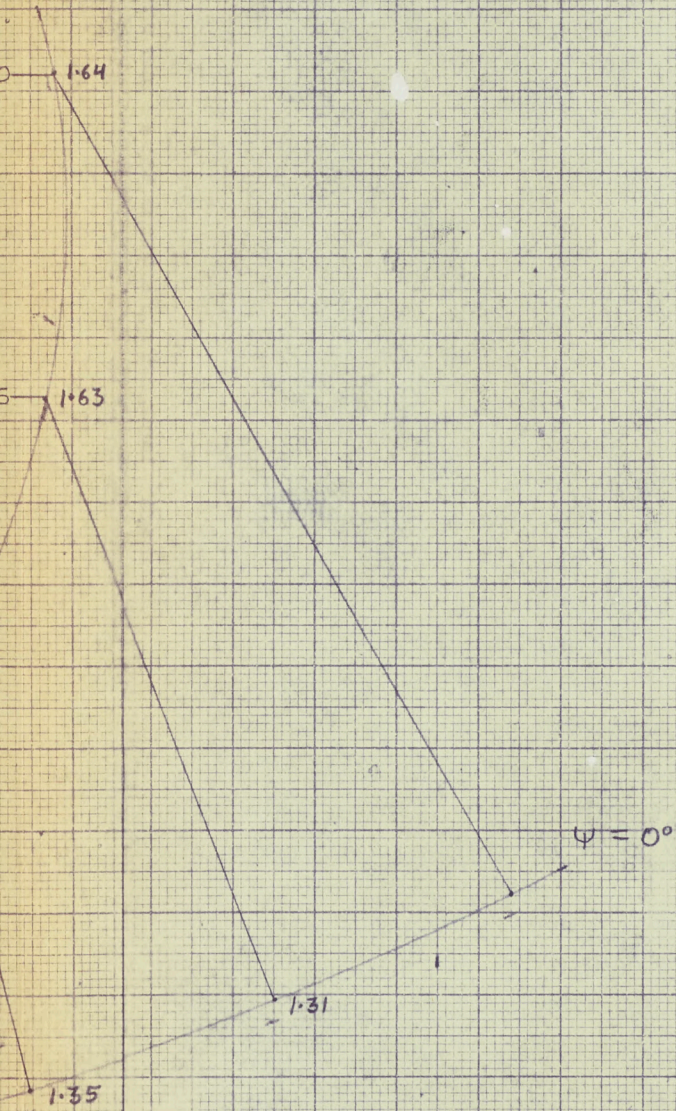


MAX. 'G' TURNS (5½ 'G' LIMIT)

H<sub>0</sub> = 70,000 FT.

M<sub>0</sub> = 1.5

ψ = -90°

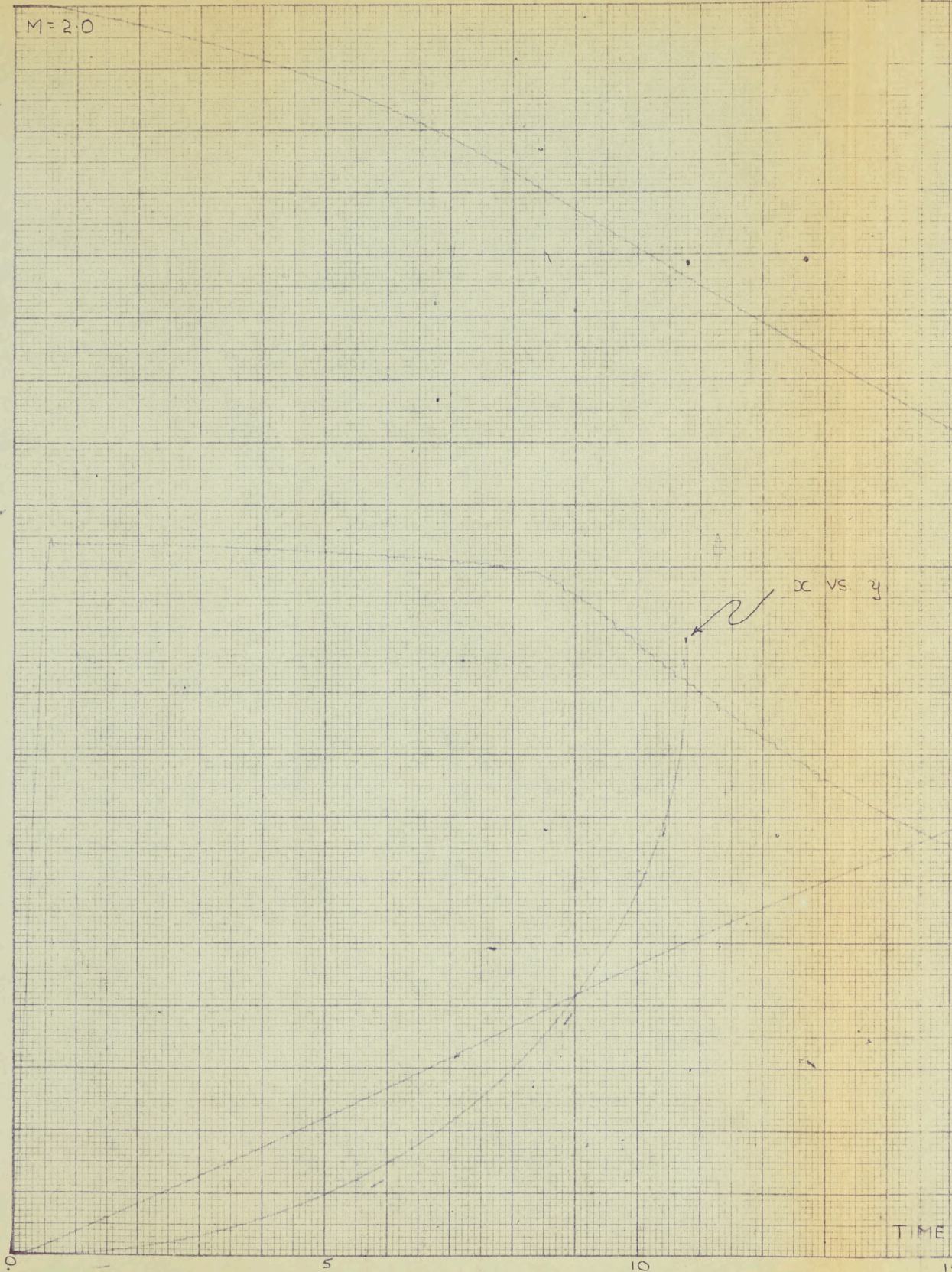


$x \times 10^{-3} = T$

SECRET

EXTRACT 2A17/PAC. MANOEUVRES/2 0

M=2.0



359-11L  
MADE IN U.S.A.

10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.



TIME

MAX. 'G' TURNS (5½ 'G' LIMIT)

$H_0 = 36,000$  FT

$M_0 = 2.0$

$\psi = 90^\circ$

$M = 0.1$

$\eta = 0.5$  'G'

$\theta = 10^\circ$

VS  $\eta$

$M$

$\eta$

TIME (SEC.)

15

20

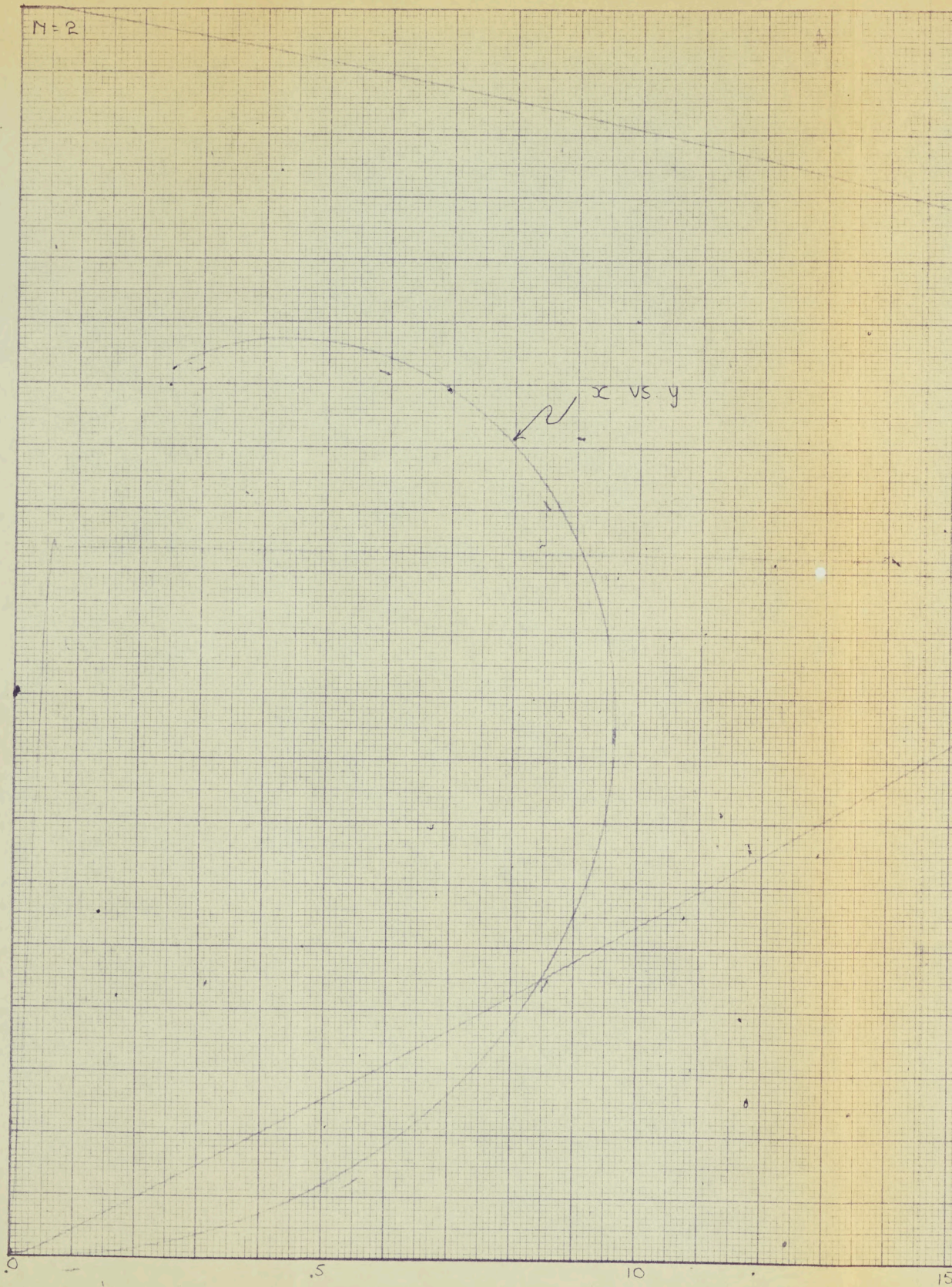
25

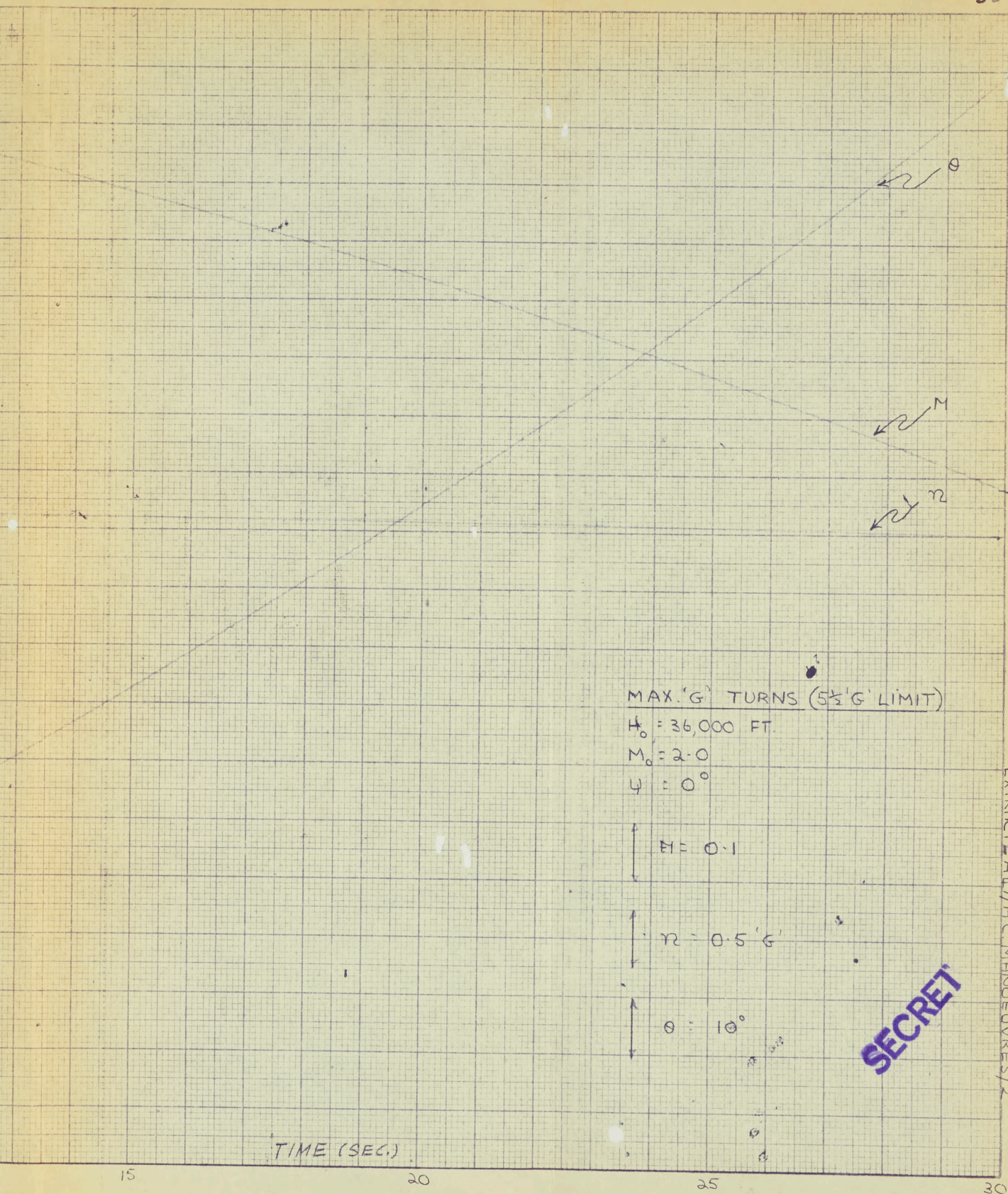
30

**SECRET**

EXTRACT 2 A47/A.C. MANOEUVRES 12

**KE**  
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
MADE IN U.S.A.  
359-11L






15

20

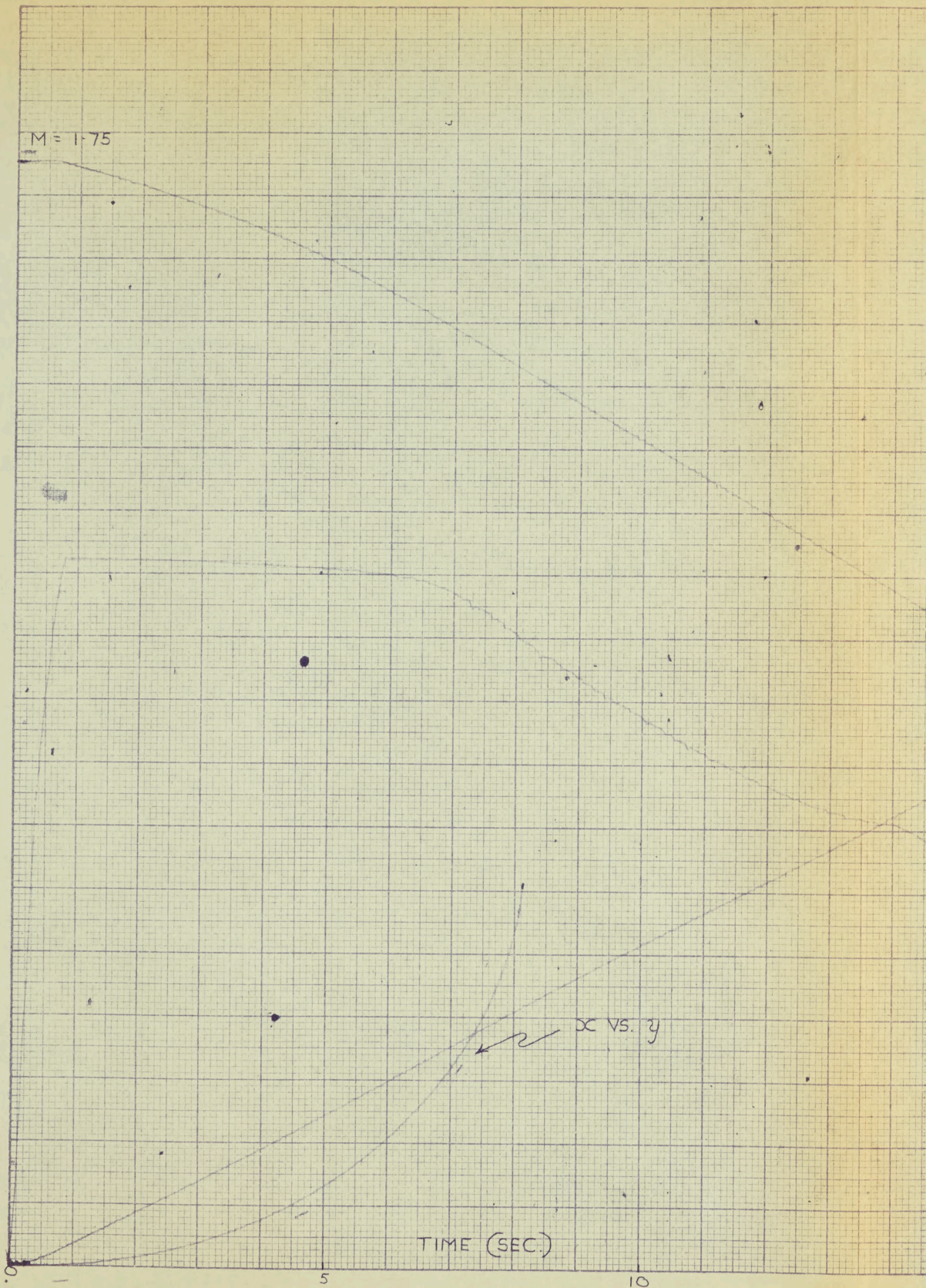
25

30

0.0

 10 X 10 TO THE 1/4 INCH  
KEUFFEL & ESSER CO.  
MADE IN U.S.A.

$M = 1.75$



MAX. 'G' TURNS ( $5\frac{1}{2}$  'G' LIMIT)

$$H_0 = 36,000 \text{ FT.}$$

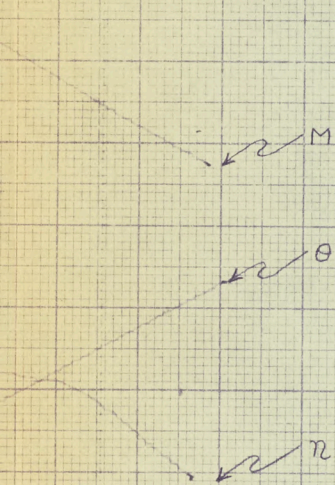
$$M_0 = 1.75$$

$$\psi = +90^\circ$$

$$M = 0.1$$

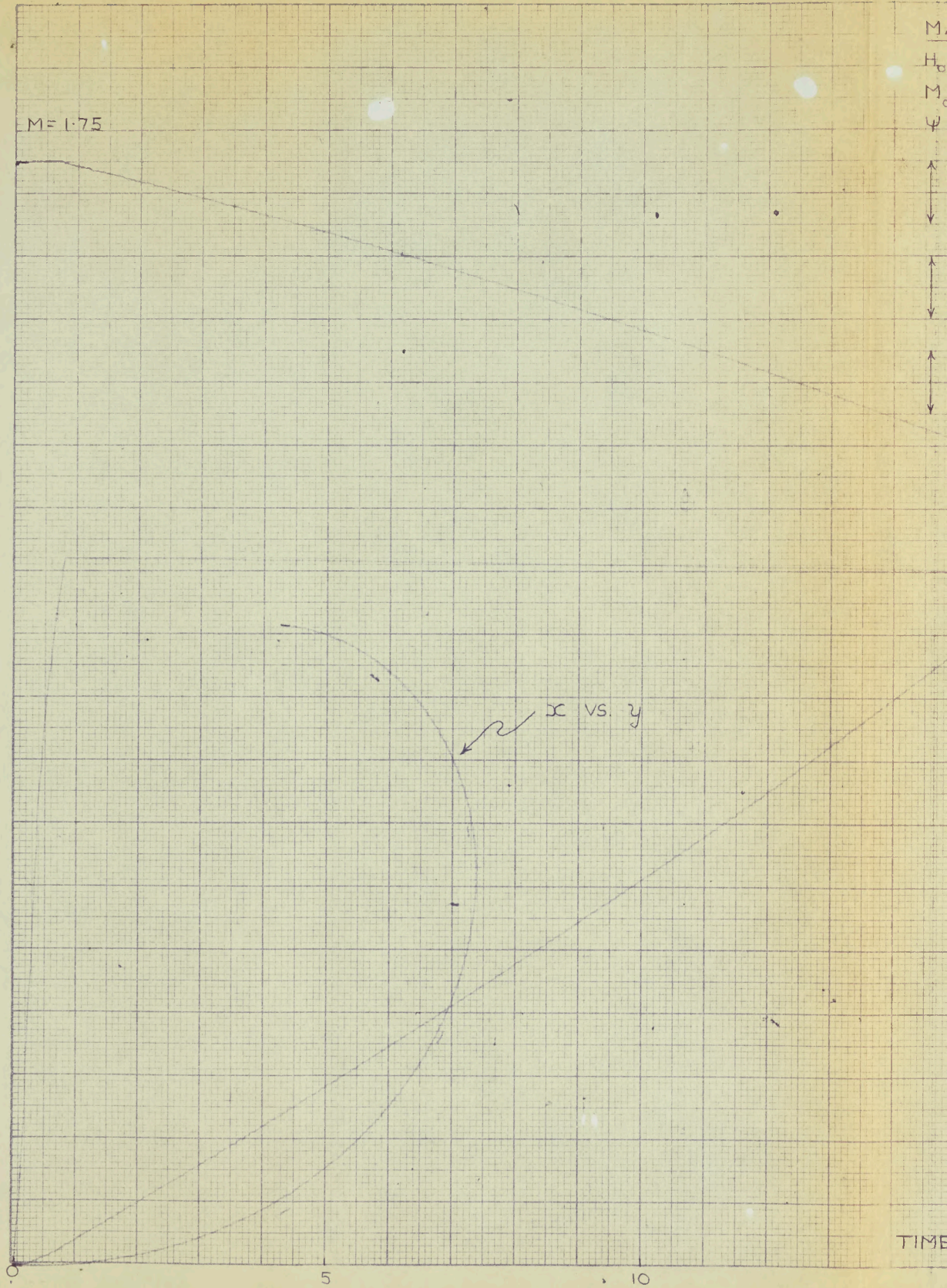
$$n = 0.5 \text{ 'G'}$$

$$\theta = 10^\circ$$



**SECRET**

K&E  
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
359-11L  
MADE IN U.S.A.



MAX. 'G' TURNS (5 1/2 'G' LIMIT)

H<sub>0</sub> = 36,000 FT.

