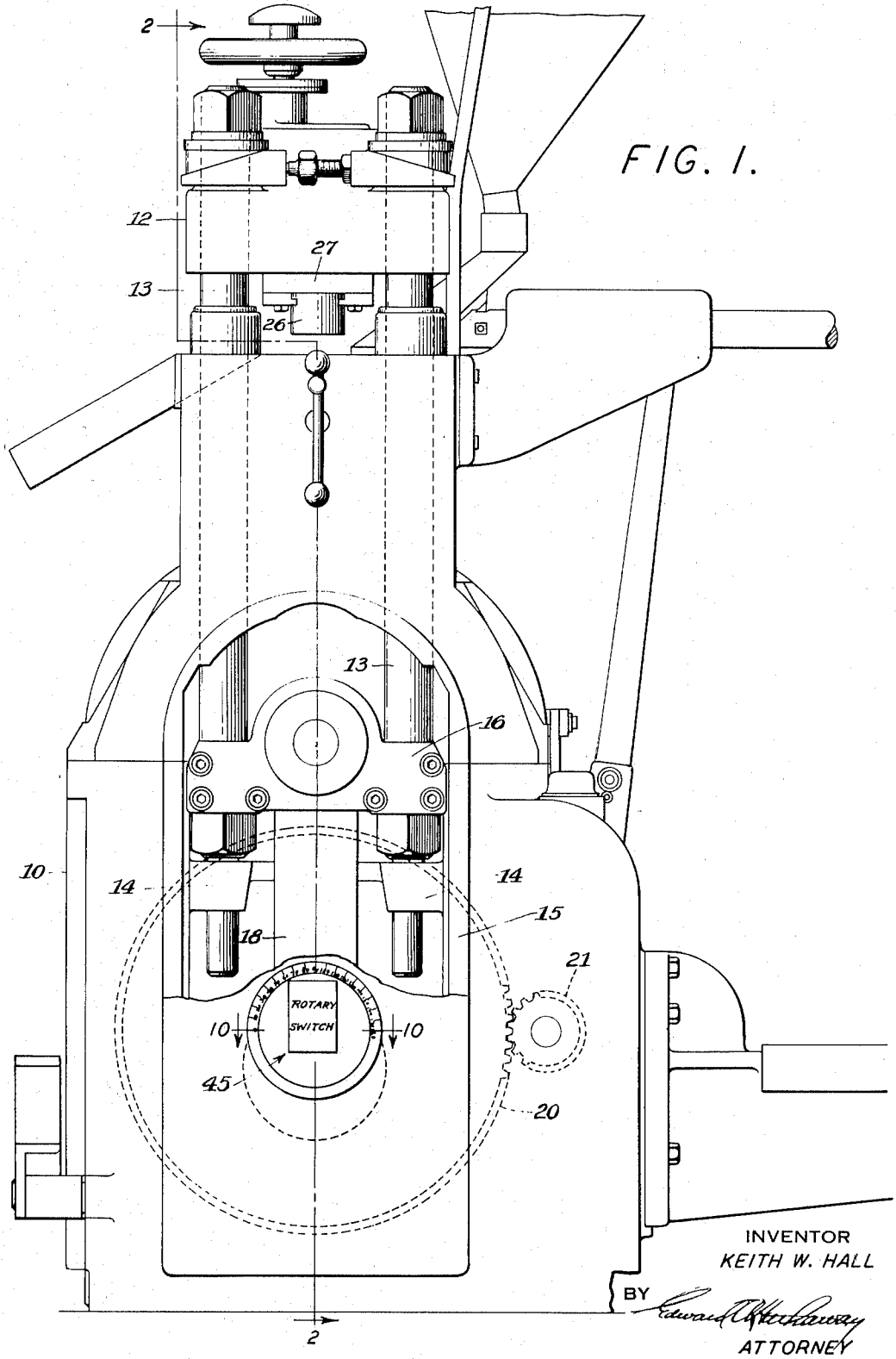
Nov. 22, 1955 K. W. HALL 2,724,145

TABLETTING MACHINE

Filed Oct. 3, 1950 6 Sheets-Sheet 1

FIG. 1.



