WALSCHAERT'S MOTION GEAR:

By far the most widely employed valve gear used on our locomotives is the Walschaerts motion. Apart from the "J" and "Ja" class locomotives which are fitted with the Baker Valve gear and a few locomotives, notably the "F" and "H" class, which have the Stephenson Link motion, the balance of our locomotive power is fitted with Walschaerts motion.

Invented by Egide Walschaerts in 1844 and perfected by Heusinger von Waldegg in 1849, it gradually came into favour in Continental Europe during the latter half of the nineteenth century, and from about the year 1900 onwards has been increasingly adopted as standard in this country. Its principal advantages are:-

(a) Good steam distributing qualities.
(b) Simplicity, lightness, suitability for plain or piston valves having either inside or outside admission
(c) Easy operation, (the reversing gear having only to shift the comparatively light radius rods instead of the whole mass of the links and four eccentric rods of the Stephenson Link motion)
(d) Applicability to the best position for the valves, i.e. outside and above the cylinders and the centre lines of the valve spindle and piston rod parallel.

On page 55 of the Handbook of Instructions, for Enginedrivers, Firemen and Cleaners is a diagram of a very modern design of Walschaerts motion arranged for distribution steam by means of inside admission piston valves.

GENERAL DESCRIPTION:

The ordinary type of steam locomotive has two valve gears, or one for each valve, so connected as to be moved by one reverse lever. Each valve gear consists of the same parts, and, therefore, when identifying the parts, both gears do not have to be shown in the same view. However, it is necessary to show the two valve gears in order that students may understand how the movement of the reverse lever is transmitted to both. In fig.(1) (a), (b); and (c) attached to this lesson, are shown three side views of a complete single Walschaert valve gear when an inside-admission valve is used, and fig 2 is a partial view which shows how the connection is made between the gears on each side so that the movement of the reverse lever and the reach rod can be transmitted to both. Similar parts in all of the views have the same reference numbers.

NAMES OF PARTS

The names of the parts shown in fig. 1 are as follows:-

(1) the eccentric crank, (2) the eccentric rod, (3) the expansion link with the link foot (4) ; (5) the die-block; (6) figs.1 &2, the reverse shaft; (7) the reverse shaft crank with arms 7' and 8'; fig.2, the reverse shaft arm, (9) fig. 1, the radius rod; (10) the radius rod hanger or lifting links: (11) the lap and lead rod; (12) the union link, (13) the valve stem: (14) the valve stem crosshead guide. (15) the valve stem crosshead; (16) the gear frame or expansion link support (17) the reach rod; (18) the counter balance spring and casing. The valve gear is shown in fowward gear in fig. 1 (a), in mid-gear in (b) and in backward gear in (c).

GENERAL ARRANGEMENT OF PARTS:

The general arrangements of the parts of the Walschaert valve gear will be explained by referring to fig.1. A detailed explanation of the arrangement and construction at the different points in the gear will be given at a later stage of this lesson.

The eccentric crank (1) is placed on the end of the main crank-pin (a), the bolt (b), which passes through the eccentric crank, and a circular slot in the side of the crankpin, which keeps the crank from coming off the pin, and the key (c), which prevents the crank from turning on the pin. The rear end of the eccentric rod is placed on a pin in the eccentric crank which is usually made in one piece with the crank and stands at right angles to it. The front end of the eccentric rod is forked and is connected to the expansion link foot (4) by the pin (d). The gear frame (16) is here shown as being made in one piece with the guide yoke (5), but it is usually made separately. The guide yoke is bolted to the end of a cross-tie (e) which extends across the frames to the other side and serves as a support for the other combined yoke and gear frame. A bracket or knee is bolted to each frame at the point where the cross-tie crosses it and the cross-tie is bolted to this bracket. The expansion link (3) is carried in the gear frame on the link trunnions (f), (one on each side). The radius rod (9) is forked where it passes through the expansion link, and the die-block (5) sits between the forks and is held in the rod by the die-block pin (g). The die-block(5) which moves in a slit in the expansion link, shown by dash lines, when the radius rod is raised and lowered, is used to transmit the backward and forward movement of the expansion link to the radius rod. The rear end of the radius rod swings in the lifting links or radius rod hanger(10), which is connected at the upper end to the arm (8) of the reverse shaft crank, while the front end of the rod is connected by the pin, (11) to the top of the lap and lead rod (11). The connection between the valve-stem crosshead (15) and the lap and lead rod, is made by the pin (j), and the lower end of the lap and lead rod is connected to the union link (12) by the pin (k). The back end of the union link works freely on the outer end of the wrist pin (1) The valve-stem crosshead guide (14) is cast in one piece with the back valve chamber head and the valve-stem (13) is connected to the crosshead (15) by a key not shown in the sketches. The end of the reach rod (17) is forked and is connected to the arm of the reverse shaft crank (7) by a pin (n).

