March 24, 1942. E. F. WICHOREK 2,277,573

MULTIPLE DISTRIBUTOR VALVE

Filed April 8, 1940 4 Sheets-Sheet 1

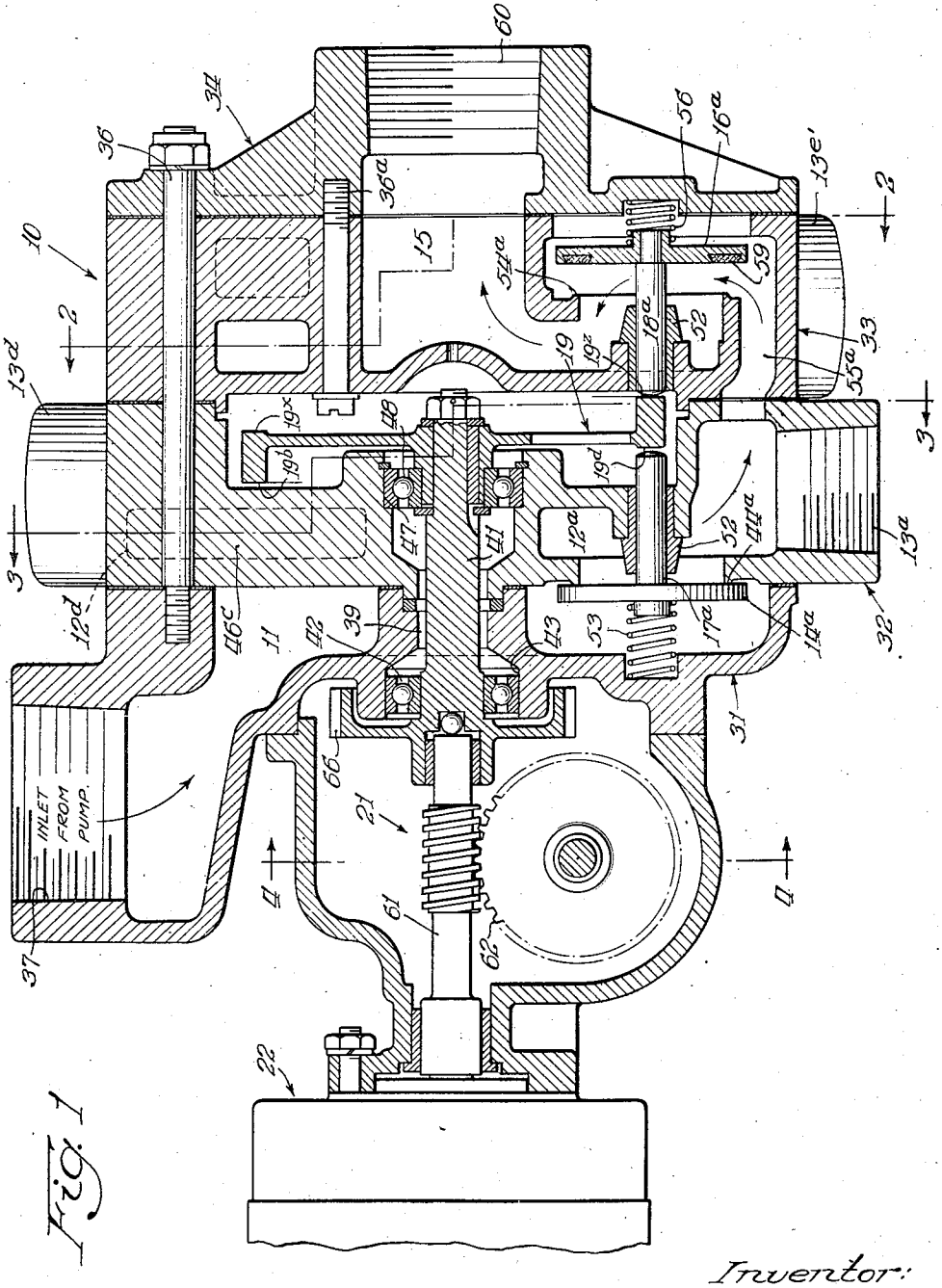


