Aug. 16, 1927. 1,639,087

D. F. GRAHAME

DRIVE FOR STOKERS

Filed March 20, 1922 6 Sheets-Sheet 1

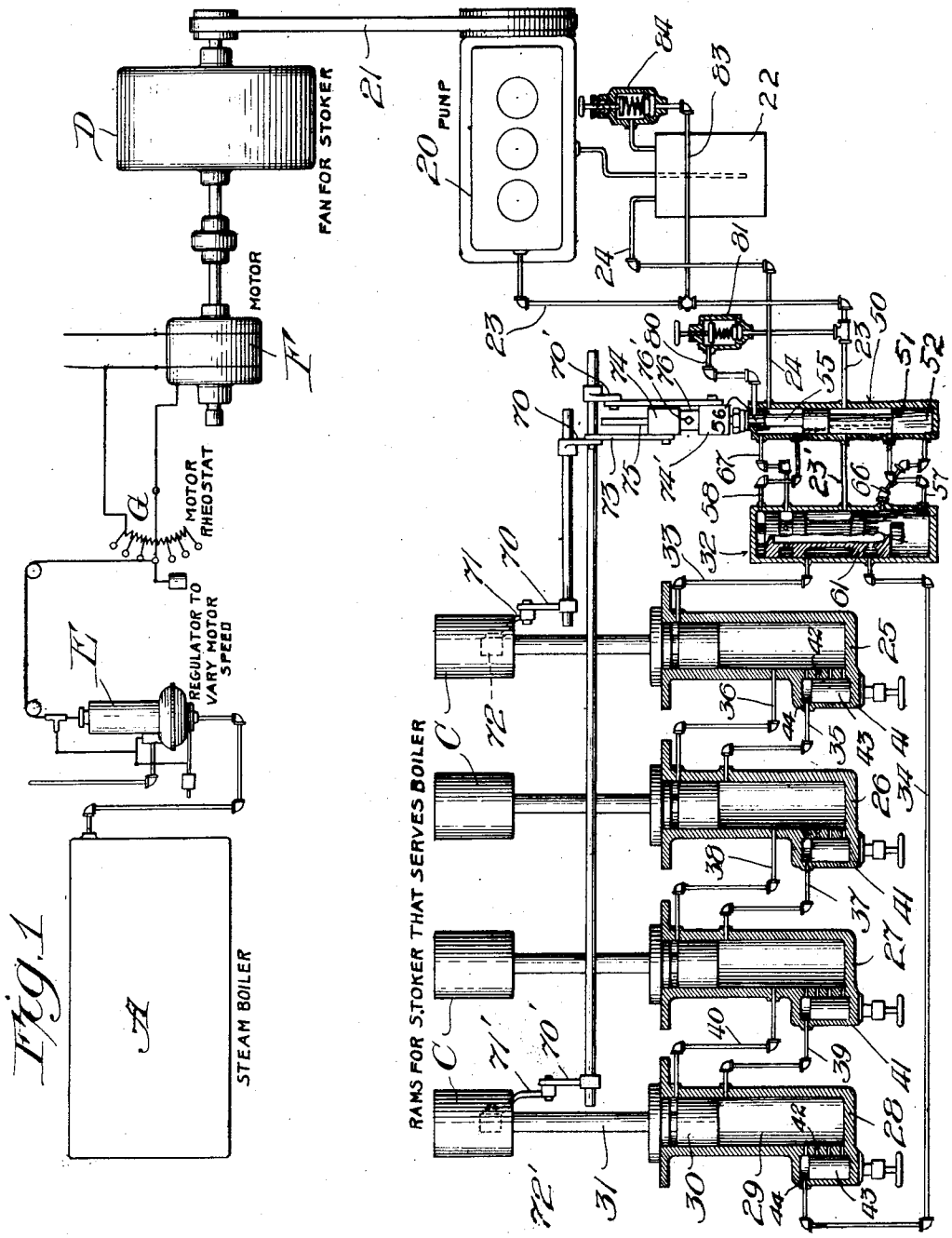


Fig. 1

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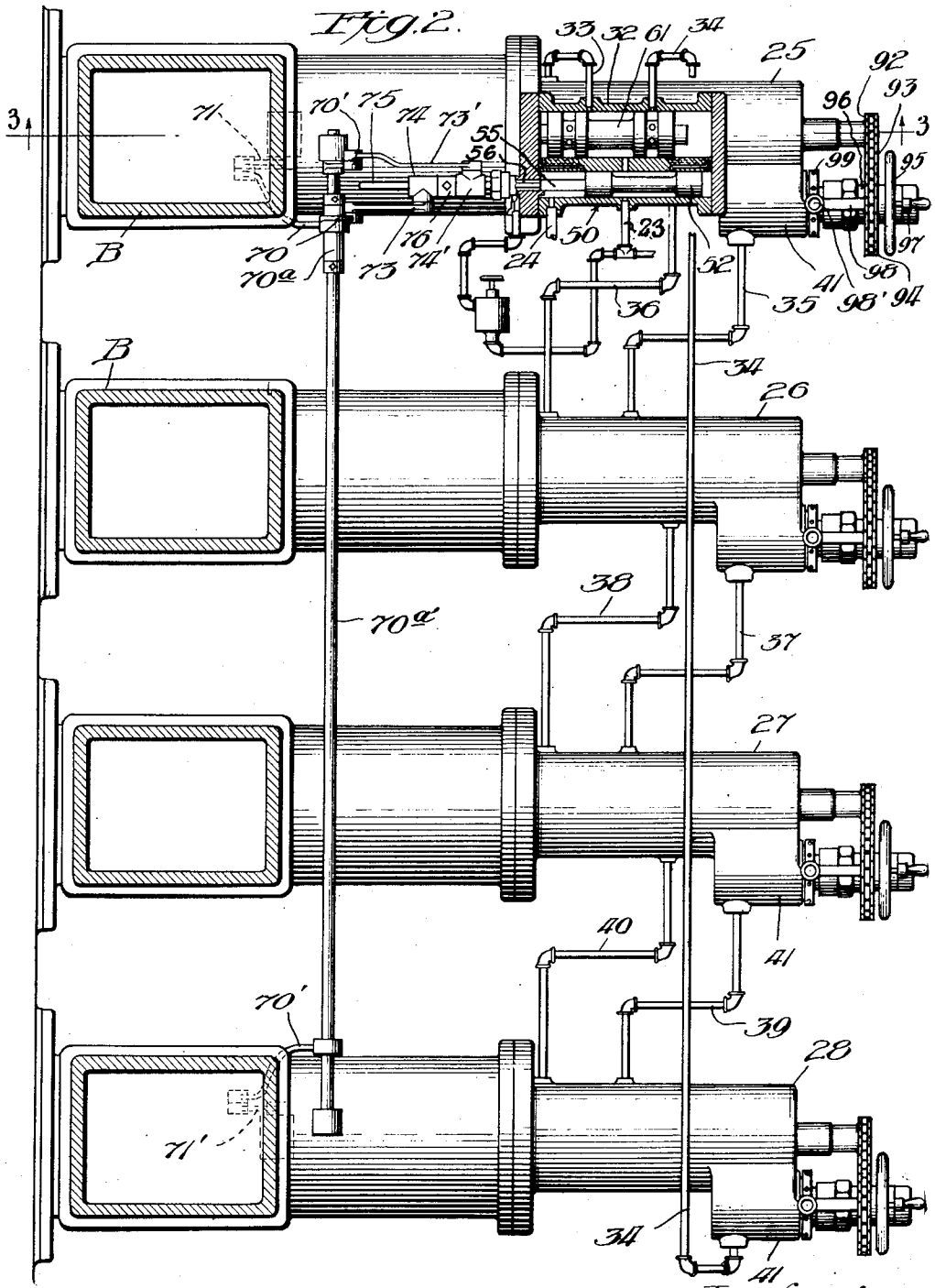
Aug. 16, 1927. 1,639,087

