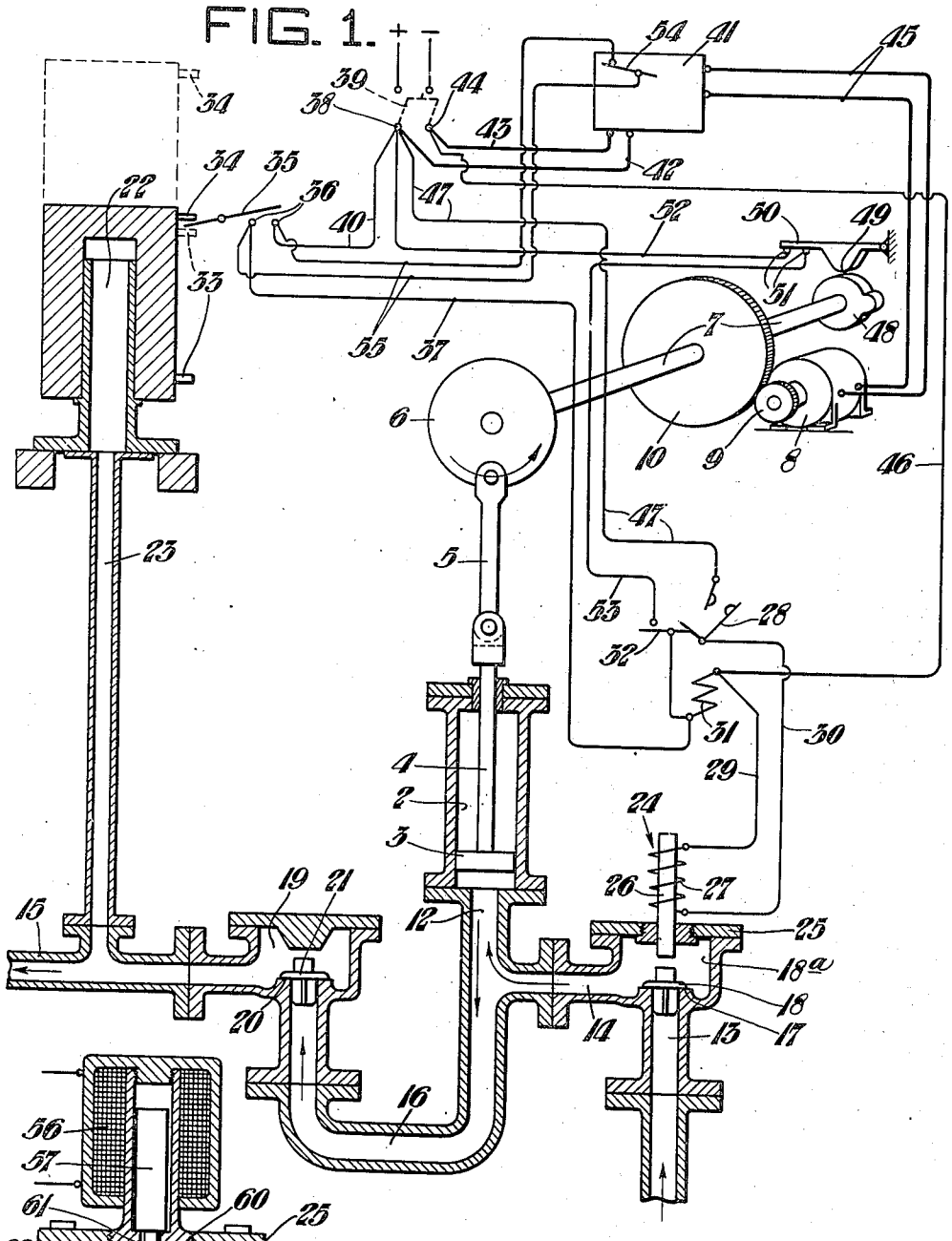
Dec. 14, 1943. C. L. BRISTOL 2,336,526

MEANS FOR CONTROLLING THE OPERATION OF PUMPS AND THE LIKE

Filed July 2, 1941

FIG. 1.



