

[72] Inventor Patrick J. Pollard
Warren, Mich.
[21] Appl. No. 661,395
[22] Filed Aug. 17, 1967
[45] Patented June 15, 1971
[73] Assignees George Apostle;
DeWayne P. Carlson
Muskegon, Mich., part interest to each

[56]

References Cited

UNITED STATES PATENTS

3,435,120	3/1969	Corwell	273/54
3,289,574	12/1966	Webb	101/93
3,295,438	1/1967	Webb	101/93
3,310,659	3/1967	Apostle	235/92
3,124,355	3/1964	Mentzer	273/54

Primary Examiner—Maynard R. Wilbur

Assistant Examiner—Robert F. Gnuse

Attorney—Harness, Dickey and Pierce

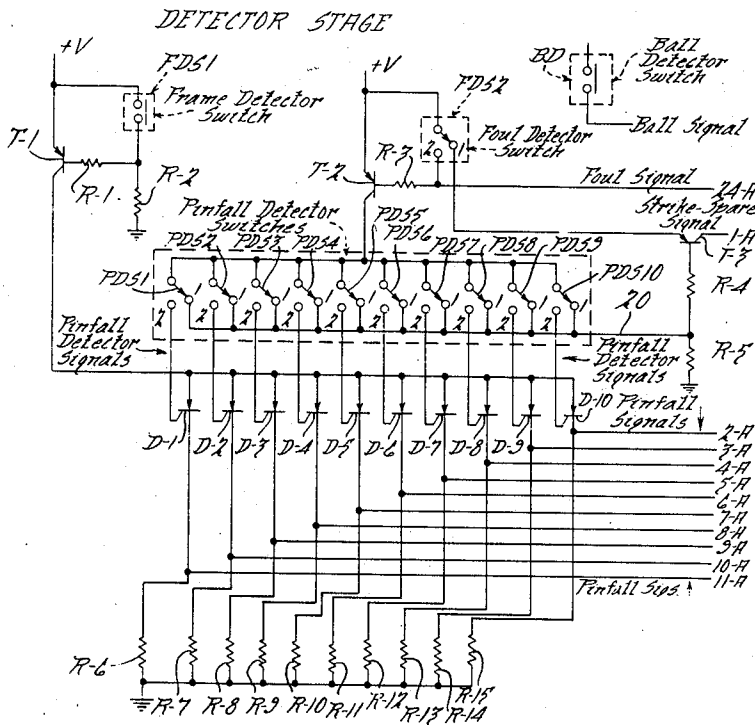
[54] BOWLING SCORE COMPUTER
24 Claims, 24 Drawing Figs.

[52] U.S. Cl. 235/92 GA,
273/54 C

[51] Int. Cl. G06m 3/06

[50] Field of Search 235/92;
273/54

ABSTRACT: Apparatus for computing and recording bowling scores.