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DRIVE FOR STOKERS

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Fig. 2.



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DRIVE FOR STOKERS

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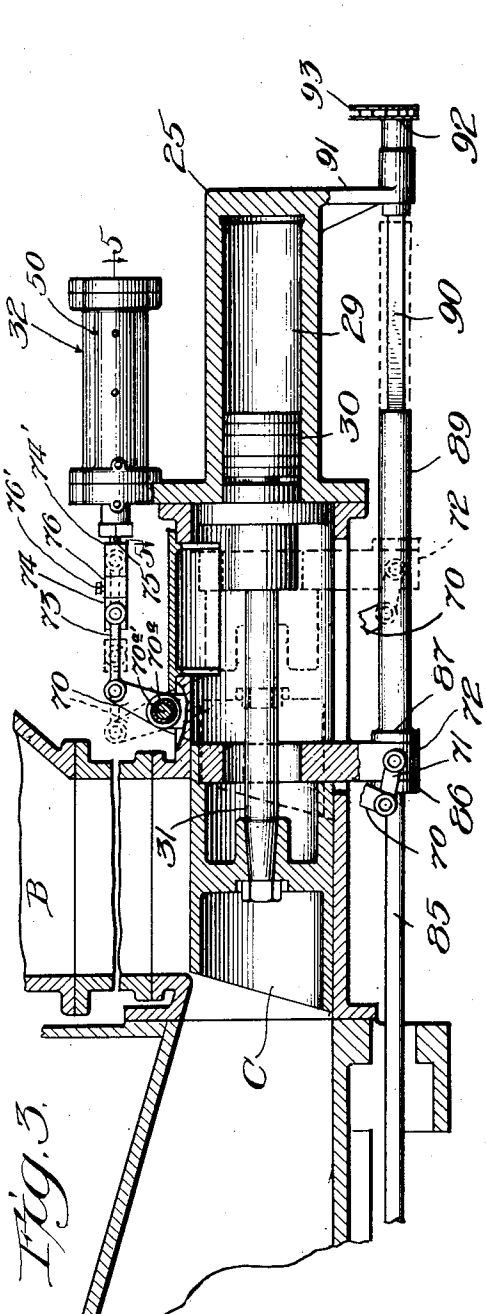


Fig. 3.

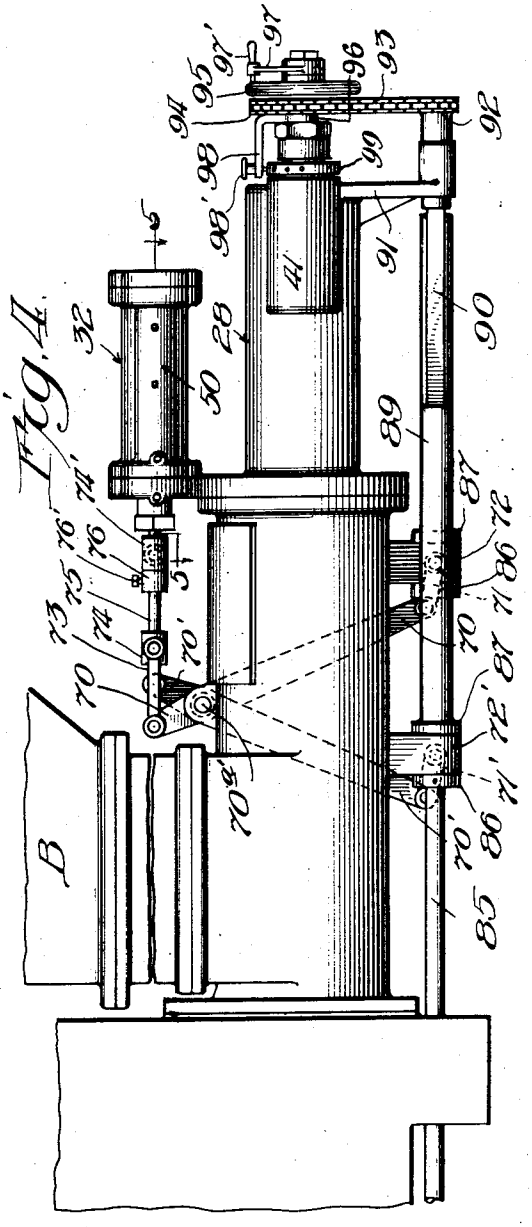


Fig. 4.

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Aug. 16, 1927. 1,639,087

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DRIVE FOR STOKERS

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Fig. 5.