Fig. 1

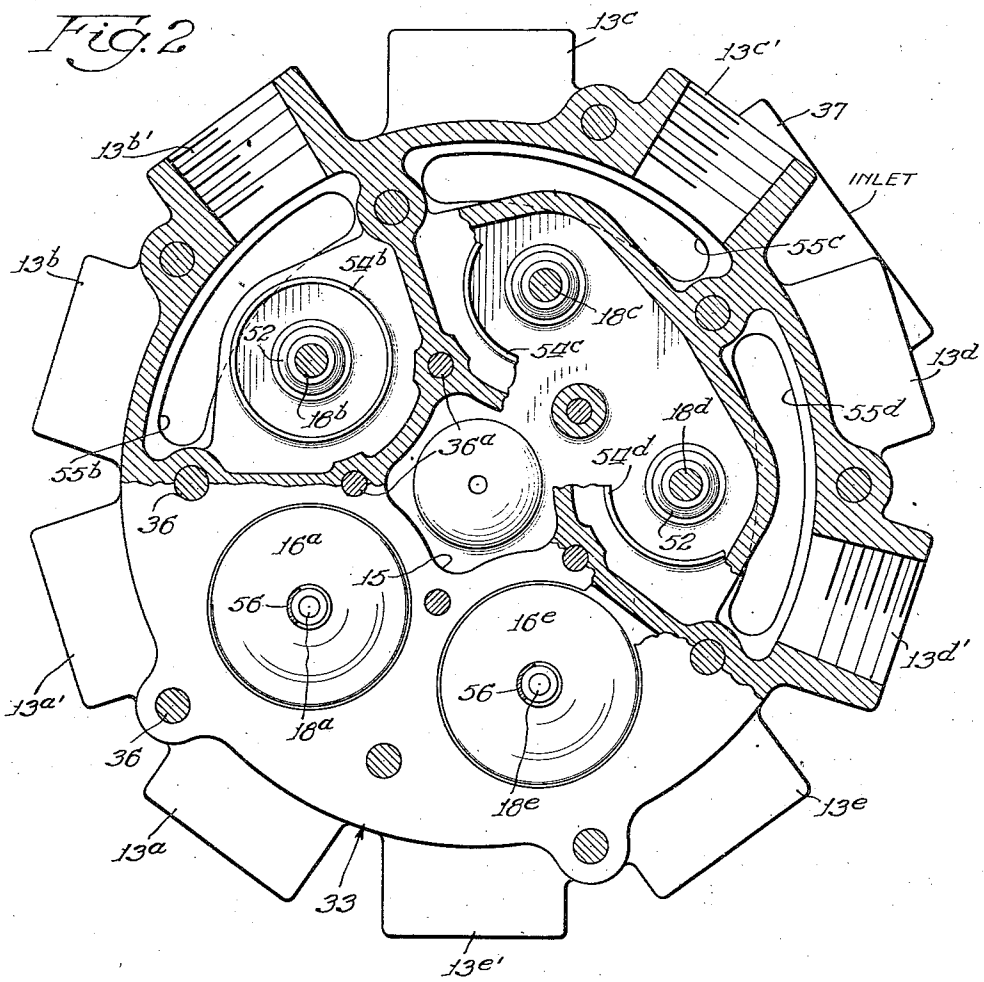
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MULTIPLE DISTRIBUTOR VALVE

