# A. F. NAGLE.

## DYNAMOMETERS.

No. 195,837. Patented Oct. 2, 1877.

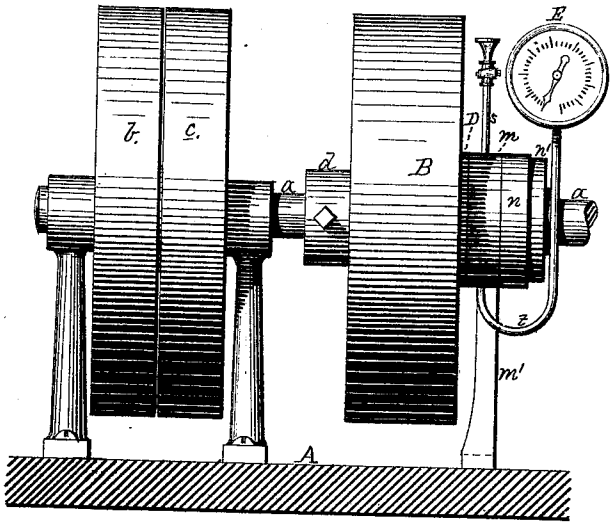


Fig. 1.

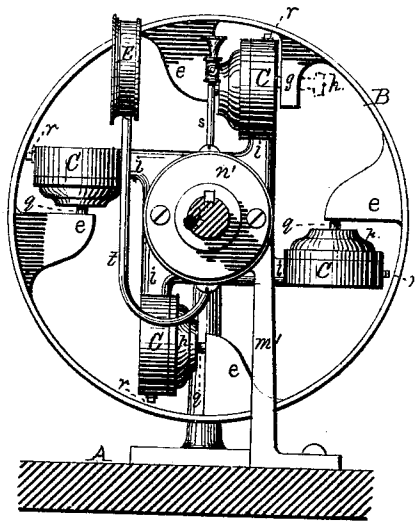


Fig. 2.

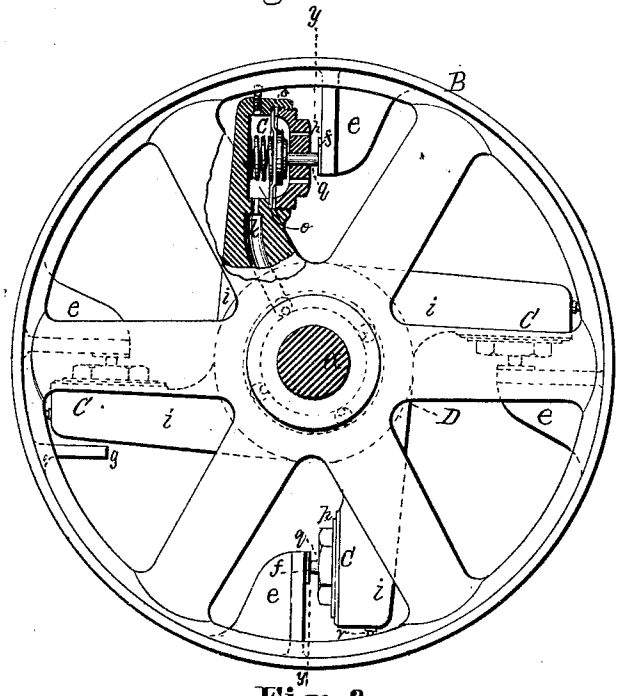


Fig. 3.

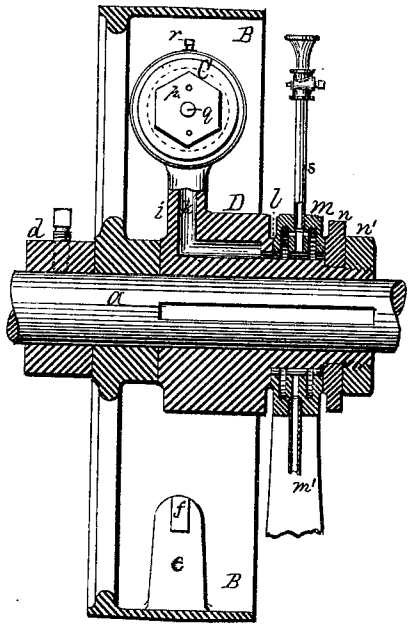


Fig. 4.

WITNESSES.

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## IMPROVEMENT IN DYNAMOMETERS.

Specification forming part of Letters Patent No. **195,837**, dated October 2, 1877; application filed August 6, 1877.