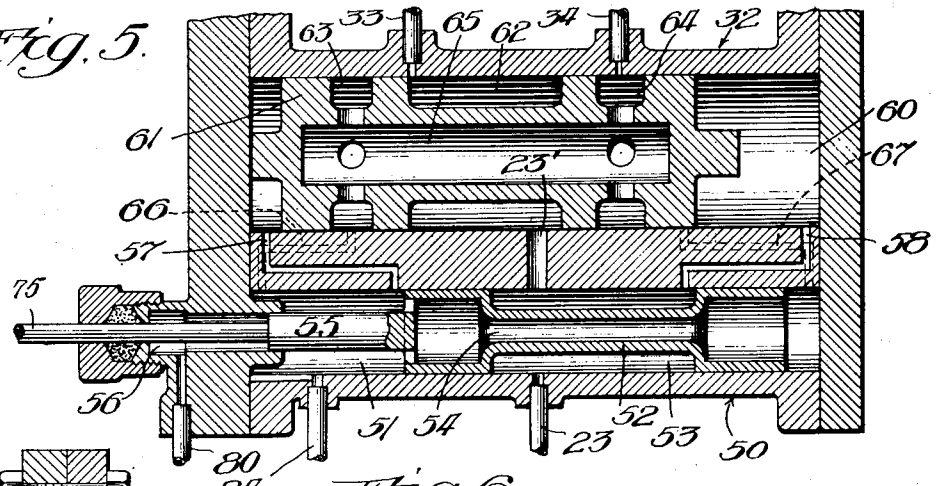


Fig. 6.

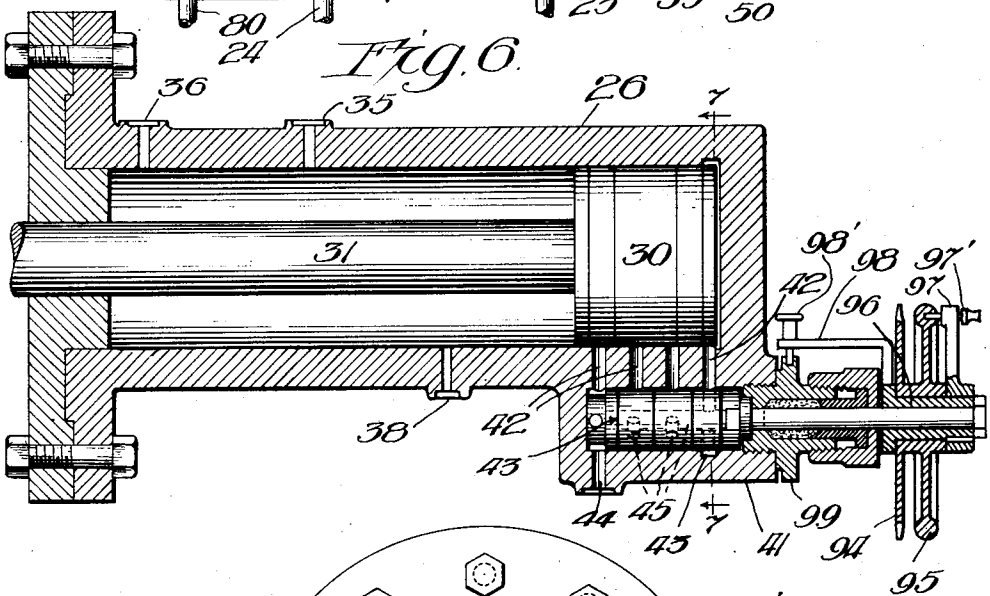
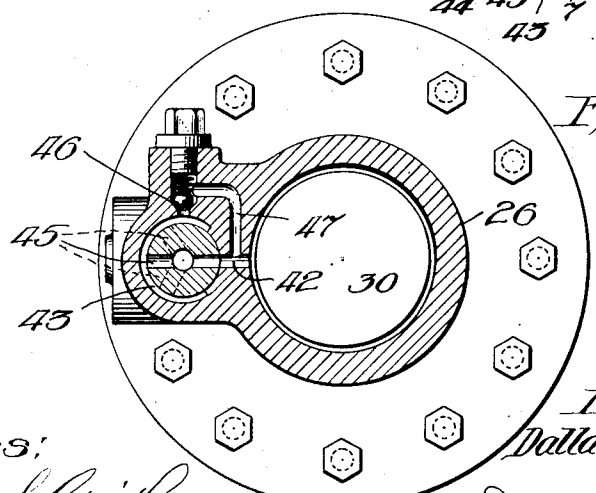


Fig. 7.



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DRIVE FOR STOKERS

Filed March 20, 1922 6 Sheets-Sheet 5

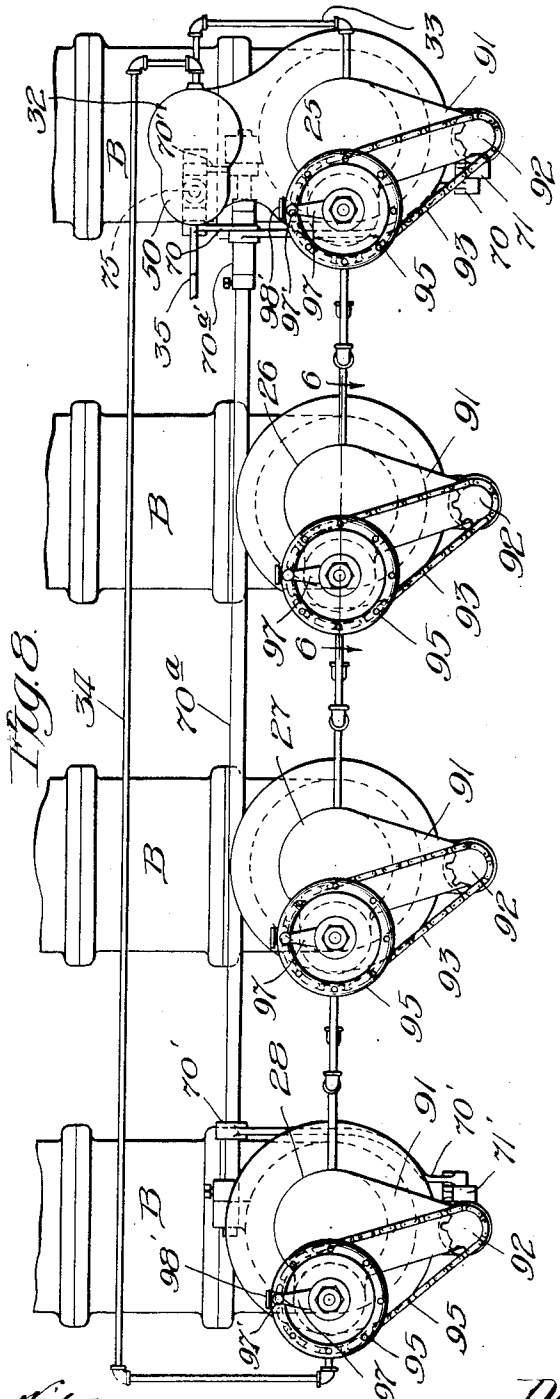


Fig. 8.