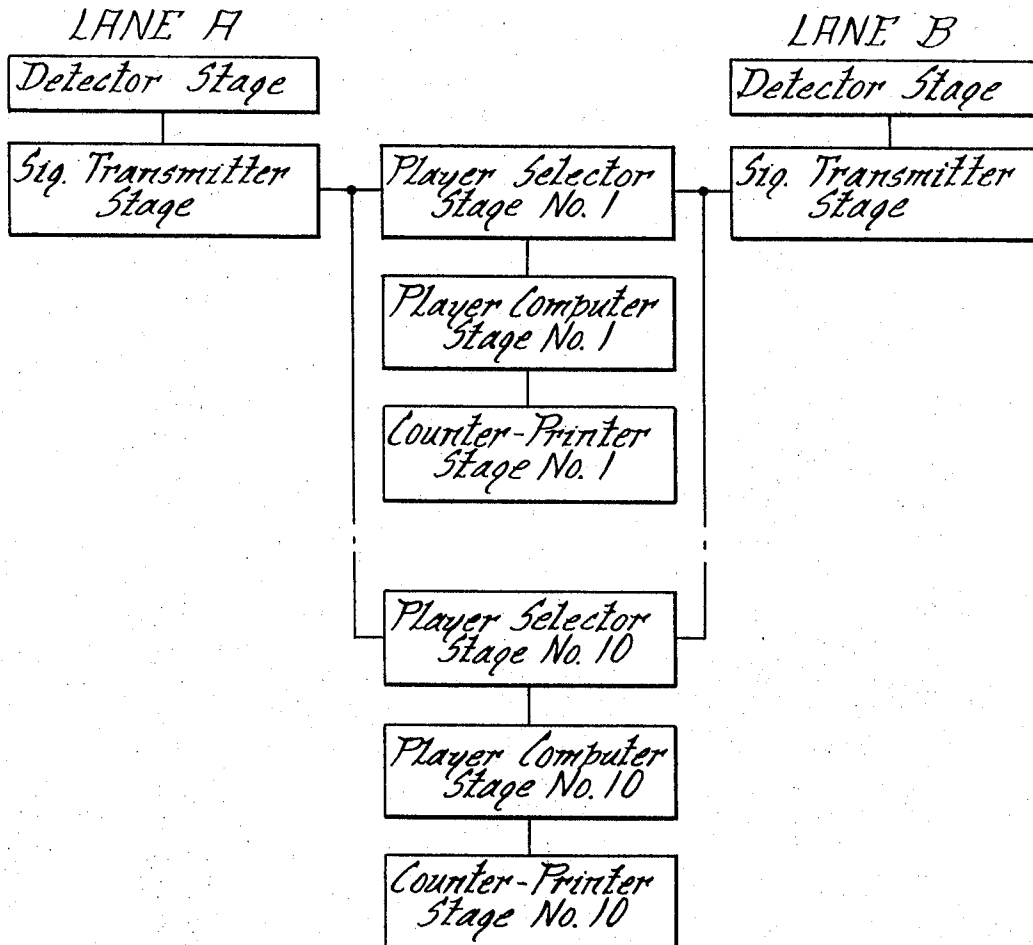


FIG. 1.

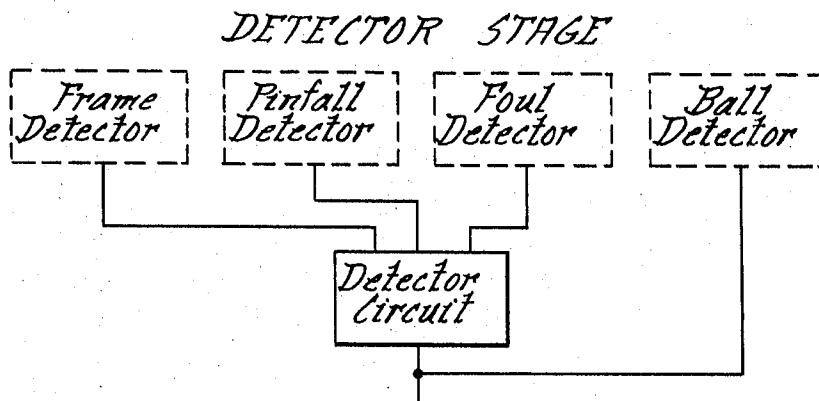


FIG. 2.

INVENTOR.
Patrick J. Pollard
 BY
Harness, Dickey & Pierce
 ATTORNEYS.

PLAYER COMPUTER STAGE

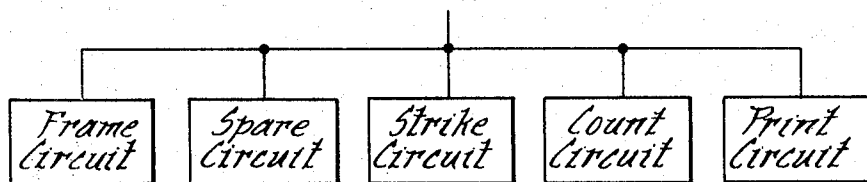


FIG. 3.