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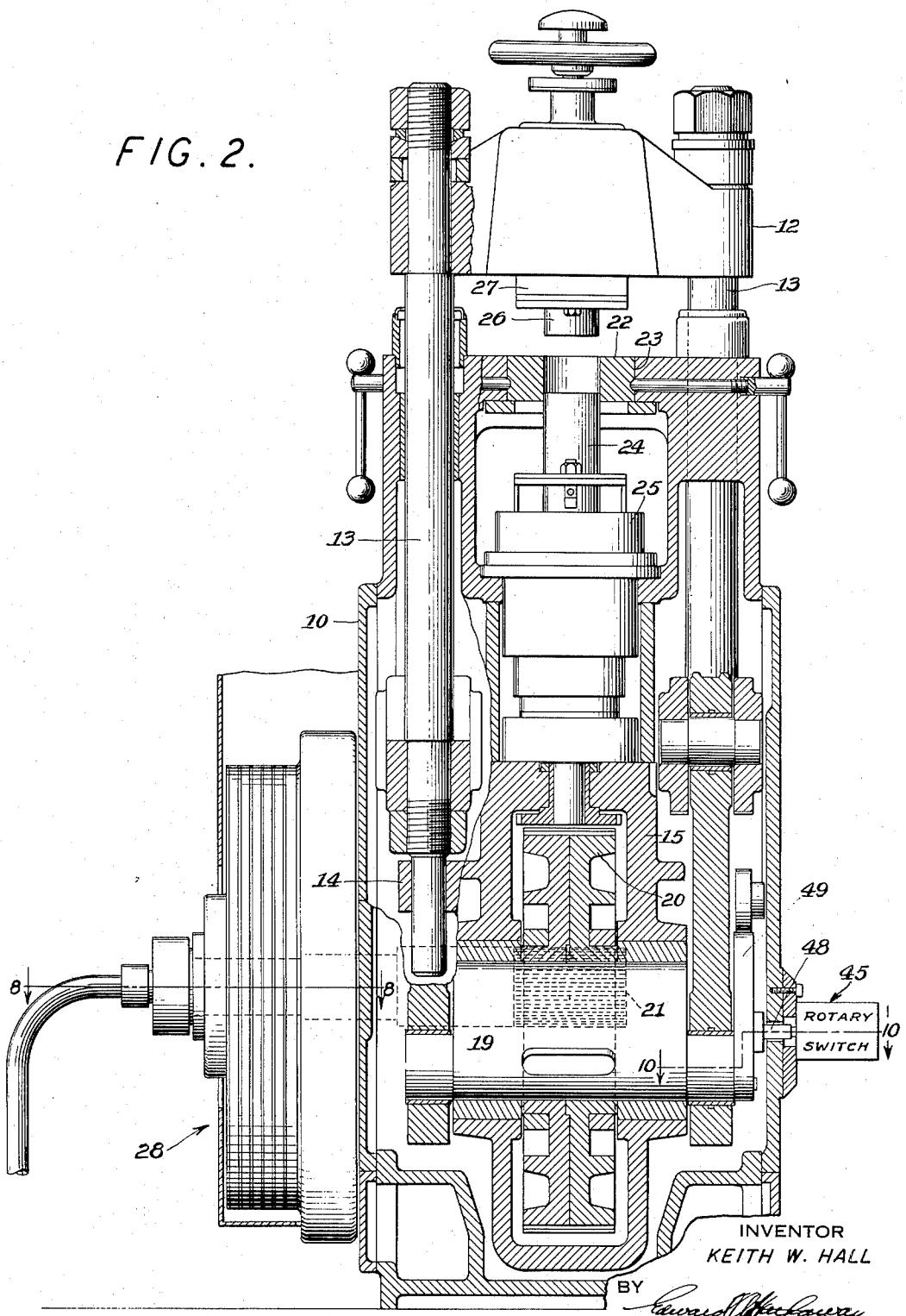
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Nov. 22, 1955 K. W. HALL 2,724,145

TABLETTING MACHINE

Filed Oct. 3, 1950 6 Sheets-Sheet 2

FIG. 2.



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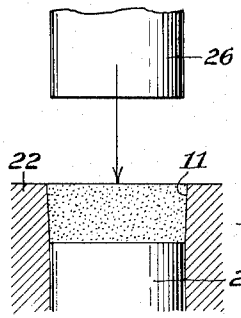
BY

ATTORNEY

Nov. 22, 1955 K. W. HALL 2,724,145

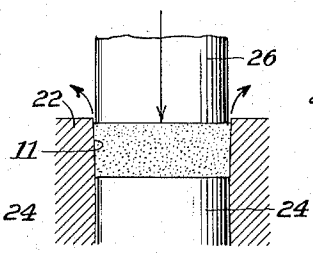
TABLETTING MACHINE

Filed Oct. 3, 1950 6 Sheets-Sheet 3



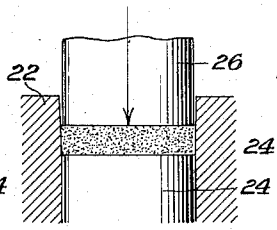
INITIAL DOWN STROKE

FIG. 3.



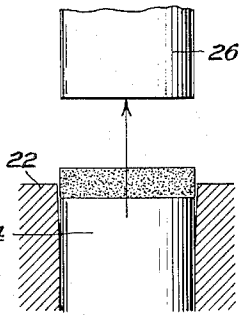
PRE-COMPRESSION DWELL

FIG. 4.



FINAL DOWN COMPRESSION STROKE

FIG. 5.



RETURN UP-STROKE AND PREFORM EJECTION

FIG. 6.

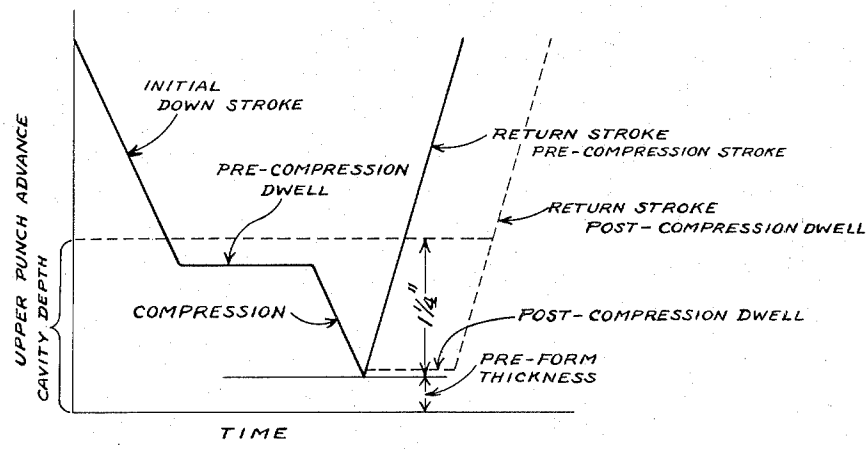


FIG. 7.

