Setting the Eccentric Crank

Applicable to Constant Lead Design Walschaerts or Baker Valve Gears

By Jeffrey G. Hook

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Introduction.

The link of a Walschaert valve gear, or the gear connecting rod of a Baker valve gear, receive their reciprocating motion from the eccentric rod which is driven by the rotary motion of the eccentric crank pin. The eccentric crank pin is attached to the eccentric crank which is in turn attached to the end of the main pin. The eccentric crank may also be referred to as the return crank.

Images and Figures are generally below their respective descriptions or captions.

Image 1. View of the right side of Deerfield and Roundabout Railway Engine Number 284 equipped with Walschaert constant lead valve gear with principle parts named.

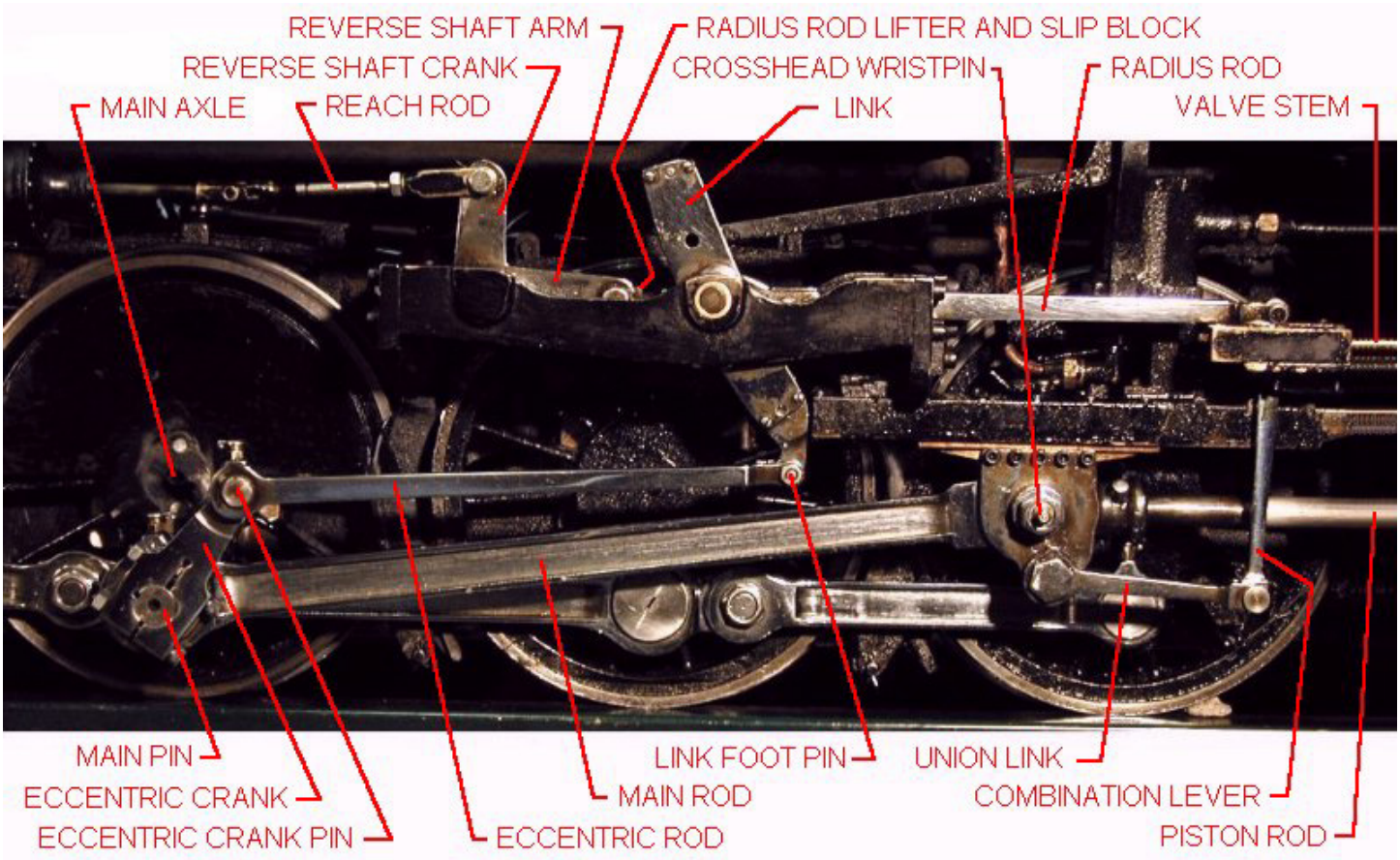
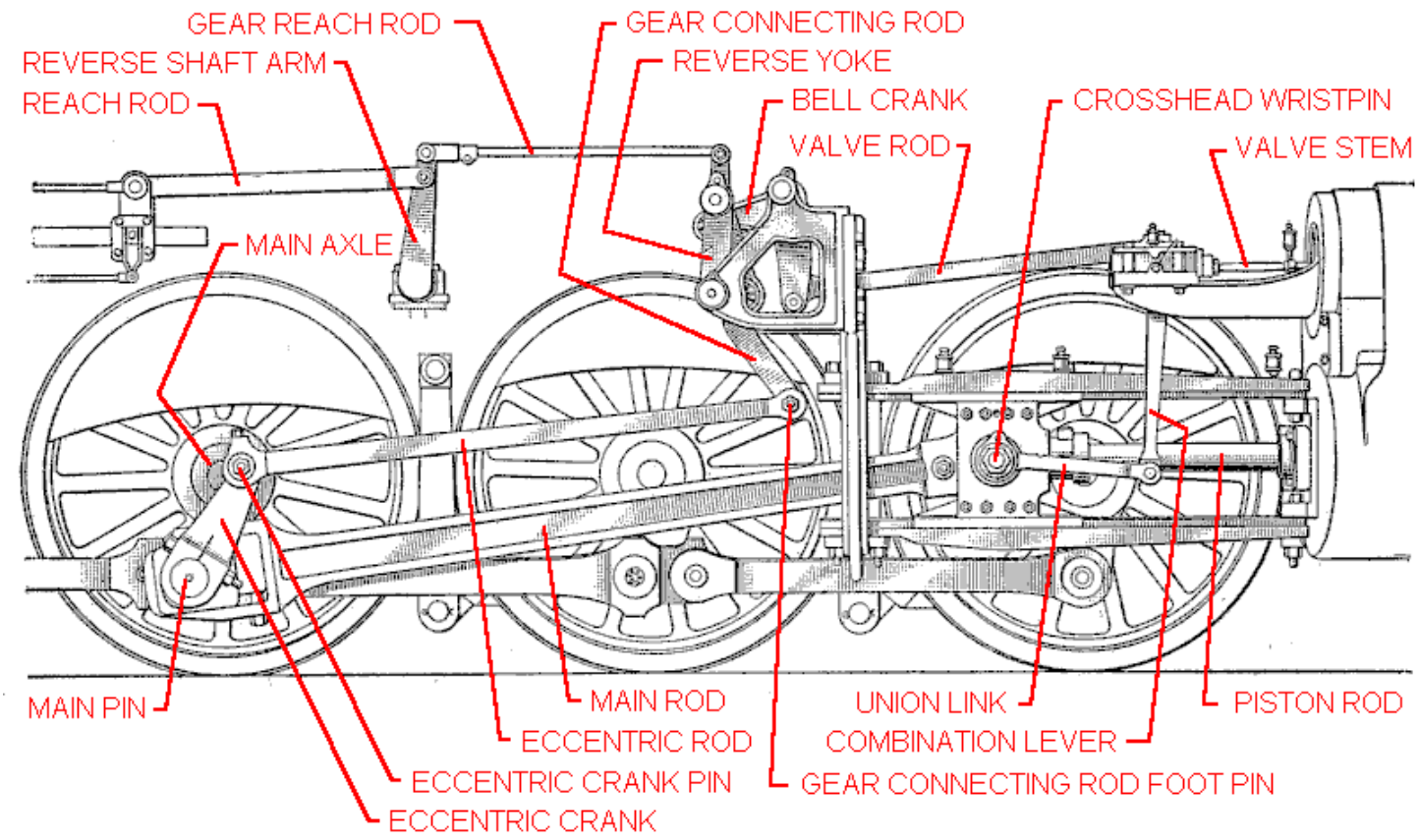


