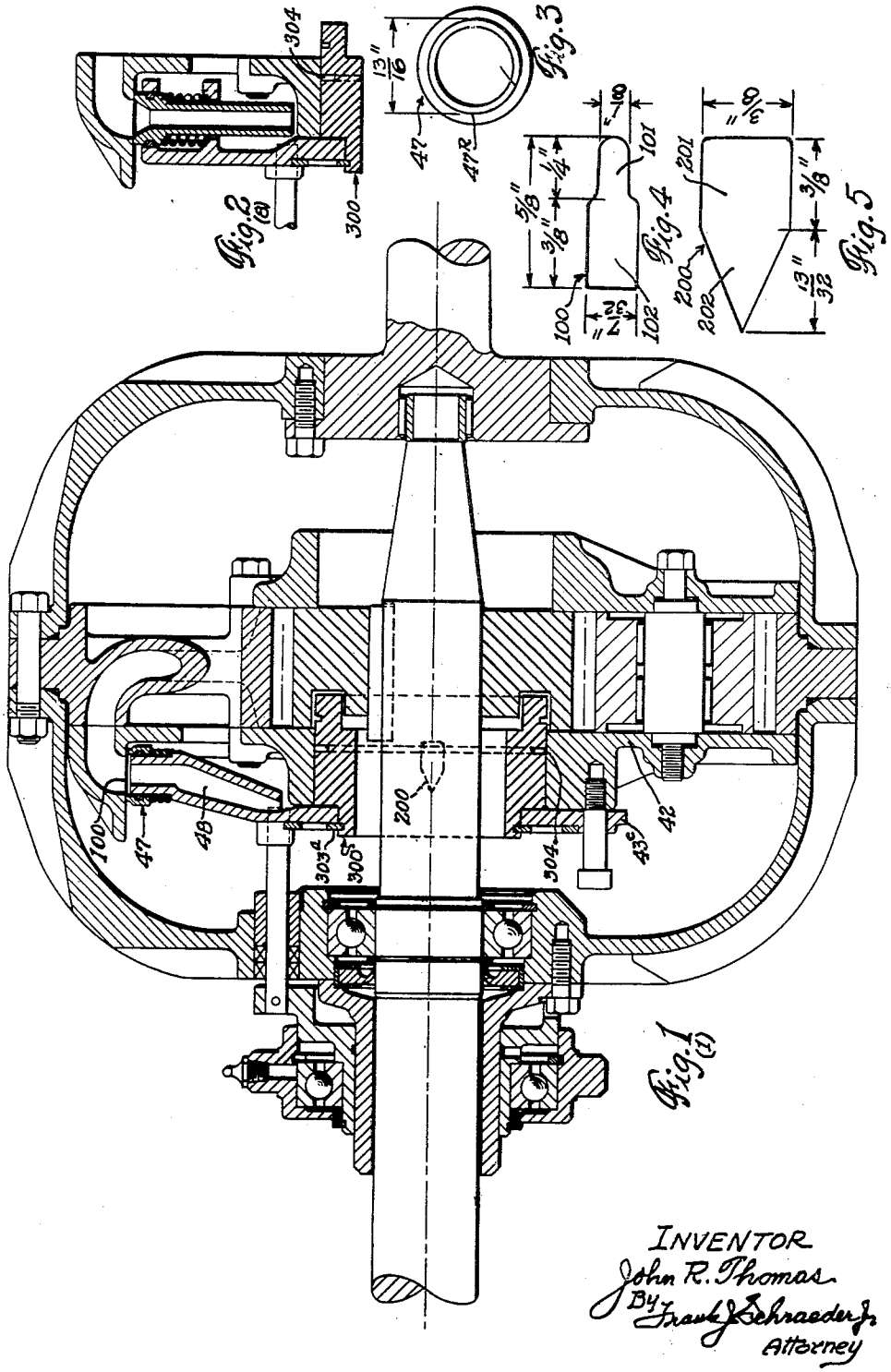
July 12, 1955 J. R. THOMAS 2,712,867

VARIABLE SPEED HYDRAULIC CLUTCHES

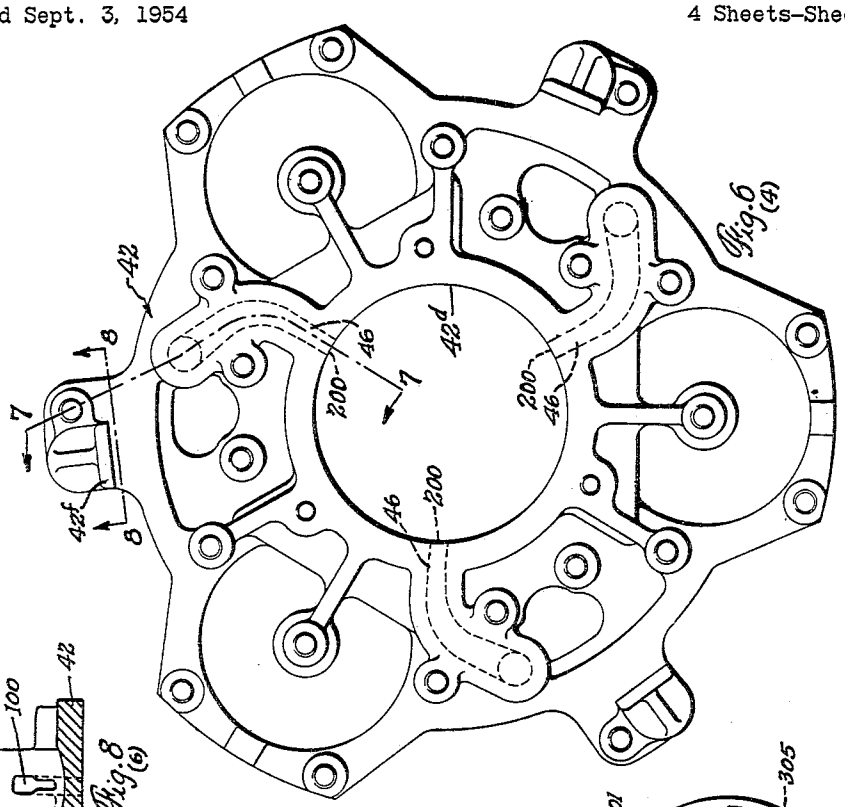
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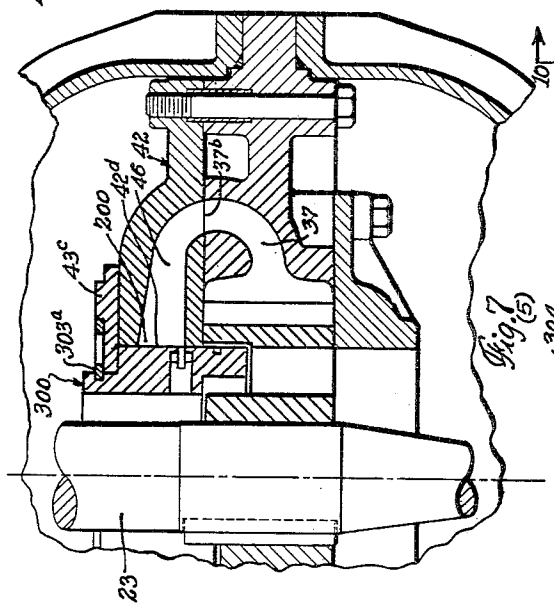
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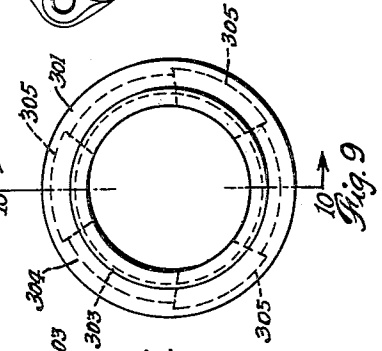
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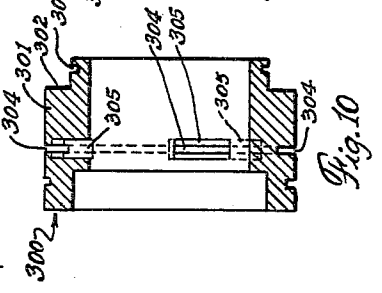









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VARIABLE SPEED HYDRAULIC CLUTCHES

