

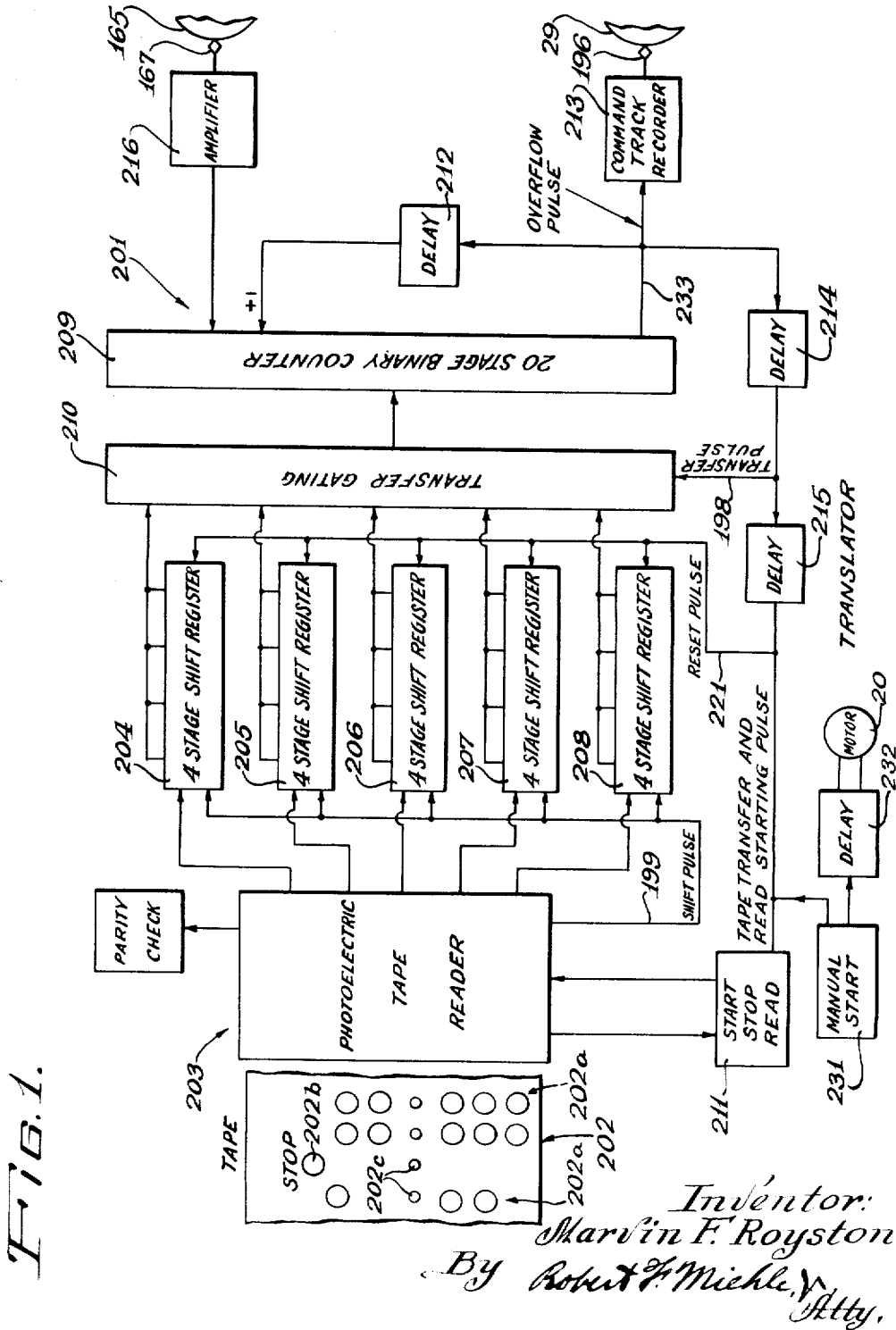
Feb. 16, 1965

M. F. ROYSTON
TRANSLATOR SYSTEM

3,170,143

Filed Aug. 8, 1960

6 Sheets-Sheet 1



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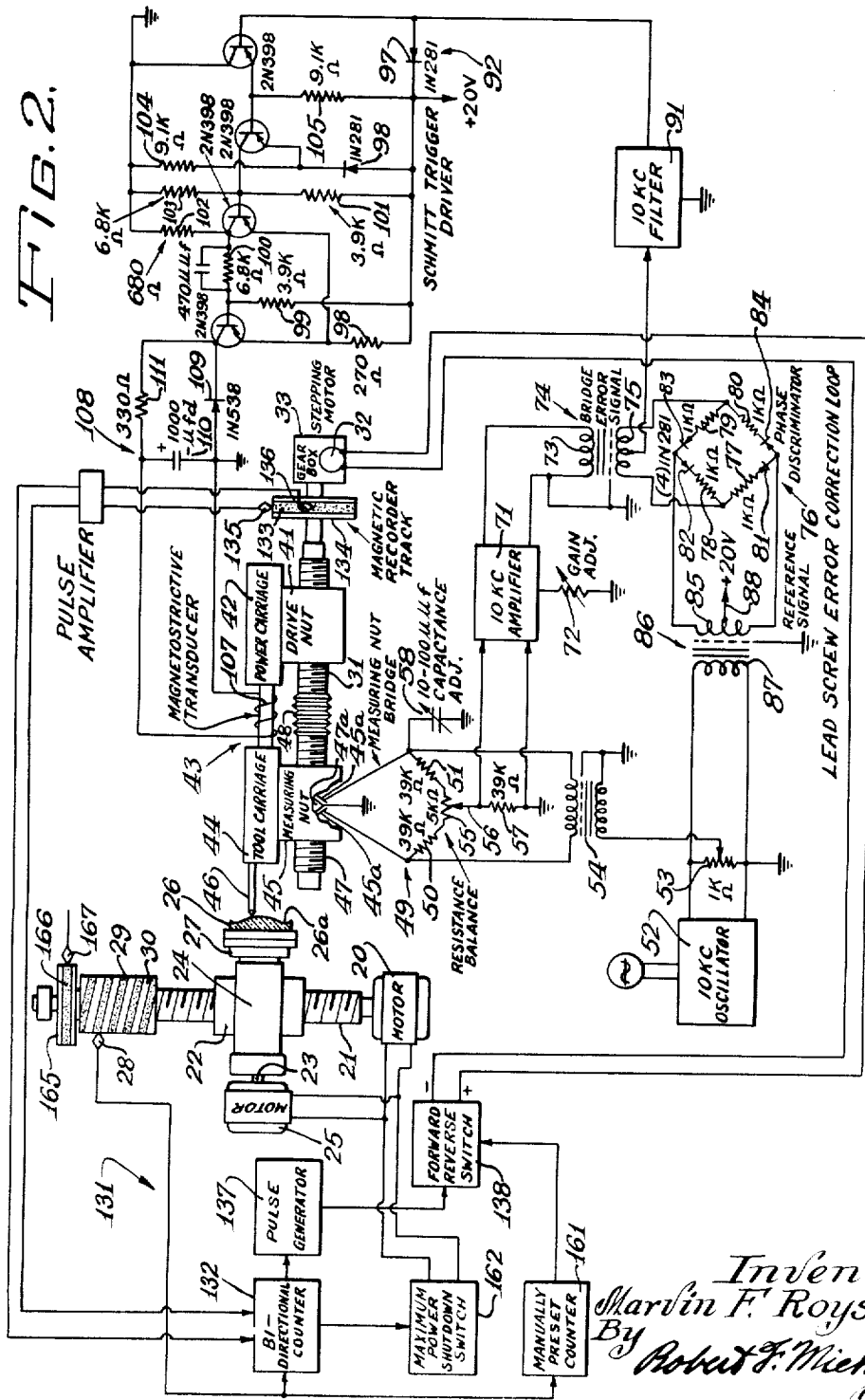