Figure 1. View of the right side of a locomotive equipped with Baker constant lead valve gear with principle parts named.

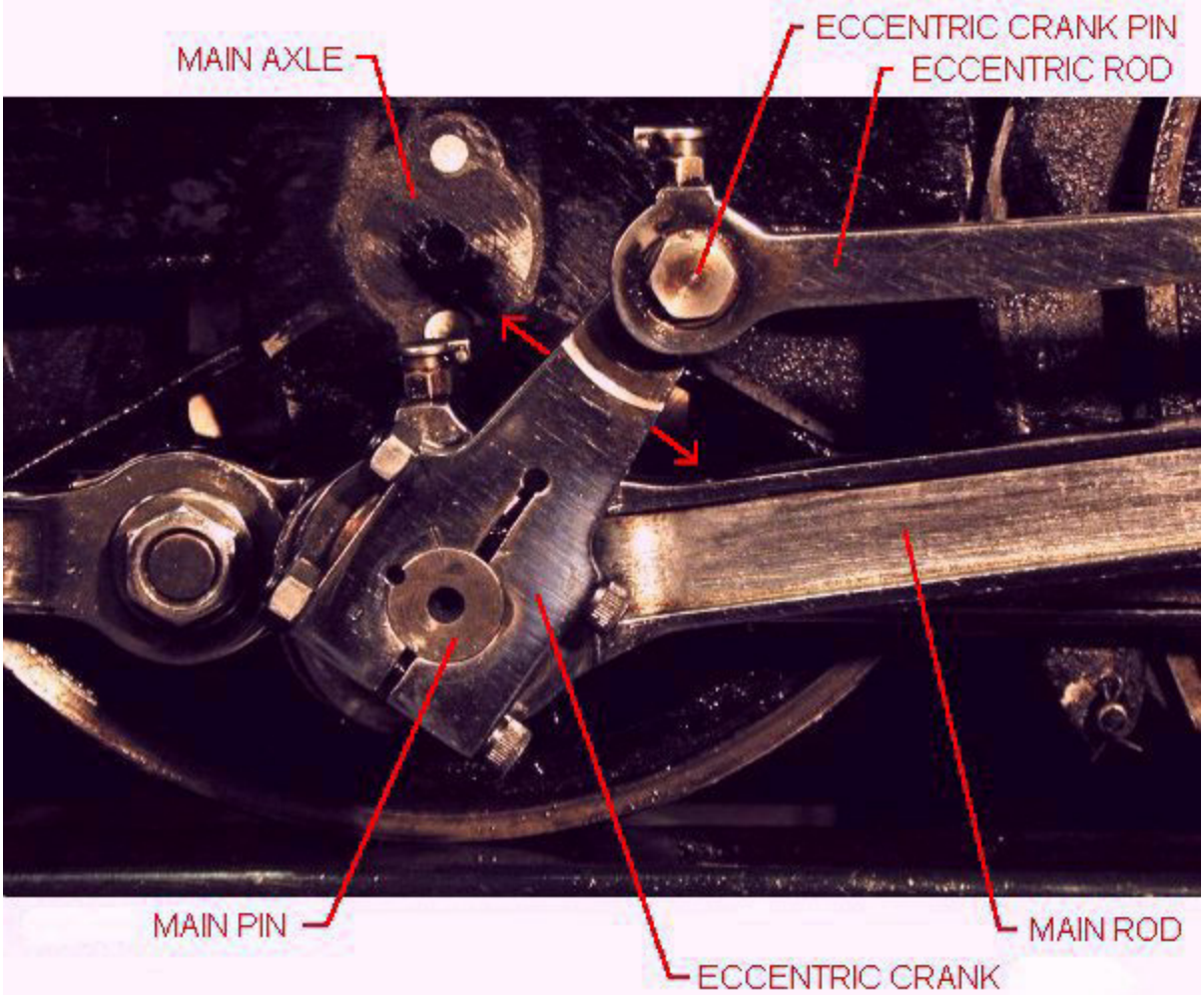


In order for either of these valve gears to provide correct steam distribution to the cylinder, the reciprocating motion, or forward and backward swing, of the Walschaert link or the Baker gear connecting rod must occur in specific relation, or timing, to the rotation of the main pin. The dimensions and position of the eccentric crank that will place the eccentric crank pin in the proper position relative to the main pin in order to provide the correct timing is determined by the engineering department and is specified on the locomotive construction drawings.

During the manufacture of a locomotive unavoidable discrepancies occur between the intended design dimensions and the actual finished dimensions of the various components and their locations relative to one another when assembled on the frame. If the eccentric crank is installed exactly as specified on the construction drawings, without taking into consideration any of the dimensional discrepancies that may exist, then the correct relationship, or timing, between the Walschaert link and the main pin, or the Baker gear connecting rod and the main pin, may not be achieved. This may result in incorrect steam distribution to the cylinder and a locomotive that sounds "lame."

After completing the construction and assembly of the valve gear, adjustments are made to the various components in an effort to compensate for any dimensional discrepancies that may exist. These adjustment procedures comprise what is generally referred to as valve setting. The procedure which pertains to the adjustment of the angular position of the eccentric crank on the end of the main pin is referred to as setting the eccentric crank.

Image 2. Close up view of the eccentric crank. The red arrows indicate the directions of movement that may be required when setting the eccentric crank.



Timing Relationship between the Walschaert Link and the Main Pin.

The most common design of Walschaert valve gear is that having constant lead. For such a design the timing relationship between the link and the main pin is correct when the reciprocating motion, or swinging motion, of the link is 90 degrees out of phase in relation to the dead centers of the main pin.

The dead centers of the main pin are used as the primary reference points for setting the eccentric crank, therefore it is of utmost importance that it is known that they have been accurately established. For further instructions go to Finding Locomotive Dead Centers.

The following figures illustrate a theoretical Walschaert valve gear having no lost motion and correct timing relationship between the link and the main pin.

Figure 2. Main pin on front dead center and link at position (X) of the swing of the link.

