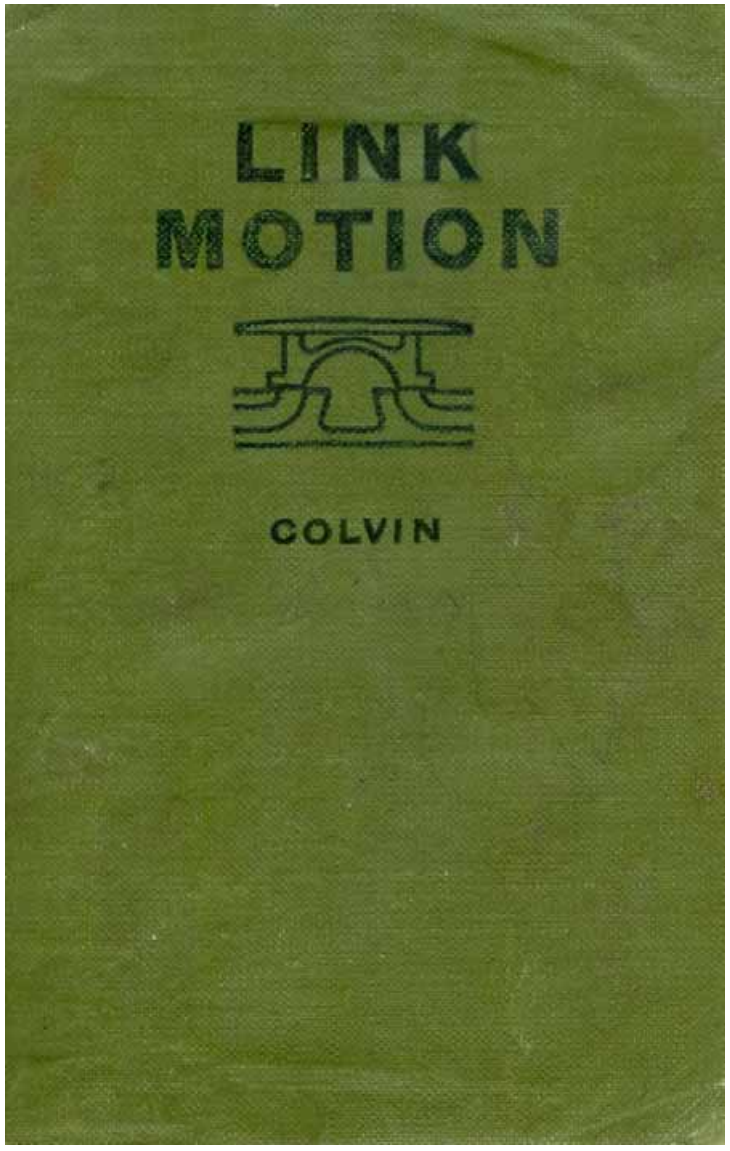


7+ RAILROADER

A Gift to You

Robinson & Associates, publishers of the ***7+ RAILROADER*** and the ***Grand Scales Quarterly*** magazines, consider it a privilege to be of service to the live steam hobby. This partial reproduction of a vintage locomotive valve gear manual is offered free of charge as a token of our appreciation for you, our loyal readers.

The ***7+ RAILROADER*** and the ***Grand Scales Quarterly*** are the only journals in North America dedicated exlusively to riding-size, scale railroads. Be sure to stop by our web sites.

www.7plusrailroader.com

www.grandscales.com

Grand Scales
QUARTERLY

LINK MOTIONS, VALVE GEARS AND VALVE SETTING

A practical treatise which explains the mysteries of valve setting. Shows the different valve gears in use, how they work and why. Piston and slide valves of different types are illustrated and explained.

BY

FRED H. COLVIN

ASSOCIATE EDITOR "AMERICAN MACHINIST"

Third Edition, Revised and Enlarged

NEW YORK:
THE NORMAN W. HENLEY PUBLISHING COMPANY
132 NASSAU STREET
1914

Slide Valve Setting

The practice of locomotive valve setting in many repair shops may differ somewhat in the details from those given herewith, but this method is the one that essentially must be followed to get the data required for intelligent adjustment of the eccentrics and the lengths of the eccentric rods. The prime requirement of locomotive valve setting is that the exhausts shall sound "square", and to do so the cut-offs must be nearly equal all around. But the valve-setter does not usually trouble himself about the point of cut-off in the first instance; he sets the valves for equal leads at full stroke all around, assuming that the cut-offs will be approximately equal, which is the case with well-designed link motions. By

