March 7, 1944. C. R. TURNER 2,343,347

OPERATION CONTROLLING METHOD AND MEANS

Filed April 13, 1940 4 Sheets-Sheet 1

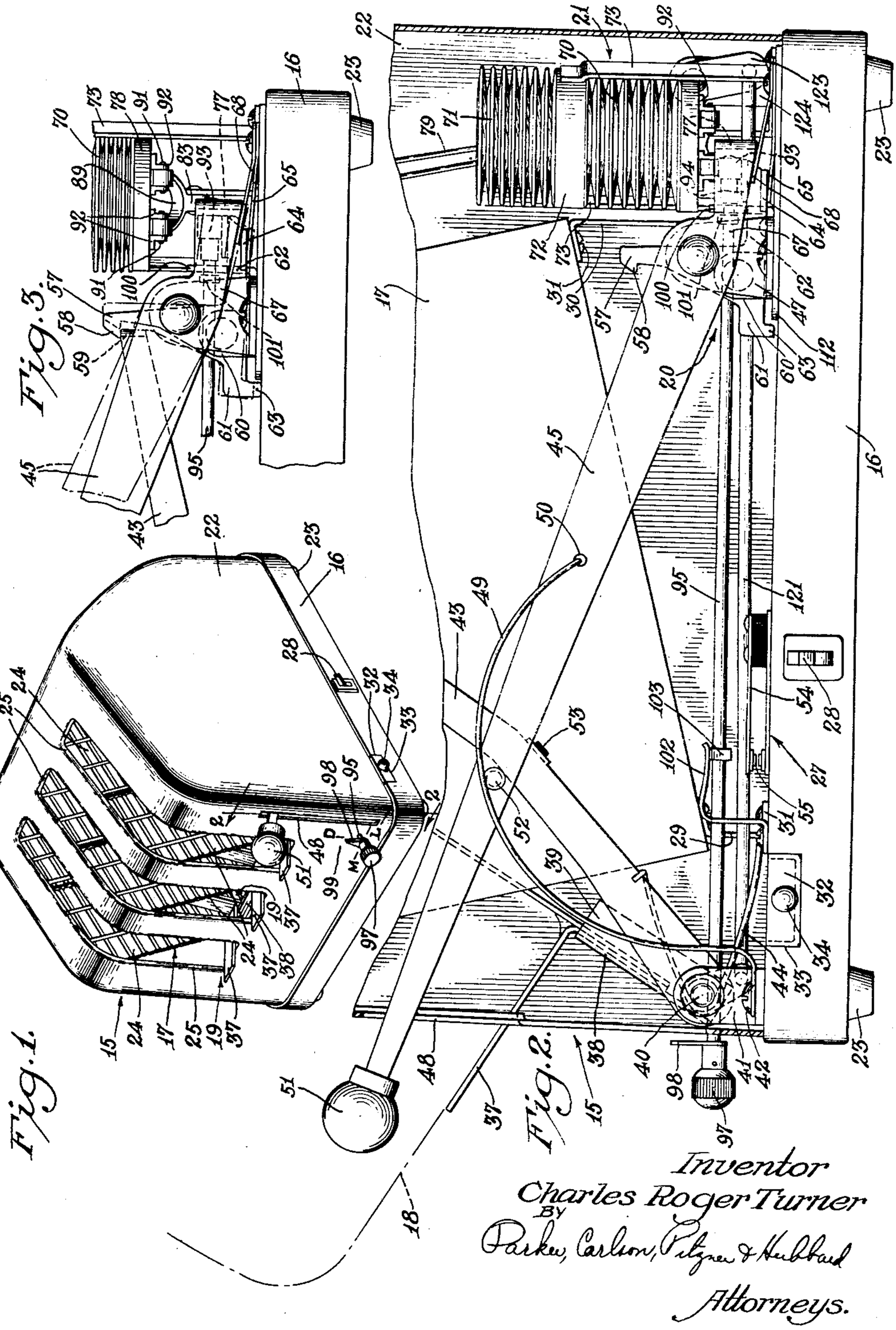

Fig. 1.

Fig. 2.

Fig. 3.

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OPERATION CONTROLLING METHOD AND MEANS

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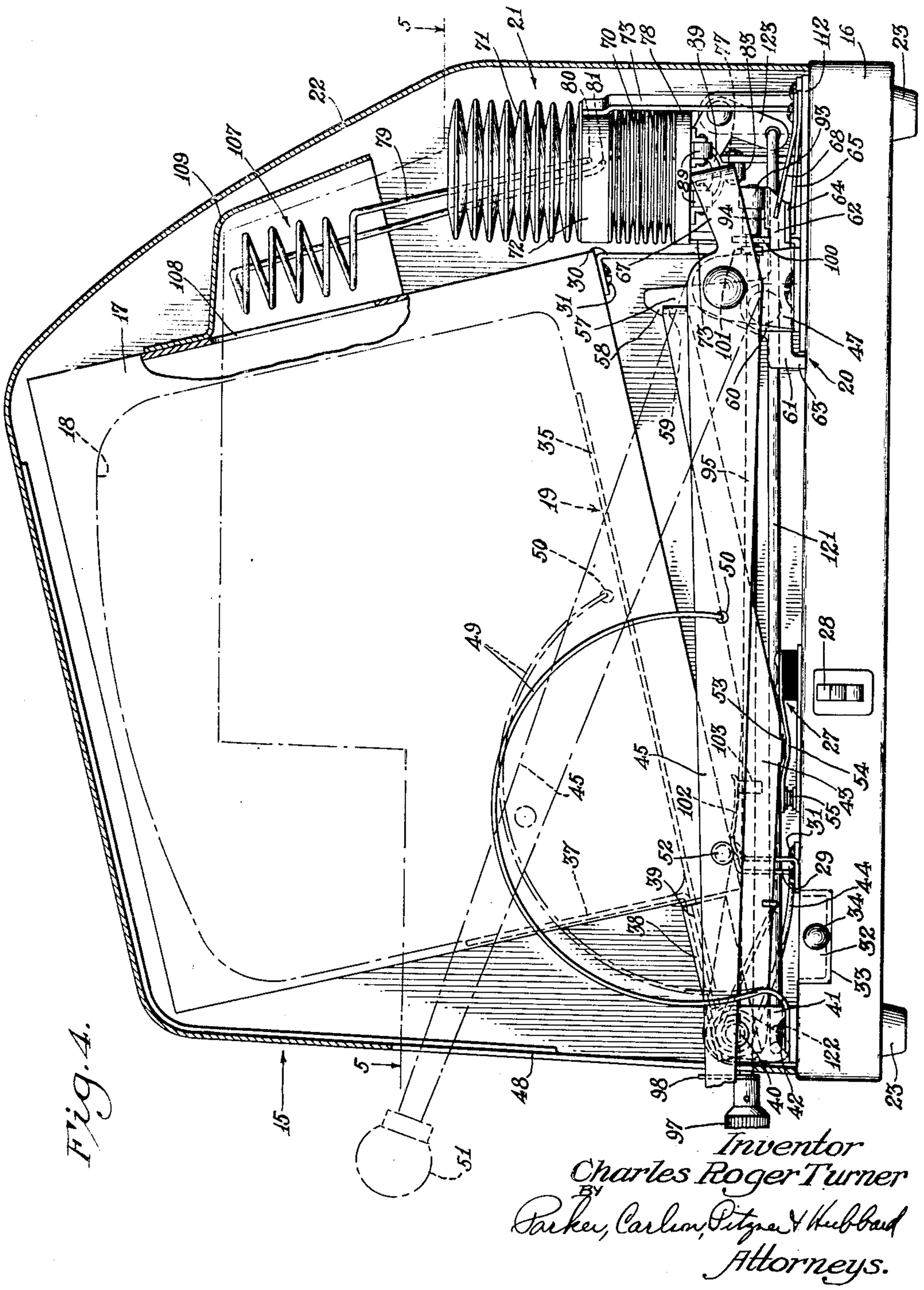

Fig. 4.

