Cause of the Relation of the Coefficient of Adhesion to the Length of Belt in Contact with the Pulley.

BY WM. B. COOPER.

I submit the following as a simple explanation of a mechanical phenomenon the cause of which is not at first apparent. All the explanations in the text books are technical, and consequently not popular.

The law governing friction between surfaces is that it is directly related to the pressure with which they are brought together regardless of the *extent of surface in contact.*

If a belt is passed over a fixed pulley and attached to a weight, it is well known that the power necessary to raise the weight by drawing upon the other end will increase if the portion of the belt in contact with the pulley is increased, and to such a degree that if several turns are made around the pulley, the power required bears no comparison to the weight raised, so great has the friction become.

To explain this, let us imagine the portion in contact with the pulley to be divided into a number of sections; now, when sufficient power is applied to raise the weight, it is clear that, commencing at the weight end, the first section requires to move it a power equal to the weight, plus the friction between itself and the pulley; the second section will have a larger coefficient of friction on account of its being brought into closer contact with the pulley; this results from the fact that the resistance to be overcome is the weight, plus the resistance of the first section. Thus it is manifest that the last section has to overcome, the weight, plus the sum of all these increasing coefficients of all the other sections.

This explains the cause of the ability to transmit so much power by a belt coming in contact with only half of the periphery of a pulley.

This phenomenon is made possible by the convexity of one of the surfaces and the flexibility of the other. A number of shoes attached together would operate in the same way as the belt.

Where the surfaces are of such a character that the friction is at a maximum between certain pressures, it is clear that, where those pressures are exceeded, the width becomes an important factor, as it alters the pressure per inch between the surfaces; in other cases it is immaterial. The same would, of course, be true regarding the area of contact of inflexible surfaces.

SELF-REGISTERING SHIP'S COMPASS.

Among the exhibits at the recent Northeast Coast Exhibition which attracted a very large share of attention, perhaps none was of more universal interest than the self-registering ship's compass invented by Mr. Robert Pickwell, civil engineer, Hull, and which we now illustrate from diagrams and description given in the *Engineer*. This instrument has been subjected to a series of practical tests on passages between Hull and London, Hull and Newcastle, and Hull and Hamburg, with a view to ascertain its accuracy and usefulness, and in each case it has proved a remarkable success in keeping an accurate record of the working of the ship. So sensitive, indeed, is the apparatus that the act of heaving the lead twice and of stopping to take the pilot on board are distinctly shown on the diagram.

The engraving, Fig. 1, represents an elevation of a compass binnacle and stand, of the pattern used by the inventor, and Fig. 2 a cross section showing the inside compass and lamp, and the adaptation of the patent self-registering apparatus under the compass card. The wooden stand is lashed and screwed to the deck, which carries the ordinary bowl, covered by the binnacle top, with glass windows, the stand being of any convenient height. Inside the outer bowl the compass bowl is hung on gimbal rings in the usual way, and the compass card is seen below the glass cover or lid of the inner bowl, light being supplied at night by a top lamp, as shown in Fig. 2. The registering apparatus is fitted in the bowl below the card, and is indicated in Fig. 1 of the engraving. It consists of a barrel, Figs. 1 and 2, containing clockwork, which causes a second barrel within the first to continuously revolve at a given speed, the outer barrel being fixed and having two slots cut through on its upper surface parallel to the axis. The compass card has also a slot, shown by the dark line, curved in such a manner that some one part of it is always across one or other of the straight slots in the drum, and as the inner barrel is when in use covered with sensitized paper, it will be at once understood that in whatever course the ship is being steered a ray