"full stroke" is meant that the reverse lever is placed in the extreme positions front and back so that in either forward or backward motion the valves are almost entirely under the influence of the forward or backing eccentrics as the case may be. One reason for setting locomotive valves by the leads is that it only needs two easily fixed points for each side from which to start, *i. e.,* the dead centers. Therefore setting valves by the leads requires that the dead center points shall be accurately determined, which is done substantially as follows:

We will suppose that the main rods are coupled up and that the valve motion parts are all properly connected. The locomotive should stand on a piece of level track where it can be easily moved to and fro by three or four laborers armed with pinch-bars. The valve-setter should have an assistant to hold the wheel tram while he attends to getting the measurements and catching the points on the crosshead. This is the old-fashioned way; of course, if a valve-setting machine is provided the labor is lessened, but the operations are

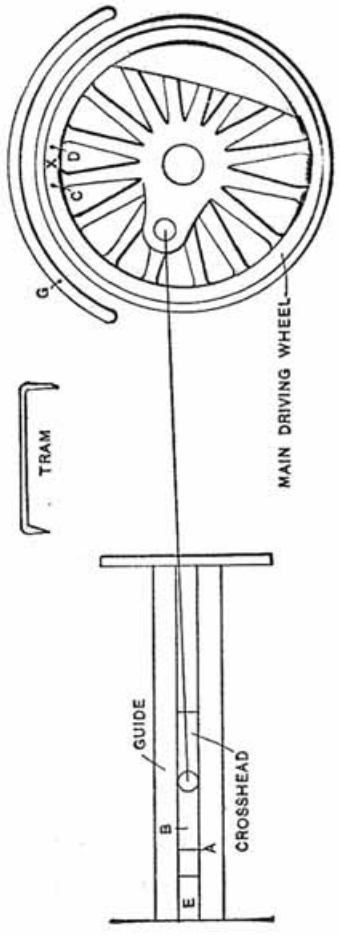


Fig. 10. Finding the Dead Centers.

the same, that is, the dead centers must be found, the cranks successively placed on the centers, and the leads measured.

First, to find the dead centers: Move engine ahead until, say, the crank on the left side is nearly upon the center and the crosshead is within, say, ½ inch of the end of the stroke, as in figure 10. Make a prick-punch mark, *G*, upon the wheel cover or some other convenient part. With one point of the wheel tram in the punch mark, *G*, scribe the line *C* upon the rim of the wheel. At the same time draw a vertical line, *B*, across the guide and the crosshead. Or better, provide a short tram like the wheel tram and mark a short arc upon the crosshead with one end while the other rests in a punch mark on the guide or guide-block *E*. Now move the engine ahead until crosshead stops moving ahead and begins moving back. Stop moving when the line *B* again coincides with the mark upon the guide. Again, with the wheel tram mark an arc upon the wheel at *D*. With dividers find the exact center between *C* and *D* and mark it with the

punch. Now with the reverse lever in the backward motion move the locomotive slowly backward until the wheel tram point just drops into the middle punch mark on the driving wheel. The left-hand engine is now upon the exact dead center, front.

Second, to get the leads: Since the lever was in the backward motion when the front center was caught, it follows that lead of the valve upon front center backward motion can now be measured. If the steam chest cover is off the lead can be measured directly with a scale applied directly to the edge of the valve and the outside edge of the steam port. But the usual practice is to set the valves with the covers on, which requires the previous marking of the valve positions when just opening, upon the valve stem, using another tram for this purpose. This is called getting the "openings." So with these marks upon the valve stem the measurements may be taken with the steam chest covers in place, and it is more convenient and accurate to get them in this manner. Suppose that the lead or

valve opening is found to be just 1/8 inch. A memorandum is made of the fact. Then the position of the valve is gotten with the reverse lever in the forward motion. Say in this case the valve is just beginning to open, or is "line-and-line." Make a note to that effect. Now we are ready to move the locomotive one-half turn to get the crank upon the back center. As a matter of practice it is usual to move only one-quarter of a turn and get the leads on the opposite side, but since that is a duplication of what has already been told we will omit the steps for the opposite side for the sake of brevity and clearness.