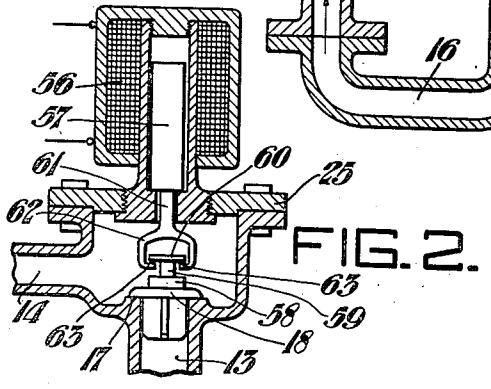


FIG. 2.

Inventor:
CHESTER L. BRISTOL,
by: John E. Jackson
his Attorney

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MEANS FOR CONTROLLING THE OPERATION OF PUMPS AND THE LIKE

Chester L. Bristol, Elyria, Ohio, assignor to National Tube Company, a corporation of New Jersey

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4 Claims. (Cl. 103—40)

This invention relates to pumps and the like, and particularly to an improved means for controlling the operation of the same.

There is oftentimes provided with pumps for pumping liquids and gases an accumulator or storage means, such as a tank, for storing the particular liquid or gas being pumped from its source of supply. Heretofore, it has been the common practice to provide means for automatically starting the pump when the accumulator or other storage means is about empty and means for automatically stopping the pump when the accumulator or storage means becomes filled. Oftentimes the liquid consumption of the devices connected to the discharge line is extremely great, thereby resulting in the accumulator or storage means being filled and emptied quite frequently over a relatively short period of time, thus necessitating very frequent stopping and starting of the driving motor and the pump. Such frequent starting constitutes abnormally severe duty on the pump and its associated equipment, and since the pump is usually started under full load conditions, that is, against the back-pressure produced by the head of liquid in the accumulator or storage means, it is evident that terrific electrical and mechanical stresses are set up in the parts of the pump and the driving motor which consequently result in excessive maintenance and repair costs. Furthermore, such frequent starting under load results in an abnormally heavy drain on the electrical supply which, of course, is objectionable, as well as expensive.

Accordingly, it is the general object of the present invention to provide an improved means for permitting a pump to operate continuously and uninterruptedly after it is desired that the liquid being pumped no longer be discharged therefrom, which is simple and inexpensive in its construction and use and, at the same time, one which is efficient and effective.

It is a further object of the invention to provide an improved means for arresting one of the valves of the pump from movement so as to maintain the valve in an open position after it is desired that the liquid being pumped no longer be discharged from the pump whereby the liquid passes back and forth through the open valve as a result of the continuous pumping operation thereof.

It is a more specific object of the invention to provide a solenoid for holding one of the valves of the pump in an open position after it is desired that the liquid being pumped no longer be discharged from the pump, whereby the liquid passes back and forth through the open valve as a result of the continuous pumping operation of the pump.

Various other objects and advantages of this invention will become more apparent during the course of the following specification and will be particularly pointed out in the appended claims.

In the accompanying drawing there is shown, for the purpose of illustration, one embodiment which my invention may assume in practice, and a modification thereof.

In this drawing:

Figure 1 is a vertical section through a pump showing schematically the improved means of my invention incorporated therewith for controlling the operation of the same; and

Figure 2 is a vertical section through the inlet valve showing a modification of the solenoid assembly for actuating the valve.

It will be understood that the improved means of my invention may be used for controlling the operation of either liquid or gas pumps of both pressure and vacuum types, having one or more single or double-acting cylinders and with either single or multiple valves for each cylinder, but in the present instance it is shown merely for the purpose of illustration incorporated with a single cylinder, single action liquid pump having one intake or suction valve and one discharge or exhaust valve.

In the drawing there is shown, in Figure 1, a simple pump consisting of a cylinder 2 in which there is positioned a reciprocable piston 3 carried by a piston rod 4. The upper end of the piston rod 4 is connected through the connecting rod 5 to a crank 6 carried by a shaft 7. The shaft 7 is driven by motor 8 through the action of a gear 9 carried by the shaft of the motor and a gear 10 carried by the shaft 7.