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Fig. 2



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MULTIPLE DISTRIBUTOR VALVE

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Fig. 3

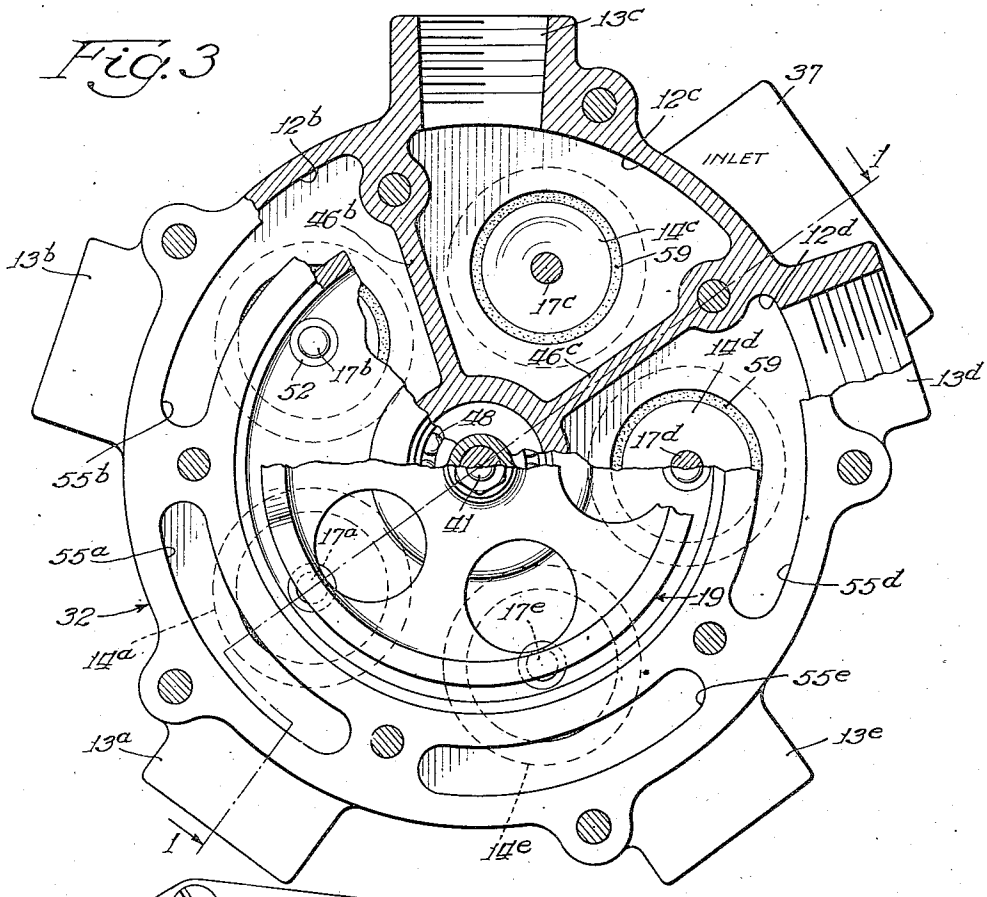
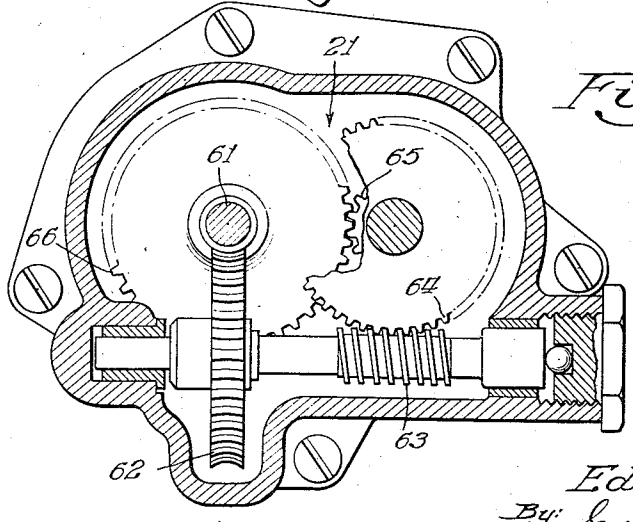