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OPERATION CONTROLLING METHOD AND MEANS

Filed April 13, 1940 4 Sheets-Sheet 3

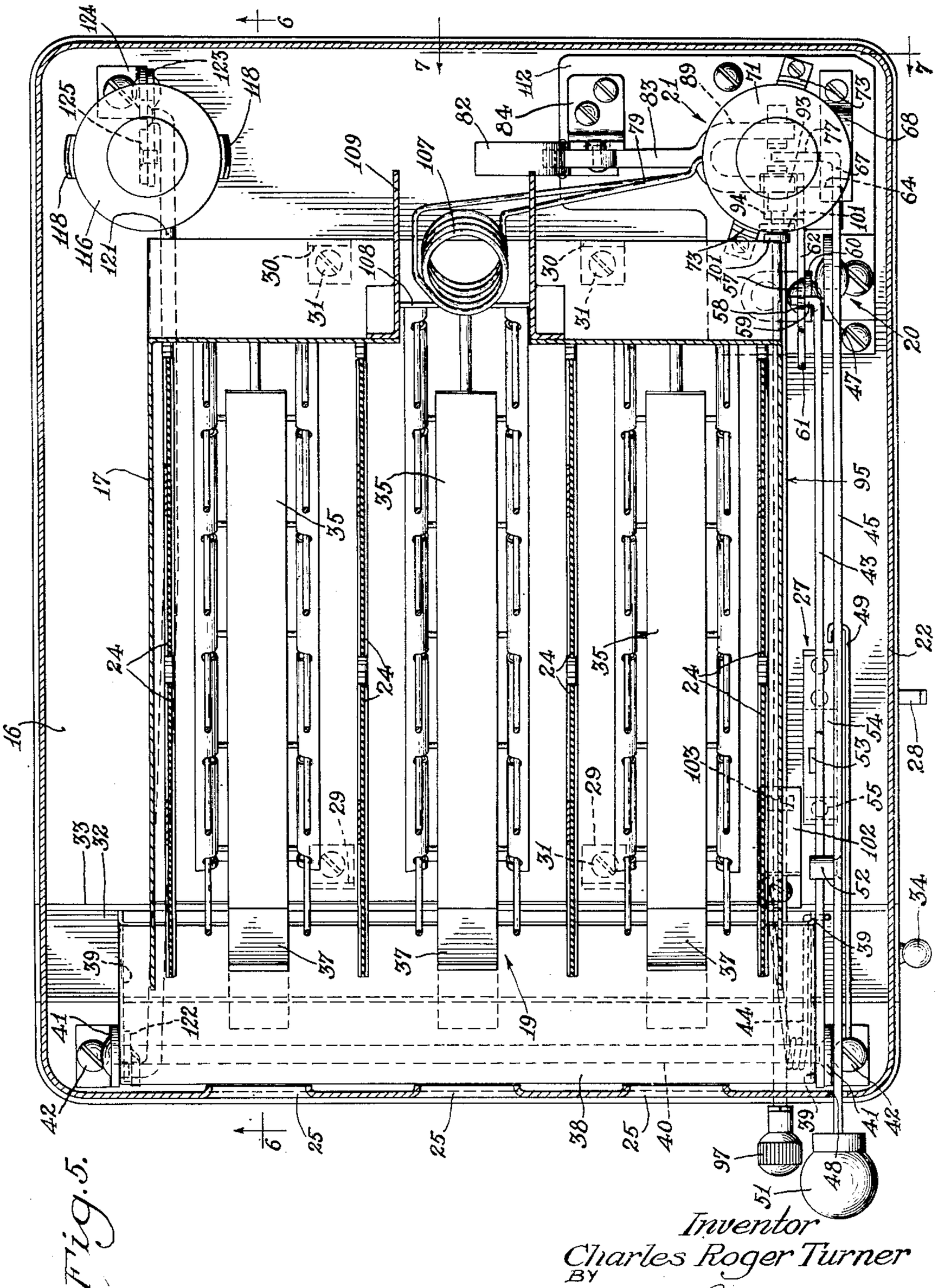

Fig. 5.

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OPERATION CONTROLLING METHOD AND MEANS

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Fig. 6.

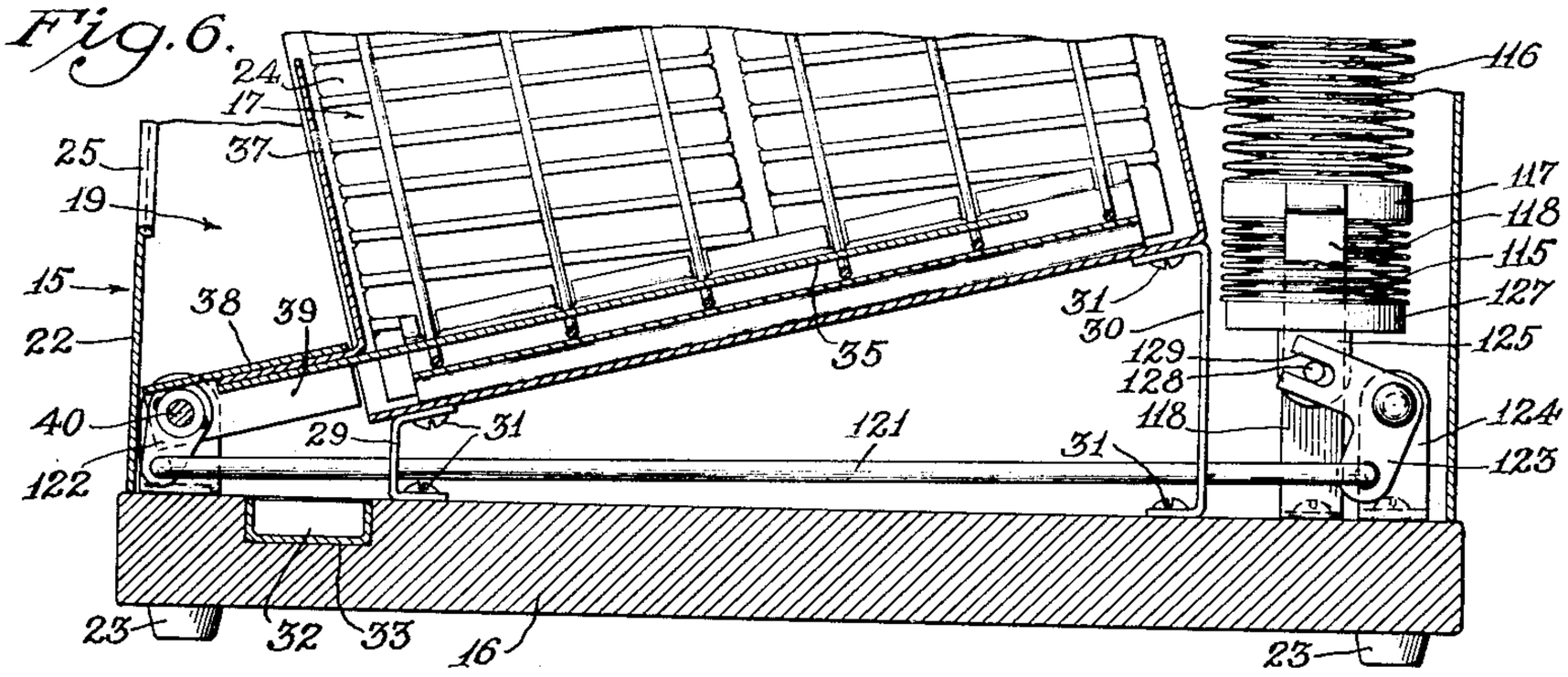


Fig. 8.

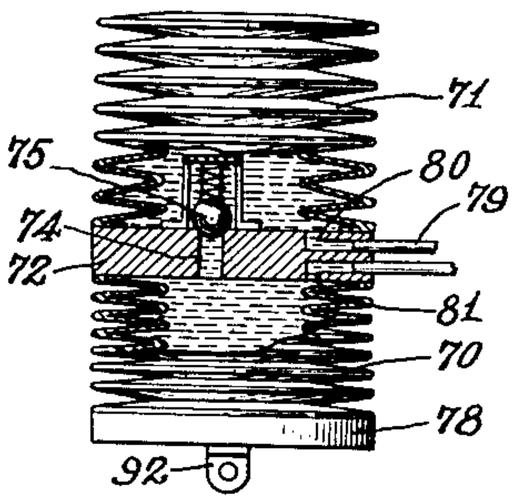


Fig. 9.