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TABLETTING MACHINE

Filed Oct. 3, 1950 6 Sheets-Sheet 4

FIG. 8.

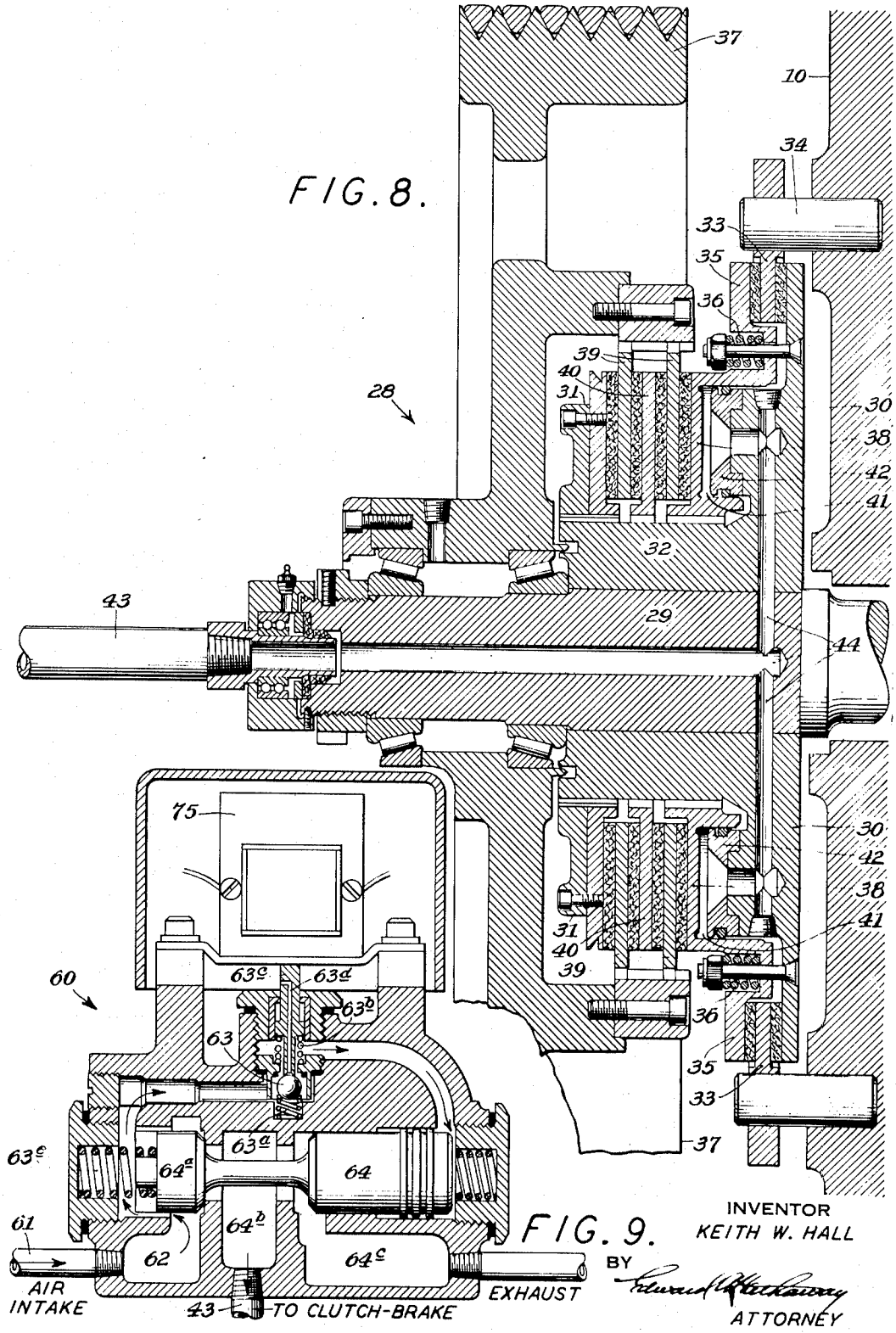


FIG. 9.

