crease the cylinder power of a locomotive, concerns its effect on the steam consumption of the engine. Will its use produce a horse power upon less steam than the device which it supersedes. If it will, then, when the boiler is supplying all the steam it can make, it will permit the cylinders to deliver more power than they were able to do without it. If it does not increase the efficiency of the cylinder action it cannot really increase the power.

This suggests the inquiry as to whether the distribution of steam in the cylinders of simple engines is satisfactory, whether, for example, we ought to persist in efforts to secure square cornered cards. The reply is, that in most cases wherethe gear is sufficiently heavy and stiff, to do the work for which it is designed, the distribution as obtained from present gears is satisfactory. The typical locomotive card, displaying the wire-drawing action throughout the cycle, which, especially at high speed, is strongly marked, is, after all, a card of high efficiency. The steam consumption of the locomotive is less than that of most other forms of high speed steam engines employing atmosphere exhaust, even when the speed is increased to limits which far outstrip those common to stationary engines. Its work is to be regarded as highly efficient. So well do the better class of valve gears which are now in common use perform their work that anyone who attempts to increase the power of a modern locomotive by improving its steam distribution will find but a narrow margin on which to work. The Stephenson link motion has been used on locomotives for very many years, almost since its first development. However, on large power, the Walschaert gear, on account of its important mechanical advantages, is displacing it to quite an extent.

The most suitable form of radial gear for locomotives is unquestionably the one invented by the Belgian engineer, Egide Walschaert, in 1844, and applied to locomotives a few years later, but it was not properly understood or appreciated during the first 20 years following its invention, and has ever since then made slow headway until a few years ago, when it took quite a sudden move forward and is at present the dominating valve gear throughout the continent of Europe, and is fast gaining ground in this country. This gear may be said to be based on a fundamental principle of its own, but has been subject to a few modifications without any improvements over its original form. The motion of the valve is derived from two sources—namely, the main crank by connection to the crosshead, and from an eccentric placed approximately at right angles to the main crank. The crosshead connection imparts the motion of lap and lead at the extremities of the stroke of the piston at which moment the link is in its central position. Therefore in mid gear with the reverse lever in its centre notch, this will be all the motion imparted to a radius equal to the length of the radius bar. By moving the reverse lever forward the eccentric motion is brought into combination with the motion from the crosshead, producing a valve opening for a forward motion of the engine, and by moving the reverse lever backward the link block is brought to the opposite side of link fulcrum, resulting in a valve opening governing the backward motion of the engine, in effect similar to that of the Stephenson motion. The action of this one eccentric is therefore the same as if there were two eccentrics, one for forward and one for backward motion placed diametrically opposite each other, and the angle of advance in the Stephenson motion is taken care of by the main crank in the crosshead connection. The latter motion being constant, it follows that the lead remains constant at all points of cut-off.

The proportions of the various parts of the Walschaert gear cannot be determined experimentally, nor should any change in setting the valves be made unless the effect of the change is known in advance. It is, therefore, important that the different parts of the motion should be made and set correctly from the beginning, and there will be no need for changes when the original dimensions are maintained. The difference in this gear for outside and inside admission valves must be considered in setting the eccentric crank, and as the forward motion of the engine should preferably be taken from the lower end of the link, when the eccentric crank will follow the main crank for inside admission valve and lead the main crank for outside admission valve. For outside admission valve the radius bar is connected to the combination lever below the valve stem and for inside admission above the valve stem.

The motion is reversed by an arm connected to the radius bar. The sliding lifter, the best method of suspension of the radius bar but due to wheel arrangements of various designs of engines, this is not always applicable, but must be substituted by swinging lifters, which when properly placed give for all practical purposes equally good results.

Following are general notes for adjusting Walschaert gear:—

1. Ascertain by the following method the position of the eccentric crank. Mark the position of the link relative to its midde position on both of the dead centres of the main crank. If the position of the link is the same in both cases the eccentric crank position is correct, if not, the eccentric crank should be lifted until this occurs, or as near so as possible.