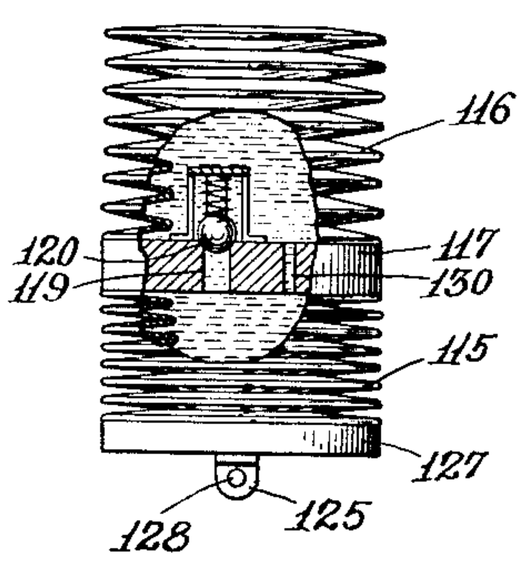


Fig. 10.

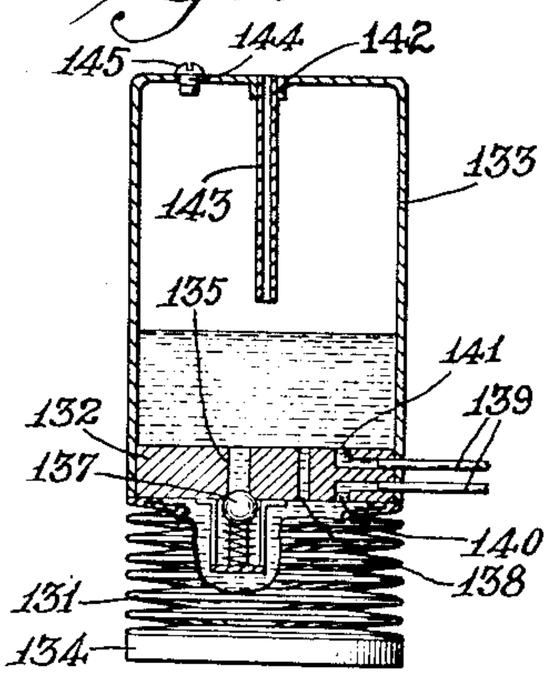
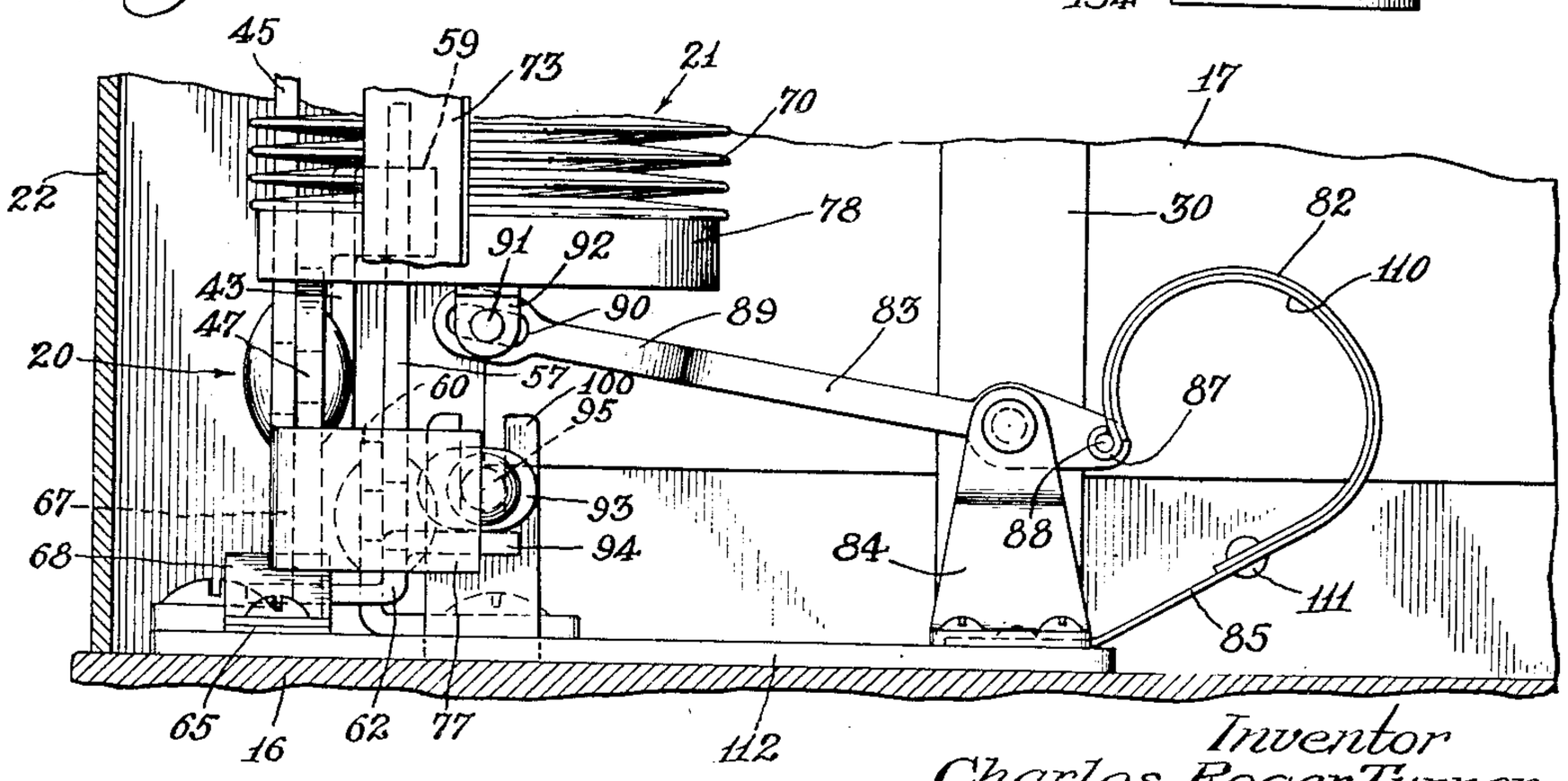


Fig. 7.



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Patented Mar. 7, 1944

2,343,347

UNITED STATES PATENT OFFICE

2,343,347

OPERATION CONTROLLING METHOD AND MEANS

Charles Roger Turner, Evanston, Ill.

Application April 13, 1940, Serial No. 329,452

26 Claims. (Cl. 161—1)

This invention relates to a novel operation controlling method and means, and more particularly concerns such a method and means for timing the operation of intermittently operable apparatus and the like subject to temperature variations.

A general object of the invention is to provide an operation controlling method and means of this character capable of functioning efficiently with substantial accuracy and practical uniformity of results over a wide range of operating conditions, and requiring but few, easily produced and simply cooperative parts capable of long, trouble-free performance.

Another object is to provide an operation controlling method and means for use under conditions where given uniform results are required in the face of temperature variations tending to alter such results, compensation for the temperature variations being accomplished by the novel employment of certain hydraulic and mechanical expedients.

Yet another object of the invention is to provide improved operation controlling means including mechanical trigger mechanism and hydraulic timing or delayed action means.

Still another object of the invention is to provide adjustable hydraulic timing or delayed action means arranged to compensate for temperature variations in the associated environment.

A further object of the invention is to provide delayed action hydraulic means adapted for use either in timing or braking associated mechanism.

A still further object of the invention is to provide an improved timed, intermittently operable heat producing device such as a bread toaster in which predetermined uniform results are obtained by automatic hydraulic compensation for operating temperature variations.

Other objects and advantages will become apparent in the following description and from the accompanying drawings in which:

Figure 1 is a perspective view of a device such as a bread toasting apparatus embodying the features of the invention.

Fig. 2 is an enlarged fragmentary vertical sectional elevational view through the apparatus taken substantially along line 2—2 of Fig. 1.

Fig. 3 is a fragmentary detail side elevational view of the trigger mechanism of the apparatus taken in substantially the same plane as in Fig. 2 but showing the parts in a different operative relationship.

Fig. 4 is a side elevational view of the bread toasting apparatus with parts broken away and in section to show details of structure with the various parts of the operation controlling means in the positions assumed at the beginning of operation.

Fig. 5 is a sectional top plan view taken through the apparatus substantially along line 5—5 of Fig. 4.

Fig. 6 is a fragmentary sectional elevational view through the apparatus taken substantially along line 6—6 of Fig. 5.

Fig. 7 is an enlarged fragmentary detail sectional view showing features of the timing means and taken substantially along line 7—7 of Fig. 5.

Fig. 8 is a detail elevational view, partially broken away, of the hydraulic timer bellows device.

Fig. 9 is a detail elevational view, partially broken away, of the hydraulic brake bellows device.