The bottom of the cylinder 2 is connected to a pipe 12 which is, in turn, connected to an inlet or intake pipe 13 by means of a pipe 14. The pipe 13 is connected to the source of supply of the liquid (not shown). The pipe 12 is also connected to a discharge or outlet pipe 15 by means of a pipe 16. There is arranged between the inlet pipe 13 and the pipe 14 an inlet valve chamber 18a having arranged therewith a valve seat 17 and an inlet valve 18 which cooperates therewith. There is also provided, between the outlet or discharge pipe 15 and the pipe 16, a discharge valve chamber 19 having similarly arranged therewith a valve seat 20 and a discharge valve 21 which cooperates therewith.

To one side of the pump there is mounted a

storage means, preferably a conventional type accumulator 22, which serves as a reservoir or storage for the high pressure side of the pumping system and which is connected to the discharge side of the line or the discharge pipe 15 by means of a pipe 23. Accumulator 22 moves to the position as shown in the broken lines of the drawing when it is filled to capacity and assumes the position shown in the full lines of the drawing when it is empty, in a well known manner.

According to the present invention, there is arranged, preferably with the inlet chamber 18a, an electromagnet or solenoid 24 which is adapted to maintain the inlet valve 18 in an open position for a purpose hereinafter to be described. The solenoid 24 is preferably mounted in a top or cover 25 of the inlet chamber which is preferably made of a non-magnetic material. The solenoid consists preferably of a core 26 and coil 27 and is mounted in the cover 25 in a leak-proof manner. The core 26 is positioned so that it will be in magnetic contact with the inlet valve 18 when the latter is in its most upward or open position. All, or at least a portion, of the inlet valve 18 is constructed of a magnetic material so that it will be attracted to the core 26 when the coil 27 is electrically excited. The solenoid or magnet coil 27 is controlled by means of a magnetic switch 28 to which it is connected by means of wires 29 and 30. There is associated with the magnetic switch 28 an operating coil 31 and an electrical interlock 32.

There is arranged on one side of the accumulator 22 an outwardly extending arm-like member 33 adjacent the bottom thereof and directly thereabove adjacent the top thereof a similar outwardly extending arm-like member 34. To one side of the accumulator there is mounted a snap or toggle switch 35 having a pair of contacts 36. The arms 33 and 34 are adapted to cooperate with and operate the switch 35 with the lower arm 33 adapted to close the switch when the accumulator approaches its upper, or filled, position, as shown in the broken lines of the drawing, and with the upper arm 34 adapted to open the same when the accumulator approaches its lower, or empty, position, as shown in the full lines. One of the contacts 36 of the switch 35 is connected to the coil 31 by means of a wire 37 and the other contact 36 thereof is connected to one of the terminals 38 of a main switch 39 by means of a wire 40.

There is provided a conventional type starting box 41 having one side thereof connected to the main switch 39, with one wire 42 thereof connected to the terminal 38 of the switch 39 and the other wire 43 connected to the other terminal 44 of the same. The opposite side of the starting box 41 is connected to the motor 8 by means of wires 45. The terminal 44 of the main switch 39 is connected also to the coil 31 by means of a wire 46 and the other terminal 38 thereof also is connected to the magnetic switch 28 by means of a wire 47.

An electrical contact making and breaking mechanism or timer arrangement to be operated by the movement of the pump mechanism is preferably provided. Such a mechanism preferably consists of a cam 48 securely mounted on the shaft 7 and which is adapted to cooperate with a cam follower 49 preferably carried by a pivoted arm 50 mounted opposite the cam. The pivoted arm in one position is adapted to cooperate with contacts 51 so as to close the circuit therethrough. Thus, it will be seen that the rotative movement of the cam 48 will alternately open and close the contacts 51. One of the contacts 51 is connected to the terminal 38 of the main switch 39 by means of a wire 52 and the other contact is connected to the electrical interlock 32 by means of wire 53.

There is also preferably provided with the starter 41 an auxiliary contact or interlock 54 which is arranged to remain electrically closed circuited at all times except when the motor 8 is running, fully accelerated. The interlock 54 is connected to the contacts 36 of the switch 35 by means of a pair of wires 55.

