proved baseless. It was said in 1869 that one telegraph wire could never take more than one message at a time, but now four, five, and even six messages can be transmitted and cross one another on the same wire. In 1870 it was declared before a Select Committee that the telephone would never come into general use. At the Paris Exhibition in 1878 a French scientific man called the electric light "an exhibition craze," and in the following year another man of science said that it would never be used in dwelling houses. But it should be remembered, in extenuation, that the telegraph shared similar neglect until a murderer happened to be captured by its agency.

One great problem is now awaiting solution, and is, perhaps, already solved. An arrangement is wanted in which large and powerful quantities of electricity may be stored and transported. By the use of such cells and accumulators the present light would at once obtain a more secure position, for the current generating them could then be drawn from the accumulator instead of directly from the machine, and thus the inequalities in the production of the latter would not be conveyed to the light. Accumulators are already made by M. Faure, but these, so far, have not found extended application. When a really strong and practicable storage apparatus has been invented, the last step in the triumph of electricity will have been made. Electric-power could then be brought to us from any part of the world.—*Industrial News.*

CHRONOGRAPH FOR ENGINEERING PURPOSES.

BY W. R. ECKART, C. E.

In the chronograph illustrated, the tracers, both for recording seconds as well as the velocity curve of the engine, are made of flat strips of spring steel, the axis of each being pivoted at the end on adjustable screw centers to prevent lost motion. By means of a small steel wire and weight extending to the opposite side, the tracers can be made to bear as lightly as desirable on the paper, and when properly adjusted the pressure is only sufficient to remove the lampblack with which the paper is coated without touching the paper, thereby leaving a fine white line on the dark background with the least possible interruption of motion. The whole is permanently set by dipping the face in shellac.

Instead of using a pendulum for producing (through an electro-magnet) the marks spacing seconds on the paper, some other method that would admit of compactness and portability was found necessary, as the chronograph was to be used not only on the surface where the pumping engines were situated, but had to be adapted to underground use.

After numerous experiments, the use of a chronoscope (or timer), such as is to be had for timing horse races, was made to give satisfactory results. (See Fig. 1, front page). A stand or base plate upon which the timer was placed had a brass stanchion suspending a fine platinum wire directly over the second hand; this wire, when at rest, bore on a piece of platinum inserted in a rubber insulator projecting from the stanchion, each of these wires being connected through the electro-magnet on the chronograph to a two-cell battery. A circuit was always formed, except when the hand of the timer, revolving once every second, swings the suspended wire free from its metal bearing at the apex of the triangular notch cut in the rubber guide piece; as contact was broken every revolution of the second hand, the armature of the electro-magnet recorded the same by a side movement of the steel tracer resting on the prepared paper of the drum. The suspending wire was made adjustable to suit the second hand, and the instrument was covered with a glass case.

Mr. Briggs states in a paper read before the Franklin Institute that Prof. Hilgard used a chronoscope for the Navy Ordnance Department, in which the second marks were 30 inches apart. I have found no trouble in speeding the revolving drum of 6" diameter, until the second marks were 20 inches apart, but for practical use, a length of three to ten inches (depending somewhat on the engine speed), was all that was desired, and by use of a standard steel scale with the inch divided into hundredths, changes of motion taking place in the one one-thousandth part of a second were easily read and recorded without trouble, and the crossing of lines due to the too frequent revolution of recording drum during one stroke of the engine was avoided. The use of the small electro-magnet, on the tracer carriage, to raise for an instant the tracing pointer off of the drum at any desired point, was found necessary in determining the effects of elasticity in the interruption and variation of motion, where a *long* line of pump rods was used, and was also found useful in fixing, positively, the exact point of closing or opening of the steam valves of the engine independent of all reference to the indicator cards taken.

Two drawings giving different views of the chronograph as constructed and used, are attached to this article, exhibiting details of construction to complete what otherwise might be considered a defective description of the instrument.

The instrument has been succesfully applied to several of the different types of large pumping engines found on the Comstock Lode, such as direct-acting flywheel engines, geared pumping engines, and the "Davy engines;" it has also been used to determine the motion and relative motion of pump rods, and pumps some 2,500 feet below the surface engine driving same, and at intermediate points. The results are exceedingly interesting and instructive, and as numerous indicator cards were taken from the engines and pumps simultaneously with the motion diagrams, nearly all conditions of motion and power, during the time under consideration, were definitely determined, and may hereafter form the subject of other papers when time will permit.

Some very important results of the elasticity of long pump rods are clearly set forth in one case: A rod at a point 1,800 feet below the surface showed a positive pause, while the engine driving it was nearly at its point of maximum motion, and pumps attached to the rods may have and do have strokes in excess of or deficient to the *stroke of engine driving same*, and to an *important extent*. Hence, I think, it can be definitely stated that any consideration of motion of pumps, or discharge capacity of same, driven by a long line of pump rods based upon the motion or stroke of a surface engine alone, will in no way be even approximate, unless the elasticity and effects of counter-balancing by balance bobs on that elasticity is also considered.

The effects of different degrees of compression upon the engines and motion of the pump rods in passing the centers have been considered, and the diagrams clearly show the importance of considering it in connection with the strength of the rods and balance bobs.

The latest use of the instrument in conjunction with an engine test has been to determine, if possible, the rate of condensation of steam per second, in the steam cylinders of a pumping engine, where the change of motion due to each fractional part of the stroke was determined. Also, a ten hour experiment trial, to show the economy of compression as compared with a ten hour trial of the same engine on the succeeding day where no compression was used (otherwise all conditions being similar), has been made, when changes of velocity of piston were determined by the chronograph.

While it is well known that a Committee of the British Association applied a chronograph of Morin's type in 1843-4, to the determination of the velocity of piston for a Cornish Pump Engine, I believe there was no application of the instrument to the rods below ground, and, from published records at my command, I am led to believe that this is the first application of a chronograph of sensitive construction ever made to pit work, and the other purposes so briefly mentioned.—*Scientific American.*

MAGNETIC PREPARATIONS OF STEEL AND IRON.

Many investigations upon the relation between the molecular conditions of iron and steel produced by heat, by torsion, and by annealing processes, and the resulting changes in magnetic conditions, have been made. It appears from the paper of Louis M. Cheesman that the effect of mechanical hardening has not been properly investigated, and this paper contains the results of his investigation upon this point. The method of research consisted simply in determining the magnetic moment of the magnetic bar after it had been subjected to well devised mechanical pressures. The result of his investigations is summed up as follows: Iron in a mechanically hard condition can receive more permanent magnetism than in a soft condition. The magnetic moment of a steel magnet in a mechanically hard condition is greater or smaller than in a soft condition, according as the ratio of its diameter to its length is less or greater than a certain limit.—*Ann. der Physik und Chemie.*

Sharp castings are obtained from cast iron holding too much phosphorus to be good for puddling or for castings requiring strength. Such metal is very good for ornaments having no strains to bear.