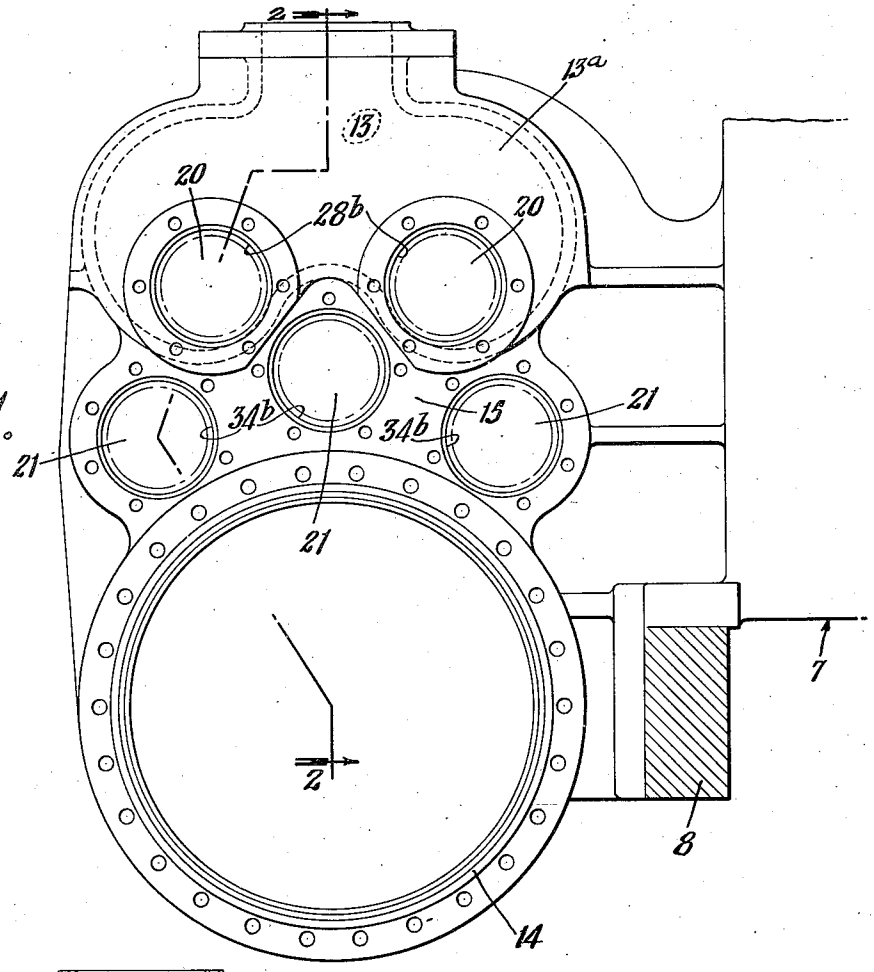
June 11, 1946. J. KIRCHHOF 2,401,764

POPPET VALVE LOCOMOTIVE

Filed Feb. 15, 1945 4 Sheets-Sheet 1

Fig:1.



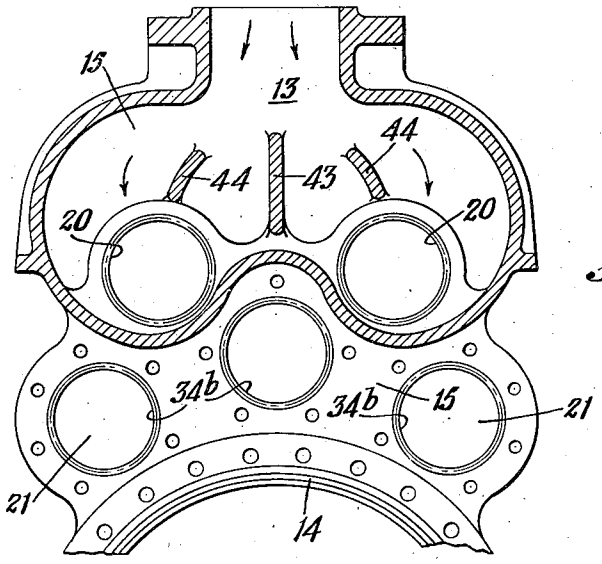


Fig:4.

