This invention relates to fluid pressure operated systems generally, and in a specific embodiment has more particular reference to improvements in hydraulic control valves of sectional construction.

Sectional control valves generally comprise a top manifold to which pressure fluid is supplied from a pump, a bottom manifold in which exhaust fluid is collected prior to return thereof to a reservoir, and as many similar control sections or valve units as desired attached one upon the other and confined between the top and bottom manifolds.

Each of the valve units contains one or a pair of service passages which open laterally to one side of the unit, and a valve element that is movable to selectively communicate a service passage of the unit with either the inlet manifold or with the exhaust manifold. For that purpose, the individual valve units of sectional control valves are necessarily provided with registering passages, often referred to as carry-over passages, that extend downwardly through the bank or stack of units. At least one of such carry-over passages constitutes fluid supply means that communicates with the receiving chamber of the inlet manifold, and at least one other such carry-over passage constitutes fluid return means that communicates with a chamber in the exhaust manifold.

In sectional control valves of the so-called open center type herein concerned, registering passages in all of the valve units of the bank or stack provide a through passage leading entirely through the stack, and which communicates the inlet manifold with the exhaust manifold. Hence all of the valve elements of the stack are in neutral positions. Shifting of the valve element of any unit out of neutral to an operating position blocks the through passage and causes pressure fluid to be diverted to a service passage of the adjacent unit.

In a control valve intended for series-parallel circuit operation, the through passage also serves as the supply passage, and pressure fluid is diverted from it into the feeder passage means whenever the valve element of any valve unit is shifted to an operating position. In a control valve intended for parallel circuit operation, however, other registering passages in all of the valve units provide a supply passage separate from the through passage, leading downwardly from the inlet manifold through all of the valve units and communicating with the feeder passage means in each unit.

While control valves of sectional construction have many well-known advantages, one very annoying and highly objectionable characteristic was common to past valves of this nature. All were subject to external leakage at the points where the individual valve units were secured to one another and to the manifolds. High pressure hydraulic fluid from the registering ends of the supply and/or through passages would seep into the joints between the sections and escape to the exterior of the valve mechanism, despite the presence of mating flat surfaces on the adjacent units, and despite the use of O-ring seals for each downwardly extending "carry-over" passage, tightly confined between the units, and each enclosing the end of its particular passage at its zone of registry with a continuation of said passage in an adjoining unit.

As a result, past sectional control valves for hydraulic mechanisms were not only wasteful of hydraulic fluid, but they allowed oil to leak onto and soil the apparatus upon which they were mounted. This, of course, caused considerable dirt and dust to accumulate upon the oily external surfaces of the valve and the apparatus upon which it was mounted, and especially on such dirt moving apparatus as bulldozers, graders, front end loaders and the like.

With this objection in mind, it is the purpose of this invention to provide a sectional control valve of the character described, which is constructed to eliminate external leakage of hydraulic fluid from the joints between the sections of which the valve is comprised.

More specifically, it is the purpose of this invention to provide a control valve of sectional construction wherein the mating faces of the sections are so formed that any hydraulic fluid which seeps into the junctions between valve sections from the registering ends of high pressure "carry-over" passages is free to flow at low pressure into a return passage for return to the reservoir of the system with which the valve is used, so as to assure against external leakage of fluid at the junctions of the valve sections.

In this respect, it is a further purpose of the invention to provide a sectional control valve wherein the registering mouths of the carry-over passages in adjacent housing sections are closely grouped and open to substantially central localized zones of the mating faces of the sections, and wherein the mouths of the fluid return means communicate with a shallow sump or most formed in the face of one of the sections at each of its junctions and which most surrounds the mouths of the high pressure carry-over passages to receive any fluid leaking therefrom and allow it to flow at low pressure into the adjacent mouth of the fluid return means for return to the reservoir of the system with which the control valve is used.

A further purpose of the invention is to provide a sectional control valve of the character described, wherein a single low pressure O-ring seal or gasket confined between adjacent housing sections and surrounding the sump or most effectively precludes external leakage of fluid from the joints between the sections.