The valve gear on each side of the locomotive is connected by the reverse shaft (6), fig.2., which turns in boxes (d) on the gear frames when the reverse lever is moved. The reverse-shaft crank (7),made in one piece, is keyed or bolted to one end of the reverse shaft and the reverse shaft arm (8) to the other end. The two reverse shaft arms are connected by the radius rod hangers or lifting links to the radius rods; hence when the reverse lever is moved, the reach rod, through its connection with the reverse shaft crank, turns the reverse shaft, and, depending on the direction of movement, raises or lowers the arms, (8)and the radius rods (9). The combined guide yoke and gear frame bolts at the points (m) to the rectangular plate or casting (e), fig. 1, which extends across and is connected to the frames by brackets. Strictly speaking, the casting, (e) is the guide yoke, and the part (16) is the gear frame and guide-yoke end. The purpose of the counter balance spring, which is connected to the reverse shaft by an arm and a rod, is to make it easier to move the reverse lever against the weight and friction of the valve gear The spring is compressed when the radius rods are lowered to the bottom of the expansion links, hence the expansion of the springs helps to lift the rods to the top of the expansion links as shown in the view (a) of fig.1.

A complete locomotive valve gear (by which is meant the two gears, a part of which is shown in fig.2) may be considered as made up of two parts. One part is directly concerned with valve movement, and is in operation when the locomotive is in motion, while the other part is used to transmit movement to the first part through the reverse lever. The eccentric cranks, the eccentric rods, the expansion links,and the die-blocks,the radius rods and the lap and lead rods, there being two of each of the above, are the parts of the gear which have to do with moving the valves. The other part of the gear comprises the two radius rod hangers (or lifting links), the reverse shaft crank, the reverse shaft arm and the reverse shaft.

These parts are used to transmit the movement of the reverse lever equally to the valve gear on each side of the locomotive.

GENERAL OPERATION:

MOVEMENT IMPARTED BY THE REVERSE LEVER:

Any movement of the reverse lever, changes the position of the die-blocks and radius rods in the expansion links. The action which occurs is as follows:-

In fig. 1 (b) and 2, when the reverse lever and reach rod are moved forwards, the reverse-shaft crank arm moves in the same direction and thus turns the reverse shaft. The reverse shaft arms, fig.2., move upwards, and the lifting links or radius rod hangers, the radius rods,&the die-blocks are raised to the position shown in fig.1 (a). Therefore in this case, the die blocks are in the upper half of the expansion links, in forward gear. When the reverse lever is moved from the front to the back corner of the quadrant, the reverse shaft crank turns the reverse shaft and the downward movement of the reverse shaft arms, lowers the lifting links, the radius rods and the die-blocks to the lower half of the expansion links. The extent of the valve movement when the reverse lever is moved depends on the position of the main crankpins. With the main crank pin (a) fig. 1 on the bottom quarter, moving the reverse lever from the front to the back corner of the quadrant causes the valve to close the front steam port and open the back steam port.

The cut-off is longest with the die-blocks in the ends of the expansion links and decreases as the die-blocks are brought nearer to the centre of the expansion links. With the dieblocks in the centre of the expansion links, the port opening obtained with the locomotive on the dead centres is equal to the lead. The valve begins to close the port as soon as the maincrank pin leaves the dead centre.