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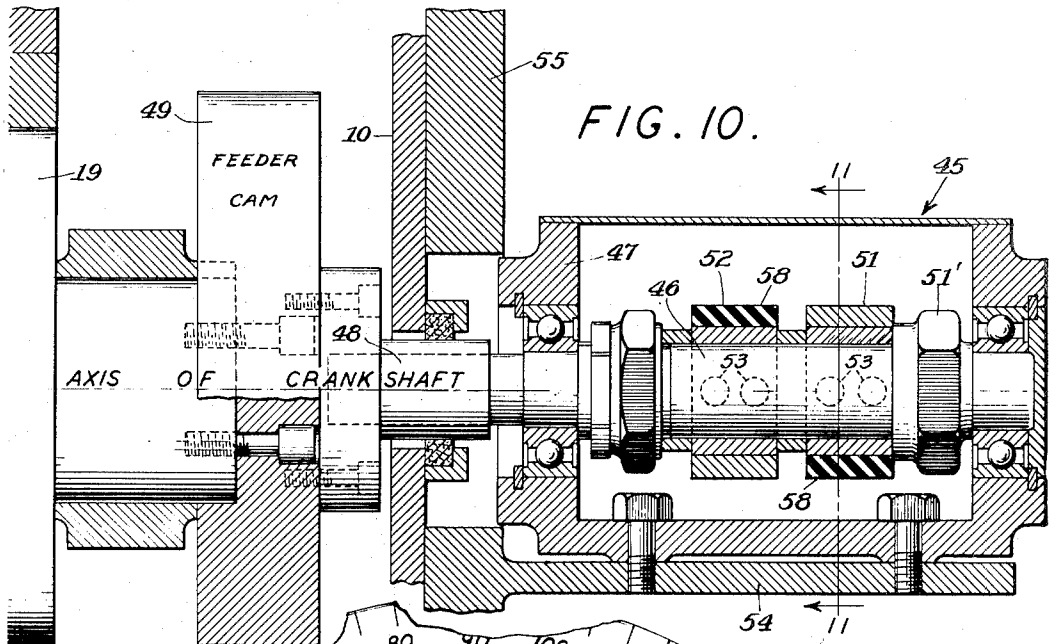
ATTORNEY

Nov. 22, 1955 K. W. HALL 2,724,145

TABLETTING MACHINE

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FIG. 10.



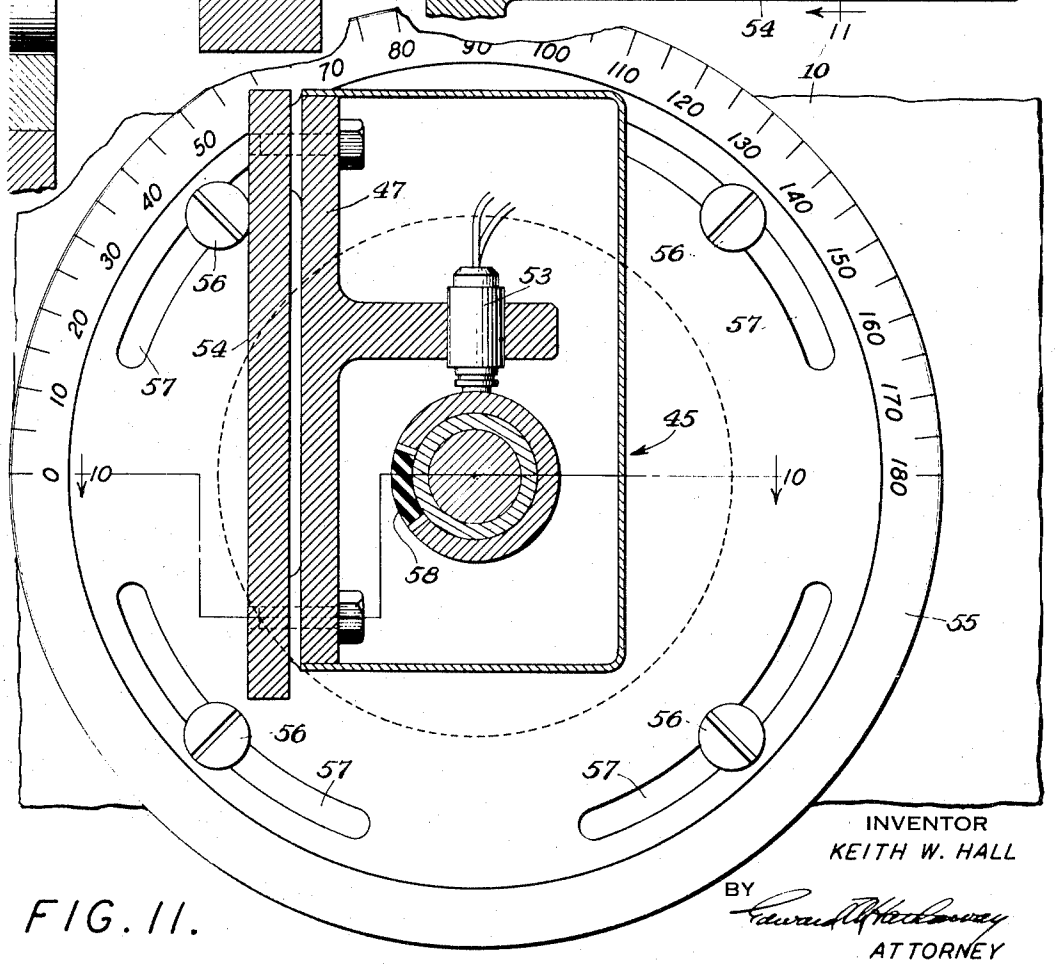


FIG. 11.