In a broader sense, however, it is an object of this invention to provide a simple but effective solution to the problem of external leakage of hydraulic fluid from the junction between two bodies that may be components of any fluid pressure system, and which have both high and low pressure fluid passages that open to said junction.

With these and other objects in view which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawings illustrate one complete example of the physical embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

FIGURE 1 is a side elevational view of a sectional control valve embodying this invention;
FIGURE 2 is a cross sectional view taken on the plane of the line 2—2 in FIGURE 1;
FIGURE 3 is a longitudinal sectional view taken on the plane of the line 3—3 of FIGURE 1; and
FIGURE 4 is a perspective view of portions of two adjoining sections of the control valve, showing these sections separated and illustrating the construction employed at their mating faces to prevent external leakage of hydraulic fluid from their junction.

Referring now to the accompanying drawings, the sec-
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3. A hydraulic control valve which embodies this invention is comprised of the customary top and bottom housing sections 5 and 6, respectively providing inlet and exhaust manifolds, and a body that is comprised of any desired number of individual control sections or valve units 7 stacked one upon the other and confined between the top and bottom manifolds. A plurality of bolts pass downwardly through both manifolds and the stack of control sections therebetween to hold all of the sections tightly clamped together.

By way of example, the body of the control valve has here been illustrated as comprising two valve units 7, which may be identical in every respect, and which are of the open center type and adapted to effect parallel circuit operation of two different hydraulic circuits (not shown).

In the valve shown by way of example, the upper manifold 5 has an inlet or pump port 9 at its top, an inlet chamber 10 in its interior, and an outlet port 11 opening through a substantially central portion of its bottom. Similarly, the exhaust manifold 6 has an exhaust chamber 12 in its interior, an inlet port 13 opening through its top in vertical alignment with the port 11 of the top manifold, and in this case, the exhaust manifold also has an outlet or reservoir port 14 opening through its bottom.

Though not essential to the invention, the valve units 7 have been shown as of the double acting type. Each has a bore 15 and a spool type valve element 16 which is sliceable endwise back and forth in the bore from a neutral position seen in FIGURE 2, to each of a pair of operating positions in either of which it is adapted to communicate one of a pair of service passages 17 with the chamber 10 of the inlet manifold and the other service passage with the chamber 12 of the exhaust manifold.

The service passages 17 extend laterally outwardly from the bore 15 and terminate in motor ports 18 which open laterally to one side of the unit and are connectible with the opposite ends of a hydraulic cylinder or the like.

Each of the service passages is selectively communicable with either the inlet or the outlet manifold under the control of the valve element 16. For that purpose, the body of the control valve is provided with supply and exhaust headers 19 and 20, respectively, which extend vertically through the stack of valve units 7 in laterally spaced relation. The inlet end of the supply header 19 comprises a passage 21 through the bottom of the inlet manifold, vertically registering supply passages 22 in the valve units or control sections 7, which are thus communicable with the inlet chamber 10 through the passage 21. The lower end of the supply header is closed by the bottom manifold 6.

In more or less similar fashion, the outlet end of the exhaust header 20 comprises a passage 23 through the top of the exhaust manifold 6, leading to its chamber 12, and vertically registering exhaust passages 24 in the valve units or control sections 7. In this case, however, the upper end of the exhaust header has been shown extended upwardly into the top manifold 5 by means of a passage 25 in the latter, into which pressure fluid may flow from a relief valve 26 in the event the pressure of fluid in the inlet chamber 10 reaches an excessively high value.

The body of the control valve also has a substantially centrally located through passage 28, between the supply and exhaust headers and which may be of the conventional zig-zag type comprising a pair of adjacent upstream and downstream branches in each valve unit communicating with one another through the bore therein, and opening to the top and bottom of the valve section in registry with one of the branches of an adjacent valve section upstream branch of the through passage 28 in the top valve section 7 communicates with the outlet port 11 of the inlet manifold, and the downstream branch of the through passage in the bottom valve unit communic-
tively precluded, and in a manner which involves the use of but a single low pressure O-ring seal 40 or an equivalent gasket confined between each pair of adjacent housing sections. For that purpose, one such O-ring seal 40 is confined in an annular groove 41 in the face of each of the housing sections at its underside. The depth of the groove, of course, is preferably slightly less than the thickness of the O-ring, and it is located some distance inwardly from the periphery of the more or less circular pad 39 in which it is cut. The groove 41 defines the outer limit of a shallow sump-like depression or moat 42 in the face of the pad 39, which depression surrounds what might be termed an island 43 having part of the flat face 38 thereon for intimate mating engagement with the face 36 of the section therebeneath.