2. After the eccentric crank has been correctly set, the eccentric rod should be lengthened or shortened, as may be required to bring the link in its middle position, so that the link block can be moved from its extreme forward to its extreme back position without imparting any motion to the valve.

3. The difference between the two positions of the valve on the forward and back centres of the engines is the lap and lead doubled, it is the same in any position of the link block and cannot be changed by changing the position of the reverse lever.

4. The train marks of the opening moments at both ends of the valve should be marked upon the valve stem and the latter lengthened or shortened until equal leads at both ends are obtained.

5. Within certain limits this lengthening or shortening may be made on the radius bar, if it should prove more convenient, but it is desirable that its length should be so nearly equal to the radius of the link that no apparent change in the lead should occur in moving the link block as stated in no. 2.

6. The lead may be increased by reducing the lap, and the cut-off points will then be slightly advanced. Increasing the lap produces the opposite effect on the cut-off and reduces the lead by the same amount. With good judgment these quantities may be varied to efface the irregularities inherent in transforming rotary into lineal motions.

7. The valve events are to a great extent dependent on the location of the suspension point of the lifter of the rear end of the radius bar, when swinging lifter is used, which requires that this point should be properly laid out by careful plotting.

The chief point of difference between the Walschaert and Stephenson gear, when both are in proper condition is, as previously stated, that the former gives to the valve a constant lead at all cut-offs, whereas the latter produces an increase of lead by linking up the engine and becomes excessive at short cut-offs. This very point has been the subject for much controversy, and has probably done more than anything else to retard the progress of the use of Walschaert gear, as it has been argued that in full gear, when the speed of the engine, generally is low, only small lead is needed, but at a high speed more lead is required, which is accomplished by the Stephenson motion, though this admittedly becomes excessive at early cut-offs, causing considerable compression and pre-admission detrimental both to maintenance and smooth running, and in fact, to some degree counteracts the work done by the steam on the driving side of the piston, which thereby also affects the speed of the engine.

It was generally discovered that the required lead for short cut-off and high speed was of no practical detriment to the working of the engine in full gear, as the pre-admission at that point is disappearingly small. The proper amount of lead, however, is dependent somewhat on the service, and the port open ing becomes larger with a larger lead, or in other words, when all other conditions are equal in a Stephenson or Walschaert gear, the openings differ by the same amount as the lead, so that one-sixteenth more lead gives one-sixteenth wider port opening, but it is hardly advisable to make this over one-quarter or five-sixteenths inch as a maximum, as the advantage of any additional port opening by means of a larger lead is more than offset by the increase in compression and pre-admission, the larger lead would bring about at early cut-offs, and would do no good in the later cut-offs even if it does no harm.

There is no fundamental reason why the Walschaert gear should produce any economy in steam consumption over the Stephenson motion when both are in the best condition, but an advantage in this respect comes to the former by the fact that it remains in its good condition if once made so, from one stopping to another and is, therefore, on an average more economical both in steam consumption and maintenance of the gear than the latter.

On one engine, no. 912, on the Lake Shore and Michigan Southern after making 39,000 miles, the total lost motion in the valves was one-sixteenth inch. Another engine, no. 5912, equipped with Stephenson link motion had five-sixteenths inch lost motion in the valve stem after making 32,000 miles.

Large eccentrics, besides occupying too large space, wear unevenly, and lubrication is difficult with the high surface velocities of the larger sizes. With hardened pins and bushings the Walschaert gear has not this disadvantage.

Stephenson links, under the influence of two eccentrics, move through wide angles, resulting in a wedging action of the link block, which strains the gear when working hard, and produces lost motion, whereas the Walschaert links

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A TRIBUTE FROM QUEBEC.

J. G. Scott, ex-General Manager Great Northern Railway and Quebec and Lake St. John Railway, writes from Quebec:—

"I have much pleasure in enclosing my renewal subscription to the Railway and Marine World. I am ashamed to send so small a trifle for so valuable a publication. It is replete with the most interesting information, and is worth ten times the subscription. I do not see how any railway man in Canada could be without it."