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Nov. 22, 1955 K. W. HALL 2,724,145

TABLETTING MACHINE

Filed Oct. 3, 1950 6 Sheets-Sheet 6

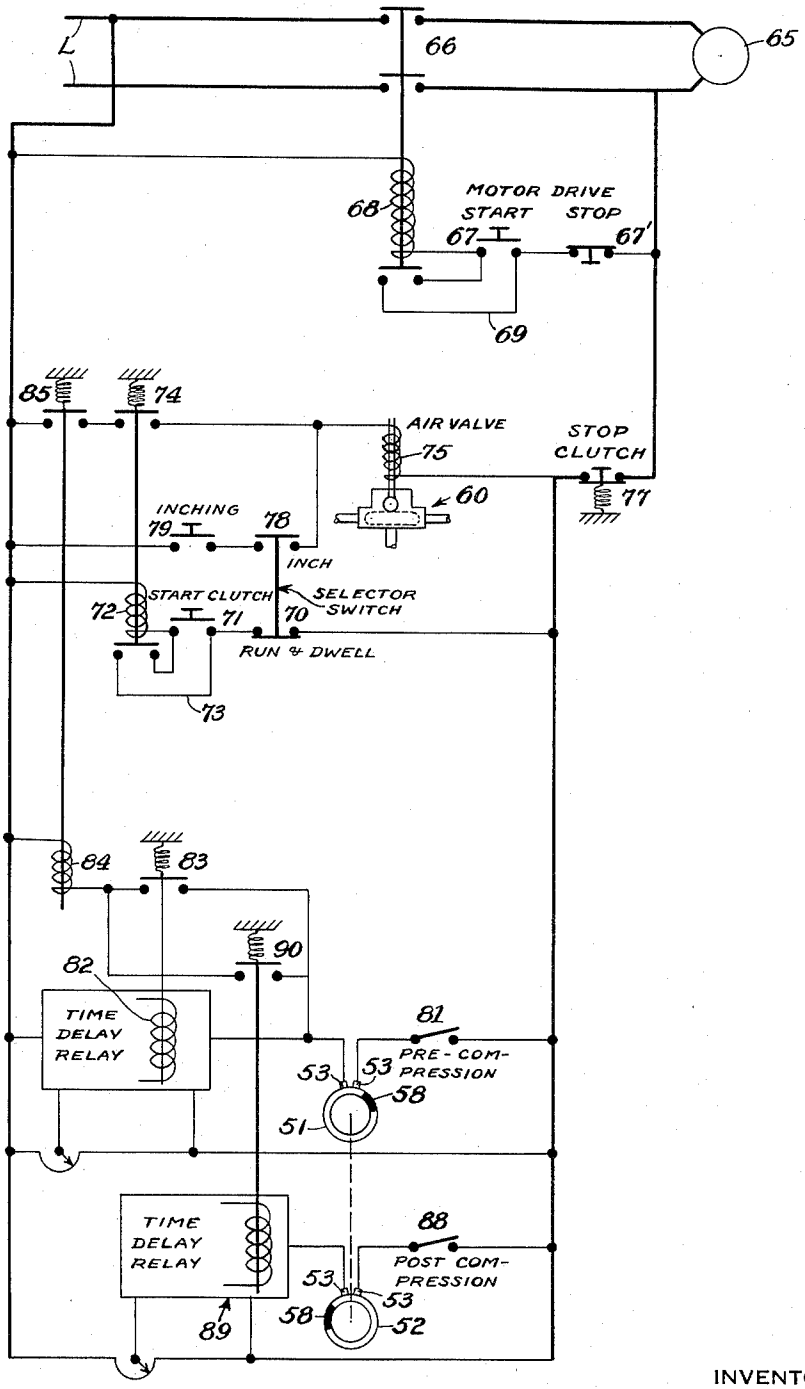


FIG. 12.

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2,724,145

Patented Nov. 22, 1955

2,724,145

TABLETTING MACHINE

Keith W. Hall, Ann Arbor, Mich., assignor to Baldwin-Lima-Hamilton Corporation, a corporation of Pennsylvania

Application October 3, 1950, Serial No. 188,233

4 Claims. (Cl. 18—16.5)

This invention relates generally to preform presses for tabletting plastic powders and other materials and more particularly to means for eliminating laminations in and splitting of the preforms.

When fine plastic powders, having a consistency of flour or talcum powder, are tabletted or preformed on various types of presses, especially conventional high speed mechanical presses, they tend frequently to have laminations therein which makes the preform friable and subject to splitting. This splitting or laminating of the tablet is caused by air becoming trapped in the die cavity when the compressing plunger enters the same, the air being naturally distributed throughout the fine powder in the minute interstices thereof when in its loose condition. Certain theories have been advanced as to how this trapped air acts in producing the laminations or the splitting and various arrangements have been heretofore proposed and used in an effort to control or eliminate the action of the air. For instance the end face of compression punches have been provided with radial lines or grooves to allow such air to escape or the clearance between the punch and mold has been increased, and, in other instances, the press has been equipped with a floating head which produces a dwell at the end of the compression stroke or the speed of operation of the press has been slowed down or the compressing plunger is lifted to allow escape of air and then its compression stroke is resumed, or the compression plunger stroke has a dwell effected by a predetermined pressure thereby maintaining the material under a constant pressure while attempting to expel the air. However, none of these or other arrangements has been really satisfactory, and when it is considered that the material worked upon in my invention is an extremely fine powder, it is seen that this is a highly aggravating factor and that the problem is most serious.

Under other circumstances a fully compressed tablet, even though the air has been effectively eliminated, will shatter or separate when the compression pressure is released. This is particularly true of preforms made of "melamine" or other plastics having similar characteristics.

One object of my invention is to provide an improved combination of elements that eliminates laminations in the tablets or preforms or the splitting or shattering thereof, regardless of whether the aggravating condition occurs prior to the actual compaction or upon release of the compacting pressure.