Fig. 4



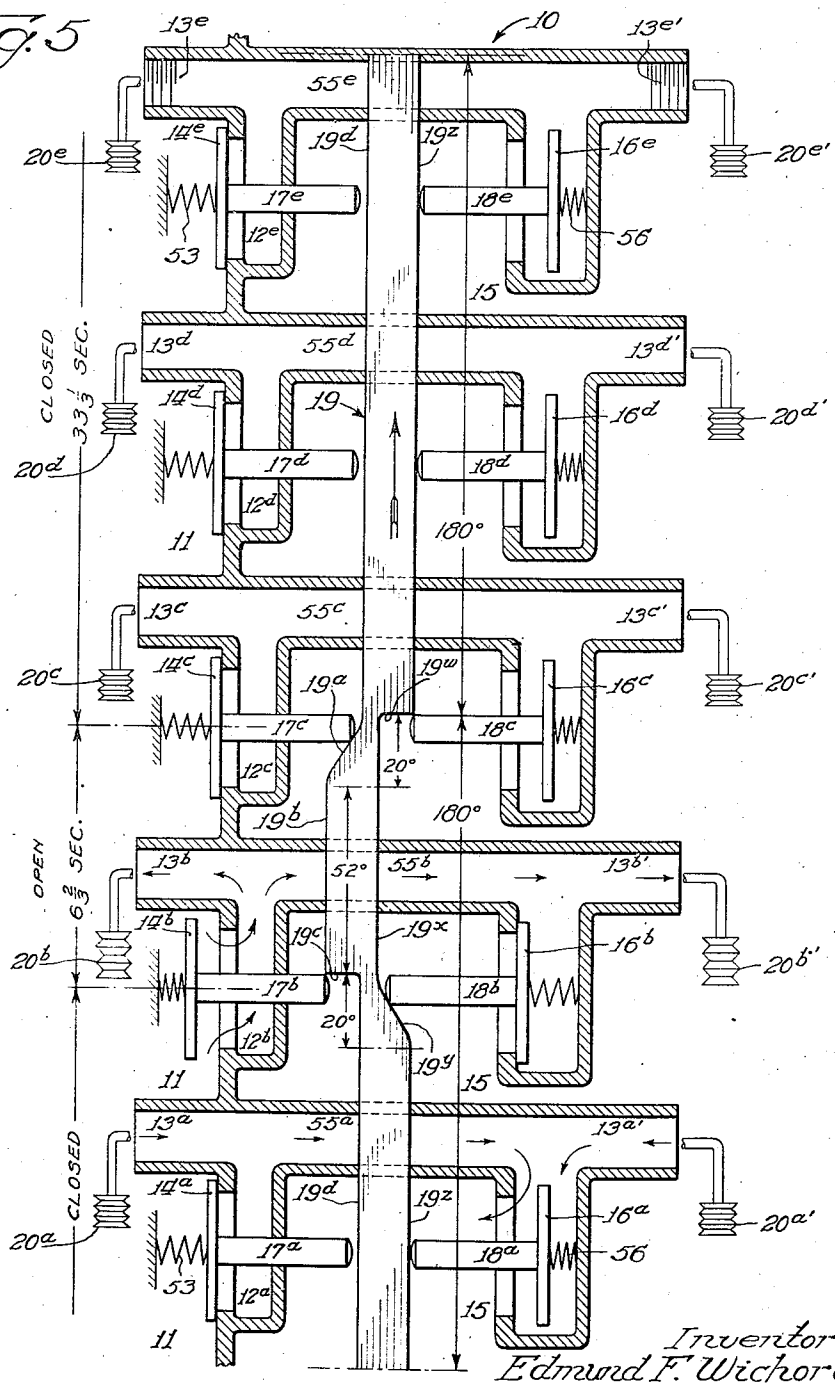
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MULTIPLE DISTRIBUTOR VALVE

Filed April 8, 1940 4 Sheets-Sheet 4

Fig. 5



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Patented Mar. 24, 1942 2,277,573

UNITED STATES PATENT OFFICE

2,277,573

MULTIPLE DISTRIBUTOR VALVE

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Application April 8, 1940, Serial No. 328,439

6 Claims. (Cl. 277—20)

This invention relates to multiple distribution valve assemblies including an arrangement for operating the valves in a predetermined related sequence.