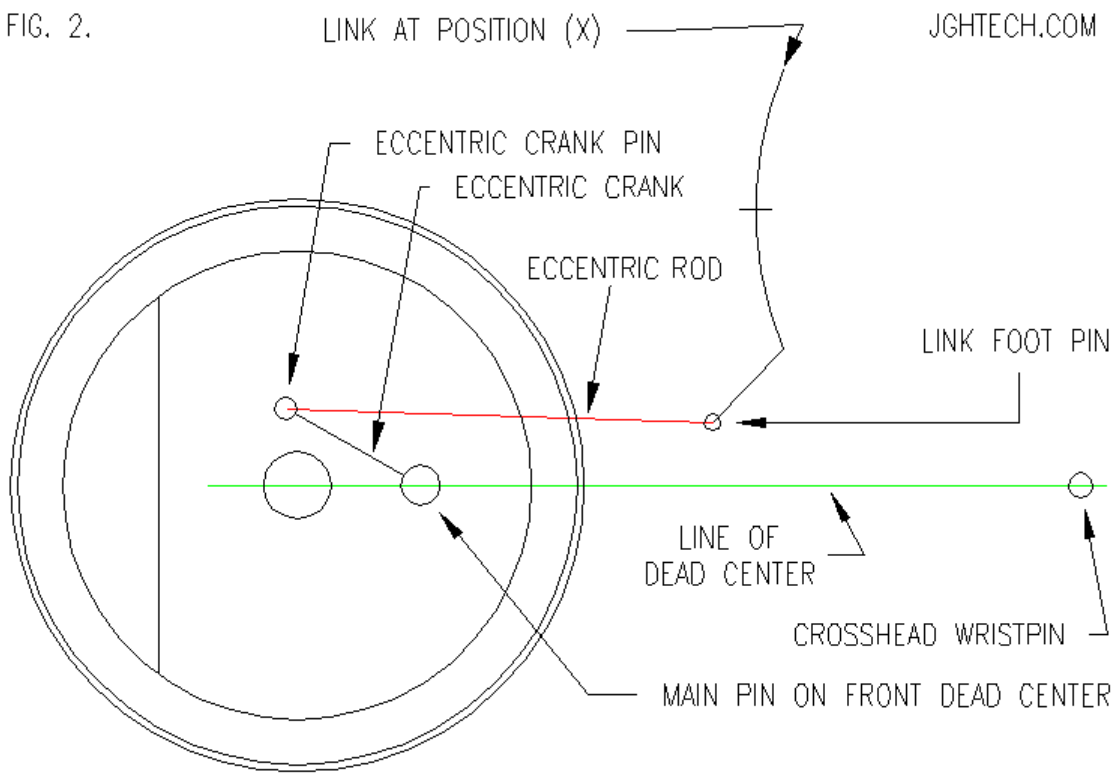


Figure 3. Main pin on bottom quarter and link at position (Y) which is one of two points of maximum swing of the link.

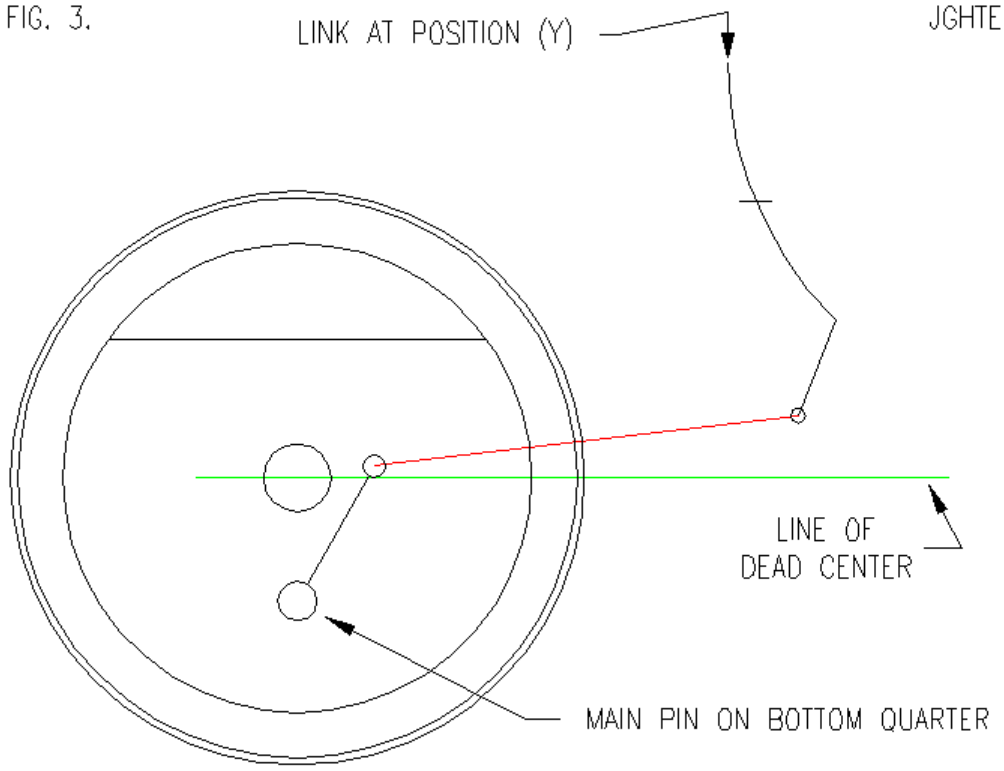


Figure 4. Main pin on back dead center and link again at position (X) of the swing of the link.