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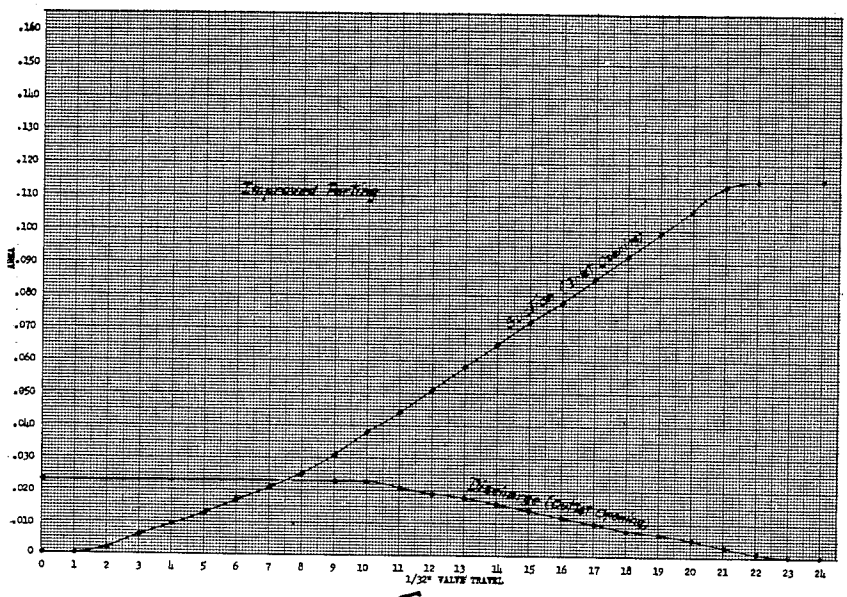



Fig. 11

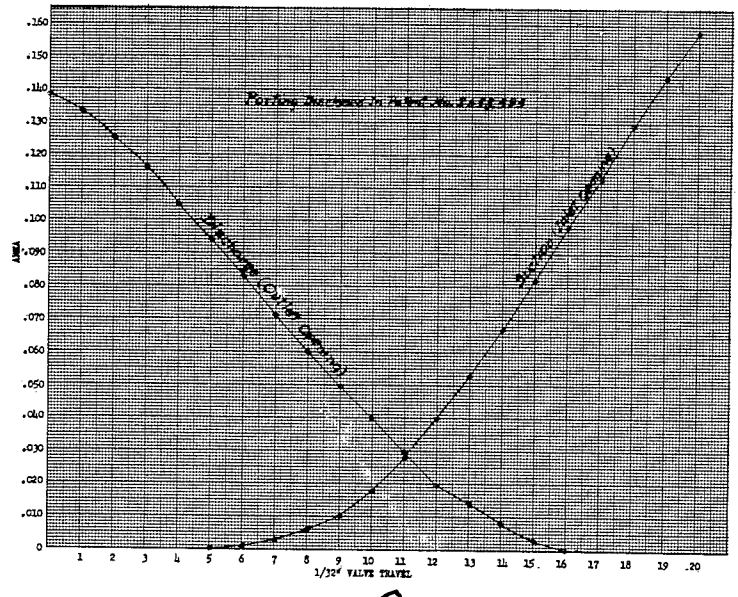



Fig. 12

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VARIABLE SPEED HYDRAULIC CLUTCHES

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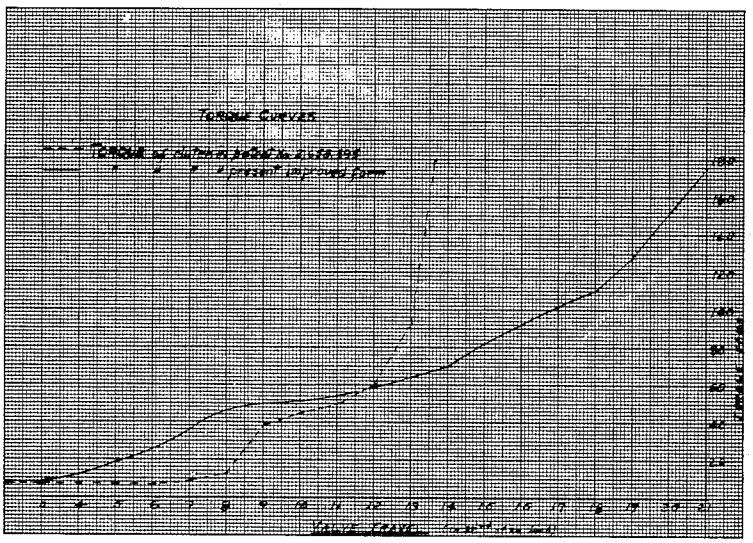



