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(54) Mailing machine including printing drum control system.

(57) A mailing machine base 12 has a postage meter 14 mounted thereon. The meter includes a postage printing drum 64 having a home position. The base comprising, structure for moving the drum, a d.c. motor 110 for driving the drum moving structure, a microprocessor 122, a power switch connected between the d.c. motor and microprocessor, a comparator 125 connected between the microprocessor and d.c. motor for receiving therefrom a signal corresponding to the back e.m.f. voltage of the d.c. motor and providing a comparison signal to the microprocessor. The microprocessor is programmed for : providing a reference voltage signal for the comparator corresponding to a desired back e.m.f. voltage for causing the d.c. motor to drive the postage printing drum at t desired constant velocity, energizing the power switch with a first signal for causing the d.c. motor to accelerate the drum at a substantially constant rate to substantially the desired constant velocity from the home position thereof during a first predetermined time interval, determining whether the back e.m.f. is greater than the reference voltage, energizing the power switch with the first signal for a second predetermined time interval if the back e.m.f. voltage is not greater than the reference voltage, and energizing the power switch with a second signal for a third predetermined time interval if the back e.m.f. voltage is greater than the reference voltage and delaying energizing with the second signal if the back e.m.f. voltage is not greater than the reference voltage, thereby causing the d.c. motor to continue driving the drum at substantially the desired constant velocity.

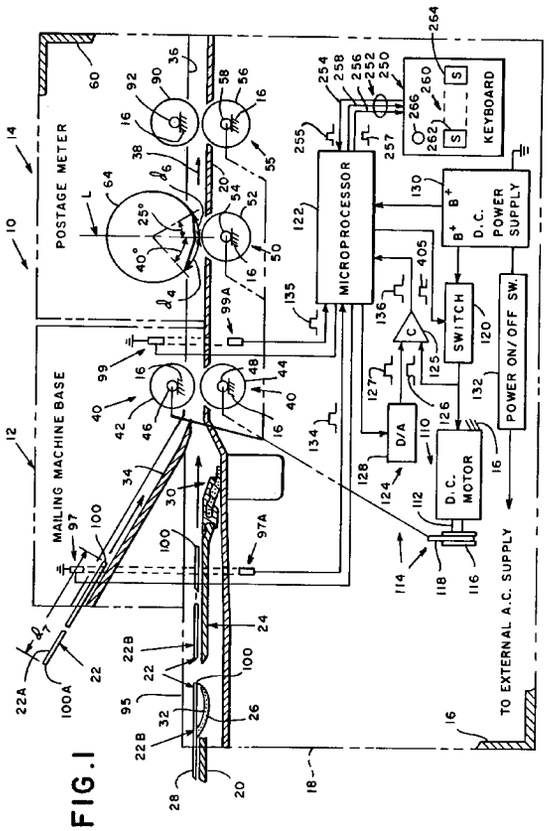


FIG. 1

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The present invention is generally concerned with apparatus including sheet feeding and printing structures, and more particularly with a mailing machine including a base adapted to have mounted thereon a postage meter, and improved drive systems and control structures therefor.

As shown in U.S. Patent No. 4,774,446, for a Microprocessor Controlled D.C. Motor For controlling Printing Means, issued September 27, 1988 to Salazar, et. al. and assigned to the assignee of the present invention, there is described a mailing machine which include a base and a postage meter removably mounted thereon. The base includes sheet feeding structure for feeding a sheet in a downstream path of travel through the machine, and includes two sheet sensing structures located a known distance from one another along the path of travel. And, the postage meter includes a rotary printing drum for printing postage indicia on a sheet while feeding the sheet downstream in the path of travel therebeneath. The sensors successively sense the sheet in the path of travel and provide successive signals to a microprocessor to permit the time lapse between the signals to be used for calculating a count corresponding to the sheet feeding speed. Moreover, the base includes a d.c. motor for driving the postage printing drum, and an encoder coupled to the drum drive shaft for providing signals indicative of the position thereof to a counting circuit which, in turn, provides a count to the microprocessor indicative of the peripheral speed of the postage printing drum. And, the computer is programmed to successively sample the counts corresponding to the sheet feeding speed and the speed of the periphery of the drum to adjust the motor drive between sampling time instants and generate a motor drive signal for causing the motor to drive the drum at a velocity which matches the peripheral speed of the drum with the sheet feeding speed.

Thus it is know in the art to provide a closed loop, sampled data, feed back control system in a mailing machine base for continuoUSly matching the peripheral speed of a postage printing drum to the feeding speed of a sheet.

As shown in U.S. Patent No. 4,864,505 for a Postage Meter Drive System, issued September 5, 1989 to Miller, et. al. and assigned to the assignee of the present invention, there is described a mailing machine base having a postage meter mounted thereon, wherein the base includes a first d.c. motor for driving the postage printing drum via a drum gear in the meter, a second d.c. motor for driving the structure for feeding a sheet through the machine, and a third, stepper, motor for driving a linkage system connected in bearing engagement with the postage meter shutter bar for moving the shutter bar out of and into locking engagement with the drum drive gear.

Thus it is known in the art to provide three separate motors for driving the sheet feeding, shutter bar moving and postage printing drum driving structures in a mailing machine base. And, it is known to provide a stepper motor for driving a linkage system to move the postage meter shutter bar into and out of locking engagement with the drum drive gear.

As shown in U.S. Patent No. 4,787,311, for a Mailing Machine Envelope Transport System, issued November 29, 1988 to Hans C. Mol and assigned to the assignee of the present invention. There is described a mailing machine base having a postage meter mounted thereon, wherein the time lapse between spaced sensors in the path of travel of a sheet is utilized by a microprocessor for calculating a sheet feeding speed, and wherein the speed of a stepper motor, connected for driving the postage printing drum under the control of the microprocessor, is adjusted to match the peripheral speed of the drum with the sheet feeding speed.

Thus it is known in the art to provide a microprocessor driven stepper motor in a mailing machine base for driving a postage printing drum at a peripheral speed which matches the speed of a sheet fed therebeneath.

As noted above, the structures utilized in the prior art for sheet feeding, shutter bar moving and postage printing drum driving purposes include the sophisticated feedback control system of the '446 patent, which continuously controls the motion of a postage printing drum to conform the same to a trapezoidal-shaped velocity versus time profile, having a constant velocity portion which results in the peripheral speed of the drum matching the speed of sheets fed through a mailing machine, and include the relatively inexpensive substitute of the '311 patent, which includes a stepper motor operated for matching the peripheral speed of the drum to the sheet feeding speed without regard to the acceleration and deceleration velocity versus time profile characteristics of the drum. Each of such systems has its drawbacks, for example, encoders are expensive, as are software solutions which take into consideration the technical specifications of the motors controlled thereby. And both of such expenses are major considerations in competitively pricing mailing machines for the marketplace. Further, stepper motors are noisy, as are linkage systems, which tend to suffer from wear and tear over time and become noisy. And, the combination of a stepper motor and linkage system for driving a shutter bar tends to cause the moving shutter bar to be noisy. In addition to being irritable to customers, noise normally signals wear and tear and, since mailing machines must normally withstand the wear and tear of many thousands of operational cycles in the course of their expected useful life, maintenance problems are compounded by the use of noisy systems in mailing machines. And, such considerations are of major importance in generating and retaining a high level of customer satisfaction with the use of mailing machines. Accordingly it

would be desirable if there was available a low cost, low operational noise level, maiing machine base.

The invention provides, inter alia, a mailing machine base adapted to have a postage meter mounted thereon, wherein the meter includes a postage printing drum having a home position, the base comprising, means for moving the drum, a d.c. motor for driving the drum moving means, a microprocessor, a power switch connected between the d.c. motor and microprocessor, a comparator connected between the microprocessor and d.c. motor for receiving therefrom a signal corresponding to the back e.m.f. voltage of the d.c. motor and providing a comparison signal to the microprocessor, and the microprocessor programmed for, providing a reference voltage signal for the comparator corresponding to a desired back e.m.f. voltage for causing the d.c. motor to drive the postage printing drum at a desired constant velocity, energizing the power switch with a first signal for causing the d.c. motor to accelerate the drum at a substantially constant rate to substantially the desired constant velocity from the home position thereof during a first predetermined time interval, determining whether the back e.m.f. is greater than the reference voltage, energizing the power switch with the first signal for a second predetermined time interval if the back e.m.f. voltage is not greater than the reference voltage, and energizing the power switch with a second signal for a third predetermined time interval if the back e.m.f. voltage is greater than the reference voltage and delaying energizing with the second signal if the back e.m.f. voltage is not greater than the reference voltage, thereby causing the d.c. motor to continue driving the drum at substantially the desired constant velocity.

As shown in the drawings wherein like reference numerals designate like or corresponding parts throughout the several views:

Fig. 1 is a schematic elevation view of an example of a mailing machine embodying the invention, including a base having a postage meter mounted thereon, showing the sheet feeding structure of the base and the postage printing drum of the meter, and showing a microprocessor for controlling the motion of the sheet feeding structure and the drum;

Fig. 2 is a schematic end view of the mailing machine of Fig. 1, showing the postage printing drum, drum drive gear and shutter bar of the meter, and showing the shutter bar and drum drive systems of the base;

Fig. 3 is a schematic view of structure for sensing the angular position of the shutter bar cam shaft of Fig. 2, and thus the location of the shutter bar relative to the drum drive gear;

Fig. 4 is a schematic view of structure for sensing the angular position of the printing drum idler shaft of Fig. 2, and thus the location of the postage printing drum relative to its home position;

Fig. 5 is a schematic view of the substantially trapezoidal-shaped velocity versus time profile of desired rotary motion of the postage printing drum of Fig. 1;

Fig. 6 is a flow chart of the main line program of the microprocessor of the nailing machine base of Fig. 1, showing the supervisory process steps implemented in the course of controlling sheet feeding, and shutter bar and postage printing drum motion;

Fig. 7 is a flow chart of the sheet feeder routine of the microprocessor of Fig. 1, showing the process steps implemented for accelerating the sheet feeding rollers to a constant feeding speed, and thereafter maintaining the speed contant.

Fig. 8 is a flow chart of the shutter bar routine of the microprocessor of Fig. 1, showing the process steps implemented for controlling shutter bar movement out of and into locking engagement with the postage printing drum drive gear;

Fig. 9 is a flow chart of the postage meter drum acceleration and constant velocity routine of the microprocessor of Fig. 1, showing the process steps implemented for controlling the rate of acceleration of the postage printing drum, from rest in its home position to a substantially constant sheet feeding and printing speed, and thereafter controlling the drum to maintain the speed constant; and

Fig. 10 is a flow chart of the postage printing drum deceleration and coasting routine of the microprocessor of Fig. 1, showing the process steps implemented for controlling the rate of deceleration of the postage printing drum, from the substantially constant sheet feeding and printing speed, to rest in its home position.

As shown in FIG. 1, the apparatus in which the invention may be incorporated comprises a mailing machine 10 including a base 12 and a postage meter 14 which is removably mounted on the base 12.

The base 12 (Fig. 1) generally includes suitable framework 16 for supporting the various component thereof including a housing 18, and a horizontally-extending deck 20 for supporting sheets 22 such as cut tapes 22A, letters, envelopes 22B, cards or other sheet-like materials, which are to be fed through the machine 10. Preferably, the base 12 also includes conventional structure 24 for selectively deflecting an envelope flap 26 from an envelope body 28 together with suitable structure 30 for moistening the strip of glue 32 adhered to the envelope flap 26, preparatory to feeding the envelope 22B through the machine 10. In addition, the base 12 preferably includes an elongate angularly-extending deck 34 for receiving and guiding cut tapes 22A past the moistening structure 30 preparatory to being fed through the machine 10. When mounted on the base 12, the postage meter 14

forms therewith a 36 slot through which the respective cut tapes 22A, envelopes 22B and other sheets 22 are fed in a downstream path of travel 38 through the machine 10.

For feeding sheets 22 into the machine 10, the base 12 preferably includes input feeding structure 40 including opposed, upper and lower, drive rollers, 42 and 44, which are axially spaced parallel to one another and conventionally rotatably connected to the framework 16, as by means of shafts, 46 and 48, so as to extend into and across the path of travel 38, downstream from the cut tape receiving deck 34. In addition, the base 12 includes a conventional intermediate feeding structure 50, including a postage meter input roller 52, known in the art as an impression roller, which is suitably rotatably connected to the framework 16, as by means of a shaft 54 so as to extend into and across the path of travel 38, downstream from the lower input drive roller 44. Still further, for feeding sheets 22 from the machine 10, the base 12 includes conventional output feeding structure 55, including an output feed roller 56 which in suitably rotatably connected to the framework 16, as by means of a shaft 58, so as to extend into and across the path of travel 38, downstream from the impression roller 52.

As shown in Fig. 2, the postage meter 14 comprises framework 60 for supporting the various components thereof including rotary printing structure 62. The rotary printing structure 62 includes a conventional postage printing drum 64 and a drive gear 66 therefor, which are suitably spaced apart from one another and mounted on a common drum drive shaft 68 which is located above and axially extends parallel to the impression roller drive shaft 54, when the postage meter 14 is mounted on the base 12. The printing drum 64 is conventionally constructed and arranged for feeding the respective sheets 22 (Fig. 1) in the path of travel 38 beneath the drum 64, and for printing postage data, registration data or other selected indicia on the upwardly disposed surface of each sheet 22. When the postage meter 14 is mounted on the base 12, the printing drum 64 is located in a home position thereof which is defined by an imaginary vertical line L extending through the axis thereof, and the impression roller 52 is located for urging each sheet into printing engagement with the printing drum 64 and for cooperating therewith for feeding sheets 22 through the machine 10. The drum drive gear 66 (Fig. 2) has a key slot 70 formed therein, which is located vertically beneath the drum drive shaft 68 and is centered along an imaginary vertical line L_1 wich extends parallel to the home position line L of the printing drum 64. Thus, when the key slot 70 is centered beneath the axis of the drum drive shaft 68 the postage meter drum 64 and drive gear 66 are located in their respective home positions. The postage meter 14 additionally includes a shutter bar 72, having an elongate key portion 74 which is transversely dimensioned to fit into the drive gear's key slot 70. The shutter bar 72, which is conventionally slidably connected to the framework 60 within the meter 14, is reciprocally movable toward and away from the drum drive gear 66, for moving the shutter bar's key portion 74 into and out of the key slot 70, under the control of the mailing machinen base 12, when the drum drive gear 66 is located in its home position. To that end, the shutter bar 72 has a channel 76 formed therein from its lower surface 78, and, the base 12 includes a movable lever arm 80, having an arcuately-shaped upper end 82, which extends upwardly through an aperture 84 formed in the housing 18. When the meter 14 is mounted on the base 10, the lever arm's upper end 82 fits into the channel 76, in bearing engagement with the shutter bar 72, for reciprocally moving the bar 72. As thus constructed and arranged, the shutter bar 72 is movable to and between one position, wherein shutter bar's key portion 74 is located in the drum drive gear' key slot 70, for preventing rotation of the drum drive gear 66, and thus the drum 64, out of their respective home positions, and another position, wherein the shutter bar's key portion 74 is located out of the key slot 70, for permitting rotation of the drum drive gear 66, and thus the drum 64.

The postage meter 16 (Fig. 1) additionally includes an output idler roller 90 which is suitably rotatably connected to the framework 60, as by means of an idler shaft 92 which axially extends above and parallel to the output roller drive shaft 58, for locating the roller 90 above and in cooperative relationship with respect to the output feed roller 56, when the postage meter 14 is mounted on the base 12. Further, the base 12 additionally includes conventional sheet aligning structure including a registration fence 95 against which an edge 96 (Fig. 2) of a given sheet 22 may be urged when fed to the mailing machine 10. Moreover, the base 12 (Fig. 1) preferably includes sheet detection structure 97, including a suitable sensor 97A, located upstream from the input feed rollers, 42 and 44, for detecting the presence of a sheet 22 being fed to the machine 10. And, the base 12 preferably includes sheet feeding trip structure 99, including a suitable sensor 99A, located downstream from the input feed rollers, 42 and 44, for sensing the leading edge 100 and trailing edge 100A of each sheet 22 fed thereby into the mailing machine 10.

As shown in Fig. 1, for driving the input, intermediate and output sheet feeding structures 40, 50 and 55, the mailing machine base 12 preferably includes a conventional d.c. motor 110 having an output shaft 112, and a suitable timing belt and pulley drive train system 114 interconnecting the drive roller shafts 48, 54 and 58 to the motor shaft 112. In this connection, the drive train system 114 includes, for example, a timing pulley 116 fixedly secured to the motor output shaft 112 for rotation therewith and a suitable timing belt 118 which is looped about the pulley 116 and

another timing pulley of the system 114 for transmitting motive power from the pulley 116, via the remainder of the belt and pulley system 114, to the drive roller shafts 48, 54 and 58.