According to this invention, each of the passages that collectively define the through passage 28 and the supply header 19, open through either the flat faces 36 of the housing sections or their mating flat faces on the islands 43, in substantially close proximity to one another as best seen in FIGURE 4. Specifically, the lower ends of the supply header passages 21 and 22 open downwardly through the islands 43, alongside the lower branches of the through passage 28 in each section. The upper ends of these same passages open through the faces 36 at the tops of the sections.

However, the passages 23, 24 and 25 of which the exhaust header 20 is comprised, communicate with the depression or moat 42 in the underside of each housing section. The lower ends of passages 24 and 25 open directly through the bottoms of the moats, while the upper ends of the passages 23 and 24 open through the faces 36 at locations opposite the moat. Consequently, any two adjacent branches of the exhaust header will communicate with one another through the depression or moat 42.

With the construction described, it will be apparent that any high pressure fluid in either the through passage 28 or the supply header 19, that may seep out between the mating faces of the sections at the island 43, will flow into the moat 42 from whence it is free to discharge into the exhaust header 20 for return to the reservoir of the hydraulic system with which the control valve is employed. It will also be appreciated that the single O-ring seal 40 which surrounds the moat is never called upon to retain fluid at high pressure. This follows from the fact that the moat is at atmospheric or low pressure by reason of its connection with the exhaust header 20. Hence, the pressure of fluid in the moat can never exceed that which obtains in the reservoir of the system with which the valve is used.

The single low pressure O-ring seal is thus effectively able to preclude external leakage from the junction between adjacent housing sections, and it is of further significance that the O-ring seals lie within the circle of holes 45 provided for the bolts 8 by which the housing sections are held assembled.

Persons skilled in the art will appreciate that the O-ring seals could be confined in grooves in the pads 37, rather than in the pads 39. Likewise, the moats could just as well be provided in the upper faces 36 of the sections, or even in both of the mating faces 36 and 38.

While this invention has been described in connection with hydraulic control valves of sectional construction, it will be apparent that the unique seal means can be advantageously employed at the junction between any two bodies having a pair of passages that open to said junction, as long as one of the passages is connectable with an exhaust line or a reservoir to conduct leakage fluid thereto. An example of an arrangement of the type referred to is that which exists between the bottom valve unit 7 and the exhaust manifold 6, wherein the supply header 19 dead ends at the top face 36 of the exhaust manifold, and wherein any high pressure fluid that leaks out of the lower end of the supply header is free to flow into the moat 42 for discharge at low pressure through the return passage 23.

From the foregoing description, taken together with the accompanying drawings, it will be readily apparent to those skilled in the art that this invention for the first time provides effective seals for the joints between the housing sections of sectional control valves and the like, to assure against the possibility of external leakage, and that the invention achieves this objective in a particularly novel manner which entails the use of but a single O-ring seal confined between the housing sections at their junctions.

What is claimed as my invention is:

1. A sectional control valve comprising a plurality of housing sections secured together in stacked relation to provide a valve bank having fluid inlet and exhaust ports, and wherein one or more of said sections comprise control sections having carryover passages therein which connect with one another at the junctions of the sections and provide high pressure fluid supply and low pressure fluid return passage means respectively communicating with the inlet and exhaust ports, each control section having service passage means for connection with a fluid motor and a movable valve element to control communication of its service passage means with its supply and return passage means, characterized by the following:

(A) that said sections have substantially flat mating faces at their junctions;

(B) that the carryover passages in the sections are closely grouped and have ends that open to said junctions within a zone of substantially small area;

(C) that said faces of the sections have flat surfaces that intimately engage flat surfaces on the mating faces of adjacent sections all around the ends of the supply passage means to provide high pressure surface seals that minimize leakage of high pressure fluid from the supply passage means into the junctions between the sections;

(D) that one of the sections at each of said junctions has a shallow depression in its face that extends outwardly from and surrounds the adjacent high pressure surface seal and zone to which the carryover passages open;

(E) that said return passage means opens to each of said junctions at a location outside of the adjacent high pressure surface seal and to the depression surrounding the latter so that the depressions provide shallow low pressure spaces to receive fluid that may leak past the high pressure surface seals from the supply passage means, and from which spaces such leakage fluid can flow at low pressure to the return passage means;

(F) and means at each of said junctions defining a low pressure seal completely surrounding the adjacent depression.