Fig. 10 is an elevational view, partially in section, of a modified form of hydraulic delayed return or timing bellows device.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail certain preferred embodiments, but it is to be understood that I do not thereby intend to limit the invention to the specific forms disclosed but intend to cover all modifications and alternative constructions falling within the spirit and scope of the inventiton as expressed in the appended claims.

In many instances uniform results can be obtained from a given operation only by fairly accurate proportionment of operating time to operating temperature, the requirement generally being a time interval inversely proportioned to the temperature. For example, in intermittently operable, heat producing culinary apparatus such as bread toasters, roasters, waffle makers, biscuit makers, egg boilers, and the like, the results are rather critically dependent directly upon the length of time the article of food being treated is subjected to any given temperature.

According to the present invention highly uniform results in practical operation are attained by an improved method which utilizes a liquid of predetermined heat sensitivity. The liquid is first transferred from one chamber to a second as an incident to setting the associated apparatus into operation for treating the selected food item. Transference of the liquid is then reversed by drawing or forcing the liquid from the second

chamber into the first chamber through a restricted passage or bleeder duct which permits the liquid to pass only at a predetermined rate depending upon its viscosity. As viscosity of the liquid is altered by temperature changes, so also is the flow through the bleeder passage for any given hydraulic pressure or suction employed in forcing the liquid therethrough. When the proper adjusted amount of fluid has returned to the first chamber treatment of the food in the apparatus is automatically discontinued either by shutting off the heat source or by removing the food, or both. In some instances, it may only be necessary to give an audible or visual signal for announcing completion of the particular operation or treatment. However the case may be, upon return of the predetermined quantity of liquid to the first chamber a trip or actuator is moved to effect the desired result. In addition certain features of the invention are applicable as well to other delayed action operations such as braking, regulating and the like.

When applied to a bread toaster, the features of the invention are employed in conjunction with the bread rack and the heat source thereof. The bread rack should preferably be of a type which is biased normally to assume a loading position outside of the heating or toasting zone and is moved into and releasably held in such zone when loaded with slices of bread. Upon completion of the desired degree of toasting the rack is released to carry the toast out of the toasting zone; and the heat source, usually comprising radiant electrical heating elements, is shut off. In this environment, the control system includes a trigger mechanism in conjunction with the bread rack holding means. Release of the trigger is effected automatically, after a time interval preadjusted for the degree of toasting desired and concurrently compensated for temperature variations, by the controlled transfer of the timing fluid from one chamber to another as explained above until a suitable trip is operated. The timing fluid chambers may be at least in part of collapsible construction and contained in a timing unit cooperatively associated with the trigger mechanism. A similar hydraulic arrangement, utilizing the restrained liquid flow principle may be used to brake and avoid precipitate jarring return of the released bread rack out of the heating zone. The arrangement is preferably such that positioning of the bread rack in the toasting chamber, turning on of the heat source, and conditioning of the timer and brake is effected by a single motion of an operating member.

Referring now to the drawings, a practical exemplary embodiment of the invention, comprises an electrically operated bread toaster 15 of improved design including a base 16 which carries a toasting chamber 17 wherein slices of bread 18 to be toasted are adapted to be removably supported by a rack 19. The toaster is of the type in which the toasting heat is produced only while the bread is within the toasting chamber, and the period of toasting is automatically controlled to remove the bread from the heat zone and discontinue the production of heat when the desired degree of toasting has been accomplished. Operation of the toaster is controlled by a trigger mechanism 20 responsive to timing means 21. Pleasingly enclosing the toaster mechanism and engaging along its lower edge in any preferred fashion with the base 16 is a suitably shaped removable casing 22.

The base 16 may be formed of any suitable material such as a preferred type of molded plastic having both electrical and heat insulating properties. To support the base in spaced relation to a table or other surface upon which the toaster may be placed in operation and provide a heat insulating air space therebetween, supporting bosses or legs 23 may be provided adjacent to the four lower corners of the base.

In the present instance, the toasting chamber 17 is formed as a generally rectangular housing which may be fashioned from sheet metal or other suitable material and which provides an enclosure for a series of vertically supported, spaced parallel radiant electrical heating elements 24 (Figs. 1, 5 and 6). The heating elements are arranged to provide therebetween a plurality of vertical pockets or stalls for the slices of bread 18 to be toasted. Introduction into and removal of the bread slices from the toasting stalls in a generally front to rear direction is made possible by having the front and top of the toasting chamber open and providing in the enclosure casing 22 a series of entrance slots 25 running through the top and front walls thereof in registration with the toasting stalls. Electrical energy for the heating elements 24 is supplied from any suitable source in a well known manner and is controlled by a switch 27 mounted upon the base 16 inside of the casing 22. Further control for the electric current may be provided by a suitable manually operable master snap switch mounted in one side of the base 16 and having an outwardly projecting vertically movable operator 28.

By preference, the toasting chamber 17 is mounted in a forwardly tilting relation to the base 16 to facilitate introduction of the bread to be toasted, and is fastened to the base through the medium of front and rear brackets 29 and 30, respectively, which are secured in place by means of screws 31 (Figs. 2, 5 and 6). For effecting the tilted mounting of the toasting chamber the front brackets 29 are substantially shorter than the rear brackets. Crumbs dropping downwardly from the toasting bread will slide forwardly along the slanting bottom wall of the chamber and fall therefrom into a tray 32 which is slidably mounted in a transverse groove 33 in the upper wall of the base 16 below the forward lower edge of the chamber 17. For emptying the crumb tray it may be withdrawn by means of a knob or handle 34 (Figs. 1 and 5).

To facilitate introduction of the bread into and removal thereof from the toasting chamber 17, the bread rack 19 is mounted for pivotal movement to carry the bread slices 18 in a path which transcribes an arc running in a generally front to rear direction through the toasting stalls. For this purpose, the bread rack 19 is preferably formed of a plurality of individual bread slice carriers 35 in the same number as there are toasting stalls in the chamber 17 and each comprising an elongated inwardly projecting flat bar which may be formed of suitable sheet metal or thin bar stock and which has rigidly cooperating therewith a right angular front retainer bar 37. The latter may be of L-shape having a forwardly projecting leg engaging flatwise with the forward portion of the associated bar 35. Both of the bread carrier bars may be of a width which will just clear the side edges defining the enclosure toast slots 25.

At their connected forward ends, the several

bread carriers 35 are secured in parallel relation at spaced intervals to a pivot plate 38 which has right angular flanges 39 at its opposite ends in this instance projecting downwardly and pivotally connected as by means of a shaft 40 to upstanding brackets 41 secured as by means of screws 42 to the forward portion of the base 16. The relationship of the bread rack to the toasting chamber 17 is such that in the non-toasting condition of the device, the retainer bars 37 lie in a loading position wherein they project in a generally upwardly slanting plane forwardly through the entrance slots 25 (Figs. 1 and 2) so that the bread slices may conveniently be placed into the pockets formed in the angle between the bars 35 and 37. As a result the bread need not be handled at the top of the toaster but can be handled at the front thereof entirely outside of the flow of convected heat which normally tends to rise from the heated toaster, and danger of the user burning himself is greatly minimized if not altogether prevented.

In operation, the bread rack is swung about its pivotal axis to move the carrier bars 35 into toasting position substantially parallel to the bottom wall of the chamber 17 and with the retainer bars 37 substantially parallel to the forward edges of the chamber side walls in closing relation to the forward ends of the toasting stalls (Figs. 4 and 6). In the toasting position of the bread rack 19, the bread slices are wholly within the toasting chamber and the closure provided by the retaining bars 37 avoids detrimental inflow of cold air into the heating zone through the front openings of the entrance slots 25.

Means is provided for normally biasing the bread rack 19 to assume the loading position and such means is arranged to be connected releasably with the trigger mechanism 20 and concurrently close the normally open electrical control switch 27. Herein this means includes a rearwardly projecting lever 43 of generally upwardly directed dog leg shape located at one side of the toasting chamber 17 and having its forward end fixedly secured to the adjacent bread rack pivot plate flange 39 (Figs. 2, 4 and 5). Resilient biasing means such as a jackknife tension spring 44 is coiled about the shaft 40 and has one leg in engagement with the base 16 while the other leg engages under the lever 43 for normally urging the same upwardly into a position where the bread rack is held in its loading position.