The improved pump-controlling means of my invention functions in the following manner. The main switch 39 is first closed so that the current will pass through the lines 42 and 43 to the starting box 41. The starting box is then manipulated so as to permit current to flow through the conductors 45 to the starting motor 8 which drives the piston 3 of the pump through the action of gears 9 and 10, shaft 7, crank 6, connecting rod 5 and piston rod 4. As the piston 3 moves upward, or away from the position shown in Figure 1 of the drawing, on its intake or suction stroke, the discharge valve 21 will remain closed on its seat 20 as shown due to back-pressure in the line 15 and its own weight and the intake valve 18 will be lifted from its seat 17 and opened by the pressure of the liquid from the intake line 13. This permits the liquid being pumped to enter the inlet chamber 18a and the pipe 14 from which it flows in the direction of the arrow into the pipe 12, thence into the cylinder 2 in front of the piston 3 therein.

At the end of the intake stroke of the piston 3, the flow of the liquid into the cylinder ceases, thus permitting inlet valve 18 to drop by its own weight and be fully seated upon its seat 17. Upon the downward movement of the piston 3, the liquid is forced out of the cylinder 2 into pipe 12 in the direction of the arrow and since inlet valve 18 is now closed, the pressure of the liquid flowing from cylinder 2, due to the action of the piston 3, forces open the discharge valve 21 and raises it from its seat 20, thus permitting the liquid to flow from the pipe 16 in the direction of the arrow, past valve 21 into the discharge chamber 19 and thence into the discharge line 15. When the piston 3 completes the discharge stroke by reaching the initial starting position, as shown in the drawing, the discharge flow of the liquid ceases and discharge valve 21 drops to a seated position on its seat 20. This completes one revolution of the crank 6 and completes one cycle of the pump operation, and continued rotation of the crank repeats the cycle as above described.

As has been heretofore explained, in many pump installations the consuming devices connected to the end of the discharge line 15 do not require continuously the full liquid capacity of the pump and, therefore, storage means is provided for storing the liquid. In the present case there is provided the accumulator 22 for storing the excess liquid. In addition to its storage capacity, the accumulator, by reason of its weight and the head of the liquid therein, serves to maintain a constant pressure in the pipe 23 and the discharge pipe 15 to which it is connected during the intake stroke of the pump and during the period of idleness of the piston 3.

It will be seen that if either the inlet valve 18 or the discharge valve 21 can be made temporarily inoperative by holding one of the valves in its open position, the pump can be indefinitely op-

erated without stopping the same even after it is no longer desired to discharge the liquid from the discharge line 15 and after the accumulator 22 has become filled. That is, with the pump in operation, the liquid being pumped would be forced back and forth through the open valve and the pump would not produce sufficient piston pressure to open the other valve or discharge valve against the high pressure produced by the accumulator and, consequently, the pump would operate without load. It is more desirable to apply this control feature to the inlet valve and for this reason the controlling means of the present invention, namely, the electromagnet 24, is shown incorporated with the inlet valve 18 in the present instance.

The electromagnet 24, and its associated parts, functions in the following manner. Assuming the pump is to be started after a period of idleness, with the accumulator 22 being empty and all of the parts of the pump being in the position shown in Figure 1 of the drawing, the pump will function as previously described until the accumulator 22 is filled and raised to the position as shown in broken lines of the drawing. As the accumulator 22 is moved to its filled or upper position, the lower extending arm 33 carried thereby will actuate the switch 35, thus closing the contacts 36. An electrical circuit is then established from the terminal 38 or the positive side of the line of the switch 39 through wire 40, contacts 36, wire 37, coil 31 and wire 46 to the terminal 44, or the negative side of the line at switch 39. The current, in passing through the coil 31, closes magnetic switch 28 and there is then established a circuit from the terminal 38 or the positive side of the line of the switch 39 through the wire 47, the wire 30, the coil 27 of the solenoid 24, wires 29 and 46, to the terminal 44 or the negative side of the line of the switch 39. The current, in passing through the coil 27 of the solenoid 24, magnetizes the core 26 thereof which, in turn, attracts, through the action of magnetic force, the inlet valve 18 and holds the same in its open position, thus permitting the pump to continue to operate, but remaining unloaded as above described. This condition prevails until the consumption of the liquid through discharge line 15 nearly depletes that stored in the accumulator 22.