M. F. ROYSTON

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TRANSLATOR SYSTEM

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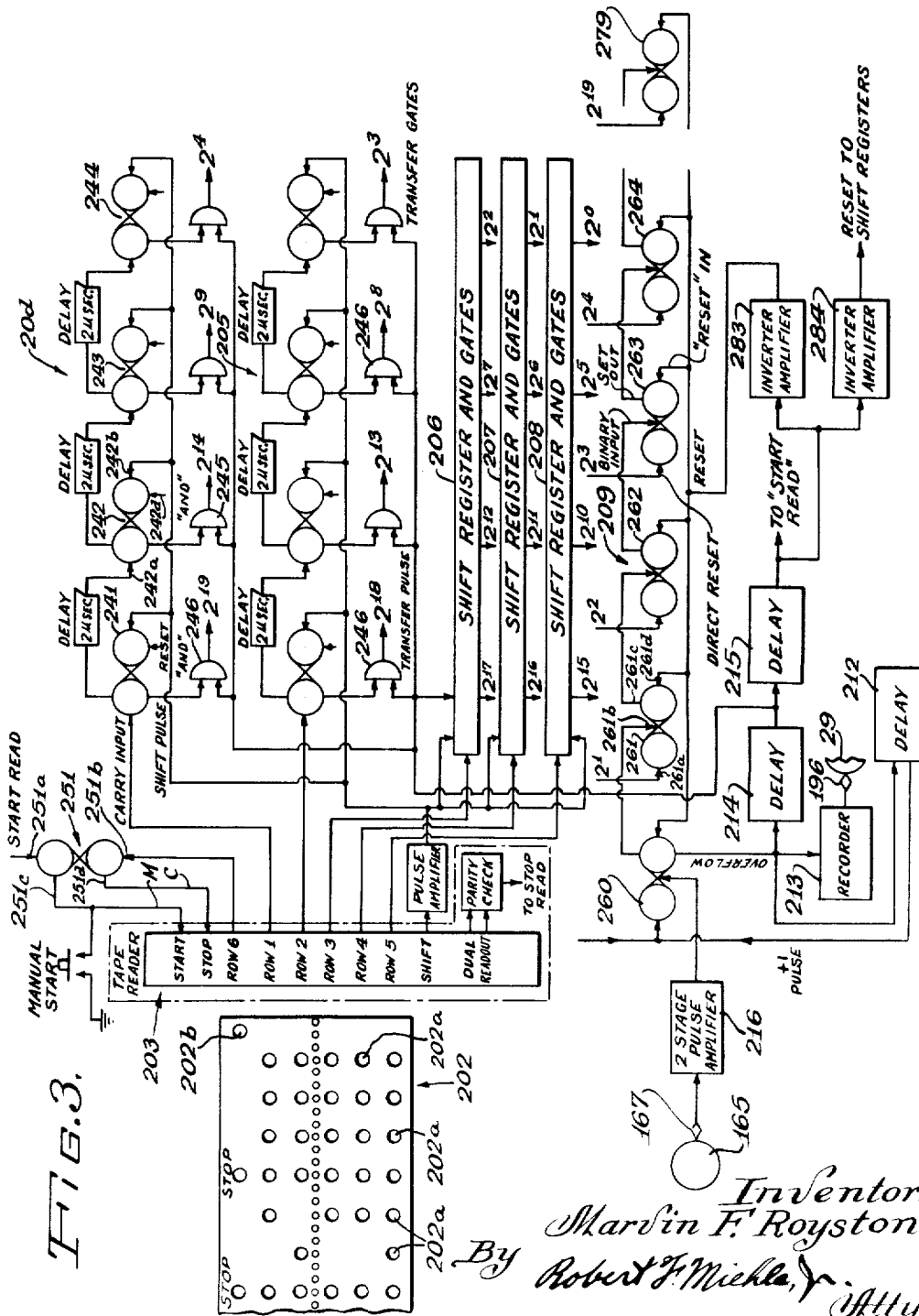
M. F. ROYSTON