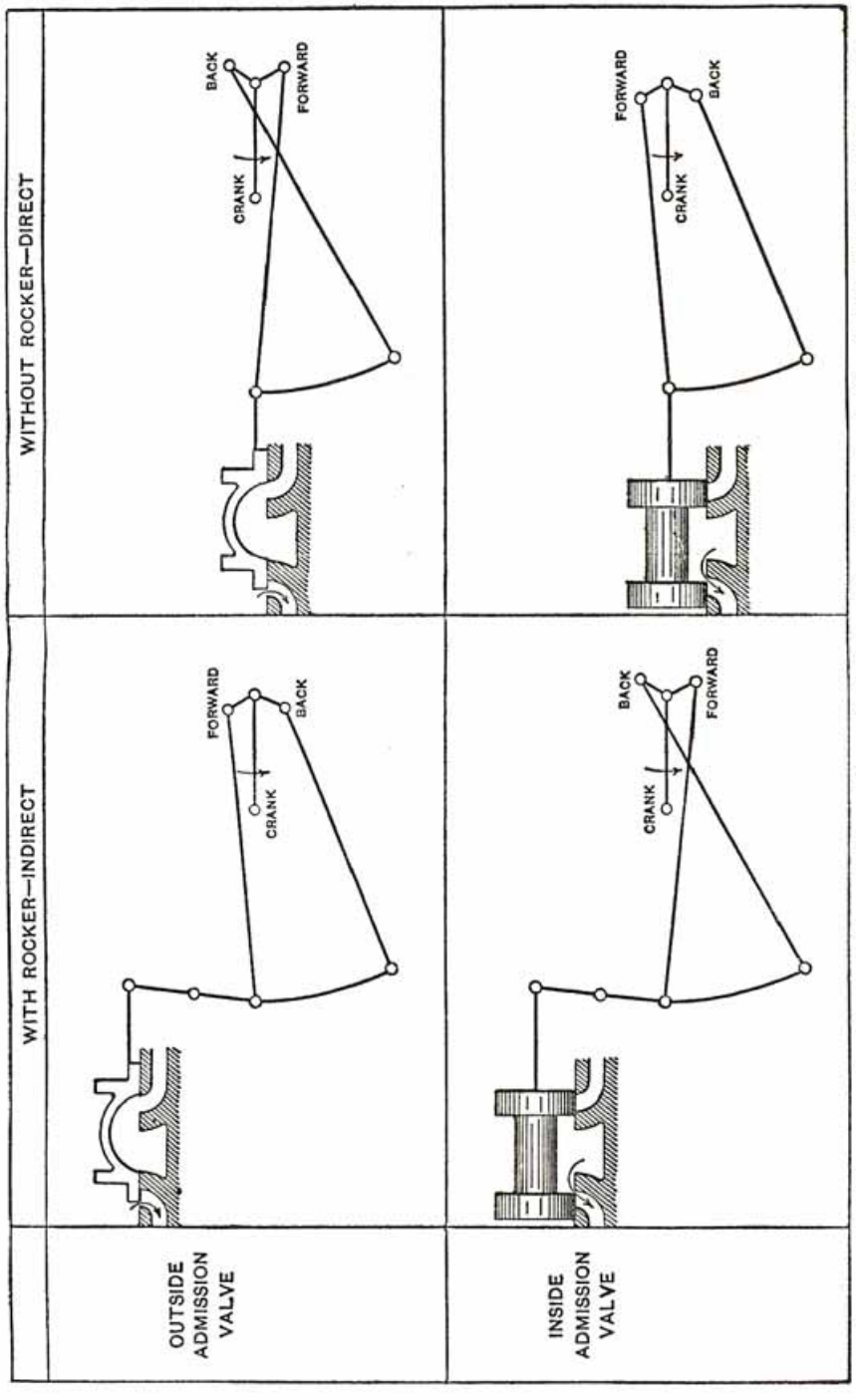
Having moved locomotive to the back center the same operation in every detail is again gone through and the leads, obtained for both forward and backward motion, are measured. Suppose that in backward motion the valve is found to be line-and-line; also line-and-line in the foward motion. This completes the necessary data for one side. The next step is to use the knowledge acquired by the aforesaid somewhat laborious process in

making the changes in eccentrics and eccentric rods necessary to give equal leads and presumably equal cut-offs.

