

United States Patent

[11] 3,579,217

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[21] Appl. No. **735,737**
[22] Filed **June 10, 1968**
[45] Patented **May 18, 1971**
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[56]

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[54] **METHOD AND APPARATUS FOR DETECTING AND INDICATING MALFUNCTION OF A TABLETING MACHINE**
5 Claims, 6 Drawing Figs.

[52] U.S. Cl. 340/253,
317/27, 324/103, 340/267
[51] Int. Cl. G08b 21/00
[50] Field of Search..... 340/248-
—256; 340/179; 324/103, 107, 110, 142; 73/204;
317/18, 16, 27

ABSTRACT: Method and means for monitoring a multistation tableting machine with respect to the forces applied by tablet-forming punch means to tablets successively formed in and ejected from said machine which comprises continuously measuring the electric power requirement of said machine with respect to predetermined overload and underload norms of operation.

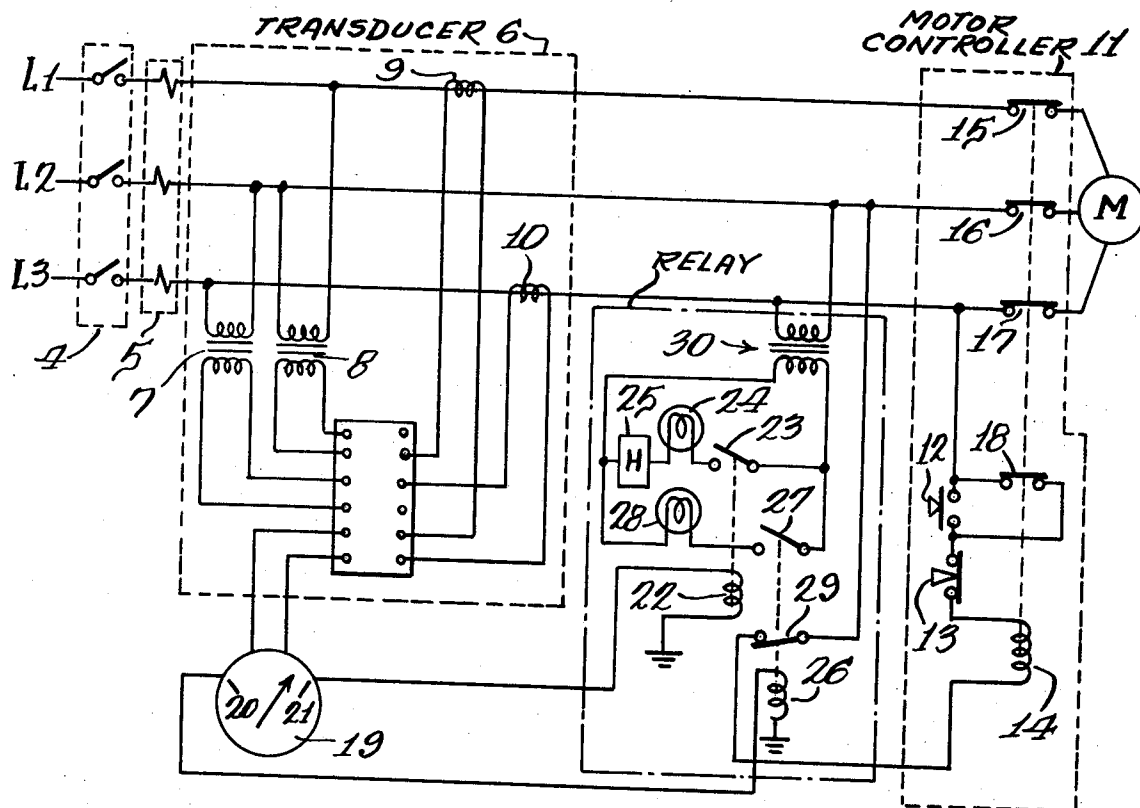


Fig. 1.

