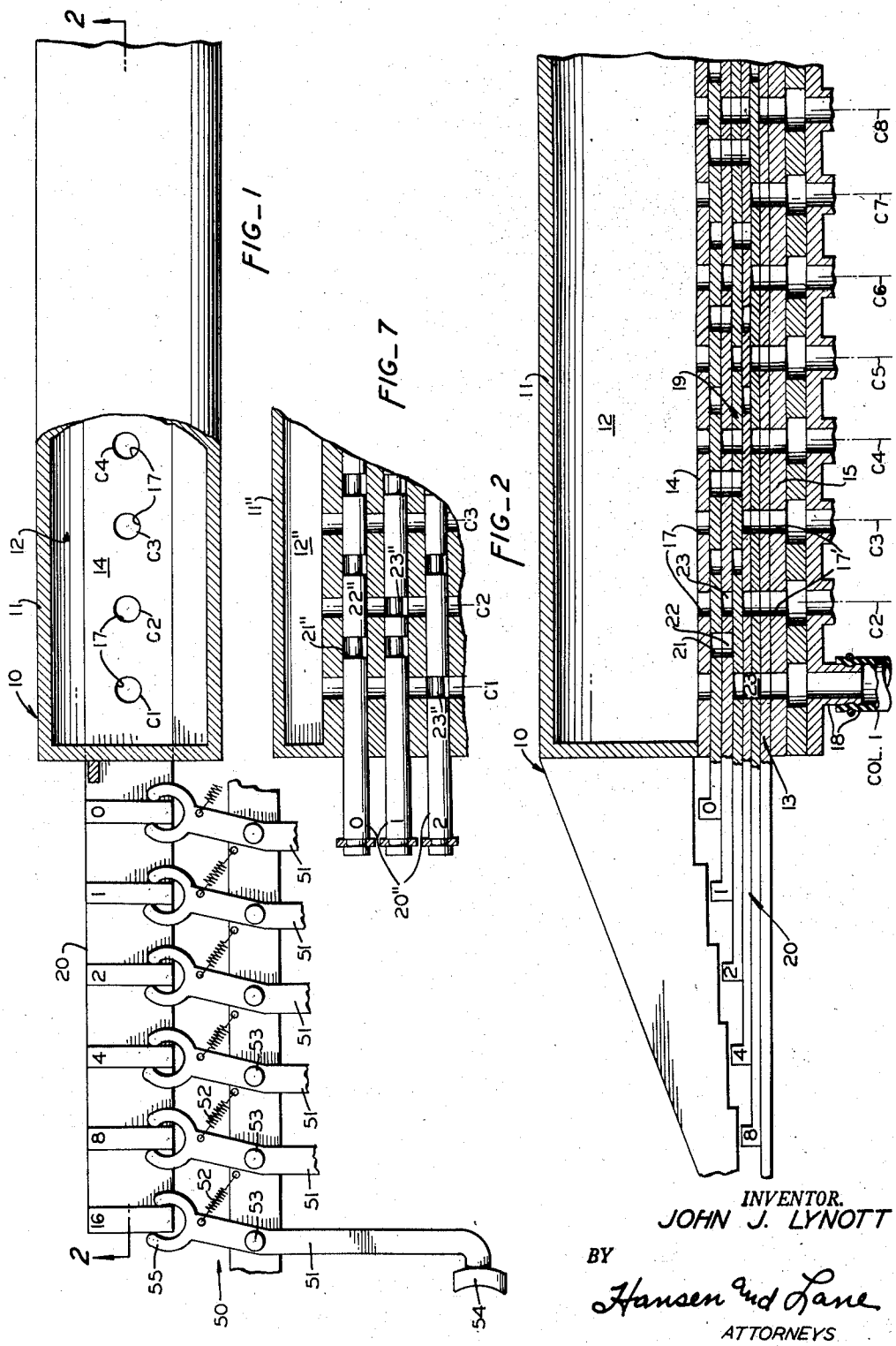
Sept. 15, 1959 J. J. LYNOTT 2,904,070

MULTI-PORT SELECTOR

Filed June 6, 1955 2 Sheets-Sheet 1



INVENTOR.
JOHN J. LYNOTT

BY
Hansen and Lane
ATTORNEYS

Sept. 15, 1959 J. J. LYNOTT 2,904,070

MULTI-PORT SELECTOR

Filed June 6, 1955 2 Sheets-Sheet 2

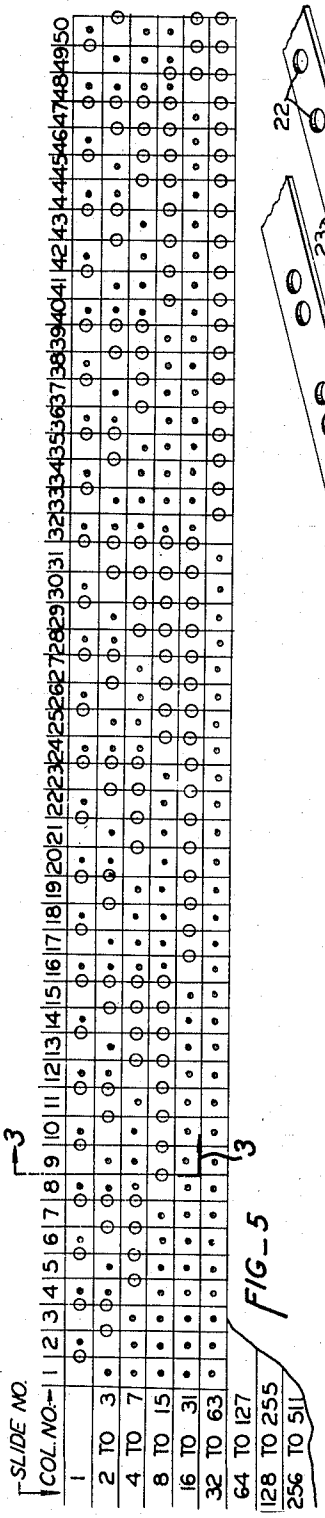


FIG_5

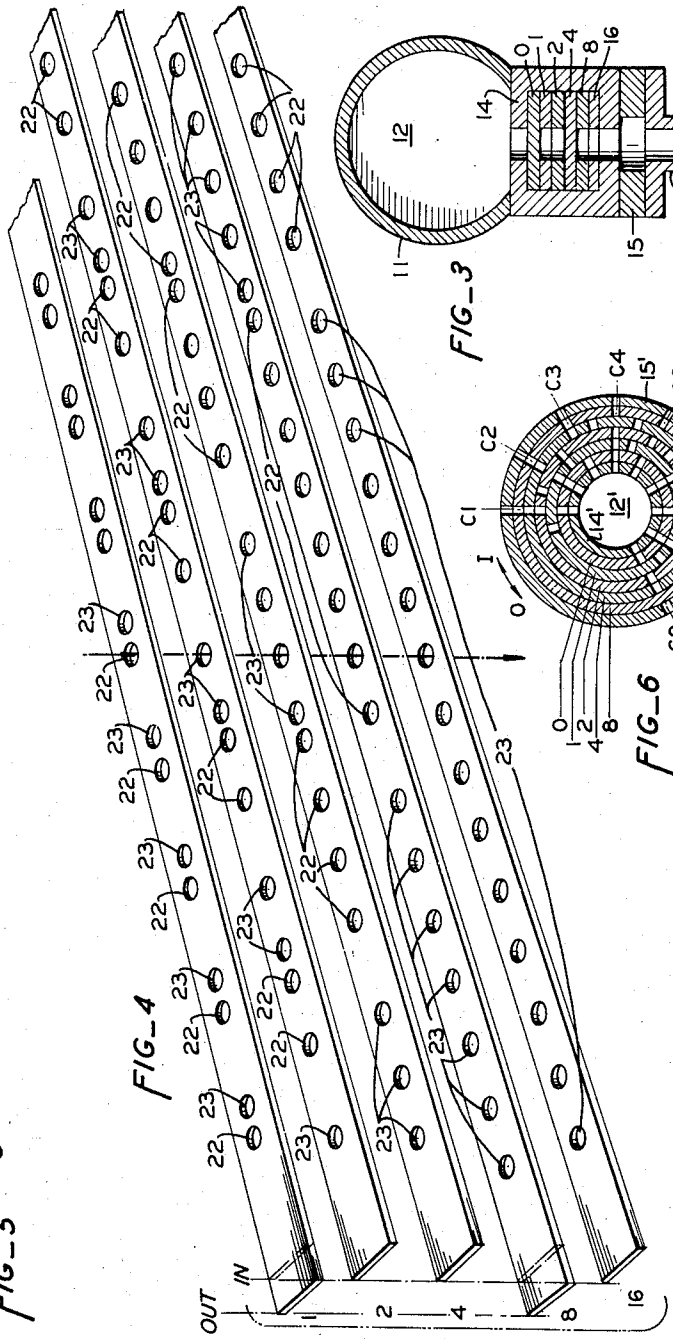


FIG_4

FIG_3

FIG_6

INVENTOR.
JOHN J. LYNOTT

BY

Hansen and Lane

ATTORNEYS

United States Patent Office 2,904,070 Patented Sept. 15, 1959

2,904,070

MULTI-PORT SELECTOR

John J. Lynott, Los Gatos, Calif., assignor to International Business Machines Corporation, New York, N.Y., a corporation of New York

Application June 6, 1955, Serial No. 513,206

5 Claims. (Cl. 137—552.5)

This invention relates to distributing valves and more particularly to a permutation valve for serving fluid to ports of differing assigned value or identity.

The invention herein contemplates the use of apertured slides for separating a fluid supply manifold from independent valued ports and for communicating any particular one of such ports therewith upon predetermined setting of a selected one or group of such apertured slides. In this connection the invention broadly embraces a port selection valve based upon the permutation bar principle.

It is a further object of this invention to provide in a port selection valve a plurality of slides apertured in accordance with a pattern based upon binary numbers and correlated for serving fluid to a preselected column or passage. In this connection each binary slide is provided with bi-pass or valueless apertures as well as valued apertures serving a particular column with which it is