*To all whom it may concern:*

Be it known that I, AUGUSTUS F. NAGLE, of the city and county of Providence, in the State of Rhode Island, have invented certain new and useful Improvements in Dynamometers; and I do hereby declare that the following specification, taken in connection with the drawings furnished, and forming a part of the same, is a clear, true, and exact description of my invention.

The object of my invention is to produce a durable and reliable dynamometer of more simple construction than any heretofore made of which I am cognizant, and to obviate the use of such springs, levers, and weights as have heretofore been employed in this connection.

My invention consists, mainly, in the combination, with a testing-pulley and a pressure-gage of any suitable character, of one or more pressure-chambers, which have a variable cubic capacity, and communicate with the pressure-gage. The pressure-chambers and their communicating passages are air-tight, and are usually filled with water or other suitable liquid; but for testing exceedingly light powers I propose, if necessary or desirable, to fill the chambers with air under a light pressure, and then to adjust the pressure-gage accordingly. The pressure-chambers have a variable cubic capacity, because of their containing a piston or an equivalent device, which, when pushed inward, lessens the interior capacity of the chamber. The pistons or their equivalents are practically maintained in contact with the testing-pulley, so that the latter, in proportion to its work, forces the pistons inward, and reduces the interior or cubic capacity of the chambers, thereby inducing a pressure upon the fluid contained therein, and causing the degree of pressure to be indicated by the pressure-gage.

My invention further consists in certain minor details and combinations, which are hereinafter set forth and specifically claimed.

To more particularly describe my invention I will refer to the accompanying drawings, in which—

Figures 1 and 2 represent, respectively, in side and end view, one of my dynamometers. Fig. 3 represents, on an enlarged scale, the shaft in section, and the testing-pulley in end view, with one of its arms broken away to show one of the pressure-chambers, which is drawn in section to exhibit its interior. Fig. 4 represents the same in central section on line *y y*, Fig. 3.

For general service my apparatus is mounted upon a bed-plate, A, which is to be temporarily bolted to a floor or beam adjacent to the machine which is to be tested. When constructed so as to be applied directly to shafting, as is sometimes desirable, the bed-plate is dispensed with. The bed-plate is provided with standards and boxes for supporting the shaft *a*, on which is mounted a fast and a loose pulley, as at *b* and *c*, respectively, for communication by belting with a driving-shaft.

B denotes the testing-pulley, which is belted to the machine to be tested. It is loosely mounted on the shaft *a*, and runs in contact with a collar, *d*, which is secured to the shaft by a set-screw. On the testing-pulley, projecting inward from its rim, are four lugs, as at *e e e e*, equidistant from each other, and also equidistant from the shaft. Each lug has a steel face, as at *f*. Adjacent to one of the lugs *e* is a fifth lug, *g*, which is preferably provided with a set-screw, which projects toward the face of the adjacent lug *e*, as indicated in dotted lines at *h*, Fig. 2.

The number of pressure-chambers C may be varied, and, although one could be relied upon, I prefer to have at least two, oppositely located, so that as they are rapidly revolved by or with the shaft, one chamber will serve to balance the other, and for that reason if three or more are employed they should be located equidistant from each other. In this instance, four pressure-chambers are employed. They are all alike in form and dimensions, and each is located within the outer end of an arm, *i*, the four arms being united by a hub, D, which is common to all the chambers. The hub is secured to the shaft *a* in this instance by a key or feather.

It is immaterial whether the pulley be loose and the hub tight on the shaft, or vice versa; but if the hub be loose, then the pulley to which power is applied from the main shaft should be keyed to the hub, in which case

power would thence be applied to the machine to be tested, through the testing-pulley, whether it revolved loosely on the shaft or with it. I prefer, however, the loose pulley and the keyed hub, as shown.

Each pressure-chamber has a duct, *k*, which extends within the arm to the body of the hub, and thence longitudinally to an annular shoulder thereon, as at *l*, Fig. 4, at which point all of the ducts communicate with the interior of a grooved annulus, *m*, which is supported by an independent standard or bracket, *m'*, and affords an annular chamber surrounding that portion of the hub D. The joints on each side of the annulus *m* are packed in any suitable manner, and a means for maintaining packing contact is afforded by the washer *n* and the nut *n'* on the outer end of the hub, which is threaded to receive it.

It will be seen that the grooved or chambered annulus is not in contact with the hub, except laterally with the shoulder *l*, and that therefore all of the pressure-chambers, by way of their respective ducts, are in free communication with the annular chamber surrounding the hub beneath and within the annulus.

