weigh 100 tons, and have four continuous-current motors which have forced ventilation. They are 40 feet long, and have a tractive effort of 36,000, with a maximum speed of 35 miles an hour. The gear ratio is 4.37. The engine is capable of hauling an 1,800-ton train of wagons at 10 miles an hour on the 1 in 50 approach gradients. The new electric goods locomotives for the New York, New Haven, and Hartford Railway are of the 2-4-4-2 class, with a two-wheeled bogie carried at the end of each four-wheeled driving bogie. On each axle is a 300 horse-power single-phase motor, with auxiliary apparatus for operation from the 600-volt continuous-current conductor rail on one part of the line, and the 11,000-volt alternating current trolley wire on the remainder of the line. The engine is 50 feet long, and weighs 130 tons, with 95 tons on the 5¼-foot driving wheels. It can haul a 1,500-ton train at 35 miles, or an 800-ton train at 45 miles an hour. An experimental engine of the 4-6-2 class has two 800 horse-power single-phase alternating current motors mounted above the frame, with cranks and connecting rods to two end countershafts, from which return rods lead to the wheels. Still another electric locomotive, built for experiment, has a friction-wheel connection to

the wheels instead of the usual gears to the axles. A 75 horse-power motor mounted between the axles of the driving bogie, carries at each end a 12-inch wheel engaging with the treads of one pair of wheels. The motor runs continuously, and is raised and lowered by a pneumatic apparatus so as to put the wheels in or out of action. Tests of this machine in competition with an ordinary geared locomotive having two motors of 35 horse-power showed a considerable saving in current.

Heavy trains are a prominent feature of American railway service, especially where there is a constant and heavy traffic of iron ore or coal. On the Virginian Railway, built with easy gradients and equipped with powerful locomotives for heavy coal traffic, a train of no less weight than 9,120 tons has been hauled by a Mallet engine. This was for 120 steel wagons, each carrying 55 tons of coal and weighing 7½ tons loaded. The engine weighs 160 tons; tender, 80 tons; gross total 9,360 tons. The standard coal train on this road consists of 80 wagons, with 4,400 tons of coal; the weight—including wagons—is 6,132 tons; to this must be added 18 tons for the brake van, 135 tons for the engine, and 80 tons for the tender,

or a gross total of 6,355 tons. The regular locomotives of these trains are of the 2-8-2 class, weighing 135 tons, with 110 tons on the 4¾ feet drivers. The cylinders are 24 inches by 30 inches, and the boiler has 4,530 square feet of heating surface, with 51 square feet of grate.

Trains in excess of the standard have been hauled in many cases up to 7,800 tons, and the run of 125 miles to the shipping port is made at the rate of 15 miles per hour, including the time for all stops. On the Pennsylvania Railway a train of 105 steel wagons with 5,540 tons of coal, and a gross weight—including engine—of 7,644 tons, made a run of 127 miles in seven hours. Coal trains of 4,850 to 6,150 tons gross total weight have also been hauled on this railway. On the Lake Shore and Michigan Southern Railway a train of 100 steel wagons carrying iron ore and weighing 7,430 tons was hauled 65 miles at an average speed of 12 miles an hour. In some cases these very heavy trains are due to special conditions, such as a previous congestion of traffic at some point, but it is worth noting that the standard coal train of the Virginian Railway has a gross total weight of 6,365 tons and a net load of 4,400 tons of coal.

SOME PRINCIPLES OF EFFICIENCY.

CURING A SICK INDUSTRY.

BY HARRINGTON EMERSON.

THE owners of a large industrial plant with many orders ahead desired to increase the output from thirteen units a month, the highest average up to that time, to twenty-three units a month, and to do this in ten months.

The manager of the plant, a man of unusual ability but of the old school, had been in charge for some time, but knew only one way to deliver the increase, namely, to add to the equipment and employ more men. He therefore countered the demand of the owners for twenty-three units by asking for \$500,000 worth of additional equipment. Even if this capital investment had been possible, it was no solution of the difficulty, as it would have taken at least a year, probably longer, to secure the new equipment.

When matters were in this state—demand for increased output by owners, demand for increased equipment by manager—an investigation of the plant was made by two competent efficiency engineers of wide experience, who submitted a long report of which the concluding paragraphs were:

Your plant consists of a large machine shop, boiler shop, erecting shop, blacksmith shop, foundry.

Having examined into the conditions of each of the shops and having consulted with the manager, the superintendent, the various foremen, some of the contractors, and a number of men, we are able to state definitely that with some slight physical betterments, and provided the present manager or a man of similar disposition be in authority, the output of your shops can be increased 60 per cent, without adding to the present forces, without adding to the equipment, and without increasing the payroll more than 10 per cent, and that these results can be gradually attained within a period of six months.

To accomplish these results certain principles of organization were advocated. The organization and principles were adopted and applied by the manager, and the results are shown by an extract from a letter, written by the local official ten months later.

New York, May 1, 1908.

It will interest you to know that our output for the month of April showed an increase of 69.2 per cent over the monthly average of the last fiscal year.

The average working hours are 9 per day instead of 10 as formerly. The payroll reduction is 15 per cent, amounting to \$8,000 to \$10,000 a month less than last year.