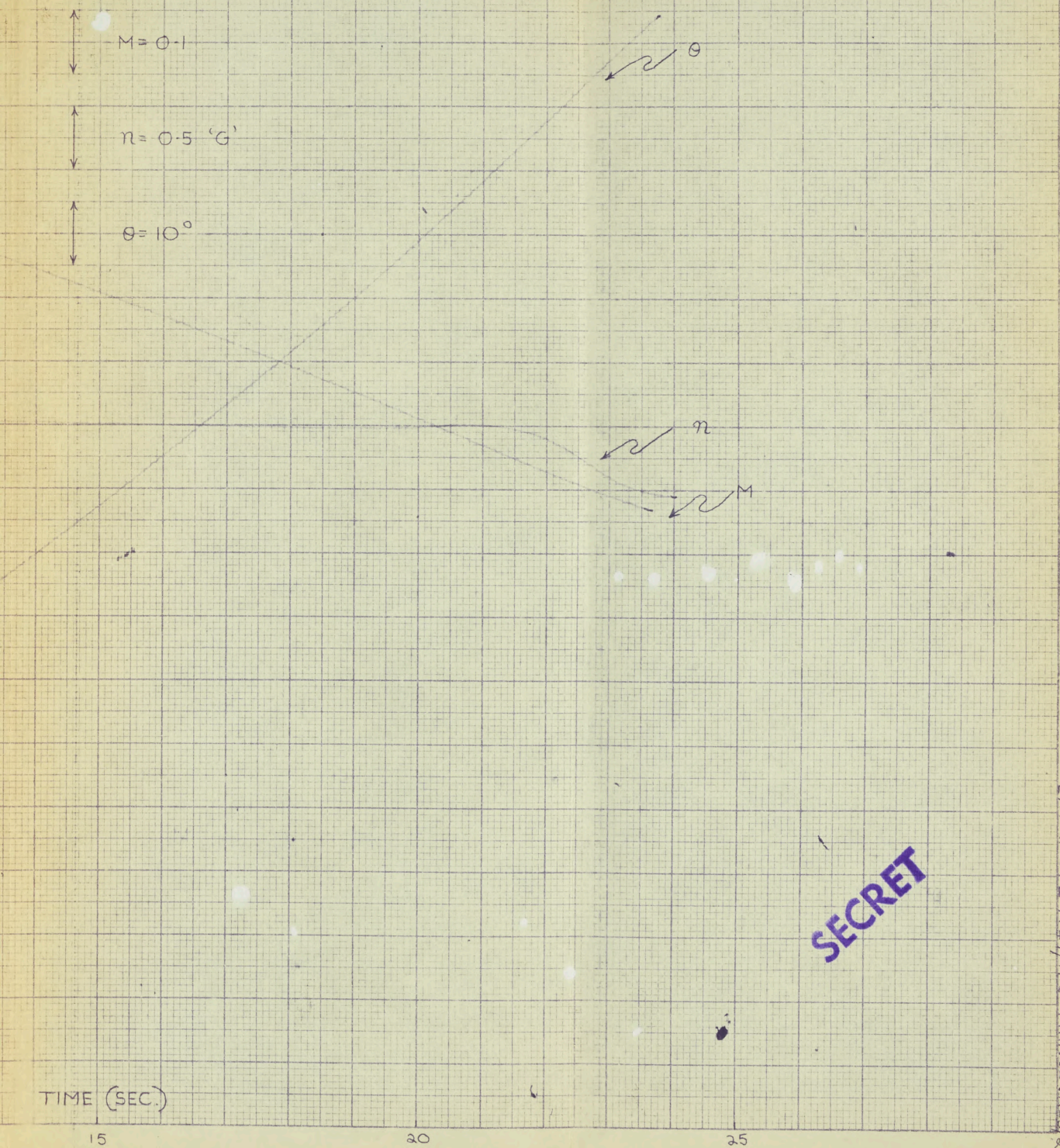
M<sub>0</sub> = 1.75

ψ = 0°

M = 0.1

n = 0.5 'G'

θ = 10°



**SECRET**

EXTRACT 2 A47/P.C. MANDREVER/2

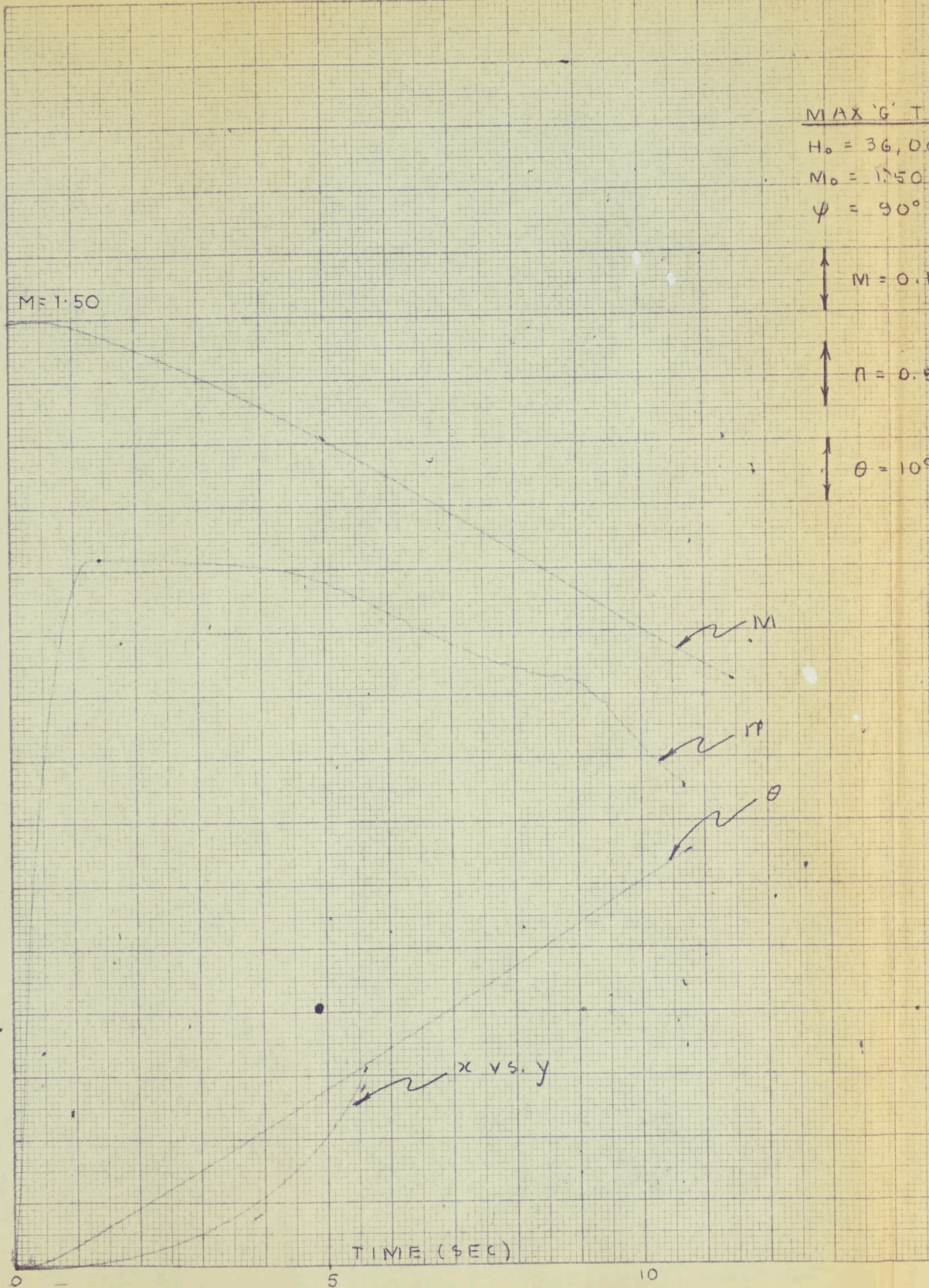
TIME (SEC.)

15

20

25

KE  
10 X 10 TO THE 1/2 INCH 359-11L  
KEUFFEL & ESSER CO. MADE IN U.S.A.



X 'G' TURNS ( $5\frac{1}{2}$  'G' LIMIT)

= 36,000 FT

= 1750

=  $90^\circ$

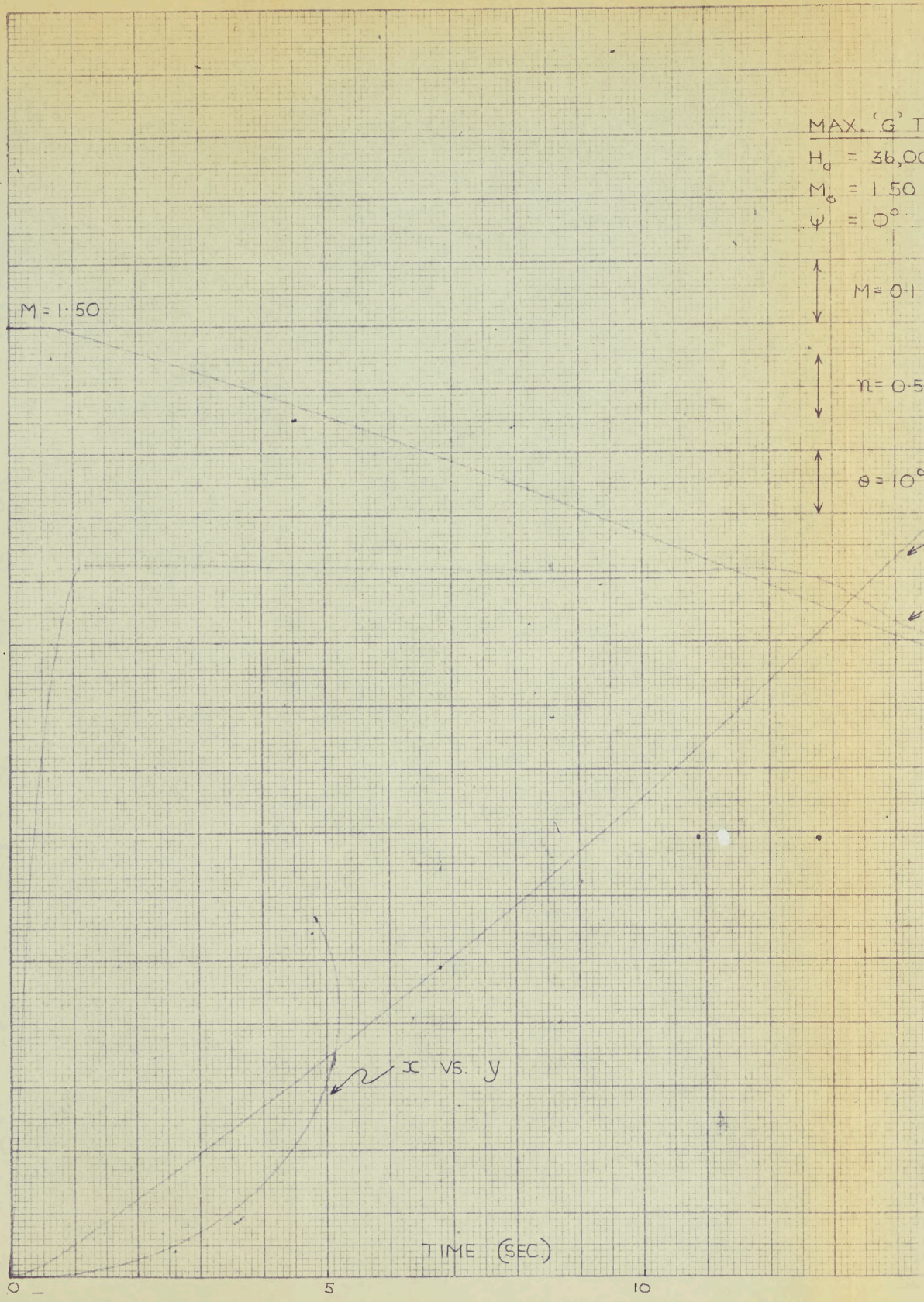
M = 0.1

n = 0.5%

$\theta = 10^\circ$

SECRET

K&E  
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
MADE IN U.S.A.  
359-111L



1. 'G' TURNS (5 1/2 'G' LIMIT)

36,000 FT

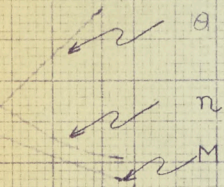
1.50

0°

M=0.1

n=0.5 'G'

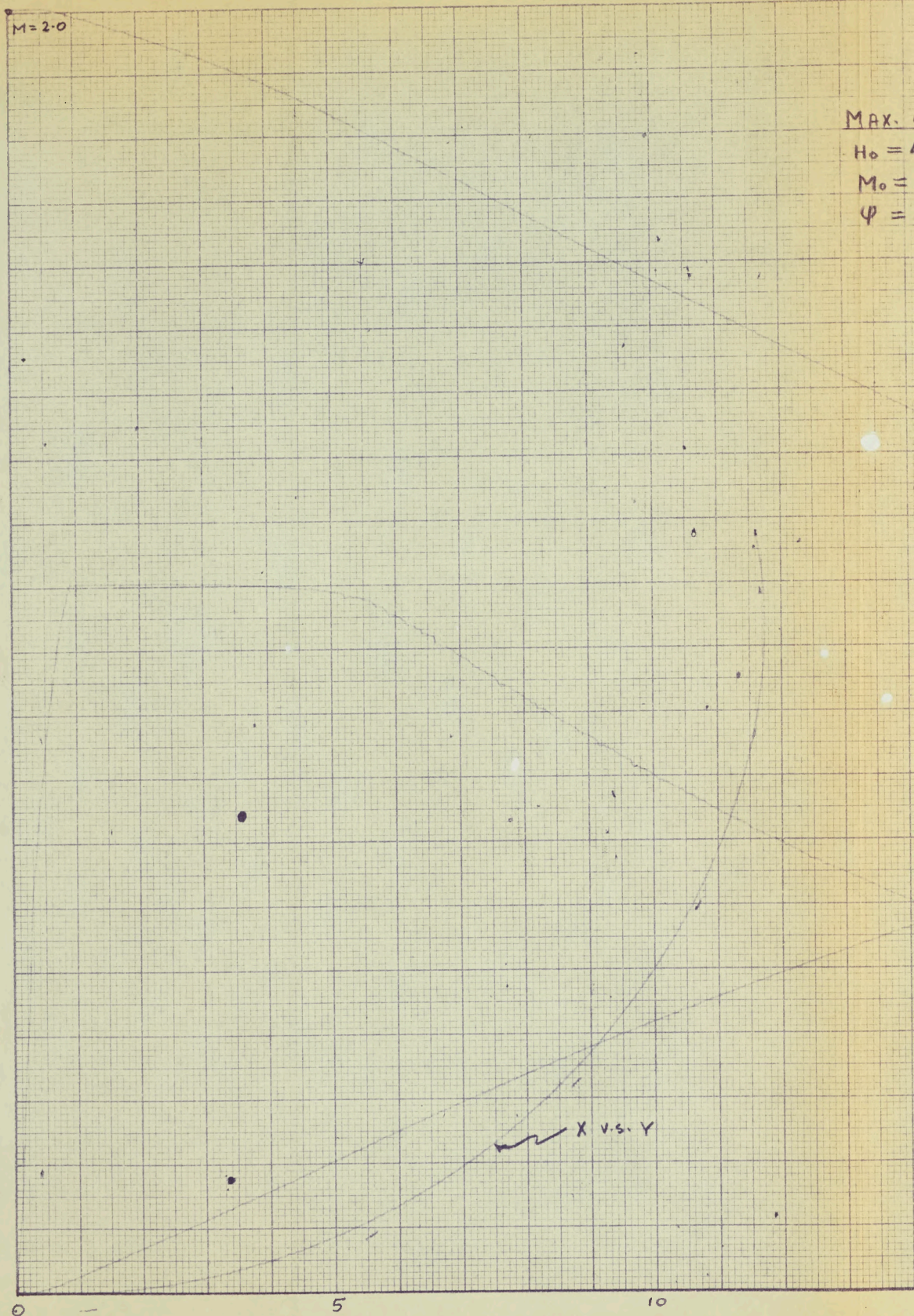
θ=10°



SECRET

EXTRACT 2. A47/P.S. MANOEUVRES/2

**KE** 10 X 10 TO THE 1/2 INCH 359-11L  
KEUFFEL & ESSER CO. MADE IN U.S.A.



AX. G TURNS (5.5 G LIMIT)

$\rho = 40,000'$

$t_0 = 2:00$

$\phi = 90^\circ$

$M = 0.1$   
 $n = 0.5 \text{ G}$   
 $\theta = 10^\circ$



**SECRET**

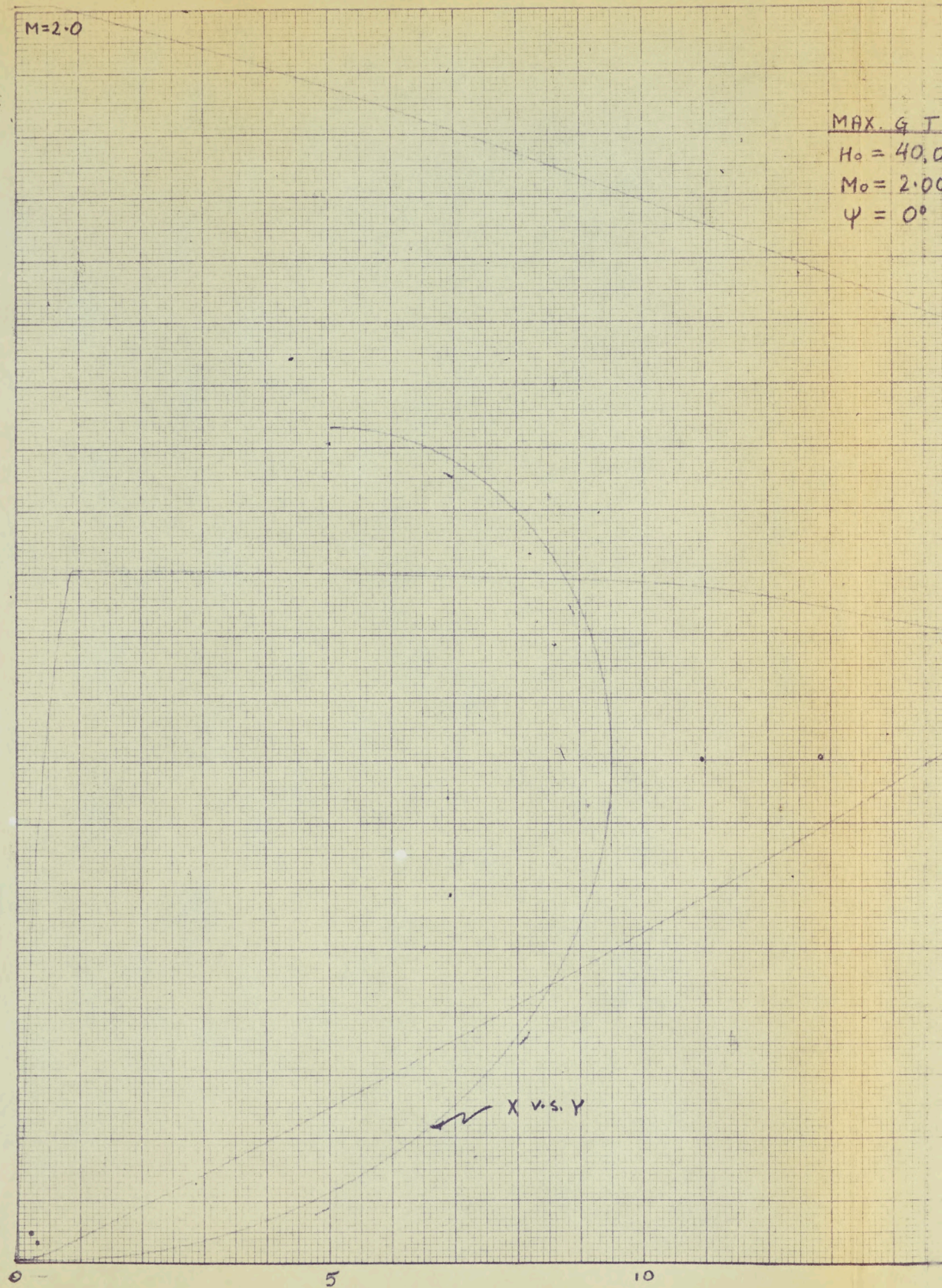
EXTRACT 2 A 47/R.C. MANOEUVRES 12

TIME (SEC)

15

20

K&E  
10 X 10 TO THE 1/2 INCH 359-111L  
KEUFFEL & ESSER CO. MADE IN U.S.A.



M=2.0

MAX. G T

$H_0 = 40.0$

$M_0 = 2.00$

$\psi = 0^\circ$

X v.s. Y

MAX. G TURNS (5.5 G LIMIT)

$$H_0 = 40,000'$$

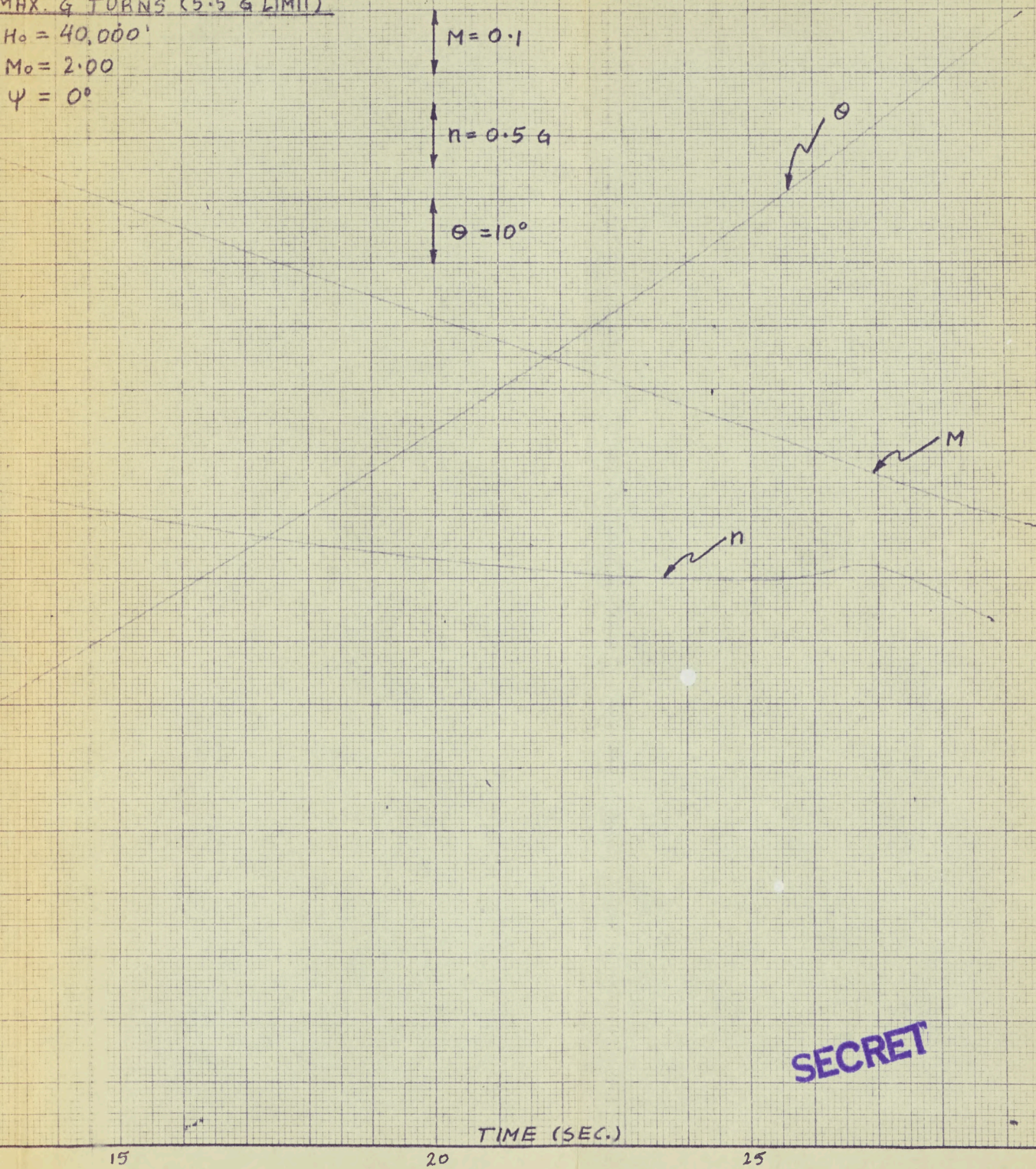
$$M_0 = 2.00$$

$$\psi = 0^\circ$$

$$M = 0.1$$

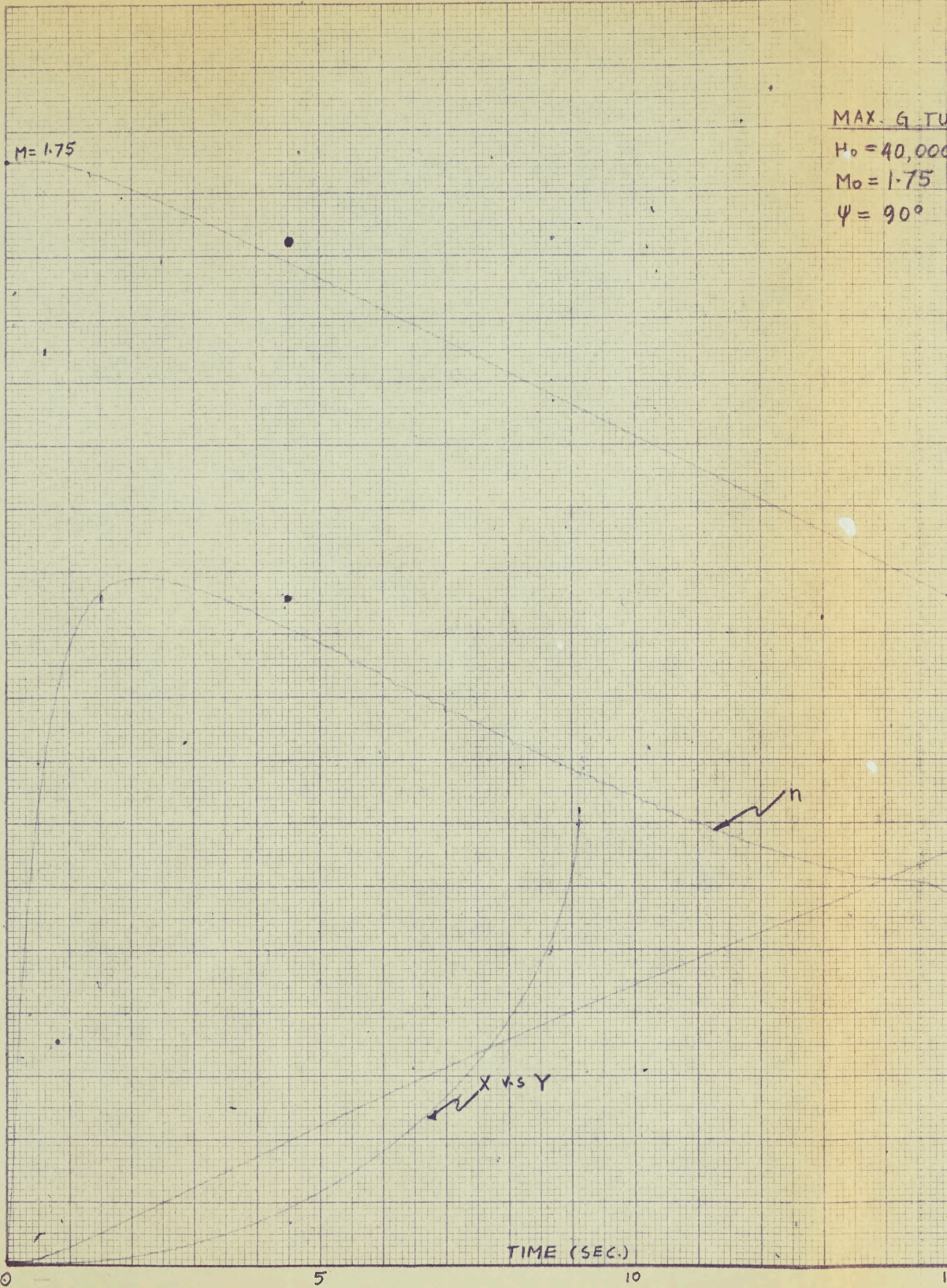
$$n = 0.5 g$$

$$\theta = 10^\circ$$



**SECRET**

K&E  
10 X 10 TO THE 1/2 INCH  
KELIFFEL & ESSER CO.  
359-11L  
MADE IN U.S.A.



