

STEAM ADMISSION.

III.

IN the last paper the action of steam on the engine piston was considered from the point of view that when the exhaust valve opens to allow the steam to escape, the pressure in the cylinder should not be *below* that into which it is to discharge, and should be only a little above that pressure. From this way of looking at the matter, the size of engine required for any given horse power can be determined when the speed of engine and pressure of steam are also known.

There is, however, another aspect of the part of the working of the steam engine which should not be overlooked. In the ordinary crank engine, the piston as it moves back and forth in the cylinder, has a constantly varying rate of speed, and at each end of the cylinder the motion stops. The piston, piston-rod, cross head and part of the connecting rod, all partake in this rest, and change of direction and rate of speed. They are called the reciprocating parts, and their weight has much to do with the smooth working of the engine.

In order that an engine may work smoothly, the bearing surfaces must fit fairly, and be of such size that when the greatest pressure is on them, there may still be a film of oil between the metals. The crank pin is one of the most troublesome parts of the engine. It should be fair to the bearing in the connecting rod at every part of the revolution, and all who have had to do with engines know how difficult it is to get this, especially when an engine is being used with steam of high pressure, as only a very little bending or yielding of the frame is enough to make the crank pin out of truth in its bearing.

At the end of the stroke when steam is admitted and is at the highest pressure, the pressure passes straight through to the crank pin, and the pressure on the crank pin could be easily determined were the whole at rest, but, though the reciprocating parts are at rest, the crank pin is not, but is moving on in its course at its regular speed.

The pressure bears on the reciprocating parts and some of it is absorbed in producing motion in these parts, and the heavier they are the less the pressure in the crank pin during part of the stroke. The speed of the reciprocating parts gradually increases till at about half stroke, it is about the same as that of the crank pin. The power absorbed by the reciprocating parts during this time is equal to their weight lifted as many feet high as would be necessary in order to produce their velocity by falling. This can be calculated by the rules relating to the velocity of falling bodies.

So soon as the highest speed has been reached, it at once begins to slacken until it ceases at the end of the stroke. During this part of the stroke the reciprocating parts increase the pressure in the crank pin by the same amounts as they diminished it in the first part of the stroke, and the heavier they are, the more they increase this pressure.

By adjusting the weight of the parts for a known pressure and load, it is possible to have the engine working with an almost constant pressure on the crank pin.

It will be found a useful study to take an indicator diagram, and dividing it into about six parts, calculate the speed of the reciprocating parts at each point, and their effect on the pressure on the crank pin. If the reciprocating parts after half stroke are gradually losing speed, why keep up the steam pressure in the cylinder endeavoring to make them go faster, while the very constriction of the engine compels them to go slow? Would it not be better to make the steam pressure so high and the reciprocating parts so heavy that the work could be done in the first half of the stroke and the exhaust opened almost immediately after half stroke?

DETERIORATION IN BOILERS.

"ONE very important cause of deterioration in boilers is due to their becoming too small to do the work without forcing, so that the pulsations of the engine cause a well marked succession of shocks on the boiler, which result in the weakening of the material."—*Journal of Commerce*, Aug. 28, 1890

The above statement, if true, would be a most alarming one. Boilers are made of steel or iron plates, and a "succession of shocks results in the weakening of material!"

Railway bridges are also made of steel and iron plates, and every time a train crosses a bridge there is a "succession of shocks," and the material ought also to be weakened and in a short time the bridge will fall!

Many buildings are now erected with steel girders carrying the floors, and every time a man walks across the floor there is a "succession of shocks," and if this weakens the material, the man has only to keep on walking and down will come the building.

When a metal beam or bar is subjected to a load or to a shock, there is a tendency to change the form or to bend the beam. When the load is removed or the shock is over, the beam will resume its original position unless the strain produced by the load or shock has been in excess of what is sometimes termed the elastic limit of strength of the beam. If the strain be within the elastic limit, it may be repeated, an infinite number of times and yet there will be no evidence of any weakening of the material, but if it be in excess of the elastic limit, it has only to be repeated a sufficient number of times to break the beam.

However, there is another feature of the action of the metal which must not be overlooked. It is that the limit of elasticity is not constant throughout the succession of shocks required to break the beam. After the load has been several times applied and removed, it is found that a greater weight is required to produce the same amount of bending; that is, the limit of elasticity has been increased. It is, however, a question whether or not the safety of the beam has been increased.

In the case of a steam boiler, it will be more intel-

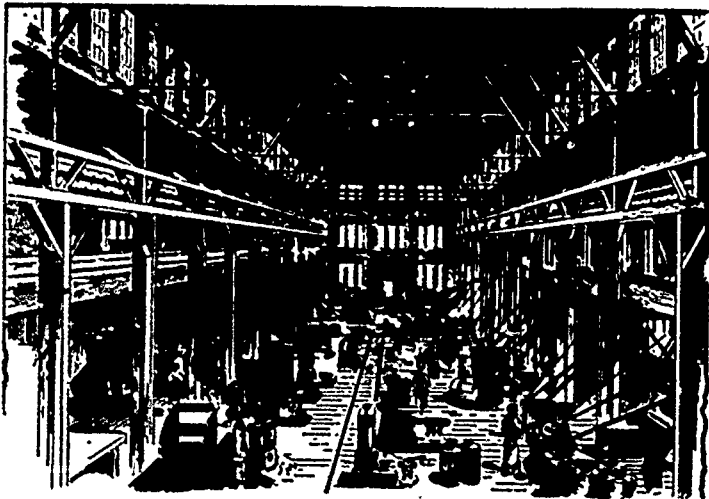
ligible if a definite example be considered. Let the boiler be sixty inches in diameter and made of steel plates 5-16 inch thick, double rivetted in longitudinal seams, and carrying a steam pressure of 120 lbs. per sq. inch, what is the strain upon the metal? Is it below or above the elastic limit of the metal?

The weakest part of the shell is the rivetted joint, but at that point the limit of strength is not the tensile strength but the shearing strength of the rivets, and of the metal between the rivet holes. The strain produced on the metal of a shell sixty inches diameter and 5-16 inch thick, 120 lbs. pressure, will be equal to about 11,520 pounds per sq. inch. The strength of boiler steel may be taken at 60,000 pounds, and the elastic limit at certainly not less than 25,000 pounds, so that to produce a strain equal to the elastic limit, the steam pressure would require to be about 260 pounds per square inch. The ordinary working pressure is not in excess of 120 pounds, and it must be a very unusual and remarkable arrangement of engine the pulsations of which could possibly produce a "succession of shocks" of sufficient force to raise that pressure to the amount necessary to affect the strength of the metal.

Engineers in charge of steam boilers and engines have troubles enough to contend with in keeping things right, without giving their nerves a "succession of shocks" over the idea that every stroke of the engine is weakening the plates of the boiler.

Mann Bros. electricians, Montreal, suffered a slight loss by fire on the 27th inst.

Mr. Westhead, engineer of the McClary Mfg. Co.'s works at London, was severely injured a few days ago, by being struck by the fly wheel. He is recovering.



MACHINE SHOP, EDISON WORKS, PETERBOROUGH, ONT.