As shown in Fig. 1, for controlling the angular velocity of the sheet feeding rollers 44, 52 and 56, and thus the speed at which sheets 22 are fed into, through and from the machine 10, the mailing machine base 12 preferably includes a field effect transistor (FET) power switch 120 which is conventionally electrically connected to the d.c. motor 110 for energization and deenergization thereof. In addition, for controlling the sheet feeding speed, the base 12 includes the sheet detection structure 97 and sheet feeding trip structure 99, a microprocessor 122 to which the FET power switch 120, sheet detection structure 97 and sheet feeding structure 99 are conventionally electrically connected, and a voltage comparing circuit 124 which is conventionally electrically interconnected between the microprocessor 122 and d.c. motor 110. Preferably, the voltage comparing circuit 124 includes a conventional solid state comparator 125, having the output terminal thereof connected to the microprocessor 122. In addition, the comparator 125 has one of the input terminals thereof connected to the d. c. motor 110, for sampling the motor's back-e.m.f. voltage and providing a signal, such as the signal 126, to the comparator 125 which corresponds to the magnitude of the back-e.m.f. voltage. And, the comparator 125 has the other of the input terminals thereof connected to the microprocessor 122 via a suitable digital to analog converter 128, for providing the comparator 125 with a signal, such as the signal 127, which corresponds to a predetermined reference voltage. Further, the base 12 includes a conventional d.c. power supply 130, to which the FET power switch 120 and microprocessor 122 are suitably connected for receiving d.c. power. Moreover, the base 12 includes a manually operable on and off power switch 132, which is electrically connected to the d.c. supply 130 and is conventionally adapted to be connected to an external source of supply of a.c. power for energizing and deenergizing the d.c. supply 130 in response to manual operation of the power switch 132. In addition, for controlling the sheet feeding speed, the microprocessor 122 is preferably programmed, as hereinafter discussed in greater detail, to respond to receiving a sheet detection signal, such as the signal 134, from the sensor 97A, to receiving a sheet feeding signal, such as the signal 135 from the sensor 99A, and to receiving successive positive or negative comparison signals, such as the signal 136 from the comparator 125, for causing the d.c. motor 110 to drive each of the sheet feeding rollers 44, 52 and 56 at the same peripheral speed for feeding sheets 22 through the machine 10 at a constant speed.

As shown in Fig. 2, for driving the shutter bar lever arm 80, the mailing machine base 12 preferably includes a conventional d.c. motor 140, having an output shaft 142, and includes a drive system 144 interconnecting the lever arm 80 to the motor shaft 142. The drive system 144 preferably includes a timing pulley 146 which is suitably fixedly connected to the output shaft 142 for rotation therewith. In addition, the drive system 144 includes a cam shaft 148, which is conventionally journaled to the framework 16 for rotation in place, and includes a rotary cam 150, which is conventionally connected to the cam shaft 148 for rotation therewith. Moreover, the drive system 144 includes a timing pulley 152, which is suitably fixedly connected to the cam shaft 148 for rotation thereof. Preferably, the rotary cam 150 and pulley 152 are integrally formed as a single piecepart which is injection molded from a suitable plastic material. In addition, the drive system 114 includes a conventional timing belt 154, which is suitably looped about the pulleys, 146 and 152, for transmitting rotary motion of the motor drive shaft 142 to the cam shaft 148, and thus to the rotary cam 150. Still further, the drive system 144 includes the lever arm 80, which is preferably conventionally pivotally attached to the framework 16, as by means of a pin 156, and includes a yoke portion 158 depending therefrom. Preferably, the rotary cam 150 is disposed in bearing engagement with the yoke portion 158 for pivoting the yoke portion 158, and thus the lever arm 50, both clockwise and counterclockwise about the pin 156.

For controlling movement of the shutter bar lever arm 80 (Fig. 2), and thus movement of the shutter bar 72, into and out of the drum drive gear slot 70, the mailing machine 12 includes the microprocessor 122, and includes the sheet feeding trip structure 99 (Fig. 1) which is conventionally electrically connected to the microprocessor 122. In addition, for controlling shutter bar movement, the machine 10 (Fig. 2) includes a power switching module 160 which is connected between the d.c. motor 140 and microprocessor 122. Preferably, the switching module 160 includes four FET power switches arranged in an H-bridge circuit configuration for driving the d.c. motor 140 in either direction. In addition, the switching module 160 preferably includes conventional logic circuitry for interconnecting the FET bridge circuit to the d.c. motor 140 via two electrical leads, rather than four, and for interconnecting the FET bridge circuit to the microprocessor 140 via two electrical leads, 161A and 161B, rather than four, such that one of the leads, 161A or 161B, may be energized, and the other of the leads, 161B or 161A, deenergized, as the case may be, for driving the d.c. motor 140 in either direction. In addition, for controlling movement of the shutter bar 72, the base 12 includes cam shaft position sensing structure 162 electrically connected the microprocessor 122. The structure 162 includes a cam-shaped disk 164, which is conventionally fixedly mounted on the cam shaft 148 for rotation therewith. The disk 164 (Fig. 3) inclu-

des an elongate arcuately-shaped lobe 166, having an arcuately-extending dimension d_1 which corresponds to a distance which is slightly less than, and thus substantially equal to, a predetermined linear distance d_2 (Fig. 2) through which the shutter bar key portion 74 is preferably moved for moving the shutter bar 72 out of locking engagement with the drum drive gear 66. Preferably however, rather than provide the disk 164, the rotary cam 150 is provided with a lobe portion 166A which is integrally formed therewith when the cam 150 and pulley 152 are injection molded as a single piecepart. And, the shaft position sensing structure 162 includes conventional lobe sensing structure 168 having a sensor 170 (Fig. 3) located in the path of travel of lobe, 166 or 166A, as the case may be. As thus constructed and arranged, when the cam shaft 148 (Fig. 2) is rotated counter-clockwise, the lever arm 80 is pivoted thereby about the pin 156 to move the shutter bar 72 through the distance d_2 and out of locking engagement with the drum drive gear 66. Concurrently, the lobe, 166 or 166A (Fig. 3), is rotated counter-clockwise through the distance d_2, causing the leading edge 172 thereof, followed by the trailing edge 174 thereof, to be successively detected by the sensor 170, for providing first and second successive transition signals, such as the signal 175 (Fig. 2), to the microprocessor 122, initially indicating that movement of the shutter bar 72 has commenced and that the shutter bar 72 (Fig. 2) is blocking the sensor 170 (Fig. 3), followed by indicating that movement of the shutter bar 72 has been completed and that the sensor 170 (Fig. 3) is unblocked. Thereafter, when the cam shaft 148 (Fig. 2) is rotated clockwise, the lever arm 80 is pivoted thereby about the pin 156 to move the shutter bar 72 back through the distance d_2 and into locking engagement with the drum drive gear 66. And, concurrently, the lobe, 166 or 166A (Fig. 3), is rotated clockwise, through the distance d_2, causing the trailing edge 174 thereof, followed by the leading edge 172 thereof, to be successively detected by the sensor 170, for providing third and fourth successive transition signals 175 to the microprocessor 122 which again successively indicate that movement of the shutter bar 72 has commenced and that the sensor 170 (Fig. 3) is blocked, and movement of the shutter bar 72 (Fig. 2) has been completed and the sensor 170 (Fig. 3) in unblocked. In addition, for controlling movement of the shutter bar 72 (Fig. 2), the microprocessor 122 is preferably programmed, as hereinafter described in greater detail, to respond to receiving a sheet feeding signal 135 from the sensor 99A, and to receiving successive sets of transition signals 175 from the sensing structure 168, for timely causing the FET module 160 to drive the d.c. motor 140 to rotate the cam 150 counter-clockwise, for moving the shutter bar 72 through the distance d_2 and thus out of locking engagement with the drum drive gear 66 and until the second of the successive transition signals 175 is received, and, after a predetermined time interval during which the printing drum 64 is driven through a single revolution as hereinafter discussed, for causing the FET module 160 to then drive the d.c. motor 140 to rotate the cam 150 clockwise, for moving the shutter bar 72 back through the distance d_2 until the fourth of the successive transitions signals 175 is received to indicate that the shutter bar 72 has been moved into locking engagement with the drum drive gear 66.

As shown in Fig. 2, for driving the drum drive gear 66 and thus the drum 64, the mailing machine base 12 preferably includes a conventional d.c. motor 180, having an output shaft 182, and includes a drive system 184 for interconnecting the drum drive gear 66 to the motor shaft 182 when the postage meter 14 is mounted on the mailing machine base 12. The drive system 184 preferably includes a timing pulley 186 which is suitably fixedly connected to the motor output shaft 182 for rotation therewith. In addition, the drive system 184 includes an idler shaft 188, which is conventionally journaled to the framework 16 for rotation in place, and includes a timing pulley 190, which is conventionally fixedly connected to the idler shaft 188 for rotation thereof. Moreover, the drive system 184 includes a conventional timing belt 192, which is suitably looped about the pulleys, 186 and 190, for transmitting rotary motion of the motor drive shaft 182 to the idler shaft 188, and thus to the pulley 190. Preferably, the base 12 additionally includes a pinion gear 194, which is conventionally mounted on, or integrally formed with, the idler shaft 188 for rotation therewith. Further, the base 12 also includes an idler shaft 196, which is conventionally journaled to the framework 16 for rotation in place, and includes a drive system output gear 198. Preferably, the output gear 198 is suitably dimensioned relative to the drum drive gear 66 such that the gear ratio therebetween is one-to-one. And, the drive system output gear 198 is conventionally fixedly mounted on the Idler shaft 196 for rotation thereof and is dimensioned so as to extend upwardly through an aperture 199 formed in the housing 18 to permit the drum drive gear 66 to be disposed in meshing engagement with the drive system output gear 198, when the postage meter 14 in mounted on the base 12, for driving thereby to rotate the printing drum 64 into and out of engagement with respective sheets 22 fed into the machine 10.

For controlling rotation of the drive systems output gear 198 (Fig. 2), and thus rotation of the printing drum 64, the mailing machine base 12 includes the microprocessor 122, and includes power switching structure 200 connected between the d.c. motor 180 and the microprocessor 122. Preferably, the switching structure 200 includes a first FET power switch 202, nominally called a run switch, which is energizeable for driving the motor 180 in one direction, i.e., clockwise, and includes a second FET power switch

204, nominally called a brake switch, connected in shunt with the first FET power switch 202, rich is energizeable for dynamically braking the motor 180. In addition, for controlling rotation of the printing drum 64, the base 12 includes a voltage comparing circuit 206, which is conventionally electrically interconnected between the microprocessor 122 and d.c. motor 180. Preferably, the voltage comparing circuit 206 includes a solid state comparator 208, having the output terminal thereof connected to the microprocessor 122. In addition, the comparator 208 has one of the input terminals thereof connected to the d.c. motor 180, for sampling the motor's back-e.m.f. voltage and providing a signal, such as the signal 210 to the comparator 208 which corresponds to the magnitude of the back-e.m.f. voltage. And, the comparator 108 has the other of the input terminals thereof connected to the microprocessor 122, via a suitable digital to analog converter 212 for providing the comparator 208 with an analog signal, such as the signal 214, which corresponds to a predetermined reference voltage. In addition, for controlling rotation of the printing drum 64, the base 12 includes idler shaft position sensing structure 220 electrically connected to the microprocessor 122. The structure 220 preferably includes a cam-shaped disk 222, which is conventionally fixedly mounted on the idler shaft 196 for rotation therewith and thus in step with counter-clockwise rotation of the drum 64, due to the one-to-one gear ratio between the drive system output gear 198 and drum drive gear 66. The disk 222 (Fig. 4) includes two, elongate, arcuately-shaped lobes, 224 and 226. The lobes 224 and 226 are preferably separated from one another by a two degree gap 228 which is bisected by a vertical line L_2 which extends through the axis of the disk 222 when the disk 222 is located in its home position, which home position corresponds to the home position of the drum drive gear slot 70 (Fig. 2) and thus to the home position of the printing drum 64. The lobe 224 (Fig. 4) has an arcuately-extending dimension d_3, which corresponds to a distance which is preferably slightly less than, and thus substantially equal to, the linear distance d_4 (Fig. 1) through which the outer periphery of the printing drum 64 is initially driven counter-clockwise from the home position thereof before being rotated into engagement with a sheet 22 fed into the machine 10. And, the lobe 226 (Fig. 4) has an arcuately-extending dimension d_5 which corresponds to a distance which is preferably slightly less than, and thus substantially equal to, the linear distance d_6 (Fig. 1) through which the outer periphery of the printing drum 64 is driven counter-clockwise upon being rotated out of engagement with a sheet 22 fed thereby through the machine 10. Further, the shaft position sensing structure 220 includes conventional lobe sensing structure 230 having a sensor 232 (Fig. 4) located in the path of travel of the lobes, 224 and 226. As thus constructed and arranged, assuming the shutter bar 72 (Fig. 2) is moved out of locking engagement with the drum drive gear 66, when the drive system output gear 198 commences driving the drum drive gear 66 and printing drum 64 from their respective home positions, the disk 222 (Fig. 4) is concurrently rotated counter-clockwise from its home position. As the lobe 224 is rotated through the distance d_3, causing the leading edge 234 of the lobe 224, followed by the trailing edge 236 thereof, to be successively detected by the sensor 232, successive first and second transition signals, such an the signal 240 (Fig. 2), are provided to the microprocessor 122, initially indicating that drum 64 (Fig. 2) has commenced rotation from the home position thereof, followed by indicating that the drum 64 has rotated 40° through the distance d_4. In addition, the transition signal 240 provided by the sensor 232 detecting the lobe's trailing edge 236 indicates that the drum 64 has rotated into feeding engagement with a sheet 22 fed into the machine 10. There after, when the disk 222 and thus the drum 64 (Fig. 1) continue to rotate counter-clockwise, and the printing drum 64 prints indicia on the sheet 22 as the sheet 22 is fed thereby through the machine 10, until the such rotation causes the leading edge 242 (Fig. 4) of the lobe 226, followed by the trailing edge 244 thereof, to be successively detected by the sensor 232. Whereupon the sensor 232 provides successive third and fourth transition signals 240 to the microprocessor 122, initially indicating that the drum 24 has rotated 335° and out of feeding engagement with the sheet 22, followed by indicating that the drum 64 has rotated through 358°, and thus substantially through the distance d_6 and back to the home position thereof. Still further, for controlling rotation of the printing drum 64, the microprocessor 122 is preferably programmed, as hereinafter described in greatzr detail, to timely respond to the completion of movement of the shutter bar 72 out of locking engagement with drum drive gear 66, to timely respond to the transition signals 240 from the idler shaft sensing structure 230 and to timely respond to receiving successive positive or negative comparison signals, such as the signal 248 from the comparator 208, to cause the FET switch 202 to drive the d.c. motor 180 for initially accelerating the drum 64 through an angle of 40°, followed by driving the drum 64 at a constant velocity through an angle of 295°, to drive each of the rollers 44, 52 and 56 at the same peripheral, sheet feeding, speed. Moreover, the microprocessor 122 is preferably programmed to timely deenergize the FET run switch 202, and to energize the FET brake switch 204 to thereafter decelerate and dynamically brake rotation of the motor 180 to return the drum 64 through an angle of 25° to the home position thereof at the end of a single revolution of the drum 64.

In addition, for controlling operation of the base 12 (Fig. 1) and thus the machine 10, the base 12 preferably includes a conventional keyboard 250 rich is

suitably electrically connected to the microprocessor 122 by means of a serial communications link 252, including a data input lead 254, for providing signals, such as the signal 255, to the microprocessor 122, a data output lead 256, for providing signals, such as the signals 257 to the keyboard 250, and a clock lead 258 for providing clock signals to the keyboard 250 to synchronize communication between the keyboard 250 and microprocessor 122. The keyboard 250, which has a plurality of manually actuatable switching keys 260, preferably includes a print mode key 262, which is manually actuatable for causing the base 12 to enter into a sheet feeding and printing mode of operation, and a no-print mode key 264, which is manually actuatable for causing the base 12 to enter into a sheet feeding but no printing mode of operation. Further, the keyboard 260 preferably includes a service light 266 which is preferably intermittently energized in a blinking mode of operation is response to signals 257 from the microprocessor 122 whenever the base 12 is in need of servicing, for example, due to the occurrence of a jam condition event in the course of operation thereof.