GENERAL OPERATION OF THE GEAR:

The general operation of the gear is as follows:- When the locomotive is in motion, the rotation of the main crank pin imparts a circular movement to the eccentric crank and the back end of the eccentric rod and a vibratory movement in an arc to the front end of the rod. This causes the expansion link to swing backwards and forwards in the gear frame on the link trunnions and thereby transmit a back and forth movement to the radius rod, the back of end of which swings in an arc on the bottom of the radius rod hanger. The movement of the radius rod merges with that of the lap and lead rod before it is transmitted to the valve steam and valve. The bottom end of the lap and lead rod has a backward and forward movement, in an arc, and this, when transmitted to the top of the lever in combination with the action of the radius rod at this point, imparts the required movement to the valve to keep the locomotive in operation. The lap and lead rod acts on the valve in opposition to the crank when passing dead centres.

LOCATION OF RADIUS ROD CONNECTION WITH OUTSIDE AND INSIDE ADMISSION VALVES:

The radius rod is not connected to the lap and lead rod at the same point with an outside admission valve as with an inside admission valve. With an outside admission valve, the radius rod is connected to the lap and lead rod between the ends, and with an inside admission valve, the connection is made at the upper end of the lap and lead rod.

The reason is that an outside admission valve, during the lap and lead movement, moves in the direction opposite to the piston, while an inside admission valve moves in the same direction; Therefore, the radius rod connection, which acts as a fulcrum, must be located accordingly.

The lap and lead movement refers to the movement of the valve from the lead opening at one port to the lead opening at the other port. When the piston moves from the front to the back end of the cylinder, the movement of the valve has to be forward or in a direction opposite to that of the piston in order to close the front steam port, and to open the back port the amount of the lead. Therefore, the fulcrum of the lap and lead must be between the ends so as to cause the movement at the bottom of the lever to be converted into a movement in the reverse direction at the top.

WITH AN INSIDE ADMISSION VALVE and the piston making the same movement, the whole movement of the valve, in order to close the front steam port and open the back port the amount of the lead, must be backwards or in the same direction as the piston. Therefore, the radius rod connection or the fulcrum point of the lap and lead rod must be located so as to cause the valve to move in the same direction as the piston and this in consequence requires that the fulcrum be located at the upper end of the lever. It is thus possible to tell whether a locomotive has an inside or outside admission valve by observing where the radius rod is connected to the lap and lead rod. If it is between the ends, the valve is OUTSIDE ADMISSION; if at the end, the valve is INSIDE ADMISSION.

DIFFERENT ARRANGEMENTS OF GEAR:

There is very little difference in the arrangement of the Stephenson valve gear as applied to locomotives of different types This does not apply to the Walschaert gear, as at certain points the design of the valve gear is influenced by the type and construction of the locomotive. The principal variations in the gear arrangement are found in the type of gear frame used to support the expansion link, in the method of carrying the rear end of the radius rod, and in the arrangement of the arms of the reverse shaft crank.

TYPES OF GEAR FRAMES:

Reason for different types:-

The type of gear frame depends on the location of the guide yoke, for the reason that the complete gear frame, or at least one end of it, is always connected to the yoke. The location of the guide yoke varies because it has to be connected to the main frame of the locomotive, and thus must be placed at a point where the frame can be reached without interference from the driving wheel, and this in consequence, fixes its position either in front or back of the leading driving wheels.

When a locomotive has a two-wheel leading bogie, the leading driving wheel is so close to the cylinder that the guide yoke has to be placed at the extreme end of the guide bars in order to clear the wheel and connect to the frame. In this case the type of gear frame shown in fig.1 is generally used because the guide yoke is far enough from the steam chest to permit of a proper design of the parts of the gear forward of the yoke.

When a locomotive has a four-wheel leading bogie, the trailing bogie wheel is almost entirely behind the cylinder, and this brings the leading driving wheel between the rear of the guide bars and the main frame. For this reason the guide yoke has to be placed ahead of the leading driving wheel and quite close to the steam chest in order to connect to the frame. In this event the type of gear frame shwon in fig.1 cannot be used because the frame is too close to the steam chest to permit of the valve gear being properly designed. To bring the expansion link about the same distance from the steam chest as before and thereby proportion properly the valve gear, the type of gear frame shown on page 55 of the handbook of Instructions for Enginedrivers Firemen and Cleaners is used.