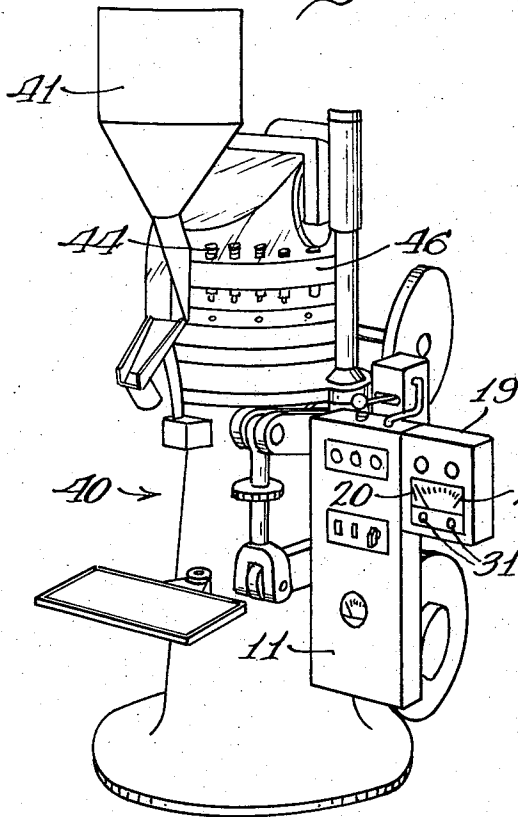


Fig. 2.

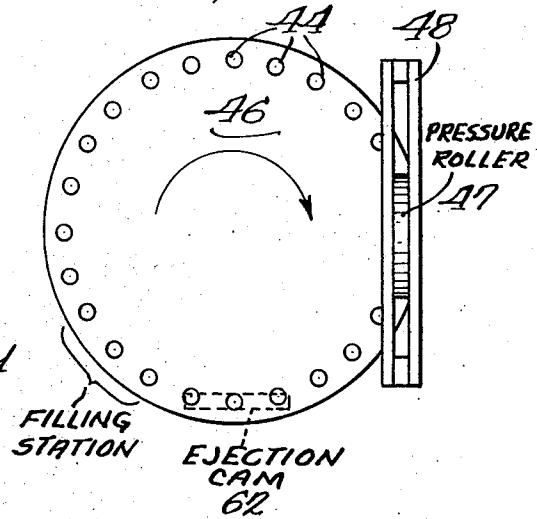
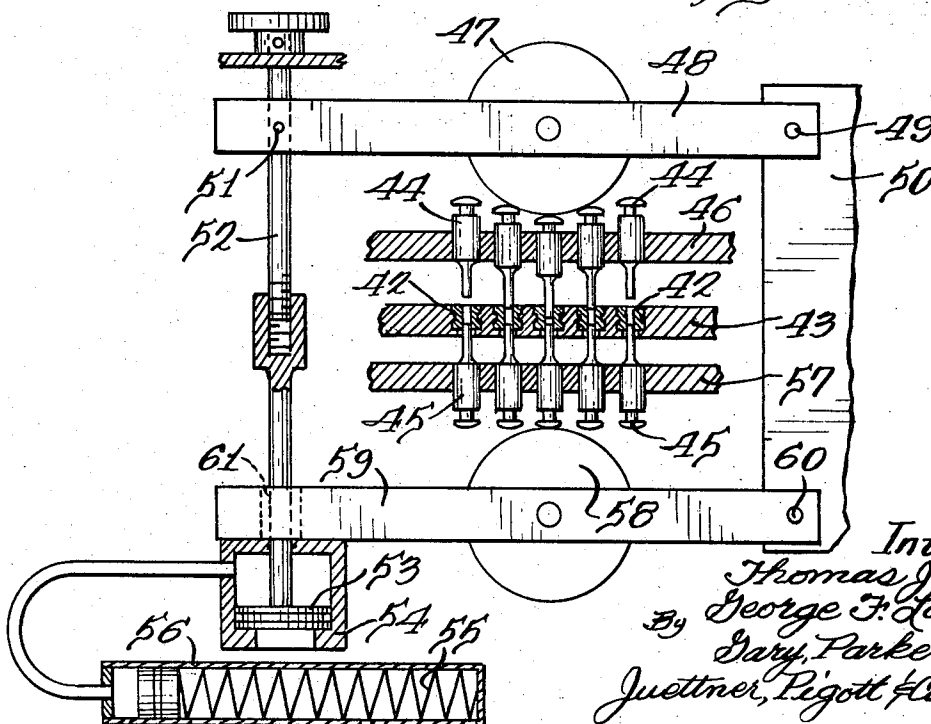


Fig. 3.