associated only when selectively registered with such column. This object further contemplates the provision of correlated series of binary valued apertures on adjacent slides for serving a column having a value corresponding to the compound value of all binary slides selected.

Briefly stated, this invention contemplates the provision of a selection valve including a plurality of adjoining members each movable between two positions to serve one or another independent port either alone or when moved conjointly with one or more of the other adjoining members.

It is another object of this invention to provide a port selection valve in which each binary slide presents a valued aperture to a column in which such binary value is essential either alone or when compounded with one or more other binary values to make up a valve opening at a column corresponding in number to the total value of such single or compounded binary values.

These and other objects and advantages of the present invention will become more apparent from a reading of the following description in the light of the drawings in which:

Fig. 1 is a fragmentary view, partly in plan view and partly in horizontal section through a valve embodying the present invention, a limit stop member being broken away.

Fig. 2 is a sectional view taken substantially along line 2—2 of Fig. 1, the limit stop member being shown.

Fig. 3 is a transverse section through Fig. 1 taken along line 3—3 thereof (as well as of Figs. 4 and 5).

Fig. 4 is an exploded perspective view of a plurality of permutated binary slides embodied in the illustrations of Figs. 1 through 3.

Fig. 5 is a schematic chart in which a plurality of permutation slides are laid out in plan position relative to each other to illustrate the cooperation thereof with each other for selecting a port or column of predetermined value.

Fig. 6 is a modified arrangement of relatively movable members embodying the present invention.

Fig. 7 is another form of structure embodying the principle of this invention.

The valve structure is generally designated **10** in the drawings. It includes a casing **11** providing a manifold **12** and a guideway **13** separated by one side wall **14** of the casing. The guideway **13** has a plate **15** in spaced parallel relation with respect to the side wall **14** of the casing. Both the wall **14** and the plate **15** are provided with sets of aligned outlet ports **17—17'** each set being equally spaced from the next successive set thereof.

Each outlet port **17'** on the outer plate **15** is preferably in the form of a nipple suitable for sealed connection to a conduit or tube **18** in turn communicating with some instrumentality (not shown) to be operated by fluid under pressure. Each set of outlet ports **17—17'** constitutes the upper and lower end respectively of a "column" C bearing a particular numerical value, beginning adjacent one end of the casing and increasing digitally, i.e., by ones in succession toward the other end of the casing. Thus the first set of outlet ports **17—17'** comprise the upper and lower ends of column No. 1, the next set of ports **17—17'** are in column No. 2 and so on upward. By "column" in this specification and in the claims is meant the passage which becomes formed by the ports **17—17'** through the intervening passages of the interposed valve members, hereinafter to be described.