In the first place we will change the lengths of the eccentric rods or blades if any change is required. In the backward motion we found 1/8 inch lead on the front center and zero lead on the back center. Therefore the eccentric rod must be *shortened* for indirect slide valve motion just one-half of 1/8 or 1-16 inch. This is supposing the upper and lower rocker arms to be of the same length, and they are usually so near the same length that the difference is not noticeable unless the movement is great. With this change made the backing eccentric rod is properly adjusted. Means are usually provided —slotted holes or butted rods with liners between—for making the changes in eccentric rod lengths. In the forward motion the valve was found to be line-and-line on both forward and back centers so that no change is required in the lengths of the forward eccentric rod length.

Now we are ready to make any

changes in the positions of the eccentrics. What these changes shall be depends upon the practice laid down by the "powers that be." If 1-16 inch lead in full stroke is the rule the forward eccentric must be rolled on its shaft *toward* the crank, since it has no lead as it stands. This applies to indirect or rocker-connected outside admission valves. But if we turn the eccentric in the direction that the wheel will run when the valve is controlled by that eccentric, that is, forward for the forward motion eccentric, we shall always *increase* the lead no matter whether the motion is direct or indirect and with either outside or inside admission valves. To *decrease* the lead turn the eccentric in the opposite direction to which the wheel turns when the reverse lever is in the forward motion. If, however, the rule is to set the valves line-and-line in full stroke, we shall not touch the forward eccentric, but must move the backing eccentric away from the crank (in this case) and always opposite to the direction the wheel turns when the reverse lever is in the backward motion



Comparative Diagrams showing Positions of Eccentrics and Rods for Steam Admission to Front End of Cylinder, Slide and Piston Valves. with and without Rockers.

to decrease its lead. By remembering this simple rule for changing lead there need never be any confusion with any kind of valve or connection.

▼ ▼ ▼

Analysis by Diagrams

To prove this statement and to show clearly the functions of the link motion and its positions with direct and indirect connection to both outside and inside admission valves, the following diagrams, Figs. 11 to 20, inclusive, are shown in a group, and they include practically every combination that will ever be met with in locomotive practice:

Beginning with Fig. 11 we have the valve motion usually found upon American locomotives, that is, two eccentrics, link, rocker and outside admission slide valve. The diagram shows the valve just opening to admit steam to the front steam port. But first imagine the eccentric centers, *F* and *B*, directly above and below the center of the axle, that is the vertical line joining them and passing through the center of the axle would be

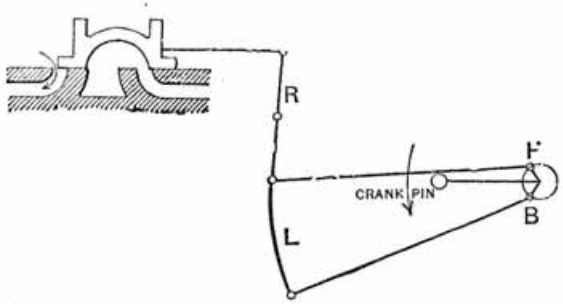


Fig. 11.

at right angles to the horizontal line passing through the crank and axle centers. In this position, however, with a valve having outside lap the front steam port would be closed when the crank is on the front center and for some distance of the crank-pin travel below the center on the return stroke. Therefore the eccentric *F*, whose rod is coupled to the

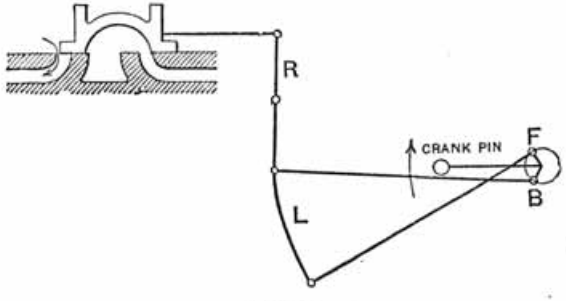


Fig 12.

link nearest the link-block (in the position shown) must be moved on the axle in the direction the crank is to turn until the valve opens, then the other eccentric, *B*, is moved toward *F*, or *against* the crank. It will now be seen that as the crank turns in the direction of the arrow the valve will continue to open and the engine to run in the forward direction.

Fig. 12 shows what would happen if we coupled the eccentric *F* to the bottom of the link and *B* to the top. The valve would be in the same position (as in this case the link-block is in line with the axle), but the engine would run the other way. To see this clearly, imagine the crank-pin to move down and it will be seen that eccentric *B* will move the valve so as to close the port. The arrow shows the way it would run.