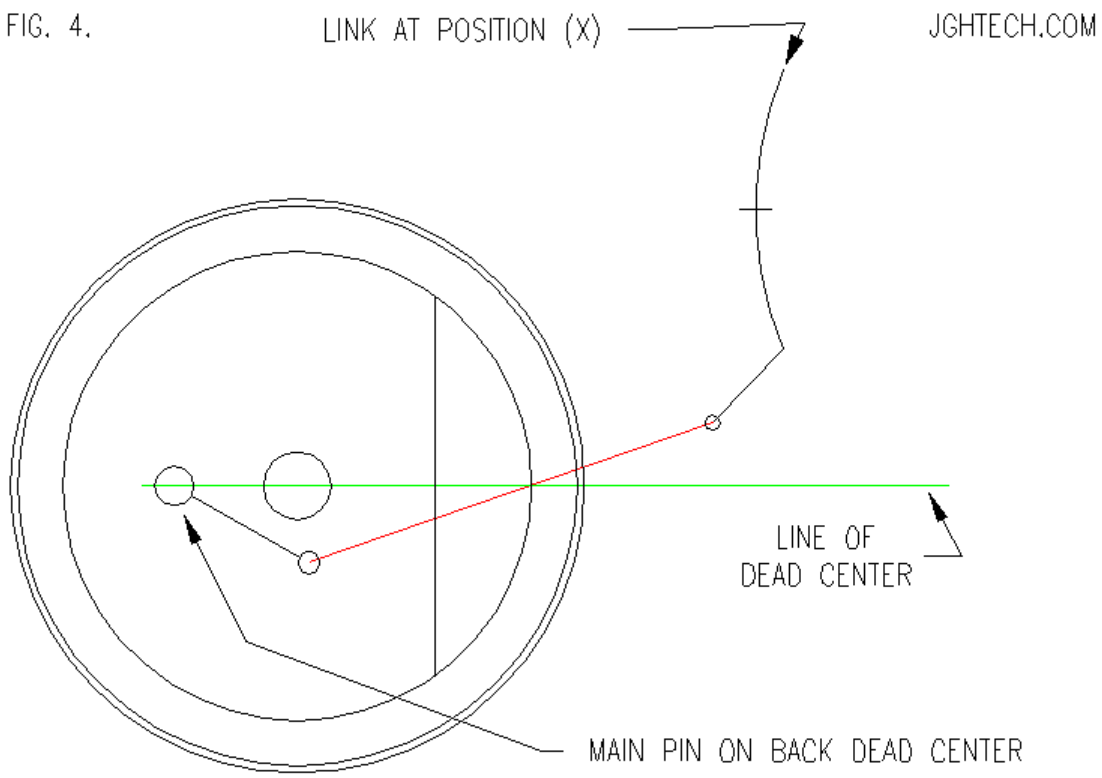
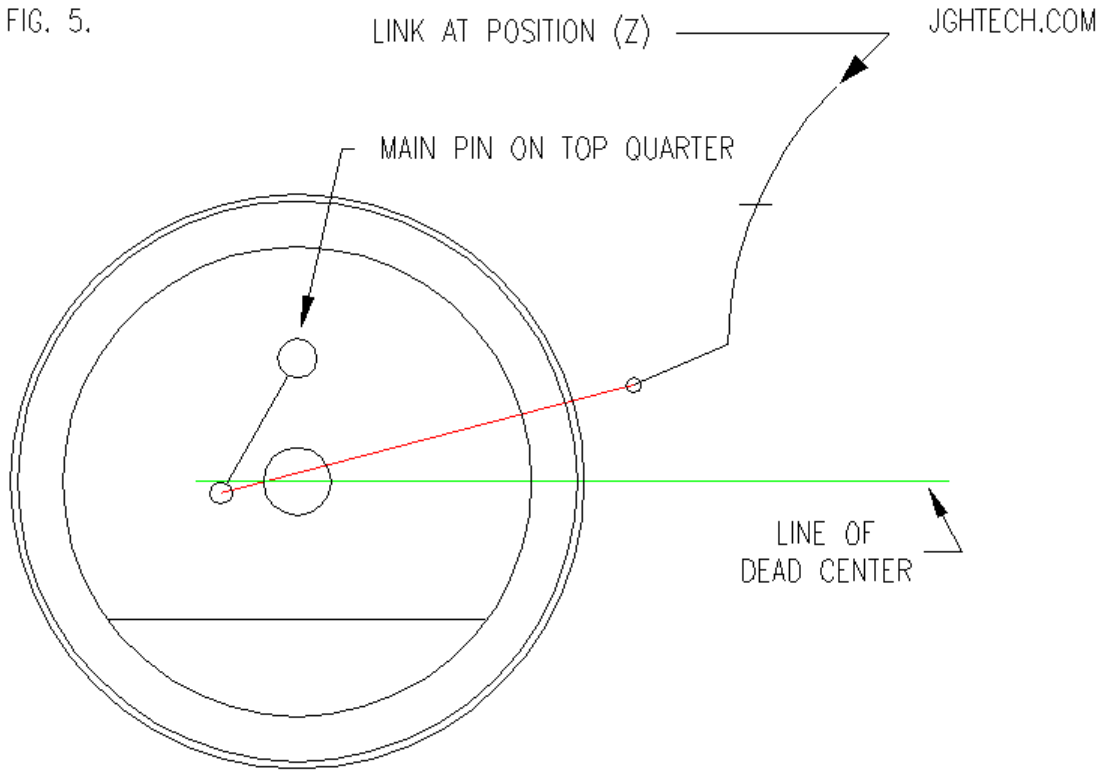