INVENTOR
JULIUS KIRCHHOF
BY
Symmes & Lechner
ATTORNEYS

June 11, 1946. J. KIRCHHOF 2,401,764

POPPET VALVE LOCOMOTIVE

Filed Feb. 15, 1945 4 Sheets-Sheet 2

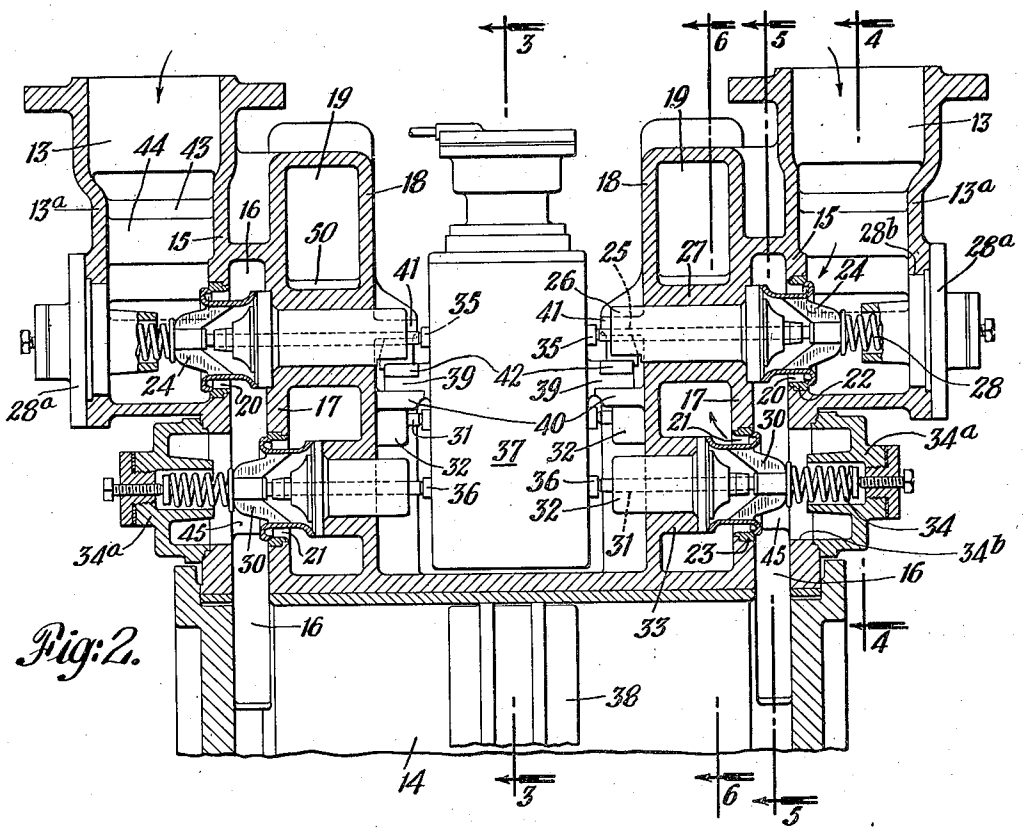


Fig: 2.

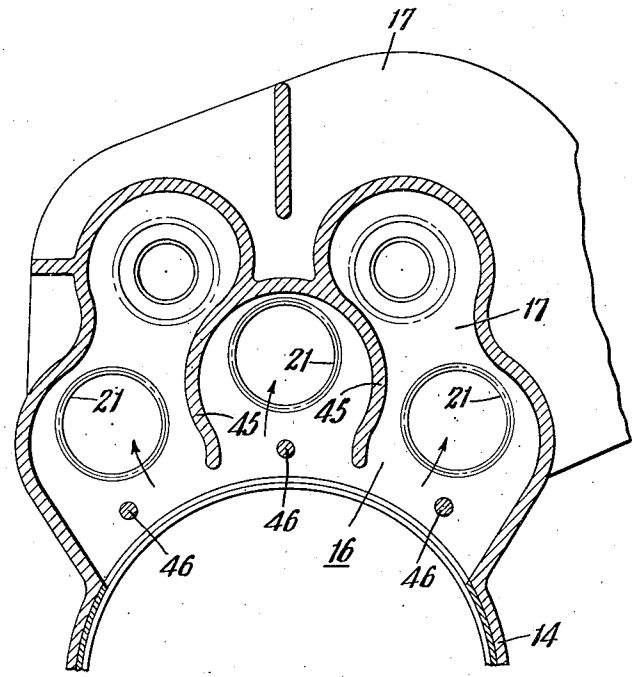


Fig: 5.