At Fig. 13 we have an inside admission valve with rocker, set to run in the usual way as indicated by the arrow. Here again we move the eccentric coupled nearest the link-block in the direction the crank moves until the valve opens port. Then we move the other ec-

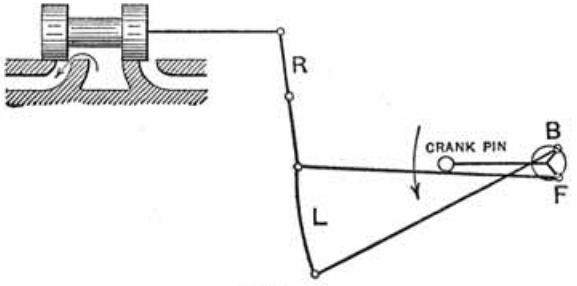


Fig. 13.

centric toward the first, *against* the crank pin, as at *B*. Turning the crank-pin as indicated opens valve wider and engine runs as it should.

Changing eccentric rods, as shown in Fig. 14, gives us reverse conditions, same as shown in Fig. 12, but the same rule holds good, as can be seen by following it out.

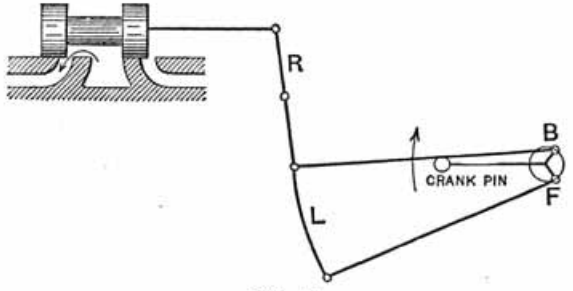


Fig. 14.

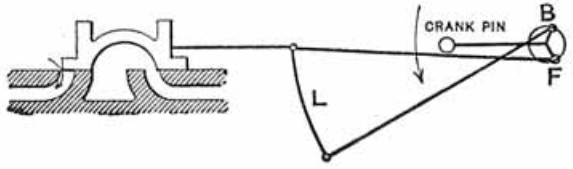


Fig. 15.

Leaving rockers out of the question and dealing with direct motion we have the regular outside admission slide valve at Fig 15. Here the forward eccentric, *F*, is at the bottom and has to be moved in the same direction as the crank-pin to give the desired lead. Here again we move the backing eccentric in the opposite direction or toward the first, an equal amount.

Again, changing the eccentric rods, as at Fig. 16, we have reversed the direction the engine will turn, but the same rule holds good.

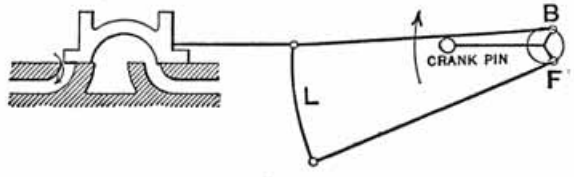


Fig. 16.

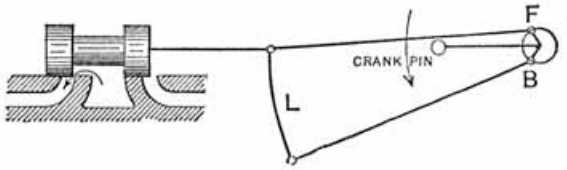


Fig. 17.

Using an inside admission valve without a rocker gives us the condition shown in Fig. 17, and here, too, the rule holds good just as it did in Fig. 11. In fact, the valve setting is exactly the same in both cases. An outside admission valve with a rocker and an inside admission valve without a rocker have the same movement and require the same setting. Of course, the reverse is also true, *i. e.*, an inside admission valve with a rocker is the same as an outside admission valve without a rocker and should be set in the same way.

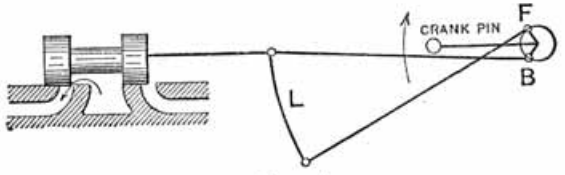


Fig. 18.

In Fig. 18 we again change the eccentric rods and find the same conditions as in Fig. 12, the rule being true in every case.