COUNTER - PRINTER STAGE

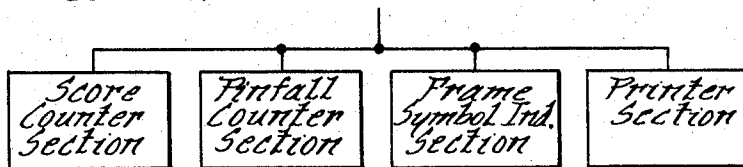


FIG. 4.

DETECTOR STAGE

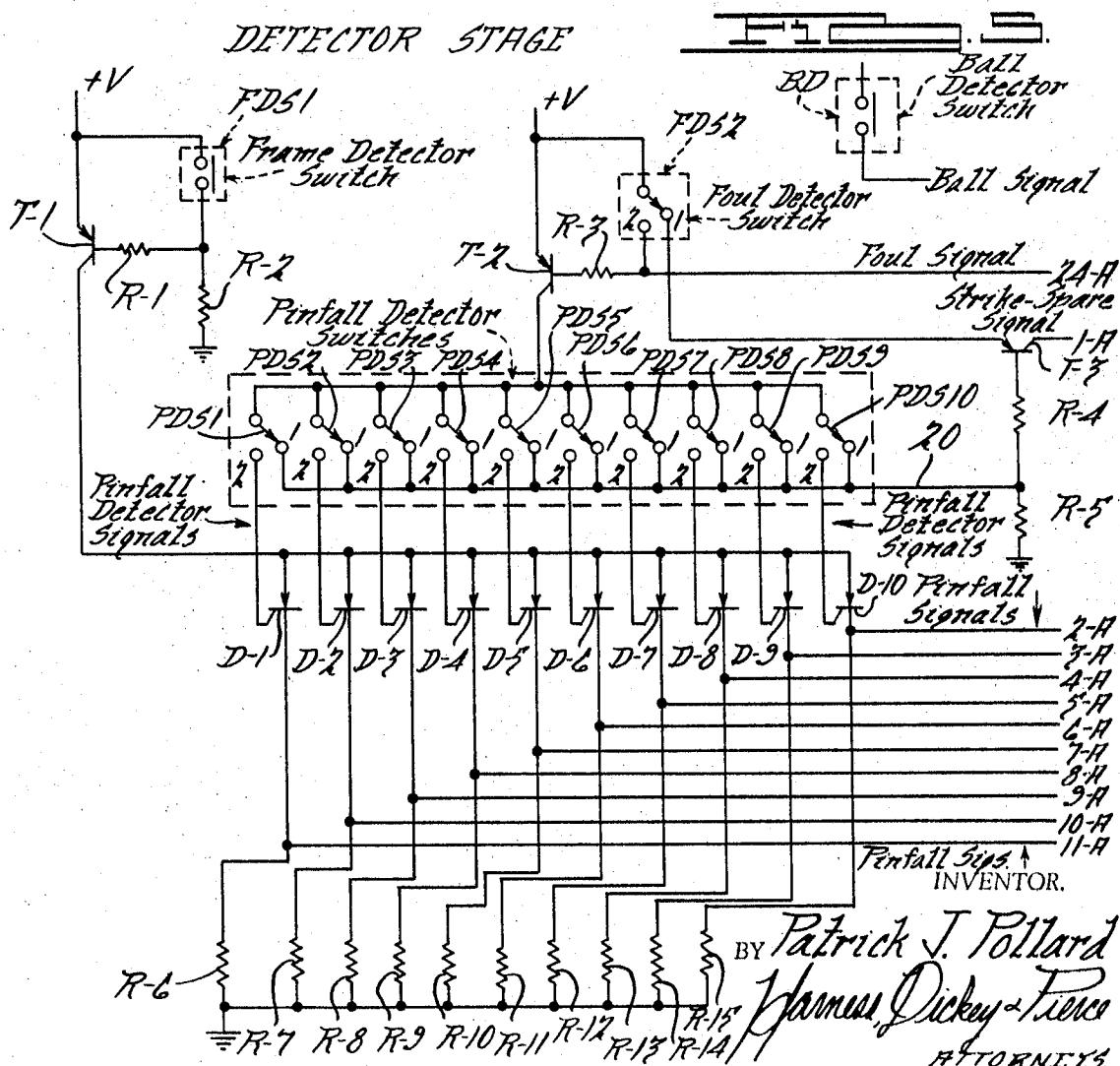


FIG. 5.