MAX. G TURNS (5.5 G LIMIT)

$$H_0 = 40,000'$$

$$M_0 = 1.75$$

$$\psi = 90^\circ$$

$$M = 0.1$$

$$n = 0.5 'g'$$

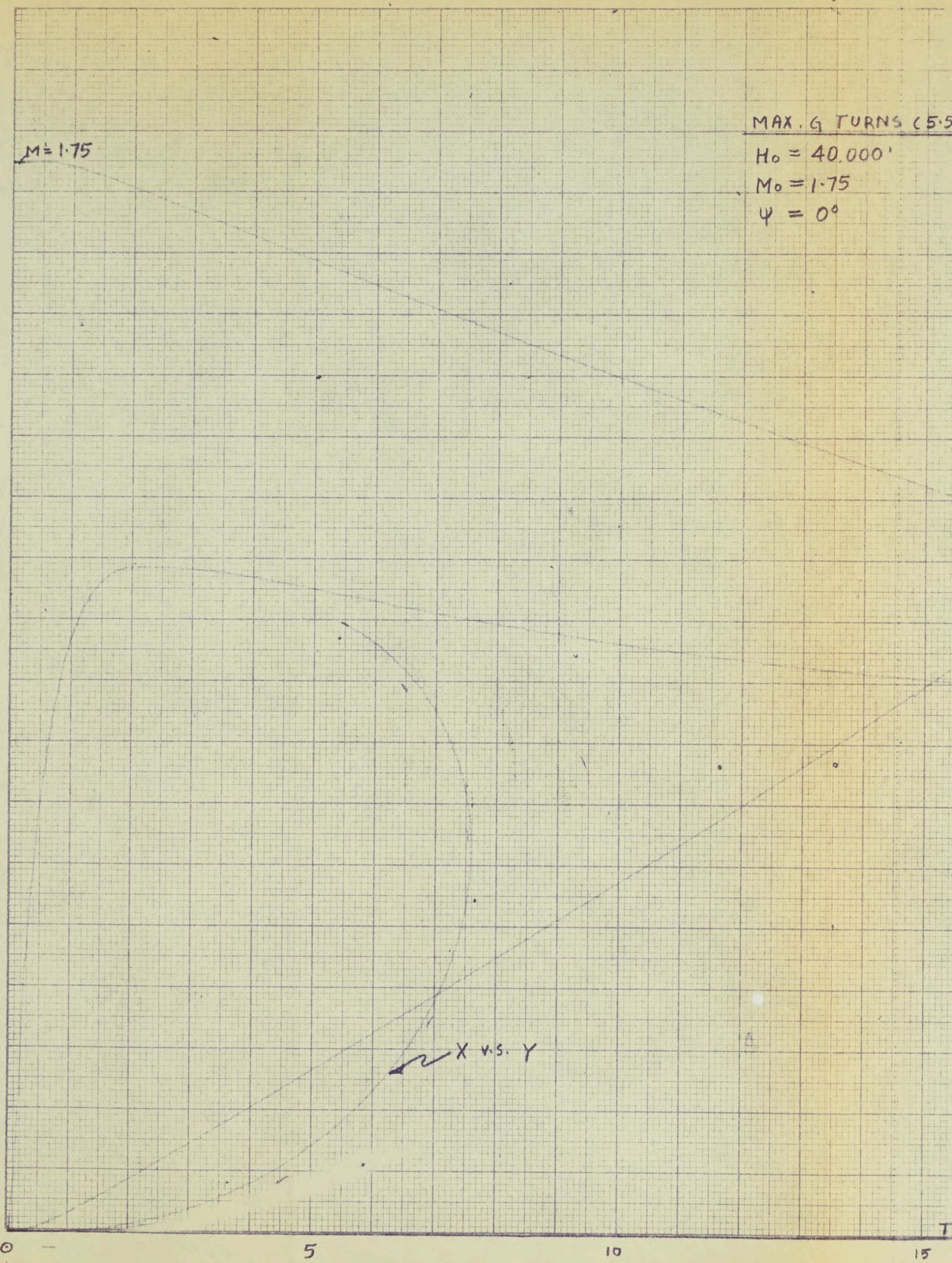
$$\theta = 10^\circ$$

M

 $\theta$ **SECRET**

EXTRACT 2 R 47/A.C. MANOEUVRES/2

10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
MADE IN U.S.A.



MAX. G TURNS (5.5)  
 $H_0 = 40,000'$   
 $M_0 = 1.75$   
 $\psi = 0^\circ$

9 TURNS (5.5 G LIMIT)

40,000'

1.75

0°

M=0.1

n=0.5 G

θ=10°

θ

M

n

TIME (SEC.)

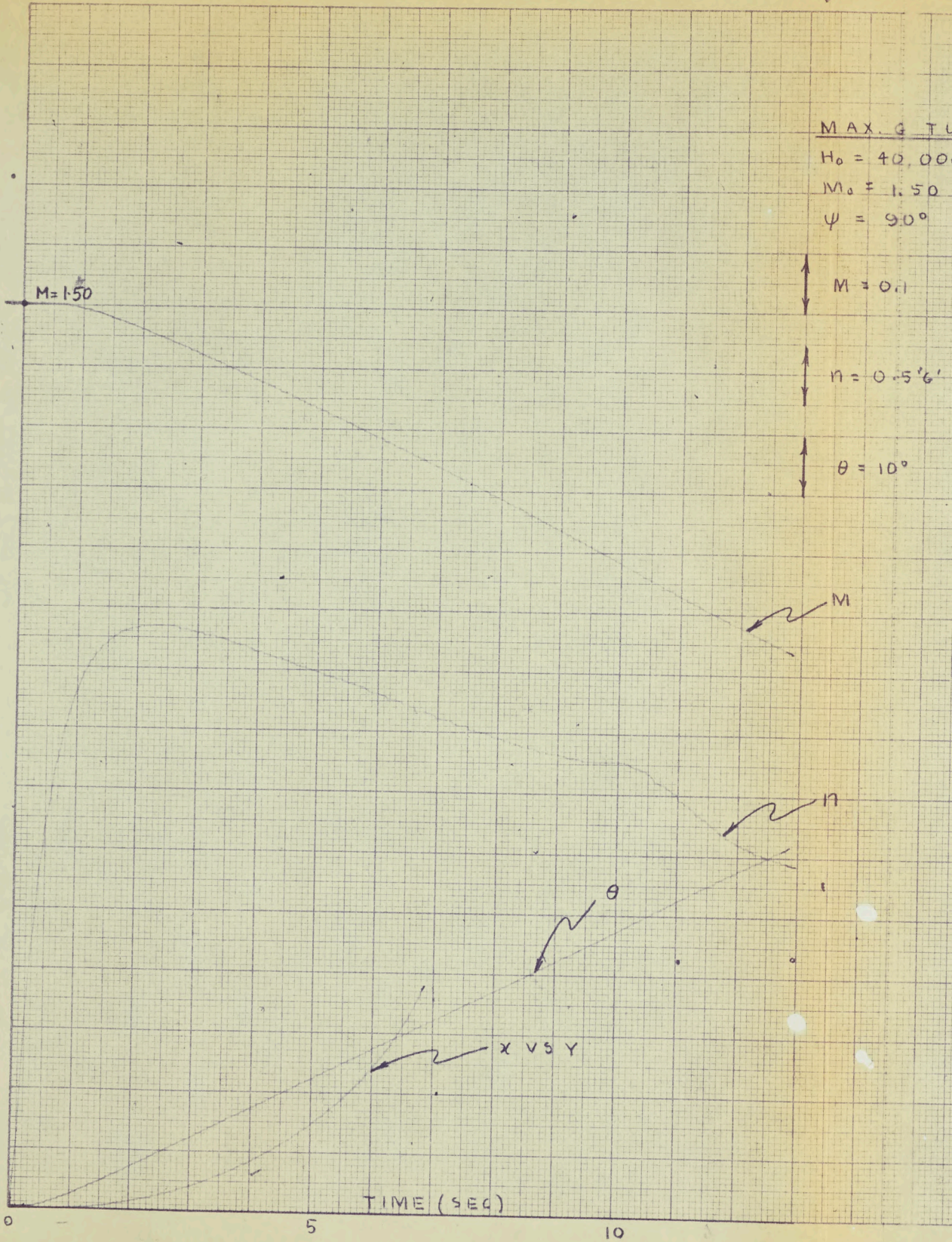
15

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SECRET

EXTRACT 2 R471/R.C. MANOEUVRES/2

K&E  
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
359-11L  
MADE IN U.S.A.



MAX. G TURNS (5.5G LIMIT)

$$H_0 = 40,000'$$

$$M_0 = 1.50$$

$$\psi = 90^\circ$$

$$M = 0.1$$

$$n = 0.5'6''$$

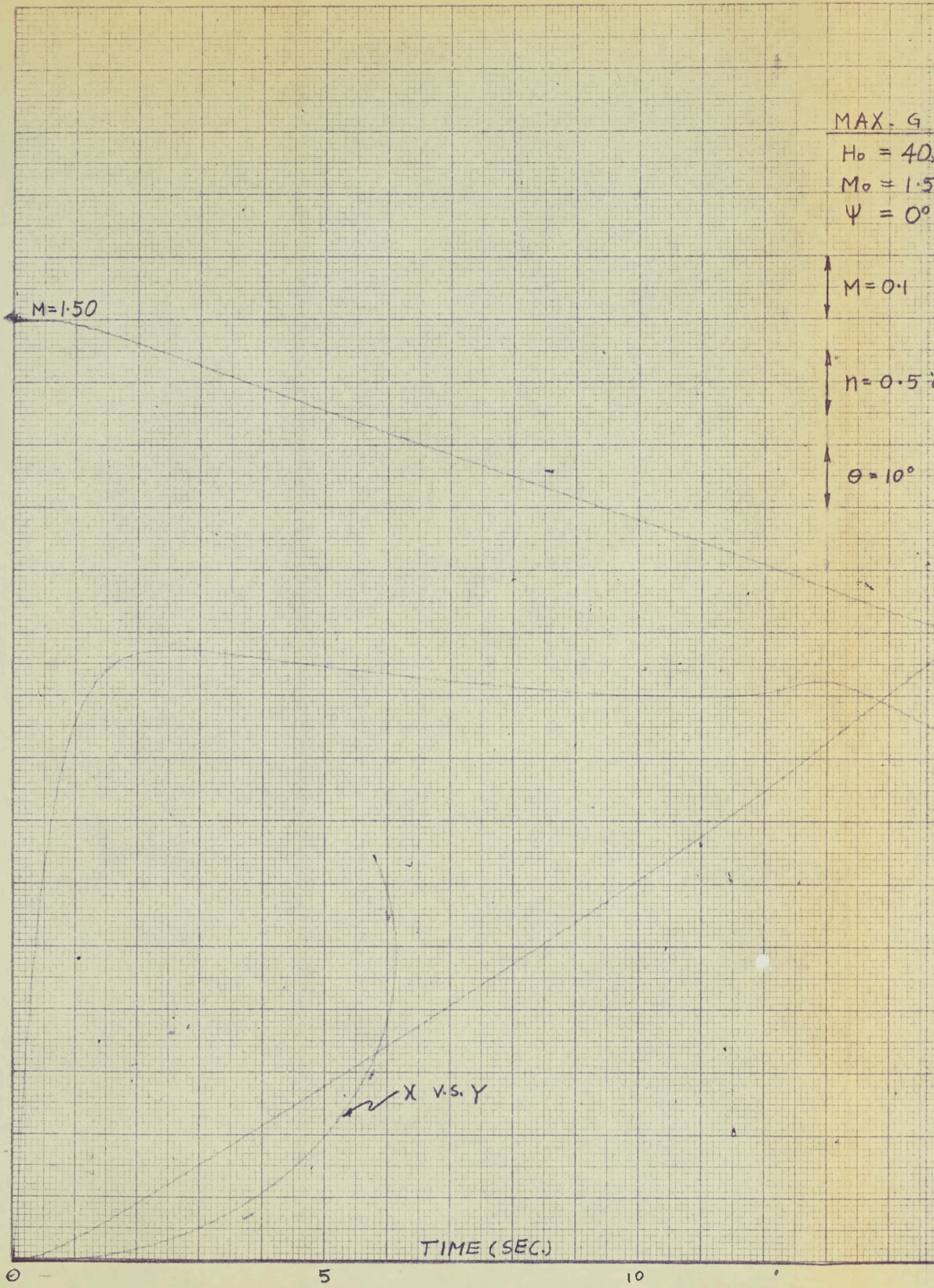
$$\theta = 10^\circ$$

M

n

**SECRET**

K&E  
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
359-11L  
MADE IN U.S.A.



MAX. 9 TURNS (5.5G LIMIT)

$$H_0 = 40,000'$$

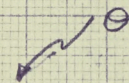
$$M_0 = 1.50$$

$$\psi = 0^\circ$$

$$M = 0.1$$

$$n = 0.5 \text{ } \ddot{g}$$

$$\theta = 10^\circ$$



$\theta$

$M$

$n$

SECRET

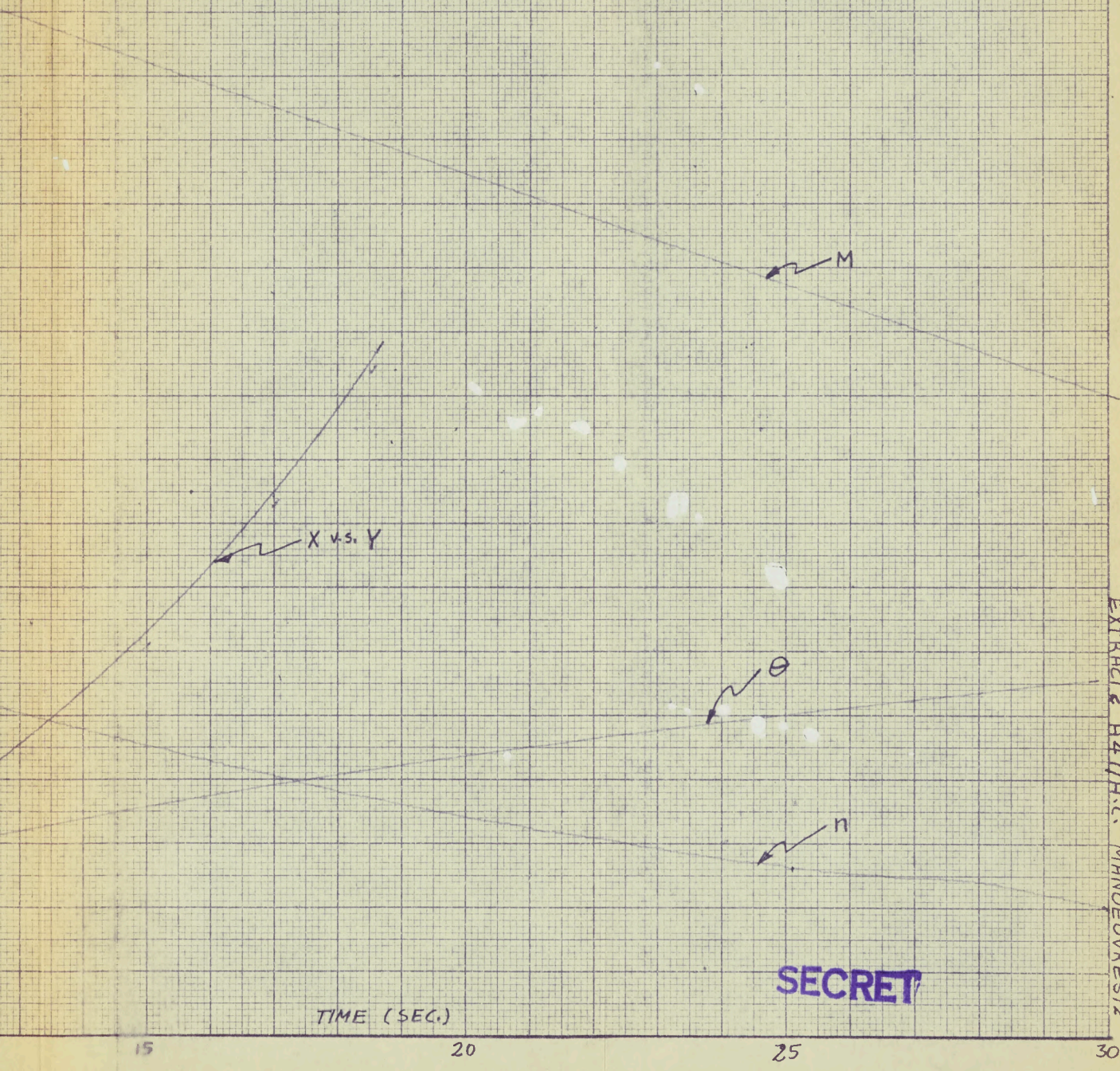
EXTRACT 2 R47/A.C. MANOEUVRES 12

K&E 10 X 10 TO THE 1/4 INCH 359-11L  
KUFFEL & ESSER CO. MADE IN U.S.A.



MAX. 'G' TURNS (5.5 'G' LIMIT)

$H_0 = 50,000'$   
 $M_0 = 2.00$   
 $\psi = 90^\circ$



**SECRET**

K&E  
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
MADE IN U.S.A.

M=2.0

M=0.1

n=0.5 G

$\theta = 10^\circ$

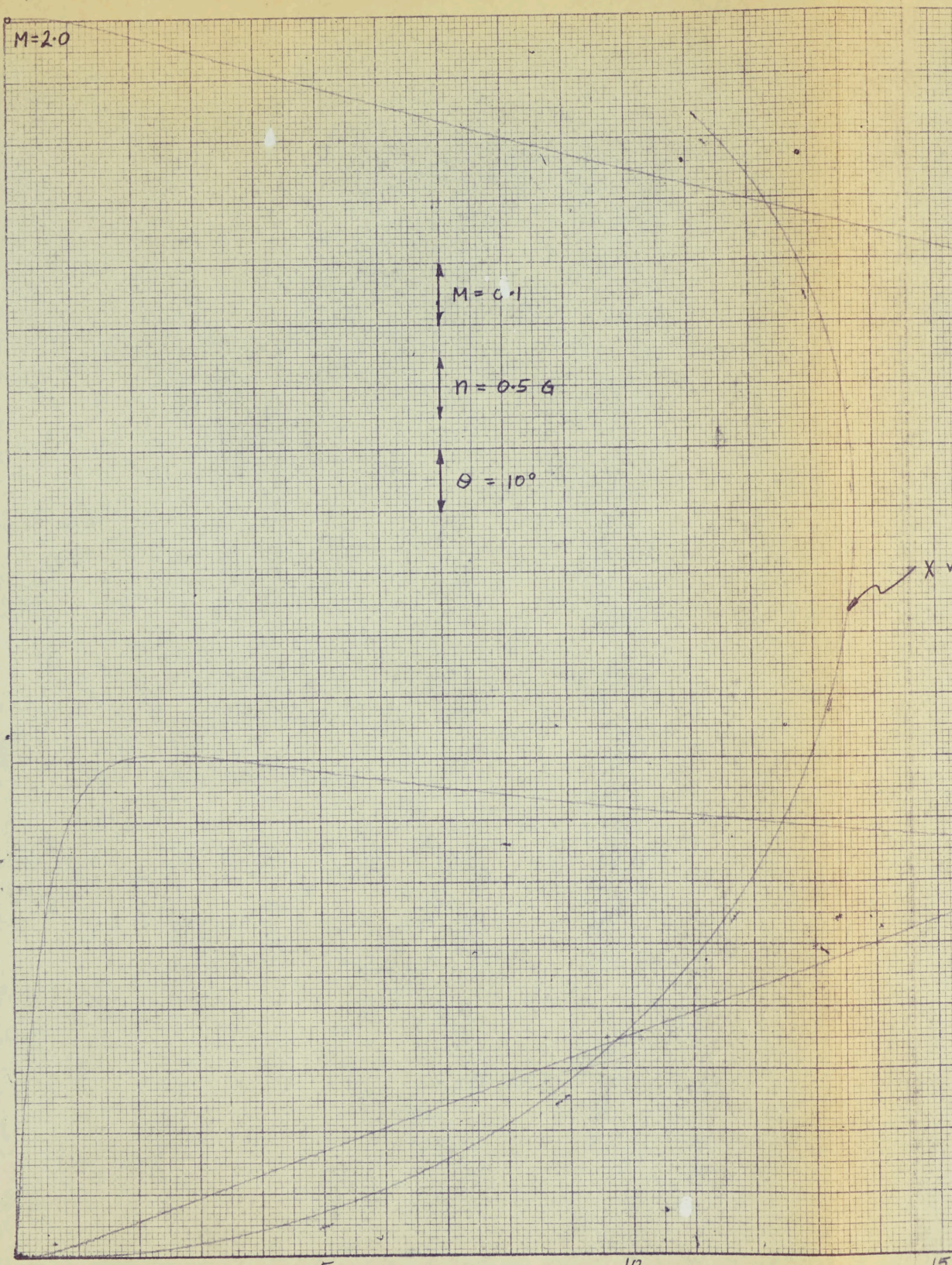
0

5

10

15

X

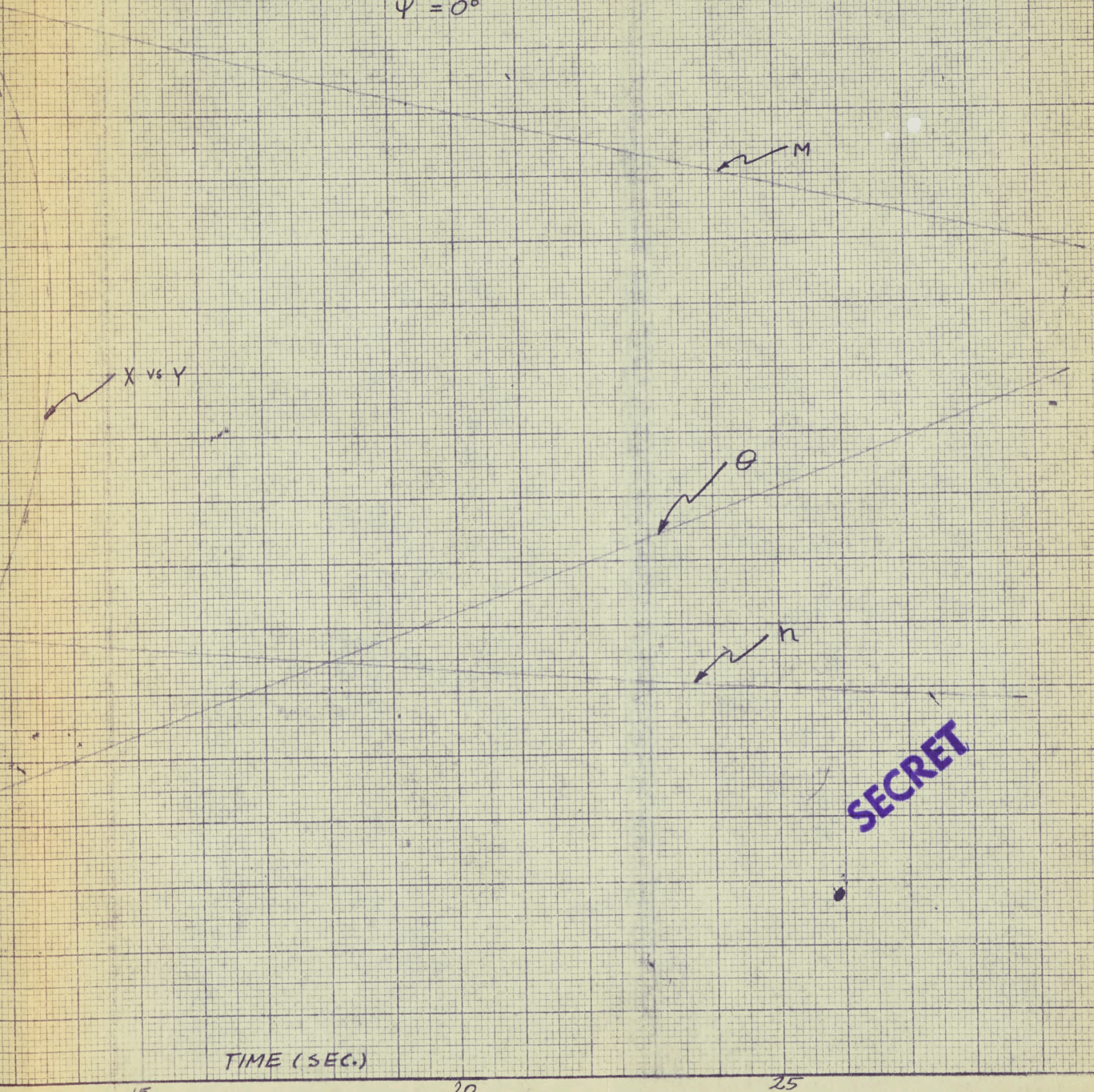


MAX. 6 TURNS (5.5 G LIMIT)

