CONSTRUCTION OF TORSIONAL TRANSMISSION DYNAMOMETER

BY--F. M. MALONEY, 1915.

A torsional transmission dynamometer or torquemeter it is some times called, is a very valuable adjunct to the equipment of an electrical laboratory. With such an apparatus the determination of iron losses, brush friction losses and bearing friction and windage losses is very simple. For the efficiency tests a torquemeter is more convenient and practical than either a brake method or a loading-back method.

This torquemeter is of the spring type designed to be used on 1800 R.P.M. machinery in the electrical laboratory. It is similar in design to the one designed by H. H. Broughton in The Electrician of December 12, 1913. The method of reading the angle of twist is called the direct method which I will explain in the following.

The angle of twist is read by means of three parallel discs (1) (2) & (3). Disc (1) & (2) are fastened to the tube covering of the spring which in turn is fastened to shaft A. In disc (1) is a radial slit about 3/4 " long and $\frac{1}{2}$ " from outside circumference. In line with this slit is another slit & window on disc (2). about 6 inches away. Disc (3) is fastened to B, and is about $\frac{1}{2}$ inch from disc (2). On the circumference of disc (3) is a scaled celluloid circle which is in line with the slits and window. As the torque meter revolves, one by placing his eye in line with the slits or by 90° mirror reflection, can by looking first through slit of (1) then through slit & window of (2) see the scale on disc three.

The width of the window is about equal to 15 degrees of arc. On illuminating the scale of the back, an observer, looking slit (1) sees a broad arc of the celluloid scale, and at the same time a bright streak due to the slit on disc 2 which serves as an index & eliminates parallax errors. With the apparatus in motion the three discs are at rest relatively to one another as long as the torque is constant, and it is evident that a clear view of part of the scale will be obtained. By getting the zero reading one can then determine the angle of twist. This method of direct

reading was first thought of by Dr. Amsler.

The springs are easily removed and with torque meter are three springs of 10 H. P, 5 H. P, & 2 H. P, appoximately to be used as the occasion requires In designing my springs, I used the formulae.

$$T = W R = \frac{F E D^4}{R\ 20\ L}$$ From Machinery's Handbook.

Where F = Deflection at point of application of load in inches.

W = Safeload, pull or pressure, in pounds.

R = Moment arm, in inches.
E = Modulus of elasticity 30,000,000 for steel.
D = Diameter of wire, in inches.

L = Length of wire or uncoiled spring, in inches.

$$T = \frac{63000 \times H.P.}{R.P.M.}$$

Where T = Torque, in inch pounds.

H. P = Horse power to be transmitted.

R. P. M = Revolutions per minute.

10 H. P.

F = about 180° and on a radius of 7" F = 22"

R = 7"

E = 30,000,000

L = 80"

D = #1wire. washburn & moen gage .283"

$$T = \frac{F E D^4}{R\ 20\ L} = \frac{22 \times 30,000,000 \times .00642}{7 \times 20 \times 80} = 378$$

$$T = \frac{63000 \times H.P.}{R.P.M.} = \frac{63000 \times 10}{1800} = 350$$

The above dimensions are then alright.

Let D = outside diameter of coil = 1.25"

D' = Mean " " " = .967"

Number of coils $= \frac{80}{.967 \times 11} = 26.3$

Pitch $= .0938 + .283 = .3768$

$H = .3768 \times 26.3 = 9.91$

5 H. P.

$H = 9.91"$ Actual 10"

$D = 1.25"$

$d =$ # 3 wire, washburn & Moen gage $= .2437$

$D' = 1.0063$

$d^4 = .003524$

$l = 100"$

$T = \frac{63000 \times H.P.}{R.P.M.} = \frac{63000 \times 5}{18000} = 175$ inch pounds.

$R = 7"$

$F = \frac{20 W L R}{E d^4} = \frac{20 \times 175 \times 7 \times 100}{30,000,000 \times .003524} = 23.16"$

The above dimension are then alright.

Number of coils $= \frac{100}{1.0063\pi} = 31.62$

Pitch $= \frac{9.91}{31.62} = .313"$

2 H.P.

$H = 9.91"$

$D = 1.25"$

$d =$ # 6 wire washburn & moen gage $= .192"$

$D' = 1.058$

$d^4 = .00136$

$l = 110"$

$T = \frac{63000 \times 2 H.P.}{1800} = 70$ inch pounds

$R = 7"$

$F = \frac{20 W l R^3}{E d^4} = \frac{20 \times 70 \times 7 \times 110}{30,000,000 \times .00136} = 26.4"$

The abofe dimensions are then all right.

Number of coils $\frac{110}{1.058\,\pi}$ 33.05

Pitch $\frac{9.91}{33.05}$ .2998"

ACTUAL DIMENSION OF SPRINGS.