A further object is to provide an improved apparatus and method of operation for controlling the trapped air in such a way that it can be effectively eliminated from within material such as fine powder and removed from the die cavity so as not to become entrapped within the interior of the preform body.

A still further object is to provide an improved apparatus which, considering the results to be obtained, is relatively simple and economical in construction, operation and maintenance and has a relatively high speed of operation which permits a mechanical type press to be used effectively.

Other objects and advantages will be more apparent to those skilled in the art from the following description of the accompanying drawings in which:

Fig. 1 is a side elevation of a preform press with a housing cover thereof removed and parts of the press omitted for the sake of clarity;

Fig. 2 is a section taken generally along the line 2—2 of Fig. 1 with certain parts broken away to show further details of construction.

Figs. 3 to 6 are diagrammatic views of the upper punch, lower punch, and die cavity of the press, showing four phases in the cycle of operation of the punches to compress a tablet in accordance with the invention disclosed herein;

Fig. 7 is a time vs. punch-movement diagram;

Fig. 8 is a sectional view of the air clutch and brake flywheel control taken substantially on line 8—8 of Fig. 2;

Fig. 9 is a sectional view of a solenoid-operated air valve for controlling the clutch and brake;

Fig. 10 is a horizontal sectional view of an adjustable commutator type timing switch for controlling the solenoid valve;

Fig. 11 is a transverse section of the switch taken on line 11—11 of Fig. 10; and

Fig. 12 is a wiring diagram of the electric circuits for operating the press and for creating a pre-dwell in each cycle of operation as well as a post-compression dwell.

In the particular embodiment of my invention which is disclosed herein merely to illustrate one specific form among possible others that the invention might take, I have generally shown in Figs. 1 and 2 a high speed preform press of the type described in Patent 2,214,505. The press has a main housing 10 and a head 12 mounted on four vertically reciprocating tie rods 13 guided at their upper ends by the housing and at their lower ends by lugs 14 of a stationary gear bracket 15. The rods are connected in pairs to equalizing members 16, Fig. 1, and thence to connecting rods 18 on a double overhung crank shaft 19 journaled in the gear bracket 15. A gear 20 and pinion 21 drives the crank shaft. A suitable die 22, Fig. 2, is held in a recess 23 while an ejector rod 24 is carried by an ejector ram 25, the ejector rod also forming the bottom of the die opening. A compression punch 26 is carried by a punch ram 27 mounted in the head 12. Inasmuch as the punch and ejector ram devices, as well as the means for feeding material to the die cavity, do not per se form a part of the present invention, further description thereof has been omitted for sake of clarity. These devices, however, and other details of the press are disclosed in said patent.

I have found that laminations or splitting of the preforms during compaction is prevented by stopping, for a relatively short period of time, the downward advance of the upper punch at a point where only the top layer of finely powdered material deposited in the cavity is depressed, but not compacted, thus allowing the air trapped in the material to escape from between the sides of the upper punch and the wall of the cavity, which may be slightly tapered preferably throughout its length, and then continuing the downward advance of the upper punch to complete the compression stroke. As the length

of this pause during the pre-compaction dwell or during the post-compaction dwell, as they might be respectively called, and the positions of the upper punch at the times of the dwells may be varied with the particular type of material being used or with the size of the tablet being made, or with both, I provide means for making adjustments towards this end. It will be understood that the dwells may be selectively or simultaneously used as is necessary.

Figs. 3 to 6 illustrate diagrammatically four phases in a cycle of operation of upper punch **26** as it compresses finely powdered material into tablet form according to the pre-compaction principles of my invention, it being understood that reference herein to powdered material includes varying degrees of fineness up to granular material. Fig. 3 shows upper punch **26** beginning its downward stroke into die cavity **11** whose walls are slightly tapered. Fig. 4 shows the point at which upper punch **26** has been stopped during its compression stroke. It is seen that while the material in the die cavity may be momentarily compressed yet in accordance with one possible theory of operation of my invention this compression is only sufficient to squeeze out the air naturally present in the powder, the air escaping from between the sides of the upper punch and the tapered walls of the die cavity, as shown by the arrows in Fig. 4. It is believed that after expulsion of the air the bulk factor of the material has been reduced only to the point where no compaction of the material has actually taken place, or if so, it is not sufficient to effect laminations. After a pause or dwell of a predetermined length of time has elapsed, upper punch **26** continues its downward stroke to the point shown in Fig. 5 when the material is finally compressed to the necessary degree of density and evenness. As there is little or no air in the material during this final compression stage which effects compaction, the release of pressure on the material by the withdrawal of upper punch **26** from the die cavity, as shown in Fig. 6, does not result in any fracture of the tablet or in the formation thereof. It has been found that the finer the material, the longer the pre-compression dwell should be although usually one-half second is the maximum.