It is an object of this invention to provide an improved multiple valve assembly capable of delivering fluid under pressure from a source of fluid pressure to a plurality of separate receivers or fluid responsive mechanisms in a predetermined related sequence. A further object is to provide an assembly of the above type effective to both deliver the fluid to and exhaust the fluid from a plurality of receivers or fluid responsive mechanisms in a predetermined related sequence.

Among the more specific objects is the provision of a novel, compact and efficient disposition of independent inlet and exhaust valves in relation to a common motor driven control member for effecting the operation of the valves in a predetermined related sequence. A more specific object is the provision of such an arrangement including at least three inlet valves adapted to separately direct fluid to the receivers or fluid responsive devices; and at least three corresponding exhaust valves for discharging said devices, together with a single motor operated arcuately adjustable control member effective to open one of said inlet valves at a time while the remaining inlet valves are maintained closed; and allowing the exhaust valve corresponding to said open inlet valve to close while maintaining all of the remaining exhaust valves open. A still more detailed object is the formation of the control member in a manner such as to effect quick or instant closing of said inlet valves and the relatively more gradual opening of these valves; as well as effecting the quick or instant closing and the more gradual opening of the corresponding exhaust valves.

Other and more specific objects, advantages and uses of my invention will become apparent from a reading of the following specification taken in connection with the accompanying drawings wherein:

Fig. 1 is an axial section view of a plural valve assembly incorporating a preferred embodiment of my invention;

Fig. 2 is a transverse section taken substantially on the line 2—2 of Fig. 1;

Fig. 3 is a transverse section taken substantially on the line 3—3 of Fig. 1;

Fig. 4 is a section taken substantially on the line 4—4 of Fig. 1; and

Fig. 5 is a schematic view showing a development of the functional parts bringing out to advantage the correlation and sequence of operation of the valves.

Referring in greater detail to the figures of the drawings, the valve assembly proper indicated generally at 10 includes a housing formed with a common inlet chamber 11 arranged to be placed in communication with a plurality of separate inlet passages or compartments 12*a*, 12*b*, 12*c*, 12*d* and 12*e*, leading to a plurality of independent pairs of outlet ports 13*a*, 13*a'* to 13*e*, 13*e'* inclusively, these ports in turn being adapted to deliver fluid pressure to individual fluid receivers or fluid responsive devices indicated schematically at 20*a*, 20*a'*, to 20*e*, 20*e'* in Fig. 5, this delivery being under the control of inlet valves 14*a*, 14*b*, 14*c*, 14*d*, and 14*e*, respectively.

Also a common exhaust chamber 15 is arranged to receive the return exhaust from the outlet ports 13*a*, 13*a'* to 13*e*, 13*e'* inclusive under the control of exhaust valves 16*a* to 16*e* inclusive. The respective sets of valves are provided with spaced opposed valve stems 17*a* to 17*e* and 18*a* to 18*e* inclusive, these stems being under the control of a disc-like cam control member interposed therebetween and indicated generally at 19. This control member is given a particular configuration including a novel arrangement of cams, dwells, and falls, and the valve stems are arranged with particular relation thereto for effecting the desired sequence of operation as will be described in greater detail. For turning the control member at a predetermined speed of rotation there is connected thereto through the medium of reduction gearing indicated generally at 21, an electric motor 22.

Turning now to the detailed construction of control member 19 and the relation thereto of the valve stems, and referring particularly to Fig. 5, it will be seen that in the present embodiment control member 19 is formed on the upper side thereof with a cam portion 19*a* of substantially 20 degrees extent effective to open inlet valves 14*a* to 14*e* inclusive in sequence as the cam is turned to the right, indicated by the arrow in Fig. 5. Cam portion 19*a* merges with positive dwell or raised portion 19*b* of substantially 52 degrees extent, effective to maintain the successive inlet valves open for a predetermined period of time. The dwell portion 19*b* merges with an abrupt drop portion 19*c* which in turn merges with dormant or inactive portion 19*d* completely out of contact with the inlet valves and having an extent of about 288 degrees. The motor and reduction gearing are arranged to turn the cam member at a substantially constant speed of ro-