From the foregoing it will be seen that the manifold **12** is adapted to serve independent consecutively numbered columnar ports. In this manner fluid under pressure flowing from the manifold **12** through any one column C will effect operation of a preselected pressure sensitive instrument at the other end of the tube **18** communicated with such column. However, flow of fluid under pressure from the manifold to the outlet port or nipple **17'** of all of the columns C is normally blocked by a valve arrangement **19** embodying the present invention now to be explained.

The valve arrangement **19** as illustrated in the drawings comprises a plurality of independent valve members, here shown as slides **20** each arranged for sliding movement either independently of the others, in bank with the others, or with preselected ones of the others, between an In and an Out position within the guideway **13** and relative to the casing **11**. The valve arrangement **19** thus comprises a block of independently movable laminar slides **20**. Each separate slide **20** is a flat metal plate in which apertures are formed in a position to register with one or another of the columns C defined by the sets of outlet ports **17—17'** formed in the casing and outer plate **15**, respectively.

It should here be noted that the present invention can be embodied in various structural arrangements as for example the coaxially arranged components as illustrated in Fig. 6 or in the alternative, the bar type slides as depicted in Fig. 7.

In accordance with the present invention, the apertured slides **20** may be represented by numbers increasing in accordance with the binary system, for example, 0, 1, 2, 4, 8, 16, etc. The first slide, represented as zero (0) in the drawings, is a gate or master slide. In this connection it will be noted that the first or gate slide "0" has apertures **21** corresponding in number and spacing with the outlet ports **17** in wall **14** so as to register with all columns C when slide "0" is in Out position. Contrariwise, when gate slide "0" is at "In" position, all of its apertures **21** are out of register with all columns C, i.e., offset relative to their respective columns C. Thus it will be seen that no fluid can flow from the manifold **12** to the balance of the binary numbered slides until the gate slide **20** is moved to "Out" position.

The balance of the slides **20** are considered binary slides, the first of which is represented as binary slide

number one (1); the second as binary slide number two (2); the third as binary slide number four (4); the fourth as binary slide number eight (8) and so on up the binary scale. See for example the diagram Fig. 5.

Each binary numbered slide **20** has two different series of apertures formed therethrough, one series consisting of valued apertures **22** and the other series consisting of passage apertures **23**. All passage apertures **23** on all binary slides **20** are disposed to align with their respective column C when such slides are in ineffective or In position. The valued apertures **22** in all binary slides **20** are offset relative to their respective column C when such slides are in normal or In position but so disposed as to become aligned with their respective column C when the slide in which they are formed is shifted to Out position.

For purposes of this explanation, the "In" position will be considered the ineffective position or that in which any valued aperture is offset or out of registration with its related column C. Alternatively, the "Out" position will be considered the effective position or that in which any slide is positioned for operatively registering each valued aperture therein with its related column C. In this connection it will be noted that all passage apertures **23** become misaligned or offset relative to their related columns when the slide on which they are formed is shifted to effective or "Out" position.

Each binary slide has its passage apertures **23** and its valued apertures **22** arranged in a pattern peculiar to its status in the binary system. Considering first the disposition of the valued apertures, each binary slide has its first valued aperture registerable with the column C corresponding in value with the number of such binary slide. In addition thereto each such slide has successive valued apertures related to successive columns up to but not including the next column corresponding in value to the next binary number, for example, binary slide No. 1 has its first valued aperture related to column No. 1 but none related to column No. 2. Binary slide No. 2 has its first valued aperture related to column No. 2 and a successive valued aperture related to column No. 3 but none related to column No. 4. Binary slide No. 4 has its first valued aperture related to column No. 4 and its next successive valued apertures related to columns Nos. 5, 6 and 7, respectively, but none at column No. 8. Binary slide No. 8 has its first valued aperture related to column No. 8 and its next successive valued apertures related to columns Nos. 9, 10, 11, 12, 13, 14 and 15 but none at column No. 16. This same pattern is repeated on each successive binary slide as illustrated diagrammatically in Fig. 5 of the accompanying drawings.