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TRANSLATOR SYSTEM

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6 Sheets-Sheet 3



Inventor:
Marvin F. Royston
By Robert F. Miehle, Jr. Atty.

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M. F. ROYSTON
TRANSLATOR SYSTEM

3,170,143

Filed Aug. 8, 1960

6 Sheets-Sheet 4

Fig. 4.

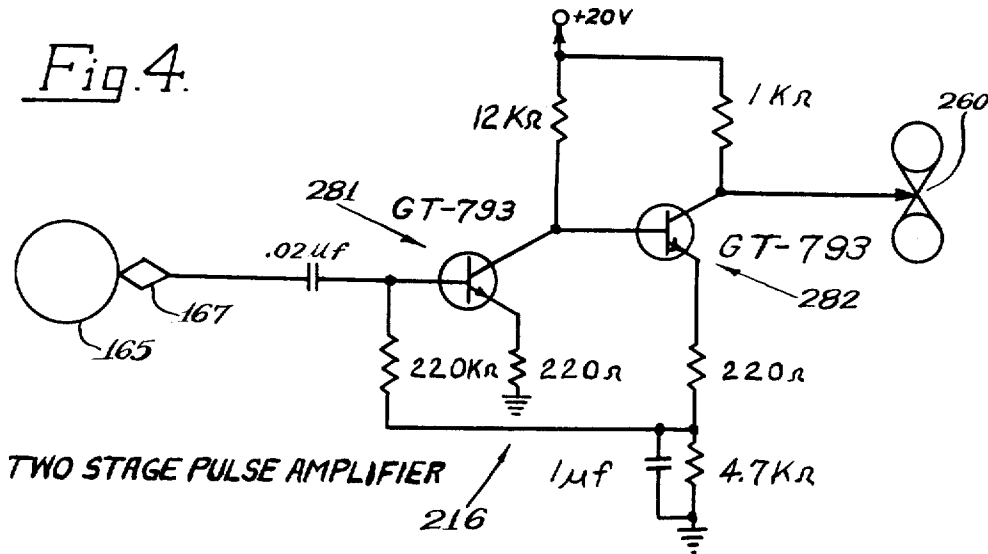
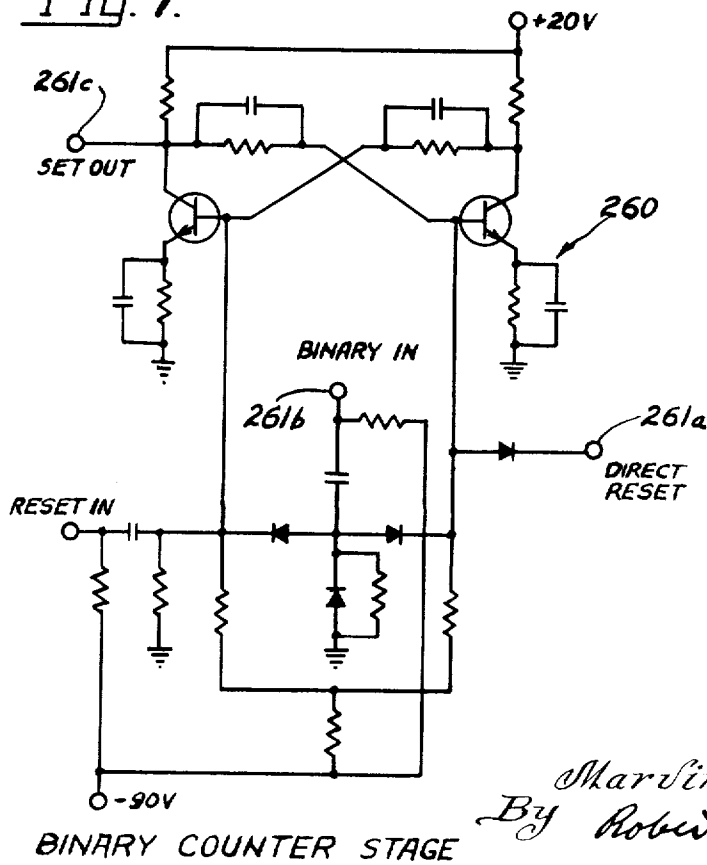


Fig. 7.



Inventor:
Marvin F. Royston
By Robert F. Mickle
Atty.

