Aug. 8, 1933. E. B. FOOTE 1,921,740

APPARATUS FOR CONTROLLING INDUSTRIAL PROCESSES

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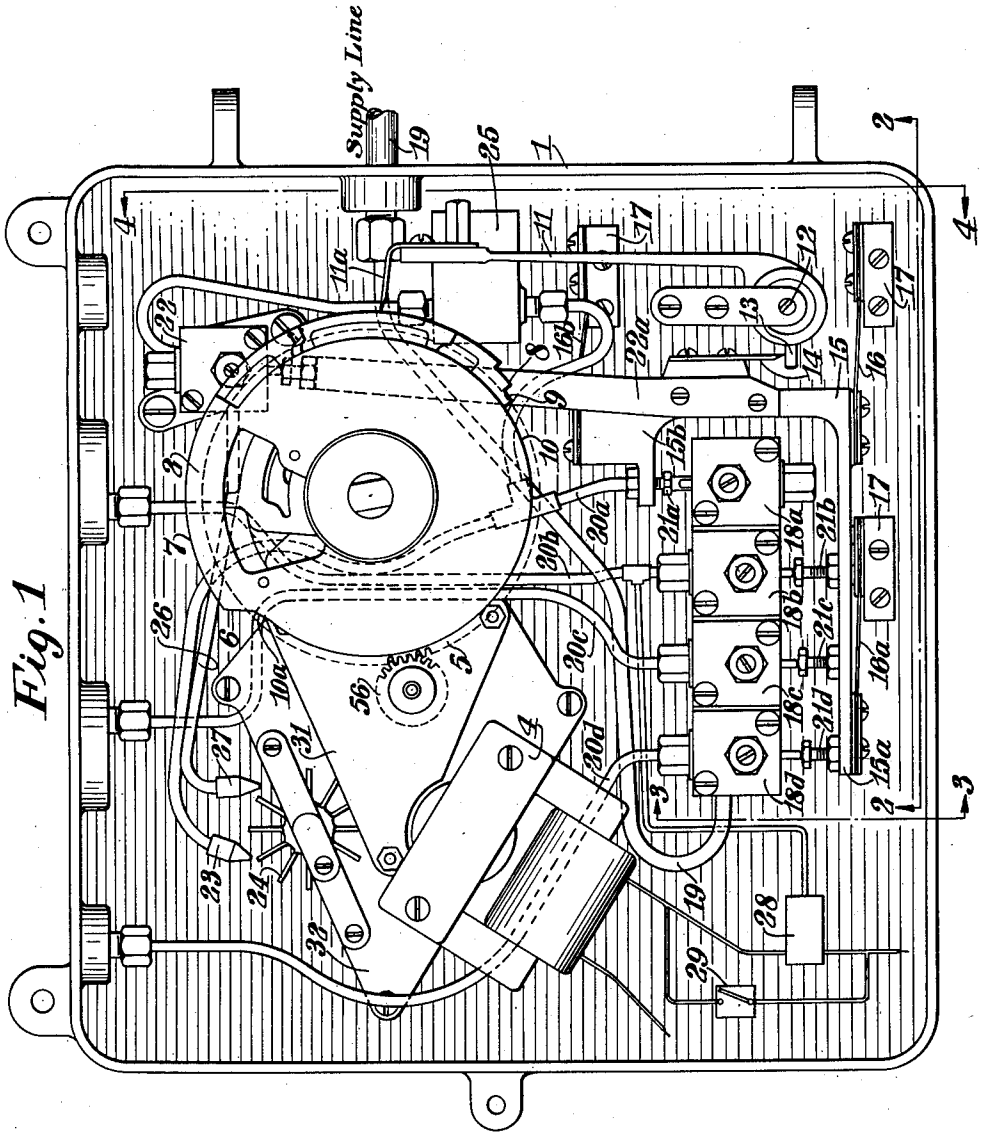


Fig. 1

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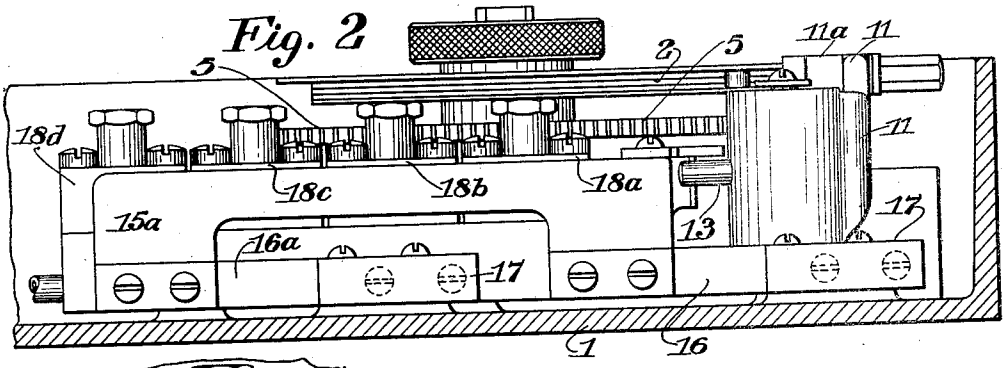
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Fig. 2