INVENTOR
JULIUS KIRCHHOF
BY
Synnestvedt & Lechner
ATTORNEYS

June 11, 1946. J. KIRCHHOF 2,401,764

POPPET VALVE LOCOMOTIVE

Filed Feb. 15, 1945 4 Sheets-Sheet 3

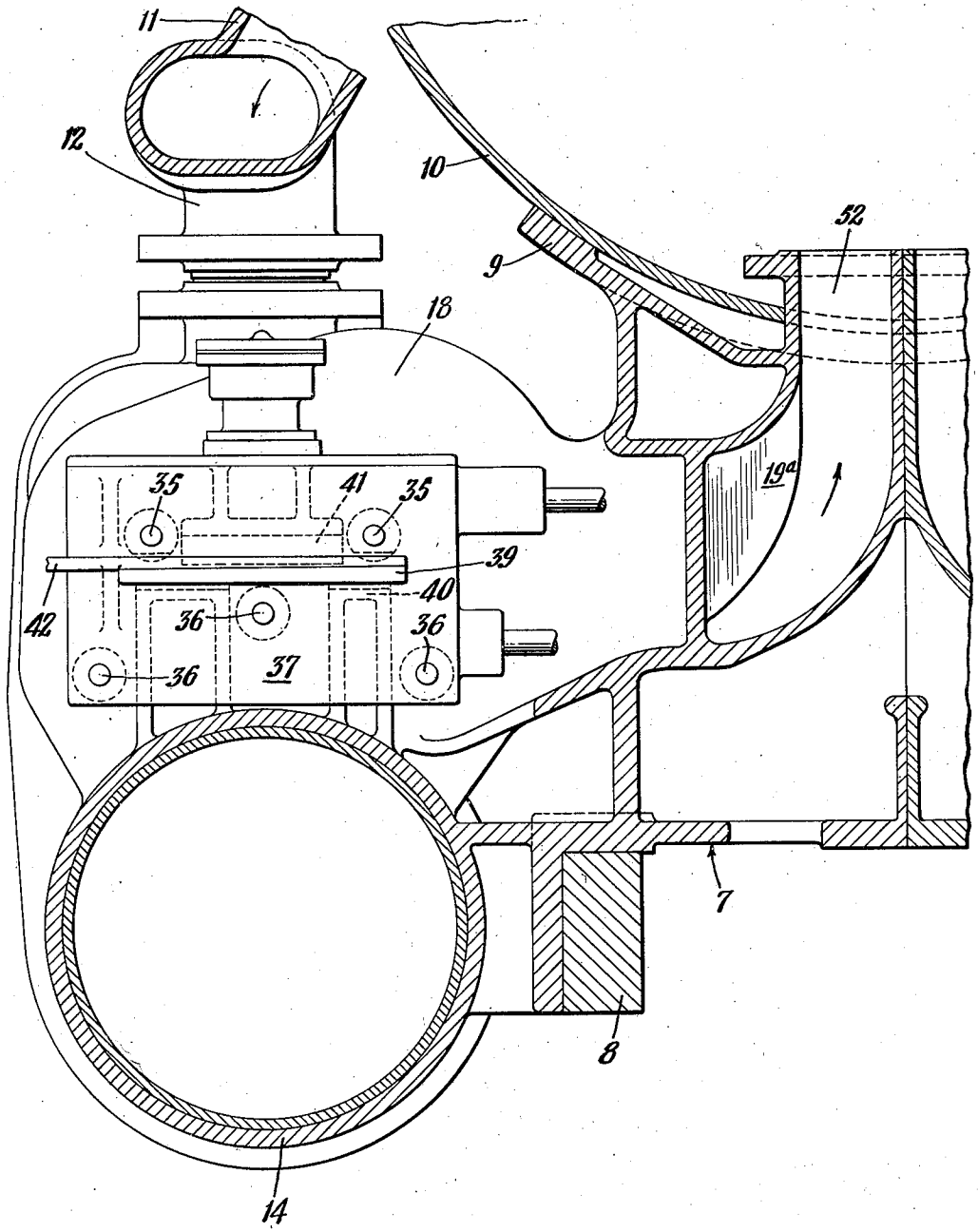


Fig: 3.