For actuating the lever 43 in opposition to the biasing spring 44 means is provided such as an elongated operating lever 45 which extends in a front to rear direction parallel and adjacent to the lever 43 and is pivotally connected adjacent to its rear end to the upstanding leg of an angular supporting bracket 47 and is of such a length that it extends forwardly through a vertical slot 48 in the front wall of the casing 22. Preferably, the operating lever 45 is biased for normally assuming an upwardly projecting relation, and means for this purpose in the present instance comprises a bowed tension spring 49 hooked at one end through an aperture 50 in the lever and secured at its other end fixedly to the base 16 as by means of the adjacent bracket fastening screw 42. The outwardly projecting or front end of the operating lever 45 provides a handle by which the lever can be manually swung up and down about its pivot and may for convenience be equipped with a removable knob 51. When the operating lever 45 is swung down, means thereon such as a laterally inwardly projecting stud 52 bears downwardly against the upper edge of the connecting lever 43 to swing the latter down until the bread rack is in its toasting position. As the toasting position is attained an insulated contact boss 53 projecting below the lower edge of the connecting lever 43 bears against an upper spring leaf 54 of the control switch 27 to close switch contact points 55 (Fig. 4).

Moreover, substantially coincident with movement of the bread rack into the toasting position, the inner end of the connecting lever 43 comes into connecting engagement with the trigger mechanism 20 which for this purpose has a latch or upstanding trigger member 57. The latter includes a forwardly projecting lug 58 that hooks into engagement with an angular terminal flange or lug 59 upon the lever (Figs. 4, 5 and 7) and holds the lever in the connected relationship. The trigger 57 is preferably of double bell crank or andiron shape pivoted upon a bracket 60 for front to rear rocking movement within limits defined by lower front and rear stop and trip legs 61 and 62, respectively. The front or stop leg 61 has a downwardly projecting stop lug 63 engageable with the base 16 for limiting forward rocking or loading movement of the trigger. The rear or trip leg 62 is formed with a laterally projecting horizontal trip flange 64 which in the loaded trigger position lies in spaced relation generally horizontally above the base 16 and is engaged thereunder by resilient biasing means such as a flat leaf spring 65 normally tending to urge the trigger toward loaded position. The trip flange 64 also serves as a stop to limit rearward rocking movement of the trigger upon full compression of the spring 65.

Through this arrangement it will be seen that it is merely necessary to press down upon the trip flange 64 of the trigger to release the catch lug 58 from the engagement lug 59 of the connecting lever 43, whereupon the released lever swings up, shifts the bread rack 19 to loading position and opens the control switch 27. Herein, trigger releasing pressure upon the trip flange 64 is effected manually through the medium of the operating lever 45 which for this purpose has a rearward extension 67 engaged by resilient means such as a flat leaf spring 68 serving as a counterpoise to the biasing spring 49 to hold the lever in a neutral position. In this neutral position the extension 67 is held out of engagement with the trigger release flange 64 but ready to engage the release flange upon relatively slight rocking movement of the operating lever against the tension of the counterpoise spring 68 as shown in dot dash outline in Fig. 3. Thus, both the conditioning of the toaster 15 for toasting and the release from such condition can be effected by actuation of the single operating lever 45.

For practical reasons, of course, it is preferred to have the trigger 57 released automatically for restoring the toaster apparatus to the non-toasting condition. According to the invention the timing means 21 effectuates this purpose through the medium of a novel hydraulic circuit in a substantially accurate, uniform manner which compensates for temperature variations in the operation of the apparatus such as may arise from changeable atmospheric temperature conditions, moisture content of the bread, drafts, ambient heat conditions in the apparatus, and the like. To this end, the timing means 21 is constructed to

be set coincident with latching of the connecting lever 43 so as then to be operative to resume gradually an initial or spent condition in which it acts automatically to release the trigger 57. As shown, the timing means 21 includes for this purpose a pair of liquid containers in the form of entirely closed expansile metallic bellows 70 and 71 coaxially mounted as a unit in fluid tight relationship upon opposite sides of a common disk-like base 72 which forms a partition therebetween. In the present instance the base member 72 is supported upon a vertical axis in fixed spaced relation above the rear trigger leg 62 by means of brackets or standards 73, the vertical spacing being such that in the expanded condition of the bellows 70 its lower end is effective to release or trip the trigger 57 as will presently be more fully explained.

The bellows are so related in the particular arrangement shown herein that the lower bellows 70 serves as a pump while the upper bellows 71 functions as a reservoir. All air is evacuated from the bellows which are filled to a predetermined extent with a liquid of suitable viscosity. The volume of liquid is preferably so proportioned with respect to the permissible internal area of the bellows that when one of the bellows is expanded, the other will be substantially collapsed, a passage 74 (Fig. 8) between the bellows in the partition member 72 providing a duct for transfer of the liquid from one bellows to the other. In the present instance the arrangement contemplates transference of the liquid through the passage 74 in one direction only, namely, from the bellows 70 to the bellows 71, a check valve 75 such as of the spring pressed ball type providing the necessary one-way liquid flow control.

Compression of the bellows 70 for pumping the liquid into the reservoir bellows 71 is effected by the operating lever 45 as an incident to latching the connecting lever 43. For this purpose the rearward extension 67 of the operating lever 45 has a laterally flanged terminus serving as a compression lug 77 (Figs. 5 and 7) which in the latching movement of the operating lever is engageable upon a diametric line and centrally with a lower closure disk member 78 on the bellows 70 (Fig. 4). Thus, at the same time that the connecting lever 43 is driven into engagement with the trigger 57, the bellows 70 is substantially compressed by the operating lever to drive a large portion of the liquid therefrom into the reservoir bellows 71.

The actual timing is effected by gradual, controlled return to the pump bellows 70 of the liquid which has been driven into the reservoir bellows 71. For this purpose a bleeder duct of small cross sectional flow area connects the two bellows. As best seen in Figs. 4 and 8, the bleeder duct may include a small diameter tube 79 which communicates at one end with the reservoir 71 through a passage 80 in the partition member 72 and at the other end communicates with the pump bellows 70 through a similar passage 81. The necessary drawing or expanding force upon the bellows 70 to create the suction for return of the liquid thereto through the bleeder duct is supplied initially by the resiliency of the metal forming the bellows walls, the normal tendency thereof being to assume a mean or non-tensioned condition. This is true not only of the bellows 70 wherein the compressed wall convolutions tend to expand but also of the bellows 71 where the expanded wall convolutions tend to assume a more nearly collapsed state. This inherent force of the bellows is soon dissipated, however, by the return of the bellows to the more normal state and means is therefore provided for creating the necessary fluid-returning hydraulic pressure differential within the bellows unit system. In the present instance gradually applied resilient pressure is supplied for this purpose by means such as a bowed push spring 82 acting through a pivoted lever 83 mounted upon an L-shaped bracket 84 rising from the base 16 at the side of the timing bellows unit opposite the operating lever 45 (Figs. 5 and 7).

The active loop of the spring 82 has at one end a relatively straight attachment leg 85 by which the spring is secured in operative position adjacent to the bracket 84 while at its opposite end the spring may be provided with spaced coaxial sleeves 87 connected by a pin 88 to the adjacent end of the lever 83. A centralized connection between the spring lever 83 and the bellows-end disk 78 is effected by providing the lever with a pair of yoke arms 89 each having a longitudinally elongated eye 90 for lost motion reception of pintles 91 which are carried by spaced downwardly projecting lugs or ears 92 upon the end disk 78. It will be observed that the ears 92 are formed on a diametric line, in the present instance at right angles to the contact line of the lever terminus push lug 77, thus to receive the lug conveniently therebetween and to assure uniform, non-tilting action upon the bellows 70. The operative relationship of the spring 82 and the lever 83 is such that the spring becomes effective to apply leverage to the bellows 70 for drawing the latter down only after substantial expenditure of the natural expanding force of the bellows. At such time the lever 83 assumes a plane which carries the spring-attached end of the lever above neutral center where the force of the spring is released for action. This spring force gradually increases as the long end of the lever continues to dip with the expanding pump bellows 70 and the short end of the lever rises higher above the neutral center. As a result the lower end of the bellows is carried gradually toward the trigger release arm 62.