Fig. 13

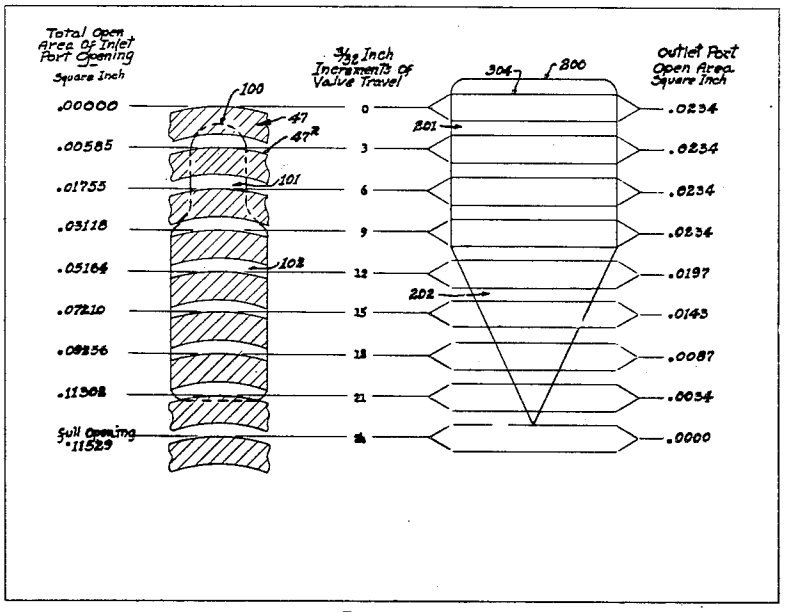



Fig. 14

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United States Patent Office

2,712,867

Patented July 12, 1955



2,712,867

# VARIABLE SPEED HYDRAULIC CLUTCHES

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Application September 3, 1954, Serial No. 454,155

13 Claims. (Cl. 192—61)

This invention is particularly directed to improving the operation and efficiency of a variable speed hydraulic clutch of the type and character disclosed in my Patent No. 2,658,595 issued November 10, 1953, to which reference is made herein for purposes of complete disclosure of the present invention.

An object of the present invention is to provide a new and improved hydraulic clutch transmission incorporating a porting of novel design and arrangement.

Another object of the present invention resides in the provision of a novel porting and discharge valve design and arrangement whereby a greater range and smoothness of controllability is attained.

Still another object of the present invention is found in providing a hydraulic clutch of the type disclosed in my prior Patent No. 2,658,595 with improved inlet and outlet openings for the fluid circuits therein and coordinating the movements of the intake and discharge control valves with respect to the improved inlet and outlet openings through the single fluid flow control instrumentality.

A further object of the present invention resides in the provision of an improved fluid discharge control valve for particularly restricting control of fluid flow from the outlet openings of the fluid circuits through the novel narrow annular slot in the outer peripheral portion of the body of the valve.

The various features of novelty whereby the present invention is characterized will hereinafter be pointed out with particularity in the appended claims, however, for a full understanding of the invention and of its objects and advantages, reference may be had to Patent No. 2,658,595 together with the following description taken in connection with the accompanying drawings, exemplifying a preferred embodiment of the invention, wherein:

Fig. 1 is a longitudinal section through a hydraulic clutch embodying my present invention; the section corresponding to that shown in Fig. 1 of said prior patent;

Fig. 2 is a vertical section of a modified form of one of the combined air and oil intake control valves illustrated in Fig. 8 of said prior patent but showing my improved discharge control valve;

Fig. 3 is a top plan view of one of the intake control valves;

Fig. 4 is a plan view of one of the fluid circuit inlet openings;

Fig. 5 is a plan view of one of the fluid circuit outlet openings;

Fig. 6 shows an outside elevation of the pump manifold;

Fig. 7 is an enlarged cross-section taken on line 7—7 of Fig. 6 showing one of the discharge ports of the manifold and a corresponding portion of the pump body and one of its discharge ports communicating with the manifold discharge port together with a portion of the novel discharge control valve;