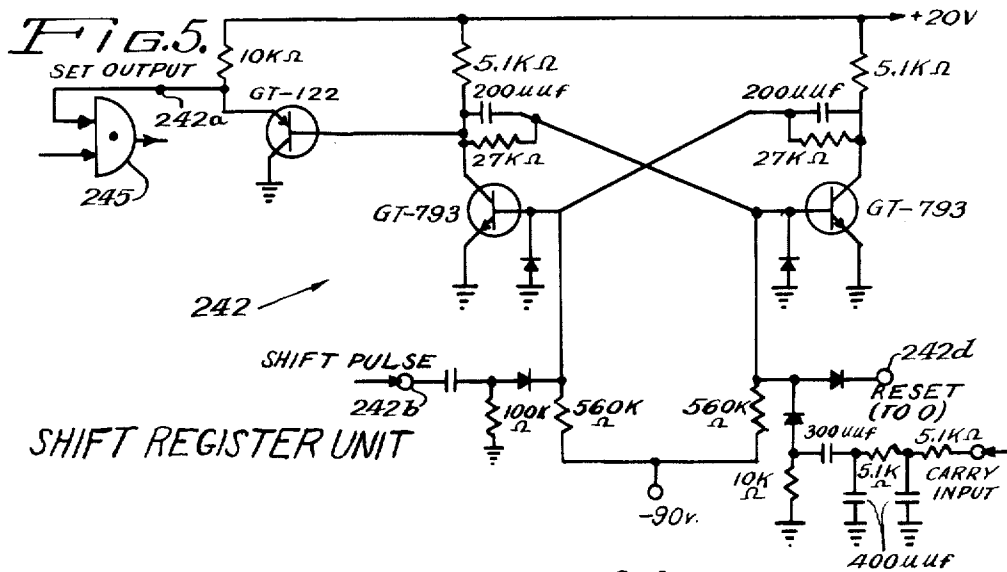
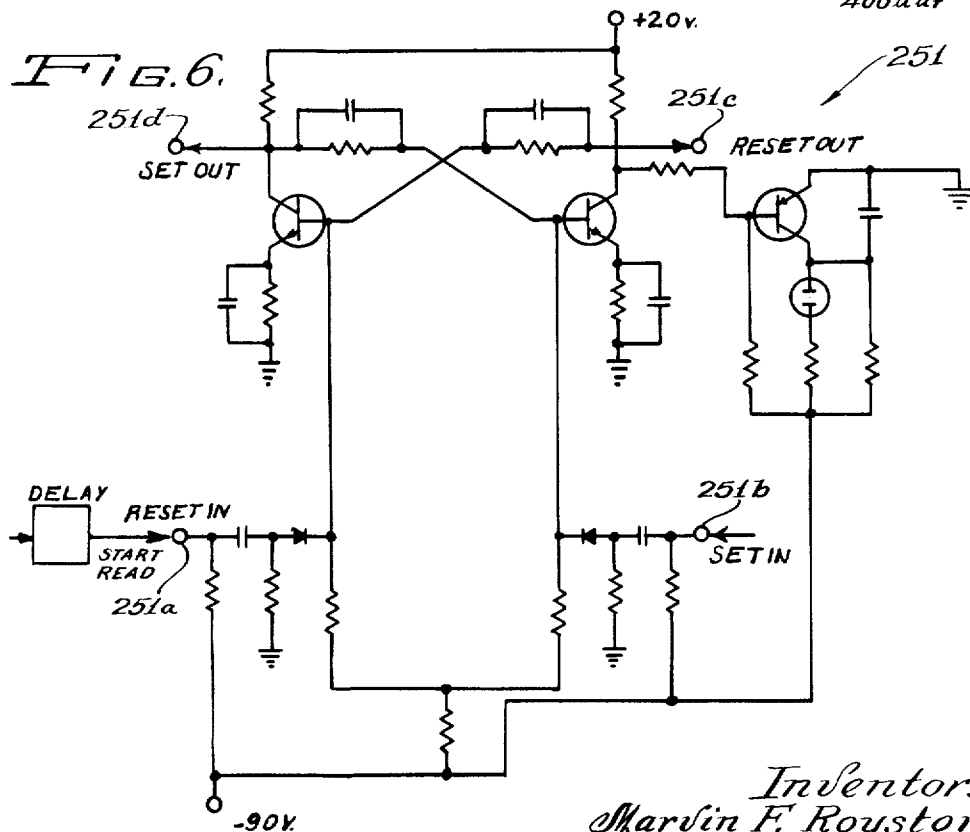
Feb. 16, 1965

M. F. ROYSTON
TRANSLATOR SYSTEM

3,170,143

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6 Sheets-Sheet 5



START-STOP By *Robert F. Mickle*,
Inventor: *Marvin F. Royston*
Atty.