Trigger release by the bellows 70 is effected in the present instance by contact between the head end of one of the yoke arms 89 and an adjustment cam 93 which rests upon a lateral release flange 94 extending integrally from the opposite side of the trigger release arm 62 from the release flange 64. The adjustment cam member 93 is in the form of an eccentric knob carried at the end of an adjusting shaft 95 (Figs. 2 and 5) which projects forwardly through the front wall of the casing 22 and carries a manually engageable head 97 equipped with an index pointer 98 (Figs. 1 and 2). The latter is registrable with suitable calibrations such as indicated at 99 to show the character of toast desired. For example, the calibrations may be for medium, light and dark toast, the shaft 95 being turned to the desired extent as indicated by the index pointer 98 whereby properly to adjust the eccentric relationship of the adjustment cam 93 to the release flange 94. Thus, where the cam 93 is so adjusted that the bellows 70 must expand to the maximum permissible distance before the cam is engaged for releasing the trigger, it follows that the length of time that the bread remains in the heat zone is accordingly prolonged and the resulting toast darker. As the cam is adjusted to be contacted after a selected shorter interval the toasting results will vary accordingly. A yoke shaped bracket 100 (Fig. 7) adjacent to the inside of the cam 93 holds the adjustment shaft 95 against

horizontal displacement but permits the necessary vertical movement thereof incident to adjustment of the cam. Longitudinal displacement of the cam is avoided by providing the shaft 95 with a retaining collar 101 on the side of the guiding yoke 100 opposite the cam head 93. In any position of adjustment, the shaft 95 is held releasably against accidental rotation by suitable means such as a detent leaf spring 102 (Figs. 2 and 5) which straddles the shaft near the forward end portion thereof and bears against any selected one of the faces, herein three in number, of a detent collar 103 fast upon the shaft.

Toasting is somewhat slower while the toaster is still in a relatively cold state because a substantial amount of heat from the heating elements 24 is absorbed by the apparatus and therefore less heat is transmitted by radiation to the bread to be toasted than is the case later on when the ambient heat has reached a substantial degree. The other factors such as temperature of the surrounding atmosphere, drafts, moisture content of the toasting bread, and the like, also have a bearing upon the toasting temperature and therefore the length of time required for the desired type of toast. According to the present invention variances of temperature are fairly accurately compensated by contemporaneous variation in the timing of any given toasting period. That is, provisions are made for decreasing the toasting time interval proportionate to increases of temperature. This is accomplished herein, by utilizing a liquid in the hydraulic timing circuit which is sensitive to temperature variations. Thus, the liquid should preferably have a viscosity which allows it to bleed from the reservoir bellows 71 to the pump bellows 70 through the bleeder duct 79 at a given velocity for a given suction force in the cold state of the apparatus and more rapidly as the viscosity decreases substantially proportionate to rises in temperature.

Sensitivity of the hydraulic timing circuit in this respect is improved by forming the bleeder duct tube 79 as a tempering coil 107 which may be located to be subjected more or less directly to heat from the toasting chamber 17. As seen in Figs. 4 and 5, this may be accomplished by locating the tempering coil 107 adjacent to a suitably dimensioned port 108 in the rear wall of the toasting chamber through which radiated heat will impinge upon the coil. To avoid overheating of the outer casing 22, a hood 109 may be fashioned to substantially enclose the coil 107 and guard against the escape of radiated heat through the opening 108 to the outer casing. As a result of this arrangement, the flow of liquid through the bleeder tube 79 at any given hydraulic force is more or less directly proportionate to the temperature to which the coil 107 is subject and this has a corresponding effect upon the time required for the pump bellows 70 to attain the trigger-releasing expanded condition. A certain amount of thinning of the liquid aside from the tempering coil 107 also occurs, of course, as ambient heat within the apparatus warms the bellows containers 70 and 71, thus further influencing the speed with which the return bleeding of liquid progresses. From this it will be clear that the device is characterized by a high degree of heat sensitivity.

Should the heat within the apparatus reach a degree where timing should be further curtailed than lowering of liquid viscosity alone will accommodate in order to avoid over-darkening of the toast, the hydraulic pressure of the liquid may be increased in order to increase the speed of flow of the liquid through the bleeder duct. In the present instance, increased hydraulic pressure is effected by increasing the energy of the spring 82 in proportion as required. To this end the spring 82 may include a bimetallic spring element 110 having a higher coefficient of coexpansion which may be secured to the inside of the principal spring loop by means of a rivet 111. Therefore as the heat within the apparatus increases above a certain point, the spring element 110 tends to expand and exerts pressure supplemental to the energy of the spring 82.

Mention may be made that because of the great sensitivity thereof to temperature variations at least certain features of the timing means may be adapted to such uses as automatic choke valves or regulator control in automotive vehicles, heat compensating regulation of timing devices such as time clocks used in photographic development work, or the like.

By preference, the lever supporting bracket 47, the trigger mechanism 20 and the timing means 21 are all mounted together upon a single base plate 112 which in turn is removably secured to the base 16. In this manner, all of the mechanisms mentioned can be conveniently handled as a unit for assembly purposes.

In order to avoid sudden jarring return of the released bread rack 19 to loading position, which might tend to catapult the toast slices therefrom, suitable restraining or brake means is provided for delaying the return action. In the present instance the brake or restraining means comprises a delayed action hydraulic bellows arrangement working upon the same principle as the timing unit. Thus, referring to Figs. 5, 6 and 9, a pair of expansible bellows containers 115 and 116 is carried by a disk-shaped rigid partition member 117 forming a partition therebetween and supporting the bellows upon a vertical axis in spaced relation above the base 16 through the medium of supporting brackets 118 at the opposite side of the toasting chamber 17 from the timing means 21. In this instance, the bellows 115 is lowermost and serves as a pump while the upper bellows 116 serves as a reservoir for liquid forced from the pump bellows through a transfer passage 119 in the partition member 117. A check valve 120 prevents return flow of the liquid through the passage 119.

An operating connection between the pump bellows 115 and the bread rack 19 is effected through the medium of a link 121 extending in a front to rear direction and having its front end connected to a crank 122 rigid with the adjacent end flange 39 of the rack pivot plate 38. At its rear end the link 121 engages the depending arm of a bell crank lever 123 pivoted upon an upstanding bracket 124. The remaining or upper arm of the bell crank 123 has a connection with a lug 125 extending centrally from the lower face of the bellows end closure plate 127. Preferably the connection between the bell crank and the leg 125 is of the lost motion type herein comprising a pin 128 upon the lug 125 and a slot 129 in the associated bell crank arm. The relationship is such that as an incident to movement of the bread rack to toasting position, the crank 122 draws the link 121 forwardly whereby to rock the bell crank 123 and drive the bellows end plate 127 upwardly to compress the pump bellows 115 and drive fluid therefrom into the reservoir bellows 116. This relationship is main-

tained until the bread rack is released for return to the inoperative or loading position, whereupon the action of the brake connecting mechanism is reversed, under the influence of the rack biasing tension spring 44. Thereupon, fluid is drawn through a bleeder duct which comprises in this instance, a passage 130 directly through the partition member 117 and of a diameter which allows just the return flow of liquid to the pump bellows at a smooth, uniform controlled rate rapid enough for all practical purposes. If desired, the liquid within the brake unit may be heat sensitive to diminish in viscosity as the ambient heat within the toaster increases, thus proportioning the speed of return of the bread rack to loading position to the surrounding heat conditions.

In the modified form of delayed action or timing unit shown in Fig. 10, the pump receptacle comprises a resilient metallic bellows member 131 secured at one end in fluid-tight relation to one side of a flat base member 132 to the opposite side of which is secured a reservoir member comprising a fixed wall tubular container 133. The opposite end of the pump bellows 131 is sealingly secured to a closure plate 134 which is adapted to be connected in any preferred manner with mechanism to be controlled by the unit. In the arrangement shown, the partition member 132 has a liquid transfer passage 135 connecting the pump bellows chamber and the reservoir chamber and a check valve 137 is carried on the pump bellows side of the partition member so that liquid may be freely drawn from the reservoir into the pump bellows but will be prevented by the check valve from returning to the reservoir through the passage 135. This arrangement of the check valve may of course be changed around to operate similarly as in the forms of the devices shown in Figs. 8 and 9 where the liquid can be freely discharged from the pump bellows through the transfer passage but cannot return to the pump bellows through such passage. On the other hand, either of the devices in Fig. 8 or 9 could, it will be apparent, be altered to operate with the check valve on the pump bellows side of the partition as shown in Fig. 10.

From the pump bellows 131, the liquid is adapted to be returned to the reservoir 133 through a main bleeder passage 138 in the partition member 132. The cross sectional flow area of the main bleeder passage 138 may, if desired, be fairly restricted so as to allow only a small substantially fixed flow of liquid therethrough. Additional liquid may be returned through an auxiliary bleeder duct comprising a tube 139 of appropriately small diameter and of the required length which is connected at one end with the pump bellows chamber through a passage 140 in the partition member 132 and with the reservoir chamber at the other end through a similar passage 141. The combined flow through the bleeder passage 138 and the auxiliary bleeder duct 139 can be calculated to comprise the total return flow to the reservoir chamber for any given hydraulic pressure and temperature. For increasing the return flow in response to temperature variations in the particular environment in which the device is in use, the auxiliary bleeder duct 139 may be located in heat transfer relation to a heat source so that the viscosity of the liquid flowing therethrough will be altered in proportion to temperature changes and thus correspondingly alter the speed with which the liquid will return to the reservoir chamber at the given hydraulic pressure.