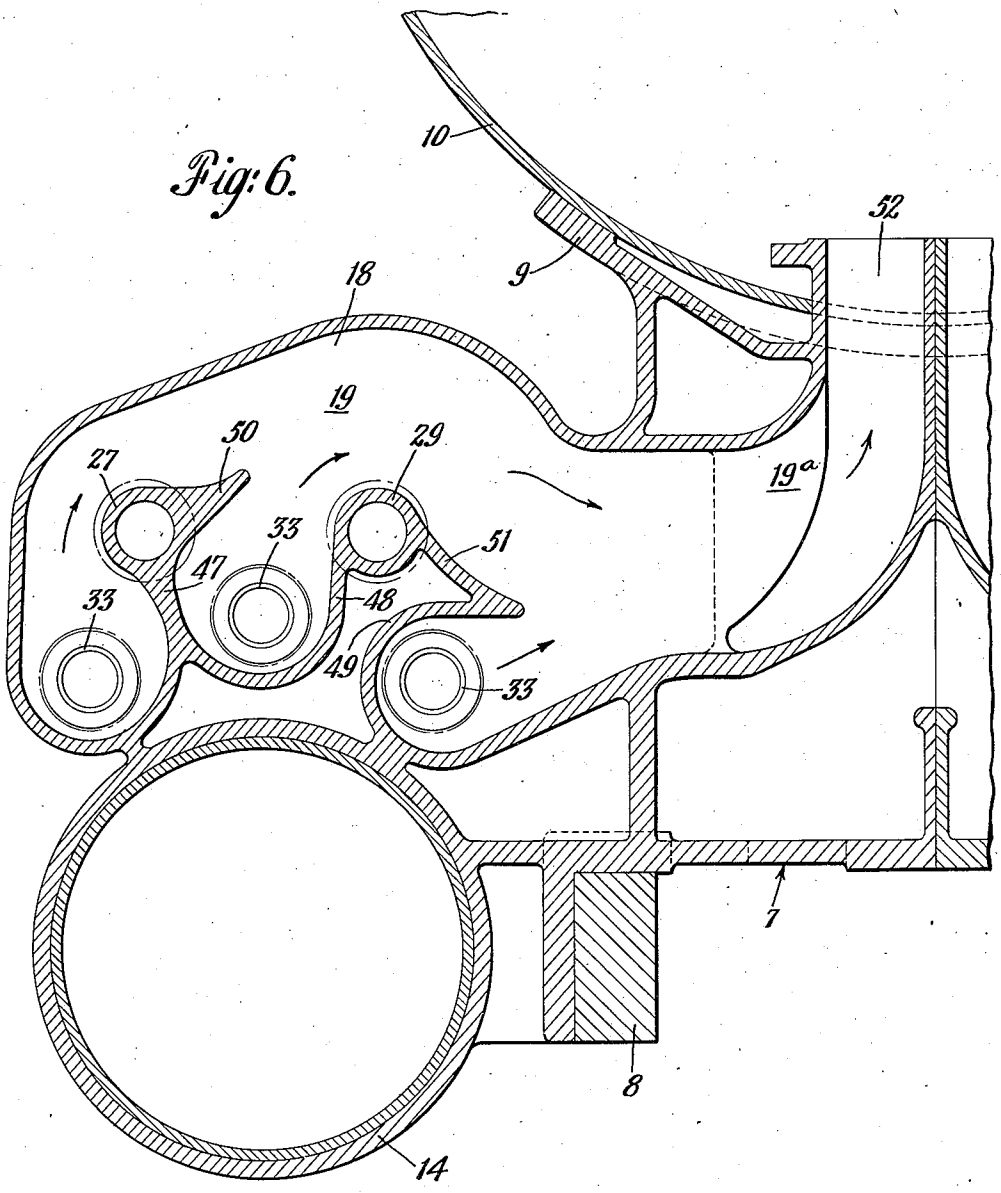
INVENTOR
JULIUS KIRCHHOF
BY
Synnestvedt & Lechner
ATTORNEYS

June 11, 1946. J. KIRCHHOF 2,401,764

POPPET VALVE LOCOMOTIVE

Filed Feb. 15, 1945 4 Sheets-Sheet 4

Fig: 6.



INVENTOR
JULIUS KIRCHHOF
BY
ATTORNEYS

Patented June 11, 1946 2,401,764

UNITED STATES PATENT OFFICE

2,401,764

POPPET VALVE LOCOMOTIVE

Julius Kirchhof, Ruxton, Md., assignor to Franklin Railway Supply Company, Inc., New York, N. Y., a corporation of New York

Application February 15, 1945, Serial No. 578,105

15 Claims. (Cl. 121—127)

1

This invention relates to poppet valve locomotives and is particularly concerned with a novel poppet valve arrangement and cooperating cylinder and saddle structure, especially adapted for use in large size locomotive engines.

One of the primary objects of the invention is to enable employment of relatively small diameter poppet valves, both for intake and exhaust, there being a plurality of valves of both types grouped in a special arrangement in a manner to maintain the cylinder port clearance volume at a minimum.

In poppet valve locomotive engines, especially of relatively large size, the cylinder port walls, because of their rather extended area, have been subject to warpage, as a result of thermal changes, etc. Any such warpage is likely to be reflected in distortion of the valve seats and the detrimental effect of such distortion is, in general, more serious with large diameter poppet valves than with small diameter valves. The employment of multiple small diameter valves, according to the invention, is therefore of advantage in overcoming difficulties due to valve seat distortion.