As shown in Fig. 6, in accordance with a preferred embodiment of the invention the microprocessor 122 is preferably programmed to include a main line program 300, which commences with the step 302 of conventionally initializing the microprocessor 122 (Figs. 1 and 2) in response to the operator manually moving the power switch 132 to the "on" position thereof to energize the d.c. power supply 120 and thus the mailing machine base 12. Step 302 generally includes establishing the initial voltage levels at the microprocessor interface ports which art utilized for sending and receiving the signals 275, 134, 176, 175, 240, 136 and 248 to and from the keyboard, sensors and comparators 250, 270, 97A, 99A, 170, 232, 125 and 248, (Fig. 1, 2, 3 and 4) for controlling the various structures of the mailing machine base 12, and setting the interval timers and event counters of the microprocessor 122. Thereafter, the microprocessor 122 executes the step 304 (Fig. 6) of initializing the components of the aforesaid various structures. Step 304 generally entails causing the microprocessor 122 (Figs. 1, 3 and 4) to scan the microprocessor ports connected to the various sensors, 97A, 99A, 170 and 232, and, if necessary, to cause the main line program to enter into a print mode of operation and drive the motors 110, 140 and 180 for causing various components of the base 12 and meter 14, including the drum drive gear 66, and thus the printing drum 64, to be driven to their respective home positions from which operation thereof, and thus of the mailing machine 10 may be initiated.

Assuming completion of the initialization steps 302 and 304 (Fig. 6), then the program 300 enters into an idle loop routine 306 which commences with the step 308 of determining whether or not a a machine error flag has been set, due to the occurrence of various events, hereinafter discussed in greater detail, including, for example, the sheet feeding structures 40, 50 or 55 (Fig. 1) being jammed in the course of feeding a sheet 22 through the machine 10, the shutter bar 72 (Fig. 2) not being fully moved through the distance d_2 in the course of movement thereof either out of or into locking- engagement with the drive gear 66, or the meter drive system 184 being jammed in the course of driving the same. Assuming a machine error flag has been set, step 308 (Fig. 6), the program 300 returns processing to idle 306, until the condition causing the error flag to be set in cured and the error flag in cleared, and a determination is thereafter made that an error flag has not been set, step 308. Whereupon, the microprocessor 122 causes the program 300 to implement the step 312 of determining whether or not a sheet detection signal 134 (Fig. 1) has been received from the sensor 97A of the sheet detection structure 97, and, assuming that it has not been received, step 312 (Fig. 6), the program 300 loops to idle, step 306, and continuously successively implements steps 308, 310, 312, and 306 until the sheet detection signal 134 is received. Whereupon, the program 300 implements the step 314 of setting the sheet feeder routine flag "on", which results in the routine 300 calling up and implementing the sheet feeder routine 400 (Fig. 7), hereinafter discussed in detail.

As the routine 400 (Fig. 7) is being implemented, the program 300 (Fig. 6) concurrently implements the step 316 of determining whether or not the sheet detection signal 134 has ended, followed by the step 316 of determining whether or not a sheet feeding trip signal 135 (Fig. 1) has been received from the sensor 99A of the sheet feeding trip structure 99. Assuming that it is determined that the sheet detection signal 134 has not ended, step 316 (Fig. 6) and, in addition, it is determined that the microprocessor 122 has not received the sheet feeding trip signal, step 318, then, the program 400 returns processing to step 316 and continuously successively implements steps 316 and 318 until the sheet feeding trip signal 135 is received, step 318, before the sheet detection signal 134 is ended, step 316. If, in the course of such processing, the sheet detection signal ends, step 316, before the sheet feeding trip signal is received, step 318, then, the program 300 implements the step 319, of setting the sheet feeder routine flag "off" followed by returning processing to step 312. Thus the program 300 makes a determination as to whether or not both sensors 97A and 99A (Fig. 1) are concurrently covered by a sheet 22 fed to the machine 10 and, if they are not, causes sheet feeding to be ended. As a result, if an operator has fed a sheet 22 to the mailing machine base 12 and it is sensed by the sensor 97A, but is withdrawn before it is sensed by the sensor 99A, although the sheet feeding routine 400 (Fig.7) has been called up and started, step 314 (Fig. 6), it will be tur-

ned off, step 319, until successive implementations of step 312 result in a determination that another sheet detection signal, step 312, has been received and the program 300 again implements the step 314 of setting the sheet feeder routine flag "on". Assuming however, that both the sheet detection and feeding signals, 134 and 135, are received, step 318, before the sheet detection signal 134 is ended, step 316, then, the program 300 implements the step 320 of determining whether the base 12 is in the no-print mode of operation, as a result of the operator having actuated the no-print key 264, (Fig. 1). Assuming that the print key 264 has been actuated, due to the operator having chosen to use the base 12 for sheet feeding purposes and not for the purpose of operating the postage meter 14, then, the program 300 (Fig. 6) by-passes the drum driving steps thereof and implements the step 320A of causing program processing to be delayed for a time interval sufficient to permit the sheet 12 being fed by the base 12 to exit the machine 10. Assuming however, that the base 12 is not in the no-print mode of operation, step 320, then the program 300 implements the step 320B of determining whether the base 12 (Fig. 1) is in the print mode of operation, as a result of the operator having actuated the print key 262. A ssuming, the inquiry of step 320B (Fig. 6) is negative, due to the operator not having chosen to use the base 12 for both sheet feeding and postage printing purposes, then, the program 300 returns processing to step 320 and continuously successively implements steps 320 and 320B until the operator actuates either the print or no-print key, 262 or 264 (Fig. 1) to cause the inquiry of one or the other of steps 320 or 320B (Fig. 6) to be affirmatively determined. Assuming that the print key 262 is actuated, causing the inquiry of step 320B to be affirmative, then the program 300 implements the step 321 of starting a time interval counter for counting a predetermined time interval t_d (Fig. 5), of substantially 80 milliseconds, from the time instant that a sheet 22 (Fig. 1) is detected by the sensing structure 99A to the predetermined time instant that the printing drum 64 preferably commences acceleration from its home position in order to rotate into engagement with the leading edge 100 of the sheet 22 as the sheet 22 is fed therebeneath.

Thereafter, the program 300 (Fig. 6) implements the step 322 of setting the shutter bar routine flag "on", which results in the program 300 calling up and implementing the shutter bar routine 500 (Fig. 8), hereinafter discussed in detail, for driving the shutter bar 72 (Fig. 2) through the distance d_2 and thus out of locking engagement with the drum drive gear 66. As the routine 500 is being implemented, the program 300 (Fig. 6) concurrently implements the step 324 of determining whether or not the shutter bar 72 (Fig. 2) has stopped in the course of being driven through the distance d_2 and thus out of locking engagement with the drum drive gear 66. Assuming that the shutter bar 72 is stopped, then, the program 300 (Fig. 6) implements the step 326 of causing the shutter bar 72 (Fig. 2) to be driven back into locking engagement with the drum drive gear 66 followed by returning processing to idle, step 306 (Fig. 6). If however, the shutter bar 72 (Fig. 2) is not stopped in the course of being driven through the distance d_2, and thus out of locking engagement with the drum drive gear 66, then, the program 300 (Fig. 6) implements the step 328 of determining whether or not the time interval count, started in step 320, has ended. And, assuming that it has not, the program 300 continuously loops through step 328 until the time interval t_d is ended. Whereupon the program 300 implements the step 330 of setting the postage meter routine flag "on", which results in the program 300 calling up and implementing the postage meter acceleration and constant velocity routine 600 (Fig. 9).

As the routine 600 (Fig. 9) is being implemented, the program 300 (Fig. 6) concurrently implements the step 332 of clearing a time interval counter for counting a first predetermined fault time interval, of preferably 100 milliseconds, during which the microprocessor 122 (Fig. 2) preferably receives the initial transition signal 240 from the sensing structure 220, due to the printing lobe's leading edge 234 (Fig. 4) being sensed by the sensor 232, indicating that the postage printing drum 64 (Fig. 2) has commenced being driven from its home position by the drum drive gear 66. Accordingly, after clearing the time interval counter, step 332 (Fig. 6), the program 300 implements the step 334 determining whether or not the printing drum 64 has commenced movement from its home position. And, assuming that it has not, the program 300 continuously successively implements the successive steps of determining whether or not the first fault time interval has ended, step 336, followed by determining whether or not the drum 64 has moved from its home position, step 334, until either the drum 64 has commenced moving before the first fault time interval ends, or the first fault time interval ends before the drum commenced moved. Assuming the first fault time interval ends before the drum has moved, then, the program 300 implements the step 338, of setting a machine error flag and causing the keyboard service light 266 to commence blinking, followed by implementing the successive machines shut-down and start-up steps 340, 342 and 344, as hereinbefore discussed in detail, and returning processing to idle, step 306. However, assuming as is the normal case that a determination is made in step 358 that the 335° transition signal 240 was timely received, i.e., at the end of the time interval t_2 (Fig. 5) of preferably 290 milliseconds, and thus before the third predetermined fault time interval is ended, step 360, then, the program 300 implements the step 363 of storing the actual time interval of duration of constant speed rotation of the postage printing drum 64, followed by the step 364 of

setting the postage meter deceleration and coasting routine flag "on", which results in the program 300 calling up and implementing the postage meter deceleration and coasting routine 700 (Fig. 10).

As the routine 700 (Fig. 10) is being implemented, the program 300 (Fig. 6) concurrently implements the step 366 of clearing the time interval counter for counting a fourth predetermined fault time interval, of preferably 100 milliseconds, during which the microprocessor 122 (Fig. 2) preferably receives the last transition signal 240 from the sensing structure 220, due to the printing lobe's trailing edge 244 (Fig. 4) being sensed by the sensor 232, indicating that the postage printing drum 64 (Fig. 2) has rotated through 359° of rotation thereof from its home position and is thus one degree from returning thereto. Thereafter, the program 300 implements the step 368 of making a determination as to whether or not the 359° transition signal 240 has been received. Assuming that it has not, the program 300 continuously successively implements the successive steps of determining whether or not the fourth fault time interval has ended, step 370, followed by determining whether or not the 359° transition signal 240 has been received, step 368, until either the 359° transition signal 240 is received before the fourth fault time interval ends, or the fourth fault time interval ends before the 359° transition signal 240 is received. Assuming the fourth fault time interval ends before the 359° transition signal 240 is received, then, the program 300 implements the step 372, corresponding to step 338, of setting a machine error flag and causing the keyboard service light 266 to commence blinking, followed by implementing the successive machine shut-down and start-up steps 340, 342 and 344, as hereinbefore discussed in detail, and returning processing to idle, step 306. However, assuming as is the normal case that a determination is made in step 368 that the 359° transition signal 240 was timely received, i.e., substantially at the end of the time interval t_3 of preferably 40 milliseconds, and thus before the fourth predetermined fault time interval is ended, step 370, then, the program 300 implements the step 374 of determining whether or not the postage meter cycle ended flag has been set, i.e., whether or not the postage meter deceleration and coasting routine 700 (Fig. 10) has been fully implemented. Assuming that the postage meter cycle ended flag has not been set, step 374, then, the program 300 (Fig. 6) continuously implements step 374 until the postage meter cycle ended flag has been set. Whereupon, the program 300 implements the step 378 of setting a postage meter trip cycle complete flag.

Thereafter, the program 300 (Fig. 6) implements the step 380 of setting the shutter bar routine flag "on", which results in the program 300 calling up and implementing the shutter bar routine 500 (Fig. 8), as hereinafter discussed in detail, for driving the shutter bar 72 (Fig. 2) back through the distance d_2 and into locking engagement with the drum drive gear 66. As the routine 500 is being implemented, the program 300 concurrently implements the step 382 of determining whether or not the shutter bar 12 (Fig. 2) has stopped in the course of being driven through the distance d_2 and thus into locking engagement with the drum drive gear 66. Assuming the shutter bar 72 is stopped, then, the program 300 (Fig. 6) implements the step 384 of setting the machine error flag and causing the keyboard service light 266 to commence blinking, followed by implementing the successive machine shut-down and start-up steps 340, 342 and 344, hereinbefore discussed in detail, and returning processing idle, step 306. If however, as is the normal case, a determination is made that the shutter bar 72 has not stopped, then, the program 300 implements the step 386 of deenergizing the FET brake switch 204 (Fig. 2), to remove the shunt from across the postage meter drive system's d.c. motor 180. Thereafter, the program 300 implements the step 320A of causing processing to be delayed for a predetermined time interval, of preferably 500 milliseconds, to permit the sheet 22 being processed by the machine 10 to exit the base 12, followed by the successive steps 390 and 392, hereinafter discussed in detail, of initially determining whether the stored, actual time intervals of acceleration and deceleration of the postage printing drum 64 (Fig. 2), and the actual movement time interval of the shutter bar 72 in either direction, is not equal to the design criteria therefor, followed by incrementally changing the actual time intervals, as needed, to cause the same to respectively be equal to their design criteria value. Thereafter, the program 300 returns processing to idle, step 306.

As shown in Fig. 7, according to the invention, the sheet feeding routine 400 commences with the Step 401 of determining whether or not the sheet feeder routine flag setting is "off" due to an error event occurring, such as one of the sheet feeder jam conditions hereinbefore discussed, in the course of operation of the mailing machine base 12. Assuming that the sheet feeder routine flag setting is "off", step 401, the routine 400 continuously loops through step 401 until the sheet feeder routine "off" flag has been cleared, i.e., reset to "on", for example, due to the jam condition having been cured. However, assuming that the sheet feeder routine flag setting is "on" then, the routine 400 implements the step 402 of clearing a time interval timer and setting the same for counting a first predetermined time interval, of preferably 300 milliseconds, during which the d.c. motor 110 (Fig. 1) is preferably energized for slowly accelerating the sheet feeding rollers, 44, 50 and 55, at a substantially constant rate during a predetermined time interval to a sheet feeding speed of twenty six inches per second for feeding one sheet 22 each 480 milliseconds. Thus the routine 400 (Fig. 7) causes the microprocessor

122 to implement the step 404 of energizing and deenergizing the FET power switch 120 (Fig. 1) with a fixed, pulse-width-modulated, signal, such as the signal 405, which preferably includes 100 positive duty cycle energization pulses of one milliseconds each in duration, separated by 100 deenergization time intervals of two milliseconds each in duration, so as to provide one energization pulse during each successive three milliseconds time interval for 100 successive time intervals, or a total of 300 milliseconds. The energization pulses are successively amplified by the FET switch 120 (Fig. 1) and applied thereby to the d.c. motor 110 for driving the rollers 44, 52 and 56, via the belt and pulley system 114. Thereafter, the routine 400 (Fig. 7) implements the step 408 of determining whether or not the acceleration time interval has ended. Assuming the acceleration interval has not ended, step 408, the routine 400 loops to step 404 and successively implements steps 404 and 408 until the acceleration time interval is ended, step 408. In this connection it is noted that the preferred acceleration time interval of 300 milliseconds in not critical to timely accelerating the sheet feeding rollers 44, 52 and 56 (Fig. 1) to the desired sheet feeding speed of 26 inches per second, since the time interval required for a given sheet 22 to be detected by the sensor 97A to the time instant it is fed to the nip of the upper and lower input feed rollers, 42 and 44, is much greater than 300 milliseconds. Assuming the time interval has ended, step 408, the routine 400 then implements the step 410 of initializing an event counter for counting a maximum predetermined number of times the counter will be permitted to be incremented, as hereinafter discussed, before it is concluded that a jam condition exists in the sheet feeding structure. Thereafter, the routine 400 causes the microprocessor 122 to implement the step 412 of determining whether or not the sheet feeder routine flag netting is "off', due to an error event occurring, such as one of the jam conditions hereinbefore discussed, in the course of operation of the mailing machine base 12. Assuming that the sheet feeder routine flag setting in "off", step 412, the routine 400 returns processing the step 401. Whereupon, the routine 400 continuously loops through step 401, as hereinbefore discussed, until the flag is reset to "on". Assuming, however that the sheet feeder routine flag setting is "on", for example due to the jam condition having been cleared, then, the routine 400 implements the step 414 of delaying routine processing for a predetermined time interval, such as two mill iseconds, to allow for any transient back e.m.f. voltage discontinuities occurring incident to deenergization of the d.c. motor 110 to be damped. Thereafter, the routine 400 causes the microprocessor 122 (Fig. 1) to sample the output signal 136 from the comparator 125 to determine whether or not the d.c. motor back e.m.f. voltage signal 126 is greater than the reference voltage signal 127, step 416 (Fig. 7).