$H_0 = 50,000'$

$M_0 = 2.00$

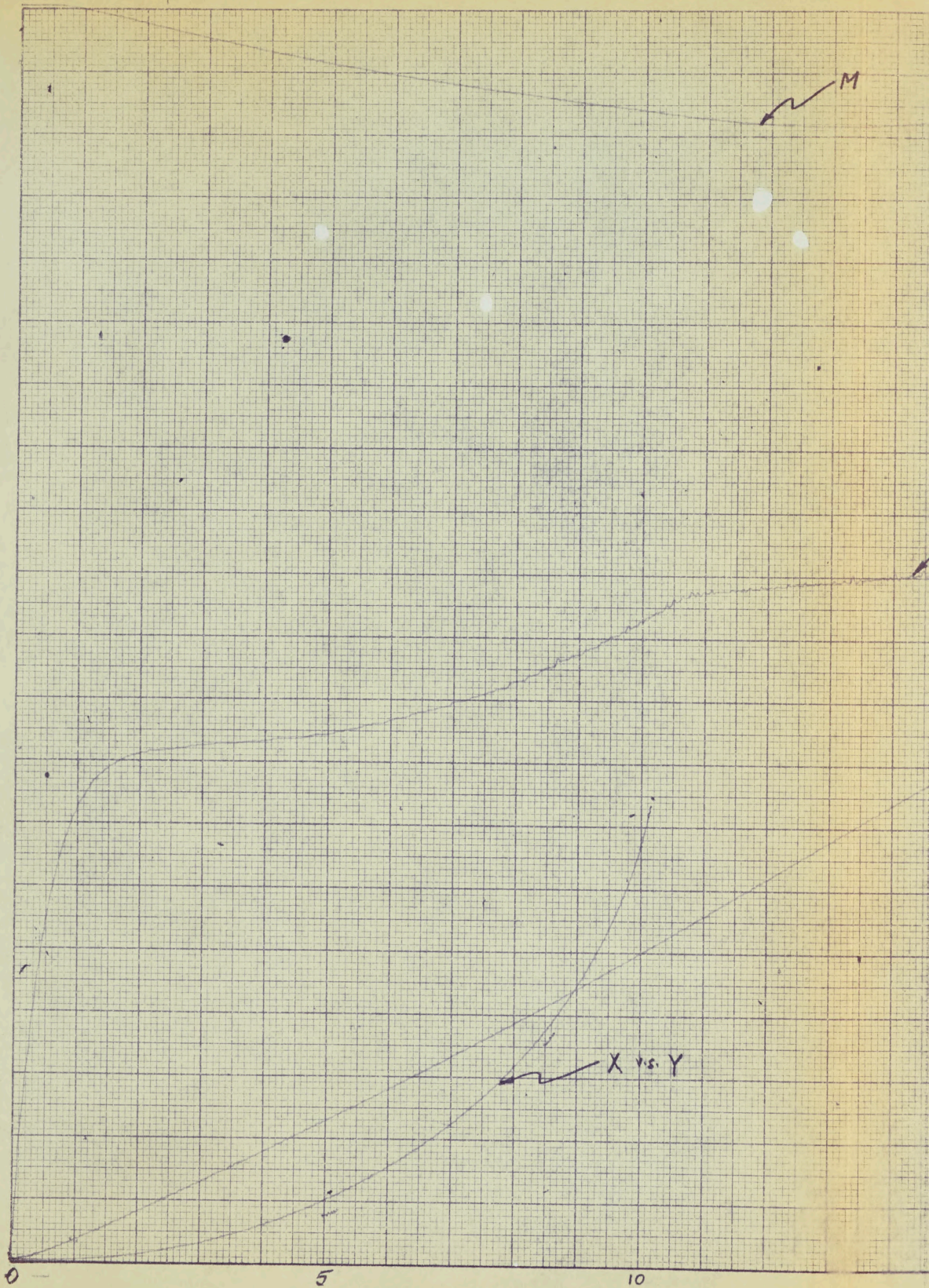
$\psi = 0^\circ$



**SECRET**

EXTRACT 2 A47/A.C. MANOEUVRES 12

K&E 10 X 10 TO THE 1/2 INCH 359-11L  
NEUFEL & ESSER CO. MADE IN U.S.A.



MAX 'G' TURNS (5.5 G LIMIT)

$$H_0 = 50,000'$$

$$M_0 = 2.0$$

$$\psi = -90^\circ$$

$$\updownarrow M = 0.1$$

$$\updownarrow n = 0.5$$

$$\updownarrow \theta = 10^\circ$$

$n$

$\theta$

TIME (SEC.)

15

20

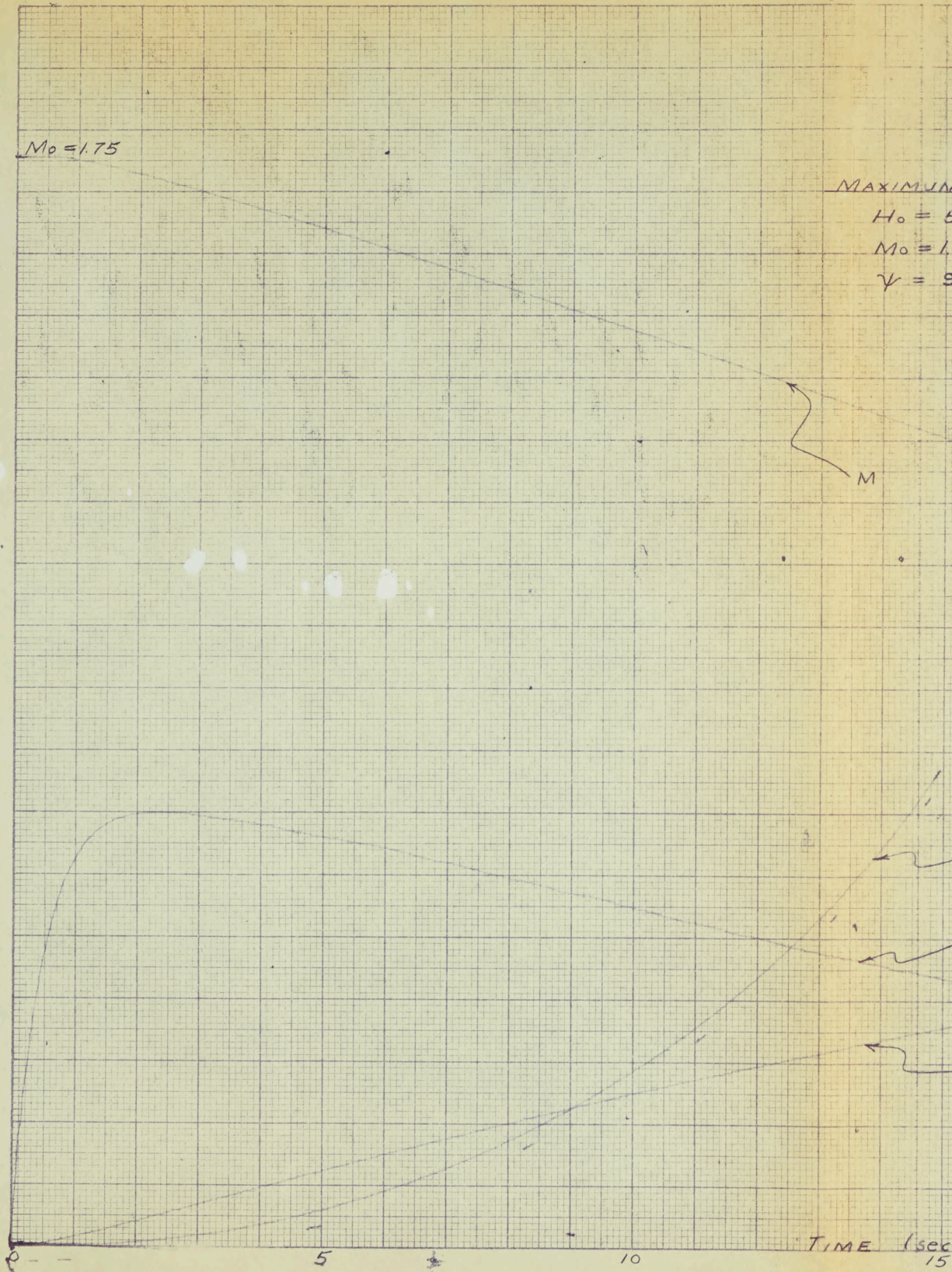
25

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**SECRET**

EXTRACT 247/A.C. MANOEUVRES/2

K&E  
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
359.11L  
MADE IN U.S.A.



MAXIMUM 'G' TURNS (5.5 'G' LIMIT)

$H_0 = 50,000 \text{ ft.}$

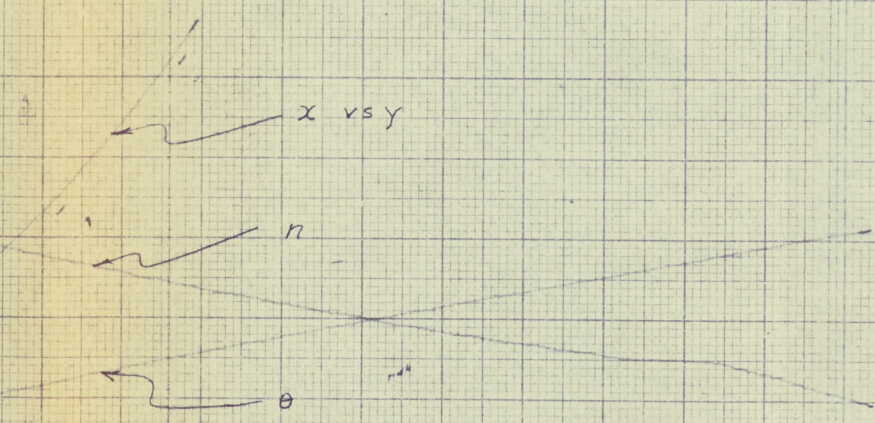
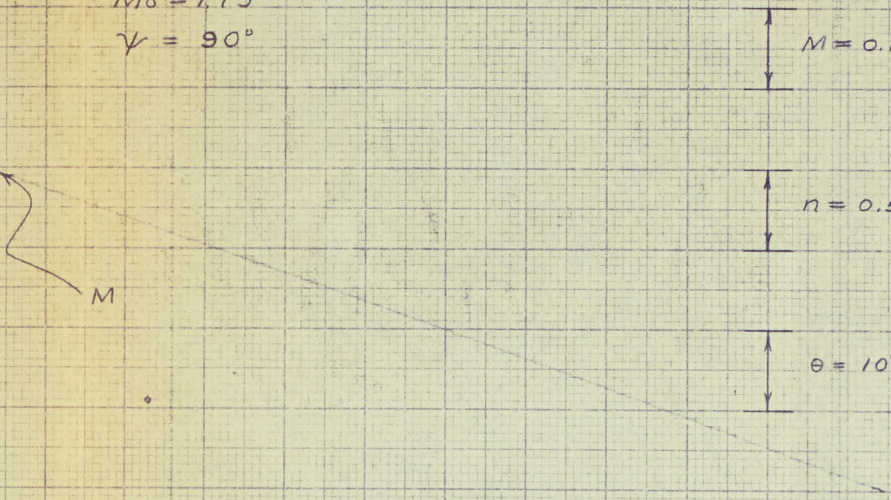
$M_0 = 1.75$

$\psi = 90^\circ$

$M = 0.1$

$n = 0.5 \text{ 'G'}$

$\theta = 10^\circ$



TIME (sec)  
15

20

25

**SECRET**

EXTRACT 1A47/H.C. MANOEUVRES/2

10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
359-11L  
MADE IN U.S.A.



MAXIMUM 'G' TURNS (5.5 'G' LIMIT)

$H_0 = 50,000'$

$M_0 = 1.75$

$\gamma = 0^\circ$

$M = 0.1$

$n = 0.5 \text{ 'G'}$

$\theta = 10^\circ$

M

x vs y

n

$\theta$

TIME (sec)

15

20

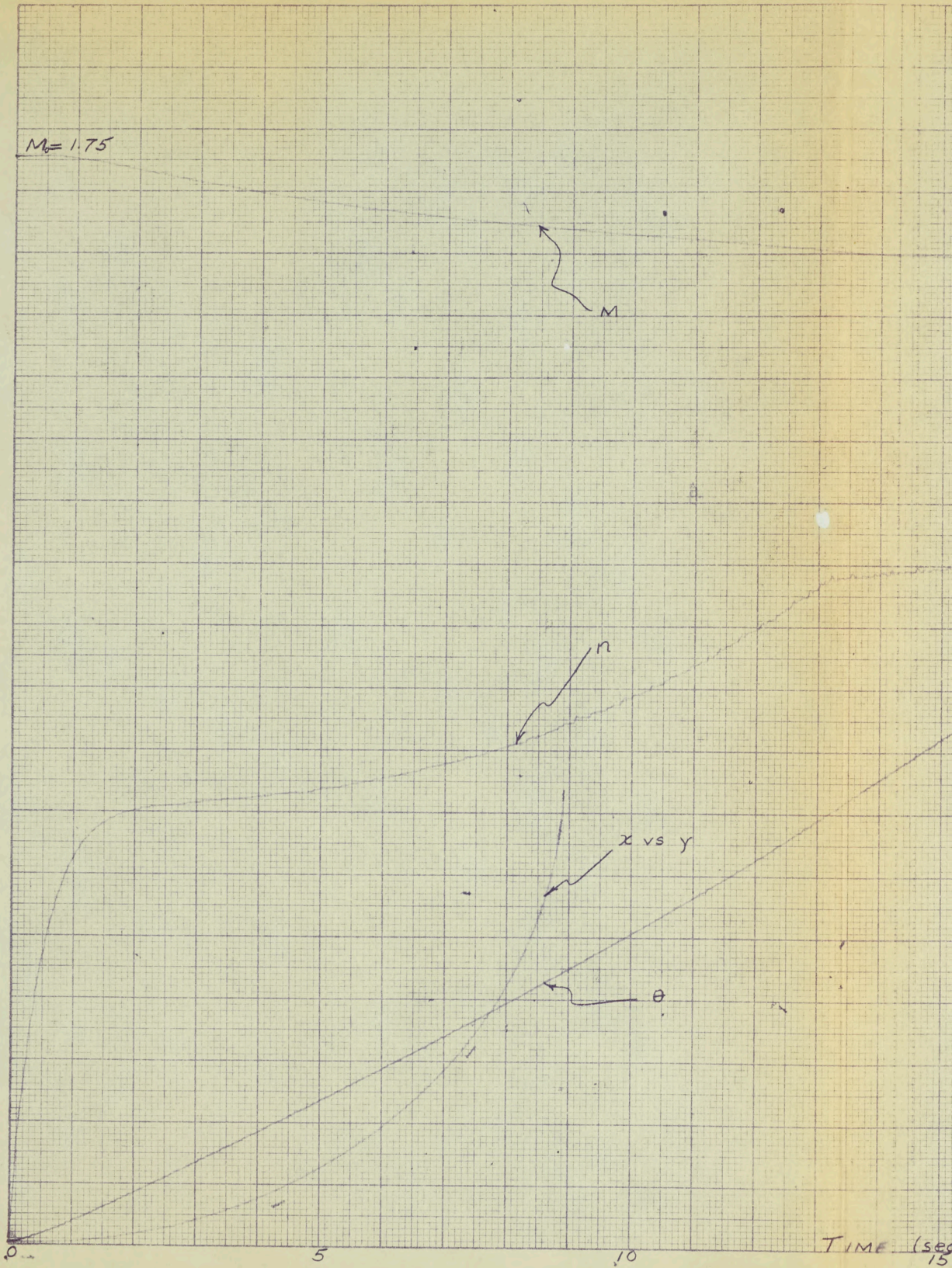
25

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SECRET

EXTRACT 847/A.C. MANOEUVRES/2

K&E  
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
359-11L  
MADE IN U.S.A.



MAXIMUM 'G' TURNS (5.5 'G' LIMIT)

$$H_0 = 50,000\text{ft}$$

$$M_0 = 175$$

$$\psi = -90^\circ$$

$$M = 0.1$$

$$n = 0.5 \text{ 'G'}$$

$$\theta = 10^\circ$$

**SECRET**

EXTRACT 847193. MANOEUVRE 5/2

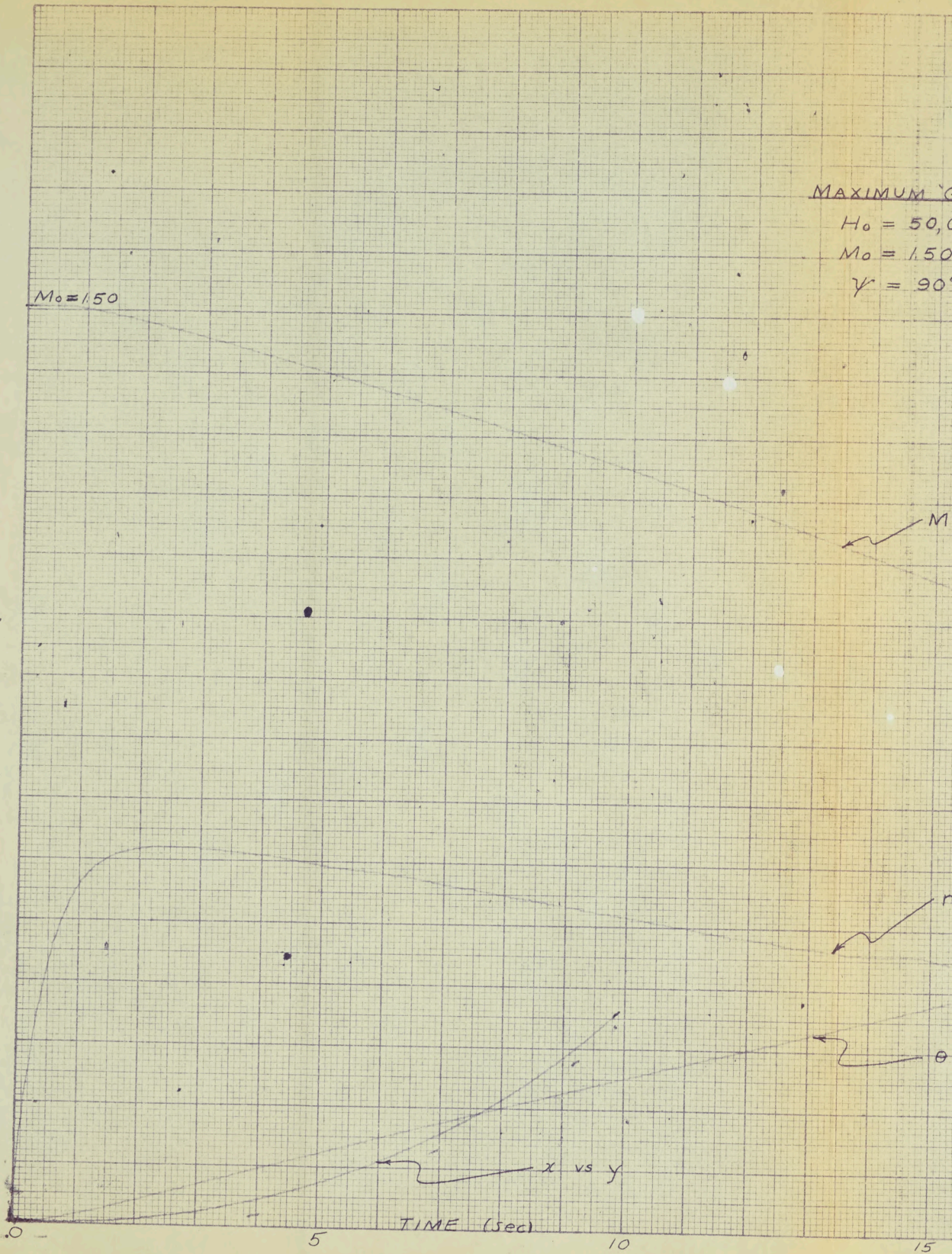
TIME (sec)

15

20

25

KE 10 X 10 TO THE 1/2 INCH 359-111L  
KEUFFEL & ESSER CO. MADE IN U.S.A.



MAXIMUM 'G' TURNS (5.5 'G' LIMIT)

$H_0 = 50,000 \text{ ft}$

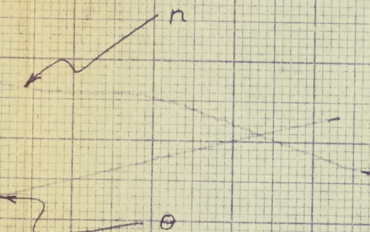
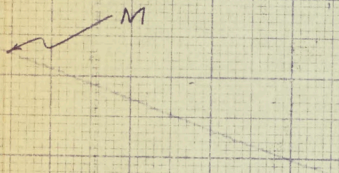
$M_0 = 1.50$

$\gamma = 90^\circ$

$M = 0.1$

$n = 0.5 \text{ 'G'}$

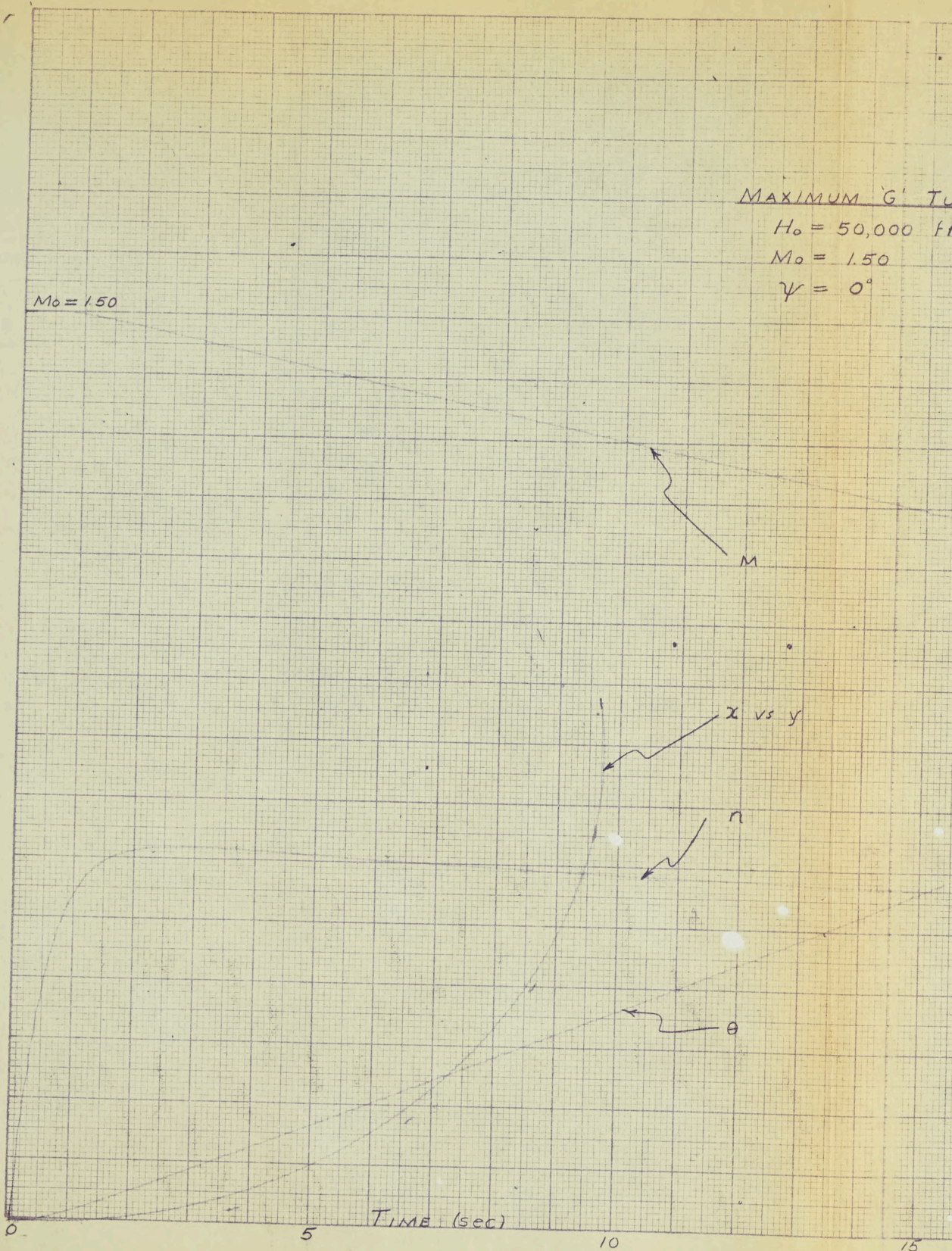
$\theta = 10^\circ$



**SECRET**

EXTRACT 1471A.C. MANOEUVRES 1/2

K&E 10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
ANN ARBOR, U.S.A.