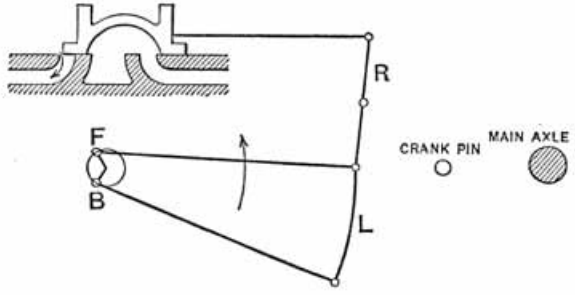


Fig. 19.

Fig. 19 shows a form of valve gear not common except on small four-driver switching engines. The eccentrics are not on the main axle but on the forward axle, as shown, and the curve of the link is backward instead of facing the front. The movement of the valve is identical and the same rule also applies just as though the eccentrics were on the main axle. The eccentrics are moved with the direction of motion and everything is just as before.

These line diagrams show exactly what will happen with any setting of eccentrics or how to set them for any case shown. For example, if a locomotive has inside admission valves and no rocker, Fig. 17 shows how to connect the rods and set the eccentrics. If there is a rocker with this same valve the proper setting is shown in Fig. 13.

If by any chance (like one case the writer knew of) you have an engine which runs forward with the reverse lever toward the tank, just change the position of the rods on the link, putting the top rod on the lower end of the link and the lower rod at the top. This is what Auchincloss meant by "crossed rods." If your engine has a valve and a rocker

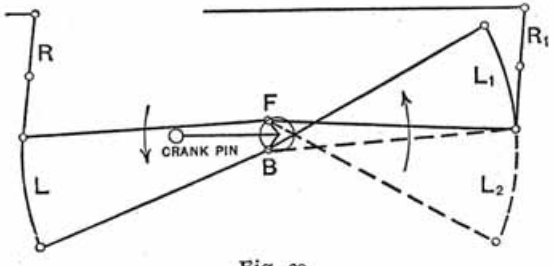


Fig. 20.

like Fig. 13, change the rods to look like Fig. 14 and the reverse lever will then be ahead when the engine is running forward.

In this condition (which does not often happen), the lead will be less at short cut-off than at full stroke. In other words, the lead decreases as it is hooked up.

This brings us to another rule or fact, which is also universal: When, in hooking up from full stroke toward the center, the eccentric straps move around the eccentrics *opposite* to the direction in which the crank is moving, the lead *increases*. And when the eccentric straps move around the eccentrics *with* the crank-pin, *lead decreases*.

This is clearly shown by Fig. 20. The left-hand portion shows a regular link motion, Fig. 11, except that the valve is omitted. Now disconnect the link hanger and swing the link around the eccentrics to the top or full line position back of the axle. Put in another rocker arm as indicated at R_1. The top eccentric rod, running from F, will now be at the bot-

tom of the link L, and the rod from B at the top. Moving the crank in the direction of the arrow now moves the lower end of the link in the same direction as the top moved before. Consequently the valve would be moved in just the same way.

Moving the link down to shorten cut-off would be moving the eccentric straps around the eccentrics *against* the movement of the crank, so that the lead would increase the same as before, in spite of the rods apparently being crossed. This shows one of the unfortunate features of the term "crossed rods."

If, however, we dropped the link all the way down as shown by dotted lines to the position L_2, we should reverse the motion, as the rocker arm and valve would then be controlled by the other eccentric B.

This sketch also helps to prove the first rule as, whether the link is in the first position or the second, the eccentric coupled nearest to the link block is moved with the crank to secure the desired

lead. Then the other is moved toward it or opposite the crank.

This is such a simple rule and yet such a valuable one that it is worth repeating until thoroughly learned. This is our reason for carefully going over its application in the various cases.

Rule I. The eccentric connected to the end of the link nearest the link-block and, therefore, governing the direction of rotation must be shifted on the axle in the direction of rotation to increase the lead of the valve.

Rule II. The distinction between "open" and "crossed" eccentric rods may be made by stating that "open" rods are those whose eccentric straps slide on the eccentrics in a direction opposite to that of rotation when the link is hooked up; with "crossed rods" the straps slide on the eccentrics in the direction of rotation when the link is hooked up. The locomotive is supposed to be standing still, and the statement, of course, applies to the movement up to the mid-gear position only.

It is also well to remember that an out-

side admission valve always moves in the same direction as the piston, while an inside admission valve always moves opposite to the piston.

Nearly all slide valves are outside admission, while the majority of piston valves are inside admission. An inside admission valve has the advantage of only having to pack the valve stem against exhaust steam. The condensation should also be less as the hottest or live steam is in the center, away from the outside or end walls of the steam chest.