DYNAMICS OF MACHINERY; PP. 1-245

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649566259

Dynamics of Machinery; pp. 1-245 by Gaetano Lanza

Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

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Trieste

DYNAMICS OF MACHINERY

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FIRST EDITION
FIRST THOUSAND

NEW YORK
JOHN WILEY & SONS
London: CHAPMAN & HALL, Limited
1911

Stanhope Press
F. H. GILSON COMPANY
BOSTON, U.S.A.

PREFACE

WHILE Chapter I treats of the principal types of Dynamometers, the remainder of this book has for its chief object to bring together, in one volume, the methods of dealing with the inertia forces that arise in various kinds of machinery especially in cases where high speeds are employed. As examples, may be cited those of high-speed steam engines, including high-speed locomotives, and of gas engines.

In these, careful consideration must be given to the action of the reciprocating parts, not only for the purpose of balancing, and hence avoiding undue strains in the machine itself, or in the foundations, and undue distortions in the rails, but also in order that the parts of the engine, including the crank shaft, etc., may be properly designed to resist the stresses to which they are subjected.

Other examples in which the inertia forces must be given careful consideration are: the inertia governor, — inasmuch as these forces affect very considerably the regulation, — pulleys, flywheels, steam turbines, dynamo armatures, centrifugal machines, hydroextractors, etc., which should be in running as well as in standing balance.

Another set of examples includes those in which the gyroscope is employed in engineering, as (*a*) the steering of torpedoes, (*b*) the steadying of vessels at sea, (*c*) the Brennan monorail car, (*d*) the gyroscopic compass, etc.

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DYNAMICS OF MACHINERY

CHAPTER I.

DYNAMOMETERS.

DYNAMOMETERS, as their name implies, are instruments for measuring power.

They may be divided into two main classes, viz., traction dynamometers and rotation dynamometers. The first are intended to measure the work done by a direct pull or thrust; as, for instance, the work done by a locomotive in drawing a train, or that required to tow a boat. Rotation dynamometers, on the other hand, are intended to measure the power transmitted to or through a rotating shaft.

Traction dynamometers are all practically some kind of a weighing device, the main part of which consists of a spring, or of a hydraulic cylinder and piston, by means of which the pull exerted is weighed, together with some device for measuring the speed of motion.

When the pull and the speed are both constant, it is only necessary to multiply them together to obtain the work done per unit of time. On the other hand, when one or both vary, it becomes necessary to have recourse to some kind of a recording apparatus, and then to obtain the area of the resulting irregular figure by means of a planimeter or otherwise.

Dynamometer Cars.

Many of the large railroads make use of a dynamometer car, principally for the purpose of obtaining a tonnage rating, for the different parts of the service; determining the amount of energy, the draw-bar pull, and the power, and hence the kind of locomotive required to perform the service.

In all these cases, the force with which the portion of the train behind the dynamometer car pulls upon the drawbar of the latter is weighed, and recorded upon a strip of paper, which is caused by suitable mechanism to travel at a speed proportional to that of the train.

We thus obtain a diagram (see Fig. 1) in which the abscissæ represent to scale distances travelled by the train along the road, while the ordinates represent to scale the draw-bar pull exerted at