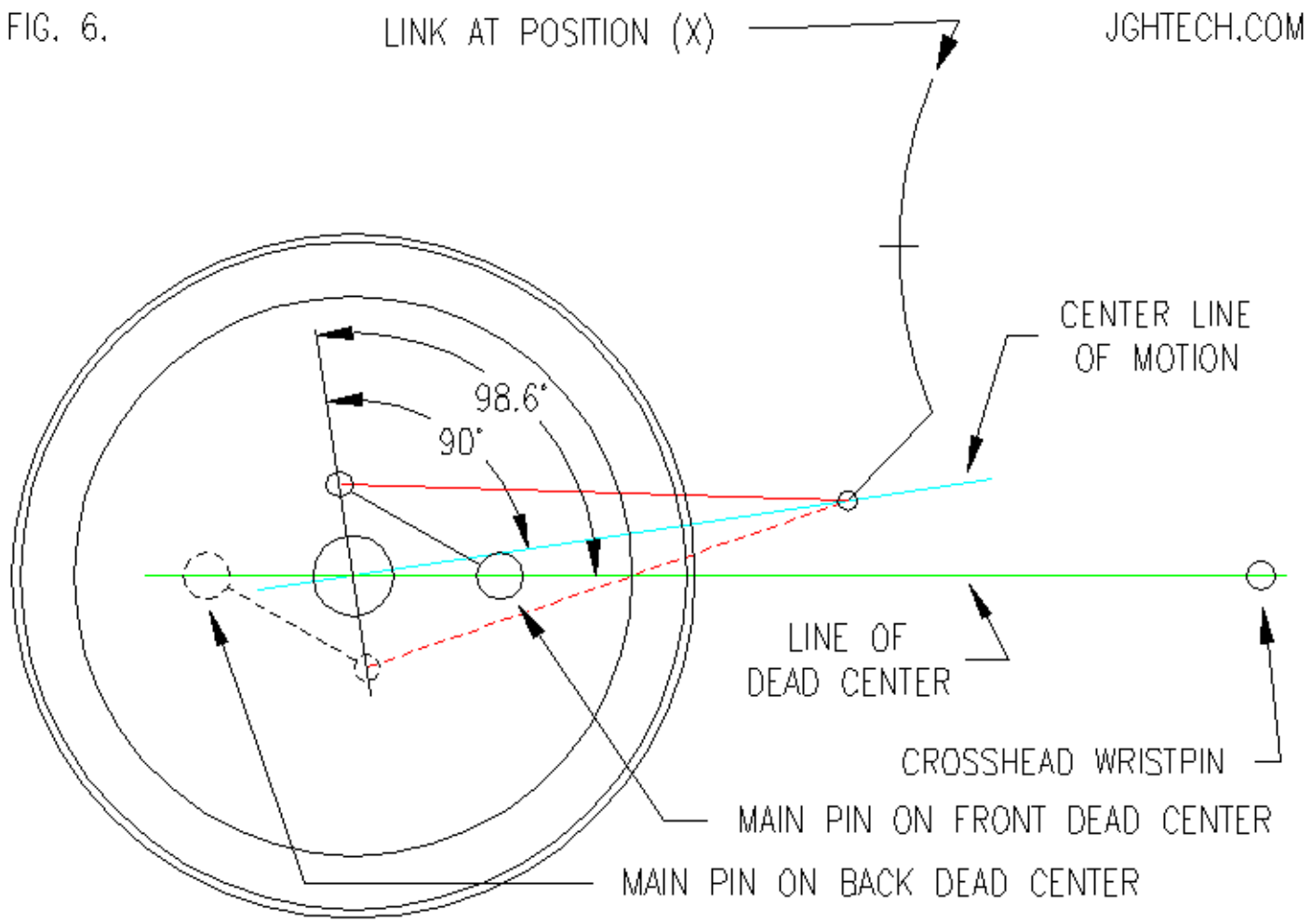


