PRACTICAL MECHANISM.

NUMBER XVIII.

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MOVEMENT OF THE PISTON AND THE CRANK.

To resume, then, we find that, under a maximum of steam lap, the valve permits, as before stated, the steam to exhaust too early in the stroke, and that, to remedy this defect, we have no alternative but to add lap on the exhaust side of the valve. To do this, however, would reduce the exhaust opening of the cylinder exhaust port; hence some alteration in the proportions of the openings is necessary to enable us to accomplish our end, which alteration is in making the cylinder exhaust port more than twice the width of the steam port, since exhaust lap can only be usefully employed under such conditions. In order to show the benefits due to exhaust lap, we will again alter our engine, giving the steam side of the valve an additional one sixteenth of an inch of lap, and placing seven sixteenths of lap on the exhaust side; hence our next experimental engine will have the following dimensions: Steam ports seven eighths of an inch wide, ribs (or bridges) each five eighths of an inch wide, cylinder exhaust port two and one quarter inches wide, exhaust port of valve two and five eighths inches wide, steam lap fifteen sixteenths of an inch, exhaust lap seven sixteenths, travel of valve three and nine sixteenth inches, eccentric rod twenty-three and three quarters inches long.

The only disadvantage arising from these alterations will be that, in consequence of widening the cylinder exhaust port, we have thrown the steam ports wider apart, and have hence had to widen the valve, and therefore to increase the area of the back of the valve upon which the steam acts, pressing the valve to its seat; so that we have proportionately increased the friction due to moving the valve under its pressure: unless the valve is balanced, in which case the increase of area makes no appreciable difference. We have, on the other hand, shortened the length of the steam passages to the amount to which we have widened the cylinder exhaust port, and gained several other important advantages, as the following tables of movements disclose:

TABLE NO. 15.—FRONT STROKE.

Piston moved inches	Port open inch	Piston moved inches	Port open inch
1	5-8	7	7-16
2	3-4	8	1-4
3	3-4	9 1-8	closed, and expansion begins
4	3-4		
5	11-16	11 3-4	closed, but expansion ends
6	5-8 bare	12	exhaust port open 9-16 inch

TABLE NO. 16.—BACK STROKE.

Piston moved inches	Port open inch	Piston moved inches	Port open inch
1	3-4	6	7-16
2	7-8	7	1-4
3	7-8	8	closed, and expansion begins
4	3-4		
5	5-8	11½	closed, but expansion ends
		12	exhaust port open 5-8 inch

In the table No. 11 given in our last, we find that the widening of the cylinder exhaust port and the addition of lap on the exhaust side of the valve has retained the steam in the cylinder during three eighths of an inch more of the piston movement in the front stroke, and during one half of an inch more in the back stroke than was previously the case; and further, that we have used the steam expansively during half an inch more of the front and during seven eighths of an inch more of the back stroke than in our last engine, the steam supply in the front stroke having been cut off a trifle earlier and the expansive steam retained longer in the cylinder. In the back stroke, however, the steam supply is cut off five eighths of an inch earlier in the stroke and the expansive steam exhausted half an inch later in the stroke, so that the back stroke has been benefited far more, by the alteration, than has the front stroke.

We shall find, however, on examination that the average width of the port opening for the admission of steam has been slightly reduced; this, however, is not of great consequence, since the ports have (as before stated) a larger area than they require when in operation as steam ports; so that, if the exhaust is found to be as free as before, the last alteration of our engine will have been beneficial in every respect.

TABLE NO. 17.—EXHAUST OF STEAM AT FRONT END.

Piston moved inches	Exhaust A, (Fig. 54,) open inch	Cylinder Exhaust B, (Fig. 54,) open inch
11 7-8	1-8	1 15-16
12	9-16	1 9-16
Return stroke		
1	7-8	3-4
2	7-8	5-8
3	7-8	5-8
4	7-8	3-4
5	7-8	7-8
6	7-8	1 1-16
7	7-8	1 1-4
8	5-8	1 1-2
9	5-16	1 13-16
9 3-4	closed, and steam cushions.	

In order to obtain the average exhaust opening during the the stroke, we must of course, at each inch of piston movement, take the port opening of A or B (as the case may be), which is the smallest; commencing, then, when the piston is at the end of the stroke, a calculation will give us eleven sixteenths of an inch as the average exhaust opening in our last table, against ten sixteenths as the average exhaust shown in table No. 13.

TABLE NO. 18.—EXHAUST OF STEAM IN BACK END.