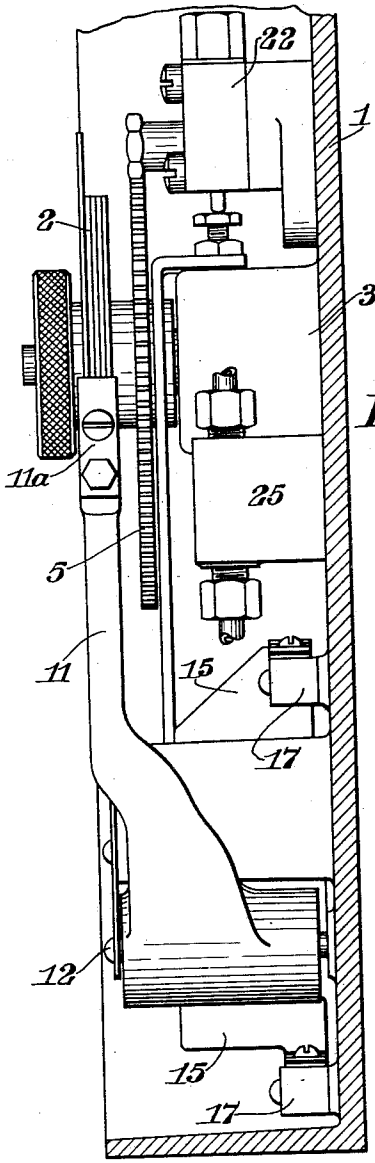
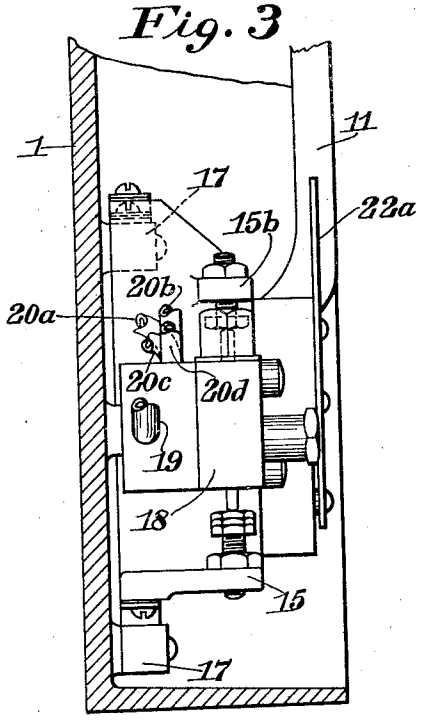


Fig. 4

Fig. 3



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UNITED STATES PATENT OFFICE

1,921,740

APPARATUS FOR CONTROLLING INDUSTRIAL PROCESSES

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Application June 26, 1930. Serial No. 464,099

10 Claims. (Cl. 161—7)

This invention relates to apparatus for controlling industrial processes.

The principal object of the invention is the provision of mechanism which may be readily compounded and adapted for the control of any desired cycle of operation.

Another object is the provision of mechanism which reduces the human factor to an irreduceable minimum.

The invention, the principle of operation on which it is based, the construction, its function and its advantages may be understood from the specification in connection with the accompanying drawings, wherein

Fig. 1 is a front view of an instrument containing control mechanism;

Fig. 2 is an enlarged sectional view taken substantially on line 2—2, Fig. 1;

Fig. 3 is an enlarged sectional view taken substantially on line 3—3, Fig. 1; and

Fig. 4 is an enlarged sectional view taken substantially on line 4—4, Fig. 1.

Having reference to Fig. 1, 1 represents the instrument casing of which the front part or cover is removed to show the mechanism within.

The operating mechanism includes chiefly a cam 2 whose shaft is mounted in ball bearings in the hub 3 (Fig. 4). The cam may be driven by any suitable motor whose speed may be substantially constant, but I prefer a synchronous motor 4 built for a frequency available at the point of application of the instrument, which is usually the commercial frequency of sixty cycles. The motion of the synchronous motor 4 is transmitted to the shaft of the cam 2 by any suitable reducing gear train (not shown) driving the large gear 5 on the cam shaft. The cam 2 has along its periphery a plurality of stepped surfaces starting with the inclined portion 6, the extended surface 7 and short surfaces 8, 9 and another extended portion 10 of smallest radius of curvature. The cam cooperates with the follower 11 through the contact finger 11*a*. The follower 11 is mounted at 12 and carries a short arm 13 constituting with the follower a bell crank lever.