Assume as in normal case that the back e.m.f. voltage is greater the reference voltage, step 416 (Fig. 7), due to the rollers 44, 52 and 56 having been accelerated to a sheet feeding speed which is slightly greater than the desired sheet feeding speed of 26 inches per second, because the rollers 44, 52 and 56 are not then under a load. At this juncture the sheet feeding speed is substantially equal to the desired sheet feeding speed, and, in order to maintain the desired sheet feeding speed, the routine 400 implements the successive steps of delaying processing one-half a milliseconds, followed by the step 420 of clearing the jam counter, i.e., resetting the count to zero, and again implementing the step 416 of determining whether or not the motor back e.m.f. voltage is greater than the reference voltage. Assuming that the inquiry of step 416 remains affirmative, the routine 400 repeatedly implements steps 418, 420 and 416 until the back e.m.f. voltage is not greater than the reference voltage, at rich juncture it may be concluded that the sheet feeding speed of the rollers 42, 52 and 56 is no longer at substantially the desired sheet feeding speed. Accordingly, the routine 400 then implements the step 424 of incrementing the jam counter by a single count, followed by the step 426 of determining whether or not the number of times the jam counter has been incremented is equal to a predetermined maximum count of, for example, 100 counts. And, assuming that the maximum count has not been reached, step 426, the microprocessor 122 causes the FET power switch 120 to be energized, step 428, for applying a constant d.c. voltage, such as the power supply voltage 134, to the motor 110, followed by delaying processing for a fixed time interval, step 430, of preferably two milliseconds, and then deenergizing the FET switch 431, step 431, whereby the FET power switch 120 is energized for a predetermined time interval of preferably two milliseconds. Thereafter, processing is returned to step 414. Accordingly, each time the routine 400 successively implements steps 414, 416, 424, 426, 428, 430 and 431, the FET switch 120 and thus the d.c. motor 110, is energized for a fixed time interval, steps 428, 430 and 431, and the jam counter is incremented, step 424, unless there is a determination made in step 416 that the d.c. motor back e.m.f. voltage is greater than the reference voltage, i.e., that the d.c. motor 110 is being driven at substantially the constant sheet feeding speed.

Referring back to step 416 (Fig. 7), and assuming that the comparison initially indicates that the back e.m.f. is not greater than the reference voltage, indicating that the sheet feeding rollers 44, 52 and 56 were not accelerated substantially to the desired sheet feeding speed of 26 inches per second in the course of implementation of steps 402, 404, and 408, then, the routine 400 continuously successively implements step 424, 426, 428, 430, 431, 412, 414 and 416 until, as hereinbefore discussed the back e.m.f.

voltage exceeds the reference voltage, step 416, before the jam count maximizes, step 426, or the jam count maximizes, step 426, before the back e.m.f. voltage exceeds the reference voltage.

Since each of such jam counts, step 426 (Fig. 7), is due to a determination having been made that the d.c. motor back e.m.f. voltage is not greater than the reference voltage, step 416, it may be concluded that there is no d.c. motor back e.m.f. voltage when the jam count reaches the maximum count, step 426. That is, it may be concluded that the d.c. motor 110 is stalled due to a sheet feeding jam condition occurring in the mailing machine 10. Accordingly, if the jam count has reached the maximum count, the routine 400 implements the successive steps of setting the sheet feeder flag "off", step 432, causing the keyboard service light 266 to commence blinking, step 434, and then setting a machine error flag for the main line program 300 (Fig. 6). Thereafter, the routine (Fig. 7) 400 returns processing to step 401. Whereupon, assuming that the motor jam condition is not cleared, the routine 400 will continuously loop through step 401 until the jam condition is cured and the "off" flag netting is cleared.

As shown in Fig. 8, the shutter bar routine 500 commences with the step 502 of determining whether or not the shutter bar routine flag setting is "off", due to an error event occurring, such as the shutter bar 72 (Fig. 2) having been stopped in the course of being driven out of or into locking engagement with the drive gear 66 in the course of prior operation thereof. Assuming that the shutter bar routine flag setting is "off", the routine 500 continuously loops through step 502 until the shutter bar routine flag "off" setting has been cleared, i.e., reset to "on", for example due to jam condition thereof having been cured. Assuming as is the normal case that the shutter bar routine flag setting is "on" then, the routine 500 implements the step 503 of clearing a counter for counting the number of positive duty cycle energization pulses the microprocessor 122 (Fig. 2) thereafter applies to the FET power switching module 160 for driving the d.c. motor 140. Thereafter the routine 500 implements the successive steps 504 and 506 of energizing the appropriate lead, 161A or 161B, of FET power switch module 160 (Fig. 2), depending upon the desired direction of rotation of the d.c. motor 140, with a first, fixed, pulse-width-modulated, signal, such as the signal 505, which preferably includes a mingle positive duty cycle energization pulse of from 500 to 800 microseconds in duration, step 504, followed by a single deenergization time interval of from 500 to 200 microseconds in duration, step 506, so as to provide one energization pulse during a one millisecond time interval. The signal 505, which is amplified by the FET switching module 160 and applied thereby to the d.c. motor 140, thus drives the motor 140 in the appropriate direction of rotation corresponding to the selected lead 161A or 161B, to cause the cam 150 to pivot the shutter bar lever arm 80 in the proper direction about the pivot pin 156 for causing the arm 80 to slidably move the shutter bar 70 partially through the distance d_2 for movement thereof either out of or into locking engagement with the drum drive gear 66. Thereafter, the routine 500 (Fig. 8) implements the step 507 of incrementing the pulse counter, cleared in step 503, a single count, followed by the step 508 of determining whether or not the shutter bar sensor 170 (Fig. 3) is blocked due to the shutter bar lobe's leading edge 172 being sensed thereby, indicating that the movement of the shutter bar 72 (Fig. 2) either out of or into locking engagement with the drum drive gear 66 has commenced. Assuming the shutter bar sensor 170 (Fig. 3) is not blocked, then, the routine 500 (Fig. 8) implements the step 510 of determining whether or not a count of the number of energization pulses applied to the FET switch 140, step 504, has reached a first maximum count of preferably 15 pulses. Assuming the pulse count is less than the maximum count, then, the routine 500 causes processing to be returned to step 504 and to continuously successively implement steps 504, 506, 507, 508 and 510, until either the shutter bar sensor 170 is blocked, step 508, before the pulse count maximizes, step 510, or the pulse count maximizes, step 510, before the shutter bar sensor 170 blocked, step 508. Assuming the shutter bar sensor 170 is blocked, step 508, before the pulse count maximizes, step 510, then, the routine 500 implements the step 512 of setting a shutter bar sensor blocked flag and returning processing to step 510. Whereupon the routine 500 continuously successively implements steps 510, 504, 506, 507, 508, and 512 until the pulse count maximizes, step 510, followed by implementing the successive steps 514 and 516 of again energizing the appropriate lead, 161A or 161B, of FET switching module 160, depending on the desired direction of rotation of the d.c. motor 140, with a second, fixed, pulse-width-modulated, signal 505, rich preferably includes a single positive duty cycle energization pulse of from 250 to 400 microseconds in duration, step 514, and then a duty cycle which is a predetermined percentage of i.e., preferably 50% of, the duty cycle of the first pulse-width-modulated signal 505, followed by a single deenergization time interval of from 750 to 600 microseconds in duration, step 516, so as to provide one energization pulse during a one milliseconds time interval. On the other hand, with reference to step 508, assuming the shutter bar sensor 170 is not blocked, before the pulse count maximizes, step 510, then, the routine 500 directly implements the successive steps 514 and 516 without having set the shutter bar sensor blocked flag in step 512. Accordingly, whether or not the shutter bar sensor blocked flag is set, step 512, the routine 500 implements the successive steps 514 and 516 of energizing the FET switching module 160 with the se-

cond pulse-width-modulated signal 505 hereinbefore discussed. Accordingly, during the initial 15 milliseconds time interval of energization of the FET switch, the sensor 170 may or may not have been blocked by the shutter bar 72, that is, the shutter bar 72 may or may not have commenced movement in either direction. And, in either eventuality the FET switching module 160 in again energized to either initially move or continue to move the shutter bar 72. Thereafter, the routine 500 implements the step 517 of incrementing the pulse counter, cleared in step 503, a single count, followed by the step 518 determining whether or not the shutter bar sensor 170 is then or was previously blocked. Assuming the shutter bar sensor 170 is not blocked, then, the routine 500 implements the step 520 of determining whether or not the sensor 170 is unblocked and, in addition, whether or not the sensor blocked flag is also set. Thus, the inquiry of step 520 is concerned with the occurrence of two events, that is, that the shutter bar sensor 170 (Fig. 3) becomes blocked and, thereafter, becomes unblocked by the lobe, 166 or 166A. Assuming that the shutter bar sensor 170 is not unblocked, whether or not the blocked sensor flag is set, or that the sensor 170 is unblocked but the blocked sensor flag is not set, then the routine 500 implements the step 522 of determining whether or not the total count of the number of energization pulses applied to the FET switch 140, step 514, has reached a total maximum fault count of preferably 75 pulses. Assuming the total pulse count has not maximized, then, the routine 500 causes processing to be returned to step 514 and to continuously successively implement steps 514, 516, 517, 518, 520 and 522 until the shutter bar sensor is blocked and thereafter unblocked, step 520. Assuming as is the normal case that the shutter bar sensor is blocked, step 518, before the total pulse count has maximized, step 522, then, the routine 500 implements the step 523 of setting the sensor blocked flag before implementing step 520. If however, the shutter bar sensor is not thereafter additionally unblocked, step 520, before the total pulse count has maximized, step 522, the routine 500 concludes that either the postage meter 14 or a jam condition in the base 12 in preventing shutter bar movement. Accordingly, the routine 500 implements the step 524 of setting a shutter bar time out flag, followed by the step 526 of setting the shutter bar routine flag "off" and returning processing to step 502. Whereupon, processing will continuously loop through step 502 until the postage meter fault or jam condition in cured and the shutter bar routine flag is set "on". At thin juncture it will be assumed, an is the normal case, that before the total pulse count has maximized, step 522, the shutter bar sensor 170 is timely unblocked after having been blocked, step 520, i.e. typically at the end of a desired predetermined time interval of preferably 30 milliseconds and thus typically when the pulse count is equal to 30. Thus the routine 500 answers the inquiry of step 520, and implements the step 527 of storing the pulse count which, due to each count occurring during successive time intervals of one millisecond, corresponds to the actual time interval required to drive the shutter bar 72 (Fig. 2) through substantially the distance d_2, without seating the same, and thus substantially either out of or into locking engagement with drum drive gear 66. Thereafter, in order to slow down movement of the shutter bar 72 (Fig. 2), before the positively seating the same, the routine 500 preferably implements the step 528 (Fig. 8) of causing the microprocessor 122 (Fig. 2) to apply a two millisecond reverse energization pulse, to the FET lead 161A or 161B, as the case may be, which is opposite to the lead 161A or 161B to which the energization pulses of steps 504 and 514, were applied. Thereafter, the routine 500 implements the step 530 of delaying routine processing for a fixed time interval, of preferably twenty mill iseconds, followed by the step 531 of clearing the pulse counter. Whereupon, in order to positively seat the shutter bar while at the same time easing the shutter bar 72 to a stop to reduce the audible noise level thereof, the routine 500 implements the successive steps 532 and 534 of energizing the FET switching module 160 with a third fixed pulse width-modulated signal, of preferably a single positive duty cycle energization pulse of 500 microseconds in duration, followed by a single deenergization time interval of 10 milliseconds in duration, step 534. Thereafter, the routine 500 implements the step 535 of incrementing the pulse counter cleared in step 531 by a single count, followed by the step 536 of determining whether or not the number of energization pulses applied in step 532 in equal to a predetermined maximum count, of preferably four pulses. Assuming that the pulse count has not maximized, then, the routine 500 returns processing to step 532 and continuously successively implements steps 532, 534 and 536 until the pulse count maximizes step 536. Whereupon the routine implements the step 526 of setting the shutter bar routine flag "off" and returning processing to step 502, which, as hereinbefore discussed, is continuously implemented by the routine 500 until the shutter bar routine flag setting is "on".

As shown in Fig. 9, the postage meter acceleration and constant velocity routine 600 commences with the step 602 of determining whether or not the postage meter acceleration and constant velocity routine flag setting is "off", as is the normal case, until, in the course of execution of the main line program 300 (Fig. 6), the program 300 implements the step 330 of setting the acceleration and constant velocity routine flag "on". Assuming that the acceleration routine flag setting is "off", step 602 (Fig. 9), then, the routine 600 continuously implements step 602 until the "off" flag setting is cleared. whereupon, the routine 600 implements the step 603 of clearing and starting a time interval timer for measuring the actual time interval re-

quired to accelerate the postage printing drum 64 (Fig. 1) from its home position and into feeding engagement with a sheet 22 fed therebeneath. Thereafter, the routine 600 (Fig. 9) implements the successive steps 604 and 606 of energizing the FET run switch 202 (Fig. 2) with a fixed, pulse-width-modulated, signal, such as the signal 605, which preferably includes a single positive duty cycle energization pulse of 1.5 milliseconds in duration, step 604, followed by a single deenergization time interval of 2 milliseconds in duration, step 606, so as to provide one energization pulse having a positive polarity duty cycle during a 3.5 millisecond time interval. Thereafter, the routine 600 implements the step 608 of causing the microprocessor 122 (Fig. 2) to sample the output signal 248 from the comparator 208 to determine whether or not the d.c. motor back e.m.f. voltage signal 210 is greater than the reference voltage signal 214. If the comparator signal 248 indicates that back e.m.f. voltage is not greater than the reference voltage, step 608 (Fig. 9), it may be concluded that the postage printing drum 24 has not yet completed acceleration to the predetermined constant velocity (Fig. 5), since the reference voltage corresponds to the predetermined constant velocity that the drum 24 (Fig. 1) is preferably driven for feeding sheets 22 at a speed corresponding to the sheet feeding speed of the sheet feeding rollers 44, 52 and 56. Thus if the inquiry of step 608 (Fig. 9) is negative, the routine 600 returns processing to step 604, followed by continuously successively implementing steps 604, 606 and 608 until the d.c. motor back e.m.f. voltage is greater than the reference voltage. Whereupon it may be concluded that the postage printing drum 64 is being driven substantially at the predetermined constant velocity causing the periphery thereof to be driven at the sheet feeding speed. Accordingly, the routine 600 then implements the successive steps of stopping the acceleration time interval timer, step 609, followed by the step 609A of storing the actual time interval required for acceleration of the drum 64 (Fig. 1) to the constant velocity (Fig. 5). Thereafter, in order to drive the drum 64 to maintain the velocity constant, the routine 600 (Fig. 9) preferably implements the successive steps 610 and 612 of energizing the FET run switch 202 with a second, predetermined, pulse-width-modulated signal, which preferably includes a single positive duty cycle energization pulse of 4 milliseconds in duration, step 610, followed by a single deenergization time interval of 2 milliseconds in duration, step 612, so as to provide one energization pulse having a positive polarity duty cycle during a six millisecond time interval. Whereupon, the routine 600 implements the step 614, corresponding to step 608, of determining whether or not the d.c. motor back e.m.f. voltage is greater than the reference voltage, indicating that the postage printing drum 64 is being driven faster than the predetermined constant velocity (Fig. 5) corresponding to the reference voltage, and thus faster than the sheet feeding speed of the rollers 44, 52 and 56 (Fig. 1). Assuming that the back e.m.f. voltage Is greater than the reference voltage, step 614 (Fig. 9) the routine 600 continuously successively implements the successive steps of delaying routine processing for 500 microseconds, step 616, followed by returning processing to and implementing step 614, until the back e.m.f. voltage is not greater than the reference voltage. At which time it may be concluded that the d.c. motor velocity is less than, but substantially equal to, the constant velocity corresponding to the reference voltage, and thus less than, but substantially equal to, the sheet feeding speed of the sheet feeding rollers 44, 52 and 56. At this juncture, the routine 600 implements the step 618 of determining whether or not the postage meter acceleration and constant velocity routine flag setting is "off", indicating that the constant velocity time interval t_2 (Fig. 5) has ended, so as to determine whether or not the drum 64 should or should not be decelerated to the home position. If the flag setting is "on", in order to maintain constant velocity of the drum 64, the routine 600 (Fig. 9) continuously successively implements the successive steps 610, 612, 614, 616 and 618 until the postage meter routine flag setting is "off". On the other hand, if the flag setting in "off", step 618, the routine 600 returns processing to step 602. Whereupon the drum 64 commences coasting and, as hereinbefore discussed, the routine 600 continuously implements step 602 until the postage meter acceleration routine flag is reset to "on".