According to a further feature of the invention, the valve arrangement for each end of each cylinder is so laid out that all the valves for admission and exhaust may be made of one size and one pattern. By using two identical admission valves and three identical exhaust valves, and disposing them in the relationship hereinafter set forth, the total flow area most desirable for admission and the total flow area most desirable for exhaust, is secured.

Beyond the foregoing the invention contemplates employment of specially arranged webbing interbracing the cylinder port walls in a manner to reduce wall warpage, and to strengthen the port walls against the steam pressure. The relative disposition of the webbing and of the multiple intake and multiple exhaust valve apertures in the cylinder port walls further contributes to reduction in warpage and the consequent undesired valve seat distortion.

Still further, according to the invention, specially arranged webbing is provided between one of the cylinder port walls and another spaced wall serving to define a live steam chest at one side of the port; the other cylinder port wall being interbraced with another spaced wall serving to define the exhaust steam passage at the other side of the cylinder port. All of the bracing and interbracing webbings for the port walls

2

are relatively arranged to contribute maximum interbracing effect, as will further appear.

According to still another feature of the invention, various of the interbracing webbings are also so disposed as to serve the further function of steam flow baffles or guides preventing choking of one valve by steam flow to or from another valve or valves.

How the foregoing, together with other objects and advantages, are attained will appear more fully from the following description referring to the accompanying drawings in which—

Figure 1 is a front elevational view of the right-hand cylinder and a portion of the associated saddle structure of a 2-cylinder locomotive engine embodying features of the invention, with the valve assemblies and cylinder head removed;

Figure 2 is a longitudinal substantially vertical sectional view taken as indicated by the irregular section line 2—2 on Figure 1, this view showing in section certain of the parts of the outermost intake and exhaust valves and the cooperating poppet valve actuating mechanism in elevation;

Figure 3 is a transverse vertical sectional view taken through the cylinder and saddle structure as indicated by the section line 3—3 on Figure 2, but showing the valve actuating mechanism in elevation;

Figure 4 is a transverse sectional view taken through the live steam chest substantially as indicated by the section line 4—4 on Figure 2, but omitting the valve assemblies;

Figure 5 is a transverse sectional view taken through the cylinder port as indicated by the section line 5—5 on Figure 2, this view also omitting the valve assemblies; and

Figure 6 is a transverse sectional view taken through the exhaust steam passage, as indicated by the section line 6—6 on Figure 2.

The cylinder and saddle structure may appropriately be cast, for example in two halves for a 2-cylinder engine as here shown, one such half being indicated generally in the drawings by the reference character 7. The casting is adapted to be supported on portions of the main frame members, one of which appears at 8. Toward its upper central portion, the casting is provided with pads such as indicated at 9 to cooperate with the smokebox shell 10 of the locomotive, into which the exhaust steam from the cylinders is delivered, as will further appear.

Live steam from the boiler is supplied through the steam pipe 11 (see Figure 3) having branches

extended fore and aft, one being shown at 12. The branches 12 extend to the steam chests 13—13 adjacent the head and rear end of the cylinder 14. Since the steam passages and valves at the two ends of the cylinder are counterparts of each other only one need be described.

Steam chest 13 is in large part defined by an outer wall 13a and one of the cylinder port walls 15 (Figures 1, 2 and 4). The cylinder port 16 is bounded at the other side by another port wall 17, the two walls 15 and 17 being in spaced substantially parallel relation and of adequate area to provide room for the valve apertures. At the side of wall 17 opposite to the cylinder port, there is another spaced parallel wall 18 cooperating with the port wall 17 to provide an exhaust steam passage 19.

The pattern or arrangement of the valve apertures is best shown in Figures 1, 4 and 5. As there seen, there are a pair of intake valve apertures 20 and a group of three exhaust valve apertures 21, the intake and exhaust valve apertures being formed, respectively, in the port walls 15 and 17. Thus, the apertures 20 provide communication between the steam chest 13 and the cylinder port 16 and the apertures 21 provide communication between the cylinder port and the exhaust steam passage 19.

The axes of the exhaust valve apertures 21 lie in angularly spaced radial planes containing the axis of the cylinder, the three exhaust valve apertures being arcuately disposed about the upper portion of the circumference of the cylinder. The axes of the intake valve apertures 20 are similarly arranged in angularly spaced radial planes containing the cylinder axis, the planes of the two sets of valves preferably being in interleaving or alternating relationship as clearly appears from the drawings.