Fig. 8 is a cross-section taken on line 8—8 of Fig. 6



showing one of the air and oil inlet openings in the pump manifold valve seat;

Fig. 9 shows an end elevation of the novel discharge control valve in the same enlarged scale as shown in Fig. 7;

Fig. 10 is a cross-section of the discharge control valve taken on line 10—10 of Fig. 9;

Fig. 11 is a chart showing comparative curves of a progressively increased oil intake area of an inlet opening and the corresponding uniform and progressively restricted discharge area of an outlet opening of a fluid circuit during the full range of movement of the flow control instrumentality from neutral to high position; the curves being of the new improved porting;

Fig. 12 shows comparative curves of the open areas of the inlet and outlet openings of porting disclosed in Patent No. 2,658,595 during full range of movement of the flow control instrumentality from neutral to high position;

Fig. 13 is a chart showing the comparative torque curves of a clutch constructed in accordance with said prior patent and when provided with the improved porting and discharge control valve disclosed herein; and

Fig. 14 is a chart showing diagrammatically several progressive positions of a portion of the rim of an intake control valve as compared to corresponding positions of the outlet control slot of the discharge control valve together with the corresponding progressively increased open areas of the inlet opening and the corresponding uniform and progressively decreased open areas of the outlet opening during the full range of movement of the flow control instrumentality from neutral to high position.

The preferred configurations and dimensions of the inlet and outlet openings shown in Figs. 4 and 5 are illustrative of the principles of the invention and, in the present instance, the dimensions of the inlet and outlet openings are those applicable to a clutch of the type disclosed in said patent capable of transmitting 44 horsepower at 1500 R. P. M.

Only certain pertinent principal elements of the clutch disclosed in said patent are designated herein by identical reference numerals employed for such elements in said patent; the elements shown but not designated by reference numerals are the same elements as employed in said patent.

All new elements disclosed in the drawings are designated by reference numerals with three digits beginning with numeral 100.

The numerals of the figures disclosed in the attached new drawings which are similar to those disclosed in said patent show in parentheses the numeral of the corresponding figure in said patent.

Among the new improved features of the present clutch are the following:

New fluid intake port inlet openings 100 shown in Figs. 4, 8 and 13 have been substituted for the inlet openings $45^a$ shown in Fig. 6 of said prior patent;

The discharge control valve 300 may preferably be formed separately from the body $43^c$ herein shown in Figs. 1, 2 and 7 operatively connected to the body $43^c$ by a suitable snap ring;

New fluid outlet openings 200 shown in Figs. 5, 7 and 13 are provided in the cylindrical seat $42^d$ in the manifold 42 under the control of the discharge valve 300; and

The discharge control valve 300 has been completely redesigned as herein shown in Figs. 1, 2, 7, 9 and 10; these discharge valve improvements have therefore substantially modified the old openings $46^b$ and $43^a$ in the manifold 42 and valve 43 respectively and have

eliminated entirely the stabilizing port 42e as more clearly shown herein in Fig. 7.

It should be noted that in the following exemplary disclosure of the intake control valves 47, the intake port inlet openings 100, and the discharge port outlet openings 200, all dimensions shown are applicable to a clutch of the character described transmitting 44 horsepower at 1500 R. P. M.

*The intake valves*

The intake control valves 47 empolyed herein are the same as disclosed in said patent; the effective outside diameter of the rim being 13/16 of an inch as shown in Fig. 3 herein.

*The intake port inlet opening*

As disclosed herein in Figs. 4, 8 and 13, each intake port inlet opening 100 may be described as consisting of a comparatively narrow open portion of 1/8 of an inch width extending outwardly axially from a semicircular edge of 1/16 of an inch radius for a length of 1/4 of an inch whereat this narrow open portion merges into an open portion of increased width of 7/32 of an inch which extends outwardly axially for a length of 3/8 of an inch. In other words, the length of the narrow portion of the opening is equal to substantially 2/5 of the total length of the entire opening; the width of the narrow portion is equal to substantially 4/7 of the width of the wider portion of the opening; and the width of the wider portion is equal to substantially 7/20 of the entire length of the inlet opening.