BY Patrick J. Pollard
Harness, Dickey & Fieco
ATTORNEYS

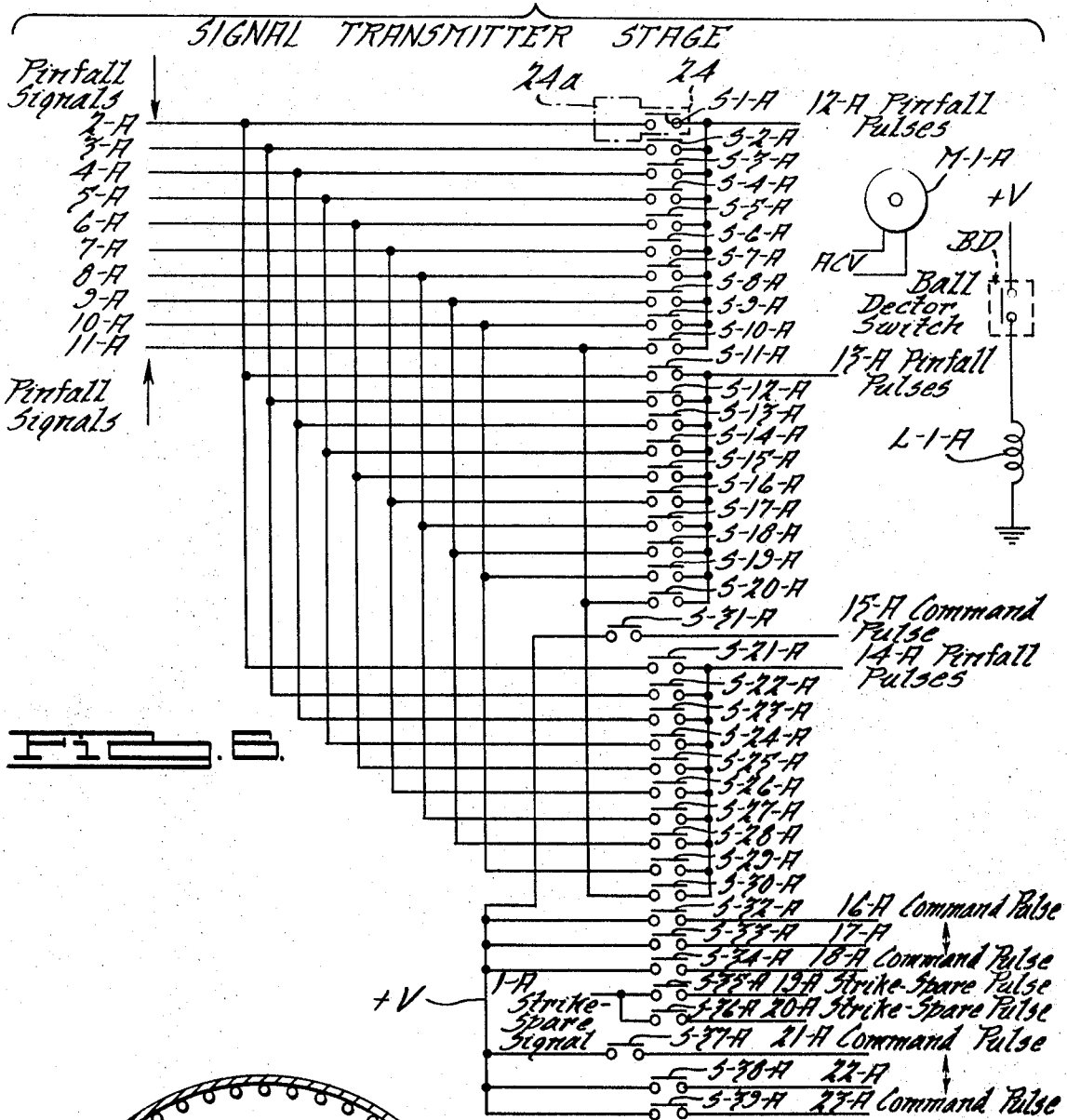


FIG. 6.

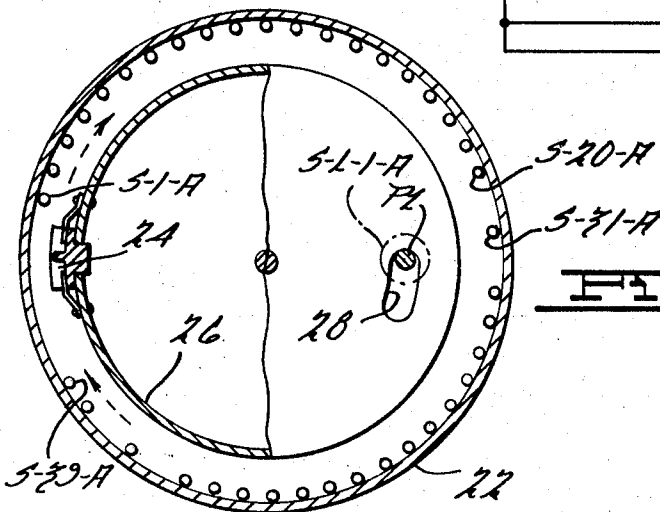


FIG. 7.