As shown in Fig. 10, the postage meter deceleration and coasting routine 700 commences with the step 602 of determining whether or not the deceleration and coasting routine flag setting is "off", as in the normal cane, until, in the course of execution of the main line program 300 (Fig. 6), the program 300 implements the step 364 of setting the deceleration and coasting routine flag "on". Accordingly, if the inquiry of step 702 (Fig. 10) is negative, the routine 700 continuously implements step 702 until the deceleration and coasting routine flag netting is "on". Whereupon the routine 700 implements the step 704 of setting the acceleration and constant velocity routine flag "off", which, as previously discussed, results the routine 600 (Fig. 9) returning processing to step 602. Thereafter, the routine 700 (Fig. 10) implements the successive steps of delaying routine processing for a time interval of preferably 100 microseconds, step 708, followed by the step 709 of clearing and starting a deceleration time interval timer for measuring the actual time interval required to decelerate the postage printing drum 64 (Fig. 1) out of feeding engagement with a sheet 22 being fed thereby and to return the drum 64 to its home position. Thereafter, in order to commence deceleration of the drum 64, the routine 700 initially implements the successive steps 710 and 712 of energizing the FET brake switch 204 (Fig. 2)

with a first, fixed, pulse-width modulated signal, such as the signal 709, which preferably includes a single positive duty cycle energization pulse of 4 milliseconds in duration, step 710, followed by a single deenergixation time interval of 2 milliseconds in duration, step 712, so as to provide one energization pulse having a positive polarity duty cycle during a 6 millisecond time interval. Then, the routine 700 implements the step 713 of clearing a counter for counting the number of positive duty cycle energization pulses that the microprocessor 122 (Fig. 2) will thereafter apply to FET brake switch 204 in order to continue decelerating rotation of the drum 64 to its home position. Thus the routine 700 (Fig. 10) thereafter implements the successive steps 714 and 716 of energizing the FET brake switch 204 with a second fixed, pulse-width-modulated signal 709, which preferably includes a single positive duty cycle energization pulse of one milliseconds in duration step 714, followed by a single deenergization time interval of 2 milliseconds in duration step 716, so as to provide one energization pulse having a positive duty cycle polarity during a 3 millisecond time interval. Whereupon, the routine 700 implements the successive steps of incrementing the pulse counter, cleared in step 713, a single count, followed by the step 718 of determining whether or not the pulse count applied in step 714 is equal to a predetermined maximum count, of preferably 6 pulses. Assuming that the pulse count has not maximized step 718, then the routine 700 returns processing to step 714 and continuously successively implements steps 714, 716 and 718 until the pulse count maximizes, step 718. At this juncture, rotation of the postage printing drum 24 will have been decelerated for a predetermined time interval t_4 (Fig. 5) of preferably substantially 24 milliseconds of the 40 milliseconds t_3 preferably allotted for returning the drum 64 to its home position. Thus the drum 64 will have been decelerated sufficiently to permit the drim 24 (Fig. 1) substantially to coast to its home position. Accordingly, the routine 700 then implements the step 720 of reducing the value of the reference voltage signal 214 (Fig. 2) provided to the comparator 208 by the microprocessor 122, followed by the successive steps 720 and 722 of energizing the FET run switch 202 with a first, fixed, pulse-width modulated signal 605, which includes a single positive duty cycle energization pulse of preferably 500 microseconds in duration, step 720, followed by a single deenergization time interval of two milliseconds in duration, so as to provide one positive duty cycle energization pulse during a two and one-half millisecond time interval. Whereupon the routine 700 implements the step 724 of commencing determining whether or not the microprocessor 122 (Fig. 2) has received the last transition signal 240, due to the trailing edge 244 (Fig. 4) of the printing lobe 226 being detected by the sensor 232, indicating that the postage printing drum 64 (Fig. 1) has returned to its home position, step 724. Assuming the drum home position signal 240 has not been received, step 724, then, the routine 700 implements the step 726 of causing the microprocessor 122 (Fig. 2) to sample the comparator output signal 248 to determine whether or not the d.c. motor back e.m.f. signal 210 is greater than the reduced reference voltage signal 214. Thus, although the drum 64 will have initially been driven to its home position since the reference voltage has been reduced, the comparator 208 will at least initially indicate that the d.c. motor back e.m.f. voltage is greater than the reduced reference voltage, step 726, (Fig. 10) indicating that the d.c. motor is rotating too fast with the result that the routine 700 will continuously successively implement the successive steps of delaying routine processing for 500 microseconds, step 728, allowing the drum to coast to the home position, followed by again implementing step 726, until the back e.m.f., voltage is no longer greater than the reduced reference voltage. It this juncture it is noted that although the drum home position signal 240 (Fig. 2) has not been received, since the d.c. motor back e.m.f. is less than the reference voltage it may be concluded that the drum 64 has coasted substantially to the home position. Thus, the routine 700 (Fig. 10) then implements the successive steps of stopping the deceleration time interval timer, step 729, set in step 709 followed by storing the actual deceleration time interval, step 729A. Whereupon the microprocessor 122 drives the drum 64 to its home position by returning processing to step 720 and successively implementing steps 720, 722 and 724, with the result that the drum home position signal 240 is received, step 724. Thus, due to utilizing a reduced reference voltage, when comparing the same to the motor back e.m.f. voltage, the drum 64 is permitted to coast under the control of the microprocessor 122 until just prior to returning to its home position, at which juncture the drum is driven to its home position under the control of the microprocessor 122. Thereafter, the routine 700 implements the step 730 of energizing the FET brake switch 204 with a single positive polarity duty cycle pulse of thirty milliseconds in duration, to positively stop rotation of the drum 64 (Fig. 2) at the home position. Whereupon the routine 700 (Fig. 10) implements the successive steps of setting a postage meter cycle end flag for the main line program, step 732, followed by causing the deceleration and coasting routine flag to be set "off", step 734, and then returning processing to step 702, which, as hereinbefore discussed, is continuously implemented until the postage meter routine deceleration and coasting routine flag setting is "on".

As hereinbefore noted, in the course of implementation of the shutter bar routine 500 (Fig. 8), and, in particular, in the coarse of implementation of step 527, the actual time interval required to drive the shutter bar 72 (Fig. 2) in either direction through the distance d_2 in stored during each sequence of operation

of routine 500 (Fig. 8). Correspondingly, in the course of implementation of the postage meter acceleration and constant velocity routine 600 (Fig. 9) and, in particular in step 609A thereof, the actual time interval required to accelerate the postage printing drum 64, from rest to the desired sheet feeding of 26 inches per second, is stored, during each sequence of operation of the routine 600 (Fig. 9). And, in the course implementation of the postage meter deceleration and coasting routine 700 (Fig. 10), and, in particular, in step 729A thereof, the actual time interval required to accelerate the postage printing drum 64, from the constant sheet feeding speed thereof to substantially at rest at the home position thereof, is stored during each sequence of operation of the routine 700 (Fig. 10). Moreover, as hereinbefore discussed, each sequence of operation of the shutter bar, acceleration and deceleration routines 500 (Fig. 8), 600 (Fig. 9) and 700 (Fig. 10), is under the control of the main line program 300 (Fig. 6), which preferably includes the step 390, implemented in the course of each sheet 22 being fed through the machine 10, of making successive or parallel determinations as to whether the stored actual value of the time interval for driving the shutter bar in either direction is not equal to the preferred time interval of 30 milliseconds, whether the stored actual values of the time interval for accelerating the postage meter drum is not equal to the preferred time interval of 40 milliseconds, and whether the stored actual value of time interval for deceleration of postage meter drum is not equal to 40 milliseconds, step 390. Assuming the inquiry of step 390 is negative, the routine 300 returns processing it idle, step 306. Assuming however, that the inquiry of step 390 is affirmative, with respect to one or more of the determination, then the routine 300 implements the step 392 of selectively changing the duty cycle of the energization pulses provided to the H-bridge FET module 160 (Fig. 2) or FET run switch 202, or both, during each sequence of operation thereof, by predetermined incremental percantages or amounts tending to cause the shutter bar drive motor 140 or postage meter drum drive motor 180, or both, to timely drive the shutter bar 72 or timely accelerate or decelerate the drum 64, as the case may be, in accordance with the preferred, design criteria, time intervals noted above.

Among the aims of the particular embodiment of the invention are: controlled sheet feeding, shutter bar moving and postage printing drum driving structures in a mailing machine base;

to provide a microprocessor controlled d.c. motor for accelerating sheet feeding rollers at a substant:ally constant rate to a substantially constant sheet feeding speed;

to provide a microprocessor controlled shutter bar moving system in a mailing machine base;

to provide a microprocessor controlled d.c. motor for timely accelerating a postage meter drum from rest, in its home position, to a substantially contant velocity, and then maintaining the velocity constant; and

to provide a microprocessor controlled d.c. motor for timely controlling deceleration of a postage printing drum from a substantially constant velocity to rest in its home position.

Claims

1. A mailing machine base adapted to have a postage meter mounted thereon, wherein the meter includes a postage printing drum having a home position, the base comprising:
   a. means for moving the drum;
   b. a.d.c. motor for driving the drum moving means;
   c. a microprocessor;
   d. a power switch connected between the d.c. motor and microprocessor;
   e. a comparator connected between the microprocessor and d.c. motor for receiving therefrom a signal corresponding to the back e.m.f. voltage of the d.c. motor and providing a comparison signal to the microprocessor; and
   f. the microprocessor for:
      i. providing a reference voltage signal for the comparator corresponding to a desired back e.m.f. voltage for causing the d.c. motor to drive the postage printing drum at a desired constant velocity,
      ii. energizing the power switch with a first signal for causing the d.c. motor to accelerate the drum at a substantially constant rate to substantially the desired constant velocity from the home position thereof during a first predetermined time interval,
      iii. determining whether the back e.m.f. is greater than the reference voltage,
      iv. energizing the power switch with the first signal for a second predetermined time interval if the back e.m.f. voltage is not greater than the reference voltage, and
      v. energizing the power switch with a second signal for a third predetermined time interval if the back e.m.f. voltage is greater than the reference voltage and delaying energizing with the second signal if the back e.m.f. voltage is not greater than the reference voltage, thereby causing the d.c. motor to continue driving the drum at substantially the desired constant velocity.

2. The mailing machine base according to Claim 1, wherein the first signal is a first pulse-width-modulated signal including a first predetermined duty cycle.

3. The mailing machine base according to Claim 2, wherein the microprocessor is programmed to determine whether the actual time interval required to accelerate the drum to the desired constant velocity is equal to the first predetermined time interval, and the microprocessor programmed to incrementally adjust the duty cycle if the actual time interval is not equal to the first predetermined time interval.

4. The mailing machine base according to Claim 1, wherein the second signal is a second pulse-width-modulated signal including a second predetermined duty cycle.

5. The mailing machine base according to Claim 1 including means for sensing angular rotation of the postage printing drum, and the microprocessor programmed for receiving a signal from the sensing means when the drum commences rotation from the home position thereof.

6. The mailing machine base according to Claim 5, wherein the microprocessor is programmed for determining whether the drum rotation commencement signal is received from the sensing means before the end of a predetermined fault time interval.

7. The mailing machine base according to Claim 6, wherein the microprocessor is programmed for implementing a shut-down routine if the drum rotation commencement signal has not been received at the end of the fault time interval.

8. The mailing machine base according to Claim 1 including means for sensing angular rotation of the postage printing drum, and the microprocessor programmed for receiving a signal from the sensing means when the drum has rotated through a predetermined angle of rotation from the home position thereof.

9. The mailing machine base according to Claim 8, wherein the microprocessor is programmed for determining whether the rotation angle signal is received from the sensing means before the end of a predetermined fault time interval.

10. The mailing machine base according to Claim 9, wherein the microprocessor is programmed for implementing a shut-down routine if the rotation angle signal has not been received at the end of the fault time interval.

11. A mailing machine adapted to have a postage meter mounted thereon, wherein the meter has a postage printing drum having a home position, and the base comprising:
    a. means for moving the drum;
    b. a.d.c. motor for driving the drum moving means;
    c. a microprocessor;
    d. a power switch connected between the d.c. motor and microprocessor for driving the d.c. motor;
    e. a power switch connected between the d.c. motor and microprocessor for dynamically braking the d.c. motor;
    f. a comparator connected between the microprocessor and d.c. motor for receiving therefrom a signal corresponding to the back e.m.f. voltage thereof and providing a comparison signal to the microprocessor; and
    g. the microprocessor programmed for:
        i. energizing the braking switch with a first signal for a first time interval predetermined to cause the d.c. motor to decelerate the drum at a substantially constant rate from a substantially constant velocity thereof;
        ii. energizing and deenergizing the braking switch with a second signal successively during each of a predetermined number of successive second predetermined time intervals,
        iii. providing a reference voltage for the comparator having a value which is less than the back e.m.f. voltage corresponding to the constant velocity,
        iv. energizing the driving switch with a third signal for a third predetermined time interval,
        v. determining whether the drum is in the home position,
        vi. determining whether he back e.m.f. is greater than the reference voltage if the drum is not in the home position,
        vii. energizing the braking switch with a fourth signal for a fourth predetermined time interval if the drum is in the home position to ensure the drum is stopped in the home position,
        viii. energizing the driving switch for the third time interval if the back e.m.f. voltage is not greater than the reference voltage and delaying the third time interval of energization of the driving switch if the back e.m.f. is greater than the reference voltage to permit the drum to coast.

12. The mailing machine base according to Claim 11, wherein the first signal is a first pulse-width-modulated signal including a first energization pulse having a first predetermined duty cycle.

13. The mailing machine base according to Claim 12, wherein the microprocessor is programmed to determine whether the actual time interval required to decelerate the drum substantially to rest in the home position thereof is not equal to a predetermined total desired time interval, and the microprocessor programmed for incrementally adjusting the duty cycle of the first signal if the actual time interval is not equal to the total desired time interval.

14. The mailing machine base according to Claim 11, wherein the second signal is a second pulse-width-modulated signal including a second energization pulse having a second predetermined duty cycle.

15. The mailing machine base according to Claim 11, wherein the third signal is a third pulse-width-modulated signal including a third energization pulse having a third duty cycle.

16. The mailing machine base according to claim 11, wherein the fourth signal is a fourth pulse-width-modulated signal including a fourth energization pulse having a fourth duty cycle.

17. The mailing machine base according to Claim 11 including means for sensing angular rotation of the postage printing drum, and the microprocessor programmed for receiving a first signal from the sensing means when the drum has rotated through a first predetermined angle of rotation from the home thereof.

18. The mailing machine base according to Claim 17, wherein the microprocessor is programmed for determining whether the first drum rotation angle signal is received from the sensing means before the end of a predetermined fault time interval.

19. The mailing machine base according to Claim 18, wherein the microprocessor is programmed for implementing a shut-down if the first drum rotation angle signal has not been received at the end of the fault time interval.

20. The mailing machine base according to Claim 11 including means for sensing angular rotation of the postage printing drum, and the microprocessor programmed for receiving a second signal from the sensing means when the drum has rotated through a second predetermined angle of rotation from the home position thereof and has returned to the home position.

21. The mailing machine base according to Claim 20, wherein the microprocessor is programmed for determining whetehr the second drum rotation angle signal is received from the sensing means before the end of a predetermined fault time interval.

22. The mailing machine base according to Claim 21, wherein the microprocessor is programmed for implementing a shut-down routine if the second drum rotation angle signal has not been received at the end of the fault time interval.

