On a "Speed Indicator" for Ships' Propellers

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XII. On a "*Speed Indicator*" for Ships' Propellers. By Sir
ARCHIBALD CAMPBELL of Blythswood and W. T. GOOLDEN*.

[Plate IX.]

IN February of last year, when visiting one of H.M. Dockyards, it was pointed out to us that a very urgent need was felt of some means of indicating with certainty the speed of naval engines, especially in ships carrying twin-screws, where the engines are not only distinct, but separated from each other by iron bulk-heads which prevent any communication between the two engine-rooms. The authorities intimated also that it was desired that several indications should be made simultaneously in various parts of the ship, and that the apparatus should be as far as possible automatic, and require no trouble or attention.

There are at present one or two instruments in existence for this purpose, but their indications are found to be untrustworthy when at sea ; and we were warned that no instrument in which the force of gravitation played a part would be likely to receive any attention at the Admiralty. This consideration excludes the use of ball-governors or of any device depending on the weight of a fluid column ; and led us to consider whether the desired conditions could not be fulfilled by a purely mechanical arrangement founded on the ordinary equation involving angular velocity,

$$v = r\omega.$$

It was at first difficult to see how this principle could be applied to a direct measure of ω , as no simple means are known whereby the variation in the velocity v of a point moving in a straight or curved path can be continuously measured. But it was soon apparent that the variable angular velocity ω of a body A can be compared with the constant angular velocity ω' of another body B, if a point on B at a distance r' from its axis of rotation has the same linear velocity as a point on the circumference of A. We then get

$$\omega = \frac{\omega'}{r} r',$$

in which $\frac{\omega'}{r}$ is constant, and thus ω varies as r' .

* Read May 24, 1884.

elevation.

K

clutch.

plan.

The condition is evidently satisfied by a disk pressing on the surface of a cone revolving at a uniform speed ; for the linear velocity of the point in the perimeter of the disk which is in contact with the cone, being identical with that of the corresponding point of the cone, will be proportional to the radius of the corresponding circular section of the cone, and consequently to the distance of the point of contact from the apex of the cone. If, further, the disk forms the nut of a screw rotating in the opposite direction to the cone, and the axis of the screw is placed parallel to the side of the cone, it is obvious that the nut and screw must have the same angular velocity for the nut to be at rest on the screw ; and the disk will therefore take up a different position on the screw as the velocity of the latter changes in value.

In the "Blythwood Speed Indicator" the screw is driven by the engine or shaft whose speed is to be indicated, while the cone has a constant speed communicated to it by clock-work. A scale placed under the screw shows the speed of the nut and screw when the nut is at rest ; and by a series of electric contact-pieces attached to a cable, the indications can be transferred to dials placed at any distance from the machine.

When the engines reverse, a clutch keeps the screw revolving always in the same direction, and at the same time pulls over a commutator placed in the electric circuit, so that the dials show not only the speed, but also the direction of motion, ahead or astern.

The clock is wound by the engine, and stops when the machinery is at rest ; and having a carefully balanced friction-governor, it is independent of gravity, and therefore keeps its time under all conditions of wind and weather.

We propose to add to the instrument a drum carrying prepared paper, upon which as it revolves a pencil will continuously trace the position of the nut, and thus keep a record of the performance of the engine for future reference.

The same principle can evidently be applied to a comparison of the speeds of two engines or rotating shafts, where both are variable, if one drives the cone and the other the screw,

for $\frac{\omega}{\omega'} = \frac{r'}{r}$, in which r is constant.

We desire in conclusion to express the obligation we are under to Mr. Hilger for the admirable skill and patient intelligence with which he has successfully carried out our idea.

XIII. *The Gas-Engine Indicator-Diagram.* By Professors
W. E. AYRTON, F.R.S., and JOHN PERRY, M.E.*

[Plate X.]

THE members of this Society are probably aware that gas-engines are now largely in use, and that their use is still extending rapidly. There can be no doubt that gas-engines would be largely used, even if they were wasteful of fuel, on account of their being always ready to start or stop, and their requiring so little attention; but it is gradually becoming clearer that even small specimens of this kind of engine, whose history is merely beginning, are in actual fact less wasteful of fuel than the largest and most carefully constructed steam-engines. It is, for example, a demonstrated fact that, with a Dowson's generator not larger than the boiler used in the corresponding steam-engine, an Otto engine uses only 1·1 lb. of coal per indicated horse-power per hour. It is therefore not unreasonable to suppose that gas-engines will soon be employed even in the propulsion of ships.

The rapid growth of this new application of science renders it necessary that help should be given to practical men to enable them to use such observations as they are constantly making. This paper is intended to teach such men a *method* of obtaining information from the indicator-diagram of a gas-engine.

2. *The Action in the Otto Gas-Engine.*—This large model which we exhibit has been constructed in the workshop of the Finsbury College, to enable students to follow the motions of different parts of the gas-engine. It will be seen that when the piston is at the end of its stroke, only what we call the clearance-space behind it is filled with fluid. This fluid is a mixture of carbonic acid, water-vapour, and nitrogen, whose

* Read April 26, 1884.