To create a pause or dwell in the cycle of operation of the press, I have provided as one element of my combination a well-known type of air clutch-brake-flywheel mechanism generally indicated at **28** and shown in particular in Fig. 8. This mechanism includes a shaft **29** connected to the driving pinion **21**, Fig. 1, and carries a rotatable brake shoe disk **30** and a clutch backing plate **31** formed on a common hub **32** which is fixed to shaft **29** to rotate therewith. A stationary brake disk **33** is axially slidably mounted on a series of stationary pins **34** secured in press housing **10**. A second brake shoe disk **35** is slidably keyed to hub **32** and is normally biased by springs **36** to bring the two brake shoe disks into contact with the brake disk **33**. Inasmuch as this mechanism is to alternately apply the brake and to transmit power from a belt driven flywheel **37** to pinion shaft **29** the shiftable brake shoe disk **35** is provided with a clutch disk portion **38** which is biased to its unclutched position by the springs **36**. Interposed between clutch disk **38** and clutch backing plate **31** are clutch disks **39** secured to flywheel **37** to rotate therewith and a clutch disk **40** slidably keyed to hub **32**. To apply the clutch, a series of axially extending cylinders **41** are placed around the axis of shaft **29** and are formed in the rear of clutch plate **38** while suitable pistons **42** are formed on the brake shoe disk **30**. An operating fluid medium such as air is admitted or exhausted through a pipe **43** and passages **44** to the cylinders **41**. Upon admission of air to these cylinders the clutch plate **38** engages the various clutch disks and clutch shoes with each other to cause the flywheel **37** to transmit power to pinion shaft **29**. Upon release of such air pressure the springs **36** simultaneously disengage the clutch disks and shift brake shoe disk **35** against brake disk **33** to stop rotation of pinion shaft **29** substantially instantaneously. The clutch and brake may be thus alternately engaged or disengaged with a high degree of rapidity suitable for effecting necessary ram dwell at the proper point in the press cycle as well as to continue the press after the dwell.

To coordinate this clutch and brake operation with the ram movements as well as to be able to vary the timing of the cycle events I provide a rotary commutator type switch generally indicated at **45**, Figs. 2, 10 and 11, comprising a slip ring shaft **46** journaled in a housing **47** and suitably connected to the crank shaft **19** by a pin **48**, Fig. 2 mounted upon the side of a material feeder cam **49** in axial alignment with the crank shaft axis.

A pre-compression timing slip ring **51** and a post-compression timing slip ring **52** are mounted on shaft **46** to rotate therewith. These rings can be relatively angularly adjusted by releasing a clamping nut **51'** which holds the rings on the shaft. Brushes such as **53**, Fig. 11, are provided, two for each of the slip rings. The position of these brushes is indicated in dotted circles in Fig. 10. The brushes are supported in the housing **47** which in turn is bolted to a flange **54** projecting axially from an adjusting disk **55**. This disk is held on the side of the press frame **10** by a series of clamping studs **56** extending through arcuate slots **57** concentric with the crank shaft axis whereby upon loosening the studs the disk may be angularly rotated to the desired extent and then clamped in position. In this manner the relation of the brushes **53** is changed with respect to insulated segments **58** of the respective slip rings which, of course, are also insulated from the shaft **46**. The timing slip ring assembly controls flow of air to the clutch and brake cylinders **41** by a solenoid-controlled air valve generally indicated at **60**, Fig. 9, suitably mounted on the press at any convenient location.

Air pressure from any suitable source is admitted through pipe **61** and then continuously through passages **62** of a piston guide and upwardly past a ball valve **63** to the right end of a piston **64** to move the piston and an attached valve **64*a***, whereupon air is admitted to a chamber **64*b*** from which it flows to the clutch brake cylinders. Simultaneously with the opening of valve **64*a*** the left end of the piston acting as a valve closes communication between the chamber **64*b*** and an exhaust chamber **64*c*** which leads through a suitable exhaust pipe to the atmosphere. The ball valve **63** is depressed to the position shown in Fig. 9 when the solenoid is energized but when the solenoid is de-energized a spring **63*a*** raises the ball to a seat to shut off flow of air to the right end of piston **64** and a spring **63*b*** continues to raise the solenoid stem **63*c*** to a still further upper position. The stem has a vent passage **63*d*** whose lower end is closed when in engagement with the ball valve **63** but when this ball is seated and the stem **63*c*** is raised, air pressure at the right end of piston **64** is then vented to the atmosphere through passage **63*d*** thereby allowing a spring **63*e*** to move the piston and valve **64*a*** to the right position shown in Fig. 9. In this position air pressure in the clutch cylinders is vented to the atmosphere through chambers **64*b*** and **64*c***.

To control the clutch air valve **60** and the press drive I have provided a circuit diagrammatically shown in Fig. 12. A main motor **65** for driving the press pinion **21** is supplied with current from a main line L controlled by a switch **66**. To start the motor a switch **67** normally biased to open position is momentarily closed thereby energizing a solenoid **68** which closes a holding circuit **69** to maintain main switch **66** closed. There are now three possible press operations: 1—continuous operation (without dwell), 2—inching, and 3—pre-compression and/or post-compression dwells.

In continuous operation a "run" switch **70** is first closed manually and then a start clutch switch **71** normally biased open is manually closed thereby energizing a sole-

noid 72 which is maintained energized by a holding circuit 73. Energization of solenoid 72 closes an air valve switch 74 to energize a solenoid 75 which actuates the air valve 60 to engage the clutch in the manner previously described. To stop this continuous operation it is only necessary to momentarily open a normally closed switch 77 which breaks the circuit through air valve solenoid 75 and holding circuit 73, although allowing press motor 65 to continue driving the flywheel 37. To stop the press motor a switch 67' is opened.