Piston moved inches	Exhaust A, (Fig. 54,) open inch	Exhaust B, (Fig. 54,) open inch
11 3-4	1-8 full	1 7-8
12	5-8 barely	1 7-16 full
1	7-8	7-8
2	7-8	3-4
3	7-8	3-4
4	7-8	3-4
5	7-8	13-16
6	7-8	7-8
7	7-8	1 1-16
8	13-16	1 1-4 full
9	1-2	1 9-16
10	3-16	1 7-8
10 9-16	closed, and steam cushions.	

The average exhaust of the above is one hundred and thirteen one hundred and sixtieths of an inch against the average of one hundred and sixteen one hundred and sixtieths of an inch, shown in table No. 14, which shows a slight loss in our last experiment; this is, however, an apparent and not a real loss, for the reason that, in our last experiment, the steam was cut off earlier in the stroke, so that the quantity of steam to be exhausted was less than in the former instance; hence the exhaust opening, in our last experiment, when considered with relation to the quantity of steam required to pass through it in a given time, becomes greater than was formerly the case. It will also be observed that the exhaust in our last experiment is (in both strokes) more free during the early part of the stroke, that is to say, from the first to the fifth inch of the piston movement, than was the case in our previous experiment, which is a gain of great value, since it is during that part of the stroke that the exhaust opening is at its least, from the partial closure of the cylinder exhaust port.

In the front stroke, at the nine and three quarters inches, and in the back stroke, at the ten and nine sixteenths inches of piston movement, the exhaust is closed so that whatever steam, on the exhaust side of the piston, remains in the cylinder at those points is compressed by the advancing piston, and acts as a cushion to reverse the motion of the reciprocating parts of the engine, easily and without noise (in the same manner as the same end is obtained by giving lead to the valve). It is the lap on the exhaust side of the valve which causes this partial closure and compression of the exhaust steam (which is commonly called cushioning on exhaust lap), and which effects a saving of steam, inasmuch as it may be so proportioned as to enclose and compress sufficient steam to just fill the steam passages with steam at full pressure by the time the piston has arrived at the end of its stroke; so that, when the valve opens, no steam will be required from the steam chest to fill such passages, and the valve need not therefore be given any lead, which, in turn, leads to another advantage, inasmuch as, to take the lead off the valve, we must set the eccentric back so that its throw line will be more nearly at a right angle to the center line of the crank, and the variation in the valve movement (explained in Fig. 53 and its accompanying remarks) will be less. By taking the lead off the eccentric, we however decrease the opening of the steam port during the first two inches of the piston movement, which is a decided disadvantage, even though the average opening of the steam port remains the same in either case, because the closure of the port of the valve is proportionately delayed.

The extreme limit to which the addition of steam lap, the widening of the cylinder exhaust port, and the addition of exhaust lap may be usefully employed is governed by, first, the exhaust opening becoming diminished when the piston is at the end of the stroke and during the latter part of the exhaust; secondly, by the increased pressure of the valve to its seat (already referred to); thirdly, by a proportionate increase in the travel; and fourthly, by the point in the stroke at which the exhaust lap will close the exhaust port, and thus shut in and compress a portion of the steam, on the exhaust side of the piston, in the cylinder: it being evident that, if the quantity of steam so enclosed be excessive, the piston will compress it to such an extent as to make its pressure, by the time the piston has arrived at the end of the stroke, greater than is the pressure of the steam in the steam chest, and of course very much greater than the pressure of the steam on the steam side of the piston (which has decreased in consequence of its expansion), thus entailing a serious back pressure, and causing the steam compressed in the steam passage to be forced back into the steam chest so soon as the valve opens. It is obvious, however, that if the valve has any lead on it, this back pressure will be less than if there were no lead, because the steam would be forced back into the steam chest earlier, and therefore before it was compressed to so great a degree; but in either case sufficient exhaust lap to cause such steam to be forced by the piston back into the steam chest would entail a loss of power from back pressure, and place a severe strain on some of the parts of the engine, as already explained in our remarks on excessive lead.

To illustrate these points let us alter our engine as follows: Steam ports seven eighths of an inch wide, ribs five eighths of an inch wide, cylinder exhaust port two and three quarters inches wide, steam lap one and one eighth inches, exhaust lap three quarters of an inch.

These alterations necessitate that the valve travel be increased from three and nine sixteenths inches to four inches, causing an increase in the distance traveled by the valve, and therefore in the power employed in moving it, of over 12 per cent (unless the valve be balanced).