*The discharge port outlet opening*

As disclosed herein in Figs. 5, 6, 7 and 13, each discharge port outlet opening 200 may be described as consisting of an initial 3/8 of an inch square opening extended outwardly axially into an isosceles triangular form of opening whose altitude may be 3/8 of an inch but preferably is 13/32 of an inch. In other words, the altitude of the isosceles portion of the opening is not axially less in length than the axial length of the square portion of outlet opening, and, still in other words, the base of the isosceles portion is equal in length to the axial length of the square portion of the outlet opening.

Figs. 4 and 5 show respectively preferred improved configurations of the intake circuit inlet openings 100 and the discharge circuit outlet openings 200 which have been employed in successful coaction to produce the smooth progressively increased range of torque controllability shown in Fig. 13 wherein is also charted the comparative torque curve of a clutch constructed with inlet and outlet port openings in accord with said prior patent.

In the clutch herein disclosed, the pump manifold plate 42 is provided with a plurality of fluid intake extensions 42f each containing an intake port 45 having an inlet opening 100 as more clearly shown herein in Fig. 8.

*The fluid discharge control valve*

The fluid discharge control valve, generally designated by numeral 300, consists of a cylindrical hollow body 301 annularly recessed at its outer end, as at 302, for positioning within the triangularly shaped body 43c and is also provided with an annular groove 303 adapted to receive therein a snap ring 303a that operatively ties the valve to the body 43c for concurrent movement therewith. This valve is also provided with a comparatively very narrow annular fluid discharge slot 304, which in actual practice has been only 1/16 of an inch in width and which extends radially inwardly from the outer periphery of the valve body only partially into the body. Three preferably slightly inwardly converging discharge ports 305, circumferentially equally spaced, extend radially outwardly from their



open discharge ends within the inner cylindrical face of the body 301 into communication with the slot 304; the ports 305 being preferably wider axially of the valve than the slot 304. The discharge control valve 300 is axially movable upon the centrally disposed valve seat 42d of the manifold 42.

*Operation*

The general operation of the herein disclosed variable speed hydraulic clutch is described in said prior patent. As herein disclosed the combined intake and discharge valve control instrumentality includes the air intake passages 48 and their operatively associated air and oil intake control valves 47 together with the improved single fluid discharge control valve 300. In Figs. 1 and 7, the combined valve control instrumentality is shown in neutral position wherein only air is circulating through the gear pump.

As the valve control instrumentality is moved from neutral position outwardly, toward the left as viewed in Fig. 1, the intake control valves 47 will be moved to uncover progressively increased open areas of the intake inlet openings 100 throughout the full range of their movements. This is graphically illustrated by the suction curve shown on the chart in Fig. 11 and also the chart in Fig. 14. During this full range of movement there are being admitted into the pump circuits fluid mixtures of a progressively increased volume of oil and a progressively decreased volume of air. During such outward movements, the inlet control valves 47 first traverse the elongated narrow portions 101 of the inlet openings 100 and then traverse the wider portions 102 thus every advanced outward movement has the additive effect of uncovering progressively increased areas of inlet openings until the inlet openings are finally fully open to the inflow of only oil.

Concurrently with the outward movements of the intake control valves 47, as above described, the discharge control valve 300 is moved outwardly from its neutral position shown in Figs. 1 and 7 whereupon its flow control slot 304 is caused first to traverse the rectangular outlet areas 201 of the discharge outlet openings 200 and finally the progressively decreased triangular areas 202 of the outlet openings. This is graphically illustrated by the discharge curve shown on the chart in Fig. 11 and also the chart in Fig. 14. It will now be evident that during such progressive outward movement, the discharge control valve 300 constantly maintains predetermined uniform areas of uncovered outlet openings for and during nine increments of its initial movement whereupon the outlet openings progressively decrease in open areas until fluid discharge is completely arrested at which time the intake inlet openings 100 will have become fully open to the inflow of oil.

It will now be apparent that the fluid flow controlling elements of the concurrently movable intake and discharge valves are the outer circumferences 47R of the rims of the intake control valves 47 together with the slot 304 of the discharge control valve 300. The comparative graphic illustration of the concurrent movements of the inlet and outlet controlling valves, shown in increments of 3/32 of an inch, is found in Fig. 14.

