PHIPPS & BIRD

Phipps & Bird, Inc. *Manufacturers of Scientific Instruments* P.O. Box 27324 Richmond, Virginia 23261 (804) 264-7590

MUSCLE LEVER

7047-000

AND MODELS

7038-000	7039-000
7046-000	7047-000 (Old Model)

OPERATING INSTRUCTIONS

AND

PARTS LIST

PRINTED IN U.S.A.

MAY 198[illegible]

INTRODUCTION

The Muscle Lever is an instrument used to record muscle contraction. It may be used with any of a variety of skeletal, cardiac, or smooth muscle preparations. Muscle contraction patterns are translated to motion of a writing device to make a record on a Kymograph.

Phipps & Bird has, over the years, supplied a variety of Muscle Lever packages for Kymography. While their appearance and assembly details vary, all Phipps & Bird Muscle Levers operate in the same way. This manual pictures assemblies with parts which may or may not be present on your Muscle Lever. However, the instructions are applicable to all Phipps & Bird Muscle Levers.

For convenience, Phipps & Bird offers a single package Muscle Lever set which combines all parts previously supplied in various packages:

7047-000	Combination Muscle Lever - Provides for either smoke or ink writing. Includes muscle lever, after-loading assembly, pen and ink reservoir, pen swivel, stylus, and hooked lever.

Previous Phipps & Bird Muscle Lever packages:

7038-000	Smoke Writing Muscle Lever - Included muscle lever and stylus.
7039-000	Smoke Writing Muscle Lever - Included muscle lever with after-loading assembly and stylus.
7046-000	Ink Writing Muscle Lever - Included muscle lever, pen and ink reservoir, and pen swivel.
7047-000 (Old model)	Ink Writing Muscle Lever - Included muscle lever with after-loading assembly, pen and ink reservoir and pen swivel.

ASSEMBLY AND OPERATING INSTRUCTIONS

Attach the Muscle Lever to the Kymograph Support Rod with a Double Right Angle Clamp, as illustrated in Figure 5-1. The following number references are to Figures 1 through 4.

SMOKE WRITING

For writing on the smoked paper surface of the kymograph, the stylus (7) is inserted in the hole in the pivot (8) to the desired length and clamped in the pivot by tightening the clamp nut (9). The Support Rod, Clamp, and Muscle Lever should be re-positioned so that the stylus is tangent to the Kymograph Drum.

INK WRITING

For writing on kymograph paper with a capillary pen, the Pen Swivel (22) is used with the Pen and Ink Reservoir (10). The swivel permits the pen to fall against the drum by gravity. Lighter and more even pressure is provided, and adjustment for pen writing is easier. Insert the shank of the swivel in the hole in the pivot (8) and insert the pen stem (10) through the hole in the swivel shaft. Before the clamp nut (9) is tightened, see that the swivel shaft is tipped about ten or fifteen degrees from the vertical with its top end tilted toward the writing surface. For best results, the pen stem and the shank of the pen swivel should be approximately in line when the whole assembly is completely set up for writing. The tip of the pen should be as nearly perpendicular to the kymograph writing surface as possible.

HOOKED LEVER

The Hooked Lever (12) is inserted in the second hole in the pivot (8) and clamped in place with the clamp nut (9). A thread (#40 nylon sewing thread is recommended) is attached from the muscle to the hooked lever. Loading weights may be suspended from the hooked lever to provide a force for the muscle to act against. (For small muscle or smooth muscle experiments, the thread suspending the weights may be carried around the pulley on the pivot (8) in the appropriate direction to provide light forces against the muscle).

AFTER-LOADING ASSEMBLY

This attachment is used to prevent weights from stretching the muscle, until muscle loading is wanted, by stopping the motion of the hooked lever. The stopped position is adjusted with the screw (15) which can be locked with the nut (16). This assembly may be installed in other positions when necessary by removing the screw (13) and re-installing the assembly as desired.