TYPES OF RADIUS ROD HANGERS:

There are two general ways of connecting the back end of the radius rod to the reverse shaft crank. The drawing of the Ab.class locomotive clearly shows the arrangement which is mostly used on our locomotives. The lifting links connect the arms on the weighbar shaft with the radius rods on each side of the locomotive, and serve to lift the radius rod and the die-block from the full forward position at the bottom of the expansion link to the full back gear position at the top of the expansion link. The reverse shaft has a balance weight attached to each side of the motion to assist in reversing from forward to back gear. This system of reversing varies from the system shown on fig. 1 of the attached lesson, where (18) shows the use of a counter balance spring.

The diagram shown in the special Instructions on page 55, shows the second type which is principally used on the "K" class locomotives. In the latter drawing, the radius rod slides in a block pivoted between the arm of the reversing shaft. The lifting link arrangement is in more general use, however, on our locomotive.

DIRECT AND INDIRECT MOTION:

The motion of a valve gear is said to be DIRECT when the eccentric rod moves in the same general direction as the valve. The motion is INDIRECT when these parts move in opposite directions. The Walschaert valve gear is direct with the locomotive moving forward with the die-block in the lower half o f the expansion link because the movement of the eccentric rod can then be delivered directly to the radius rod and the valve. The gear is indirect with the die-block in the upper half of the expansion link, because, asthe expansion link is pivoted at the middle, the movement of the eccentric rod is necessarily in a direction. opposite to that of the upper end of the expansion link and the radius rod.

The Stephenson valve gear is either direct or indirect in both gears, but with a gear like the Walschaert with the link swinging on a pivot, the movement if direct in forward gear, must be indirect in backward gear.

INSIDE ADMISSION VALVE AND DIRECT MOTION:

With an inside admission valve and direct motion, the eccentric crank is set exactly in the same position as with an outside admission valve and indirect motion in that the centre of the eccentric crank is either about one-quarter turn behind the maincrank pin or about the same amount ahead of it, and the difference between the positions is about one-half a turn of the crankpin.

WALSCHAERT VALVE GEAR:

THE GEAR FRAME:

The purpose of the gear frame is to carry or support the link and one end of the reverse shaft. The gear frame is sometimes called the Link Support.

CROSS-TIES AND GUIDE YOKES

The purpose of the cross-ties and guide yokes is to connect the gear frames of the locomotive. They also serve as frame braces and as a means of connecting the boiler to the frames.

ECCENTRIC CRANK:

The purpose of the eccentric crank is to give the valve, with the locomotive in full gear, a movement equal to the specified valve travel. It also serves as a collar to hold the connecting-rod on the main crank-pin. The eccentric crank consists of a short arm rigidly secured to the outer end of the main crank pin from which it obtains its

movement. It is set in such a position that the end moves in a path having a diameter smaller than that of the main pin. Due largely to the fact that the swing of the link is much less than the swing of the link foot, the eccentric crank has to be designed with a throw greater even than the total valve travel, so as to obtain, with the locomotive in full gear, the valve travel specified in the design.

ECCENTRIC ROD:

The purpose of the eccentric rod is to transmit the movement of the eccentric to the expansion link.

THE EXPANSION LINK

The purpose of theexpansion link is to transmit the movement of the eccentric crank and the eccentric rod to the radius rod. It also permits the locomotive to be reversed and the cut-off changed.

THE RADIUS ROD:

The purpose of the radius rod is to transmit the movement of the expansion link to a point on the combination lever, or lap and lead rod as it is generally called. The radius rod may be in one or two pieces, depending on how it is carried at the rear end, but the one-piece construction is the more generally used on our locomotives. The "K" type of locomotive may be cited as an exception.

LAP AND LEAD ROD:

The lap and lead rod serves the same purpose as a crank set 90 degrees from the eccentric crank and with a throw equal to the lap and lead.

UNION LINK:

The purpose of the union link is to transmit the movement of the crosshead to the lower end of the lap and lead rod. The union link is always forked at the FRONT END and may or may not be forked at the back end, depending on whether it is connected to an arm on the crosshead or the little end pin, as illustrated in the diagram on page 55 of the Handbook of Instructions for Enginedrivers, Firemen and Cleaners.