tation such that the overall time between the beginning of the opening of any particular inlet valve and the closing thereof is about 6⅔ seconds. This leaves 33⅓ seconds during which each inlet valve is maintained closed, a period of one complete cycle of rotation of the cam member 19 being 40 seconds. Control member 19 on the opposite side is formed for cooperation with exhaust valves 16*a* to 16*e* inclusive, and includes abrupt drop portion 19*w* effective to permit quick closing of each of the exhaust valves slightly prior to the beginning of opening movement of the associated inlet valve. Drop portion 19*w* merges with dormant portion 19*x* effective to permit the exhaust valve to remain closed during the open position of the corresponding inlet valve, this being slightly more than 72 degrees or 6⅔ seconds in extent.

It will be noted that there is a slight, though not appreciable overlapping of the inlet valve open position by the closed position of the exhaust valve. Merging with the dormant portion 19*x* is a cam portion 19*y* effective to open the associated exhaust valve in slightly less than 20 degrees following the closure of the corresponding inlet valve. A positive dwell portion 19*z* merges with cam portion 19*y* and is effective to maintain all but one of the exhaust valves in open position. From the above, it will be made to appear that a succeeding exhaust valve (proceeding from left to right in Fig. 5) is caused to quickly close substantially simultaneously with the quick closing of the preceding inlet valve. This is followed by the relatively less rapid opening of the exhaust valve corresponding to said preceding inlet valve and the relatively less rapid opening of the inlet valve corresponding to said succeeding exhaust valve.

I have described above in detail the arrangement of one preferred embodiment of my invention including what is believed to be a new and improved sequence of operation of the valves by means of the novel construction and operation of control member 19. It will nevertheless be understood that certain of these features may be varied without departing from the broader aspects of my invention. For example, the exact time of opening and closing of the valves and the number of the valves may be varied. The correlation between the operation of the inlet and exhaust valves may be varied without departing from the broader aspect of my invention. Other changes of a similar character will become apparent to those skilled in the art.

The source of pressure may be any readily available arrangement including pumping means. However the present valve assembly will work to particular advantage in an aircraft system wherein a single source of pressure is furnished by an accumulator (not shown) maintained charged with fluid such as oil under a relatively high pressure.

Referring now more specifically to the novel details of construction of valve assembly 10, the same is composed of a plurality of separable castings in general axial alignment. These castings are preferably of a light alloy such as aluminum particularly where the assembly is for use on aircraft. A first end casting or housing member 31 has mounted thereon in generally concentric relationship, a first intermediate casting or housing member 32 which in turn carries a second intermediate casting or housing member 33 upon which there is mounted in concentric relation an end closure casting or housing member 34, these castings being fastened together by bolts 36 and 36*a* and having the usual sealing gaskets interposed therebetween. End housing member 31 is formed with a fluid pressure inlet port 37 communicating with inlet chamber 11. Centrally, housing 31 is orificed at 39 for the passage therethrough of drive shaft 41 in turn journalled at its outer end in anti-friction bearing 42 received in a recess 43 in the outer portion of closure member 31. Intermediate housing 32 is formed with a plurality of circularly disposed valve seats 44*a* to 44*e* inclusive for cooperation with inlet valves 14*a* to 14*e* inclusive communicating with corresponding inlet chambers 12*a* to 12*e* inclusive separated by rib-like walls or partitions 46*a* to 46*e* inclusive, only some of which are shown in Fig. 3.

Housing member 32 is formed centrally thereof with a recess 47 for the reception of anti-friction bearings 48 supporting the inner end of shaft 41 on which in turn is mounted control member 19. Valve stems 17*a* to 17*e* inclusive and valve stems 18*a* to 18*e* inclusive extend inwardly into juxtaposed position with reference to control member 19 and are supported in identical bearing members 52, these valves being urged to closed position by identical springs 53 as well as by the inlet pressure acting thereagainst. The second intermediate housing member 33 is similarly formed with a corresponding number of exhaust valve seats 54*a* to 54*e* inclusive in juxtaposed relation to valve seats 44*a* to 44*e* and communicating therewith through passages 55*a* to 55*e* inclusive. These valves are similarly urged to closed position by means of identical springs 56 as well as by means of the pressure acting thereagainst. The exhaust valve stems 18*a* to 18*e* are likewise mounted in bearings 52 and extend into the path of cam control member 19. Each of the valves is provided with a facing material 59 of any well known character such as neoprene for improving the sealing characteristics. Exhaust chamber 15 may be connected with the atmosphere through outlet port 60.