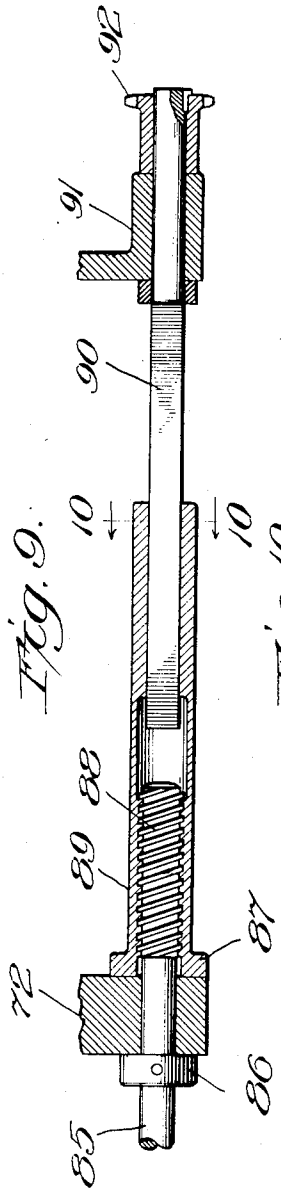


Fig. 9.

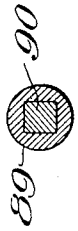


Fig. 10.

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DRIVE FOR STOKERS

Filed March 20, 1922 6 Sheets-Sheet 6

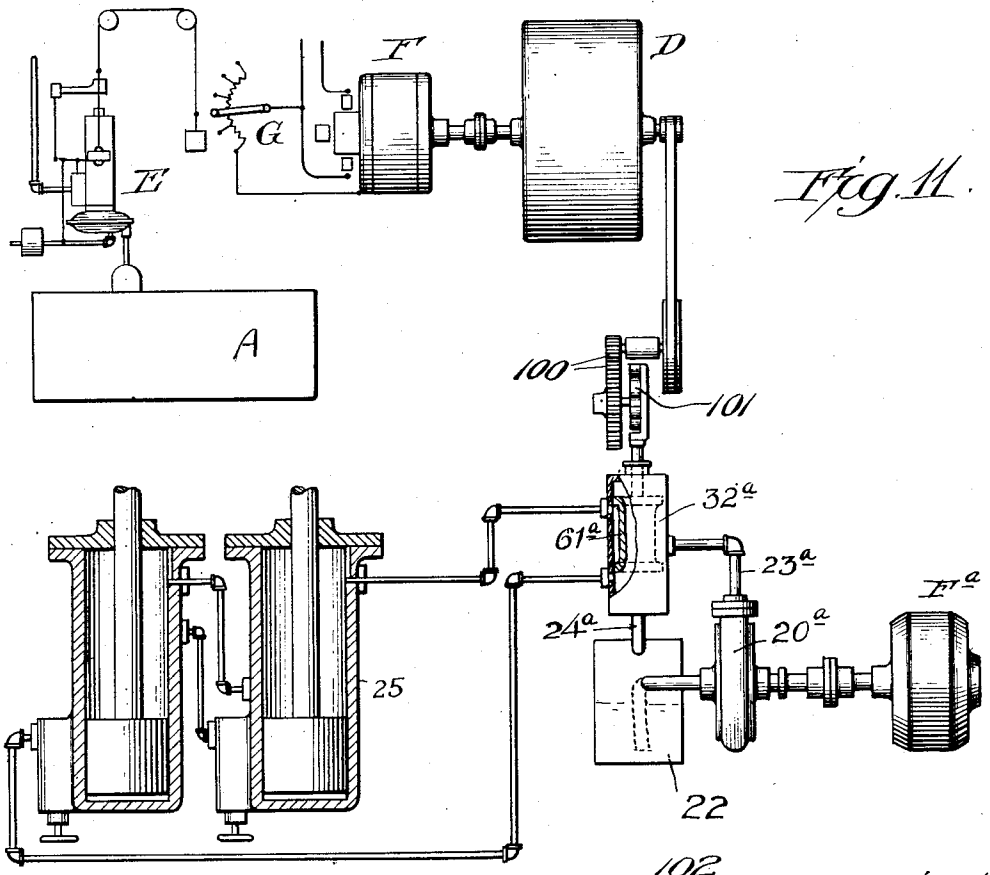


Fig. 11.

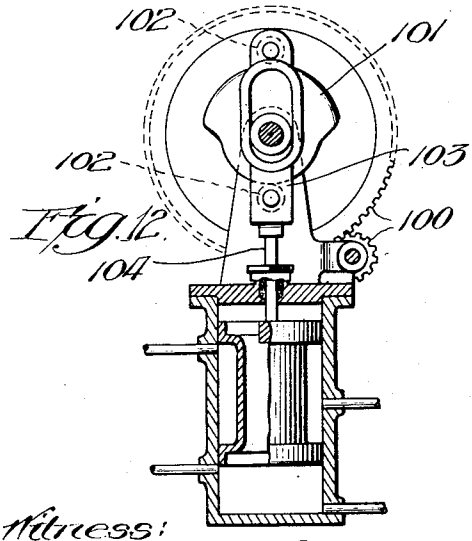


Fig. 12.