2. The sectional control valve of claim 1, wherein said supply passage means comprises:

(A) an open center passage through which fluid entering the inlet port normally flows to the exhaust port, but which flow can be blocked at any control section by the valve element in said section,

(B) a feeder passage separate from the open center passage but also connected with the inlet port, through which pressure fluid flows to the service passage means of any of the control section when the open center passage is blocked by the valve element of said control section;

(C) said feeder passage opening to the junctions at said zone of substantially small area;

(D) and said intimately engaging flat surfaces on the sections at their junctions defining surface seals that extend individually around the ends of the open center passage and the feeder passage.
3. The sectional control valve of claim 1 wherein each of said low pressure seals comprises an O-ring confined in an annular groove in the face of one of the sections.
4. The sectional control valve of claim 3 wherein said annular grooves are in the sections having the depressions and define the outer boundaries thereof.
5. As an article of manufacture, a valve unit for sectional control valves, comprising:
   (A) a housing having opposite sides, opposite ends, flat top and bottom parallel faces, a bore extending from one end of the housing to the other, to slidably receive a valve element, and service passage means connecting with the bore and opening to one side of the housing;
   (B) closely adjacent carryover passages in the housing extending downwardly therethrough and comprising supply passage means connecting with the bore to supply fluid under pressure to the service passage means under the control of a valve element in the bore, and an exhaust passage connecting with the bore, to which fluid returning to the service passage means can be directed by a valve element in the bore,
   (C) said supply passage means having ends that open to substantially corresponding localized zones of both of said faces through flat high pressure sealing surfaces thereon that completely surround said ends of the supply passage means,
   (D) one of said faces of the housing having a shallow depression therein that surrounds said adjacent sealing surface,
   (E) the exhaust passage opening to both faces of the housing at corresponding areas closely adjacent to the ends of the supply passage means but having one end opening only through the bottom of said depression,
   (F) and an annular groove in one of said faces of the housing to receive a low pressure sealing member, said groove surrounding an area substantially corresponding in location and in extent to that of said depression.
6. In combination with a pair of one piece bodies that are tightly secured together:
   (A) finished flat uniplanar surfaces on the bodies in intimate engagement with one another at their junction throughout spaced inner and outer zones, the latter of which zones completely surrounds the former;
   (B) a high pressure fluid passage in one of the bodies having a mouth that opens to said junction wholly within said inner zone whereby the intimate engagement of said body surfaces at said inner zone, all around said mouth of the high pressure passage, provides a high pressure surface seal integral with the bodies to minimize leakage of fluid from said high pressure passage into the junction between the bodies;
   (C) a low pressure return passage in the other body having a mouth that opens to said junction at a location between said zones and wholly to one side of but near said inner zone;
   (D) a shallow depression in one of the bodies at said junction, coextensive with said space between the zones and separate from the return passage, to receive any fluid that may leak past said high pressure surface seal from the high pressure passage, and through the bottom of which depression the mouth of the low pressure passage opens whereby the depression is at all times at low pressure;
   (E) an annular groove in one of the bodies, opening to said junction and encircling said depression along the outer edge thereof,
   (F) and an annular sealing member confined in said groove and engaging the finished flat surface on the adjacent body to provide a leakproof joint between the bodies employing but one annular sealing member which need only retain low pressure fluid in said depression.
7. The combination of claim 6, further characterized by:
   (A) a second high pressure passage in said first designated body having a mouth that likewise opens to said junction wholly within said inner zone and closely adjacent to the mouth of the first designated high pressure passage;
   (B) and said intimately engaging surfaces at the inner zone providing individual high pressure surface seals around said mouths of the high pressure passages.

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