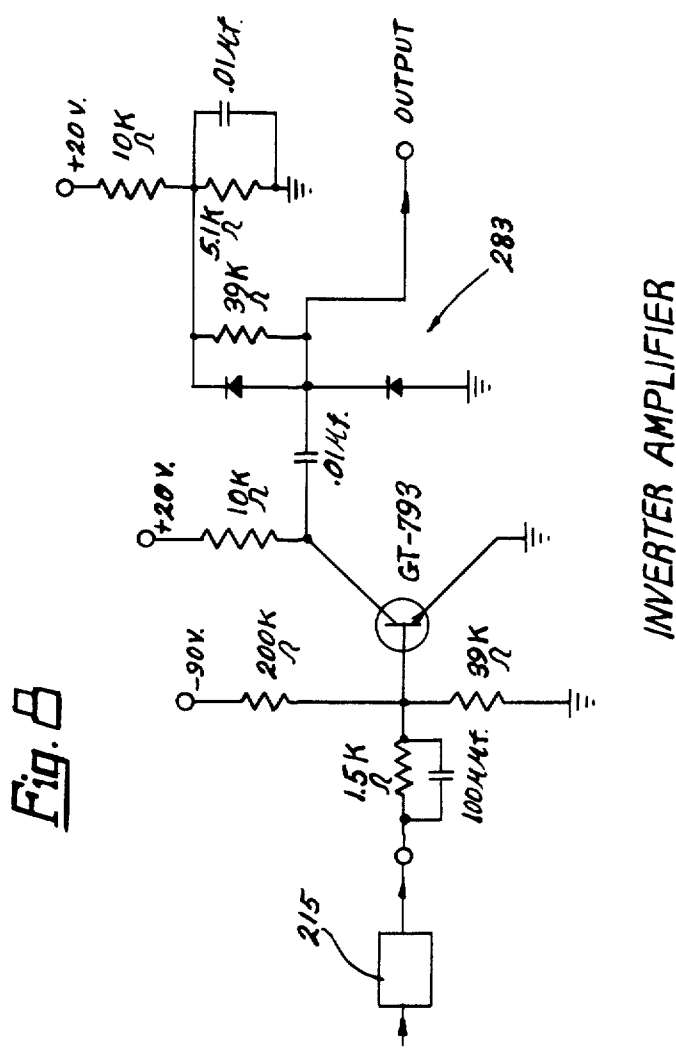
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M. F. ROYSTON
TRANSLATOR SYSTEM

3,170,143

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6 Sheets-Sheet 6



Inventor:
Marvin F. Royston
By Robert F. Mickle, Atty.

1

3,170,143

TRANSLATOR SYSTEM

Marvin F. Royston, Skokie, Ill., assignor to Bell & Howell Company, Chicago, Ill., a corporation of Illinois
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7 Claims. (Cl. 340-172.5)

This invention relates to a translator system, and more particularly to translator circuitry for setting up signal pattern controlled machines.

An object of the invention is to provide a translator system for magnetically recording a pattern of machine controlling pulses onto a magnetic strip of the machine.

Another object of the invention is to provide a translator for recording pulses on a drum of a work feeding screw of a machine for grinding a lens blank, the pulses to be used in the operation of the machine to actuate the tool feed of the machine, the pulses being generated by a code perforated tape resulting from a ray tracing computing machine.

A complete understanding of the invention may be obtained from the following detailed description of a translator system forming a specific embodiment thereof, when read in conjunction with the appended drawings, in which:

FIG. 1 is a block diagram view of a translator system forming one embodiment of the invention;

FIG. 2 is a schematic view of a lens grinding machine which is to be set up by signals from the translator system of FIG. 1;

FIG. 3 is a block diagram view of the translator system of FIG. 1 shown in greater detail; and

FIGS. 4 to 8 show detailed wiring diagrams of components of the translator system.

The invention provides a translator system operable by a coded perforated tape to record magnetic pulses on a magnetic drum of a feed screw lens grinding machine. The translator system is actuated by the tape through a tape reader and by equally spaced pulses from a magnetic track on a disc rotated by the feed screw to record pulses on the drum for selected numbers of pulses. The tape sets up a counter through a shift register or memory circuit to send a pulse upon the occurrence of a predetermined number of pulses from the disc. The pulse actuates a recorder to record a pulse on the drum, and also actuates gating to transfer subsequently stored pulses from the shift register to the counter and actuates the tape reader to advance the tape one word, and the reader sends selected pulses according to that word to the shift register.

Referring now in detail to the drawings, there is shown in FIG. 2 a motor 20, which is to rotate a very accurate work screw 21 continuously at a predetermined rate of speed. The screw extends along what may be termed the X axis. Rotation of the screw advances a work carriage 22 along the X axis, and the carriage carries a spindle 23 thereon in a bearing structure 24 together with a spindle driving motor 25 to rapidly rotate the spindle together with a lens blank 26 carried by a blocking member or work holder 27 centered on and fixed rigidly to the spindle. As the carriage 22 is moved along the screw 21, a magnetic player head 28 carried by the carriage travels along a helical magnetic record track 29 on a drum 30 fixed to and rotated by the screw 21. The pitch of the track 29 is identical with the pitch of the screw 21, and recorded pulses are spaced along the track in a predetermined pattern. These pulses are designated as command pulses and as each of these pulses is picked up by the head 28, a drive screw 31 is caused to be rotated through a predetermined small angle by a known stepping motor 32 and known reduction gearing 33. The

2

drive screw is very precise and has an error within known limits.

The drive screw 31, when rotated, serves to drive a drive nut 41 along an axis which is designated the Y axis and is transverse to the X axis. The drive nut is rigidly connected to a power carriage 42, which is rigidly connected by a magnetostrictive transducer device 43 to a tool carriage 44. The tool carriage 44 carries a measuring nut 45 and a known abrading tool 46 rigidly thereon. The tool 46 may be non-rotating as shown or may be rotated by a motor (not shown) on the tool carriage. The measuring nut 45 extends along a portion of a measuring screw 47, and, with the screw 47, forms an electrostatic screw measuring device of the type disclosed and claimed in co-pending application Serial No. 824,665, filed July 2, 1959, now Patent No. 3,030,578 issued April 17, 1962 by Gerhard Lessman and assigned to the common assignee. The measuring screw is aligned with the drive screw 31 and is drivingly connected thereto by a bellows coupling 48. The pitches of the threads of the screws 31 and 47 and the nuts 41 and 45 are equal.