The valve will now be eight instead of seven and one eighth inches wide as before, causing it to be pressed to its seat with over 12 per cent more pressure than before. The exhaust opening will be diminished as follows (those points in the stroke here omitted not being affected by the change)

TABLE NO. 19.—EXHAUST AT FRONT END.

Piston moved inches	Exhaust open inch	Loss inch
12	1-2	1-16
Piston returned		
7	5-8	1-4
8	5-16	5-16
9	exhaust closed, cushioning begins	

TABLE NO. 20.—EXHAUST AT BACK END.

Piston moved inches	Exhaust open inch	Loss inch
12	3-8	1-4
Piston returned		
7	3-4	1-8
8	9-16	1-4
9	1-4	1-4
9 7-8	exhaust closed, cushioning begins.	

Here, then, we have a large decrease in the exhaust openings, and have cushioned on exhaust lap three quarters of an inch earlier in the front stroke and eleven sixteenths of an inch earlier in the back stroke: the other alterations being that the expansion of our new engine will begin at eight and three quarters inches of the front and at seven and five eighths inches of the back stroke, that is to say, the steam has been used expansively during five eighths of an inch more of the piston movement during the front, and during five eighths of an inch more of the back stroke than was the case previous to the last alteration made in our engine. The effect of such a movement would be to place an amount of back pressure (due to cushioning on the exhaust side to an excessive degree) so great as to force the valve off its seat and produce a serious strain upon the engine, and to produce a back pressure during the earlier part of the exhaust by cramping it.

Exhaust lap, sufficient to prevent the exhaust from taking place too early in the stroke, is shown by our tables to be in every way desirable; but when it is employed to cushion, or, in other words, to answer the purpose of lead, great care must be taken as to its proportion, which must, in all cases, depend upon the pressure of the steam used, and the speed at which the piston travels. With high pressures and speeds, a minimum only of exhaust lap is permissible. Another effect of exhaust lap is to take some of the lead off the eccentric, and to that extent to correct the irregularity in the points of cut-off, expansion, etc.

It will be observed that the variation in the point of cut-off at one end, as compared to the other end of the stroke, becomes greater in proportion to the increase of steam lap; and there is no way of remedying this defect except we produce still greater evils in other directions. Were we to equalize those points of cut-off by giving different amounts of steam and exhaust lap at one, as compared to the other, end of the valve, we should increase the variation in the steam and exhaust openings, and cushion at widely differing points in the stroke; so that, when we have proportioned the steam lap to cut-off at about three quarters of the stroke, and the exhaust lap so as to leave the exhaust port open (when the piston is at the end of the stroke) to the amount of about two thirds of the full width of the steam port, we have obtained all the benefits due to the employment of either of them, nor can we alter the value to accomplish a gain in any direction without entailing a loss in another.

If the cylinder exhaust port is twice the width of the steam port, and no exhaust lap is employed, the valve may have steam lap to about the width of the steam port; but if the cylinder exhaust port is made more than twice the width of the steam port, a proportionate amount of steam and exhaust lap may be added. For locomotives, common proportions are: Steam ports one and one quarter inches wide, rib one inch, cylinder exhaust port two and one half inches, steam lap one inch, lead of valve three sixteenths of an inch, travel of valve four and one half inches, exhaust lap being dispensed with, except it be sufficient to just prevent communication between the steam ports when the valve is in the middle of its travel.

Actinic Light.

The *Athenæum* says: "When the vapor of bisulphide of carbon is mixed with nitric oxide gas, the mixture, on ignition, burns with an intensely luminous flame of high actinic power, but of only momentary duration. MM. Delachanel and Mermet have, however, recently succeeded in producing a lamp in which this gaseous mixture may be conveniently burnt, and thus applied to photographic purposes. The nitric oxide is generated by the action of iron on a mixture with vapor of bisulphide of carbon; the mixed gases are burnt in a kind of Bunsen's burner, the products of combustion being rapidly carried off by a chimney. For the purposes of the photographer, this new flame is said to be superior to that of the magnesium lamp, while it is estimated to have twice the chemical power of the oxyhydrogen flame, and three times that of the electric light.

AN interesting phenomenon is now observed in Cadunk, Lily and Lake ponds, at Southington, Conn. Decomposition of vegetable matter on the bottom is producing carburetted hydrogen gas, which may be ignited at this season by applying a match at holes made in the ice.