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Fig. 4.

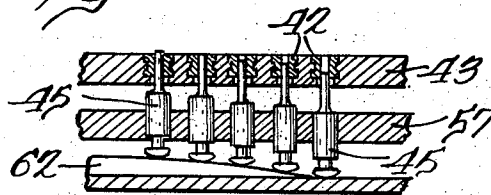


Fig. 5.

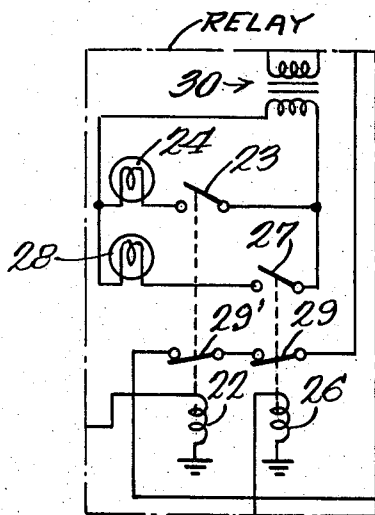
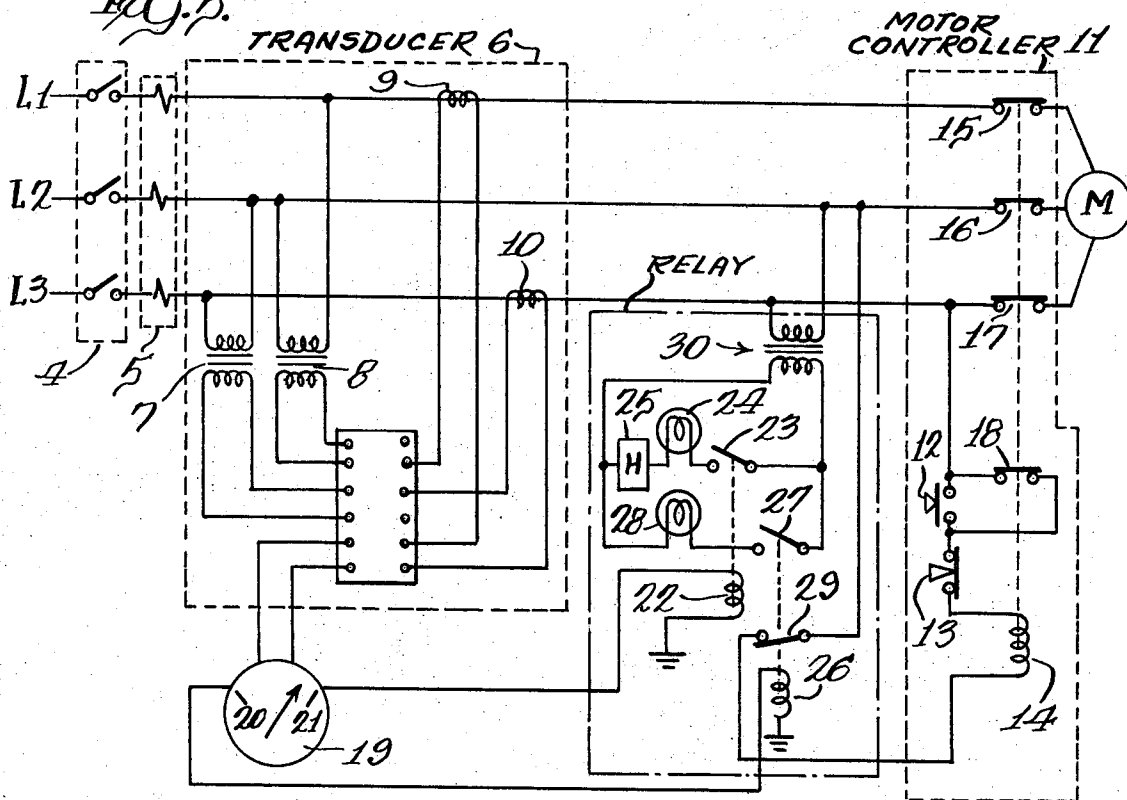


Fig. 6.