Threads 47a of the screw 47 and 45a of the nut 45 overlap one another and form two capacitors which are connected in adjacent arms of a bridge circuit 49. The capacitances of these two capacitors are equal only when the nut 45 is in the desired position thereof along the screw 47 and when the nut is in a position shifted along the screw 47 from its desired position, one of the capacitors increases in capacitance and the other decreases, both changes being proportional to the square of the distance of shift or longitudinal decentering. The bridge circuit 49 also includes equal resistors 50 and 51 in its other arms and is supplied with power from an oscillator 52, a voltage divider 53 and a transformer 54. The bridge also includes a trimming or balancing variable resistor 55 whose contactor 56 is connected to voltage divider 57 forming the output of the bridge circuit and receiving any error output from the bridge circuit due to any occurring inequality of the pair of capacitors formed by the threads 45a and 47a. An adjustable balancing capacitor 58 is connected between one corner of the input of the bridge circuit and ground.

Any error output of the bridge circuit 49 is fed to a known amplifier 71 adapted to amplify ten kilocycle frequency signals and having a rheostat 72 for initially adjusting the gain thereof. The amplified error signal is fed to a winding 73 of a transformer 74 which also has a center tapped winding 75. The center tapped winding 75 has its ends connected to a phase discriminator circuit 76 including resistors 77 to 80 and rectifiers 81 to 84 and connected at its input to center tapped secondary winding 85 of transformer 86, primary winding 87 thereof being supplied by the oscillator 52. The center of the winding 85 is supplied with a constant positive D.C. voltage by conductor 88 leading to a known D.C. source (not shown). The phase discriminator circuit serves to detect the error signal by the phase difference between the reference signal and the error signal. An input diode 97 cancels out any signal from the bridge circuit which is due to lead of nut 44 from its desired centered position when the nut 45 is being driven to the left as viewed in FIG. 2.

The lag and lead error signals are fed with the ten kilocycle frequency reference signal to a ten kilocycle filter 91 which filters out the reference signals leaving only the amplified error signal which then is fed to a trigger circuit 92. The trigger circuit includes transistors 93 to 96, diode rectifiers 97 and 98, resistors 99 to 105 and a capacitor 106. The trigger circuit is turned on when the D.C. input thereto rises above its threshold voltage. The output of the trigger circuit is applied to a winding 107 of the transducer 43 by means of a resistance-capacitance

network 108 and a rectifier 109, which protects the circuit 92 from transients. The network 108 includes capacitor 110 and resistor 111 and serves to slow and prolong the application of the error correcting power to the transducer 43. The transducer 43 corrects the error.

Synchronization of the drives of the feed screws 21 and 31 is effected by a numerical control system 131 driving the screw 31 in response to command signals caused by selected rotations of the screw 21. The control system is disclosed in detail and certain features thereof are claimed in co-pending application Serial No. 47,993, filed by Du Wayne E. Stevens on the same date as the present application, now Patent No. 3,075,095 issued January 22, 1963 and assigned to the common assignee. The command pulses recorded on the helical magnetic track 29 are spaced apart selected angles according to the desired pattern.

The playback head 28 is carried with the carriage 22 so that it is maintained in engagement with the helical track, and as each recorded pulse on the track 29 comes to the head 28, the pulse is fed to a bi-directional counter 132. Sine wave slave pulses are recorded on a track 133 on drum or disc 134 fixed to the screw 31. The sine wave is such that each crest is spaced from the succeeding (or preceding) crest the same predetermined angle which is equal to four times the angle through which the screw 31 is turned upon each stepping of the motor 32, which angle of screw movement moves the tool 46 a distance of about 0.6 micro-inch along the Y axis. Each time either a trailing edge or a leading edge of the sine wave on the track 133 travels past either playing magnetic head 135 or playing magnetic head 136, it sends a monitor or response pulse to the counter 132.

When the counter 132 has received a command pulse from the head 28, the counter 132 actuates a pulse generator 137 to actuate an electronic switching circuit 138 to send a driving pulse to the stepping motor 32 to step the drive screw 31 through an angle corresponding to one quarter of the angle subtended by one cycle of the sine wave on the disc 134. The command pulses from the track 29 represent predetermined distances of travel of the work or blank 26 along the X axis. Then the counter 132 receives a monitor pulse from one of heads 135 and 136, and stops the motor 32.

To reverse the direction of travel of the tool 46 along the Y axis at a predetermined point in the cutting or turning operation, an electronic settable counter 161 is provided. The counter 161 receives each monitor pulse from the track 29, and after the number of pulses for which the counter 161 is set has been received by the counter 161, it actuates the switch 138 to reverse the polarity of the driving pulses to the motor 32 to thereby reverse the direction of drive of the drive screw 31. Then for each command pulse received by the counter 132, the motor 32 is stepped to move the tool 46 to the right, as viewed in FIG. 2, and then stopped by the subsequent response pulse.

The function of the monitor or response pulses from the disc 133 is to stop the motor 32 after the lead screw 31 has been rotated through the desired angle for one command pulse. If a predetermined number of successive command pulses are received by the counter 132 with no intervening monitor pulse, the counter 132 pulses a shutdown switch 162 to shut off power from the motors 20 and 25. Likewise, if a lag of two successive monitor pulses are applied to the counter 132 with no intervening command pulse, the counter 132 sends an actuating pulse to stop further actuation of motor 32 until another command signal is received.