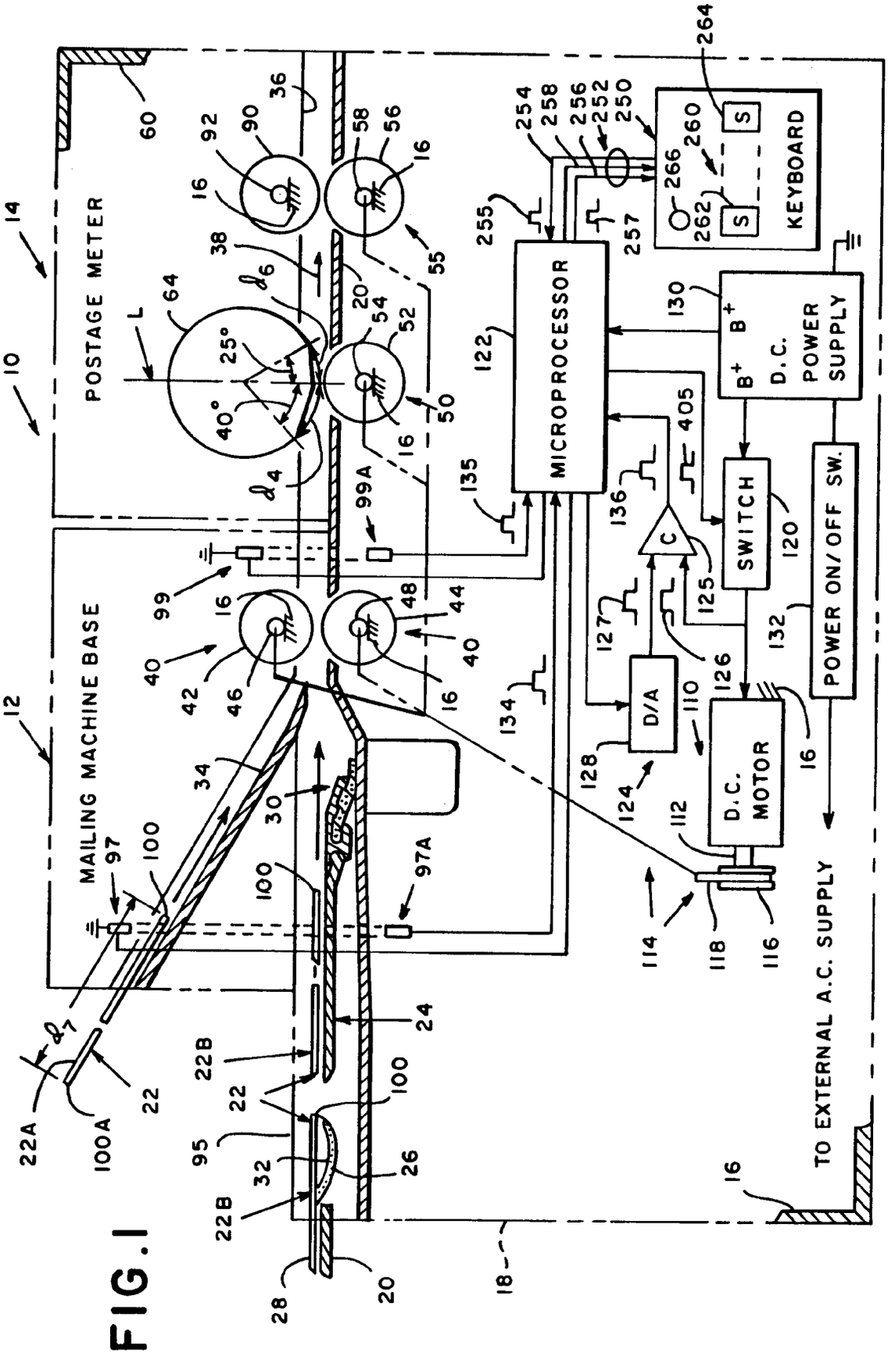

POSTAGE METER
MAILING MACHINE BASE
MICROPROCESSOR
KEYBOARD
D.C. POWER SUPPLY
SWITCH
POWER ON/OFF SW.
D.C. MOTOR
D/A
TO EXTERNAL A.C. SUPPLY
10
12
14
16
18
20
22
22A
22B
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
55
56
58
60
64
90
92
95
97
97A
99
99A
100
100A
110
112
114
116
118
120
122
124
125
126
127
128
130
132
134
135
136
250
252
254
255
256
257
258
260
262
264
266
405
L
25°
40°
δ_4
δ_6
δ_7
B+
C
D/A
S

FIG. 1

FIG. 2

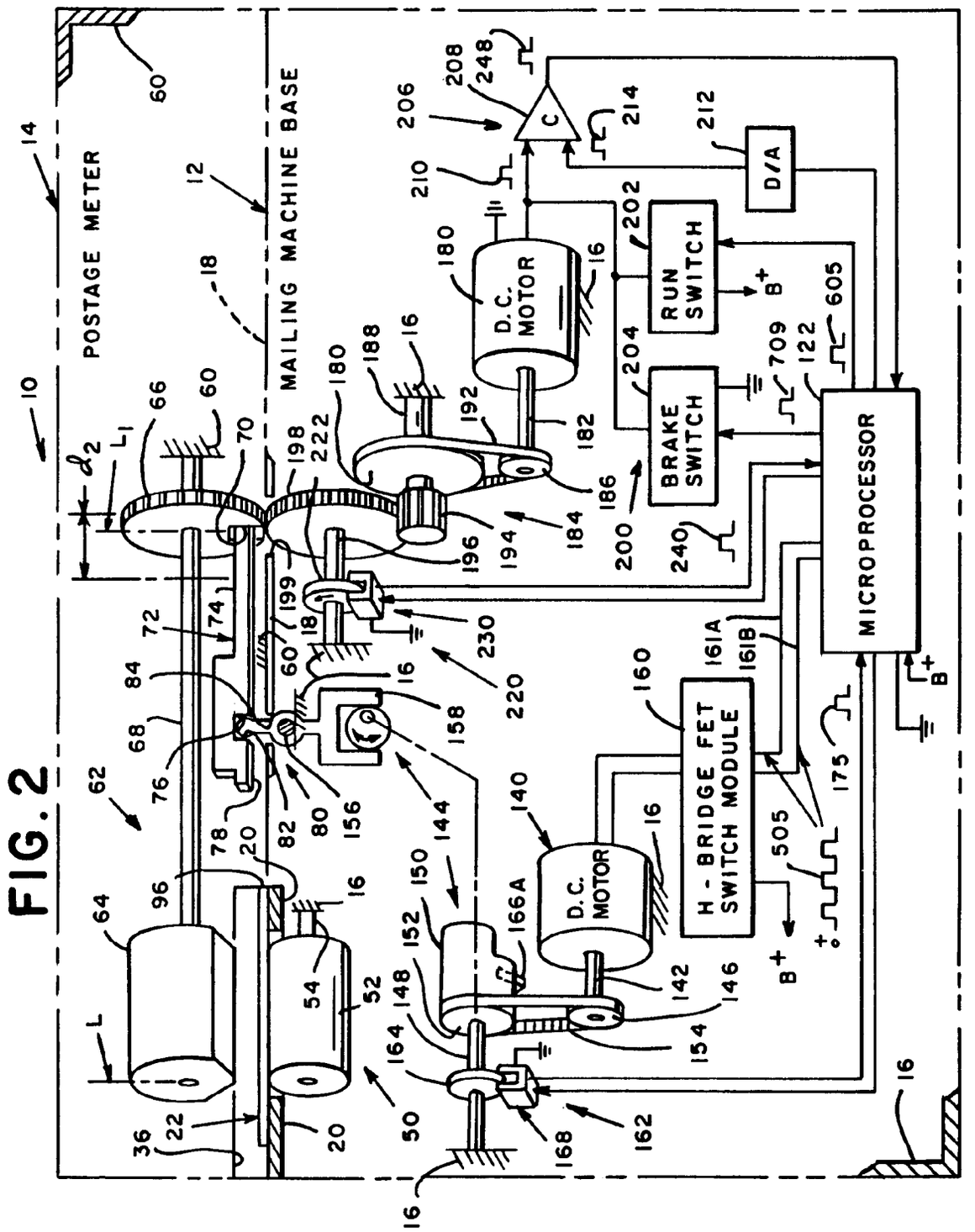

POSTAGE METER
MAILING MACHINE BASE
MICROPROCESSOR
RUN SWITCH
BRAKE SWITCH
D/A
H - BRIDGE FET SWITCH MODULE
D.C. MOTOR
D.C. MOTOR
D.C. MOTOR
B+

FIG. 3

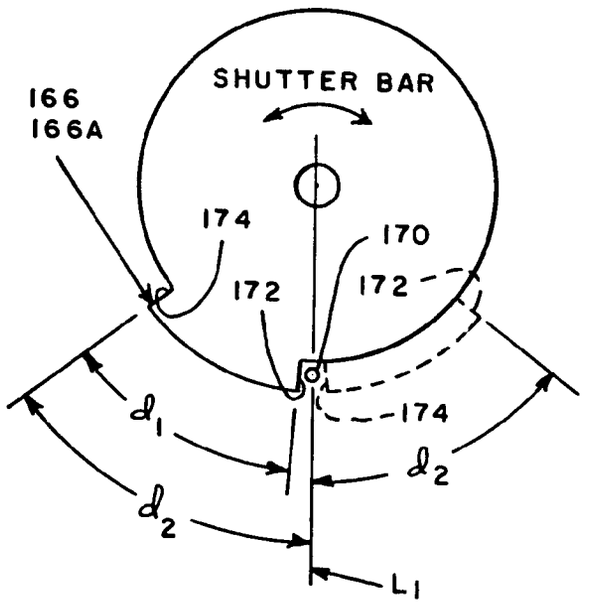


FIG. 4

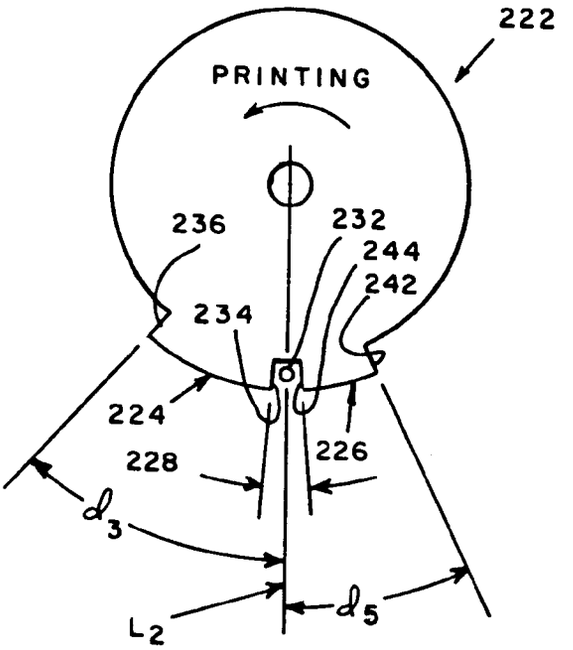


FIG. 5

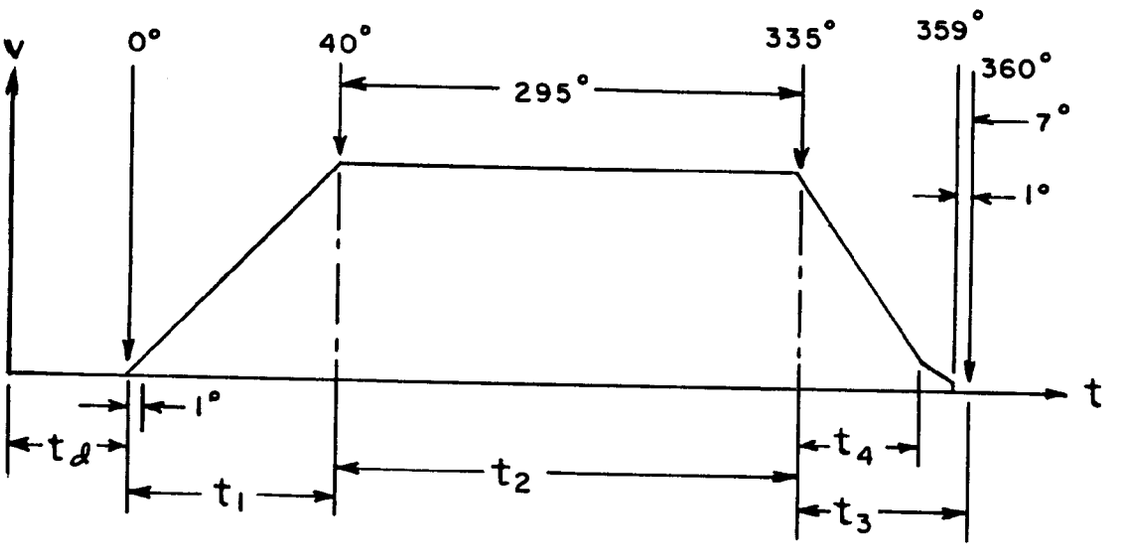


FIG. 6A

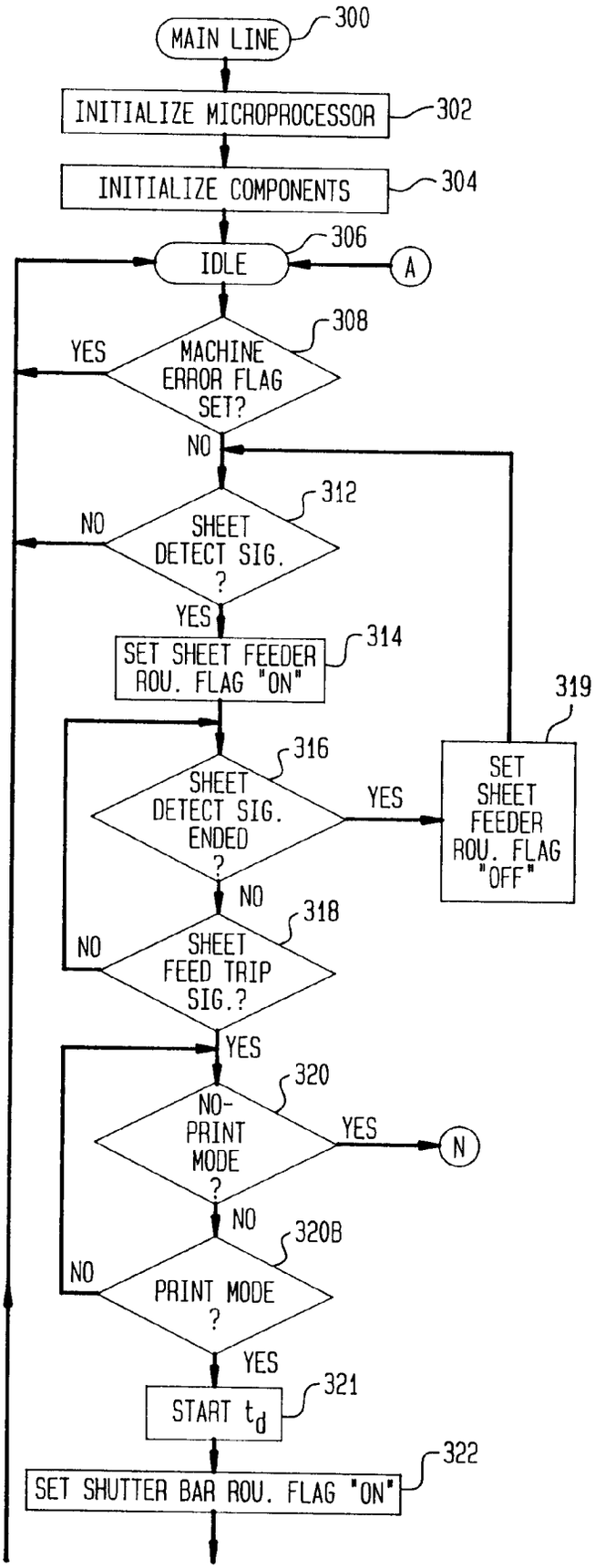

MAIN LINE
300
INITIALIZE MICROPROCESSOR
302
INITIALIZE COMPONENTS
304
IDLE
306
A
MACHINE ERROR FLAG SET?
308
YES
NO
SHEET DETECT SIG. ?
312
NO
YES
SET SHEET FEEDER ROU. FLAG "ON"
314
319
SHEET DETECT SIG. ENDED ?
316
YES
SET SHEET FEEDER ROU. FLAG "OFF"
NO
SHEET FEED TRIP SIG.?
318
NO
YES
NO- PRINT MODE ?
320
YES
N
NO
PRINT MODE ?
320B
NO
YES
START t_d
321
SET SHUTTER BAR ROU. FLAG "ON"
322