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METHOD AND APPARATUS FOR DETECTING AND INDICATING MALFUNCTION OF A TABLETING MACHINE

This invention relates to improvements in tableting machines and particularly to means for controlling them, with the end in view of controlling the character of the tablets produced thereby.

As is well known, the conventional tableting machine to which this invention is directed comprises at least one set of three rotatable discs, the intermediate one being formed with die cavities and dies adapted to receive the material to be tableted, which is generally designated as granular material, together with conventional lubricants and/or other tableting adjuvants. The granular material to be tableted is then compressed between punches carried by a lowermost disc and punches carried by an uppermost disc under the influence of a pressure roll, the punches in the upper disc being under progressive compression whereas the punches in the lower disc are essentially stationary during the tableting operation but upon lifting of the punches from the upper disc the punches of the lower disc are raised to eject the formed tablets.

Among the problems is the fact that tableting pressures can range as high as 150,000 pounds per square inch. Under such pressures rather amazing things happen and it is believed that a "tornado" effect takes place on the granular material thereby wearing away the walls of the die cavity in an intermediate portion of the die. The result when the walls become excessively worn is a tablet that is actually larger in diameter than the intended diameter of the die cavity. Since this enlargement is only in the intermediate part of the die, when the lower punch is operated to eject the tablet from the die, it must recompress the tablet to the original diameter of the upper part of the die cavity, thereby necessitating excessive or overload power requirements which would serve to inform the operator of the need to replace one or more dies before the machine is seriously damaged and before the tablets being formed are too far off from specifications.

Other factors influencing the product include the amount of granulation in each tablet, consistency of granulation in terms of particle shapes and sizes, amount of lubrication, amount of moisture, and other various physical characteristics of the tablet and its hardness (too slow to disintegrate) and softness (crumbling during packaging) of the tablets.

The effort necessary to compress a tablet is based on several factors such as (a) the physical properties of the granulation involved; (b) the size and shape of the finished compressed tablet; (c) the physical condition of the tooling and various machine components; and (d) the type and degree of lubrication employed both in the machine and in the product.

Two specific points of concern in a tableting operation are the load in the pressure roll position and the load at the ejection point where the finished tablets are expelled from the die cavity.

The pressure rolls on a tableting press close the punches on the granulation and exert the pressure necessary to cause the granulation to bond properly into the form of the tablet.

A change in this compacting pressure would indicate a change in the granulation such as moisture content, particle shape and size distribution, bonding agent, etc., or an insufficiency of granulation indicating improper feed.

All of the above are indications that the tablets being formed would not be acceptable and/or that if the machine were to continue to run on this basis that material would be wasted or that serious damage to the compacting tools or the parent machine would result.

As previously indicated, normal compaction pressures for pharmaceutical granulations will range up to approximately 150,000 pounds per square inch dependent on the specific granulation. When the punches are retracted after exerting this force, there remains a residual stress in the formed tablet which exerts a strong lateral pressure on the die walls. This pressure or force tends to lock the tablet in its compacted position, the degree dependent on the finish of the die surface

involved, the angle of this surface relative to the desired ejection path, the amount of effective lubrication present and the "spring back" quality of the particular granulation.

The lower punch on the tableting machine rides up a ramp or ejection cam to push the formed tablet out of the die. The pressure on the punch head exerted by this cam is directly related to the above tablet to die-wall locking effect, the degree of lubrication between the punch head and cam, and the physical condition of these surfaces.

It is an object of this present invention to sense slight deviations from the norm in press operation due to the foregoing and other causes in order to (a) insure proper formation of the tablet and (b) avoid major problems with the tooling or the tableting machine as a whole including the guarding against worn cams or punch heads, lack of proper tooling lubrication, worn dies, off-specification or broken tooling, and improper set up (tooling distortion).