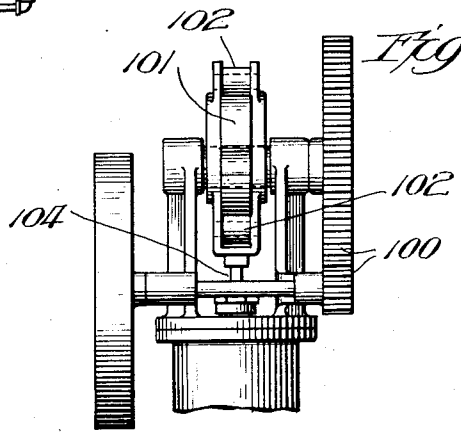


Fig. 13.

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Patented Aug. 16, 1927. 1,639,087

UNITED STATES PATENT OFFICE.

DALLAS F. GRAHAME, OF TORONTO, ONTARIO, CANADA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO RILEY STOKER CORPORATION, OF WORCESTER, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

DRIVE FOR STOKERS.

Application filed March 20, 1922. Serial No. 545,044.

My invention has for its general object to provide improved driving means for actuating the coal feeding rams of an underfeed stoker, and more particularly it provides an improved hydraulic drive for such rams.

In commercial practice it has been usual to employ either a purely mechanical drive or a steam drive for the ram, but each such practice has limitations and disadvantages which are obviated by my present hydraulic drive. Structural simplicity, low primary cost, operating economy, stabilization of power-demand, safety, low maintenance cost, and flexibility of control are more specific objects sought, and conjointly attained, in embodiments of my present invention.

For purposes of disclosure the accompanying drawings show the application of my invention mainly in diagrammatic form, for ease of understanding, without attempt at preserving proportions which will vary widely for different installations, as will be understood by those skilled in the art; and it will be appreciated that the specific structural embodiments shown and the arrangements which I illustrate may widely be varied to meet the specifications for different industrial installations.

In the drawings Fig. 1 is a diagrammatic representation of an installation embodying my invention, the ram cylinders, reversing valve, pilot valve, and other associated elements being shown in section; Fig. 2 is a plan view of a battery of rams, with parts of the hydraulic control mechanism broken away; Fig. 3 is a section that, as to the ram proper, is taken on line 3—3 of Fig. 2, but with auxiliary parts in elevation; Fig. 4 is a side elevation of the ram structures as viewed from the left (Fig. 1) of the series or battery; Fig. 5 is an enlargement of the valve structure on line 5—5 of Figs. 3 and 4; Fig. 6 is a horizontal section on line 6—6 of Fig. 8; Fig. 7 is a vertical section on line 7—7 of Fig. 6; Fig. 8 is an end elevation of the ram-battery; Fig. 9 is a detail of a pusher-rod adjuster, shown in vertical longitudinal section; Fig. 10 is a cross-section on line 10—10 of Fig. 9; Fig 11 is a diagrammatic view of a modified system embodying my invention; Fig. 12 is a side elevation showing the detail of a valve-operating portion and Fig. 13 is an elevation thereof from the right of Fig. 12.

It is well understood in the art that a boiler A, may be fired from a furnace which is equipped with an underfeed stoker having a battery of retorts each fed with fuel from its coal hopper B by means of a reciprocable ram or plunger C, air to support combustion being force-fed to the retort tuyères as from a fan D.

It is also known practice in underfeed-stoker equipment, automatically to govern air-supply and fuel-supply consistently with each other and with the demands of the boiler-pressure conditions, various specific organizations to this end being known. In Fig. 1, I diagrammatically illustrate a pressure-responsive regulator for controlling the fan-speed, the fan D being shown as operated from an electric motor F, and the regulator E suitably controlling the motor-rheostat G, so as to increase the fan-speed when the boiler pressure drops and decrease the fan speed as the boiler pressure rises. The fan D may, therefore, be taken as any automatically-controlled device from which the hydraulic system for operating the ram may, in turn, be controlled, in order thus to accommodate the ram-operations to boiler-pressure conditions.

In the construction illustrated in Fig. 1, 20 indicates a pump driven by connections 21 from the fan shaft and serving to take liquid from the sump 22, impel it through supply pipe 23 to the ram-engine for return to the sump through a return pipe 24. The several rams or plungers C are respectively operated by the engines 25, 26, 27 and 28 identical in general construction. Each engine involves a cylinder 29 and a piston 30, the latter connected by rod 31 with the appropriate ram C, each cylinder being connectible at opposite ends with a pressure pipe 23 and return pipe 24, and these connections being reversible as by a reversing valve structure 32 so that the piston may be reciprocated. The several engines of the battery I prefer to arrange for successive connection with the pump 20 as a source of pressure supply, so that, during each working piston-stroke, one piston only is in travel, the other pistons being inert. In so organizing the engines, for individual and

successive operation, I prefer to interconnect the engines in the hydraulic piping system so that each engine acts, in part, as a valve for control of the engine next to it in the series, so that (referring to Fig. 1), assuming pressure to be admitted behind the piston of cylinder 25, such piston will make its out-stroke or idling stroke and by so doing the piston of cylinder 25 will open a pressure connection behind piston of engine 26, and so on through the series, each piston successively making its out-stroke. Thereupon, pursuant to a suitable operation of the reversing valve 32, pressure connections to the extreme engines will be reversed and the piston of engine 28 will first make its in-stroke, opening pressure transferring connections for engine 27, and so on back through the series.

Specifically, inner end of cylinder 25 has a single piping connection 33 with valve 32, to be connected with either the pressure pipe 23 or the return pipe 24, according to the position of valve 32. Between the several engines of the series, engine 25 has connections 35 from its outer end port to a port of cylinder 26 more than piston-length from the inner head of the latter, and the inner end port of engine 26 has connection 36 to engine 25 more than piston-length from the outer head of the latter; such connections being duplicated at 37 and 38 as between engines 26 and 27 and at 39 and 40 as between engines 27 and 28. It will now be apparent that, assuming that valve 32 connects pipes 33 and 34, respectively, with pipes 23 and 24, the pump-pressure communicated through pipes 23 and 33 will first force out the piston of engine 25 until it opens the pipe connections 36, whereupon engine 26 will receive pressure and the outstroke of its piston will begin, and so on throughout the series until the piston of the end engine 28 is forced out. The sequence of operations having occurred, valve 32 may be shifted, (as by automatic engine operated means hereafter to be described) to reverse the pressure and return connections so as to connect pipe 23 with pipe 34 and pipe 33 with pipe 24, whereupon the piston of engine 28 will first be forced inward until it opens connection 39, so communicating pressure to the engine 27, and so on back through the line.