The arm 13 supports a plate 14 which is part of a frame 15 which includes at the bottom a relatively long arm 15*a* and at the top a short arm 15*b*. The frame 15 is normally maintained in a fixed position by means of leaf springs 16, 16*a*, 16*b* attached at one end to blocks 17 and secured at the other end to the frame 15. The leaf springs are of the same length so that all points of the frame have straight-line motion in vertical direction. The leaf springs are in effect a convenient type of parallel-motion mechanism. Between the arms 15*a* and 15*b* is mounted a series of air valves 18*a*, 18*b*, 18*c* and 18*d* of a well known construction for individually controlling the flow of compressed air from the supply line 19 to the different service lines 20*a*, 20*b*, 20*c* and 20*d*. While the particular purpose of these service lines does not have any special relationship to the invention proper and may be used for the control of various forms of mechanism, line 20*a* in the particular instance is used for the operation of mechanism to be more fully described and lines 20*b*, 20*c* and 20*d* may be assumed to operate diaphragm valves for controlling the operation of a vulcanizing press or the like. The valve stems of the valves 18*b*, 18*c* and 18*d* extend downwardly and are acted upon by adjustable abutments 21*b*, 21*c* and 21*d* on arm 15*a* while the valve stem of the valve 18*a* extends upwardly and is acted upon by the adjustable abutment 21*a* on arm 15*b*. The abutments 21*b*, 21*c* and 21*d* actuate the corresponding valve stems when the frame 15 is moved upwardly while the abutment 21*a* actuates the stem of valve 18*a* when the frame 15 moves downwardly. By means of the adjustable abutments a differential setting can be so made as to actuate the different valves at different times.

The valve 18*a*, in the particular instance, controls the flow of the air to a nozzle 23 which is directed against an impulse wheel 24. Valve 18*a* is opened when the contact finger 11*a* of the follower 11 drops from the cam surface 9 down upon the surface 10 and a stream of air from the nozzle 23 causes the wheel 24 to rapidly turn, thereby causing the cam 2 to quickly rotate until the contact finger rides up the short incline 10*a*. When the finger 11*a* reaches about the uppermost point of the incline 10*a*, the frame 15 has been raised sufficiently so that the arm 15*b* has released the stem of valve 18*a* and has allowed the latter to close. Just when the valve 18*a* is about to close, an additional valve 22 is operated by means of arm 22*a* which is attached to the frame 15, and allows air from a tank 25 to flow through conduit 26 to nozzle 27. Nozzle 27 is directed against wheel 24 so as to be in opposition to the nozzle 23. The arrangement including tank 25, valve 22 and nozzle 27 is in substance a brake mechanism for stopping wheel 24 when the contact finger 11*a* has about reached the top of incline 10*a*.

Tank 25, which is just large enough to contain a sufficient volume of air to stop the wheel 24, is connected to the conduit 20*a* and is filled

while the valve 18*a* is open, a check valve in the connection preventing return flow of the compression fluid.

The synchronous motor 4 and the wheel 24 are independent of each other. The mechanism, which does not form a part of this invention, is more fully described in the application of E. B. Foote et al., Ser. No. 464,100 filed June 26, 1930.

The synchronous motor 4 may be controlled by a pneumatic switch 28 which is connected to one of the conduits 20*b*, 20*c*, 20*d*, of that valve which closes last as the contact finger 11*a* drops from the surface 9 down to the surface 10. In the particular instance the switch 28 is connected to the conduit 20*b*. When the valve 18*b* is closed so that no air flows into conduit 20*b*, the switch 28 opens and breaks the circuit of the motor 4. To start the cycle of operation, the synchronous motor may be started by means of a switch preferably a push button switch 29 shunting the pneumatic switch 28. As soon as the contact finger 11*a* has started up the inclined surface 6, the valve 18*b* is opened and the pneumatic switch 28 is operated to close the circuit of the motor 4, when the push button can be released without opening the circuit.

The only manual operation to be performed is pushing the button 29. Thereupon the motor 4 starts to turn the cam 2, successively operating valves 18*b*, 18*c* and 18*d* which in turn cause the operation of industrial apparatus. When finally the follower 11*a* successively drops from the cam face 7 to the step surfaces 8 and 9 and then upon the surface 10, the valves 18*d*, 18*c* and 18*b* are again operated to terminate the industiral operation and the impulse motor 24 is operated to quickly bring the cam again to the starting position, when the mechanism is automatically stopped. Then after the necessary preparation is made for performing another cycle, the actuation of the push button is again the only manual work to be done to carry out the new cycle of operation.

The principal advantage of the arrangement is that the cam 2 may be given any desired contour to operate any desired number of valves in a predetermined time relation. The system thus may be readily adapted with very small changes for any of the many industrial operations and processes.