INVENTOR.
Patrick J. Pollard
 BY
Harness, Dickey, Pierce
 ATTORNEYS

PLAYER SELECTOR STAGE CIRCUIT

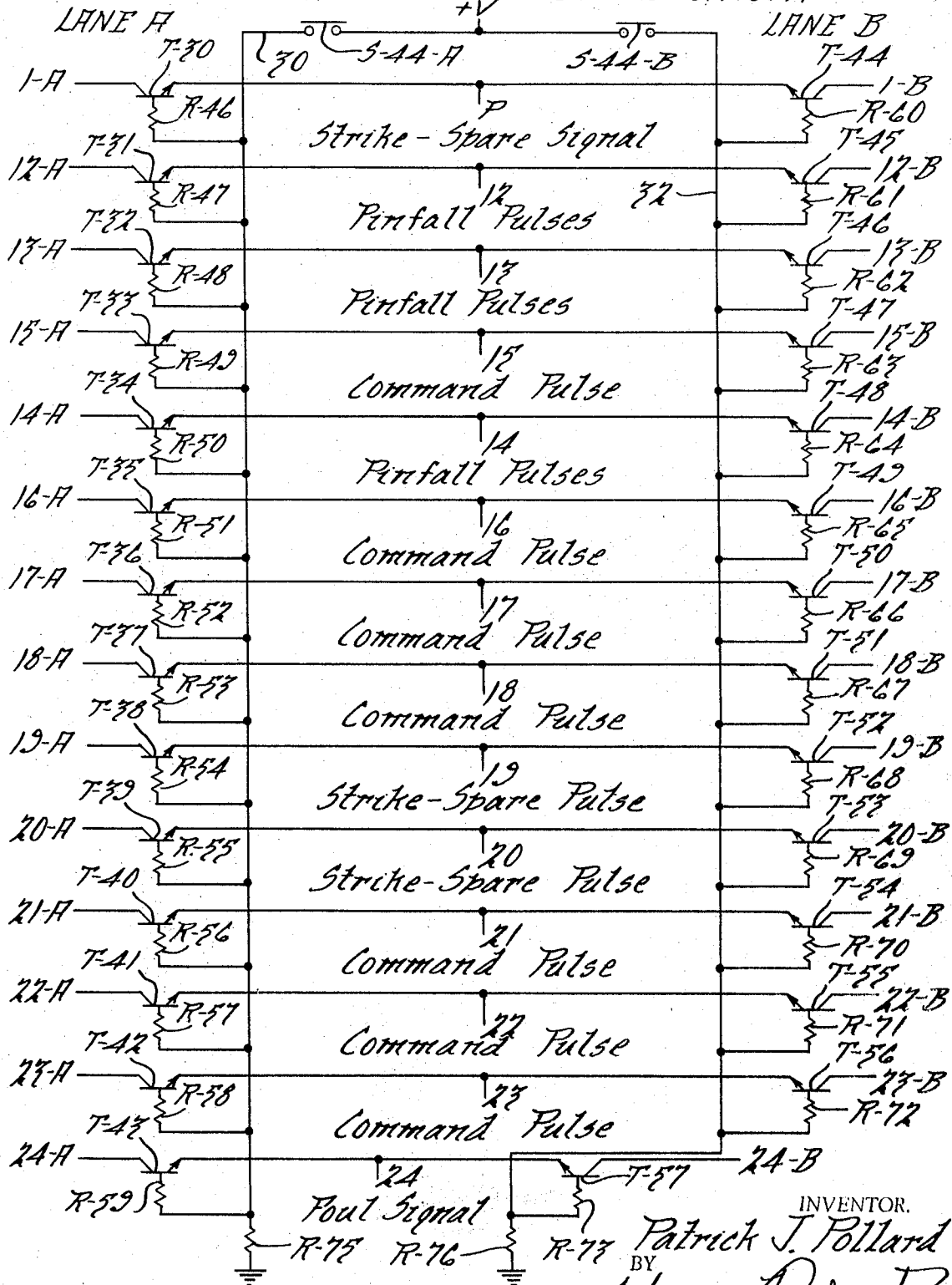


FIG. 8.