Development of undesirable pressure conditions within the reservoir 133 by fluctuation in the liquid level is avoided by having the internal dimensions thereof greater than required for accommodation of the maximum volume of liquid and venting the extra space thus provided to atmosphere. In the present instance the vent comprises a port 142 opening through the outer end of the reservoir casing and a spill-preventing tube 143 which projects inwardly from the port 142 toward but short of the highest liquid level attained when the brake unit is upright. The reservoir casing and the vent tube 143 are so proportioned, moreover, that when the unit is tipped over on one side the tube remains entirely above the liquid and when the unit is inverted the inner end of the tube is above the liquid level. Thus, air may pass freely into and out of the reservoir through the tube 143 but liquid cannot escape through the vent. Liquid may be filled into the reservoir 133 through an inlet port 144 which may be closed by a screw plug 145.

From the foregoing it will be apparent that the present invention provides a novel operation controlling method and means of high efficiency and reliability requiring but relatively few, inexpensive and simple parts in practice and acting to give consistently accurate and uniform results for a wide range of conditions. Since there are but few relatively moving parts necessary to carry out the invention, operating tolerances due to friction drag are practically negligible and continual accuracy in operation is assured. The novel hydraulic timing or delayed action circuits are capable of highly sensitive response to temperature variations as a result of which operation of the associated apparatus may be accurately compensated by minute degrees within a wide range in a manner which assures constant uniformity of results.

I claim as my invention:

1. The method of controlling the action of a working device through a cycle of operation involving variable temperature conditions which includes the steps of driving a liquid of predetermined heat sensitivity from one chamber to a second chamber as an incident to commencement of the cycle of operation, returning the liquid from the second chamber to said one chamber through a bleeder passage, and in the passage subjecting the liquid to the variable temperature conditions for controlling the viscosity of the liquid and thereby determining the rate at which the liquid returns to the said one chamber so as to substantially synchronize the time of the cycle of operation in inverse ratio to the prevailing temperature.

2. The method of controlling the cycle of operation of a device by means of a hydraulic control system including a pair of chambers only one of which can have the major volume of liquid therein in any given condition of the system, which includes the steps of driving the liquid from one chamber to the other at one point in the cycle of operation of the device, metering a portion of the liquid from the second chamber to the first under substantially constant flow at given hydraulic pressure and simultaneously returning additional of the liquid from the second chamber to the first chamber through a bleeder duct, and subjecting the liquid flowing through the bleeder duct to variable tempera-

ture conditions to vary the rate of flow thereof at the given hydraulic pressure so as to compensate the time interval for completing said cycle of operation in accordance with temperature variations.

3. Means for controlling the cycle of operation of an associated device comprising, in combination, means for initiating a cycle of operation of the device, and means for timing the completion of the cycle of operation including a hydraulic system having a liquid chamber, a liquid in said system, means for effecting the evacuation of liquid of predetermined viscosity at room temperature from said chamber coincident with initiation of the cycle of operation, means for conducting the liquid for return to the chamber at a restricted rate, said means being arranged to be subjected to variable heat conditions during the cycle of operation in order to alter the viscosity of the liquid and vary the rate of return flow of liquid to the chamber, and means for terminating the cycle of operation upon return of the liquid to the chamber.

4. In combination in apparatus of the character described, a device normally biased to assume a first position and mounted to be actuated from the first position to a second position, trigger mechanism, means for connecting said device with said trigger mechanism to hold the device in the second position, timing means including an expansible bellows and means carried thereby for releasing said trigger mechanism in the expanded condition of the bellows to permit return of the device under its bias to said first position, and means independent of said releasing means for compressing said bellows coincident with connection of the device with said trigger mechanism.

5. In combination in apparatus of the character described, a pivoted device having first and second positions attained by pivotal movement thereof, electrical heating means located for cooperation with said device in one of said positions and having a control switch, trigger mechanism, a lever movable with said device connectible with said trigger mechanism and arranged to operate said switch, timing means for releasing said trigger mechanism, and an operating lever arranged to set said timing means and in the same motion to act upon said connecting lever for effecting a connection with the trigger mechanism and to operate said switch, said operating lever being also movable for releasing the trigger mechanism independently of said timing means.

6. In combination in apparatus of the character described involving variable temperature conditions during operation, a timing unit including an expansible metallic bellows, liquid in said bellows, means for compressing said bellows to force the liquid therefrom, means for receiving the liquid, means for returning the liquid to the bellows, and means for expanding said bellows to create hydraulic force to return the liquid, said last-mentioned means being driven by a spring having a thermostatic compensator for temperature variations.

7. In apparatus of the character described, means defining a heating zone, a member movable into and out of the heating zone, means for actuating said member, means for holding said member in said heating zone for a substantial interval including a hydraulic timing device having a liquid of predetermined viscosity adapted to thin out at the temperatures produced in said heating zone therein, and a tempering coil located to be subjected to heat from said heating zone and arranged to provide a passage for liquid from one portion of said timing device to another portion for controlling the length of the time interval in accordance with the viscosity of the liquid passing through said coil.

8. In combination in apparatus of the character described, a timing unit including a pair of chambers, one of said chambers comprising compressible bellows, a base member closing one end of said bellows, a member of fixed shape comprising the other chamber on the opposite side of said base member, a valve controlled passage through which the liquid is adapted to be driven from one chamber to the other by pump action of said bellows, a restricted passage for returning the liquid gradually to the latter chamber by reverse action of said bellows, and an atmospheric vent in said fixed chamber member including means to prevent escape of liquid in any position of the unit.

9. In combination in apparatus of the character described having variable temperature conditions during operation, a device for movement between different stations, means for actuating said device, means for releasably holding said device at one station, means for timing the release of the device from said one station for return to the other station, and means for braking the return of the said device to said other station including a hydraulic unit having a chamber from which liquid of given viscosity is driven when said device is moved to said one station and to which the liquid can return only by restrained flow when the said device returns to said other station, said hydraulic unit being located to be subjected to said variable temperature conditions so as to affect the viscosity of the liquid and thus its rate of flow under given hydraulic force.

10. The method of proportioning the length of an operating interval of a timing device to certain variable temperature conditions where the device is dependent in operation upon the delivery through a substantially restricted passageway of a predetermined quantity of a relatively viscous liquid to a control chamber, which comprises effecting similar temperature variations in the liquid so that the viscosity of the liquid is caused to decrease or increase inversely as there is a temperature increase or decrease and thus to vary correspondingly the rate of liquid flow through the passageway to the chamber for any given hydraulic force in the passageway.

11. In the art of controlling the operation of a timing device wherein the length of a time interval between the starting and the ending of a performance in the presence of variable temperature conditions includes the filling of a chamber to a predetermined extent with a fluid entering the chamber through a restricted-flow passageway, the method of automatically varying the rate at which said filling of the chamber takes place, which comprises subjecting the fluid to said variable temperature conditions.

12. A device for controlling the action of a working apparatus through a cycle of operation involving variable temperature conditions, which includes a pair of chambers, means for effecting the driving of a liquid of variable viscosity within the range of said temperature conditions from one of the chambers to the second chamber at one point in the cycle of operation, a bleeder passageway through which the liquid can return from

the second chamber to the first chamber, the passageway being constructed and arranged to be subjected to said variable temperature conditions for controlling the viscosity of the liquid and thereby determining the rate at which the liquid returns to the second chamber, whereby substantially to synchronize the time of the cycle of operation in inverse ratio to the temperature prevailing during the cycle.

13. In a device for controlling the action of an operating mechanism, a pair of chambers, means for conducting a fluid of predetermined heat sensitivity from one of the chambers to the second chamber as an incident to setting the operating mechanism for a particular action, and means for conducting the fluid from the second chamber into the first chamber, until sufficient fluid has returned to the first chamber for completion of said action, the device being so related to the operating mechanism that the environmental temperatures will be reflected with substantial accuracy by the temperature condition of the fluid and thus the rate of flow of the fluid through the passageway.