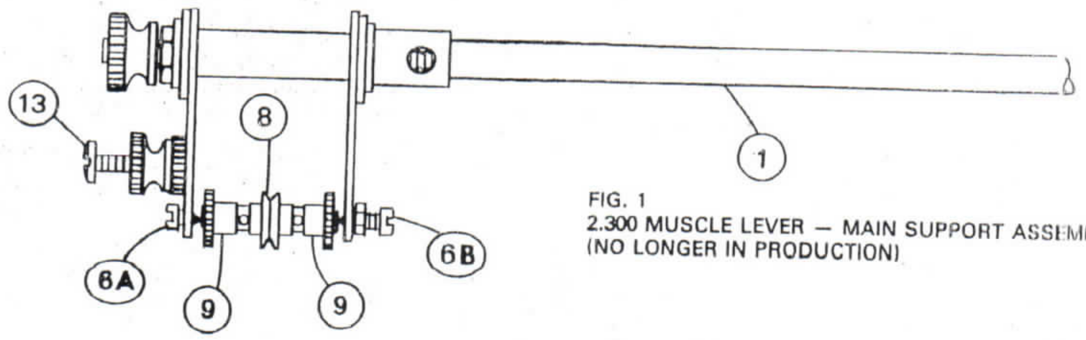


FIG. 1
2.300 MUSCLE LEVER — MAIN SUPPORT ASSEMBLY ONLY
(NO LONGER IN PRODUCTION)