I prefer that the length of stroke of each engine shall be variable to permit of individual adjustment of the feeding capacity of each ram, and further I prefer that this adjustment shall be effected by limiting the out-stroke of the piston. For this purpose, each engine cylinder has at its outward end a plurality of ports 42 arranged at different distances from the cylinder head, these opening to the casing 41 for a rotary valve 43 that constitutes the throw-controller. Port 44 (for the appropriate pipes 34, 39, 37 or 35, as the case may be) also opens to this valve chamber, and is left, by the shape of the valve 43, in constant communication with the innermost port 42. The valve body has an appropriate center passage and branch passages therethrough, generally indicated at 45, whereby rotary movement of the valve may, at the will of the operator, close off all other ports from free communication with port 44 or may open any selected one of the outer-stage ports 42 for free communication with said port 44. Thus if the outer three ports of the four that are shown be all closed, the piston 30 will stop as soon as it passes the innermost of the ports 42, by virtue of the cushion of liquid imprisoned in the end-space of the cylinder. In order, however, to insure free pressure-introduction to the outermost of the ports 42, regardless of the position of valve 43, I provide the by-pass structure clearly shown in Fig. 7, wherein a check-valve 46 is arranged in the passage 47 which affords at all times a check-valved passageway between the outermost engine port 42 and the piping port 44. While, with the construction as shown, it is true that a piston which is in the course of making a full out-stroke, under an appropriate setting of the stroke-governing valve 43, opens the pressure communication to the cylinder next in sequence before the out-stroke of the first said piston is completed, the resultant tendency to slow the stroke of both pistons until the first-named piston reaches the end of its out-stroke is not objectionable, since the rams are not doing their heaviest work under this condition. On the in-stroke each ram completes practically its full excursion before any pressure is permitted to pass to the next cylinder in line.

The period of time consumed in effecting a full reciprocation of all rams of the battery may be made to vary so as generally to accord with the requirements of the boiler for maintenance of the desired steam pressure, and to accomplish this I preferably use the fan-shaft (which itself may be controlled as to rotative speed from the boiler pressure as hereinbefore described) as a convenient and desirable instrumentality of control. Thus, in the construction shown in Fig. 1, the fan shaft drives the positive pump; pump delivery varies in accordance with speed; time consumed in the travel of the piston and ram varies with the pump delivery, and the terminal rams or engines themselves govern the reversing action of valve 32, so making the aggregate period of a cycle of operation depend upon the fan-speed. In the modification shown in Fig. 11, the pump employed is a constant-delivery pump; the ram-engines themselves have no control over the valve 32, but the valve action is directly controlled from the fan shaft, so that the cyclic periodicity is thus made variable.

In the construction shown in Fig. 1 the control of the engine-battery over the reversing valve 32 is effected through the intermediacy of a pilot valve 50, as further illustrated in greater detail in Fig. 5. Pilot valve 50, itself controlled by the extreme engines of the battery, functions principally to admit pressure into one end or the other of the cylinder for reversing valve 32, to actuate the latter valve. Specifically, cylinder 51 of the pilot valve 50 has center connection with pressure pipe 23 and an end connection with return pipe 24, and the sliding valve member 52 has between its heads the pressure space 53 and through its body has the open passage 54 to connect the end-spaces of the cylinder 51. Additionally, for purposes to be described, the valve may carry an emergency piston 55 as a valve-stem enlargement, this piston working (preferably somewhat loosely) in a cylinder extension 56, but this refinement may be omitted as far as normal operation of the valve is concerned. The pressure space 53 of the valve is constantly open thru passage 23′ to the center of reversing valve 32, and the shifting of pilot valve 52 controls only two passages 57 and 58, which lead into opposite end spaces of the reversing valve. Alternately, the valve 52 opens one of these passages to the pressure space 53 and the other said passage to an end space of the pilot valve, and consequently to the return pipe 24.

The reversing valve 32 has in its cylinder 60 a valve-piston 61 providing between its heads the pressure space 62 and in each of its heads a channel, 63 or 64, these two channels communicating with each other through a central bore 65. This valve controls the pipe-connections 33, 34 alternately to open either thereof to the pressure space 62, and the other thereof to a head-channel 63 or 64; and it also controls two return passages 66 and 67 which lead to the end chambers of pilot valve 50 and so to the return pipe 24, the arrangement being such that in either position of the reversing valve one of these passages is open to a head channel 63 or 64 and the other is closed by a head of said reversing valve. Referring to Fig. 5, it is obvious that if the pilot valve be moved from the position shown to its leftward limit of movement, the reversing valve will be pressure-moved to its rightward limit of movement, reversing the flow connections between the pump-pipes 23, 24 and the engine pipes 33, 34.

Referring to Fig. 1, a condition is shown wherein, valve 50 having been brought to the position illustrated, reversing valve 32 has just completed its movement to the position shown, connecting the pressure pipe 23 with engine pipe 33 and the engine pipe 34 with the return pipe 24. Now, as the piston of engine 25 begins its out-stroke, a lever device 70, suitably pivoted between its ends (as by mounting its sleeve portion 70^a on shaft member $70^{a'}$), is rocked, by virtue of its link connection 71 between its lower left end or arm and the arm 72 of the ram for engine 25, from the full-line position to dotted-line position shown in Fig. 3. Accordingly link 73 connected with the upper right end or arm of said lever pulls a slide-block 74 along the stem extension 75 of the pilot valve, moving said slide block away from the collar 76 which is fast to the said valve stem extension. This idling movement of the slide-block 74 does not disturb the setting of pilot valve 50, but it does free the valve stem to be moved by another slide block 74′ which rides upon the valve stem on the opposite side of collar 76. This other slide block has link and lever connections to be worked by the ram-arm 72′ of the ram for cylinder 28, these being identical in character with those heretofore described, except that the rock shaft $70^{a'}$ takes the place of sleeve 70^a, the numerals applied to parts of this second link-and-leverage train being the same as those applied to like parts of the train first described, differentiated by the exponent (′). That condition of this lever system which prevails from the time that engine 25 completes its out-stroke until engine 28 subsequently starts its outstroke is shown in Fig. 4, and it will be apparent that when the extreme engine 28 makes its outstroke, the lever 70′ will be moved into register with the position of lever 70, causing slide block 74′ to carry the collar 76 leftward, so shifting the pilot valve. Of course, when the pilot valve shifts, reversing the pressure connections to the end chambers of the reversing valve, the reversing valve in turn shifts, resultantly connecting pressure pipe 23 with engine pipe 34, and engine pipe 33 with return pipe 24, so that immediately upon completion of this shift engine 28 starts again on its in-stroke, moving slide-block 74′ away from collar 76 of the pilot valve stem and initiating the return half-cycle of operation.