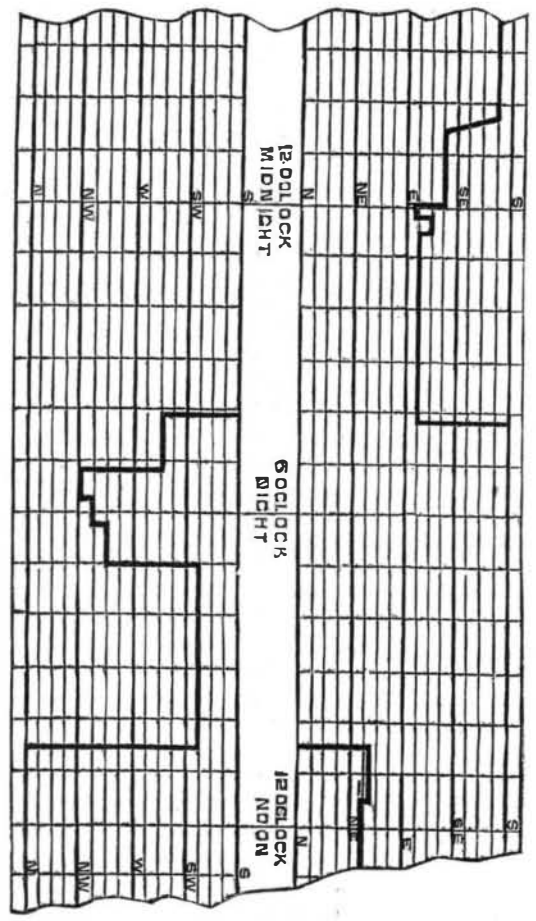

Fig. 3.—RECORD OF PICKWELL'S SELF-REGISTERING SHIP'S COMPASS.

of light either from the sun or from the lamp will pass through the small opening made at the intersection of the curved slot in the card with one or other of the straight slots in the drum envelope, and will produce a black mark upon the prepared paper, more or less distant from the center of the card, and which from its position will give an exact indication of the course of the vessel at the time. The revolving motion of the drum gives the duration of time the ship's head is on each course, as well as the time such courses are changed.

An actual diagram unwrapped from the barrel is shown in Fig. 3, vertical spaces representing directions, as indicated by the letters of the compass, and horizontal distances denoting time. To remove the paper the revolving barrel is drawn off like the drum of an ordinary Richard's indicator, through an opening in the side of the bowl, and all that is necessary to permanently fix the lines is to immerse the diagrams in a liquid solution for a short time. The papers are made for a day of twenty-four hours, or may be continuous so as to give the course for a period of three months, in which case it is proposed to inclose the apparatus in a locked case, which can only be opened by the owner of the vessel. The arrangement most in favor, however, is that for daily diagrams under the control of the captain, who can file them when fixed and produce them at the end of the voyage if required. He can also see the course made by his ship day by day in spite of thick weather, and without observation with the sextant, and can lay it down on his chart every twenty-four hours

The advantage of having an accurate record of the working of a vessel will be at once recognized by every shipowner, and as with Mr. Pickwell's invention this can be obtained without interfering with the free action of the needles, or without even altering the ordinary visible portion of the compass as at present in use, we shall hope soon to hear of its general adoption. The apparatus as at present supplied can be fitted to any ordinary compass, provided the bowl is not less than 10 inches diameter: but, if necessary, a smaller size could be made suitable for a bowl of 8 inches diameter. Mr. Pickwell received the highest award, viz., silver medal and special mention, at the Northeast Coast Exhibition.