14. A device for controlling the action of an operating mechanism subject to variable temperature conditions including means having a chamber from which fluid is adapted to be driven rapidly and is adapted to return slowly for timing the operation of said mechanism, the construction and arrangement being such that the fluid is subjected to said variable temperature conditions for increasing or decreasing the rate at which the volume of fluid displaced from said chamber is regained although the flow passageway remains unaltered.

15. Means for controlling the action of a working device through a cycle of operation involving variable temperature conditions including, in combination, an assembly having a pair of liquid chambers, a volume of liquid less than the combined capacities of the chambers and of predetermined viscosity, means cooperating with the chamber assembly for effecting a driving of the liquid from one of the chambers to the second of the chambers as an incident to commencement of the cycle of operation, means for conducting the liquid from the second chamber to the first chamber including a bleeder duct, said duct being located to subject the liquid therein to said variable temperature conditions for varying the viscosity of the liquid, and thereby determining the rate at which the liquid will return to the first chamber, other means cooperative with the chamber assembly for creating sufficient force to compel return flow of the displaced liquid through said conducting means, and means operative as an incident to return of the displaced liquid to said one chamber for terminating the cycle of operation.

16. Means for controlling an operating cycle comprising, in combination, a hydraulic control system including a liquid of predetermined viscosity and a pair of chambers, the liquid being in a volume substantially less than the combined capacities of the chambers, means in the system for effecting a driving of the liquid from one chamber to the second chamber at one point in the cycle of operation of the device, means for conducting a portion of the liquid from the second chamber to the first chamber at a substantially constant restricted rate under given hydraulic pressure, means for simultaneously conducting additional of the liquid from the second chamber to the first chamber including a bleeder duct, means operative upon return of the liquid to said second chamber for terminating the cycle of operation, and means whereby the liquid in the duct is subjected to variable temperature conditions to vary the liquid flow rate in the duct and compensate the time interval for completing said cycle of operation in accordance with temperature variations but without changing the hydraulic pressure.

17. In combination in apparatus of the character described, a pivoted device having first and second positions attained by pivotal movement thereof, means acting to force said device normally into the first of said positions, trigger mechanism, a lever secured at one end to said device so that its opposite end describes an arc of movement as said device is pivoted, said opposite end of the lever being connectable with said trigger mechanism in the second of said positions of the device, timing means for releasing said trigger mechanism, and an intermediately pivoted operating lever arranged at one side of its pivot to act upon said connecting lever to actuate said device against said forcing means from said one position to said second position, and at the same time effect a connection of said one end of the connecting lever with the trigger mechanism, said operating lever having structure on the other side of its pivot for setting the timing means in the same motion which effects said connection.

18. A substantially self-contained timing device, comprising, in combination, a base, trigger mechanism on said base including a latch and means for tripping said latch, a timing bellows arranged to engage said tripping means when expanded, a lever pivoted on said base and having one end arranged to engage said bellows for compressing the latter when the lever is pivoted in one direction, said lever being arranged for engaging the connecting means of the device to be timed to drive the connecting means into engagement with said latch as an incident to the pivotal movement which effects compression of the timing bellows.

19. A timing device substantially as set forth in claim 18 in which the bellows-engaging end of the lever is adapted when the lever is pivoted in the opposite direction to engage the trip means for releasing said latch independently of the releasing action of said timing bellows.

20. In combination in apparatus of the character described, a member adapted to be moved from one position to a second position and return in the course of a cycle of operation of the apparatus, means for moving said member from said one position into said second position as an incident to initiation of the operating cycle, means for holding said member in said second position against return to said first position, a timer arranged to act upon said holding means to cause the holding means to release the member after a predetermined time interval, said timer and said holding means including opposed abutments separable to a given extent at the initiation of said operating cycle and arranged for gradual approach during said time interval, and adjustment means including an element interposed between said abutments for transmitting operating force from the timer abutment to the holding means abutment when the abutments have approached to within a given short distance of one another, said element being controllable to vary the effective distance of ap-

proach of the abutments whereby to adjust the length of said predetermined time interval.

21. In apparatus of the character described means defining a zone within which certain critical temperature conditions are prevalent during operation of the apparatus, a member movable into and out of said temperature zone, means for actuating said member and maintaining it in said temperature zone for a substantial interval, said actuating means including a hydraulic timing device having a liquid of predetermined viscosity therein adapted to vary in viscosity in accordance with the prevailing temperatures in said zone, and a flow duct located to be subjected to the temperature prevailing in said zone and arranged to provide a passage for liquid from one portion of said timing device to another portion for controlling the length of said time interval in accordance with the viscosity of the liquid passing through the duct.

22. In combination with apparatus for handling articles to be treated within a zone wherein the temperature is subject to variation, a hydraulic timer system for correlating the interval of treatment with the prevailing temperature in said zone in order to attain uniform results in treatment at any temperature therein, the system including a sealed bellows defining a chamber and being axially flexible to act as a pump in the system, means defining a second chamber, the chambers having a liquid therein of a viscosity variable in accordance with variations in the temperature of its environment, said liquid being present in less volume than the total capacity of the chambers, a one-way liquid passage connecting said chambers enabling transfer of liquid from one of the chambers to the other of the chambers in response to pumping action of the bellows in one direction, and a duct for return of the liquid from the latter to the former chamber in response to a reverse pumping action of the bellows, the duct being of such restricted cross-sectional flow area as to restrain return flow to a predetermined rate for a given hydraulic force and viscosity of the liquid, the construction and arrangement of the system being such that the liquid is subjected to the variable temperature conditions of the treating zone so that the resulting viscosity of the liquid will be reflected in the flow rate through the return duct.

23. In a timing device for use with an apparatus operating under variable temperature conditions and in which operation of the apparatus must be correlated with the prevailing temperature in order to attain uniformity of results from said operation, means defining a hydraulic flow circuit, a liquid in the circuit of such viscosity characteristics that changes in its temperature are quickly reflected in corresponding variations in viscosity, and means for driving the liquid through the flow circuit, one portion of the circuit being of such restricted cross-sectional flow area as to restrain flow of the liquid to a predetermined slow rate at a given hydraulic pressure and viscosity of the liquid, the construction and arrangement of the flow circuit being such that the liquid is adapted to be subjected to said variable temperature conditions so as to increase or decrease the rate of flow through the restricted portion of the circuit inversely as the viscosity decreases or increases under the influence of the temperature variations, whereby to alter correspondingly the time required for the liquid to travel from one part to another part of the circuit through said restricted portion in controlling said operation.

24. In a device for controlling the operation of apparatus involving variable temperature conditions, means providing a hydraulic circuit including a liquid variable as to viscosity within the range of said variable temperature conditions and constructed and arranged for influencing said operation in accordance with the time required for a given volume of the liquid to flow from one part of the circuit to another, the circuit including a restricted passage through which the liquid must flow, which passage is of such limited cross-sectional flow area as to require a predetermined time interval for the passage of a given volume of the liquid therethrough under a given hydraulic pressure and at a given viscosity of the liquid as determined by the prevailing temperature of the liquid, and means for creating the hydraulic pressure for driving the liquid through the circuit, the temperature of at least the liquid passing through said restricted passage being adapted to be varied as said temperature conditions vary for correspondingly altering the viscosity of the liquid.

25. In combination with apparatus the operation of which is concerned with variable temperature conditions, and which includes a movable operation-controlling structure, means for timing at least a certain portion of the operation of the apparatus comprising a hydraulic circuit containing a liquid the viscosity of which varies with the temperature to which the liquid is subjected, said means including a collapsible bellows providing a chamber at one point in the circuit, the bellows being arranged to return to expanded condition after being collapsed, the circuit also including a passage for discharge of liquid from the bellows chamber as an incident to collapsing of the bellows and a return passage for slow return of the liquid into the bellows chamber to restrain expansion of the bellows to a slow rate, the liquid being subjected to temperature variations corresponding to said variable temperature conditions for correlating its viscosity with the prevailing operating temperature and thus determining the rate at which the liquid returns to the bellows chamber and thus the bellows expansion rate, and means actuated by the bellows separable from said operation-controlling structure when the bellows is collapsed and operatively engageable with the structure when the bellows returns to expanded condition.

26. A combination, as defined in claim 25, in which the operation-controlling structure includes means for varying the effective distance within the range of movement of the bellows to which the bellows-actuated means is separated from such structure in the collapsing of the bellows, for correspondingly varying selectively the interval required for return of the bellows actuated means to engagement with the operation-controlling structure in the expansion of the bellows.

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