Each valve aperture is provided with an appropriate seat, such as indicated at 22 and 23 in Figure 2. An appropriate intake poppet valve is shown at 24 in Figure 2, this valve having a stem 25 mounted in a guide 26 which guide, in turn, is received in the bore of a sleeve 27 (see Figures 2 and 6), interconnecting the two walls 17 and 18 which define the exhaust steam passage 19. The head of the guide 26 provides a seat for the second seating edge of the double-beat valve 24. A spring 28 normally urges the valve 24 toward its seat, this spring reacting against a cap member 28a which is seated on a shoulder surrounding an aperture 28b formed in the outer wall 13a of the steam chest. A similar intake valve is arranged in the other intake valve aperture 20, the valve stem guide for this valve being received in the bore provided in the sleeve 29 (see Figure 6).

One of the exhaust valves appears in Figure 2 at 30, this valve having a stem 31 received in the guide 32, which guide 32 is mounted in a sleeve 33 (see Figures 2 and 6). The head of the guide 32 provides a seat for the second seating edge of the double-beat valve 30. Closure spring 34 normally urges the exhaust valve 30 toward its seat. The spring 34 reacts against a cap member 34a which is seated on a shoulder surrounding an aperture 34b formed in the port wall 15. Similar parts are provided for the other exhaust valves.

The stems 25 and 31 of all of the valves project inwardly for cooperation with intake and exhaust valve tappets 35 and 36 which project laterally from the valve actuating mechanism 37, which desirably takes the form of a cam mechanism appropriately driven in timed relation with movements of the piston 38 in the cylinder 14.

Since the cam mechanism for actuating the valves forms no part of the present invention per se, it is not herein illustrated or described. It may be noted, however, that the cam box 37 is adapted to be mounted on the cylinder, as by means of flanges 39 which cooperate with mounting ledges 40 and 41, projecting from the inner exhaust steam passage walls 18. An appropriate means, such as a wedge 42 may be employed to securely fasten the cam actuating mechanism in proper position.

In describing the bracing webbing provided for the cylinder port walls 15 and 17, attention is first directed to Figures 2 and 4 showing a central bracing web 43 and a pair of additional webs 44—44 which are positioned in the steam chest 13 and interbrace the port wall 15 with the outer steam chest wall 13a. From Figure 4 it will be noted that the web 43 lies in a substantially vertical plane intermediate the two intake valve apertures 20—20, this plane being that in which the axis of the central exhaust valve is positioned. The web 43 aids in dividing the flow of steam entering the steam chest and in delivering the steam uniformly to the two intake valves. Webs 44—44 are angled so as not to interfere with steam flow to the intake valves.

It will be noted that the webs 43 and 44 provide bracing for the port wall 15 in its upper region, as well as for the wall 13a.

Turning now to Figure 5, it will be seen that webbing 45—45 is arranged around the central exhaust valve aperture 21, this webbing 45 serving to interbrace the two port walls 15 and 17 in the mid-region thereof. Additional interbracing of the port walls close to the cylinder itself is provided by a series of stays 46. The two port walls are thus interbraced in the central region thereof and also close to the cylinder, this being accomplished in a manner minimizing interference with the steam flow. The pattern or arrangement of the several intake and exhaust valves, particularly the arrangement of the several valves in angularly spaced planes containing the cylinder axis and the location of the intake valves above and between the exhaust valves is of importance in enabling disposition of the bracing webbing in the manner above described in order effectively to interbrace the port walls at a number of spaced points throughout the area thereof.

From reference to Figure 6 it will be seen that further bracing of the port wall 17 and of the exhaust passage wall 18, at the exhaust side is provided by webbing 47, 48 and 49, the webs 47 and 48 also being connected with the sleeves 27 and 29 in which the valve stem guides for the intake valves are mounted. Additional webbing 50 projects upwardly and inwardly (as viewed in Figure 6) from the sleeve 27 over the region in which the central exhaust valve delivers to the exhaust passage 19. This not only serves to further brace the port wall 17 and the wall 18, but to avoid flow of exhaust steam from the left-hand exhaust valve (as viewed in Figure 6) over the central exhaust valve, thereby avoiding choking of the central exhaust valve. Somewhat similar webbing 51 interconnects the webbing 49 with sleeve 29, thereby serving to avoid choking of the right-hand exhaust valve by the steam leaving the left-hand and central exhaust valves.

The exhaust valve passage 19 is extended inwardly and thence upwardly as at 19a, the passages 19—19a for each end of the cylinder being joined in a discharge passage 52 which may

deliver to the stack through an appropriate exhaust nozzle or the like (not shown).