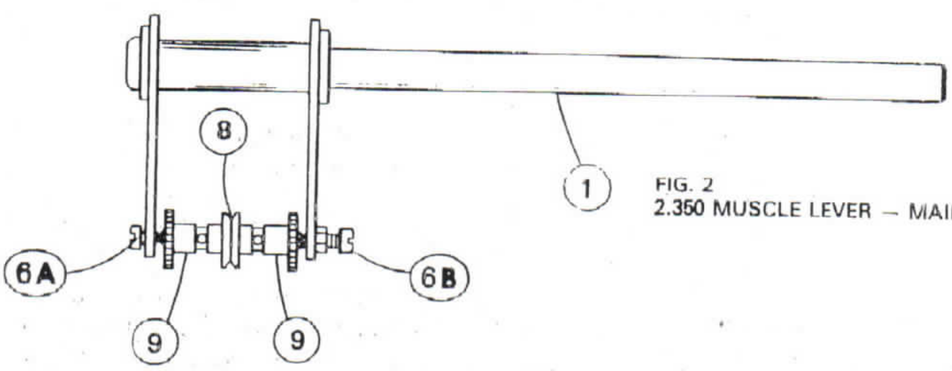


FIG. 2
2.350 MUSCLE LEVER — MAIN SUPPORT ASSEMBLY ONLY

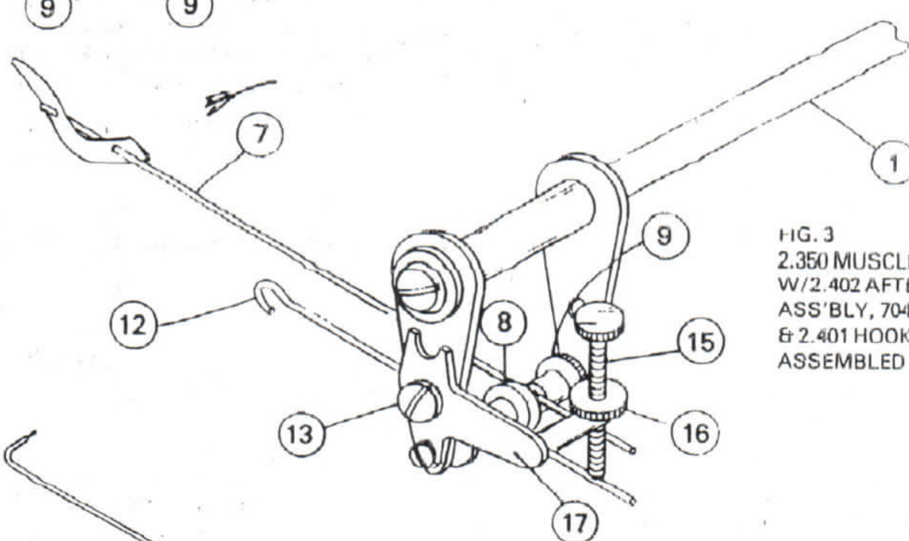


FIG. 3
2.350 MUSCLE LEVER
W/2.402 AFTER LOADING
ASS'BLY, 7045-000 STYLUS
& 2.401 HOOKED LEVER
ASSEMBLED

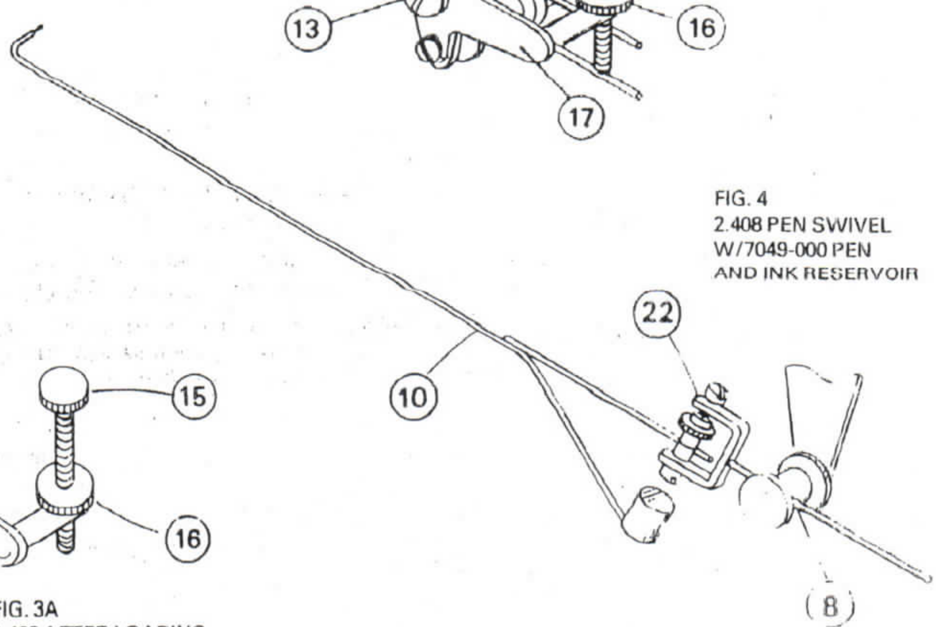


FIG. 4
2.408 PEN SWIVEL
W/7049-000 PEN
AND INK RESERVOIR

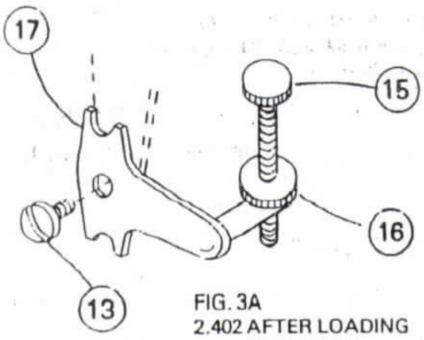


FIG. 3A
2.402 AFTER LOADING
ASSEMBLY

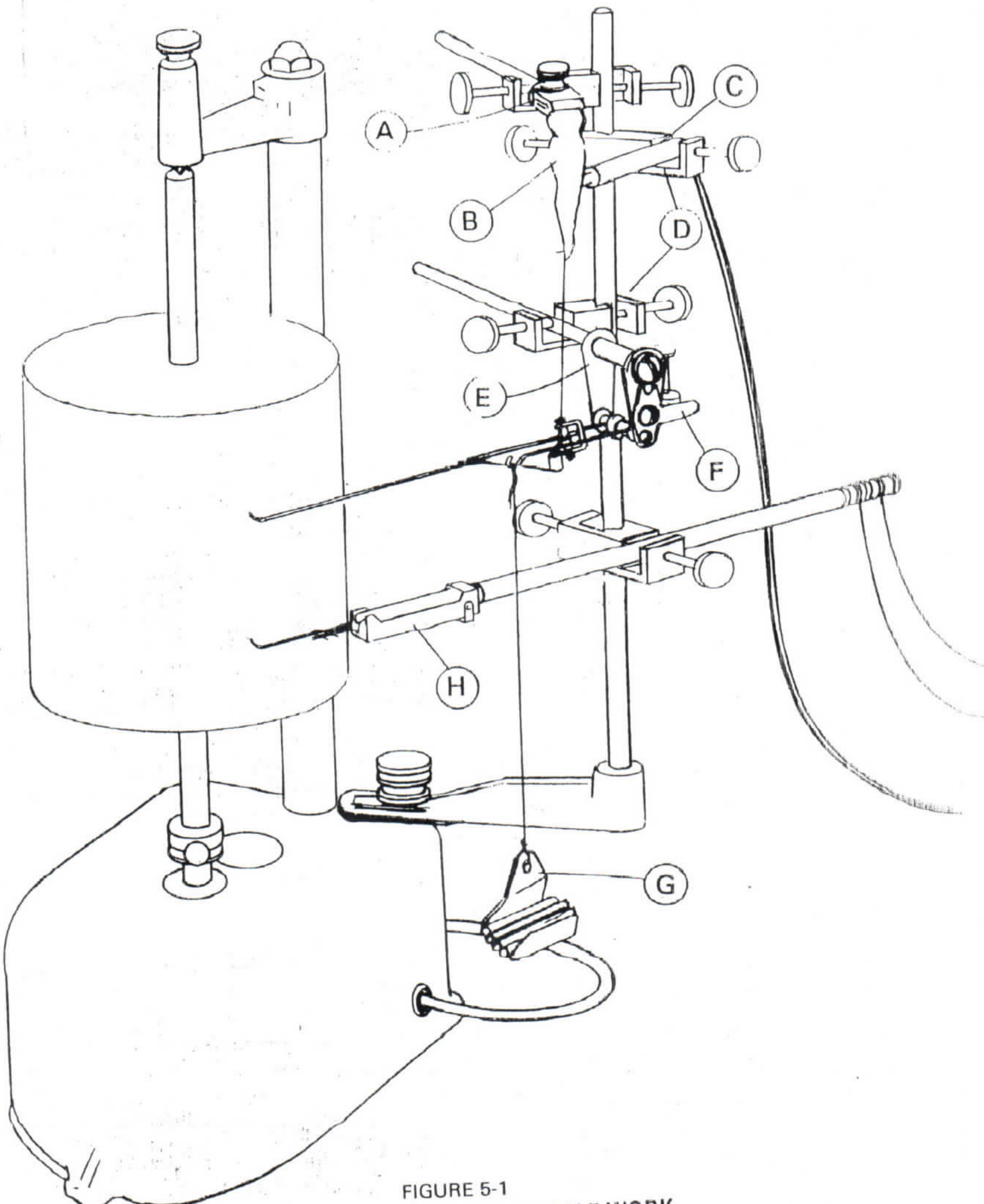


FIGURE 5-1
TYPICAL ASSEMBLY FOR MUSCLE-WORK AND MUSCLE TWITCH EXPERIMENTS

A — Femur Clamp
B — Gastrocnemius Muscle
C — Electrode
D — Double Right Angle Clamp
E — Muscle Lever
F — After Load
G — Scale Pan and Weights
H — Signal Magnet

CAPACITY OF SKELETAL MUSCLE TO DO WORK

Introduction

By attaching progressively heavier weights to a gastrocnemius muscle preparation, the two physical properties of EXTENSIBILITY and ELASTICITY can be demonstrated. The muscle fibers elongate and, within limits, the heavier the load the greater the stretch of the muscle. Under certain circumstances (as shown in this exercise) the elastic component is somewhat prestretched by the load applied and benefit is obtained through an increased work potential. The amount of work performed by a muscle may be determined by multiplying the grams of the load lifted by the height (millimeters) with the results being expressed in gram-millimeters. Up to a certain point, an increase in the load is followed by an increase in the amount of work done. However, when a muscle contracts without a load, or when the load is too heavy to be lifted, no mechanical work can be measured.

PROCEDURE

Note: The Kymograph and all associated equipment should be set up and checked BEFORE preparation of the animal or removal of any tissue. Refer to Phipps & Bird equipment manuals for instructions for assembly of the Kymograph and Inductorium (or Stimulator).

The frog muscle should be prepared for recording muscle contractility with the kymograph as follows:

Double-pith a frog and remove one leg by cutting near the pelvis. Gently remove the skin and immediately bathe the underlying muscle with amphibian Ringer's solution. Cut away all the thigh muscle, leaving only the exposed femur connected to the intact gastrocnemius muscle. Tie a ligature tightly around the Achille's tendon just beneath the muscle's insertion and then cut the tendon distal to the tie. Cut across the femur, but leave enough bone for clamping with the flat jaw clamp as shown in Figure 5-1. Tie the distal end of the preparation to the muscle lever. Bathe the muscle regularly with amphibian Ringer's solution during the entire experiment to prevent deterioration of the muscle.