The means for sensing slight or other deviations from the norm comprises the employment of a wattmeter relay that measures the power on all three legs of the powerline leading to the prime mover (electrical motor) of the tableting machine. The wattmeter relay has built in overload and underload contacts and/or relays covering several individually selectable ranges of watt loading. An overload indicator light is connected to the overload contact or relay and an underload light is connected to the underload contact or relay. For machine control purposes, a relay may be connected to each of and/or both of the underload and overload contacts or relays in order to perform appropriate control functions.

It is preferred to utilize a machine controlling relay on the underload side to automatically stop the machine at the predetermined underload condition. A frequent cause of underload is an inadequate feed, or absence of feed, of the granulation to the dies and it is important to stop the machine before tablets below specifications are made and/or the tooling is ruined. On the overload side, it is preferred to connect simply an alarm bell or horn to warn the operator that an overload condition exists, so that he can start looking for the cause of the overload condition, but without stopping the all-important production of tablets by the machine.

In operation, the initial run of a product on the press should be made with more than the normal care given to correctness of product composition, finished tablet, lubrication, tooling configuration and machine operation. The power required should then be logged.

When this product is run at a later date the above energy requirements should be referred to. Any deviation from the established value for this specific product would indicate a change in one of the variables. It will not indicate the exact trouble; it will alert the operator that there is some change in the operation and that some attention should be given to evaluate the potential hazard of continued operation.

Since one of the variables that will affect this power requirement is the volumetric feed in the die cavity, a loss of this feed due for example to bridging in the supply hopper or insufficient feed to the hopper will be sensed and the machine turned off averting the damaging of punch faces.

In subsequent operation, the wattmeter relay is set to high and low limits to the predetermined levels for a particular product. After turning on the meter any deviations in power requirement or norm in operation can be sensed and used to set the machine and/or signal the operator visually or audibly, overload protection being for an excessive loading due to machine or tooling malfunction and product variation and underload protection being to prevent deviation from normal of the granulation or running out of granulation.

Other objects and advantages of the present invention, its details of construction, arrangement of parts and economies thereof will be apparent from the following specification and accompanying drawings, wherein:

FIG. 1 is a perspective view of a tableting machine embodying the present invention.

FIG. 2 is a diagrammatic top plan view of the upper punch guide disc of the tableting machine of FIG. 1, and

FIG. 3 is a diagrammatic fragmentary side elevational view of the upper and lower punch guide discs and intermediate mold or die carrying disc, and associated parts.

FIG. 4 is a fragmentary side elevational view of the tablet ejecting means successive to the tableting of FIG. 3.

FIGS. 5 and 6 are schematic diagrams of the electrical supply and limiting control means for the device of FIG. 1.

Referring to the drawings, and particularly to FIGS. 1 to 4, the reference numeral 40 generally indicates a conventional multistation tableting machine having secured thereto and connected to its power source the wattmeter relay device 19 comprising the transducer and relay components of FIG. 5 connected to the conventional motor controller unit 11 and the power supply to the system as will be hereinafter more fully explained in detail.

The tableting machine comprises the granule supply hopper 41 leading to the dies 42 in the disc 43 wherein the granules and adjuvant material from the hopper 41 are compressed to tablets between the upper punches 44 and the lower punches 45. The upper punches 44 while retained by the plate 46 are normally urged out of the cavities of dies 42 during the die filling sequence, and then urged into the die cavities when passing under the pressure roller 47 adjustably held by the arm 48.

The arm 48 is pivotally engaged at one end 49 to a machine frame portion 50 and at its opposed end as at 51 to the adjustable yoke member 52 which terminates in a piston 53 maintained under hydraulic pressure in the cylinder 54, the hydraulic fluid being under influence of the spring 55 in cylinder 56.

The lower punches 45 are retained in the lower plate 57 and while the upper punches are pushed downwardly by roller 47, the lower punches are merely locked up by the lower roller 58 pivotally engaged in arm 59 which in turn is pivotally engaged as at 60 to frame 50. The opposed end of the arm 59 freely receives yoke member 52 through aperture 61 and thus this arm merely rests on but is not under the influence of cylinder 54 and its contained piston.

As the plates 46, 43 and 47 jointly rotate, and after they are free of the influence of pressure roller 47, the upper punches 44 are withdrawn by conventional cam means, not shown, and lower punches 45 come under the influence of a ramp or cam surface 62, as shown in FIG. 4, to eject the formed tablets from the dies 42.