10 H. P.

Outside diameter ----------1¼"

Section----------Round gage # 1

Pitch----------3/8"

Number of turns----------27

Length over-all----------10"

Material, Spring steel

5 H. P

Outside diameter----------1¼"

Section----------Round gage # 3

Pitch----------5/16"

Number of turns----------32

Length overall----------10"

Material Spring steel.

2 H. P.

Outside diameter----------1¼"

Section----------Round gage # 6

Pitch----------5/16"

Number of turns----------32

Length overall----------10"

Material, Spring steel.

Work to be done to complete the thesis.

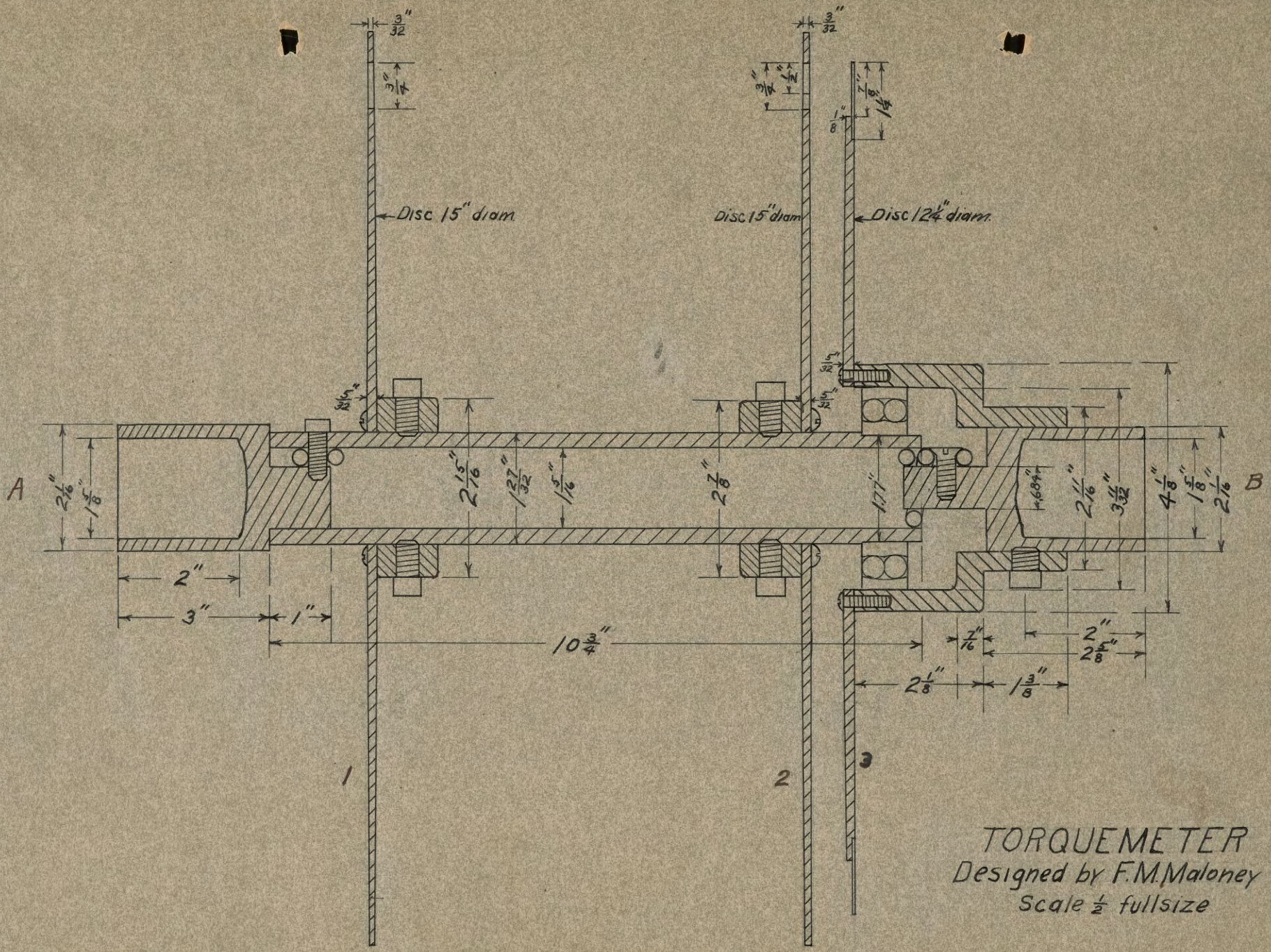
2½ discs to turn up.

Graduate celluloid disc.

Turn down end of bushing to go inside the spring.

Tap out holes in 2 collars & screw 3rd disc to face of bushing.

Make opening in Al. discs.



TORQUEMETER

Designed by F.M.Maloney

Scale 1/2 fullsize