In addition to the foregoing each binary slide has successive sets of valued apertures, the first of each said additional set commencing with the second half of the preceding series of valued apertures on the next higher numbered binary slide. In other words, binary slide No. 1 has the first of its next series of valued apertures adapted to register with the second valued aperture in the first series thereof on binary slide No. 2 as follows:

Binary slide No. 1	1		1
Binary slide No. 2		2	2
Column number =	1	2	3

Binary slide No. 2 has the first of its next series of valued apertures adapted to register with the third valued aperture in the first series thereof on binary slide No. 4 thus:

Binary slide No. 1		1		1
Binary slide No. 2			2	2
Binary slide No. 4	4	4	4	4
Column number =	4	5	6	7

Binary slide No. 4 has the first of its next series of valued apertures adapted to register with the fifth valued aperture in the first series thereof on binary slide No. 8 as follows:

Binary slide No. 1	1		1		1		1	
Binary slide No. 2		2	2			2	2	
Binary slide No. 4				4	4	4	4	
Binary slide No. 8	8	8	8	8	8	8	8	8
Column number =	8	9	10	11	12	13	14	15

The foregoing spacing of each successive series of valued apertures repeats on each binary slide for compounding its binary value with that of another binary slide or slides. Thus it will be seen that binary slide No. 1 has a valued aperture worth 1 associated with every odd numbered column C. Binary slide No. 2 has a valued aperture worth 2 associated with all columns C where the value 2 is necessary to the making up of a valve opening at such columns. In other words, binary slide No. 2 has valued apertures in sets of two, first at columns 2 and 3, skipping the next two columns (4 and 5), then adjacent the next two columns (6 and 7) and so on. Binary slide No. 4 has valued apertures in sets of four one at each of columns 4, 5, 6 and 7, skipping the next four columns (8, 9, 10 and 11) then at the next four columns (12, 13, 14 and 15) and so on. Binary slide No. 8 has valued apertures in sets of eight, one at each of columns 8 to 15 inclusive, skipping the next eight columns (16 to 23 inclusive) then at the next eight columns (24 to 31) and so on.

From the foregoing, and from the schematic chart comprising Fig. 5, it will be seen that the arrangement of the valued passages of each valve member (slide) relative to the columns is related to the binary designation of that member as follows: a member whose binary designation is x, when moved into the actuated position, i.e., the effective or Out position in the illustrated embodiments of the invention has valued passages so positioned and located as to be in alignment only with columns designated by the series x through $(2x-1)$; $3x$ through $(4x-1)$; $5x$ through $(6x-1)$; $7x$ through $(8x-1)$ . . . , etc. Thus, for example, considering the member having the binary designation 8, which is shown in Fig. 4 in the actuated, effective or Out position, it will be observed from Fig. 5 that the valued passages **23** of this member will be aligned only with the columns designated 8 through 15, i.e., x through $2x-1$, 24 through 31, i.e., $3x$ through $4x-1$; 40 through 47, i.e., $5x$ through $6x-1$, etc.

Briefly stated, it may be said that each binary slide presents a valued aperture **22** to a column C in which such binary value is essential either alone or when compounded with one or more other binary values to make up a valve opening at a column corresponding in number with the total value of such single or compounded binary values.

From the foregoing it will be appreciated that with but four binary slides provided with valued apertures as explained above, it is possible to serve any one of fifteen of the columns C. A fifth slide, binary slide No. 16, provided with valued apertures in accordance with the foregoing pattern, and in conjunction with the preceding binary slides extended will serve up to 31 columns C and so on up the binary scale as is well illustrated diagrammatically in Fig. 5.

For purposes of clarity and to distingush all valued apertures from the passage apertures in Fig. 5, only the valued apertures **22** are shown as circles while each passage aperture **23**, although identical to a valued aperture, is represented by a dot. In this connection it will be noted that no passage aperture **23** (dot in Fig. 5) is provided on any one slide at a column adapted to be served by any one valued aperture in such slide. Thus it will be appreciated that all columns C are normally closed when all binary slides **20** are in ineffective or In position. However, when any particular binary slide is shifted to "Out" position all of its valued apertures become registered with those columns with which they are associated.

Thus it will be seen that if only one binary slide is shifted only that column C corresponding to the binary value of such slide will be opened to serve fluid under pressure to its tube **18**. By the same token, should any other binary slide also be shifted to "Out" position the column corresponding to the binary value of said one slide will be closed, and a valued aperture corresponding to the value of such other slide will be registered with a column C which already has registered with it a valued aperture corresponding to the value of the first named slide. The column thus served by these two valued apertures corresponds in number to the sum of the binary value of the two slides shifted to "Out" position.