In Figs. 3, 4 and 5 I have resorted to an exemplary use of dimensions that may be employed in clutches built to transmit 44 horsepower at 1500 R. P. M. Obviously, in relatively smaller or larger clutches these dimensions would accordingly be subject to variations without departing from the basic relative configurations of the fluid circuit inlet and outlet openings which I have found function in their coaction to produce the desired greater range and smoothness of controllability.

I claim:

1. In a clutch of the character described having a plurality of fluid intake circuits and a plurality of fluid discharge circuits each having respectively an inlet opening

and an outlet opening, including an axially movable fluid flow control instrumentality provided with a plurality of intake control valves for said inlet openings and a single discharge control valve for said outlet openings, said valves being concurrently movable during axial movement of the instrumentality and said inlet and outlet openings being of such configurations and so arranged axially of the clutch that in the progressive axial movement of the instrumentality each intake control valve is progressively movable to uncover a progressively increased open area of its corresponding inlet opening throughout its entire range of movement while simultaneously said discharge control valve traverses uniform open areas of said outlet openings during a predetermined initial portion of its range of movement and thereafter traverses progressively decreased areas of said outlet openings during the remaining portion of its range of movement until fluid discharge therefrom is completely arrested whereupon the intake circuit inlet openings are fully open to the inflow of oil.

2. In a clutch of the character described as set forth in claim 1 wherein said discharge control valve traverses said uniform open areas of said outlet openings during substantially one-half of its range of movement.

3. In a clutch of the character described as set forth in claim 1 wherein said discharge control valve traverses said uniform open areas of said outlet openings during an initial portion of not less than three-eights of its entire range of movement.

4. In a clutch of the character described as set forth in claim 1 wherein each of said inlet openings consists of a comparatively narrow open portion that is initially traversed by its corresponding intake control valve and that merges into a wider open portion, the length of said narrow portion being equal to substantially two-fifths of the total length of the entire inlet opening.

5. In a clutch as set forth in claim 4 wherein the width of said narrow portion of each inlet opening is equal to substantially four-sevenths of the width of said wider portion of the inlet opening.

6. In a clutch as set forth in claim 5 wherein the width of said wider portion of each inlet opening is equal to substantially seven-twentieths of the entire length of the inlet opening.

7. In a clutch of the character described having a plurality of fluid intake circuits and a plurality of fluid discharge circuits each having respectively an inlet opening and an outlet opening, including an axially movable fluid flow control instrumentality provided with a plurality of intake control valves for said inlet openings and a single



cylindrical discharge control valve for said outlet openings, said valves being concurrently movable during axial movement of the instrumentality whereby each intake control valve is progressively movable to uncover a progressively increased open area of its corresponding inlet opening throughout its entire range of movement while simultaneously said discharge control valve progressively traverses the plurality of outlet openings, each outlet opening consisting of an open initially traversed portion of uniform width extended axially outwardly of the manifold in an isosceles-triangular-shaped open terminal portion.

8. In a clutch as set forth in claim 7 wherein said isosceles-triangular-shaped terminal portion of each outlet opening is not axially less in length than the axial length of said portion of uniform width.

9. In a clutch as set forth in claim 8 wherein the base of said isosceles portion of each outlet opening is equal in length to the axial length of said portion of uniform width.

10. In a clutch as set forth in claim 9 wherein said discharge control valve consists of a cylindrical hollow body provided with a narrow annular fluid discharge slot extending radially inwardly from the outer periphery of said valve body only partially into said body, a plurality of discharge ports, circumferentially equally spaced, extending radially inwardly from said slot to their respective discharge openings within the inner cylindrical face of said body.

11. In a clutch as set forth in claim 10 wherein said circumferentially equally spaced ports are wider axially of the valve than said annular discharge slot.

12. In a clutch of the character described as set forth in claim 1 wherein said discharge control valve consists of a tubular body provided with a narrow peripheral fluid discharge slot extending inwardly from the outer periphery of said body only partially into said body, and a plurality of circularly equally spaced discharge ports extending inwardly from said slot to their respective discharge openings within the inner face of said tubular body.

13. In a clutch of the character described as set forth in claim 7 wherein said discharge control valve consists of a cylindrical hollow body provided with a narrow annular fluid discharge slot extending radially inwardly from the outer periphery of said valve body only partially into said body, a plurality of discharge ports, circumferentially equally spaced, extending radially inwardly from said slot to their respective discharge openings within the inner cylindrical face of said body.

No references cited.