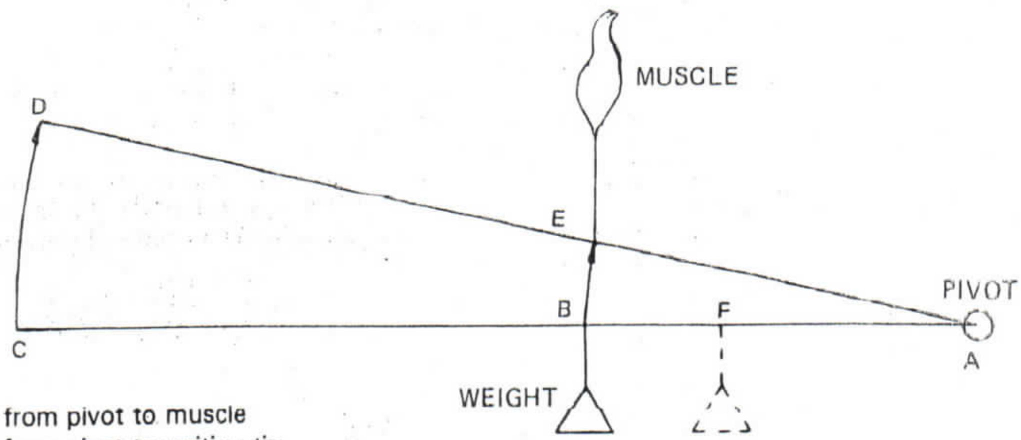
Arrange the equipment as illustrated in Figure 5-1. Make sure that the electrodes make good contact with the muscle tissue. Determine the maximal stimulus necessary by recording a simple muscle twitch. The maximal stimulus is that which produces the greatest contraction, and higher stimuli do not produce any appreciably larger response. Do this with only the scale pan connected to the lever and with the afterloading screw adjusted to prevent the muscle from being constantly stretched. Allow 20-30 seconds between stimuli. Gradually increase the stimulus voltage until the maximal stimulus is determined, being careful not to overstimulate the muscle or damage it. 2 to 5 volts is the typical maximal stimulus. Rotate the drum (clockwise) a small distance between each response so that the height of each response is distinct.

With the afterloading screw set so the muscle is not stretched, periodically increase the weight, adding 10 grams each time. As each weight is added, stimulate the muscle and record the height of the response and the weight lifted. Allow 30 seconds between measurements. Do this until the weight is reached which the muscle cannot lift.

Leave the weights in the pan and loosen the afterloading screw until the muscle is slightly stretched. Stimulate the muscle and observe if there is any lifting of the weight which it could not lift before.

Loosen the afterloading screw until the muscle is stretched, and remove the weights from the pan. Some readjustment of the height of the femur clamp may be necessary. With the same stimulating voltage as before, stimulate the muscle and record the contraction. Again, increase the weight in increments of 10 grams and record the height of each contraction as the muscle is stimulated, allowing 30 seconds between measurements. Continue until the weight is reached which the muscle cannot lift. Be sure that each contraction and each weight lifted has been recorded.

The amount of work performed by the muscle is calculated by multiplying the actual distance of the muscle contraction by the actual lifting force of it.



AB = Distance from pivot to muscle
AC = Distance from pivot to writing tip
AF = Distance from pivot to weight
CD = Height of recorded contraction
BE = Height of actual muscular contraction

FIGURE 5 -2
MUSCLE-WORK GEOMETRY

The amount of work performed by the muscle may be calculated from the recorded height of each contraction and the weight lifted. The familiar geometric relationship is shown in Figure 5-2:

$$\frac{BE}{AB} = \frac{CD}{AC} \quad \text{or,} \quad BE = \frac{(AB)}{(AC)} \times CD$$

Measure in millimeters the distance from the pivot to the point where the muscle is attached, AB. Measure the distance from the pivot to the writing tip, AC. From these data and the height of each contraction recorded on the kymograph drum, calculate the ACTUAL contraction, BE, for each weight lifted.

If the weight is suspended at a distance, AF, which is different from the point at which the muscle is attached, AB, the ACTUAL Lifting Force will not be equal to the weight. The ACTUAL Lifting Force is calculated as follows:

$$\text{ACTUAL LIFTING FORCE} = \frac{(AF)}{(AB)} \times \text{WEIGHT}$$

For example, the arrangement illustrated in Figure 5-1 (page 3) will result in an actual muscle lifting force of approximately two times the weights.

Record the height of each contraction and weight in the appropriate columns of the laboratory report sheet. Calculate the load force, actual contraction, and work done for the stretched and unstretched muscle.

These results may be graphed to compare contractility performances. On one graph, plot the Actual Contraction on the ordinate (vertical scale) versus the Actual Lifting Force on the abscissa (horizontal scale). Use solid and dashed (or different color) lines for stretched and unstretched muscle curves.

On the other graph, plot the work done on the ordinate versus the Actual Lifting Force on the abscissa for the stretched and unstretched muscle. Optimum muscle loads as well as benefit gained from stretching the muscle fibers during contraction should be evident on the completed graph.