(MAXIMUM 'G' TURNS 5.5 'G' LIMIT)

$h_0 = 50,000 \text{ ft}$

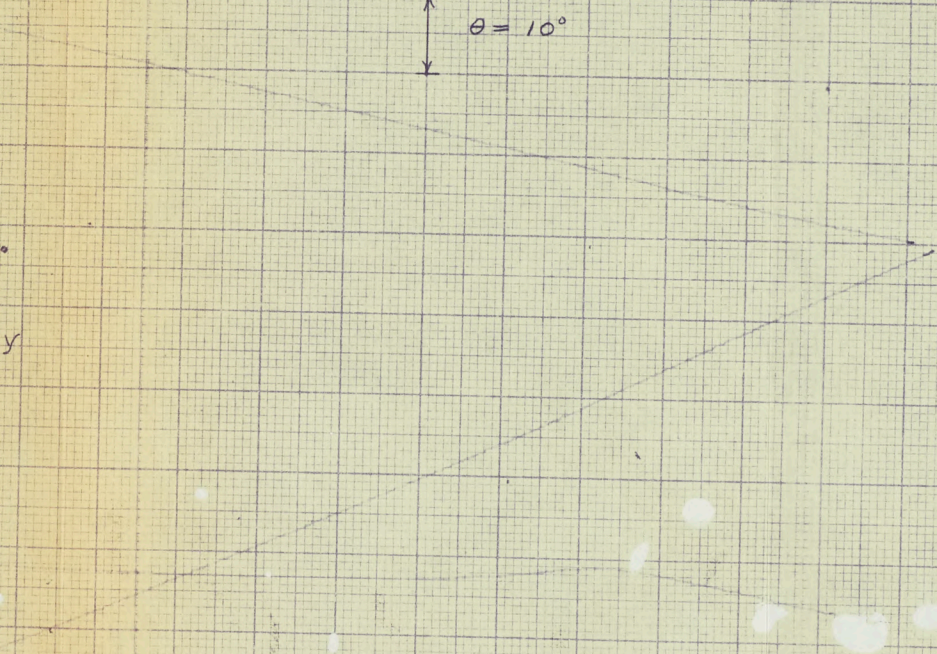
$h_0 = 1.50$

$\psi = 0^\circ$

$M = 0.1$

$n = 0.5 \text{ 'G'}$

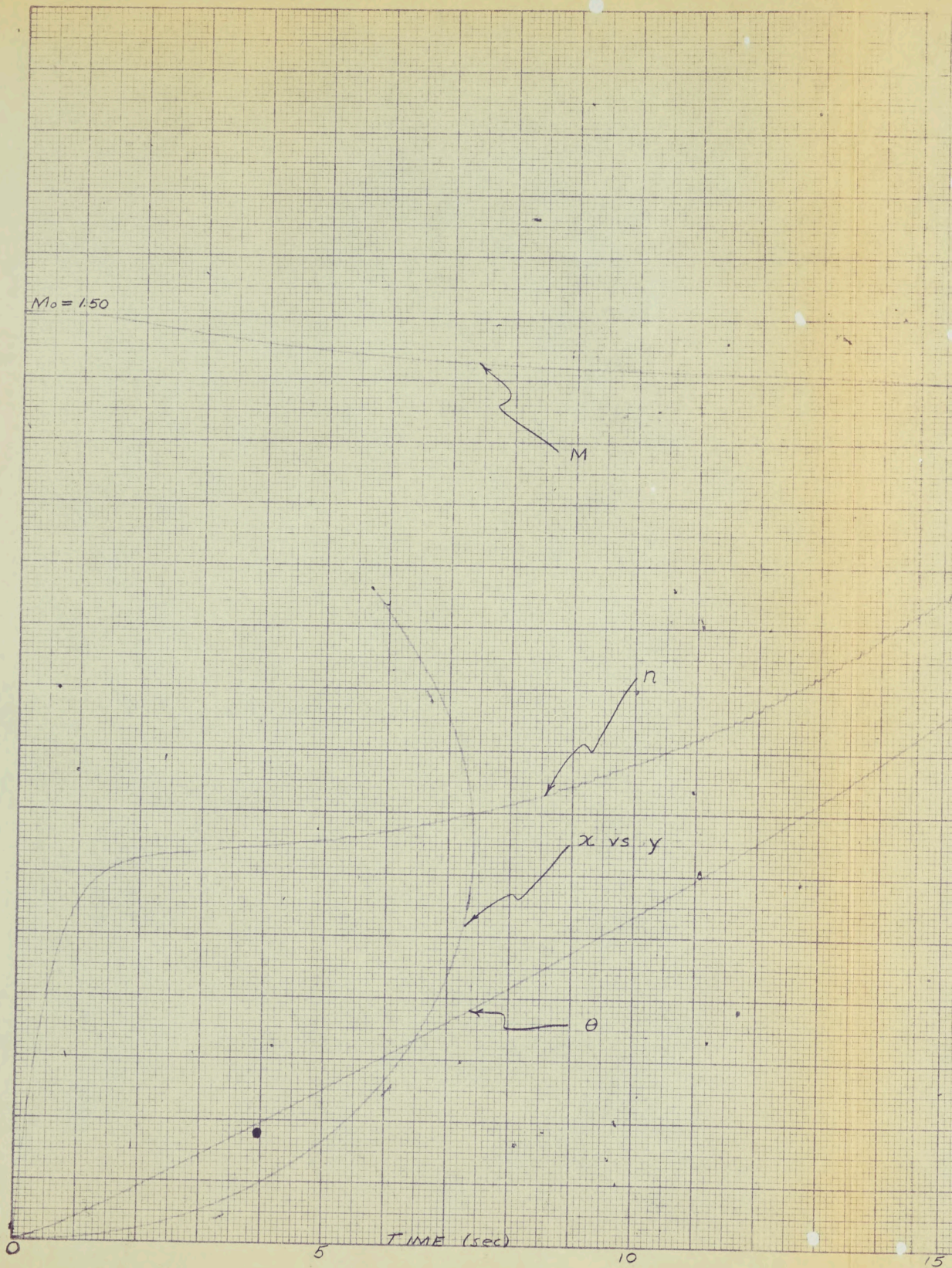
$\theta = 10^\circ$



**SECRET**

EXTRACT A 47/AC MANOEUVRES/2

KE 10 X 10 TO THE 1/2 INCH 359-11L  
KEUFFEL & ESSER CO. MADE IN U.S.A.



MAXIMUM 'G' TURNS (5.5 'G' LIMIT)

$H_0 = 50,000 \text{ ft}$

$M_0 = 1.50$

$\psi = -90^\circ$

$M = 0.1$

$n = 0.5 \text{ 'G'}$

$\theta = 10^\circ$

SECRET

EXTRACT 1A47/H.C. MANUFACTURES/2

M = 2.0

MAX. 'G' TURNS ( $5\frac{1}{2}$  'G' LIMIT)

$H_0 = 60,000$  FT.

$M_0 = 2.0$

$\psi = +90^\circ$

↑  
M = 0.1  
↓

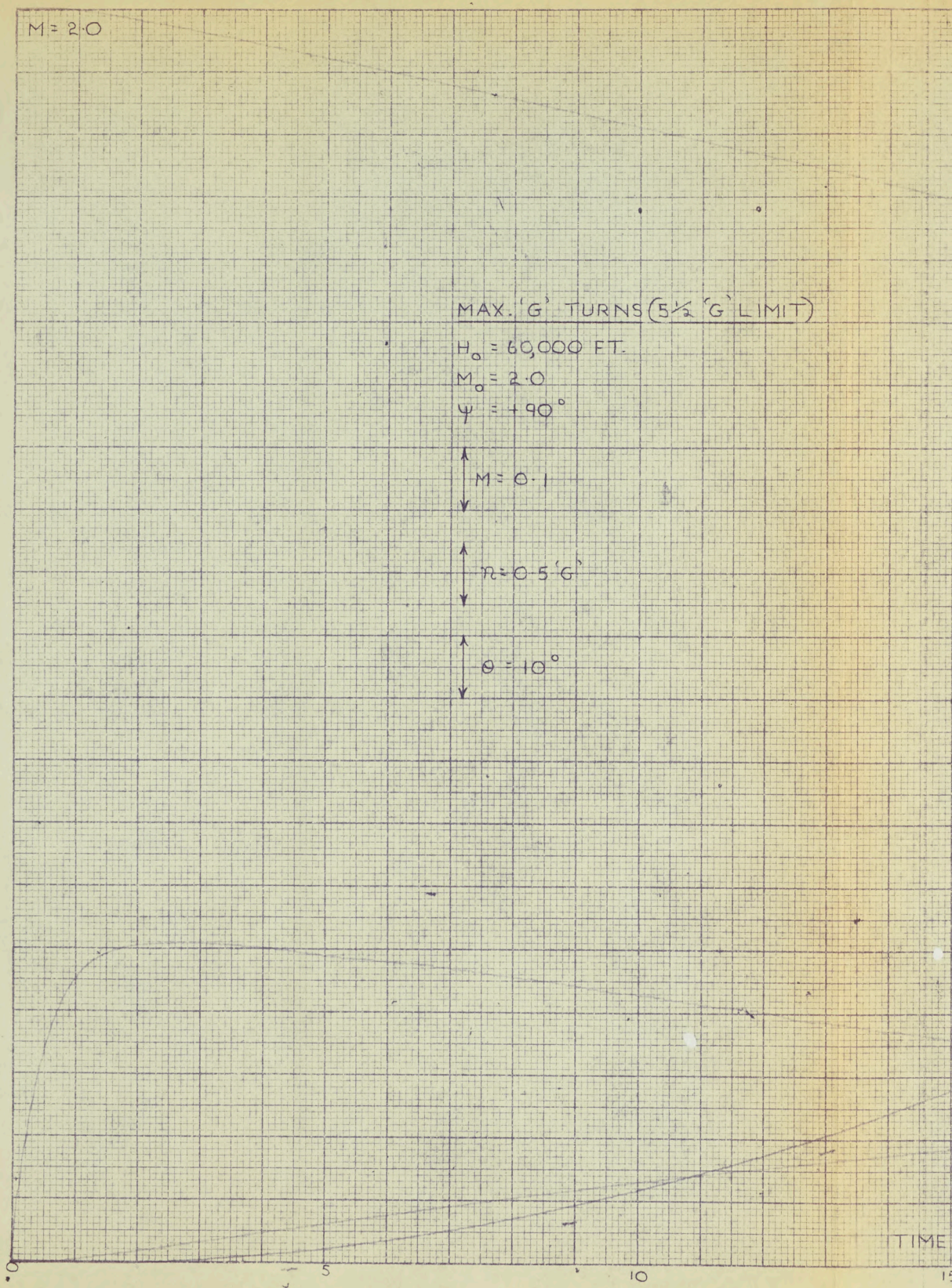
↑  
R = 0.5 'G'  
↓

↑  
 $\theta = 10^\circ$   
↓

359-11L  
MADE IN U.S.A.

10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.

K-E



TIME



TIME (SEC)

15

20

25

30

SECRET

EXTRACT 2A17/AC. MANOEUVRES/2

M=2.0

MAX. 'G' TURNS (5 1/2 'G' LIMIT)

$H_0 = 60,000$  FT.

$M_0 = 2.0$

$\psi = 0^\circ$

↑  
M = 0.1  
↓

↑  
n = 0.5 'G'  
↓

↑  
 $\theta = 10^\circ$   
↓

359-11L  
MADE IN U.S.A.

10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.

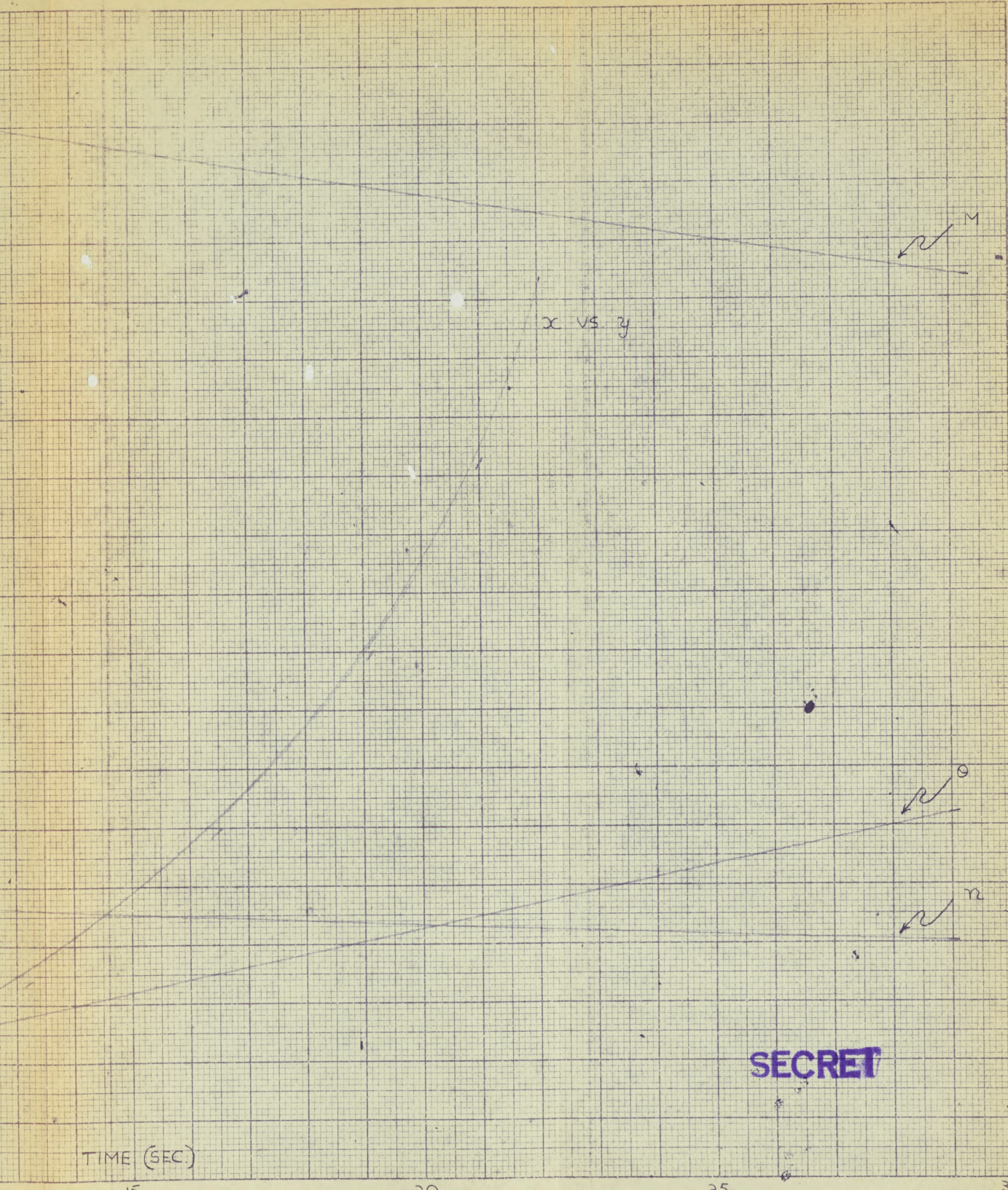
K+E

0

5

10

TIME



**SECRET**

EXTRACT 2 A17 / A.C. MANOEUVRES / 2

TIME (SEC)

15

20

25

30

M = 2.0

MAX 'G' TURNS ( $5\frac{1}{2}$  'G' LIMIT)

$H_0 = 60,000$  FT.

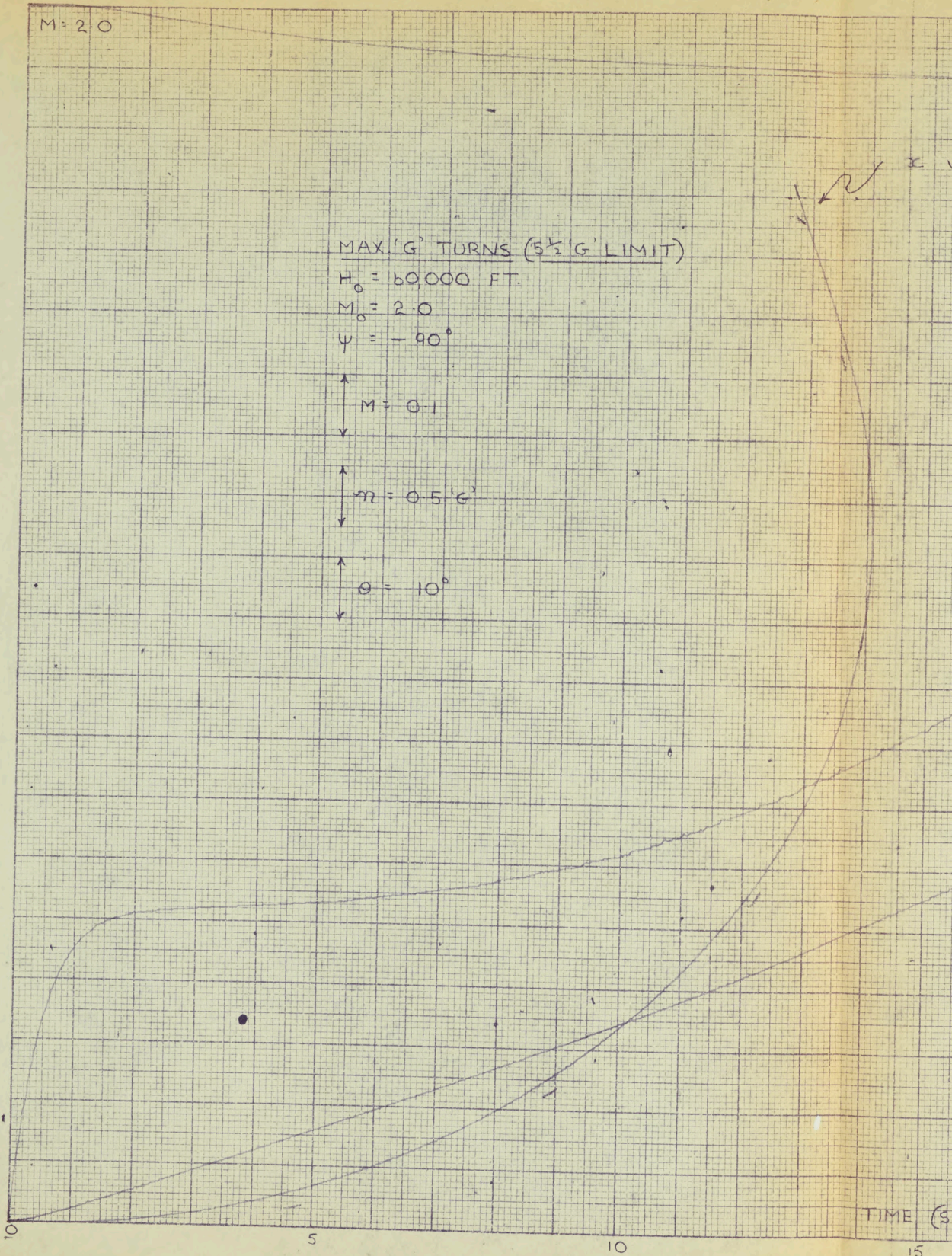
$M_0 = 2.0$

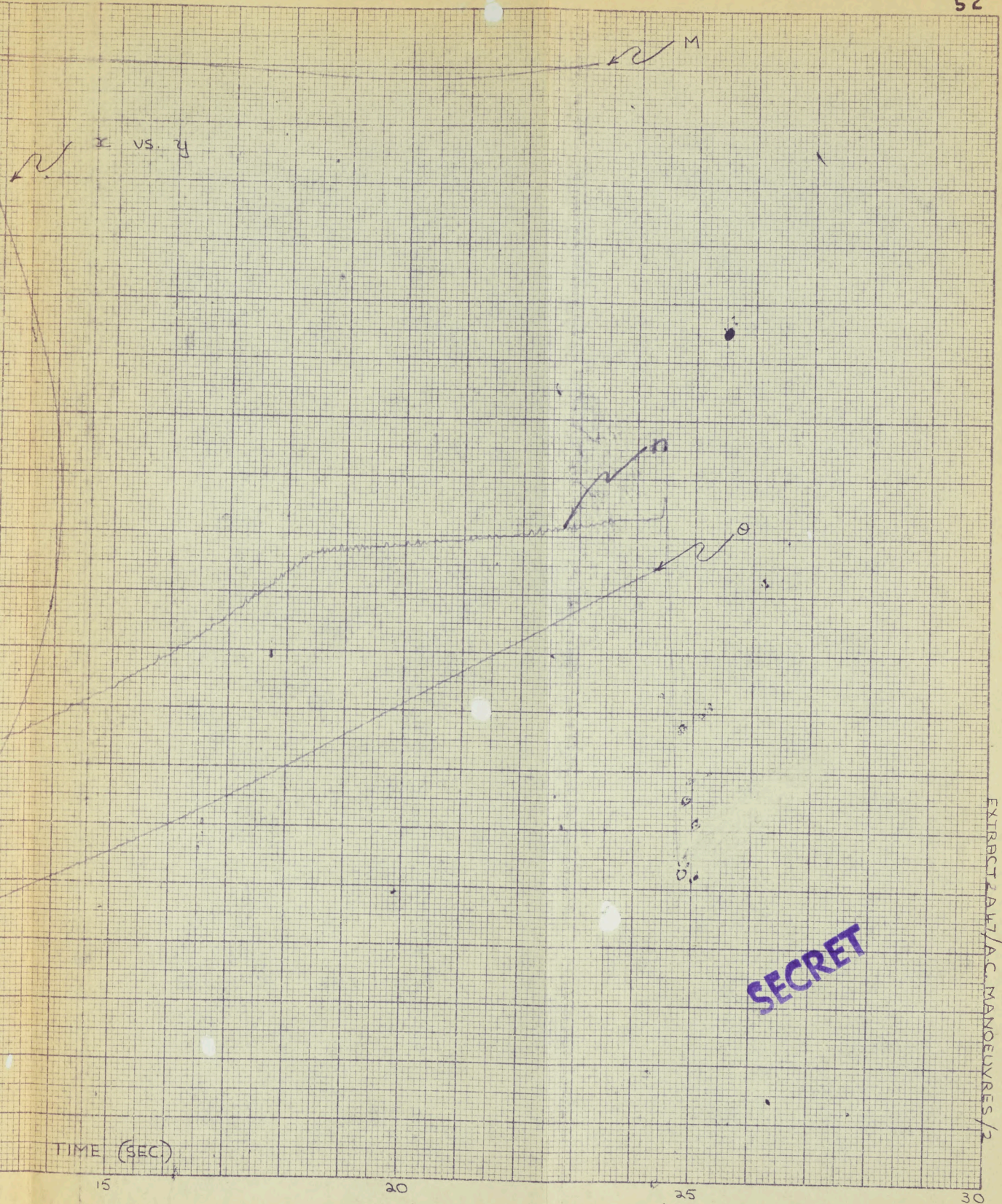
$\psi = -90^\circ$

$M = 0.1$

$n = 0.5$  'G'

$\theta = 10^\circ$



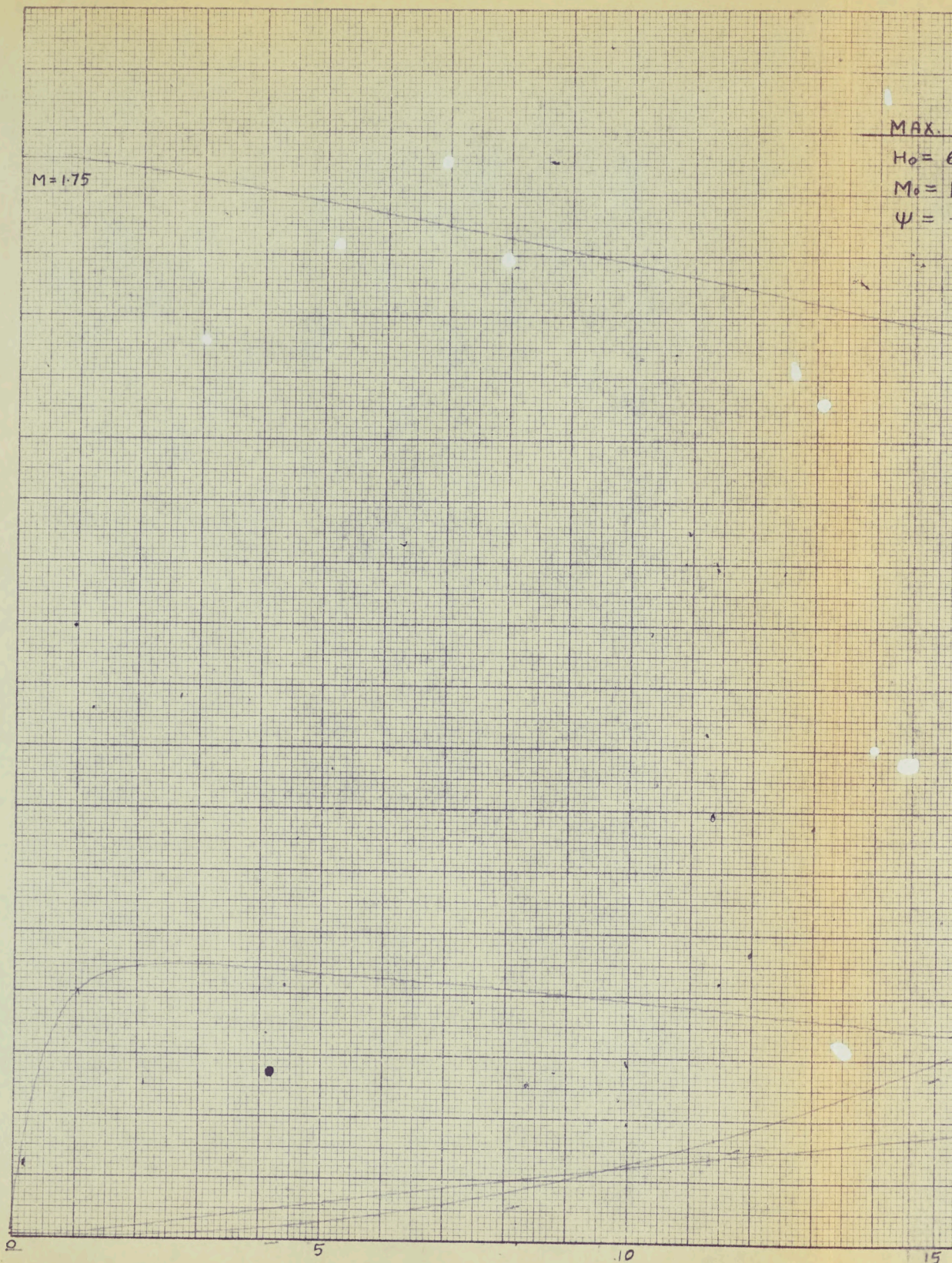


SECRET

EXTRACT 2A47/A.C. MANOEUVRES/2

359-11L  
MADE IN U.S.A.