While I prefer the annular chamber, as shown, I am well aware that the several pressure-chambers may be arranged to communicate with a central chamber within the shaft *a*, and that this chamber may be connected with the pressure-gage by means of a pipe provided with a journal stuffing-box.

I have before stated that each pressure-chamber is provided with a piston or its equivalent. While approximately desirable results may be attained with a piston in the limited sense of the term, I prefer to employ a flexible diaphragm, which, by its movements, will vary the cubic capacity of a pressure-chamber, substantially as a piston would do it, but with less friction and less liability of leakage. A flexible diaphragm is shown at *o*, which is held to its seat by a washer and a screw-cap, *p*, as clearly shown in Fig. 3. The cap has a central opening, which guides a rod, *q*, connected at its inner end with a circular plate, which is in contact with the outer surface of the diaphragm. Within the pressure-chamber, beneath the diaphragm, is a light expansive spiral spring, which serves to force the diaphragm and its plate outward, and maintain them in close contact. The cap *p* is perforated, so as to permit the free entrance and exit of air to and from the space between the cap and diaphragm during the movement of the latter when the apparatus is in service. Each chamber is also provided with a vent, *r*, which is guarded by a screw tightly tapped therein. The annular chamber, beneath the annulus *m*, is provided with a stand-pipe, *s*, having a cock and funnel, through which liquid is poured into the annular chamber, the several pressure-chambers, and the communicating ducts, the screw-vents in the pressure-chambers being so set as to allow the air therein to escape during the filling operation.

I have also before stated that I use any suitable pressure-gage. While a hydrostatic or mercury column may be successfully employed in this connection, and while I would prefer the one or the other for some particular class of service, I prefer to employ for general use the well-known Bourdon pressure-gage, and I have in this instance shown such a gage in the drawings at E, which is connected with the annular chamber by means of pipe *t*, which is also filled with liquid. The several pressure-chambers, when in position for service, are located within the space inclosed by the rim of the testing-pulley, each rod *q* being in contact with the steel face *f* of the next adjacent lug *e*; and for preventing backlash, and maintaining all of the rods in proper relation to the lugs, one of the chambers is located between the fifth lug *g* and the next lug *e*. If an adjusting-screw is employed in the lug *g*, it is so set that its inner end presses against the rear of the chamber sufficiently to secure close contact between the several rods and lugs.

The form and construction of the pressure-chambers may be largely varied; and instead of a piston or a diaphragm, a rubber bag or hollow ball may obviously be employed.

The operation of my dynamometer is as follows: If a machine is to be tested the apparatus is bolted to the floor of the mill, adjacent to the machine, in such a position as will enable proper belting to be applied from the driving-shaft to the dynamometer, and thence to the machine, and after this has been done power is applied. The pressure-chambers being attached to and revolving with the shaft *a* drives the loose pulley, which in turn drives the machine, and it is obvious that the degree of pressure upon the rods of the pressure-chambers being communicated through the diaphragms and the liquid will be indicated by the pressure-gage. The pressure being thus indicated, it is next necessary that the same be calculated with reference to the diameter of the pulley, because the points of contact between the lugs on the pulley and the pressure-chamber rods are located between the periphery of the pulley and its axis. This calculation having been made determines the number of foot-pounds of work done by the belt, which, being divided by 33,000, reduces the same to horse-powers. The gages may, when made specially for this service, have dials inscribed with due reference to the calculations referred to. If it be desirable to apply my dynamometer to a line of shafting, it is obvious that the testing pulley and pressure-chambers may be readily mounted on any shaft, it being only requisite that a bracket or standard be provided for supporting the annulus *m* and the pressure-gage.

Having thus described my invention, I desire it to be distinctly understood that I do not

limit myself to any particular construction and arrangement of the several parts, as I am well aware that they can be largely modified without materially affecting the operation of the apparatus or departing from the spirit of my invention.

I claim as new and desire to secure by Letters Patent—

1. In a dynamometer, the combination, with a testing-pulley and a suitable pressure-gage, of one or more pressure-chambers, which communicate with the gage, and have a variable cubic capacity, substantially as described.

2. The combination, with a testing-pulley, of one or more pressure-chambers, provided in each instance with a diaphragm and a rod, substantially as described.

3. The combination, with the testing-pulley, the pressure-chambers, their diaphragms, and rods, of the stationary annular chamber, substantially as described.

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Witnesses:
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