In a system as above described it is desirable to protect the apparatus against damage and interruption of coal feed that might be occasioned by a ram sticking, as sometimes it may do on its in-stroke if an obstruction gets lodged in the coal-feeding throat. By making a connection 80 between supply pipe 23 and the end of the cylinder 56 for the emergency piston 55, (Fig. 5) and including in such connection a relief valve 81 arranged to open when the pressure reaches a predetermined amount higher than the maximum normal working pressure, such a safety provision may be embodied. It will be seen that should a ram stick on its in-stroke, pressure will

build up until the valve 81 opens, admitting high pressure to the cylinder 56 for the emergency piston 55 and driving the pilot valve to its position shown in Fig. 5, accordantly producing a movement of the reversing valve such that the obstructed ram (and those which have completed their in-stroke) will be forced back to out-stroke position. Ordinarily this will be effective to loosen the obstruction. Incidentally, it will be apparent that by loosening the set screw 76′ which positions the collar 76 on the pilot valve stem, the pilot valve may be made subject to manual control, so as to be shifted only at the pleasure of the operator, the preferred looseness of fit of emergency piston 55 permitting such operation when relief valve 81 is closed. And as a further protective refinement, a by-pass connection 83 may be made direct from the pressure pipe 23 to the sump 22 and provided with a relief valve 84 tensioned to open at a somewhat higher pressure than is valve 81.

Reference has been made to the fact that the out-throw limit of the piston for each engine 25 to 28 may be varied by rotary adjustment of the valve 43 (Fig. 6), and I preferably make provision whereby adjustment in this particular may simultaneously effect adjustment of the throw of the stoker pusher-rod 85. It is well known practice in underfeed stokers to cause the ram to actuate a pusher-rod 85 which acts upon the coal in the retort, an arm such as the arm 72 on the ram acting on stops 86 and 87 on the pusher-rod, one of said stops being adjustable. In order that the throw of the pusher-rod may be varied accordantly with, or independently of (as desired), the stroke-length of the ram-engine, I thread the outer end of the pusher-rod as at 88, provide the stop 87 as a head on an internally threaded sleeve 89, and engage the outer, square-socketed end of said sleeve slidably with the squared portion of an adjusting rod 90 which I mount in a bracket 91 to be rotated by means of sprocket-wheel 92. A chain 93 connects this sprocket-wheel with the sprocket-wheel 94 which, together with its connected hand wheel 95, is rotatable on a sleeve 96 secured to the stem of the valve 43. This sleeve is connectable at will with hand wheel 95 through arm 97 and pull latch 97′, and when the sleeve is rotated by means of a valve-rotating handle (either 97 or 98) it may therefore carry with it the sprocket 94, rotating the sprocket-wheel-driven parts and adjusting the sleeve 89 along the pusher rod. Of course when the latch 97′ is disengaged from the numerous holes provided therefor in the hand wheel 95, the valve adjusting handle 97 and the pusher-rod adjusting wheel 95 may independently be operated. Sleeve 96 may be latched as by a pull-latch 98′ through handle 98 engaging a fixed, apertured rim 99.

In résumé of operation of the construction shown in Fig. 1, the fan D that supplies air to the stoker is driven at a speed which is variable, through the action of regulator E, accordantly with the requirement to maintain pressure in boiler A, and the pump 20, driven from this fan shaft, accordingly supplies pressure to the hydraulic actuating system for the fuel-feeding ram-engines, the pump-delivery varying as the pump-speed varies with the fan-speed. Under the conditions shown the pump will supply pressure through connection 23, 23′, 33 to the first engine 25 to cause its piston to travel on its out-stroke, the range of out-stroke travel of the piston being regulated by adjustment of valve 43 (Fig. 6). The fluid which initially is on the out-stroke side of the piston finds escape through pipes 35, 37, 39 and 34, the interior of valve member 61 and passage 66 to the return pipe 24 and sump 22 from which the pump draws its liquid supply. As the piston of engine 25 passes the port of pipe 36, pressure is admitted from engine 25 to the next engine 26, and so on throughout the battery until the last engine 28 makes its out-stroke. By action of ram arm 72′ on 70′, etc., this last engine, 28, on its out-stroke, shifts the pilot valve 50 to reverse position, so connecting the end chambers of reversing valve 32 with the pressure pipe 23 and return pipe 24, respectively, that said valve 32 is shifted to the other end of its range, thereby establishing pressure connection between the supply pipe 23, and engine pipe 34 and return connection from engine pipe 33 to the pipe 24. Accordantly the piston of engine 28 makes its in-stroke, followed in succession by each of the other pistons. Should any piston stick on its in-stroke, by reason of obstruction of the fuel-throat, valve 81 will open to admit high pressure to the cylinder 56 (Fig. 5) for the emergency piston 55 of the pilot valve, thereby shifting the pilot valve in an emergency reverse. On any complete stoppage, as from blocking of the pilot valve, a relief valve 84 will open to "short circuit" the pressure pipe 23 directly to the sump, when the pressure builds up to a predetermined danger point.

In the modified construction shown in Figs. 11 to 13, I illustrate the employment of a centrifugal pump 20^a, driven by its own electric motor F^a, and dispense with the pilot valve 50 and its operating mechanism by providing a mechanical drive for the valve and connecting the pressure pipe 23^a of the pump directly with the pressure chamber of the reversing valve 32^a. This valve, having

its shiftable element simplified to the open-cored form shown at 61ª, has its outlet passage communicating directly by pipe 24ª with the sump. Such a valve may be mechanically actuated, and the time of its operation may be controlled consistently with the requirements of the boiler for maintenance of steam pressure, as by the specific construction which I have diagrammatically illustrated, comprising a gear-set 100, operated from the shaft of fan D to drive, at suitably reduced rate of speed, the cam-wheel 101 which engages the rollers 102 of yoke 103 upon the stem 104 of the reversing valve.