FIG. 6

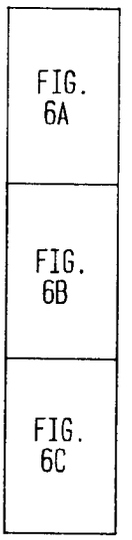
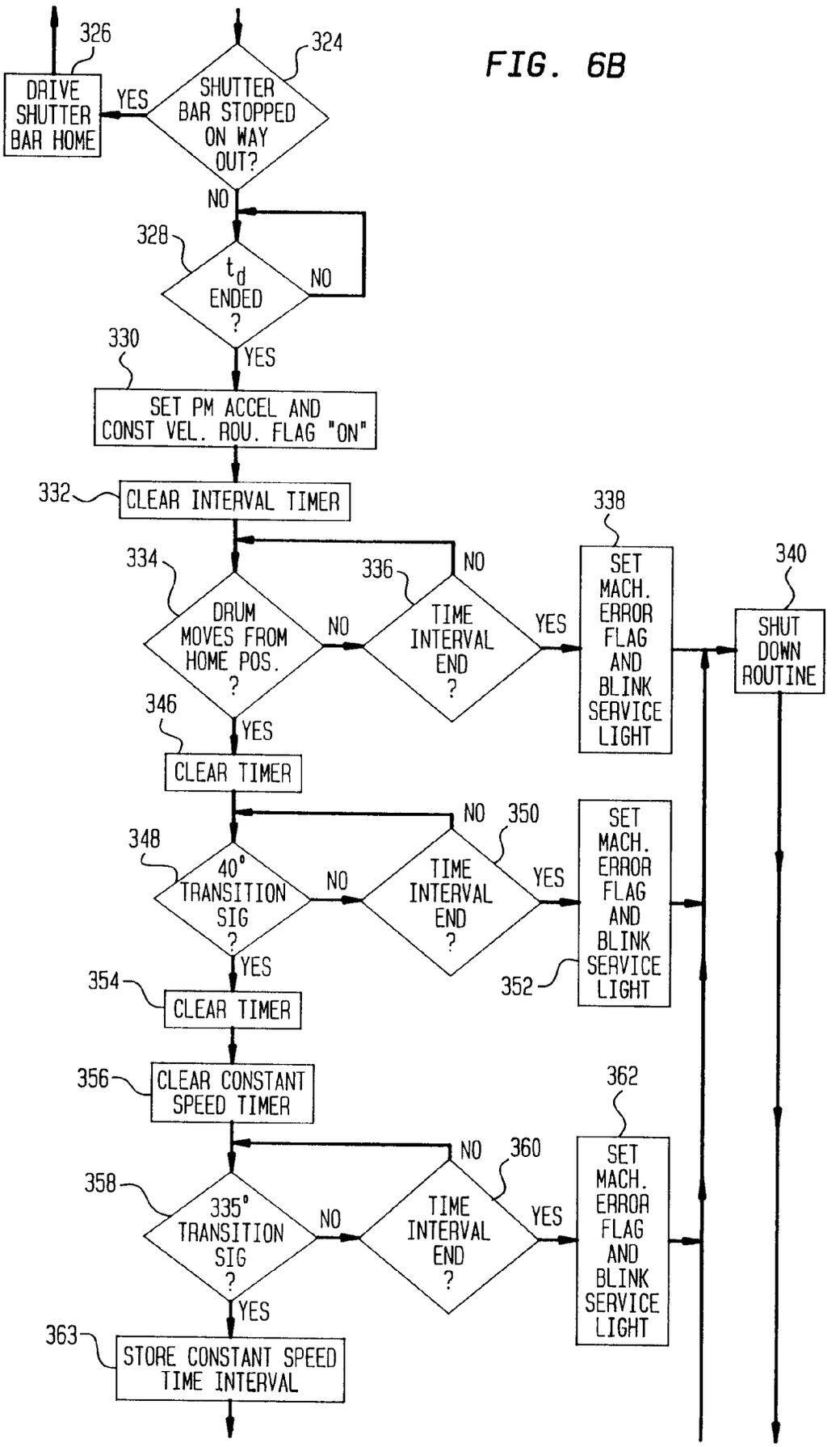

FIG. 6A
FIG. 6B
FIG. 6C

FIG. 6B


326
DRIVE SHUTTER BAR HOME
YES
324
SHUTTER BAR STOPPED ON WAY OUT?
NO
328
t_d ENDED ?
NO
YES
330
SET PM ACCEL AND CONST VEL. ROU. FLAG "ON"
332
CLEAR INTERVAL TIMER
334
DRUM MOVES FROM HOME POS. ?
NO
336
TIME INTERVAL END ?
NO
YES
338
SET MACH. ERROR FLAG AND BLINK SERVICE LIGHT
340
SHUT DOWN ROUTINE
346
YES
CLEAR TIMER
348
40° TRANSITION SIG ?
NO
350
TIME INTERVAL END ?
NO
YES
352
SET MACH. ERROR FLAG AND BLINK SERVICE LIGHT
354
YES
CLEAR TIMER
356
CLEAR CONSTANT SPEED TIMER
358
335° TRANSITION SIG ?
NO
360
TIME INTERVAL END ?
NO
YES
362
SET MACH. ERROR FLAG AND BLINK SERVICE LIGHT
363
YES
STORE CONSTANT SPEED TIME INTERVAL

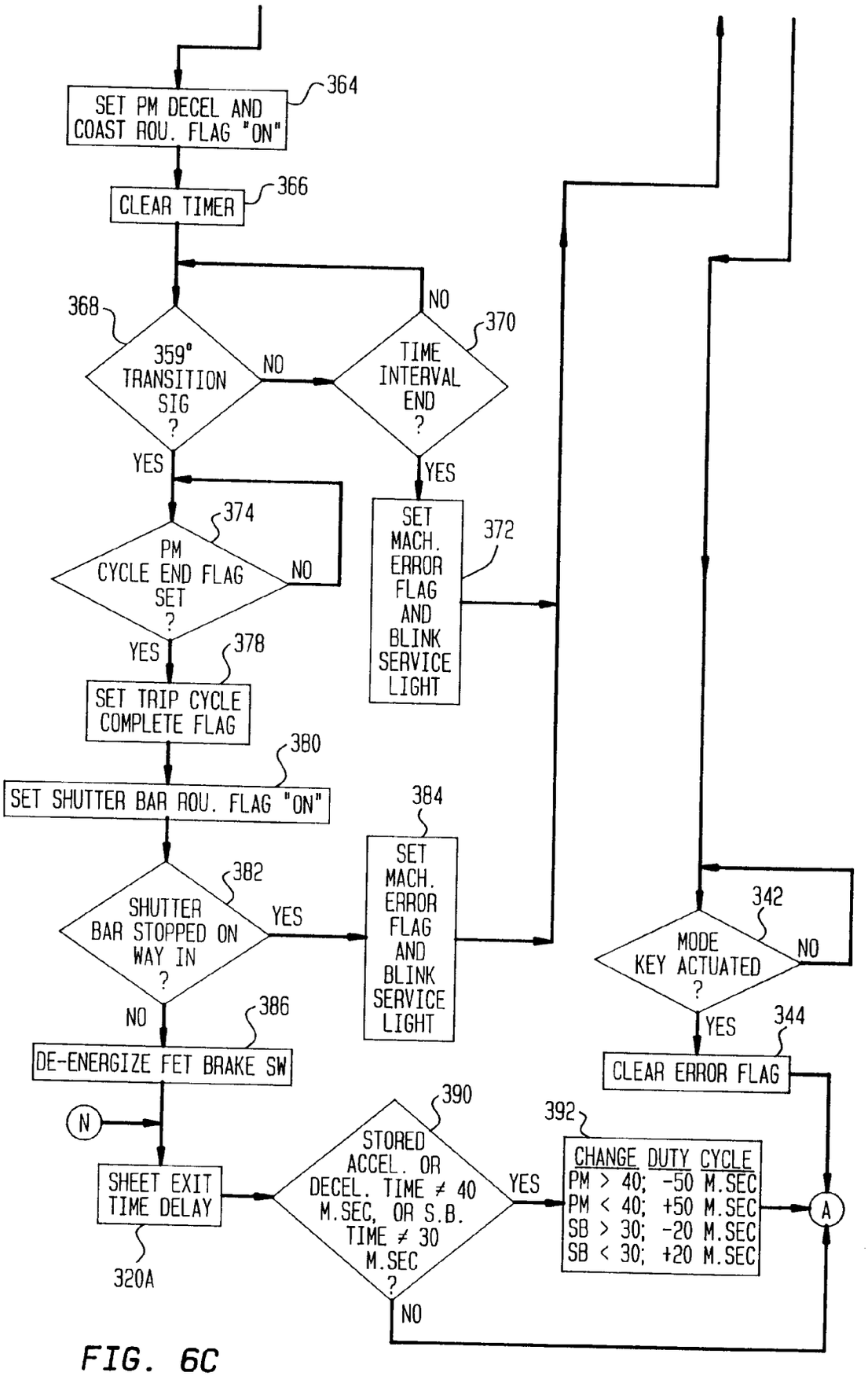

SET PM DECEL AND COAST ROU. FLAG "ON"
364
CLEAR TIMER
366
368
359° TRANSITION SIG ?
NO
370
TIME INTERVAL END ?
NO
YES
YES
374
PM CYCLE END FLAG SET ?
NO
YES
378
SET TRIP CYCLE COMPLETE FLAG
380
SET SHUTTER BAR ROU. FLAG "ON"
382
SHUTTER BAR STOPPED ON WAY IN ?
YES
NO
386
DE-ENERGIZE FET BRAKE SW
N
SHEET EXIT TIME DELAY
320A
390
STORED ACCEL. OR DECEL. TIME ≠ 40 M.SEC, OR S.B. TIME ≠ 30 M.SEC ?
YES
NO
392
CHANGE DUTY CYCLE
PM > 40; -50 M.SEC
PM < 40; +50 M.SEC
SB > 30; -20 M.SEC
SB < 30; +20 M.SEC
A
SET MACH. ERROR FLAG AND BLINK SERVICE LIGHT
372
SET MACH. ERROR FLAG AND BLINK SERVICE LIGHT
384
342
MODE KEY ACTUATED ?
NO
YES
344
CLEAR ERROR FLAG

FIG. 6C

FIG. 7

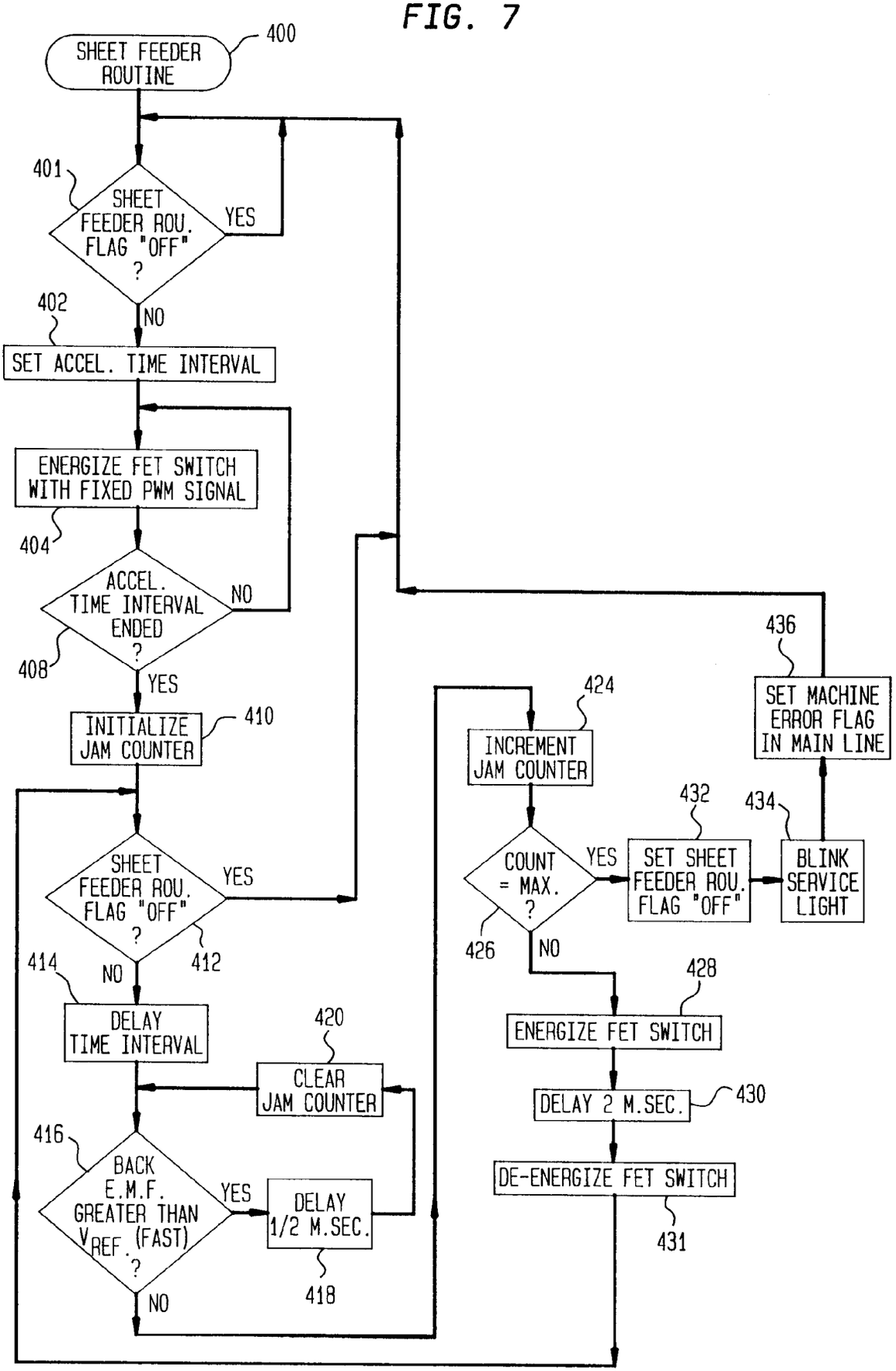

SHEET FEEDER ROUTINE
400
401
SHEET FEEDER ROU. FLAG "OFF" ?
YES
NO
402
SET ACCEL. TIME INTERVAL
ENERGIZE FET SWITCH WITH FIXED PWM SIGNAL
404
ACCEL. TIME INTERVAL ENDED ?
NO
408
YES
INITIALIZE JAM COUNTER
410
SHEET FEEDER ROU. FLAG "OFF" ?
YES
412
414
NO
DELAY TIME INTERVAL
420
CLEAR JAM COUNTER
416
BACK E.M.F. GREATER THAN $V_{REF.}$ (FAST) ?
YES
DELAY 1/2 M.SEC.
418
NO
424
INCREMENT JAM COUNTER
COUNT = MAX. ?
YES
426
NO
432
SET SHEET FEEDER ROU. FLAG "OFF"
434
BLINK SERVICE LIGHT
436
SET MACHINE ERROR FLAG IN MAIN LINE
428
ENERGIZE FET SWITCH
DELAY 2 M.SEC.
430
DE-ENERGIZE FET SWITCH
431

FIG. 8

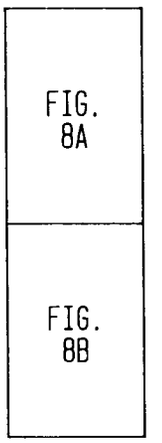
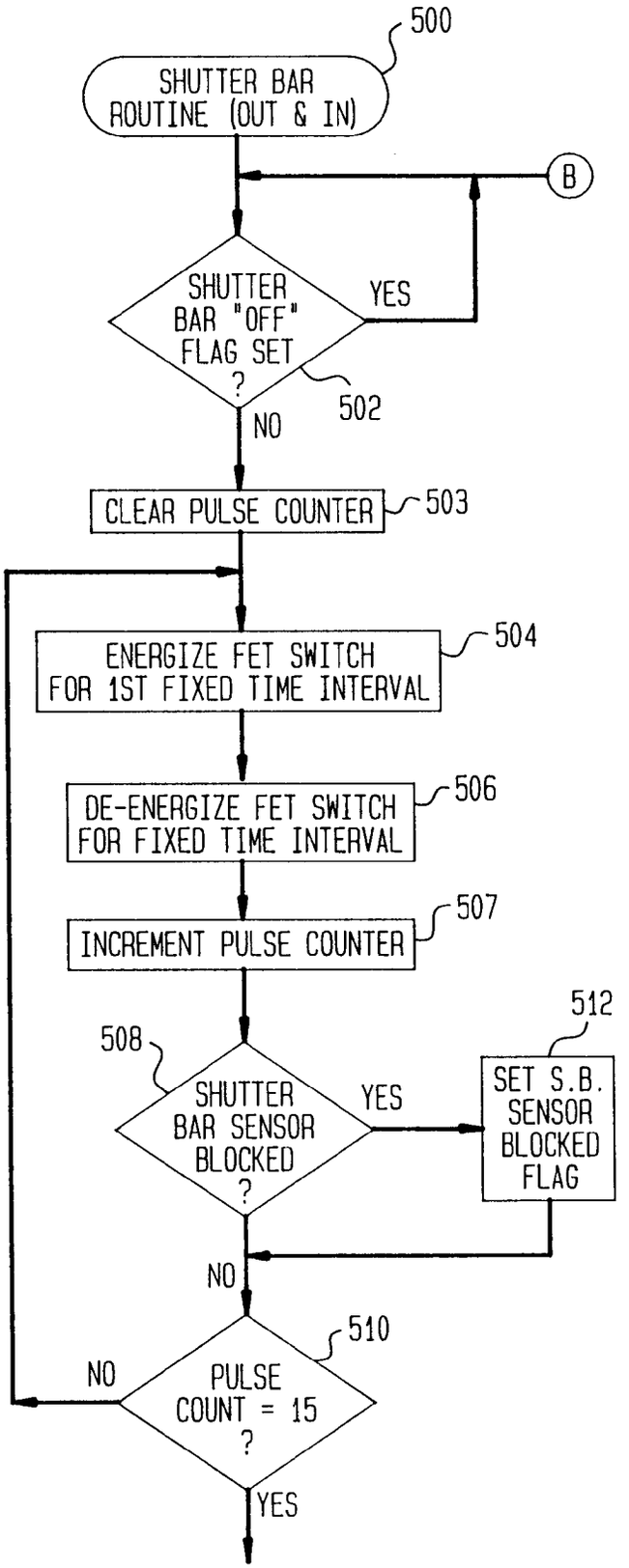