QUESTIONS

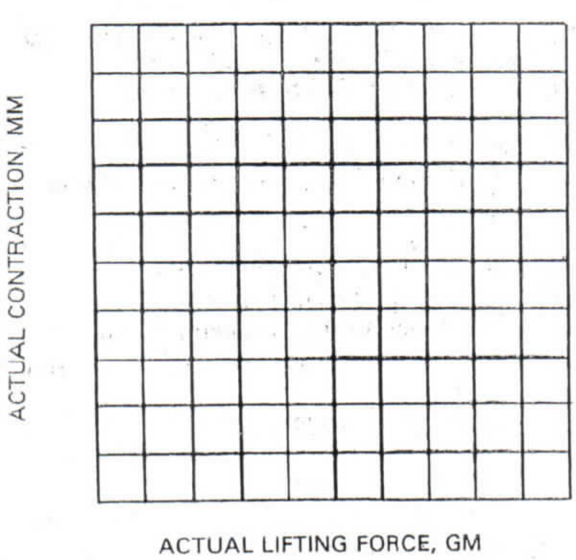
1. What is meant by "optimum load"?
2. What was the optimum load for the muscle?

Unstretched:____________________
Stretched:______________________

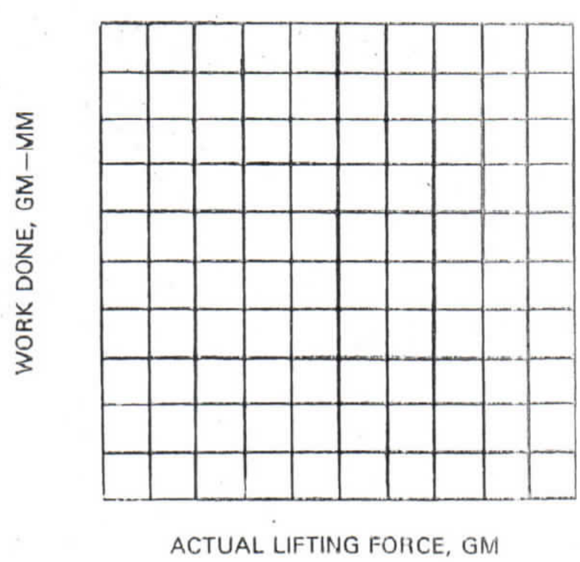
DATA

WEIGHT GRAMS	LOAD FORCE GRAMS	UNSTRETCHED			STRETCHED		
		EXTENT OF CONTRACTION		WORK DONE GM–MM	EXTENT OF CONTRACTION		WORK DONE GM–MM
		RECORDED	ACTUAL		RECORDED	ACTUAL	
10 (PAN ONLY)							

DISTANCE VS. FORCE



WORK VS. FORCE



REPLACEMENT PARTS AND ACCESSORIES
MUSCLE LEVER 7047-000

ITEM	PART NO.	DESCRIPTION
(FIG. 2)	2.350	MUSCLE LEVER (MAIN SUPPORT ASSEMBLY ONLY)
1	2.351	SUPPORT ROD, 4"
6A	2.304	PIVOT SCREW (SHORT)
6B	2.303	PIVOT SCREW (LONG) W/4-40 NUT
8	2.428	PIVOT
9	2.306	CLAMP NUT
(FIG. 3A)	2.402	AFTERLOAD ASSEMBLY
13	—	SCREW 6-32x3/16 B.H.
15	SP-50	SCREW, KNURLED
16	SP-3	NUT, KNURLED
(FIG. 4)	7050-000	PEN & RESERVIOR W/PEN SWIVEL
10	7049-00	PEN & RESERVIOR (ONLY)
22	2.408	PEN SWIVEL ASSEMBLY
7	7045-000	STYLUS (SMOKE WRITING)
12	2.401	HOOKED LEVER

ACCESSORIES FOR MUSCLE LEVER

CAT. NO.	DESCRIPTION
7011-000	ROD SUPPORT, STAINLESS STEEL
7012-000	ROD SUPPORT, S.S, W/TANGENT SCREW ADJ'T
7026-000	CLAMP, DOUBLE RIGHT ANGLE
7028-000	PEN STARTER SYRINGE TYPE
7029-000	PEN CLEANER ONLY
7095-000	SCALE PAN
7096-000	WEIGHTS, 10 GRAM
7115-204	ELECTRODES, S. STEEL TIPS
7115.200	ELECTRODES, PLATINUM TIPS