existing in the cylinder at the end of the stroke, or the "terminal pressure," as it is called. The amount of both of these factors can be determined as easily and accurately as the cubic contents of a box, or the weight of a bar of iron. It is generally advisable and always beneficial to know with precision what is going on around us—a fly wheel turns around; a piston goes backwards and forwards, but that is not all; let us see what is really being done in our 16" cylinder, with a piston speed of 400 feet per minute, and only in relation to the simple idea of distance travelled by the piston. The piston travels 490 feet per minute; in sixty minutes or one hour it travels sixty times 400 feet, or 29,400 feet, and in a working day of ten hours duration, ten times that amount, or 294,000 feet—a number too large for us to grasp—I therefore divide this distance expressed in feet by 5,280, the number of feet in a mile, and get as the distance travelled by our piston in a working day of ten hours, 55 miles and 26[illegible]0 feet. To get a step further, in a year of three hundred working days of ten hours each, our piston has travelled in the cylinder a distance of 16,704 miles. Some may think that such things as this is merely the gratification of idle curiosity, but the facts that I have stated have a bearing on our investigation this evening in a manner not suspected by the fault finder. Our 16" cylinder has a piston area of 201.062□", and moves 42 inches each stroke. The displacement of the piston or volume of steam passed through the cylinder each stroke is 201.062 x 42, or 8444.604 cubic inches; in two strokes, or one revolution, 16889.208 cubic inches. This number is getting incomprehensible already, so I will reduce it to cubic feet by dividing it by 1,728, the number of cubic inches in one cubic foot, and get for answer 9.7738 cubic feet, being the volume displaced by the piston during one revolution. But our engine makes 70 revolutions per minute, therefore the revolutions made per hour is 4,200. This number multiplied by the piston displacement per revolution gives me 41049·96 being the piston displacement in cubic feet during one hour's work. You will perceive that this is also the volume of steam that has passed through the cylinder during that time. The number 41049.96 is known as the displacement constant of one of our 16" engines making 70 revolutions per minute, and I shall use the whole number 41050 as being sufficiently close for the purpose.

Armed now with our power constant of 3, and displacement constant of 41050, we are in a position with the assistance of an indicator to quickly and accurately determine the amount of work done and the cost, whereby we can compare the performance with other classes or sizes of engines and also discover defects, if any exist, and point out the remedy.

You all know how indicators are attached to cylinders, so I will not occupy your time with that. As a general rule, the shorter the pipe and the fewer the elbows, the more reliable is the diagram. Then some form of reducing the motion is necessary to bring the stroke of the piston within the limits of the instrument. The swinging lever and the pantograph are examples of that. Nothing in indicator practice appears to have given engineers so much trouble and concern as a true reducing motion that could easily be applied to any engine. Differential pulleys, spring pulleys, inclined planes, levers, screws and pantographs have all been used. It appears to me that the proper solution of the question is to have every builder of engines put on as a permanent fixture some approved form of reducing motion.

I will now suppose that we are ready to take a diagram. The pipes have been blown through to clear them of dirt, the instrument is in place and warmed up, a card is in place on the paper drum, a true reducing motion is in place and at work with a string of the proper length communicating motion to the paper drum, and the instrument is in free communication with only one end of the cylinder. After being sure that all is right and in good working order, apply the pencil to the paper on the revolving drum with light pressure during at least one complete revolution of the crank-pin. Next shut off the steam from the instrument in the proper manner so that atmospheric pressure is on both upper and lower faces of the piston; put the pencil on the paper again and draw the atmospheric line; then unhook the string; the drum stops revolving; take off the card and you have a diagram of the pressures which existed against the face of the piston then in communication with the instrument.

I wish particularly to again call your attention to the fact that an indicator diagram is neither more nor less than a record of pressures, and from that record we perceive at once the state of affairs in that end of the cylinder. Thus if the steam port was not open at the beginning of the stroke the pencil does not rise; we see it at once on the diagram; or if the steam is held too long in the cylinder and the pencil remains up when it should be down, we see it. If the back pressure is heavy during the return stroke, if cushioning is excessive or none at all, if the steam pressure drops excessively during admission, or if the general behavior of the steam while at work is faulty, you can read it on the diagram. Besides, most important results can be obtained from it by calculation and measurement. In all cases, the length of the diagram, whatever it may be, is the stroke of the engine from which it was taken, and the heights or amounts of pressure on the diagram are measured by the scale of the spring that was in the instrument when the diagram was taken. Generally the first thing to be done is to determine the M.E.P. Till within a few years ago the only method in general use was by ordinates. In this case, any line drawn perpendicular to the atmospheric line is an ordinate, same as these perpendicular lines on the blackboard. To do this in the usual way take a short, straight edge and lay it on the diagram, so that one edge coincides with the atmospheric line; then with a small set square erect two lines touching the diagram at its ends. This defines the length of the diagram, and this length is to be subdivided into any number of equal parts, but not less than 10. This can be done by trial with a small pair of spring bows or dividers, but much better with a scale of 30, 40 or 50 to the inch. Apply the scale to the diagram and slant it till a convenient number can be read between the perpendiculars already erected, then with a needle point, or a fine point of a hard pencil make marks on the paper corresponding to the divisions on the scale; then with your straight-edge and set square draw ordinates through your divisional points. But an incomparably better method is to use this instrument which is made specially for this purpose. Lay it on the diagram and open or close it till the length of the diagram is bounded by the corresponding edges of the two outside bars. Hold it there, and with a sharp pencil rule off each bar; then you have it most accurately divided into 10 equal parts. Looking at our diagram after this is done we see that each division has two properties in common—they are all of the same width, and the sides of each are bounded by straight lines. This makes it possible to measure the height of each with close accuracy; then with the scale of the spring, measure the mean height of each division between the lines of the diagram. Pay no attention for the present to the atmospheric line. Add these all together and divide by the number of divisions—the quotient is the M.E.P. of the diagram. A better way is to lay off the division heights on the edge of a strip of paper, one after the other in succession, no breaks; measure the length of the whole with your foot rule, multiply that amount in inches and decimal parts by the scale of the spring, and divide by the number of divisions. This method is more expeditious and accurate than the first one.

(To be Continued.)

PERSONAL.

Mr. J. C. Palmer, a promising young electrician, son of the proprietor of the Palmer House hotel, Toronto, succumbed to a severe attack of diphtheria in this city, a fortnight ago. He had recently resigned a position with a New York electrical firm to take the management of the Kirby House at Brantford, of which his father is also proprietor. Deceased was a member of the National Electric Light Association of the United States and his application for membership in the Canadian Electrical Association was to have been presented at the next meeting of the Executive Committee. Of a genial disposition, the deceased was held in much regard by a wide circle of acquaintances, by whom his untimely death is deeply deplored.

PUBLICATIONS.

The April *Arena* is rich in able, thoughtful papers. Its table of contents is as varied as it is inviting. Although the most liberal and progressive of all the great reviews, the *Arena* is prospering in a manner which indicates the trend of public thought and proves that the people admire brave, outspoken, and earnest magazines.

Germany now employs for its electrical machines 731 stationary steam engines, which represent a total of 38,544 steam horse power and 63 locomotives, developing 1,266-horse power, says *Flatrusty*. This 39,610-horse can furnish 400,000 incandescent lamps of 16 candle power each. One hundred and seventy-seven stationary steam engines and 12 locomotives of 10,000-horse power are used in other electrical industries.