To initially record the pulse producing signals on the magnetic track 29 in the desired pattern to cause the machine to produce the aspheric curve 26a, there may be utilized a translator 201 shown in FIG. 1 and forming one embodiment of the invention. The translator is actuated by a tape 202 perforated in binary coded words 202a to cause electromagnetic pulses in a known magnetic re-

corder 213 which has a recorder head 196 in the position of the head 28 to be recorded on the track 29 of the drum 30. The translator is set up by the tape to record a command pulse to the track 29 when the translator receives a selected number of pulses from a set up disc 165 having a magnetic recorder track 166 and a playback head 167. The disc 165 is keyed to the screw 21 (FIG. 2) and the track 166 has a recording thereon which produces an output pulse in playback head 167 each time the screw 21 turns through a predetermined angle. The perforated tape 202 (FIG. 1) sets up the translator so that with the pulses from the disc 165, the selected pulse-producing pattern on the track 29 is effected. The pulses from the disc 165 may be considered as counter pulses, one pulse for each angular increment of the screw 21 (FIG. 1) through a very small predetermined angle. The translator is actuated by the perforated tape to record the command pulses on the track 29 after receiving selected numbers of counter pulses from the disc 165, the number of counter pulses for each succeeding output pulse being determined by the perforated tape to produce the desired pattern of spacing of the pulses on the track 29.

The binary perforated paper tape 202 is produced by a known lens design computer and contains binary coded information. Each word 202a of information contains the total number of pulses which, added to a selected number of pulses from equally spaced pulses on the disc 165, cause a command pulse to be recorded on the drum 29. The first line on the tape contains the binary numbers from 2^0 to 2^4 , the second line up to 2^8 , and so on. One row 202b is reserved for the stop code at the end of each word. A known photo-electric tape reader 203 having a head (not shown) uses silicon readout cells for maximum reliability. Upon initiating a "start read" signal from known circuit 211, the reader moves the tape 202 to the first line of holes of the word 202a. The stop control of the reader utilizes the smaller sprocket holes 202c to insure proper alignment of the larger holes for readout. The readout signals are impressed on the "set" side of the first flip-flop circuits in the first of five known four-stage shift registers 204 to 208. The shift signal pulse along path 199 then transfers this data to the second stage flip-flop circuit and the tape 202 moves to the second line of the word. This procedure repeats itself until the entire word has been read out and all the data stored in the proper register. The data is now transferred into a known twenty-stage binary counter 209 by a transfer pulse applied to known transfer gate 210 along path 198. Since the data stored in each stage of the register is unrelated to its adjacent stages, it is then transferred to the proper stage of the counter 209 to again form the exact numerical figure as was punched in the word 202a of the tape 202. The data is transferred in parallel via the transfer gate 210. The transfer signal or pulse is also delayed in time and sent along path 221 to reset the registers 204 to 208, after they have emptied, and to start the tape reader by means of the control circuit 211 to advance the tape 202 to another word 202a, read out and store the second word of information. Meanwhile, the feed screw 21 (FIG. 2) is rotated to rotate disc 165 which has equally spaced magnetic pulses on the periphery thereof and the playback or read head 167 and a known amplifier 216 transfers the pulses into the counter 209 serially. The actual information transferred into the counter 209 by the disc 165 is the complement of the number concerned and the pulses from the disc 165 add to this complement to fill up the counter 209. The extra one pulse needed to overflow the counter 209 to give a pulse output at the last stage is obtained from delayed transfer pulse circuit 212 and is fed into the first stage of the counter 209 from the preceding pulse to the recorder 213. Upon completion of the count, the overflow pulse is sent to the command track recorder 213 and is recorded on the magnetic drum 29. This latter overflow pulse also

is delayed in time by delay circuits 212, 214 and 215 and becomes the next transfer pulse, reset pulse, and the start-read signal or pulse to the tape reader 203. Sufficient delay times are used to insure proper timing.

In starting the translator 201, a known manual start circuit 231 is actuated manually to actuate the circuit 211 to start the reader 203 to feed the tape 202 there-through and read the first word 202a. Simultaneously the circuit 231 actuates a known delay circuit 232 to the motor 20. At this time an actuating pulse is on conductor 233 to record a zero command pulse on the drum 29, and send a pulse to delay circuits 212 and 214. After pulses from the first word 202a have been stored in the shift registers or memory circuits, the delay circuit 214 sends the transfer pulse to the gate 210 and to delay circuit 215. The gate 210 then transfers rapidly all the pulses from the circuits 204 to 208 to the counter 209, and then the delay circuit 215 sends a pulse which resets the registers 204 to 208 and actuates the reader 203 to start moving the tape 202 and read the second word 202a. Meanwhile, just after the shift registers have fully emptied into the counter circuit 209, the delay circuit 232 starts the motor 20, which drives the screw 21 (FIG. 2) to rotate the disc 165 and pulses from the disc 165 are applied to the counter 209 to fill the counter with pulses. Just after the shift registers empty into the counter 209, the delay circuit 212 sends the plus one pulse to the counter 209. Then when sufficient pulses from the disc 165 actuate the counter 209, the counter 209 overflows to send an overflow pulse to the recorder 213. Meanwhile the reader 203 has read the second word, and it is then transferred from the registers 204 to 208 to the counter 209 by the delay circuit 214. The pulsing of delay circuit 214, its delay and transfer pulsing, and the complete transfer of the pulses from the registers 204 to 208 are effected between adjacent pulses from the disc 165. The output pulse from delay circuit 214 also actuates the delay circuit 215 to reset the registers after they have been emptied and actuate the reader starting circuit 211 to start the reading of the third word 202a while the counter circuit 209 is being filled or counted down by pulses from the disc 165. This procedure is repeated until the command pulses all are recorded on the drum 29. Then the playback head 28 is substituted for the recording head 196 and the machine shown in FIG. 2 then is ready for operation.