By the employment of a multiplicity of valves, adequate steam flow capacity is provided in large locomotive engines, even when utilizing poppet valves which, individually, are of relatively small diameter. The small diameter of the valve apertures required in the port walls is, in turn, of importance in avoiding distortion. Moreover, distortion is very greatly reduced by virtue of the arrangement of bracing webbing provided for the port walls, there being webbing at both sides of each port wall well distributed over the total area thereof. Moreover, the webbing in the cylinder port **16** and in the exhaust passage **19** cooperates in a novel manner to strengthen the wall **17**. In this regard, it will be observed from Figure 5 that the inverted U-shaped webbing **45** must be open downwardly, so that the exhaust steam can flow upwardly to the central exhaust aperture **21**; whereas the U-shaped webbing provided by the structure **50**, **47**, **48**, in Figure 6, must be open upwardly so as to permit the discharge of the exhaust steam into the passage **19**. Thus, where the wall **17** has the least support from the one U-shaped structure it has the most support from the other.

By virtue of the nesting of the five valves in the general pattern illustrated in the drawings and described above, the clearance volume of the cylinder port is maintained at a minimum, while at the same time providing unrestricted or unobstructed flow areas for the steam entering and leaving the cylinder through the several valve apertures.

By the herein-described relative arrangement of the five valves (for one end of the cylinder), and by the disposition of the associated port, passages and webbing, the available admission and exhaust flow areas approximate the most desirable areas, with the two admission valves and three exhaust valves made identical, which has the further advantage of simplifying the manufacture of the valves themselves and the repair and maintenance of the locomotive, since a single valve type can be kept in stock for all of the valves.

I claim:

1. In a locomotive engine equipped with poppet-type steam distributing valves, a cylinder and chest structure having a cylinder port defined in part by spaced walls lying generally transverse the cylinder axis, a group of exhaust valve apertures in one of said walls, a group of intake valve apertures in the other of said walls, one of said groups comprising at least three valve apertures the axes of which lie in angularly spaced radial planes containing the cylinder axis, the axes of the apertures of the other group lying in angularly spaced radial planes intermediate said first planes and alternating therewith, and webbing interbracing the spaced cylinder port walls and lying at least in part substantially in the said intermediate radial planes.

2. In a locomotive engine equipped with poppet-type steam distributing valves, a cylinder and chest structure having a cylinder port defined in part by spaced walls lying generally transverse the cylinder axis, a group of exhaust valve apertures in one of said walls, a group of intake valve apertures in the other of said walls, one of said groups comprising at least three valve apertures the axes of which lie in angularly spaced radial planes containing the cylinder axis, the axes of the apertures of the other group lying in angularly spaced radial planes intermediate said first planes and alternating therewith, and webbing interbracing the spaced cylinder port walls and positioned between the valve apertures of said threefold group.

3. In a locomotive engine equipped with poppet-type steam distributing valves, a cylinder and chest structure having a cylinder port defined in part by spaced walls lying generally transverse the cylinder axis, a group of exhaust valve apertures in one of said walls, a group of intake valve apertures in the other of said walls, one of said groups comprising at least three valve apertures the axes of which lie in angularly spaced radial planes containing the cylinder axis, the axes of the apertures of the other group being offset from the valve apertures of the first group in a direction radially of the cylinder, and webbing interbracing the spaced cylinder port walls between the valve apertures of said threefold group.

4. In a locomotive engine equipped with poppet-type steam distributing valves, a cylinder and chest structure having a cylinder port defined in part by spaced walls lying generally transverse the cylinder axis, a live steam chest adjacent one of the port walls defined in part thereby and by a third wall spaced from said one port wall, a group of intake valve apertures in said one port wall, a group of exhaust valve apertures in the other port wall, one of said groups comprising at least three valve apertures the axes of which lie in angularly spaced radial planes containing the cylinder axis, the axes of the apertures of the other group being offset from the valve apertures of the first group in a direction radially of the cylinder and lying in angularly spaced radial planes intermediate said first planes and alternating therewith, webbing in the cylinder port interbracing the port walls between the apertures of said threefold group, and webbing in the steam chest interbracing said one port wall and said third wall.

5. A construction according to claim 4 in which said last webbing is positioned to interbrace the walls defining the steam chest, at least in a plane intermediate two intake valve apertures.