THE LIFTING LINKS:

The purpose of the lifting links is to raise or lower the radius rod and die-block. The lower end of the lifting links are connected to the radius rod by a pin which passes through the forked slot of the radius rod, and the upper end to the reverse-shaft crank, or to the reverse shaft arm, depending on the side of the locomotive it is fitted.

REVERSE-SHAFT CRANK AND REVERSE-SHAFT ARM:

The purpose of the reverse-shaft crank is to transmit the movement of the reach rod to the reverse shaft and to the lifting links on the right side of the locomotive. The purpose of the reverse-shaft arm is to transmit the movement of the reverse-shaft to the lifting links on the left side of the locomotive

REVERSE SHAFT:

The purpose of the reverse shaft is to transmit the movement of the reverse lever to the valve gear on the opposite side of the locomotive.

LOCOMOTIVE CORRESPONDENCE COURSE : FIREMENT AND ENGINEDRIVERS

LESSON No. 5 - LIST OF QUESTIONS.

1. Name the advantages of the Walschaert Motion.

2. At what point is the radius rod connected to the lap and lead rod (a) with an outside admission valve (b) with an inside admission valve.?

3. What is the position of the eccentric crank with an inside admission valve and direct motion?

4. Define DIRECT and INDIRECT motion.

5. What two general methods are used to connect the radius rod to the reverse shaft crank?

6. On what does the type of gear frame used on a locomotive depend?

7. Name the principal parts of the Walschaert valve gear.

8. In what position of the reverse lever is the eccentric crank prevented from imparting movement to the valve?

9. What is the purpose of the eccentric crank?

10. What is the purpose of the radius rod?

11. What is the purpose of the lifting links?

12. Give a brief description of the operation of the Walschaert valve motion.

13. Describe the procedure for despatching a train from an Unattended Crossing station.

14. When may shunting be carried out on the main line in Automatic Signalling areas?

15. What is the procedure to be followed if the pilot key is lost?

16. When a locomotive or train is disabled in a siding between two tablet stations, and the main line is unobstructed, what procedure must be adopted to enable traffic to be worked through the section?

17. If the locomotive of a non-stop train failed to pick up the tablet for the sectionahead, what procedure would you adopt?

18. If a train is assisted by a locomotive in the rear and the train locomotive becomes disabled so that it cannot be moved forward, what should be done to clear the section?