The same efficiency engineers were subsequently called to another plant, to investigate and to advise. In this case also their principles were accepted, their recommendations carried into effect through modified organization with the following results:

Date.	Average Number of Men.	Average Tons per Man.	Total Tonnage.	Pay Roll.	Pay Roll Cost per Ton.	Increased Efficiency of Men, Per Cent.
September, 1908	527	4.69	2,473	\$29,380	\$11.88	0.0
July, 1909	263	9.04	2,377	15,248	6.41	2.0
August, 1909	298	10.51	3,133	17,280	5.51	10.0
September, 1909	312	10.92	3,408	17,394	5.14	17.3

It is not to be supposed that two men could come from the far West, go into Eastern industrial plants, and through their own familiarity with the conditions know better how to direct them than the experienced local managers in charge. The men who came out of the West were not as well equipped with knowledge of operation or devices, were not as well acquainted with local methods and men, as the local managers, but they were far better equipped with knowledge of a new type of organization through which alone efficiency can be secured, and they had not only this knowledge, but also extended and successful experience in applying it. The difference in achievement between the modern man and the men who lived thousands of years ago is not an internal difference in quality of brain, but the tremendous external difference in conditions and equipment. The boy with the far-reaching sling knocks out the heavily armored spear-wielding giant.

It is exceedingly difficult to advocate certain principles without individuals, tribes, and nations, unable to free themselves from the personal point of view, immediately jumping to the conclusion that an attack is being made on their competency, their skill. Greek athletes could have made good records if they had had bicycles, motor cars, and aeroplanes, if they had had repeating pistols and rifles; but the arrow, however skilled the archer, does not carry as far or as straight as the rifle bullet. The principle underlying the rifle is very old—that of the blow tube—a very different principle from that of the bow and string; but the man who equips the savage with a rifle makes him more powerful than all the armored knights of chivalry, and the man who equips the modern industrial manager with a new industrial application of an old principle of organization and accomplishment, gives the mediocre manager a greater possibility of attaining high efficiency than was ever possessed even by the greatest industrial geniuses working along the old lines.

The men from the West knew the new theories because they had applied them on a tremendous scale; they knew how to design and operate a new kind of shop control, as different from the old as the rifle is from the bow—as different as bicycle riding is from walking, flying from motoring, Arabic notation from Roman numerals. These principles in their application to shop control may not appear particularly lofty inspiring, or even interesting to anyone except those whose pocketbooks are to be immediately benefited—namely, the plant owners and managers, the plant workers, and the clients of the plant; but they will evoke deeper interest when it is perceived that they are fundamental and of universal application; that in all ages lasting efficiency depended on them, and without them is always impossible; that the same principles have been applied elsewhere on a stupendous and noble scale, and that it is not men or materials, money machines, and methods that count, but far more potently, theories and principles.—Engineering Magazine.

The Pennsylvania Railway is now using signal instruction cars on all divisions. The new cars in use on the main line are 60 feet long, divided into two compartments. One room will be used for examinations, while the other will contain a table upon which

is to be placed under a glass cover a large track chart of the railway, which can be rolled back and forth by means of rollers placed at each end. This chart shows all main running tracks, switches and cross-overs, all signals, track troughs, stations and mile posts. The men will be given an opportunity to study this chart prior to passing an examination on it. Each car is provided with a set of model signals, which can be manipulated so as to show all signal indications. The cars are in charge of examiners, each of whom has an assistant. These men will have charge of all examinations, except those on machinery and air brakes. The cars will also be used for examination of employees on train rules and other subjects.

WINNERS OF THE RAND STOPE-DRILL COMPETITION.

THE winners of the stope-drill competition in the Transvaal are announced, unofficially, by the South African Mining Journal to be the Holman 2½x5 inch and the Siskol 2¾x6 inch. These machines are stated to be practically tied for first place, the next in order being the Chersen. This competition was arranged by the government and the Chamber of Mines and was commenced February 15th, 1909; thus the trials have been continuous for more than a year. There were 21 machines entered originally; of these, eight failed to pass the elimination tests and the actual competition was begun by 13 types of machine; Holman 2¾, Chersen, Holman 2½, Climax Imperial, Murphy, New Century OO, Siskol, Waugh, Westphalia and Konomax. The Climax Imperial, Murphy, Waugh and Westphalia were hammer drills, the remainder being of the reciprocating type. The essential difference between the two leading machines is stated to be that the Siskol is the faster running drill while the operating costs are considerably less in the case of the Holman 2¾ inch.

Monthly statements of progress were made until August, when these were discontinued. At that time, the relative positions of the competitors were widely different from their final standing, illustrating the fact that tests of machines over short periods are not sufficient evidence on which to base a final judgment.

In a recent number of the Journal of the Society of Chemical Industry C. Beadle and H. P. Stevens describe a machine for mechanically testing India rubber. Test pieces are cut from sheets 1 millimeter thick in the form of rings 10 millimeters diameter, with a 5 millimeter hole in the center, and are attached to two iron hooks, one fastened to a stationary block and the other to a sliding block moving horizontally on the base of the machine. A cord passing over a pulley and carrying a light metal bucket is attached to the sliding block. Tension is applied by running water into the vessel at the constant rate of 1,000 grammes per minute, and when the test-ring breaks the water supply is cut off automatically. Elongation is measured by means of a pointer attached to the sliding block and moving over a scale. When rupture occurs the hook falls and releases the indicator, which remains at the point of total elongation.