10 X 10 TO THE 1/2 INCH  
NEUFEL & EBER CO.



MAX. G TURNS (5.5 G LIMIT)

$H_0 = 60,000'$

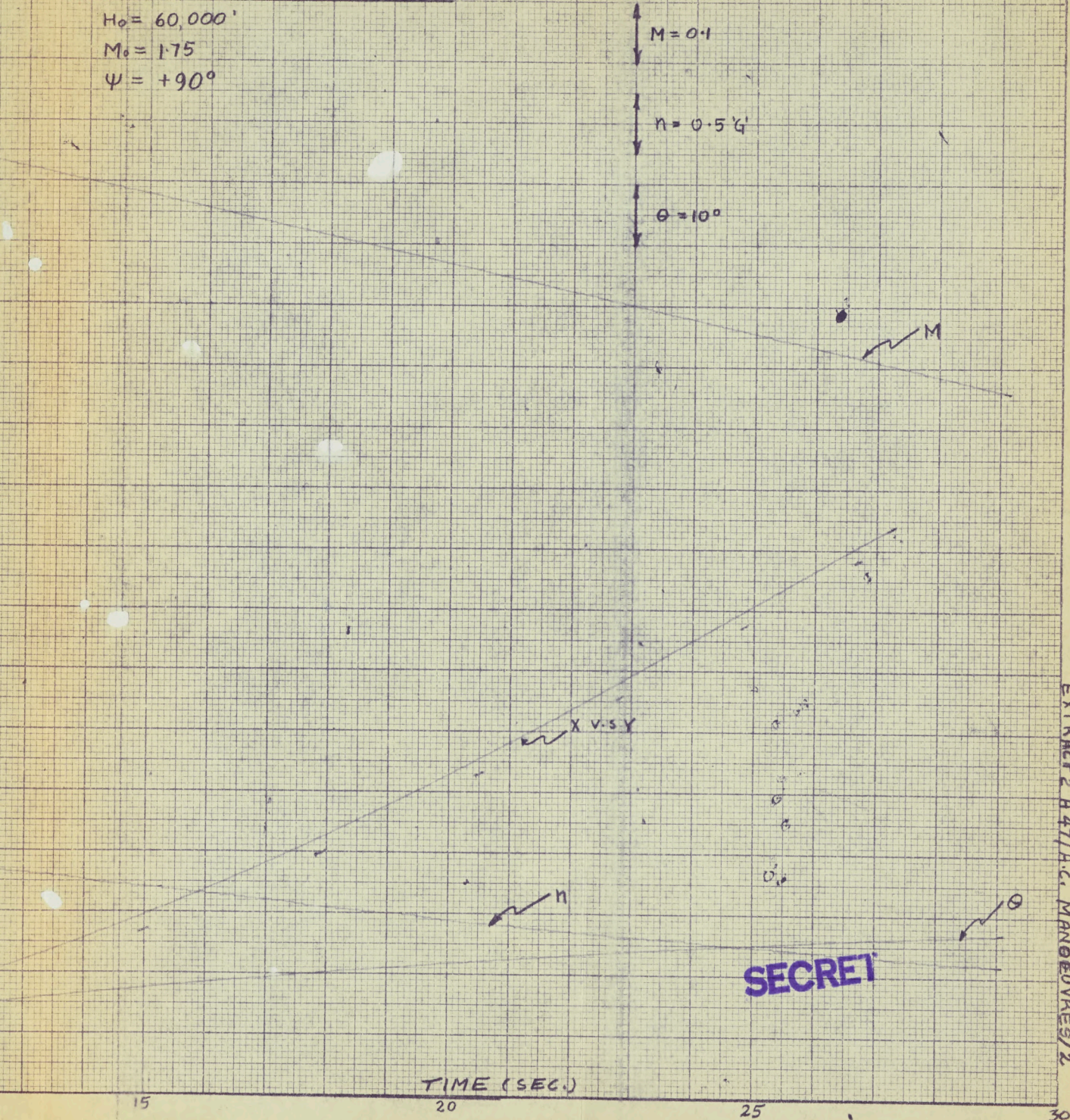
$M_0 = 1.75$

$\psi = +90^\circ$

$M = 0.1$

$n = 0.5 G'$

$\theta = 10^\circ$



EXTRACT 2 R 47/A.C. MANOEUVRES/2

SECRET

TIME (SEC.)

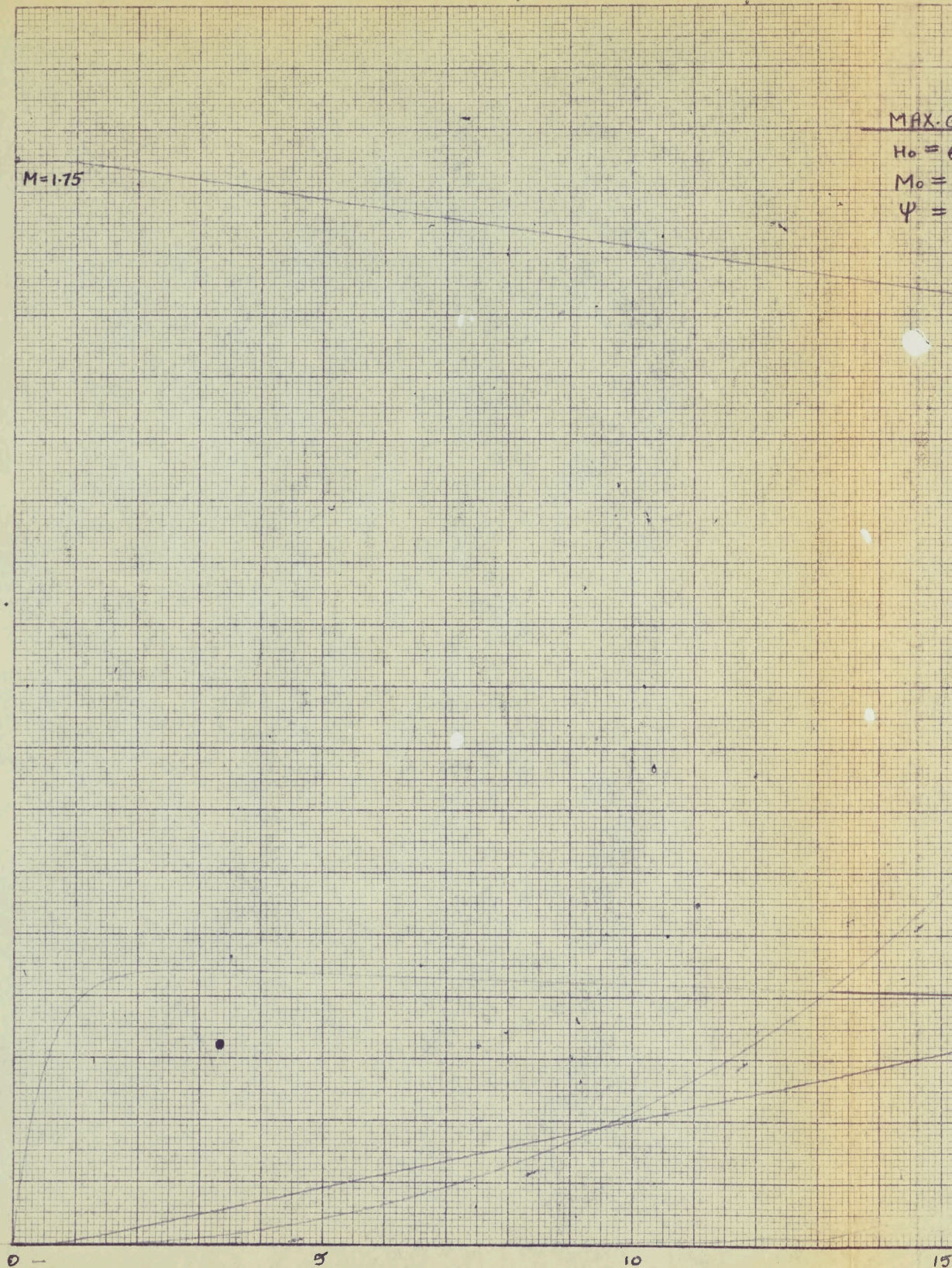
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**K&E**  
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.  
359-11L  
MADE IN U.S.A.

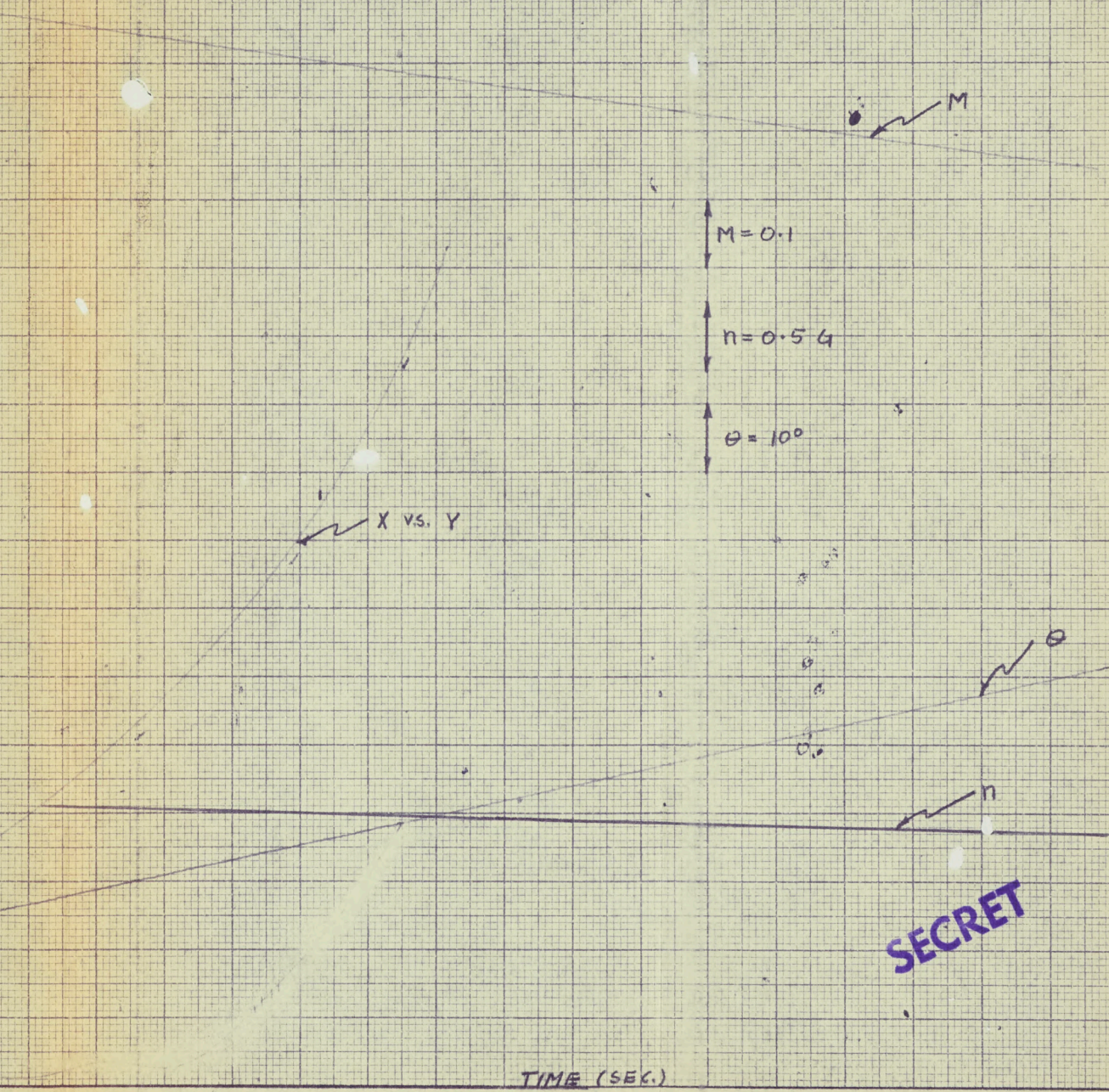


MAX-G TURNS (5.5 G LIMIT)

$H_0 = 60,000'$

$M_0 = 1.75$

$\psi = 0^\circ$



EXTRACT 28 47/R.C. MANBEVRES/2

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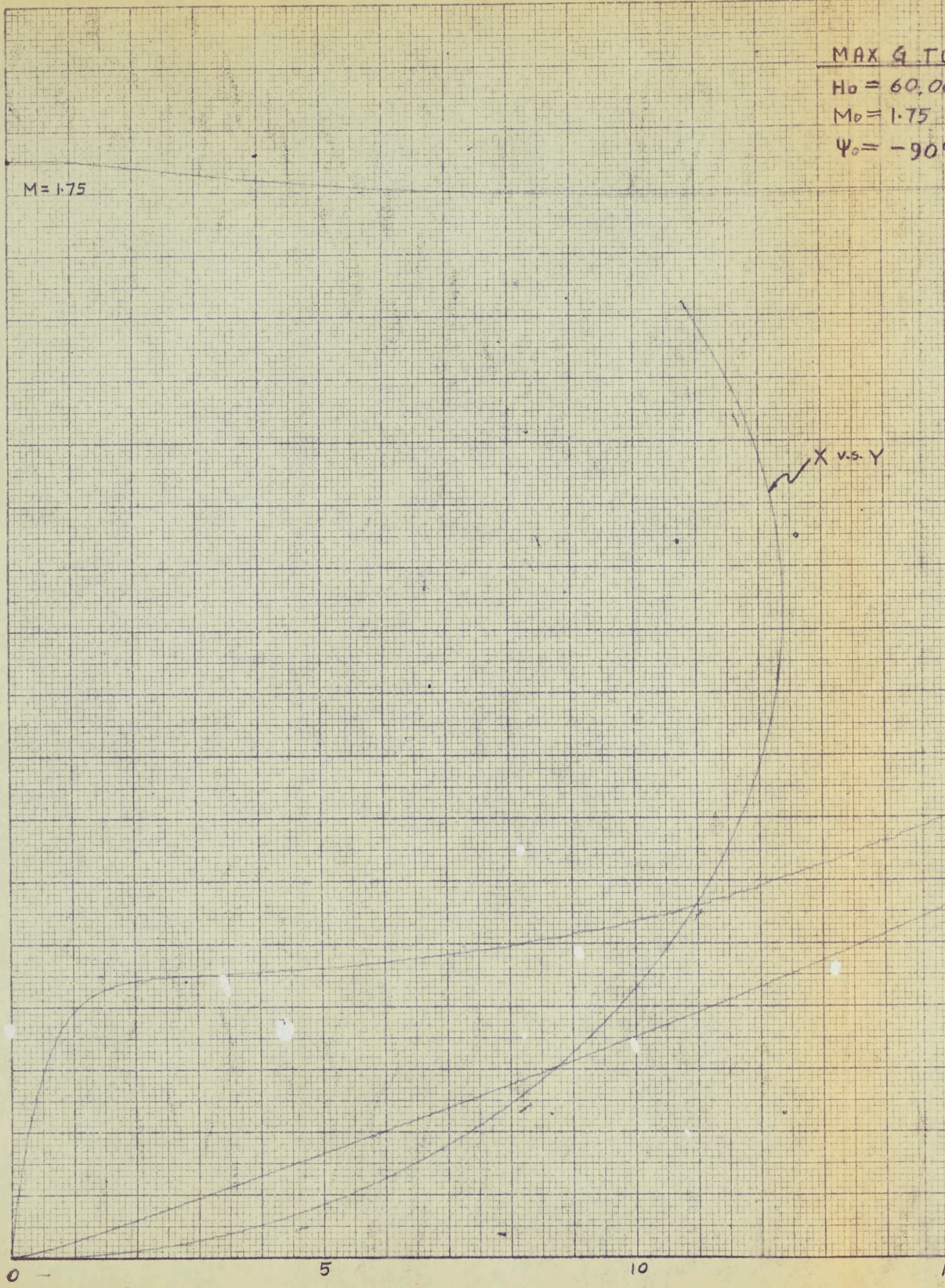
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359-11L  
MADE IN U.S.A.

10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSBER CO.



MAX G.T.  
H<sub>0</sub> = 60.0  
M<sub>0</sub> = 1.75  
Ψ<sub>0</sub> = -90

MAX G TURNS (5.5 G LIMIT)

$H_0 = 60,000'$

$M_0 = 1.75$

$\psi_0 = -90^\circ$

M

M=0.1

n=0.5G

$\theta = 10^\circ$

X v.s. Y

n

$\theta$

TIME (SEC.)

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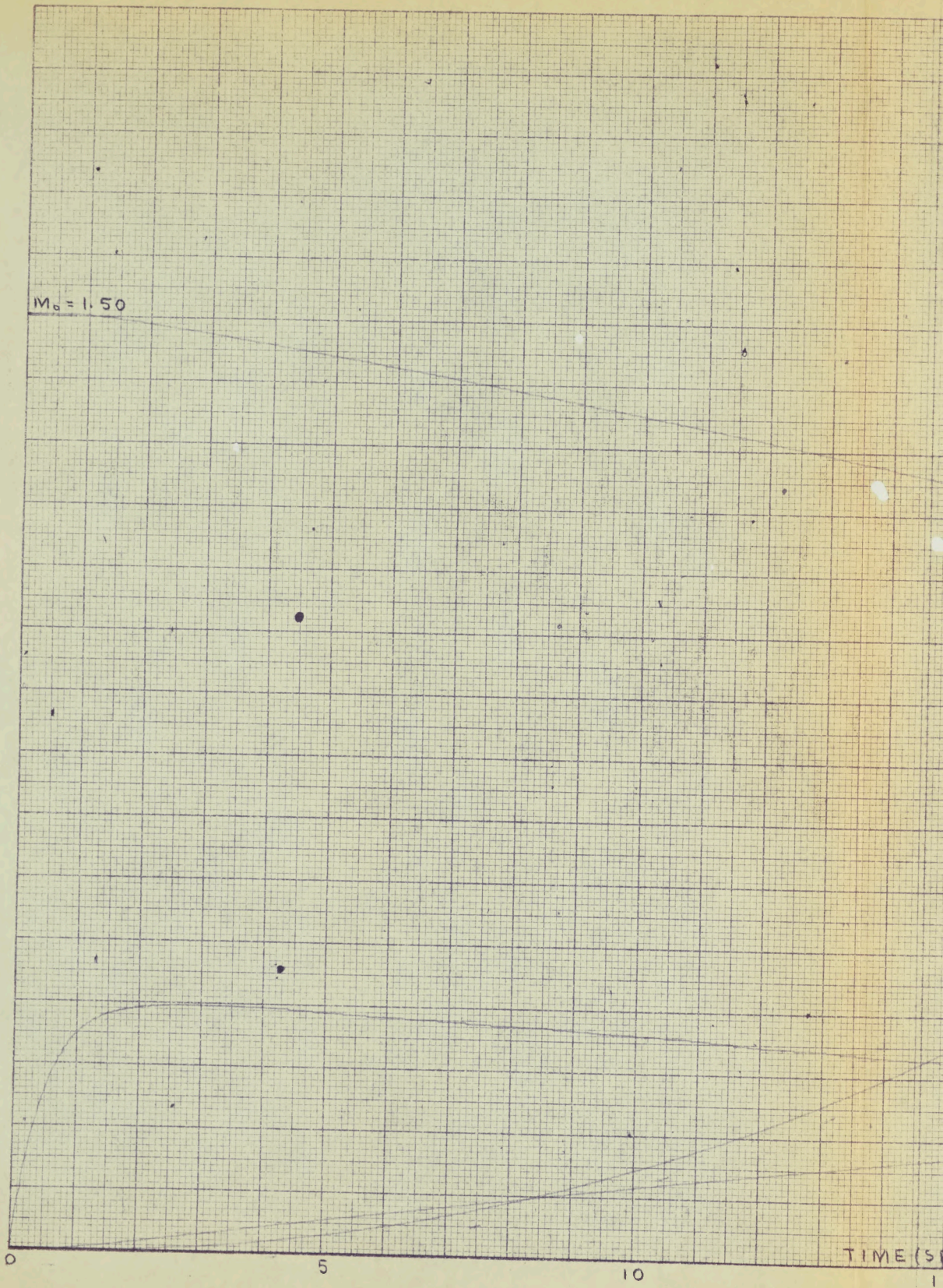
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EXTRACT 2 A47/A-C. MANOEUVRES/2 8

SECRET

359-11L  
MADE IN U.S.A.

10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.



MAX 'G' TURNS (5.5 'G' LIMIT)

$H_0 = 60,000'$

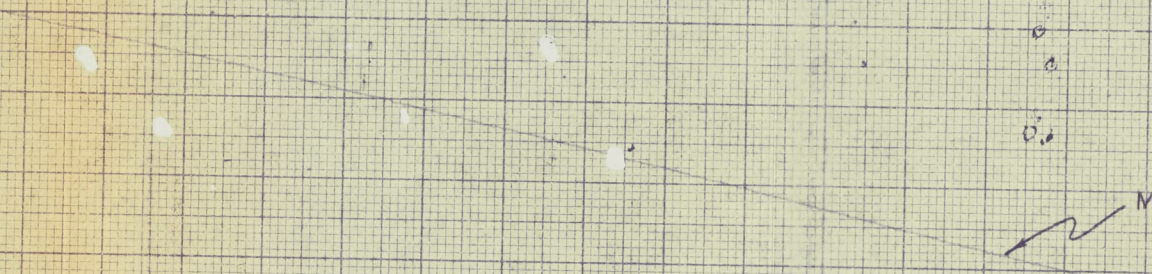
$M_0 = 1.50$

$\psi = 90^\circ$

$M = 0.1$

$\theta = 10^\circ$

$n = 0.5 'G'$



$x$  vs.  $y$

$n$

$\theta$

SECRET

TIME (SEC)

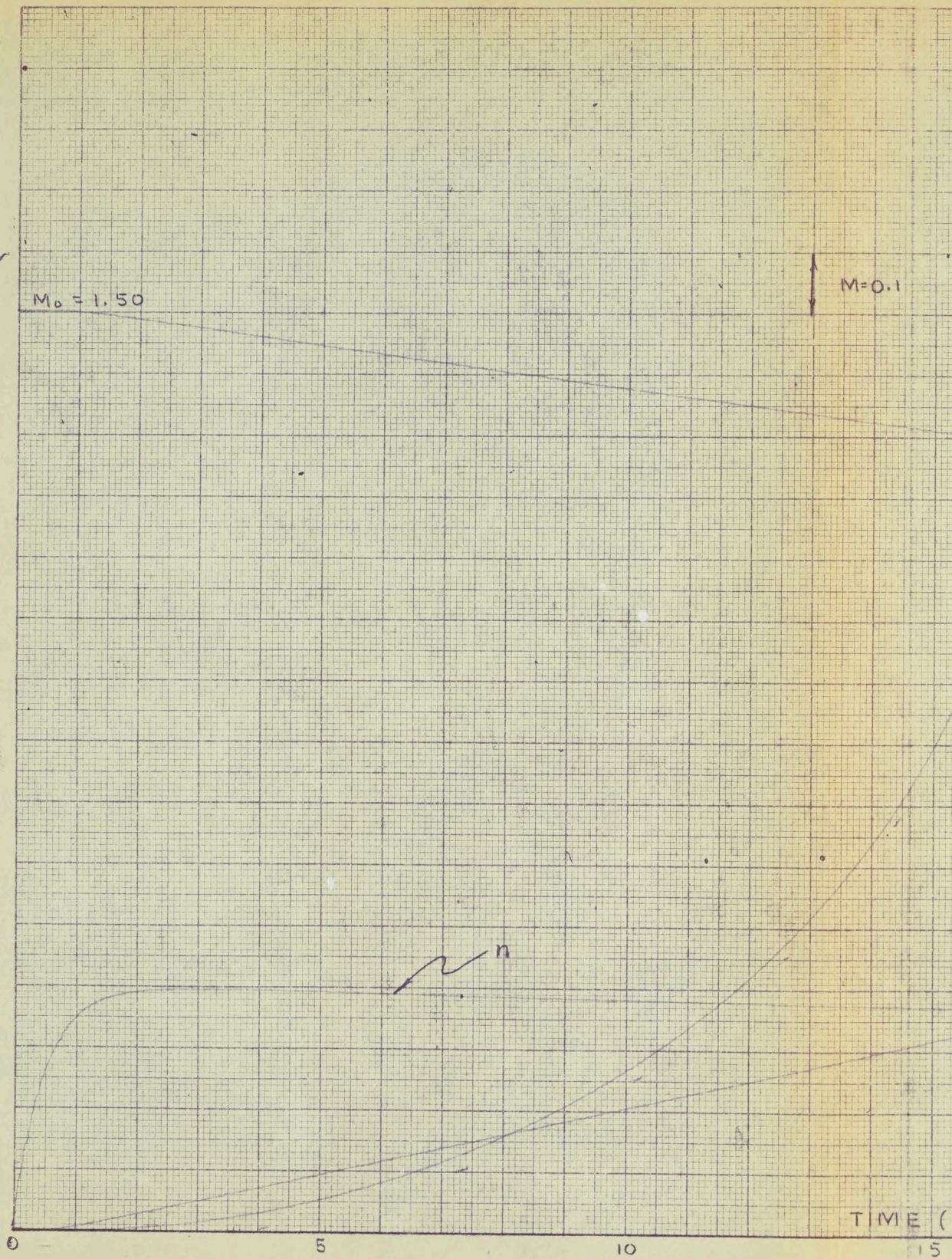
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EXTRACT 2A97/A.C. MANOEUVRES/2

K&E 10 X 10 TO THE 1/2 INCH 359-11L  
KLUFFEL & ESSER CO. MADE IN U.S.A.