Referring now more particularly to Figs. 1 and 2 it will be noted that each slide **20** has associated with it a means **50** by which such slide can be shifted from ineffective (In) position to effective (Out) position. This means **50** for all purposes and intent may be a straight forward push against a particular binary slide **20** or as illustrated in Fig. 1, a leverage **51**.

It will be appreciated that the several binary slides **20** fit snugly adjacent each other within the guideway **13**. If desired each slide **20** may have a return spring **52** connected thereto tending to return the slide to normal, ineffective or In position when aided by manual or mechanical force, as for instance by way of the leverage **51**.

Each leverage **51** is identical so that a description of one will suffice. The leverage **51** comprises a lever arm fulcrumed as at **53** somewhere between its ends. One end **54** is a tab or push button while the opposite end **55** is a yoke adapted for operative connection to its associated slide **20**. In this connection each slide **20** has a block or offset portion **56** adapted to fit within the yoke end **55** of its associated lever arm **51**. Consequently, upon manipulation of the lever arm **51** (counter-clockwise Fig. 1) the slide **20** associated therewith is shifted from ineffective to effective or Out position thus registering each valued aperture **22** on such slide with its related column C.

It should here be noted that once a slide is shifted to Out position its first binary valued aperture would immediately open up the column C associated therewith. Consequently, in order to serve only a column requiring several binary values, for example 2, 4 and 8 to serve column 14, it would be necessary to shift all of such binary slides (2, 4 and 8) simultaneously. While this simultaneous operation of the slides is contemplated, the present disclosure also includes the gate slide No. "0," previously explained, which has the function of cutting off flow of fluid through any of the columns C until the selected binary slides have been shifted from In to Out position.

With the foregoing in mind it will now be assumed that fluid under pressure is being supplied to the manifold chamber **12**. In order to serve tube **18** associated with the column C valued nine, binary slides No. 1 and No. 8 are shifted to Out position as illustrated in Fig. 4. In this connection it will be noted that column No. 9 is already open at binary slides No. 2, 4, 16, etc. for the reason that the passage apertures **23** on such slides are already or normally registered with that particular column (9). Once these slides No. 1 and No. 8 are properly shifted to Out position all of their passage apertures are misaligned with respect to the columns with which they were previously associated thus assuring that none of such columns will be opened. Simultaneously therewith column 9 is now conditioned for serving fluid. In the present disclosure when the gate or master slide No. "0" is shifted to Out position, fluid under pressure will discharge from the manifold **12** via column No. 9 into the tube **18** communicated therewith.

For the purposes of pointing out the magnitude of the present invention, Fig. 5 has been elaborated upon along its left hand margin. It will there be noted that the addition of each binary slide doubles the number of columns C which can be served. For example, it will be appreciated that when 20 slides are used such 20th slide would be identified as binary slide No. 524,288 which would serve up to column No. 1,048,375, the next (21st) binary slide numbered 1,048,376 serving up to 2,096,751 and so on.

In addition to the foregoing it will now be appreciated that the same results can be obtained with the structure illustrated in Fig. 7 in which shiftable bars **20''** are substituted for laminar slides **20**. In this arrangement fluid is supplied from the manifold **12''** as before into independent columnar ports. These ports are normally blocked by the shiftable bars **20''** guided in bores **13''** extending parallel to the manifold to traverse the columnar ports. These shiftable bars **20''** have annular grooves **21''** in lieu of apertures which grooves are either valued ones **22''** or passage grooves **23''** for the same reasons as explained in connection with the preferred embodiment of this invention.

The same results are obtained in an arrangement such as that depicted in Fig. 6 showing a plurality of coaxial tubes or sleeves **20'**. In this arrangement the innermost tube **14'** constitutes the manifold **12'** which has a plurality of radially arrayed apertures or ports as does the outermost tube **16'**. The intermediate coaxial tubes **20'** which are comparable to the slides **20** are provided with ports or apertures adapted to register or become offset relative to the radially arrayed apertures in the manifold wall **14'** and the plate or outermost wall **16'** of this arrangement. Each intermediate coaxial tube **20'** is provided with valued apertures **22'** and passage apertures **23'** in a pattern corresponding to that previously mentioned in the preferred embodiment so that when one or more of the coaxial tubes **20'** are rotated or turned relative to the others and the manifold, a columnar port is established at a preselected one of the radially arrayed apertures in the manifold. In this arrangement the intermediate coaxial members are also adapted for sliding movement lengthwise the manifold. To this end then the radially arrayed apertures in the manifold wall **14'** can be grouped in accordance with digital values so that one group thereof will serve ports from 0 to 9 and by shifting lengthwise the manifold **12'** another group of ports valued from 10 to 19 can be served if desired.