The present application is related to Foote et al. application, Serial No. 464,100, filed June 26, 1930, previously referred to, and to Hubbard application, Serial No. 464,101, filed June 26, 1930.

I claim:

1. In apparatus of the character described, the combination of a plurality of valves including valve stems exposed at the same side, an arm, parallel motion mechanism for supporting the arm at a plurality of spaced points thereon near its ends for motion toward and away from the valve stems, abutments on the arm for contact with the valve stems, means for varying the height of each abutment and means for actuating the arm, comprising a rotary cam having a composite surface the component parts of which are different distances from the center of rotation of the arm, a contact finger riding upon the surface of the cam and a single lever for transmitting the motion of the contact finger to the arm.

2. In apparatus of the character described, the combination of a plurality of valves including valve stems exposed at the same side, an arm and a leaf spring support therefor mounted at points defining a triangle and prescribing parallel motion for the arm toward and away from the valve stems, abutments on the arm for contact with the valve stems and means for varying the lengths of the abutments relatively to each other.

3. In apparatus of the character described, the combination of a plurality of valves having their valve stems exposed on one side, a valve having its valve stem exposed at the opposite side, a frame including an arm for engagement with the set of valve stems exposed at one side and an arm normally in engagement with the valve stem exposed at the opposite side, means for supporting the frame at a plurality of widely spaced points thereon near its ends flexibly for parallel motion toward and away from the valve stems, abutments on the arms for contact with the valve stems and means for varying the lengths of the abutments.

4. In apparatus of the character described, the combination with a plurality of separate control members for controlling an industrial process, of an arm, parallel motion mechanism for supporting the arm at a plurality of widely spaced points thereon near its ends for motion toward and away from the control members, means for actuating the arm, comprising a rotary cam having a composite surface the composite parts of which follow each other in a definite order, have definite angular extents and are different distances away from the center of rotation of the cam, a follower riding on the cam surfaces, means for translating the motion of the follower into motion of the said arm and adjustable means for varying the time of engagement between the individual control members and the said arm, during motion of the latter toward the control members.

5. In apparatus of the character described, the combination of a plurality of control members disposed in juxtaposition, the operative parts of which are exposed at the same side, an arm mounted at a plurality of widely spaced points thereon near its ends for parallel motion toward and away from the said operative parts, time-controlled means for moving the arm and means for varying the time of engagement between the operative parts of the different control members and the arm during motion of the latter toward the control members.

6. In apparatus of the character described, the combination of a plurality of control members disposed in juxtaposition the operative parts of which are partly exposed on one side and partly on the opposite side, a frame having arms disposed on opposite sides of the control members to cooperate with the oppositely exposed operative parts respectively, parallel motion mechanism for supporting the arm of the frame near its ends at a plurality of widely spaced points thereon and for directing the movement of the frame toward and away from the said operative parts and time-controlled means for moving the frame.

7. In apparatus of the character described, the combination of a plurality of control members having their operative parts exposed on the same side, an arm for actuating the said operative parts, the arm being mounted at a plurality of widely spaced points defining a triangle for parallel motion toward and away from the said operative parts, and time-controlled means for moving the arm.

8. In apparatus of the character described, the combination of a plurality of control mem-

bers having their operative parts exposed on the same side, an arm for actuating the said operative parts, the arm being mounted at a plurality of widely spaced points thereon near its ends for parallel motion toward and away from the said operative parts and time-controlled means for moving the arm, the relation between the control members and the arm being such that the individual operative parts are acted upon by the arm at different points in the path of motion of the latter.

9. In apparatus of the character described, the combination with a plurality of valves having their valve stems exposed in the same direction, a valve positioned in alignment with said first mentioned valves and having its valve stem exposed in the opposite direction from the other valves, a frame including parallel arms, one of which arms is mounted for engagement with the said valve stems exposed in one direction, and the other arm mounted for engagement with the valve stem exposed in the opposite direction, a spring suspension for said frame including leaf springs extending in the same direction and having one of their respective ends fixably mounted at points defining a triangle and having their free ends attached to said frame whereby its arms may assume various parallel positions, and means for actuating said frame.

10. In apparatus of the character described, the combination with a plurality of valves having their valve stems exposed in the same direction, a valve positioned in alignment with said first mentioned valves and having its valve stem exposed in the opposite direction from the other valves, a frame including parallel arms, one of which arms is mounted for engagement with the said valve stems exposed in one direction, and the other arm mounted for engagement with the valve stem exposed in the opposite direction, a spring suspension for said frame including leaf springs extending in the same direction, and having one of their respective ends fixably mounted at points defining a triangle and having their free ends attached to said frame whereby its arms assume various parallel positions, and time-controlled means for actuating said arm.

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