Figure 5. Main pin on top quarter and link at position (Z) the other point of maximum swing of the link.



Center Line of Motion.

In Figure 6 below, a blue line is drawn through the center of the axle and extends through the center of the link foot pin. This line is referred to as the center line of motion. The positions of the eccentric rod, eccentric crank pin and eccentric crank when the main pin is on the front dead center is illustrated by solid lines and circles. The positions of these same components when the main pin is on the back dead center is illustrated by dashed lines and circles. Note that when the main pin is on either the front or back dead centers the eccentric crank pin is 90 degrees from the center line of motion, and that the link is at position (X). These facts confirm that the reciprocating motion of the link will indeed be 90 degrees out of phase in relation to the main pin.



In Figure 6 above the eccentric crank pin is located 98.6 degrees counter clockwise from the main pin. This is due to the fact that the center line of motion is inclined above the line of dead center. A common misunderstanding is that the eccentric crank pin is always located 90 degrees from the main pin. This would only be true if the center line of motion coincided with the line of dead center. Generally the center line of motion of a Walschaert valve gear is inclined some amount above the line of dead center.

Initial Setting of the Eccentric Crank.

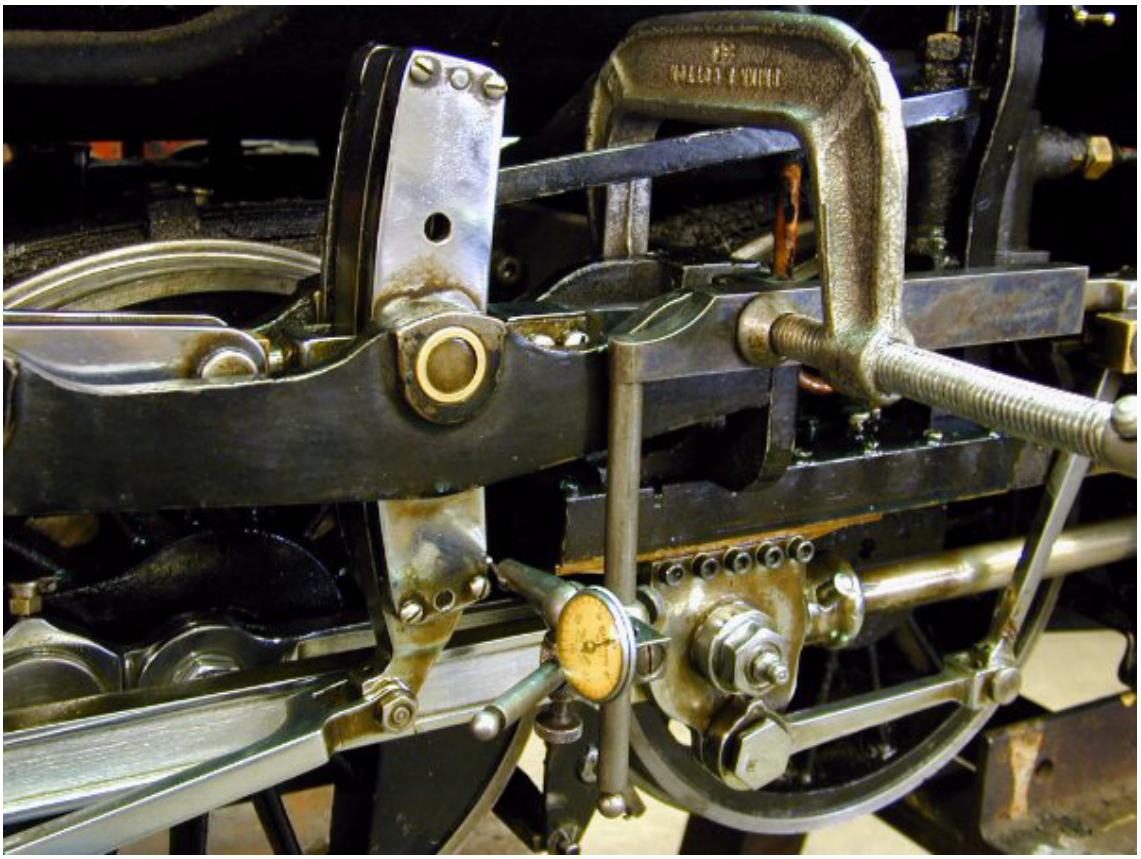
The location of the eccentric crank pin as illustrated on the locomotive construction drawings is used in making the initial setting of the eccentric crank. Due to the previously described possibility of variations in the finished dimensions of the components of the valve gear, a method must then be used which locates, or sets, the eccentric crank pin truly 90 degrees to the center line of motion.

Final Setting of the Eccentric Crank, Dial Indicator Method, Walschaert Valve Gear.

Following the principles illustrated in the previous figures, a dial indicator is attached to the locomotive in such a manner so as to indicate the position of the link when the main pin is placed on either dead center.

The radius rod should be elevated to such a position in the link that when the link is swung forward or backward there is no forward or backward motion imparted to the radius rod.

Image 3. View of dial indicator attached to the gear frame of a Walschaert valve gear.



After attaching the dial indicator to the locomotive and setting the elevation of the radius rod, the main wheel is turned one quarter turn in the direction to move the link away from contact with the dial indicator. The main wheel is then turned again in the direction to move the link toward contact with the dial indicator, and is carefully stopped when the main pin is on the dead center. The reading of the indicator is noted.

The main wheel is then turned in the direction to move the link away from contact with the dial indicator and is carefully stopped when the main pin is on the opposite dead center. The reading of the indicator is again noted.

If the two indicator readings are the same, then the eccentric crank is set correctly. If there is a difference in the two indicator readings, then the eccentric crank is carefully rotated in the appropriate direction on the main pin, and the test repeated. The procedure is continued until the dial indicator readings are the same when the main pin is placed on either dead center.

It is good practice to repeat the procedure a number of times to insure that the eccentric crank setting has been established correctly.

If the valve gear has been accurately designed, constructed and adjusted, when the main pin is placed on either dead center the link will be in such a position that when the radius rod is raised and lowered through the link there will be no forward or backward motion of the radius rod. If this is not the case, then the length of the eccentric rod, or other design elements, may not be correct.

Effects of Lost Motion.