In FIG. 3, the circuitry is shown in more detail. The reader 203 may be obtained commercially, one suitable reader being a type 196 reader sold by Feranti-Packard, Limited. The shift registers 204 and 208 are identical in construction so only register 204 will be described in detail. The register 204 includes four binary counter stages 241 to 244 identical in construction. The stage 242 is typical of the stages and has "CARRY" input terminal 242a (FIGS. 3 and 5), "SHIFT" input terminal 242b, "OUTPUT" terminal 242c to "AND" gate 245, "RESET" terminal 242d and a delay circuit 242e. The stages 241 to 244 may be commercially available units, one such unit being model SF-101 available from Computer Control Corporation. Similarly "AND" gates 245 and 246 are well known commercially available units. A "START-STOP" control 251 for the reader 203 is shown in FIGS. 3 and 6 and has input terminals 251a and 251b and output terminals 251c and 251d. The control 251 may be the circuit unit model FF-103 of the Computer Control Corporation.

The counter 209 includes stages 260 to 279, which are identical to one another and are available commercially, one being model FF-103 of the Computer Control Corporation. The stage 261 is shown in detail in FIG. 7 and has input terminals 261a and 261b, output terminal 261c and reset to zero terminal 261d. In FIG. 4 there is shown in detail the first two stages 281 and 282 of the amplifier 216 which also has further stages of known

types (not shown). Also shown in FIGS. 3 and 8 are identical inverter-amplifiers 283 and 284 for amplifying the output of delay circuit 215 for resetting the shift registers and the transfer gates 260 to 279.

Certain features of the above described machine are disclosed and claimed in co-pending application Serial No. 48,024, filed on the same day as this application by Gerhard Lessman and assigned to the common assignee and now Patent No. 3,085,371, issued April 16, 1963, and co-pending application Serial No. 47,992, filed on the same day as this application by Marvin F. Royston and assigned to the common assignee and now Patent No. 3,065,578, issued November 27, 1962.

While the invention is thus described, it is not wished to be limited to the precise details described, as changes may be readily made without departing from the spirit of the invention.

What is claimed is:

1. In a translator system, advancing means for moving a record track along a predetermined path, a recorder operable by an actuating pulse to record a command pulse on the record track, a counter adapted to supply an actuating pulse to the recorder after receiving a predetermined number of pulses, means responsive and synchronized with the advancing means for supplying said last mentioned pulses to the counter in accordance with the extent of movement of the track, and pattern controlled means for supplying pulses in a pattern sequentially to the counter to apply said command pulses to the record track in accordance with said pattern.

2. In a translator system for recording pulses in a predetermined pattern on a helical recording track keyed to and rotated by a feed screw, a pulse-producing device driven in synchronism with the feed screw and supplying pulses to a counting means in proportion to the extent of rotation of the feed screw, said counting means being responsive to pulses from the pulse-producing device for applying a pulse to the track each time the counting means counts out, and means for sequentially setting the counting means to count out at different counts.

3. In a translator system, a counter adapted when pulsed a predetermined number of times to produce a recording pulse, means operable by each recording pulse for recording a command pulse on a helical recording track rotated by a feed screw, a coded tape, a tape reader for reading "words" recorded on the tape and producing a selected number of pulses for each "word," means for applying the pulses produced from one "word" to the counter, and a pulse-producing device driven by the feed screw for applying pulses to the counter in accordance with the rotation of the feed screw to cause the counter to produce a recording pulse.

4. The translator of claim 3 wherein the pulse-producing device includes a disc having a record track thereon having equally spaced pulses therealong, and playback means for reproducing the pulses from the record track of the disc and applying them to the counter.

5. In a translator system for recording pulses in a predetermined pattern on a helical record track rotated by a feed screw, a recording head movable along the track by the screw, a tape reader adapted to advance a code perforated tape one "word" and stop and convert the "word" into a selected number of pulses and operable to repeat when pulsed, shift register means for receiving and storing pulses from the reader and resettable when pulsed, a counter adapted to produce an output pulse when pulsed a predetermined number of times plus one, transfer gating means adapted when pulsed to transfer the pulses from the shift register means to the counter, a pulse-producing device for supplying pulses to the counter proportionally to the amount of rotation of the feed screw to cause the counter to produce an output pulse, means responsive to each output pulse for actuating the recording head to record a pulse on the helical record track, first delay means operable by each output pulse to actu-

ate the transfer gating means to transfer the pulses from the shift register means to the counting means, second delay means operable by the first delay means to pulse the shift register means and pulse the reader, and third delay means operable by each output pulse to supply a "plus one" pulse to the counter after the counter has received said predetermined number of pulses.

6. The translator means of claim 5 wherein the pulse-producing device comprises a disc having an annular record track having equally spaced pulses thereon and keyed to the feed screw, and a playback head adapted to pick up the pulses from the annular record track and transmit the pulses so picked up to the counter.

7. The translator means of claim 6 wherein the record tracks are magnetic strips.

References Cited in the file of this patent

UNITED STATES PATENTS

2,413,965	Goldsmith	Jan. 7, 1947
2,537,427	Seid et al.	Jan. 9, 1951
2,540,654	Cohen	Feb. 6, 1957
2,874,343	Steele	Feb. 17, 1959
2,921,296	Flores	Jan. 12, 1960
3,003,094	Gough	Oct. 3, 1961
3,071,757	Levene	Jan. 1, 1963

OTHER REFERENCES

"Digital Thermal Microactivator," IBM Technical Disclosure, vol. 2, No. 1, June 1959.