"Inching" of the press plunger is effected by throwing the clutch in and out. To do this, switch 78 is now manually closed which by being mechanically connected to switch 70 causes the latter to open. "Inching" switch 79, normally spring biased open, is manually held closed for such length of time as the operator desires. Closure of "inching" switch 79 energizes the air valve solenoid 75, it being understood that the stop clutch switch 77 is closed by reason of being normally biased to closed position.

To obtain a pre-compression dwell it is first necessary to manually close "running" switch 70 and open "inching" switch 78. A pre-compression switch 81 is also manually closed. The clutch starting switch 71 is now closed which energizes solenoid 72 to close air valve switch 74 whereupon the clutch is engaged with the flywheel to drive the press plunger. As the press crank shaft rotates, the commutator slip ring 51 is rotated and so long as the two brushes 53 of that ring are in contact with the conducting segment of the slip ring a circuit is maintained to energize a time delay relay coil 82 which closes a switch 83, normally biased open, thereby to energize a solenoid 84 which closes an air valve switch 85. The switch 74 in series with switch 85 has been previously closed by the start clutch switch 71. When the insulated segment 58, Fig. 11, of commutator ring 51 engages one or both of brushes 53 so as to break the circuit to the time delay relay coil 82, the latter then starts its timed cycle to open switch 83 to release the clutch and then after a predetermined time to reclose switch 83 to engage the clutch. The press plunger may be thus stopped at any selected point prior to compaction of the material to allow escape of air entrapped in the material and thereafter continue the compression stroke. The time delay relays shown herein may be of any conventional and well known type and hence need not be further described.

It is sometimes desirable, as previously pointed out, to have in one cycle both a pre-compression dwell as well as a post-compression dwell, although under certain circumstances either dwell alone may be used. To obtain a post-compression dwell alone it is only necessary to close a manual switch 88 and open switch 81. The remainder of the post-compression circuit is then identical to the pre-compression circuit including a time delay relay 89 and a relay switch 90. Inasmuch as these two time delay circuits are identical further description is not necessary of the latter one, it being understood, of course, that the slip rings for the post-compression dwell are shown at 52 on the same shaft with rings 51. The post-compression dwell occurs slightly after the compression plunger retracts from the preform so that the preform can expand upwardly against the plunger which thus acts to restrain any shattering force within the preform. The dwell continues until the stresses in the preform have been sufficiently relieved or dissipated, which usually requires from one-fourth to one second. The preform thus is allowed to expand under controlled confining limits to a point where it will not shatter when the plunger is completely withdrawn and the ejector plunger ejects the preform.

To obtain both pre-compression and post-compression dwells both switches 81 and 88 will be closed and then it is only necessary to have the slip rings 51 and 52 so angularly related to each other that the insulated segments of each will not simultaneously engage the brushes of the respective rings which, if it occurred, would result in both circuits being open at the same time.

It is thus seen from the foregoing disclosure that I have provided an improved combination of elements that is highly effective and relatively economical in construction, operation and maintenance, to accomplish the result of forming preforms of solid, uniform texture throughout, free of laminations or the possibility of shattering in the case of certain plastics whose internal stresses may cause the preform to shatter upon release of the compression pressure. My improved combination not only accomplishes this result but also permits a high degree of flexibility of operation whereby the dwell cycles may be conveniently varied with a high degree of precision, this being accomplished notwithstanding the inertia and momentum forces involved in a press of the type necessary for this kind of work.

It will of course be understood that various changes in details of construction and arrangement of parts may be made by those skilled in the art without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. In combination, a press having a die cavity and a plunger for compressing powdered material therein and whose relative dimensions provide air escape clearance when the plunger enters the cavity, means for reciprocating the plunger through compression and return strokes, control means responsive to a predetermined position of the press operation for stopping and maintaining the plunger at a predetermined position after entering the cavity but before completing its compression stroke thereby to effect a pre-compression plunger dwell during which time the plunger remains stationary within the cavity for allowing escape of air from the cavity prior to compaction of material therein, means for automatically restarting the plunger compression stroke from said stationary position after a predetermined time interval and continuing the stroke to completion, and additional control means responsive to a predetermined position of the press operation for stopping the plunger at a given position within the die cavity and maintaining the plunger stationary at that position after it has started its return stroke upon completion of its compression operation thereby to effect a post-compression plunger dwell to allow controlled expansion of the compressed material, and means for automatically restarting the plunger return stroke from said position after a pre-determined time interval allowed for such expansion.

2. In combination, a press having a die cavity and a plunger for compressing powdered material therein, means for reciprocating the plunger through compression and return strokes, control means responsive to a predetermined position of the press operation for stopping the plunger at a given point in the die cavity and maintaining it stationary at that point during its return stroke after compressing the material thereby to effect a post-compression plunger dwell to allow controlled expansion of the compressed material, and means for automatically restarting the plunger return stroke from said point after a predetermined time interval allowed for such expansion.

3. The combination set forth in claim 2 further characterized in that the means for reciprocating the plunger includes a clutch and brake, and the control means includes a commutator type slip ring driven in synchronism with the plunger movement and an electrical circuit controlled by said commutator ring for effecting operation of the brake and clutch to produce the post-compression dwell.

4. The combination set forth in claim 2 further characterized in that the automatic restarting means for the plunger includes a time delay relay whose operation is initiated by the control means.

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