In any event it will be appreciated that the present invention embraces a series of collective, independently movable ported members adapted to assume one of two positions for serving a preselected identifiable columnar port to effect operation or transmit intelligence to some other instrumentality.

While the device herein has been described in specific detail it will be appreciated that it is susceptible to modification, alteration and/or variation without departing from the spirit of the invention it contains. I therefore desire to avail myself of all modifications, alterations, and/or variations as fairly come within the purview of the appended claims.

What I claim as new and desire to protect by Letters Patent is:

1. A permutation valve device comprising a manifold having a first plurality of aligned ports, means fixedly associated with said manifold in spaced relationship thereto, said means having a second plurality of aligned ports each of which is opposite to and in registry with a different manifold port, the pairs of opposite ports defining columns each of which is consecutively designated as 1, 2, 3, 4, . . ., etc., a plurality of valve members positioned in the space between said manifold and means in sealing and slidable relationship to said manifold and means as well as to each other, each valve member being individually movable between two positions, said positions comprising an actuated and a non-actuated position, each member having a first and second plurality of fluid passages therethrough designated respectively as valued and non-valued passages, the valued passages

being arranged so that they are not aligned or in register with any columns in the non-actuated position and are aligned with columns in the actuated position, and the non-valued passages being arranged so that they are in alignment with columns in the non-actuated position and are not aligned in the actuated position, each valve member being designated by a number chosen sequentially from the binary system beginning with 2°, the arrangement of the valued passages of each member relative to the columns being related to the binary designation of that member as follows: a member whose binary designation is x, when moved into the actuated position, has valued passages in alignment only with columns designated by the series x through $(2x-1)$; $3x$ through $(4x-1)$; $5x$ through $(6x-1)$; $7x$ through $(8x-1)$ . . . etc., and there being a non-valued passage for each member in every column except in those columns having valued passages.

2. An arrangement according to claim 1 wherein the valve members are cylindrical sleeves mounted telescopically one within the other, for slidable movement between actuated and non-actuated position.

3. An arrangement according to claim 1 wherein the valve members are flat strips and are movable slidably between said two positions.

4. An arrangement according to claim 1 wherein the valve members are rods slidably inserted in holes provided therefor in the means fixedly associated with the manifold, the fluid passages comprising grooves in said rods.

5. A permutation valve device comprising a manifold having a plurality of successive ports, each port defining a column, and said columns being consecutively designated as 1, 2, 3, 4 . . . etc., a plurality of valve members positioned in relatively superposed relation to cover the ports in said manifold and in sealing and slidable relationship to said manifold as well as to each other, each valve member being individually movable between two positions, said positions comprising an actuated and a non-actuated position, each member having a first and second plurality of fluid passages therethrough designated respectively as valued and non-valued passages, the valued passages being arranged so that they are not aligned or in register with any columns in the non-actuated position and are aligned with columns in the actuated position, and the non-valued passages being arranged so that they are in alignment with columns in the non-actuated position and are not aligned in the actuated position, each valve member being designated by a number chosen sequentially from the binary system beginning with 2°, the arrangement of the valued passages of each member relative to the columns being related to the binary designation of that member as follows: a member whose binary designation is x, when moved into the actuated position, has valued passages in alignment only with columns designated by the series x through $(2x-1)$; $3x$ through $(4x-1)$; $5x$ through $(6x-1)$; $7x$ through $(8x-1)$ . . . etc., and there being a non-valued passage for each member in every column except in those columns having valued passages.

References Cited in the file of this patent

UNITED STATES PATENTS

1,387,073	Reilley	Aug. 9, 1921
1,412,134	Probstel	Apr. 11, 1922
2,323,824	Maschmeyer	July 6, 1943
2,364,540	Luhn	Dec. 5, 1944
2,390,534	Heuver	Dec. 11, 1945
2,482,242	Brustman	Sept. 20, 1949
2,626,635	Eckstein	Jan. 27, 1953
2,641,280	Fleischhauer	June 9, 1953
2,751,933	Urteaga	June 26, 1956
2,774,821	Brown et al.	Dec. 18, 1956