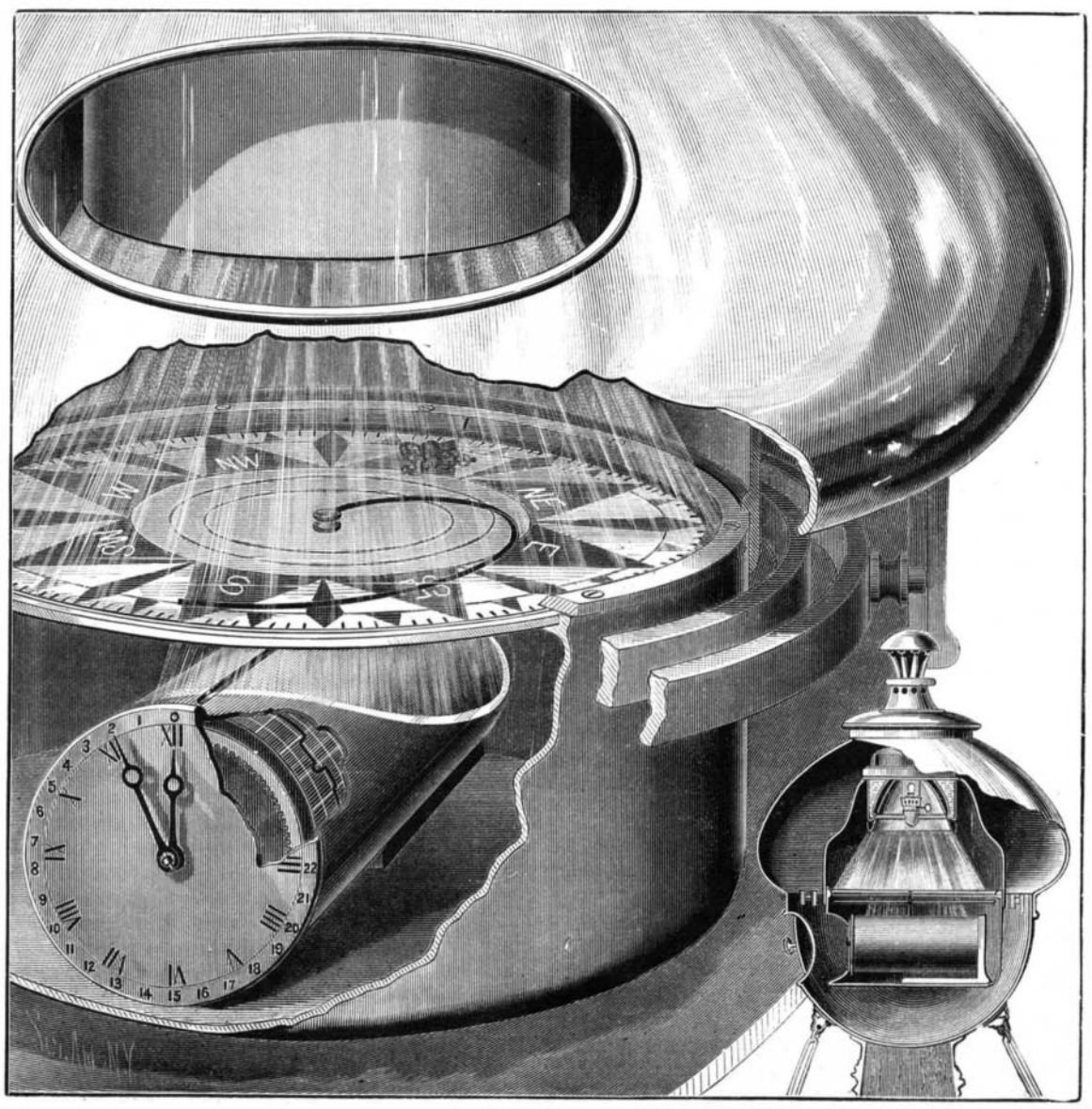

Fig. 1. PICKWELL'S SELF-REGISTERING SHIP'S COMPASS. Fig. 2.

Acid in Certain Kinds of Paper.

Papers sized with rosin size were found to have a more or less acid reaction due to free sulphuric acid, which has never been observed in samples sized with animal glue. The acid is probably derived from the alum or aluminum sulphate used in sizing, which is decomposed by contact with the vegetable fiber, as takes place in dyeing, a basic salt being deposited upon the fiber, and a portion of acid liberated.—*Prof. Feichtinger, in Chemiker Zeitung.*

Science in the Workshop.

The *Commercial Bulletin* truthfully says that when mechanics as a general body become more thoroughly impressed with the conviction that the way to advancement both as to personal position and monetary returns lies through the mastery of science in the application of principles to their daily work, we may anticipate some joint movement on their own part to establish means for acquiring technical knowledge. For instance, the laws of expansion and contraction, as applied to many castings, and even to the wrought iron and steel industries, would prevent much waste in the foundry and at the forge from the effect of unequal expansion and contraction, and also occasion fewer inequalities in the quality of that supposed treacherous material, steel. It would also prevent many mishaps to boilers, engines, and their accessories in cold weather.

A knowledge among workmen of the principles of inertia, as affecting bodies in motion, would frequently prevent a breakdown in starting or stopping machinery suddenly. For all connected with blast furnaces, the value of chemical knowledge is apparent, as enabling them to trace the cause of faulty results. There is scarcely a workshop of any importance in which an acquaintance with geometry will not be of value. In short, the value of science asserts itself every hour in the workshop. The scientific mechanic never falls into ruts either of thought or habit. Working more intelligently than others, he finds more pleasure in his labor; his suggestive faculties are ever at work, and he is ever alive to the possibility of mechanical improvements, from which he may reap a handsome reward. The manufacturers who have risen from the bench without acquaintance with technical science constantly feel themselves at a disadvantage. As all branches of science hold some relation to each other, the acquisition of any one portion of these will prove of value to the workman whatever his vocation.

THE author employs the following mixture for dyeing sole leather: 750 grammes Paris yellow, 150 grammes chrome yellow, 1250 grammes pipe clay, 1,000 grammes quercitron, 1,000 grammes alum, 750 grammes sulphuric acid, and 4 liters tragacanth solution. These are boiled together with 16 liters water, and the mixture, when cold, suitably applied.—*C. Larrabree.*