19. Describe a calling-on Signal, its indications and where placed

20 What are Diverging Junction and Directing Signals, and what is their purpose?

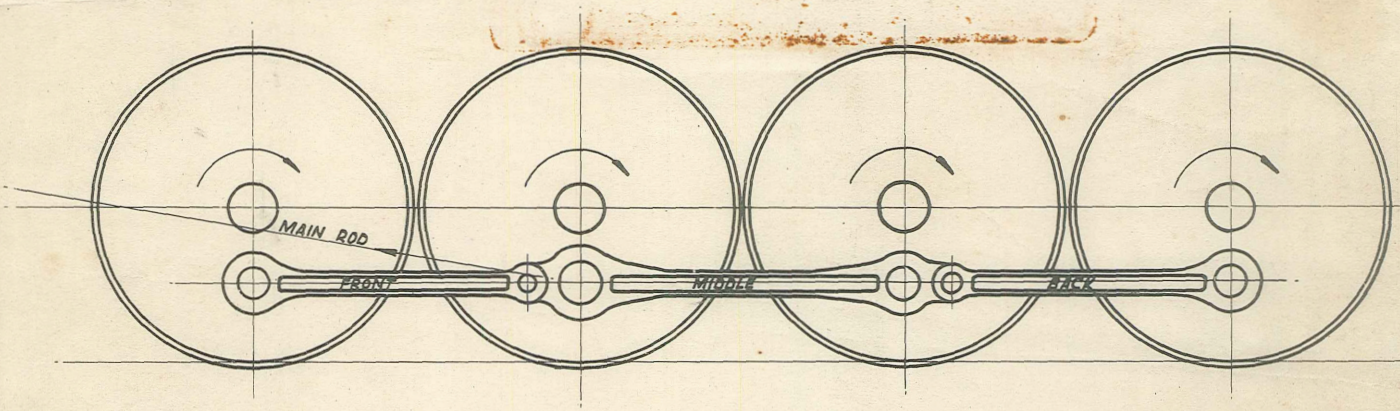

FIG. 1

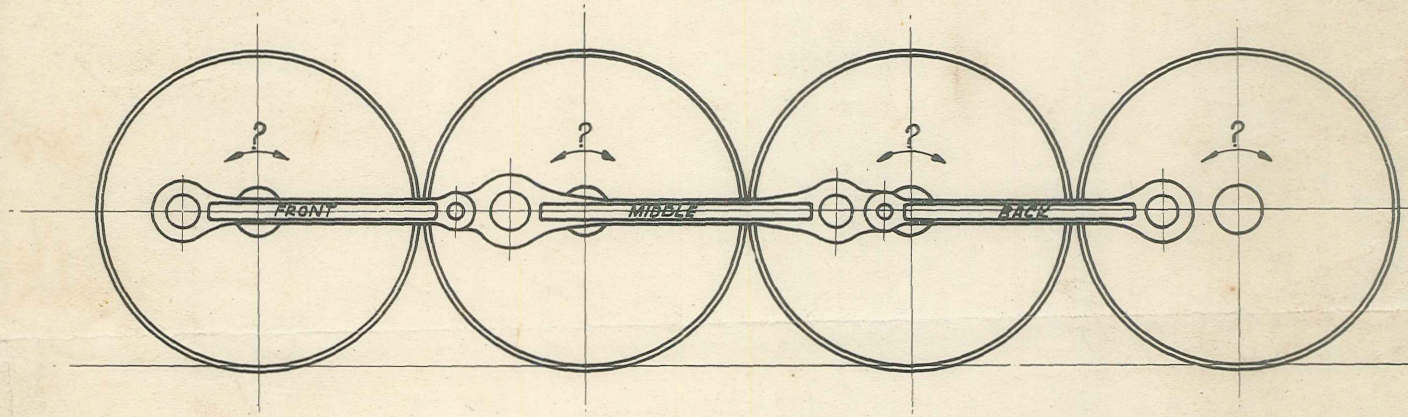

FIG. 2

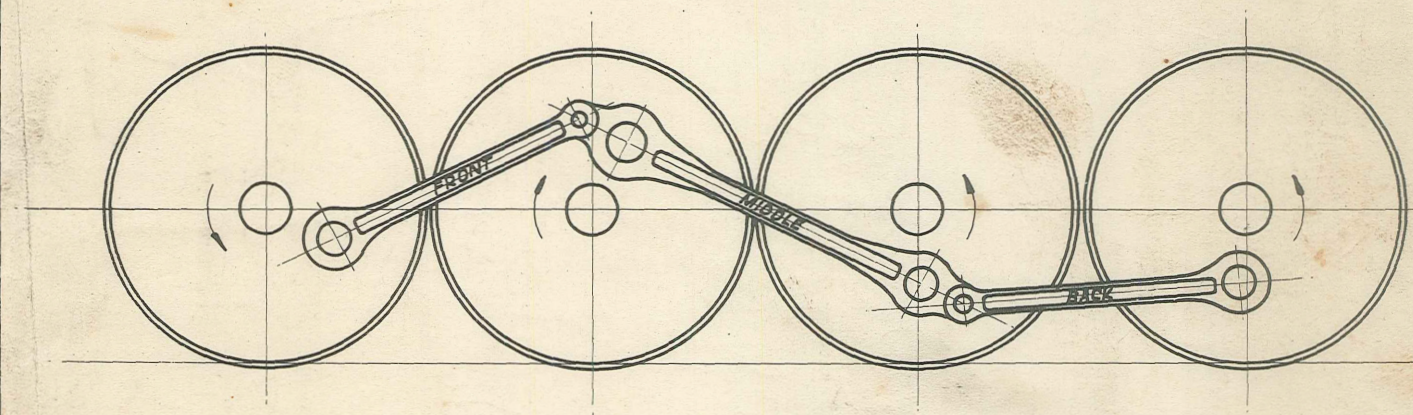

FIG. 3

POSSIBLE ACTION OF SIDE RODS WITH OTHER SIDE DISCONNECTED