years later, the principle was firmly established, and Charles Babbage, the noted English mathematician and mechanician, described in 1834, in his "Economy of Machines and Manufacturers," the minute division of labor in repetition work obtaining in his day in various industries which he illustrated. He also furnished a complete philosophy of the subject and examples of calculations as to the limits of reasonable investment in labor-saving machinery.

Industries, such as textiles, in which machinery reigned supreme at every stage, were most affected by the new principle which evolved quite naturally with the dawn of modern industrialism.

In our own day, practical political economy has been somewhat neglected by engineers, and three-quarters of a century after Babbage we find the division of labor by machines carried much farther than the divisions of handicraft, which he also advocated and described.

In many cases with us, the "trade" is still the economic unit instead of the "task," and this is particularly so in the metal manufacturing and building industries; not only so, but labor has shown no disposition to improve the "trades," many of which are notoriously wasteful of time and effort.

There can be little doubt in these days, when the high cost of living is a live topic, that economic necessity, if not inclination, will finally drive us to take up in all seriousness the conservation and intensive application of human energies in every department of activity, distributive as well as productive, and that new avenues of usefulness will open up for the production engineer.

It has not occurred to many engineers, as distinguished from the makers of purely machine-made products, to apply the intensive method of shop operation thoroughly to anything except very light and very simple repetition operations, and to not many even of these.

The second half of this paper is devoted to illustrating the principles already outlined in their application to a particular works problem. It is not in their novelty, but in their combination, intensive use and application with a measure of success to special and exacting business conditions that they perhaps merit some attention, and possibly convey, in no spirit of dogmatism, a few suggestions applicable, with suitable modifications, to other lines of work.

It may be emphasized here that the underlying practical motive of the system is not indiscriminate speeding at the expense of the workers, but the securing by co-operation of the economies obtainable through either anticipating or locating and removing all wasted time and ineffective or unnecessary effort and expense, whether clerical, manual or mechanical. It is directed towards enabling employee and capitalist alike, under the most favorable conditions to make the most of the opportunities of the working day, and in so doing a very large part of the usual burden is removed from the shoulders of the employee and placed upon the organization.

ELECTRO-MAGNETS FOR LIFTING PURPOSES.

At a meeting of the Sheffield Society of Engineers and Metallurgists, Mr. Edward C. Ibbotson, F.C.S., in the course of a lecture on the applications of electro-magnets to lifting purposes, said the strength of the magnets depended to a certain extent on the nature of the iron core. The late Dr. Snell was greatly interested in a series of experiments with different iron alloys that he tried in his endeavors to obtain with a minimum of weight the best electro-magnet for extracting pieces of steel from the eye. As iron was magnetic, i.e., could be affected by a magnet below the A critical temperature in the neighborhood of 750° C., it was possible to handle hot rails, etc., under the temperature of about 750° C., but the magnet should be properly designed for this work. Some special steels, such as manganese steels, and some high nickel steels under certain conditions, were non-magnetic at the ordinary temperature.

In drawing attention to the possibility of applying electro-magnets with advantage to every-day work, he illustrated by lantern slides the types of magnets, etc., that are in use. The first horse-shoe type was still used by some, but was now being superseded by the pot magnet, of which the Witton-Kramer magnet was a fine example. In the United States they made their magnets on truly American lines, viz., to work to their utmost limit of lifting capacity without taking much care as to the heating effect of the current on the coil. The current could be left on in the Witton-Kramer lifting magnets for an hour without injury to the coil which was mechanically protected by totally enclosing in a solid steel shell of special high permeability steel, and was made weatherproof by vacuum drying and impregnating under pressure with hot bitumen. It was then firmly fixed in the shell, and was entirely impervious to moisture. The current used was naturally direct current, and the consumption for large magnets, even where it had to be specially generated, was not a very serious cost. In many cases electro-magnets were a considerable labor-saving device.

Slides showing a number of magnets were thrown on the sheet, including a magnet lifting a seven-ton ingot; an electric locomotive job crane loading and unloading tinplate bars by means of a magnet, and a magnet suspended from an overhead crane transporting bundles of scrap wire. Numerous other types were given, showing the great adaptability of the method. By the kindness of the University authorities a demonstration was given in the metallurgical works laboratory immediately after the discussion.

PANAMA CANAL.

Canadians, as well as our neighbors in the United States, are looking forward with interest to the completion of the Panama Canal. The Pacific coast of Canada anticipates obtaining considerable benefit as the result of the building of this canal. It is thought that the waterway will be open for traffic in the early part of 1914 and formally opened in January, 1915, although President Taft recently predicted that it would be open in July, 1913. The project has a long and interesting history.

In 1825 a Frenchman obtained a franchise from New Granada, but failed to raise the necessary capital. In 1835 the United States sent an engineer to report on a canal project, but this came to nothing. In 1838 a concession was granted to France, but this concession lapsed. In 1848 a party of Americans secured a concession for a railroad across the Isthmus, and this road was opened for traffic in 1855, from Colon to Panama. Under this concession the Panama Railroad Company held exclusive right to construct a railroad or canal through certain territory, which gave it complete control of the Panama route. First-class fare for many years after the road was open was $25.00 gold, or about 50 cents per mile.

From 1853 to 1895, inclusive, this company paid dividends amounting to $37,800,000.00, or over 600 per cent. In