The dial indicator method requires that the direction of rotation of the main wheel be reversed each time the main pin is moved from one dead center to the other. This causes the eccentric rod and link to move in the same direction each time the link is moved to contact the dial indicator. This action neutralizes the effect of lost motion present in the eccentric rod and link bearings. When rotating the main wheel care must be taken to avoid going beyond the dead centers and thereby moving the link beyond the range of the dial indicator and spoiling its setting. When making adjustments, and it is necessary to move the eccentric crank away from the link, consideration must be given to the presence of lost motion and its effect on the dial indicator reading.

Timing Relationship between the Baker Valve Gear Connecting Rod and the Main Pin.

The Baker valve gear shares many of the same operating principles as that of the Walschaert valve gear. The same eccentric crank, eccentric crank pin and eccentric rod mechanism, as used on the Walschaert valve gear, is also used to drive the forward and backward swing of the gear connecting rod of the Baker valve gear.

The most common design of Baker valve gear is that having constant lead. In such a design the timing relationship between the gear connecting rod and the main pin is correct when the gear connecting rod is moved to the identical point of the swing of the gear connecting rod when the main pin is on either the front or back dead centers.

Initial Setting of the Eccentric Crank.

The location of the eccentric crank pin as illustrated on the locomotive construction drawings is used in making the initial setting of the eccentric crank. Due to the previously described possibility of variations in the finished dimensions of the components of the valve gear, a method must then be used which locates, or sets, the eccentric crank pin truly 90 degrees to the center line of motion.

Final Setting of the Eccentric Crank, Dial Indicator Method, Baker Valve Gear.

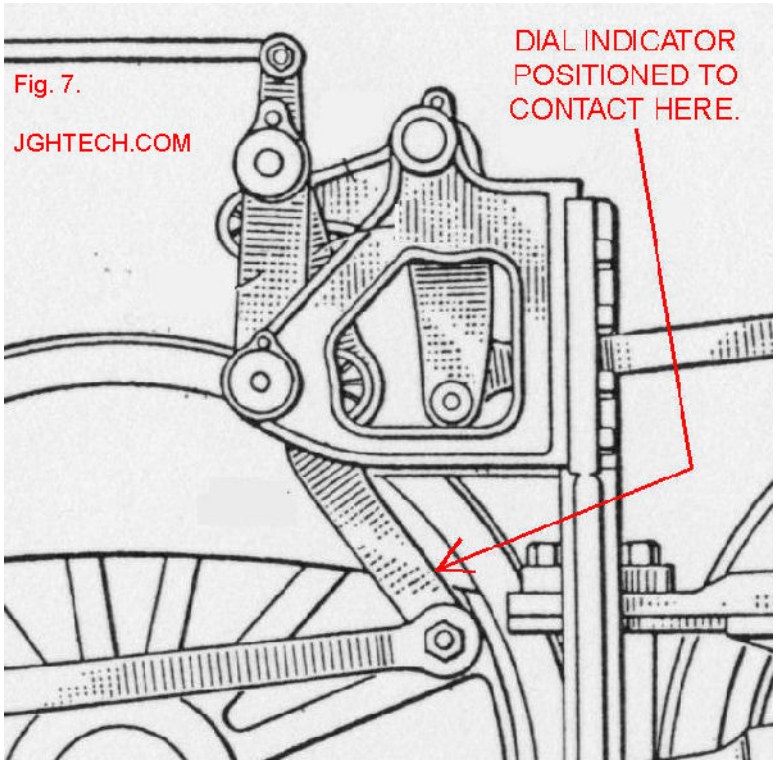
The dial indicator method of setting the eccentric crank may also be used for the Baker valve gear. In doing so the dial indicator is attached to the locomotive frame so as to contact a point near the lower end of the gear connecting rod when the main pin is on either the front or back dead center.

The reverse yoke should be placed in such a position that when the gear connecting rod is swung a few degrees forward and backward from the central position of its total swing there is no detectable motion imparted to the bell crank or valve rod. This will minimize the up and down motion of the gear connecting rod as it is swung forward and backward.

The final setting of the eccentric crank is then carried out in a similar manner as previously described for the Walschaert valve gear.

If the valve gear has been accurately designed, constructed and adjusted, when the main pin is placed on either dead center the gear connecting rod will be in such a position that when the reverse yoke is moved forward and backward a few degrees from its central position there will be no detectable forward or backward motion of the valve rod. If this is not the case, then the length of the eccentric rod, or other design elements, may not be correct.

Figure 7. Illustration of the general location at which dial indicator should contact the gear connecting rod of a Baker valve gear.



Note Regarding Baker Valve Gear.

If the Baker valve gear reverse yoke is placed in its central position and the gear connecting rod is swung to its extreme forward and backward positions of its motion, there will be a small amount of motion imparted to the bell crank and valve rod. This is due to intended design dimensional differences between components of the Baker valve gear. For this reason in the previously described manipulations of the reverse yoke or gear connecting rod, such manipulation is restricted to a few degrees either side of center of the total motion of the respective component.

Suggested Readings.

Williams, Frank, "Locomotive Valve Setting," International Text Book Co., Scranton, Pa., 1930.

Harding, J. W., "Locomotive Valves and Valve Gears," International Text Book Co., Scranton, Pa., 1937