MAX. 'G' TURNS (5.5 'G' LIMIT)

$H_0 = 60,000'$

$M_0 = 1.50$

$\psi = 0^\circ$

$M=0.1$

$n=0.5'G'$

$\theta=10^\circ$

$M=1.50$

$X$  vs.  $Y$

TIME (SEC)

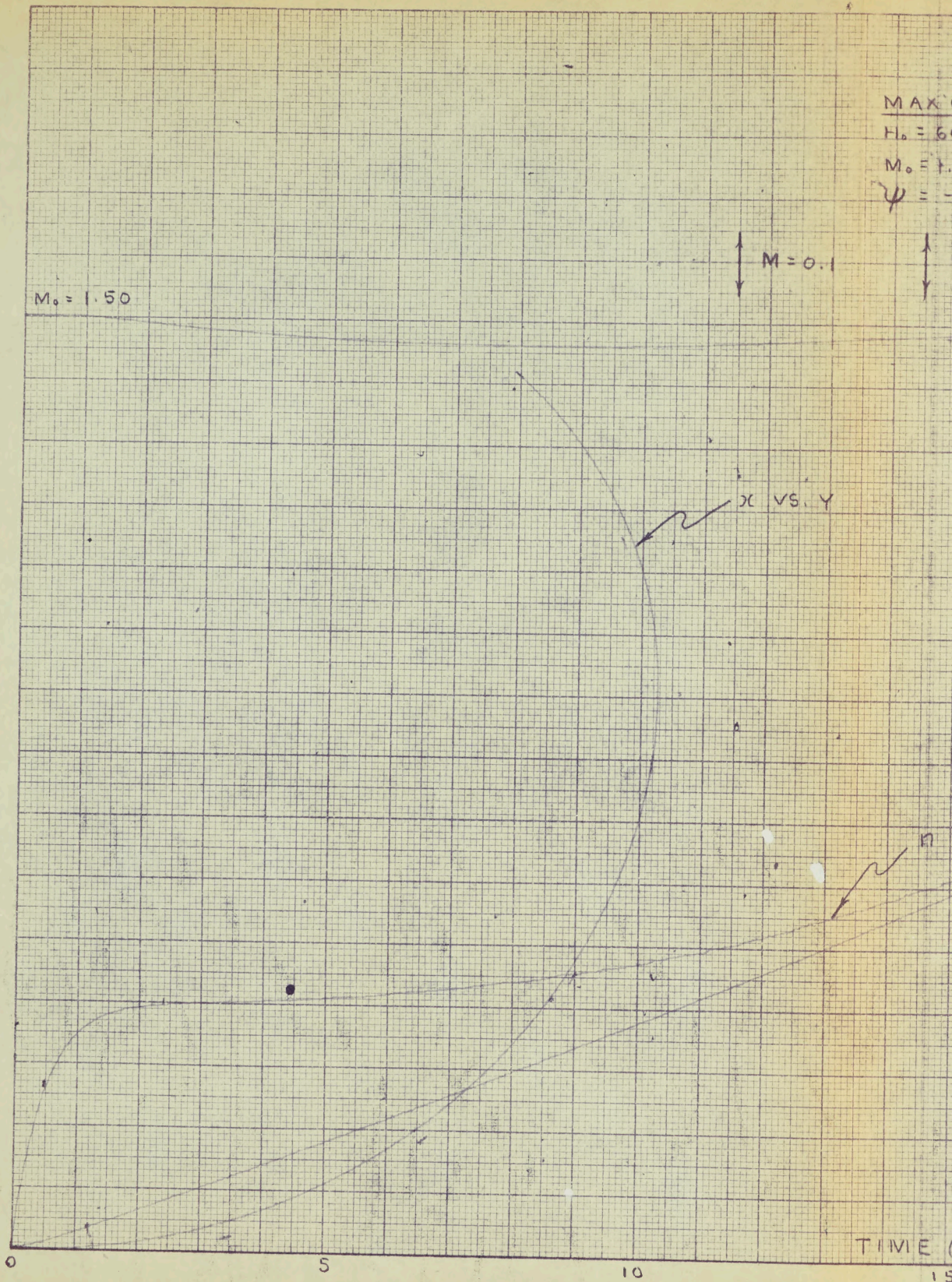
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**SECRET**

10 X 10 TO THE 1/2 INCH 359-111  
KEUFFEL & ESSER CO. MADE IN U.S.A.  
K&E



MAX  
H<sub>0</sub> =  
M<sub>0</sub> =  
 $\psi =$

TIME  
15

MAX G' TURNS (5.5 G' LIMIT)

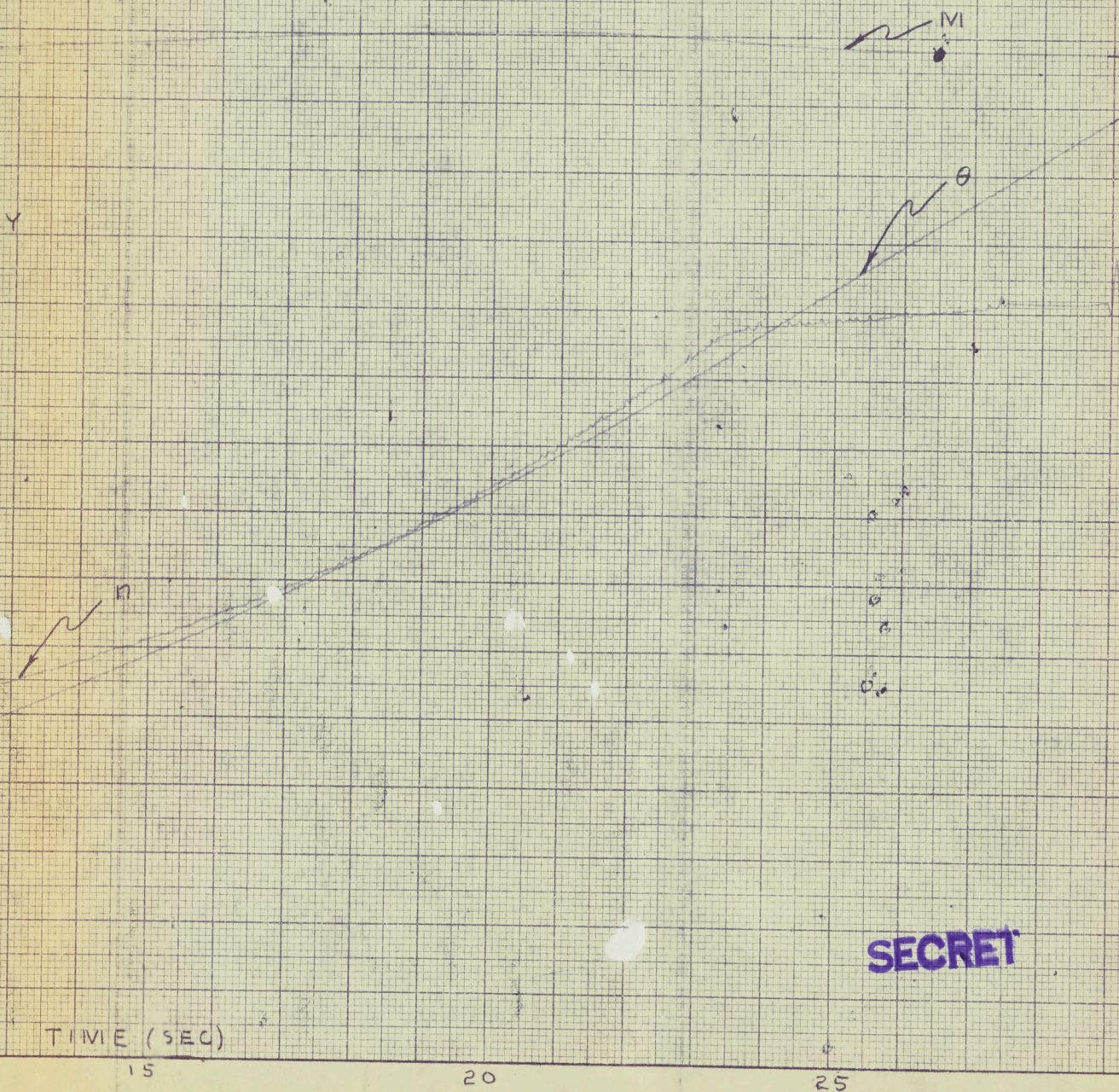
$H_0 = 60,000'$

$M_0 = 1.50$

$\psi = -90^\circ$

$n = 0.5 G'$

$\theta = 10^\circ$



EXTRACT 2A47 / A.C. MANOEUVRES / 2

M = 2.0

MAX. 'G' TURNS ( $5\frac{1}{2}$  'G' LIMIT)

$H_0 = 70,000$  FT.

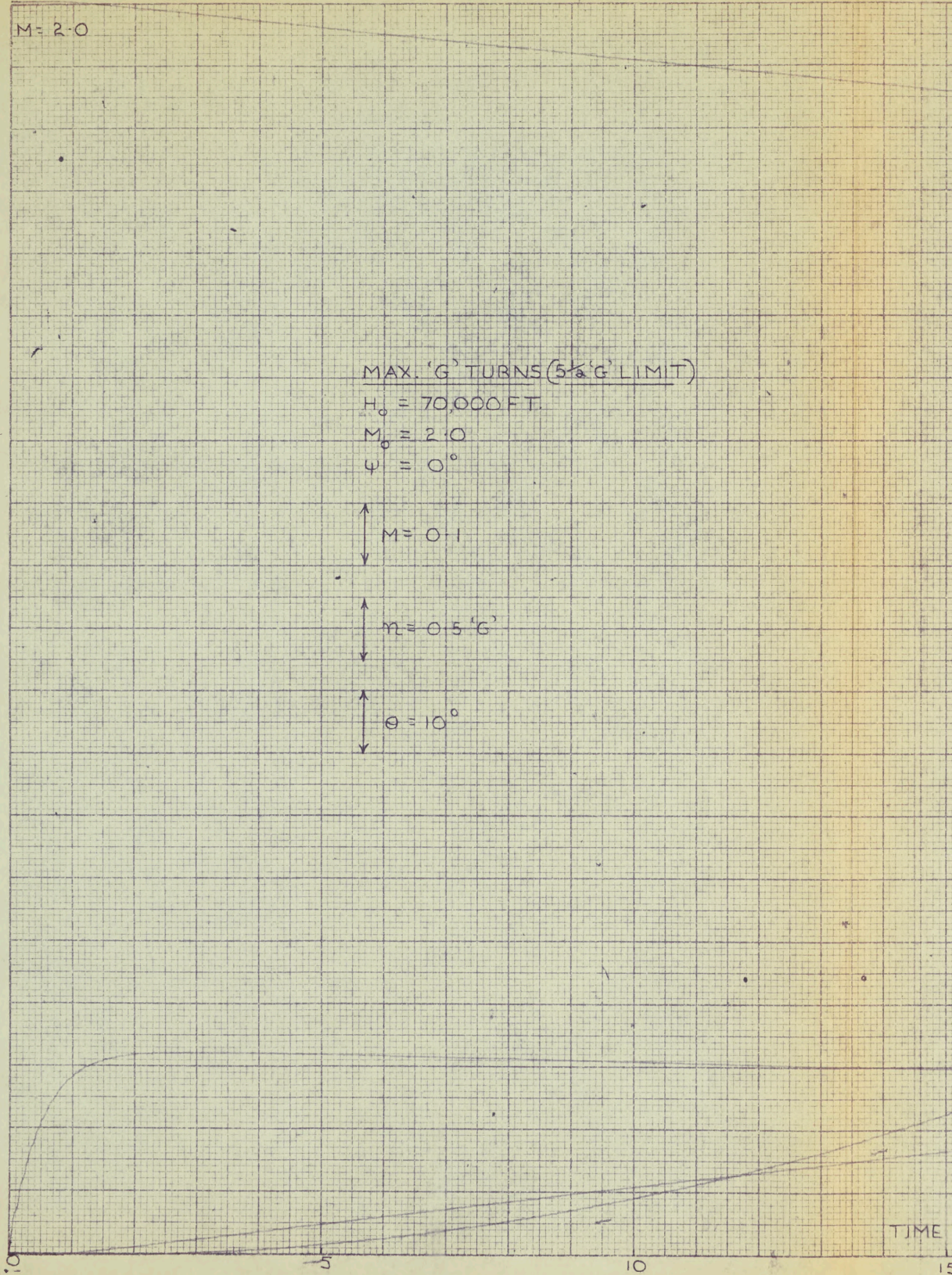
$M_0 = 2.0$

$\psi = 0^\circ$

$M = 0.1$

$n = 0.5$  'G'

$\theta = 10^\circ$



359-11L  
MAY 1954

10 X 10 TO THE 1/2 INCH  
KUPFFEL & LEBEN CO.

K&L

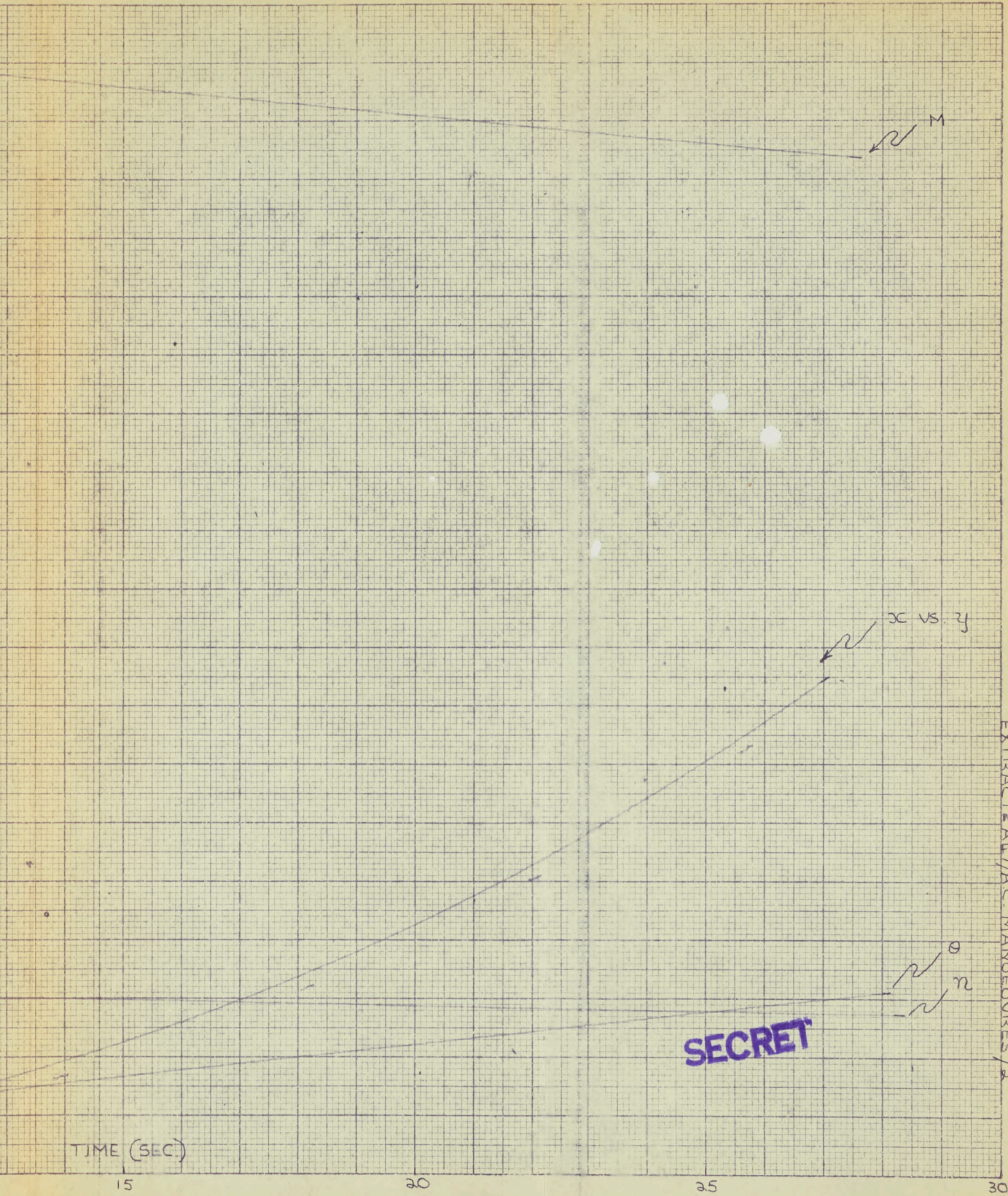
TIME

1.0

5

10

15



EXTRACT 2/21/7/AC. MANOEUVRES / 2

M = 2.0

MAX. 'G' TURN (5 1/2 'G' LIMIT)

H<sub>0</sub> = 70,000 FT.

M<sub>0</sub> = 2.0

ψ = -90°

↑  
M = 0.1  
↓

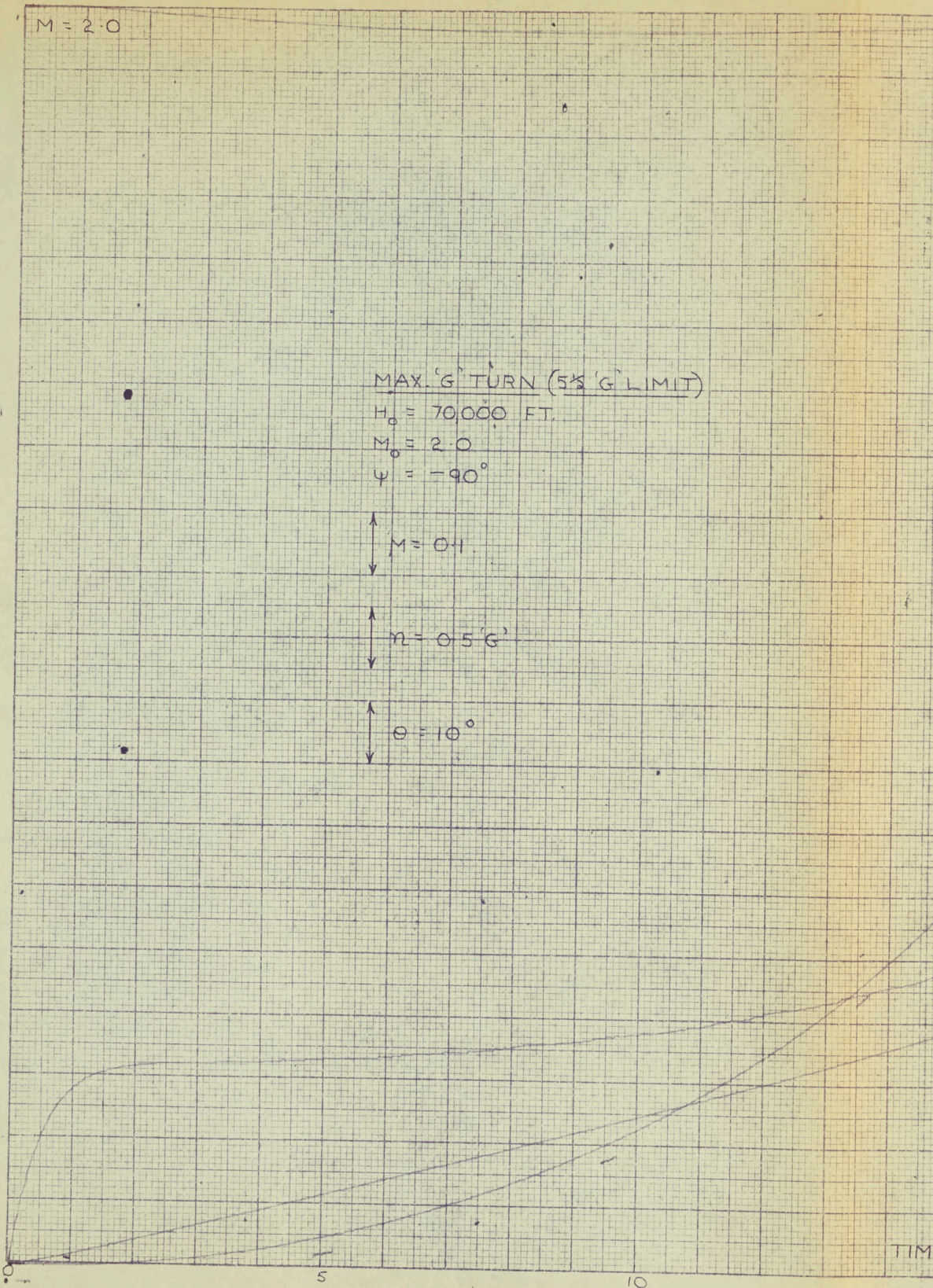
↑  
n = 0.5 'G'  
↓

↑  
θ = 10°  
↓

359-11L  
MADE IN U.S.A.