The motor 22 may be connected with shaft 41 by any desired form of reduction gearing capable of producing the reduction required, the form shown being of a conventional type including a worm shaft 61 driven by motor 22 and connected through worm gears 62, 63, 64 and gears 65 and 66.

It will thus appear that I have provided a novel arrangement of plural housings, the same being fastened together in the manner described, supporting the inlet and outlet valves and the control cam member in relationship to one another to provide a construction that is both efficient in operation as well as being readily assembled and disassembled for purpose of maintenance.

I consider my novel valve assembly as having general application wherever there is found to exist conditions which are satisfied thereby, namely, wherever it is desired to successively deliver a single source of fluid pressure such as air under pressure from a pump or accumulator to a plurality of separate fluid receivers or fluid actuated instrumentalities and exhaust fluid therefrom in a related sequence. I have found that my valve assembly has particular application to the aircraft problems of delivering air under pressure to the expansible de-icing shoes (not shown) carried on the leading surfaces of the craft. The control of the sequence, the sharp individual delivery, and the effective transition from delivery to a first expansible shoe to delivery

to a succeeding shoe make my arrangement of particular importance. Also of notable significance in aircraft application is the above pointed out compactness, resulting in making it possible to incorporate a large number of valves and the associated control member in a very small space.

While I disclosed my invention in connection with a certain specific embodiment thereof, it is to be understood that the same has a broad application, obvious changes being apparent to those skilled in the art and it is intended that my invention be defined by the appended claims which should be given a scope as broad as permitted by the prior art.

I claim:

1. In a multiple valve assembly including a valve housing formed with a common inlet chamber adapted to be placed in communication with a source of fluid pressure, and at least three separate compartments, an inlet valve associated with each compartment for admitting fluid from said common inlet chamber to said compartment and an exhaust valve associated with each compartment for exhausting said fluid from said compartment to the atmosphere, each of said compartments having at least one outlet port adapted to be connected to an external fluid receiver, and means effective to operate to open position in succession each of said inlet valves and to operate to closed position in succession each of said corresponding exhaust valves, said means comprising an arcuately adjustable disc-like control member, said control member being disposed between said inlet valves and said exhaust valves and being formed on one side with a succession of cam, dwell, and drop portions for cooperation with said inlet valves for operating the same in a predetermined sequence and formed on the other side thereof with a succession of drop, dwell, and cam portions in opposed relation to said above named cam, dwell and drop portions for operating said exhaust valves.

2. In a multiple valve assembly including a housing formed with a common fluid pressure inlet chamber and at least three separate distributing ports for delivering fluid pressure separately to a plurality of separate fluid receivers and exhausting the same therefrom in a predetermined order, means including a corresponding number of valves for admitting fluid from said common inlet chamber to said respective ports and a corresponding number of separately operable exhaust valves, one associated with each distributing port, and means effective to operate to open position in a predetermined order each of said inlet valves and to operate to closed position in a predetermined related order each of said corresponding exhaust valves, said means comprising an arcuately rotatable disc-like valve control member formed with a plurality of valve actuating surfaces for cooperation with said respective exhaust and inlet valves, said control member being formed on one side thereof with a cam portion effective to open each of said inlet valves in succession, said cam portion merging with a raised portion effective to maintain each of said valves open during a predetermined arcuate travel of said control member, said raised portion merging with an abrupt drop portion effective to permit the inlet valves to quickly close following cooperation with said raised portion, said drop portion merging with a dormant dwell portion extending over the remainder of said control member and merging with said first cam portion, said dwell portion being effective to permit all but one of said inlet valves to remain closed at a particular time, said control member being formed on the opposite side thereof with an abrupt drop portion in substantially opposed relation to said first cam portion and effective to permit the respective exhaust valves to move to closed position slightly prior to the opening of the corresponding inlet valves, said drop portion merging with a dormant dwell portion of an extent substantially commensurate with said raised portion on the opposite side of said control member and effective to allow the successive exhaust valves to remain closed during the time that the corresponding inlet valve is open, said dormant dwell portion merging with a cam portion in substantially opposed relation but slightly beyond said drop portion on the opposite side of said control member, said cam portion being effective to again open said exhaust valves, said cam portion merging with a positive raised portion extending throughout the remainder of said control member and in turn merging with said first named drop portion, said positive raised portion being effective to maintain open all of the exhaust valves except the particular exhaust valve corresponding to the inlet valve currently being held open.