6. In a locomotive engine equipped with poppet-type steam distributing valves, a cylinder and chest structure having a cylinder port defined in part by spaced walls lying generally transverse the cylinder axis, an exhaust steam passage adjacent one of the port walls defined in part thereby and by a third wall spaced from said one port wall, a group of exhaust valve apertures in said one port wall, a group of intake valve apertures in the other port wall, one of said groups comprising at least three valve apertures the axes of which lie in angularly spaced radial planes containing the cylinder axis, the axes of the apertures of the other group being offset from the valve apertures of the first group in a direction radially of the cylinder and lying in angularly spaced radial planes intermediate said first planes and alternating therewith, webbing in the cylinder port interbracing the port walls between the apertures of said threefold group, and webbing in the exhaust steam passage interbracing said one port wall and said third wall.

7. In a locomotive engine equipped with poppet-type steam distributing valves, a cylinder and chest structure having a cylinder port defined in part by spaced walls lying generally transverse the cylinder axis, an exhaust steam passage adjacent one of the port walls defined in part thereby and by a third wall spaced from said one port wall, a group of at least three ex-

haust valve apertures in said one port wall the axes of which lie in angularly spaced radial planes containing the cylinder axis, webbing in the cylinder port interbracing the port walls between the exhaust valve apertures, and webbing in the exhaust steam passage interbracing said one port wall and said third wall between the exhaust valve apertures.

8. A construction according to claim 7 in which the exhaust steam passage is extended laterally away from the region of the group of exhaust valve apertures to carry the exhaust steam to a point of discharge, and in which said webbing between the exhaust valve apertures in the exhaust steam passage is positioned to direct the exhaust steam entering the passage from one exhaust valve aperture away from the region of an adjacent exhaust valve aperture to avoid choking of the latter aperture.

9. In a locomotive engine equipped with poppet-type steam distributing valves, a group of five poppet valves arranged adjacent one end of a cylinder and comprising three exhaust valves and two intake valves, the axes of the several valves lying respectively in angularly spaced radial planes containing the cylinder axis, at least one of the intake valves lying in a plane intermediate the planes of two of the exhaust valves.

10. A construction according to claim 9 in which the planes of the intake valves occupy intermediate positions and alternate with the planes of the exhaust valves.

11. In a locomotive engine equipped with poppet-type steam distributing valves, a group of exhaust poppet valves adjacent an end of a cylinder, a group of intake poppet valves adjacent the same end of the cylinder, one of said groups incorporating at least three poppet valves arranged in an arcuate series circumferentially of the cylinder, and the valves of the other group being offset from said arcuate series in a direction radially of the cylinder.

12. A construction according to claim 11 in which the valves of said group incorporating at least three are disposed closer to the cylinder axis than the valves of the other group and in which the axes of the valves of said two groups lie in angularly spaced radial planes containing the cylinder axis, with the planes of the valves of one group alternating with the planes of the valves of the other group.

13. In a locomotive engine equipped with poppet-type steam distributing valves, a group of five poppet valves arranged adjacent one end

of a cylinder and comprising three exhaust valves and two intake valves, all of said valves being of the same diameter to thereby provide a total exhaust flow area approximating that required for efficient operation of an engine having a total admission area of said two intake valves of the same diameter.

14. In a locomotive engine equipped with poppet-type steam distributing valves, a cylinder and chest structure having a cylinder port defined in part by spaced walls lying generally transverse the cylinder axis, an exhaust steam passage at one side of the port, a plurality of exhaust valve apertures through the port wall adjacent the exhaust steam passage, a live steam chest at the other side of the cylinder port, an intake valve aperture in the port wall adjacent the steam chest, the axis of the intake valve aperture lying in a plane intermediate planes containing the axes of a pair of exhaust valves, a tubular support for an intake valve stem arranged coaxially of the intake valve aperture, said tubular support being connected with the cylinder port wall at the exhaust side and extending in the exhaust steam passage, and bracing webbing for the last mentioned port wall, the webbing being disposed in the exhaust steam passage between the exhaust valve apertures of said pair and being connected with said tubular support to cooperate therewith not only in bracing the adjacent port wall but also in deflecting exhaust steam entering the passage from one exhaust valve aperture away from the region of the adjacent exhaust valve aperture to avoid choking of the latter aperture.

15. In a locomotive engine equipped with poppet-type steam distributing valves, a cylinder and chest structure having a cylinder port defined in part by spaced walls lying generally transverse the cylinder axis, a group of port-wall apertures for at least three valves with their axes arranged in side-by-side relation, and bracing webbing at each side of one of said port walls, the webbing at each side being generally U-shaped and disposed to partially encircle a valve aperture whose axis occupies an intermediate position in the group, and the U-shaped webbing at the two sides of said one port wall being disposed in substantially inverted relation, whereby to provide bracing of the port wall, at one side or the other thereof, substantially around the entire circumference of the intermediate valve aperture.

JULIUS KIRCHHOF.