Referring to the schematic diagrams of FIGS. 5 and 6, and particularly to FIG. 5, lines L1, L2 and L3 of the conventional three-phase power supply to the machine motor M are provided with on-off master switches 4 and suitable fuses 5. The power supply is conducted through a transducer 6 including a pair of transformers 7 and 8 facilitating measurement of the voltage of the power supply and a pair of induction coils 9 and 10 associated with the "hot" lines L1 and L3 for measuring the current flow (amperes). The power supply is also conducted through a conventional motor controller 11 including start and stop buttons 12 and 13 respectively, and a self-locking relay 14 including switches in the power lines. The start button comprises a normally open pushbutton switch 12, and the stop button comprises a normally closed pushbutton switch 13. Upon closing the start switch 12, current is supplied to the coil of the relay 14 thereby pulling the line contacts 15, 16 and 17 into closed positions and also closing switch 18 in parallel with the start button whereby, upon release of the start button, the coil of the relay 14 remains energized due to the fourth set of contacts 18.

According to the present invention, the transducer 6 is employed to feed the volt-ampere measurements to a wattmeter relay 19 having a pair of adjustable contacts (indicated by slash lines 20, 21) namely a left-hand underload contact 20

and a right-hand overload contact 21. The overload contact means is coupled to an overload relay 22 including a normally open contact set 23 in series circuit with an overload light 24 and a warning bell or horn 25. The left-hand or underload contact of the meter is connected with the coil 26 of an underload relay including a normally open contact set 27 in series with an underload light 28 and a normally closed contact set 29 in series with the coil 14 of the motor controller relay 11.

In the event of underload, the relay 26 is energized to close the circuit to light 28 and to open the normally closed contact set 29 thereby to break the circuit of the coil of the motor controller relay, whereupon that relay opens to disconnect the motor M from the power supply and stop the machine. In the event of overload, the relay 22 is energized thereby to close its contact set 23 to light the light 24 and sound the alarm H. The warning light circuits are connected to the power supply independently of the motor controller by means of a transformer 30 so that the energized light will remain lit to inform the mechanic that the difficulty was either overload or underload, as the case may be. In examining the machine, subsequent to indication of underload or overload, the mechanic would open the master switch 4, thereby deenergizing the entire circuit and returning the overload or underload relay to its illustrated position.

The foregoing is the preferred circuit, wherein the machine is stopped automatically only in the event of underload, and not in the event of overload.

In the modified arrangement of FIG. 6, there is no horn and both relays have normally closed contact sets, i.e. 29 and 29' in series with the motor controller coil 14 to stop the motor for either overload or underload.

Thus, deviation of predetermined norms measured by the contacts 20 and 21 adjustably set by the controls 31-31 on wattmeter relay 19 will indicate and signal, by either visual or audible signal, or cut off the power supply, or provide a combination of these signalling means when there is a malfunction of the tableting machine, and by thus bringing such malfunction to the attention of the operator, permit prompt correction.

We claim:

1. The combination with an electric motor driven tableting machine and an electric power supply therefor of wattmeter means electrically coupled with said power supply for determining the instantaneous load on the machine's motor, means for indicating said load, and means for signalling overload and underload respectively of power supply in response to deviation from predetermined limiting norms of the machine's power requirements indicative of machine and/or tableting malfunction.

2. The device of claim 1 wherein the signalling means comprises an audible signal.

3. The device of claim 1 wherein the signalling means comprises a visual signal.

4. The device of claim 1 wherein the signalling means comprises a power cutoff relay.

5. A method for monitoring an electrically driven multistation tableting machine with respect to the forces applied by tablet-forming punch means to tablets successively formed in and ejected from said machine which comprises measuring the electric wattage requirements of said machine under normal operating conditions to predetermine the normal load on the machine and the overload and underload norms of operation thereof indicative of machine and/or tableting malfunction, continuously measuring the instantaneous wattage draw of said machine to determine the load thereon with respect to said predetermined overload and underload norms of operation, and indicating and signalling overload and underload respectively.