3. In a valve assembly adapted to charge and exhaust a plurality of receivers in succession, comprising a housing formed with a common fluid pressure inlet and a plurality of valve seats provided with inlet valves delivering to a plurality of corresponding separate compartments, a plurality of corresponding exhaust valve seats and valves received thereon cooperating with said compartments, each of said compartments having at least one outlet port adapted to be connected to an external fluid receiver, a disc-like control member formed with valve operating cam portions, raised portions, and dwell portions, said portions being disposed between said inlet and exhaust valves and being effective to simultaneously open one inlet valve at a time and to close the corresponding exhaust valve, the remaining inlet valves being maintained closed and the remaining exhaust valves being maintained open for a predetermined fraction of the rotation of said control member, then being effective to cause quick closure of said inlet valve while opening the succeeding inlet valve, said exhaust valve being opened and the succeeding exhaust valve being caused to quickly close.

4. In a distributing and exhaust valve assembly adapted to supply fluid to and discharge fluid from three or more separate fluid pressure actuated instrumentalities in sequence comprising means defining a valve housing with a common inlet, means defining a plurality of compartments in said housing, each formed with an inlet valve seat and an exhaust valve seat in communication therewith, an inlet valve and an exhaust valve in cooperation with said respective seats, and a rotatable disc-like valve actuator disposed between the effective to control said respective inlet and exhaust valves in a predetermined sequence, said actuator being formed on one side with a first cam portion effective to successively open each of said inlet valves, said cam portion merging with a positive raised portion effective to maintain each of said inlet valves open for a predetermined fraction of the total arcuate movement of said actuator, said fraction not being greater than one over the number of inlet valves, said actuator being formed on the other side thereof with an abrupt drop portion in sub-

stantial juxtaposed relation to said cam portion effective to cause a particular exhaust valve to be quickly closed slightly prior to the opening of the corresponding inlet valve, said abrupt drop portion merging with a dormant dwell portion of an extent substantially equal to that of the opposed positive raised portion and effective to allow said exhaust valve to remain closed during the open position of the corresponding inlet valve, said dormant portion merging with a cam portion effective to open said exhaust valves, said cam portion in turn joining with a positive raised portion effective to maintain all but one of said exhaust valves open.

5. In a casting assembly making up a housing for a plurality of inlet and exhaust valves, a first closure casting formed with a common inlet chamber, a first intermediate casting formed with a plurality of circularly disposed inlet valve seats communicating on one side with said common inlet chamber and on the other side with a corresponding number of separate compartments likewise formed in said first intermediate casting, said last named casting being further formed with at least one outlet port adapted to communicate each of said compartments with a separate fluid actuated instrumentality, a second intermediate casting formed with a plurality of exhaust valve seats corresponding in number to said inlet valve seats and positioned in opposed relation thereto, said two intermediate castings each being formed with separate complementarily located passages placing said corresponding inlet and exhaust valve seats in communication, a second closure casting formed with an exhaust port in communication with said exhaust valve seats and adapted to deliver to the atmosphere and means for fastening said castings together in assembled relation.

6. The arrangement of castings defined in claim 5, wherein at least one of said intermediate castings is axially recessed centrally of said valve seats to adapt the same for the reception of a disc-like valve control member between said two intermediate castings.

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