In applying reference characters to the modified form illustrated in Figures 11 to 13, I have employed like reference numerals to indicate parts which are identical with the parts previously described; for parts which have been modified I have employed the same reference numerals with the suffix "a"; and for new parts I have employed new reference numerals.

It will be observed that each hydraulic drive system described is capable of operation without provision of pressure-tank, and with equipment such that the power demand may be well stabilized and minimized, and also may be derived from sources other than the steam boiler itself. By my invention I attain a flexibility of operation advantageously superior to such mechanical drives as usually have been employed, and an avoidance of the steam consumption that, in many intallations, bans the use of steam-actuated engines for the rams.

It will be understood that in this hydraulic system any suitable liquid may be employed, oil being preferred; and it will be apparent to those skilled in the art that in the application of my invention to specific installations many changes in details of construction and arrangement may be made without departure from the spirit of my invention within the scope of the appended claims.

I claim:

1. In an underfeed stoker drive, the combination with a plurality of rams, of respective engines associated therewith, a source of supply of liquid under pressure, means for supplying the liquid to said engines, and dependent pressure connections between the engines to cause said engines to make their respective working strokes non-concurrently.

2. The combination with an underfeed stoker having a plurality of rams, of a hydraulic drive therefor comprising engines each operatively associated with its ram, a source of supply of liquid under pressure, and means for connecting said source with said engines to effect their out-strokes in one order of succession and their in-strokes in another order of succession.

3. The combination with a plurality of stoker rams and respective reciprocatory engines operatively connected therewith, of a fluid pump, means for connecting the pressure pipe for said pump to either extreme engine, and interconnections between the engines for pressure transfer from one to the other, for sequential operation of said engines by pressure introduced into an extreme one thereof.

4. In an underfeed stoker drive, the combination with the boiler, fuel-feeding rams and reciprocatory engines for said rams, of a source of supply of liquid under pressure, a reversing valve and connections between the engines and said valve, constituting a system for hydraulic actuation of said engines, and a driving element, automatically controlled as to speed in accordance with boiler pressure, said element operatively connected to a part of said hydraulic system automatically to vary the periodicity of operation of said valve.

5. The combination with a boiler and a plurality of stoker rams therefor, of respective engines for said rams, a liquid pump, connections including valving means for supplying pump pressure to said engines to operate them, means for cyclicly operating said valving means, variable speed driving means for the pump, and means controlled by the boiler pressure for varying the speed of said driving means.

6. The combination with a plurality of stoker rams, of respective reciprocatory engines operatively connected therewith, interconnections between the several engines of the series for pressure transfer from one to the other, and means for supplying liquid under pressure to either extreme engine of the series.

7. The combination of a plurality of stoker rams, respective reciprocatory engines therefor, inter-connections between the several engines of the series for pressure transfer from one to another, a liquid pump, and connections, including a reversing valve, for connecting said pump alternately with the extreme engines of the series.

8. The combination with a plurality of stoker rams, of respective reciprocatory engines operatively connected therewith, liquid pressure supply means, means for connecting said supply means with said engines to operate them including a shiftable valve, and connections between the extreme engines of the series and said valve for shifting said valve in opposite directions upon the actuation of the respective extreme engines.

9. The combination with a boiler, a plurality of stoker rams, a variable speed fan, and means controlled by the boiler pressure for regulating the fan speed, of a hydraulic system for operating said rams comprising

a plurality of engines respectively associated with the rams, liquid pumping means, and means for connecting said pumping means with the engines; and a connection between said fan and a part of said hydraulic system for varying the periodicity of cyclic operation of the engine accordantly with variations in boiler pressure.

10. The combination with a boiler, underfeed stoker rams therefor, and respective engines associated with said rams, of a variable speed pump for supplying liquid under pressure to said engines, means controlled by the boiler pressure for driving the pump at varying speeds to produce various working pressures, and a relief valve for the pump arranged to open at a pressure above normal working pressure.

11. The combination with a plurality of stoker rams with respective reciprocatory engines operatively connected therewith, a source of liquid pressure supply, means for connecting said engines reversibly with said source of pressure supply for successive operation, including a shiftable valve, automatic means for normally cyclicly operating said valve, and auxiliary automatic means for shifting said valve before the time for its normal operation upon sticking of a ram.

12. The combination with a plurality of stoker rams with respective reciprocatory engines operatively connected therewith, of a liquid pump, means including a shiftable valve to connect it with the engines to operate them in sequence, mechanical means operated by said engines for shifting said valve in normal operation; and pressure-controlled means for shifting said valve upon occurrence of abnormal pressure condition in the hydraulic system.

13. The combination with a stoker ram of a reciprocatory engine therefor, a liquid pressure pump for supplying liquid under pressure to said engine, automatic means for alternately connecting opposite ends of the cylinder of said engine with said pump, and valve means controlling ports at an end of the engine cylinder for varying the throw of the piston and ram.

14. The combination with a stoker ram of a reciprocatory engine therefor, a liquid pressure pump for supplying liquid under pressure to said engine, automatic means for alternately connecting opposite ends of the cylinder of said engine with said pump, and valve-controlled means at one end of the engine cylinder arranged to afford an inlet passage adjacent to the cylinder head and outlet passages at different distances from the cylinder head for varying the length of stroke of the piston and ram.

15. In combination, an underfeed stoker ram and its pusher-rod, a ram operating engine, means for varying the length of engine stroke, means for varying the pusher-rod throw, and operative connections between the last two said means for harmonious adjustment thereof.

16. In combination, an underfeed stoker ram, a pusher-rod therefor, an adjustable connection between the pusher rod and ram for varying pusher-rod throw, a ram operating engine, shiftable valve-means for varying the effective engine-piston throw, and operative connections between said valve and the pusher-rod adjusting means for varying their adjustment harmoniously.

17. In an underfeed stoker drive, the combination of a plurality of rams, of respective engines associated therewith, a source of supply of liquid under pressure, means for supplying the liquid to said engines, and fluid pressure connections dependently connecting said engines to cause said engines to make their working strokes non-concurrently.

18. In an underfeed stoker drive, a plurality of rams, an operating cylinder associated with each ram, and fluid pressure connections dependently connecting said cylinders to cause the non-concurrent operation thereof.

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