10 X 10 TO THE 1/2 INCH  
KRUPP & ESSER CO.

K&E



M →

h vs x

n

o

SECRET

EXTRACIZAL7/AC MANOEUVRES/2

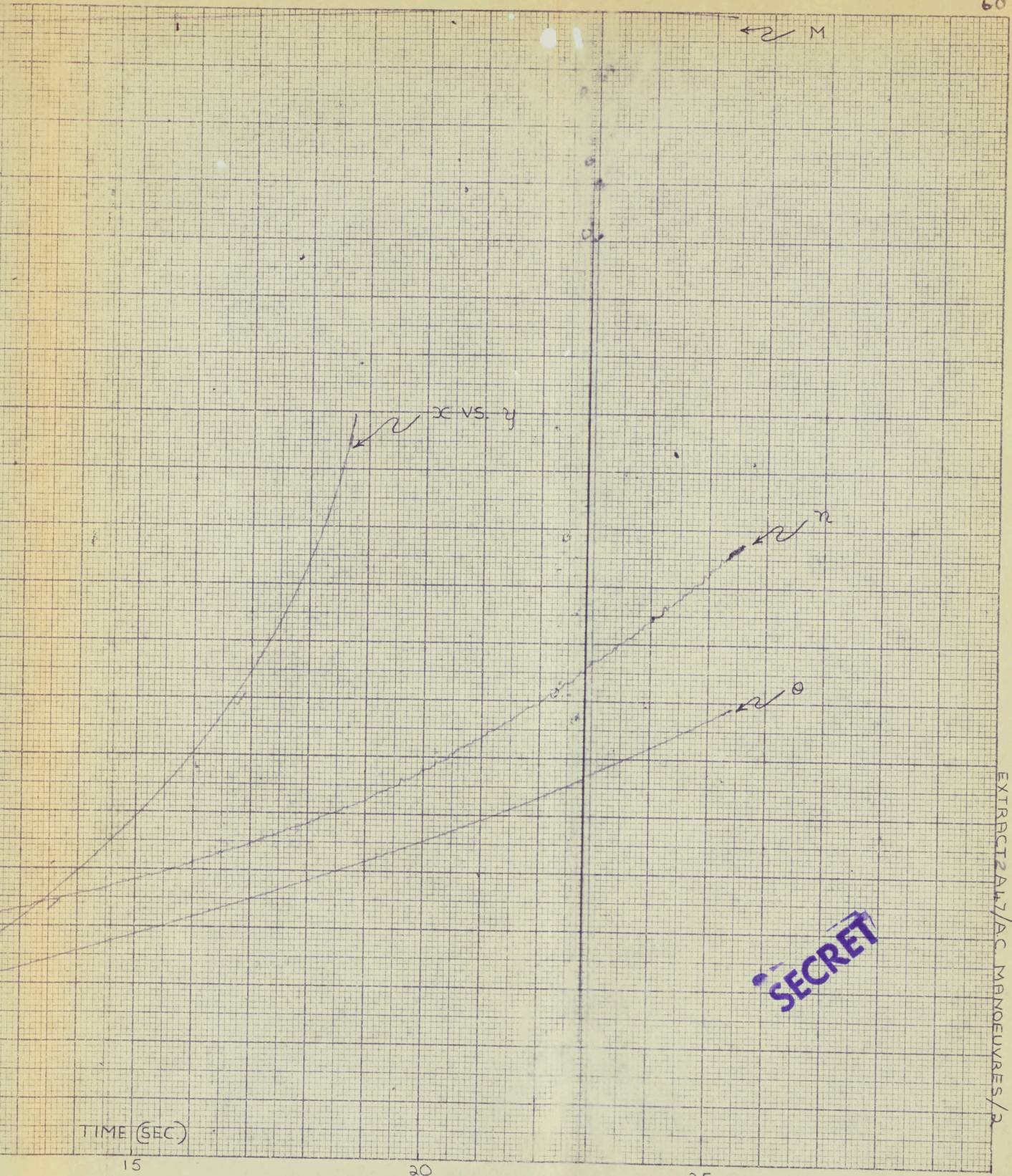
TIME (SEC)

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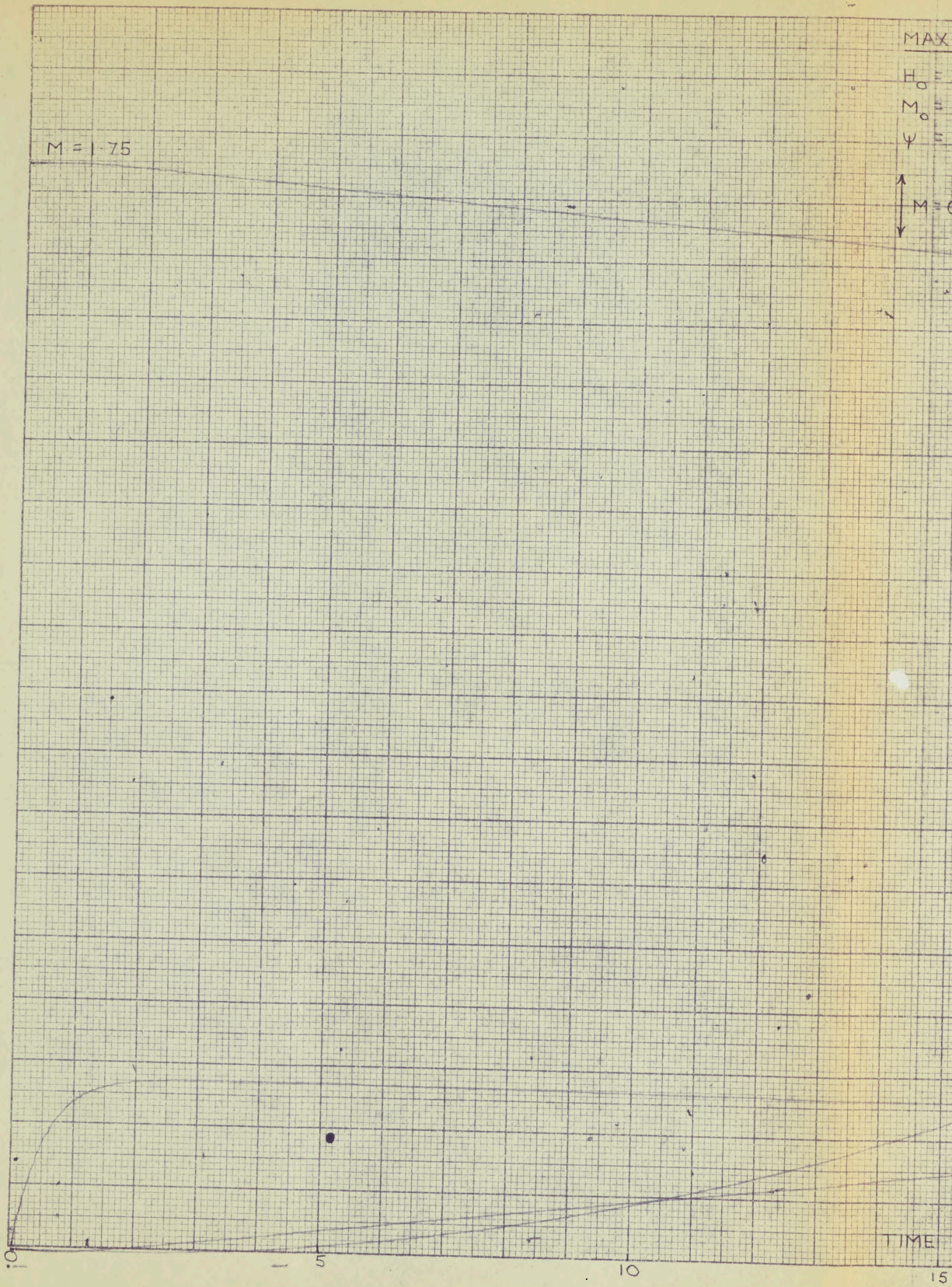
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359-111L  
MADE IN U.S.A.

10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.

K&E

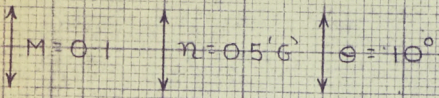


MAX. 'G' TURNS (5 1/2 'G' LIMIT)

H<sub>0</sub> = 70,000 FT

M<sub>0</sub> = 1.75

ψ = 0°



M

X vs.  $\theta$

n

$\theta$

**SECRET**

EXTRACT 2 A47/AC. MNNOEUYRES/2

TIME (SEC)

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M = 1.75

MAX. 'G' TURNS ( $5\frac{1}{2}$  'G' LIMIT)

$H_0 = 70,000$  FT.

$M_0 = 1.75$

$\psi = -90^\circ$

$\updownarrow$   
M = 0.1

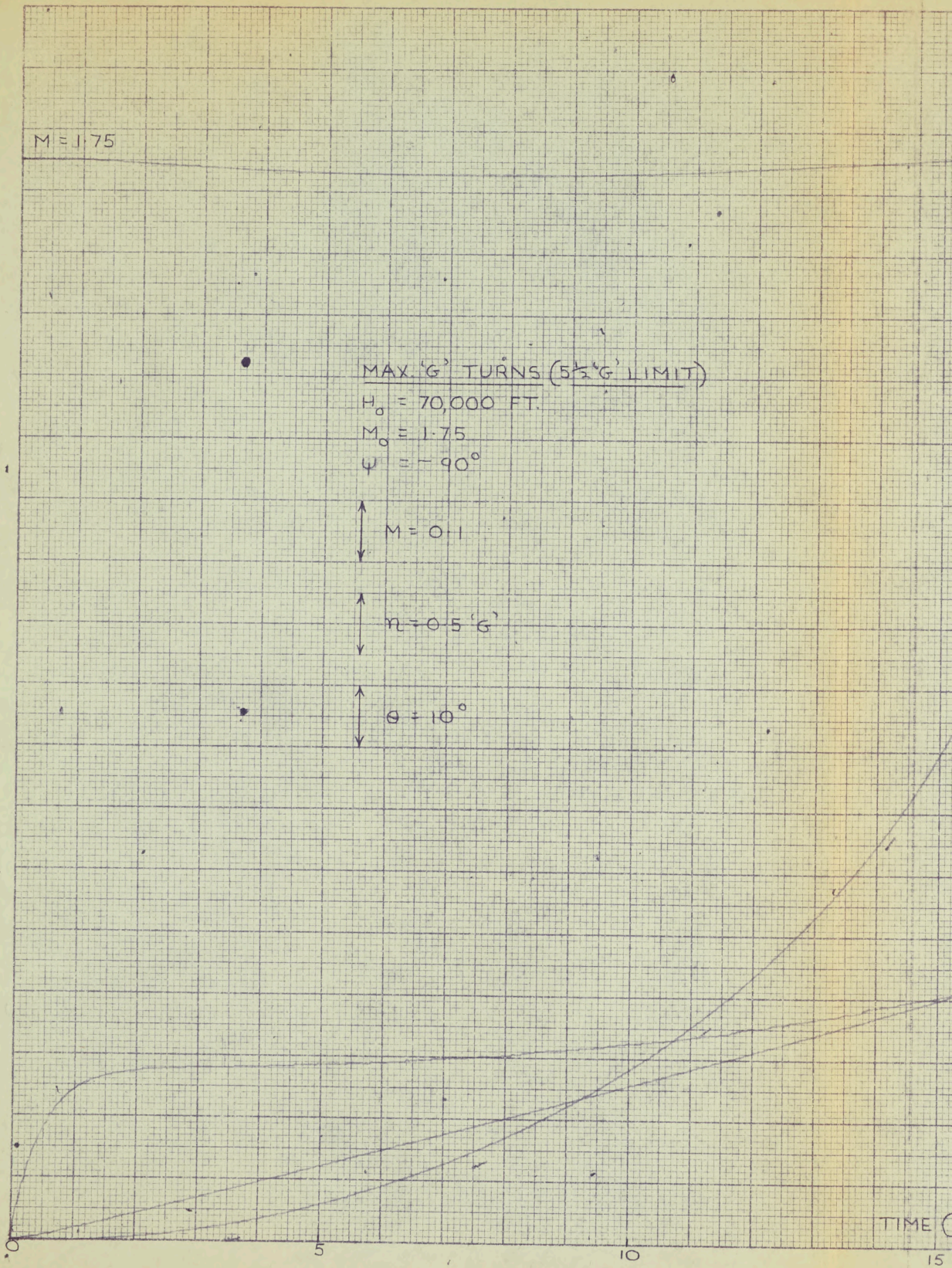
$\updownarrow$   
n = 0.5 'G'

$\updownarrow$   
 $\theta = 10^\circ$

359-11L  
MADE IN U.S.A.

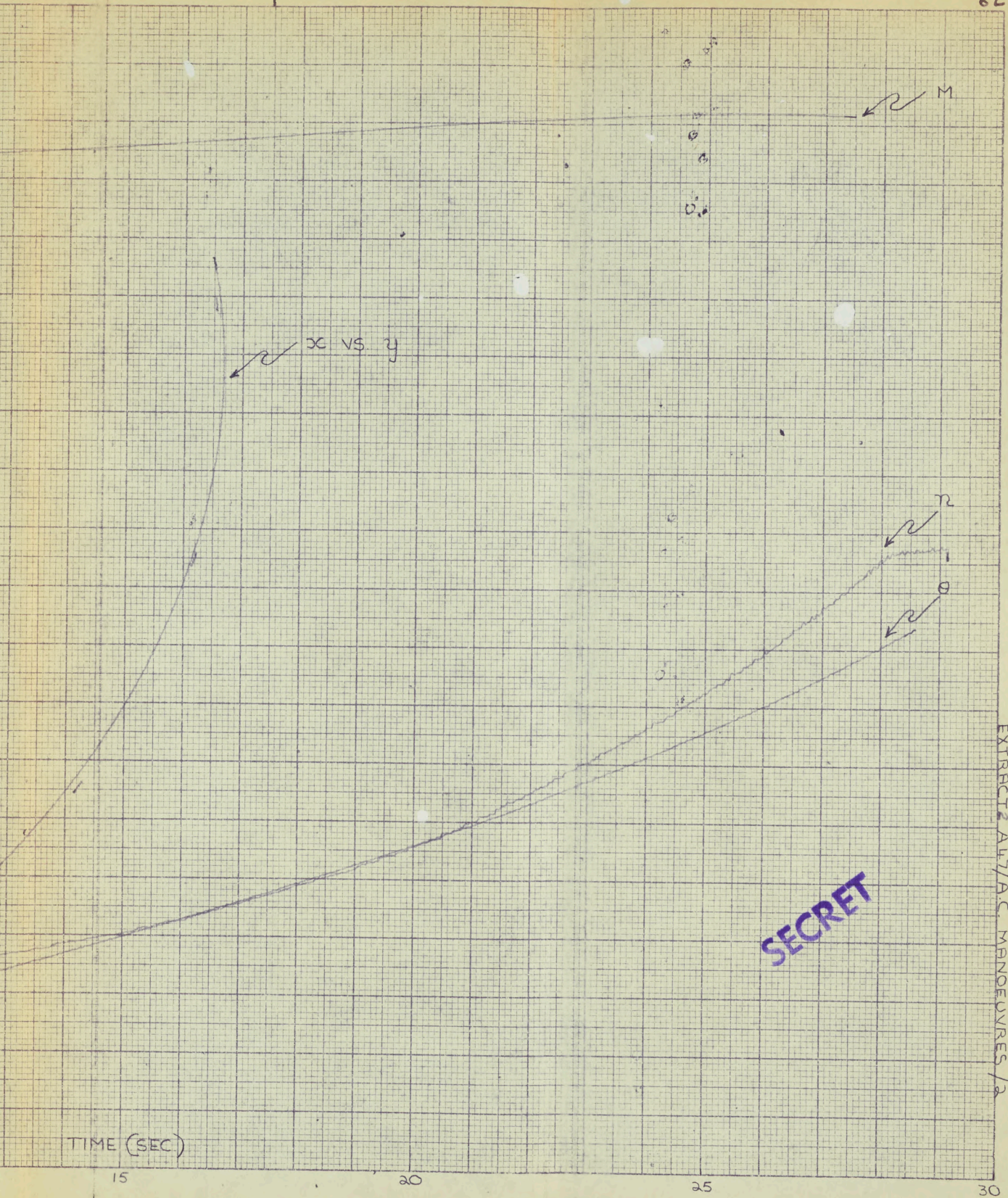
10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.

K&E



TIME

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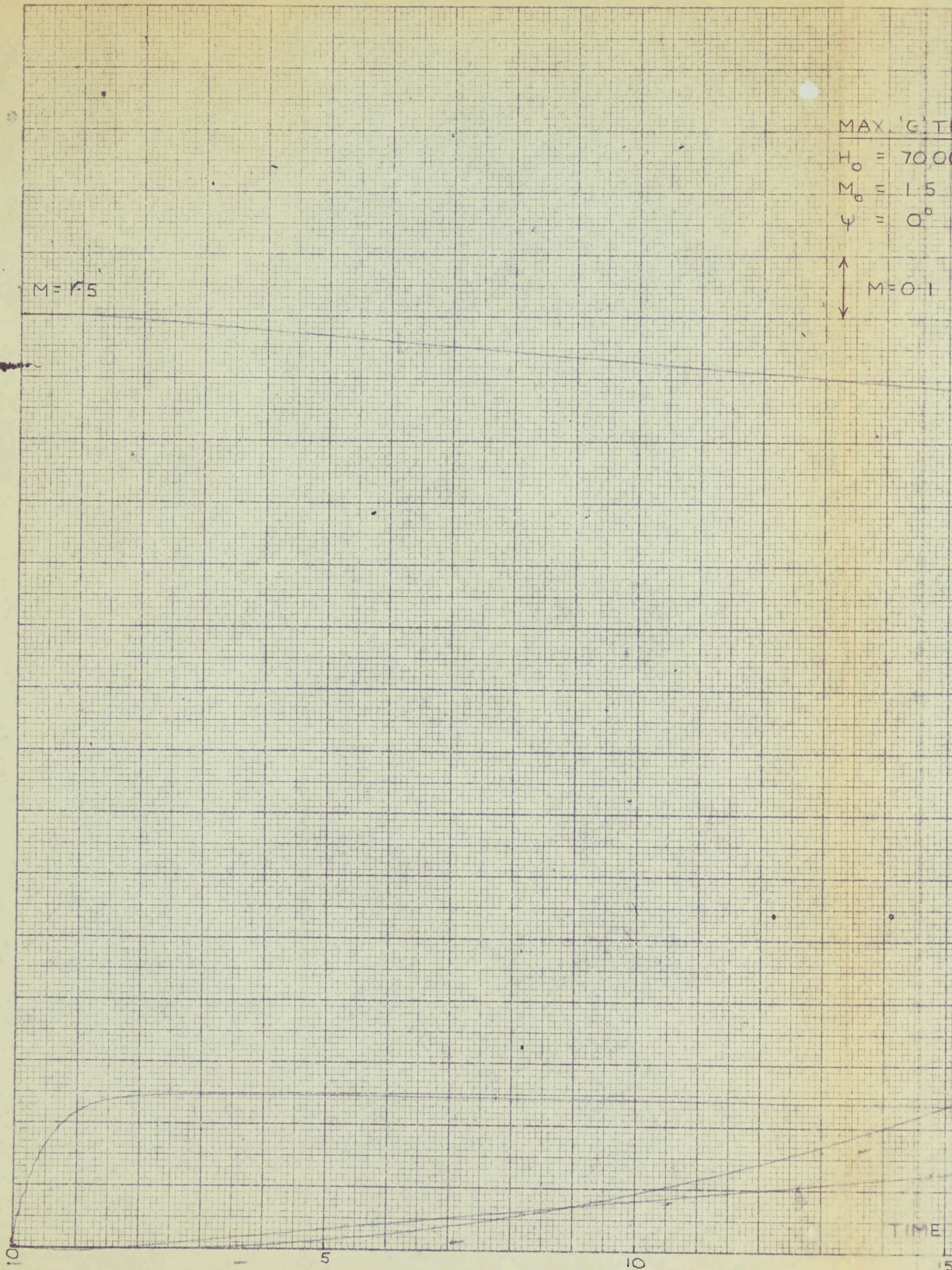
EXTRACT 2, A47/A.C. MANOEUVRES / 2

SECRET

359-111L  
MADE IN U.S.A.

10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.

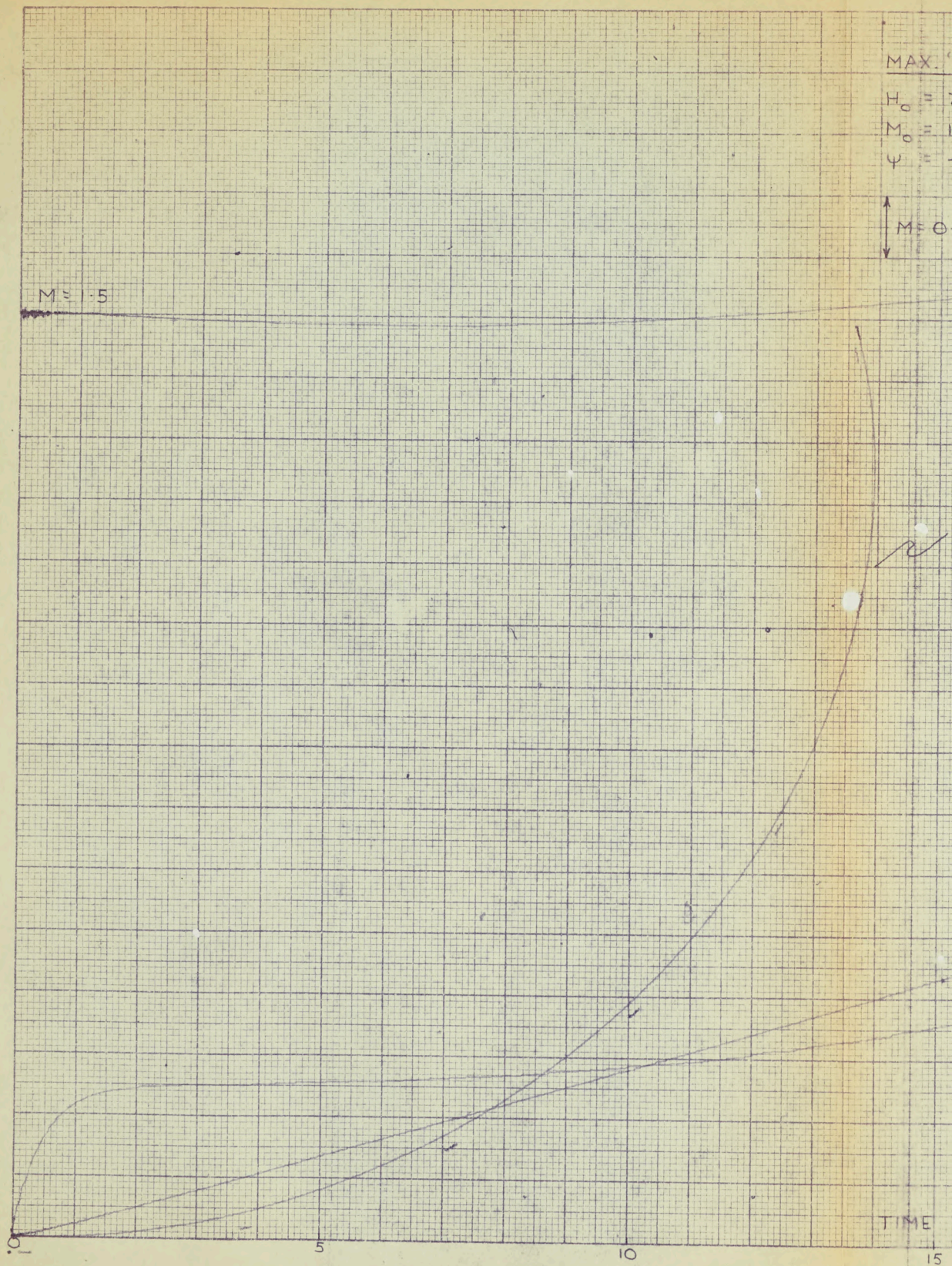
K·E





K-E 359-11L  
MADE IN U.S.A.

10 X 10 TO THE 1/2 INCH  
KEUFFEL & ESSER CO.



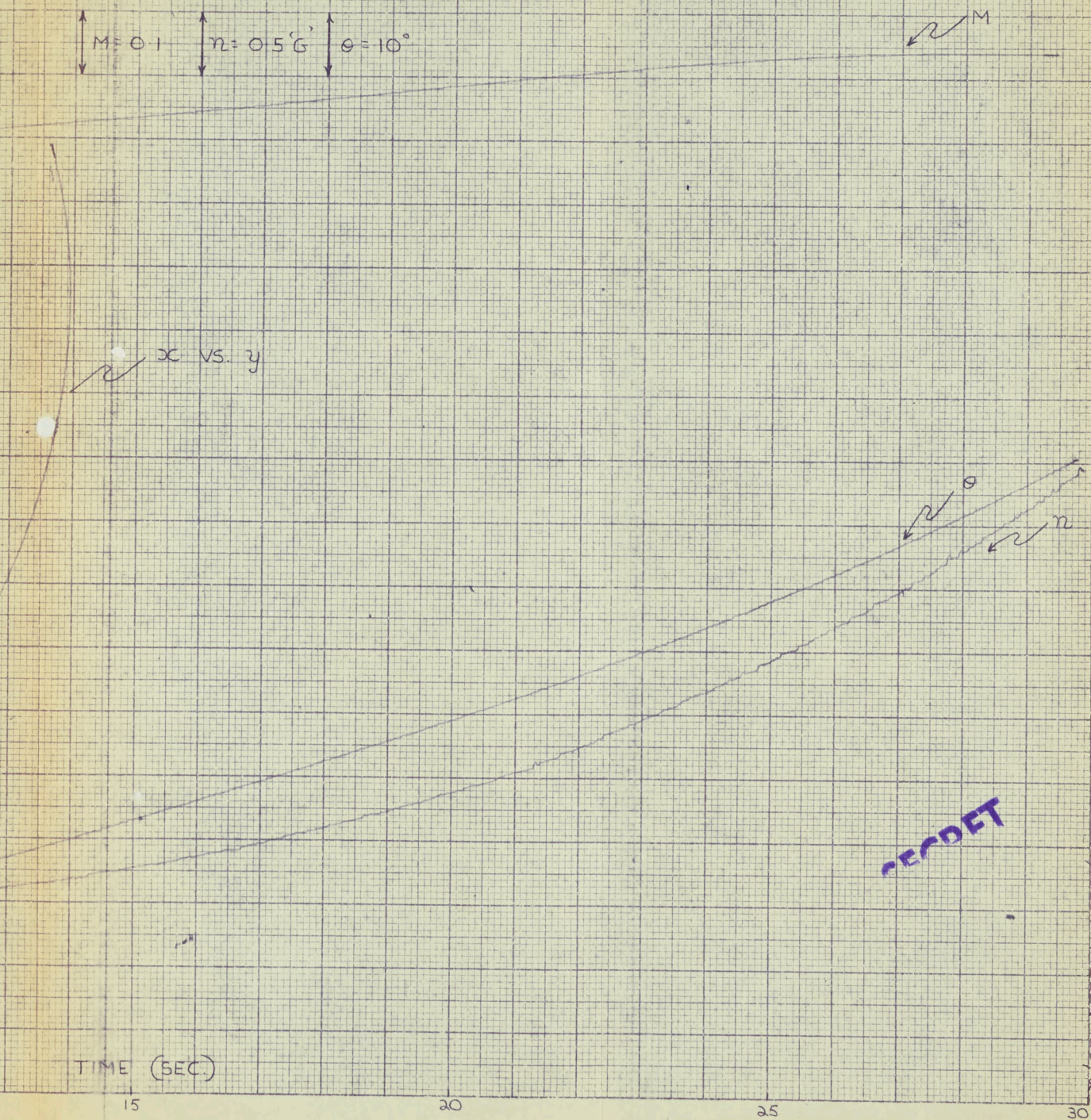
MAX. 'G' TURNS ( $5\frac{1}{2}$  'G' LIMIT)

$H_0 = 70,000$  FT.

$M_0 = 1.5$

$\psi = -90^\circ$

$M = 0.1$     $n = 0.5$  'G'    $\theta = 10^\circ$



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WU YANG  
BEIJING  
1984