FIG.
8A
FIG.
8B

FIG. 8A


500
SHUTTER BAR ROUTINE (OUT & IN)
B
SHUTTER BAR "OFF" FLAG SET ?
YES
502
NO
CLEAR PULSE COUNTER
503
ENERGIZE FET SWITCH FOR 1ST FIXED TIME INTERVAL
504
DE-ENERGIZE FET SWITCH FOR FIXED TIME INTERVAL
506
INCREMENT PULSE COUNTER
507
508
SHUTTER BAR SENSOR BLOCKED ?
YES
512
SET S.B. SENSOR BLOCKED FLAG
NO
510
NO
PULSE COUNT = 15 ?
YES

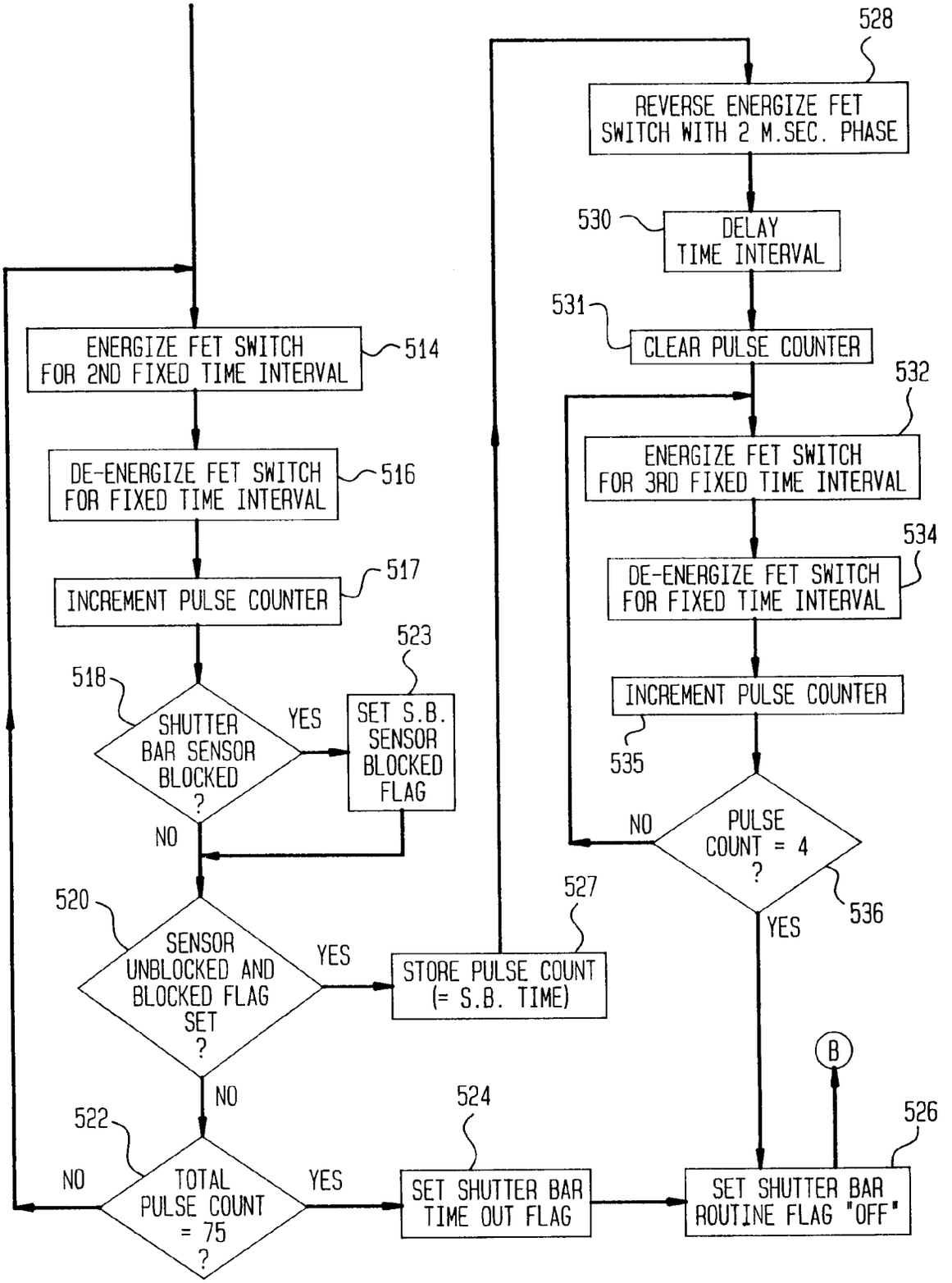

ENERGIZE FET SWITCH FOR 2ND FIXED TIME INTERVAL
514
DE-ENERGIZE FET SWITCH FOR FIXED TIME INTERVAL
516
INCREMENT PULSE COUNTER
517
518
SHUTTER BAR SENSOR BLOCKED ?
YES
523
SET S.B. SENSOR BLOCKED FLAG
NO
520
SENSOR UNBLOCKED AND BLOCKED FLAG SET ?
YES
527
STORE PULSE COUNT (= S.B. TIME)
NO
522
TOTAL PULSE COUNT = 75 ?
NO
YES
524
SET SHUTTER BAR TIME OUT FLAG
528
REVERSE ENERGIZE FET SWITCH WITH 2 M.SEC. PHASE
530
DELAY TIME INTERVAL
531
CLEAR PULSE COUNTER
532
ENERGIZE FET SWITCH FOR 3RD FIXED TIME INTERVAL
534
DE-ENERGIZE FET SWITCH FOR FIXED TIME INTERVAL
INCREMENT PULSE COUNTER
535
PULSE COUNT = 4 ?
NO
YES
536
B
526
SET SHUTTER BAR ROUTINE FLAG "OFF"

FIG. 8B

FIG. 9

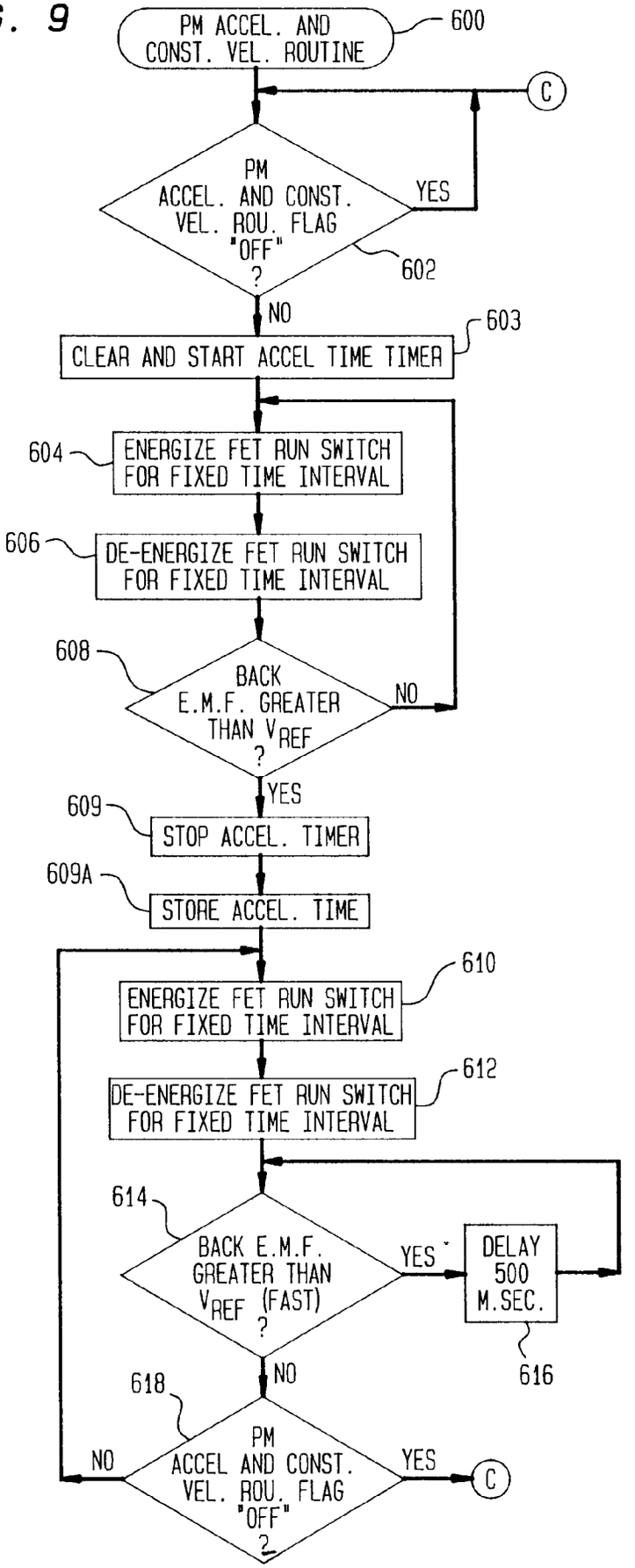
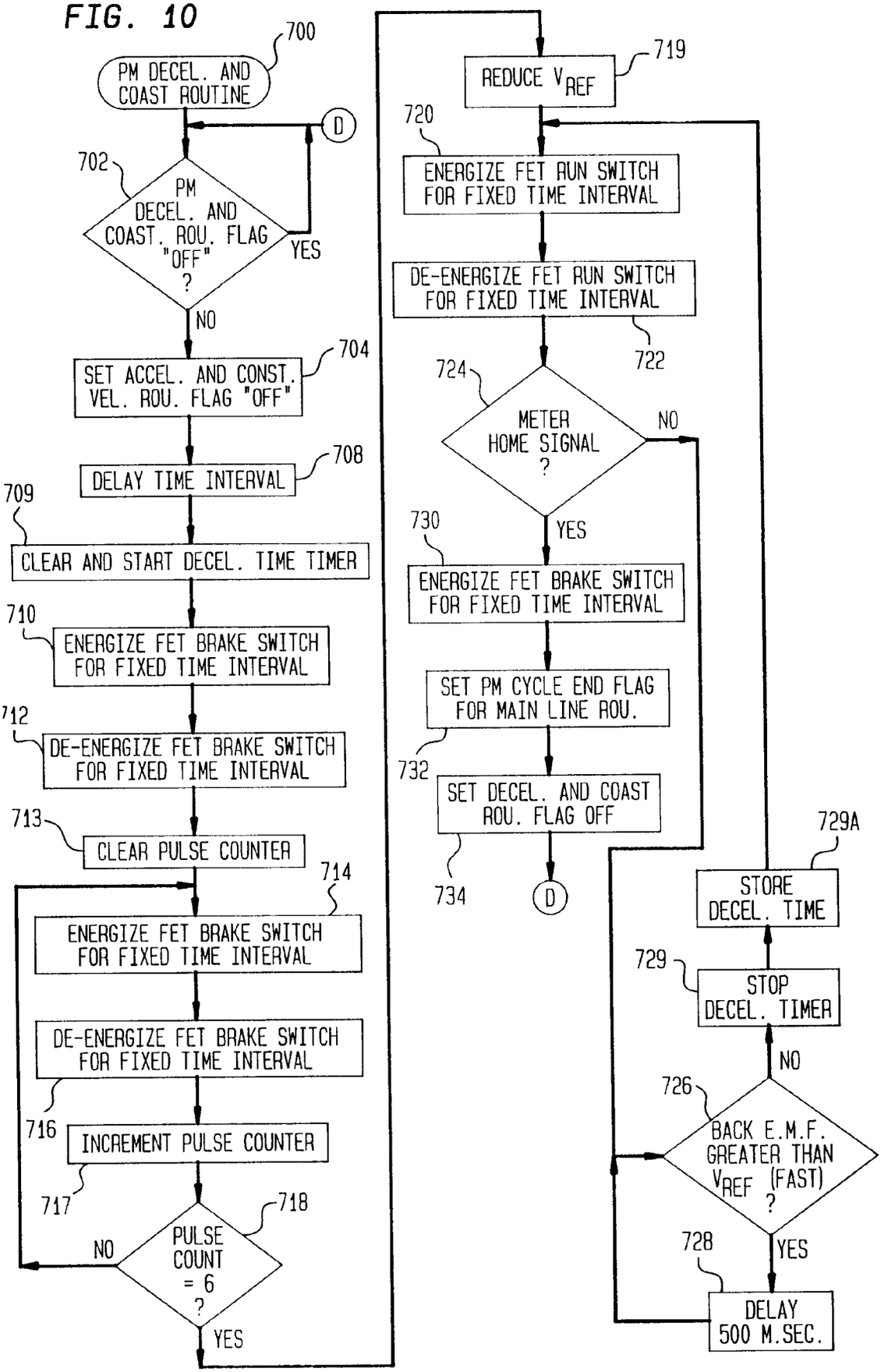

PM ACCEL. AND CONST. VEL. ROUTINE
600
C
PM ACCEL. AND CONST. VEL. ROU. FLAG "OFF" ?
YES
602
NO
603
CLEAR AND START ACCEL TIME TIMER
604
ENERGIZE FET RUN SWITCH FOR FIXED TIME INTERVAL
606
DE-ENERGIZE FET RUN SWITCH FOR FIXED TIME INTERVAL
608
BACK E.M.F. GREATER THAN V_{REF} ?
NO
YES
609
STOP ACCEL. TIMER
609A
STORE ACCEL. TIME
610
ENERGIZE FET RUN SWITCH FOR FIXED TIME INTERVAL
612
DE-ENERGIZE FET RUN SWITCH FOR FIXED TIME INTERVAL
614
BACK E.M.F. GREATER THAN V_{REF} (FAST) ?
YES
DELAY 500 M.SEC.
616
NO
618
PM ACCEL AND CONST. VEL. ROU. FLAG "OFF" ?
NO
YES
C

FIG. 10


700
PM DECEL. AND COAST ROUTINE
D
702
PM DECEL. AND COAST. ROU. FLAG "OFF" ?
YES
NO
704
SET ACCEL. AND CONST. VEL. ROU. FLAG "OFF"
708
DELAY TIME INTERVAL
709
CLEAR AND START DECEL. TIME TIMER
710
ENERGIZE FET BRAKE SWITCH FOR FIXED TIME INTERVAL
712
DE-ENERGIZE FET BRAKE SWITCH FOR FIXED TIME INTERVAL
713
CLEAR PULSE COUNTER
714
ENERGIZE FET BRAKE SWITCH FOR FIXED TIME INTERVAL
DE-ENERGIZE FET BRAKE SWITCH FOR FIXED TIME INTERVAL
716
INCREMENT PULSE COUNTER
717
718
PULSE COUNT = 6 ?
NO
YES
719
REDUCE V_{REF}
720
ENERGIZE FET RUN SWITCH FOR FIXED TIME INTERVAL
DE-ENERGIZE FET RUN SWITCH FOR FIXED TIME INTERVAL
722
724
METER HOME SIGNAL ?
NO
YES
730
ENERGIZE FET BRAKE SWITCH FOR FIXED TIME INTERVAL
SET PM CYCLE END FLAG FOR MAIN LINE ROU.
732
SET DECEL. AND COAST ROU. FLAG OFF
734
D
729A
STORE DECEL. TIME
729
STOP DECEL. TIMER
NO
726
BACK E.M.F. GREATER THAN V_{REF} (FAST) ?
YES
728
DELAY 500 M.SEC.