As the liquid in the accumulator flows therefrom, the accumulator moves downwardly to the position shown in the full lines of the drawing, and as it approaches its lowermost position, the upper arm 34 carried thereby actuates or opens the switch 35 so as to break the contact between the terminals 36 thereof thereby opening the circuit therethrough. It will be seen that the breaking of the circuit through the switch 35, of course, also opens the circuit through the coil 31. However, the magnetic switch 28, controlled by the coil 31, does not necessarily open immediately upon the breaking of the circuit through coil 31 since, when closed, a holding or sealing circuit was established from the terminal 38, or the positive side of the line of the switch 39 through the wire 52, the pivoted arm 50, the contacts 51, the wire 53, the electrical interlock 32, the coil 31, the wire 46, to the terminal 44, or the negative side of the line at the switch 39. This holding or sealing circuit maintains the magnetic switch 28 closed with the coil 27 of the solenoid 24 being still magnetized and, consequently, the valve 18 still being held in its open position thereby. The magnetic switch 28 is held in its closed position until the cam 48 carried by the shaft 7 strikes the cam follower 49 and moves the arm 50 about its pivotal connection out of contact with the contacts 51, thereby breaking the circuit through the arm 50 and the magnetic switch 28, permitting the same to open. This opening of the magnetic switch 28 deenergizes the solenoid 24 thereby permitting the inlet valve 18 to drop to a seated position on its seat 17, which restores load to the pump mechanism. It will be understood that the timing cam 48 is positioned with respect to the shaft 7 and arm 50 so that the electrical circuit is broken at contacts 51 for an interval of time during the intake stroke of the piston 3 so that the inlet valve 18 will be released during such intake stroke and not during the discharge stroke, for a reason to be hereinafter described. This completes an unloading and loading cycle and further fillings and discharges of the accumulator 22 will repeat the action of the mechanism as above described.

It should be noted that during the time the inlet valve 18 is held open by the solenoid 24 and the pump is running unloaded, the direction of liquid flow past inlet valve 18 alternates due to the reciprocating action of piston 3; and, furthermore, if valve 18 were released from core 26 during the downward, or discharge, stroke of piston 3 when liquid is flowing backward past valve 18 opposite in direction to the arrows, the action of the liquid would be such as to cause the valve to strike a terrific hammer blow as it closed on its seat 17. The object of the timer is to prevent this violent closing and hammer blow of inlet valve 18 by opening contacts 51, in the holding or sealing circuit traced above, at a time when liquid is flowing forward past valve 18 in the direction of the arrows. In other words, timer cam 48 is mounted with respect to shaft 7 and arm 50 so that contacts are opened at 51, the holding or sealing circuit broken and valve 18 released at some point and time during the upward or intake stroke of piston 3, thus enabling valve 18 to properly resume action in the normal operation of the pump. This feature is vital in the successful application of the unloader since the equipment may be wrecked by the strains set up due to the sudden and violent closing of valve.

In installations where more than one pump of the type described feed into one or more accumulators connected in common to one system, it frequently becomes necessary to start up a pump when the accumulators are being filled by the other pumps and are rising from their lowermost positions to their upper, or filled, positions with contacts 36 open. Under these circumstances the pump would have to start under back-pressure load from the accumulators. To eliminate this severe initial starting under load, interlock 54 is provided in connection with starter 41 and arranged to remain closed during the starting and accelerating period of motor 8 and to remain open during the running period. It will be seen that interlock 54 is connected in parallel with contacts 36 through wires or conductors 55. Under such conditions the pump is started by closing switch 39; interlock 54 being closed and in parallel with contacts 36 establishes an electrical circuit equivalent to closing contacts 36, thus closing the magnetic switch 28 and energizing solenoid 24, as previously described. This holds inlet valve 18 open and unloads the pump during starting. When the motor 8 is fully accelerated, starter 41 opens interlock 54, which is the equiva-

lent of opening contacts 36, after which timer contacts 51 open and valve 18 is released to load pump, as previously described.

In the application of my improved controlling means to a multiplex pump, equipment similar to that described would be provided for each cylinder and its corresponding valves. For example, a triplex, or three-cylinder, pump would require three solenoids similar to solenoid 24, three magnetic switches 28, and three sets of timer contacts 51 spaced at the proper angle (usually 120 degrees) and positioned so as to be operated in succession at the proper time. This additional equipment could be properly wired so as to be controlled by a single switch and contacts 36 operated by accumulator arms 33 and 34.

In order to obtain increased valve area, pumps are sometimes equipped with more than one discharge and inlet valve for each cylinder, and which act in unison to increase the flow of liquid. In such cases a solenoid similar to solenoid 24 would be furnished for each valve or one solenoid of proper size and shape could be provided to control all the valves simultaneously as desired.

In Figure 2 of the drawing there is shown a slight modification of the solenoid and valve assembly. For various reasons, it is advantageous in some pump installations to use an electromagnet or solenoid in which the control is accomplished by means of a suitable mechanical linkage, interposed between the solenoid and the valve, rather than by direct magnetic attraction. Such an arrangement would consist preferably of a solenoid or electromagnet 56 having a core or plunger 57. There is integrally arranged with the valve 18 an upwardly extending portion 58 having a circumferential groove 59 arranged therearound with a flange 60 arranged at the extreme upper end thereof. There is mounted in the lower end of the plunger 57 a downwardly extending stud-like link or lifting member 61 having a substantially inverted U-shaped portion 62 arranged on the extreme lower end thereof having an inwardly extending arm portion 63 which is loosely disposed in the circumferential groove 59 of the portion 58 of the valve below the flange 60 carried thereby. The groove 59 is sufficiently wide so as to permit the valve 18 to open and close without interference when the solenoid 56 is not energized, so that the lifting member 61 will assume the position as shown in the drawing. When the solenoid 56 is energized, the plunger 57 is drawn thereinto, thus moving the lifting member 61 carried thereby, together with the valve 18, in upward direction thereby opening the valve. The operation of this construction in conjunction with the other parts of the pump is essentially the same as has been hereinbefore described.

While I have shown and described several specific embodiments of my invention, it will be understood that these embodiments are merely for the purpose of illustration and description and that various other forms may be devised within the scope of my invention, as defined in the appended claims.

I claim:

1. In a pump of the class described having a reciprocating pumping element for pumping a fluid, an inlet line connected to said pump, an inlet valve arranged in said inlet line, a discharge line connected to said pump, a discharge valve arranged in said discharge line, means arranged with one of said valves for maintaining the same in an open position when it is desired that the fluid being pumped no longer be discharged through the discharge line, and a timing means for controlling the action of said last mentioned means whereby said last mentioned means is adapted to permit the opened valve to close upon the upward movement or intake stroke of the reciprocating pumping element.

2. In a pump of the class described having a reciprocating pumping element for pumping a fluid, an inlet line connected to said pump, an inlet valve arranged in said inlet line, a discharge line connected to said pump, a discharge valve arranged in said discharge line, a solenoid arranged with one of said valves for arresting the movement of the same, means for controlling the energization of said solenoid, said solenoid adapted to be controlled so as to maintain the valve with which it is associated in an open position when it is desired that the fluid being pumped no longer be discharged through the discharge line, said pump adapted to remain continuously in operation at all times when the fluid is not being discharged therefrom with the fluid passing back and forth through said open valve, and timing means for controlling the action of said solenoid whereby the intake valve is permitted to close only upon the upward movement or intake stroke of the reciprocating pumping element.

3. In a combination with a pump of the class described having a reciprocating pumping element for pumping a fluid, means for storing the fluid as it is being pumped, an inlet line connected to the pump, an inlet valve arranged in said inlet line, a discharge line connected to the pump and said storing means, a discharge valve arranged in said discharge line, means arranged with one of said valves for maintaining the same in an open position when it is desired that the fluid being pumped no longer be discharged through the discharge line, timing mechanism for controlling the actuation of said last mentioned means whereby said last mentioned means is adapted to permit the opened valve to resume its normal operative position on the suction or intake stroke of the reciprocating pumping element, and means arranged with said storing means for controlling the actuation of said last mentioned means so as to open said valve when the fluid in the storing means reaches a predetermined level.

4. In a combination with a pump of the class described having a reciprocating pumping element for pumping a fluid as defined in claim 3, wherein the means arranged with one of the valves for maintaining the same in an open position consists of a solenoid.

CHESTER L. BRISTOL.