INVENTOR.
 Patrick J. Pollard
 BY
 Harness, Dickey & Pierce
 ATTORNEYS

FRAME CIRCUIT

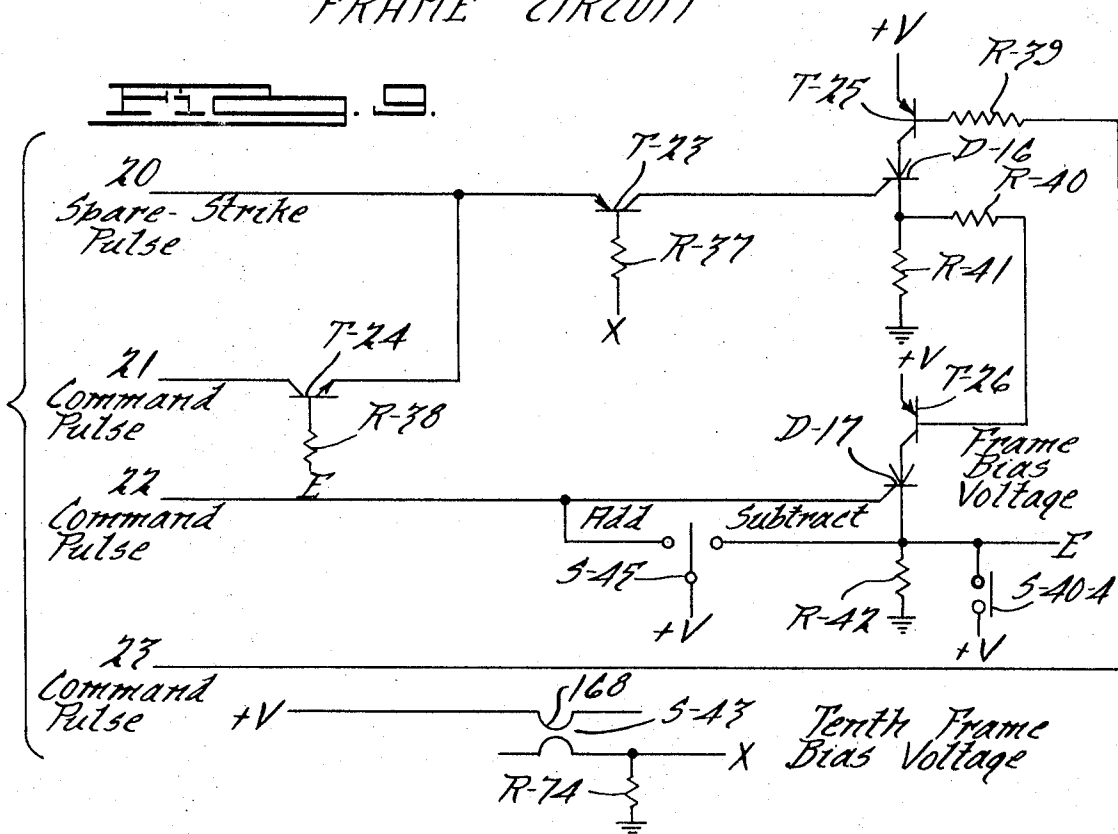
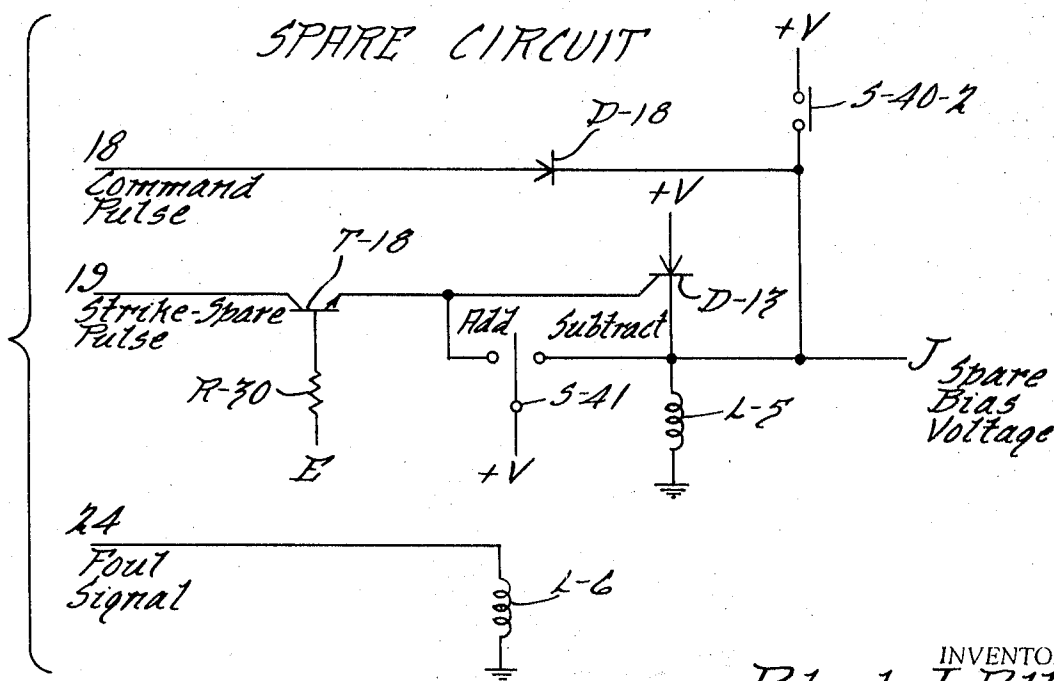
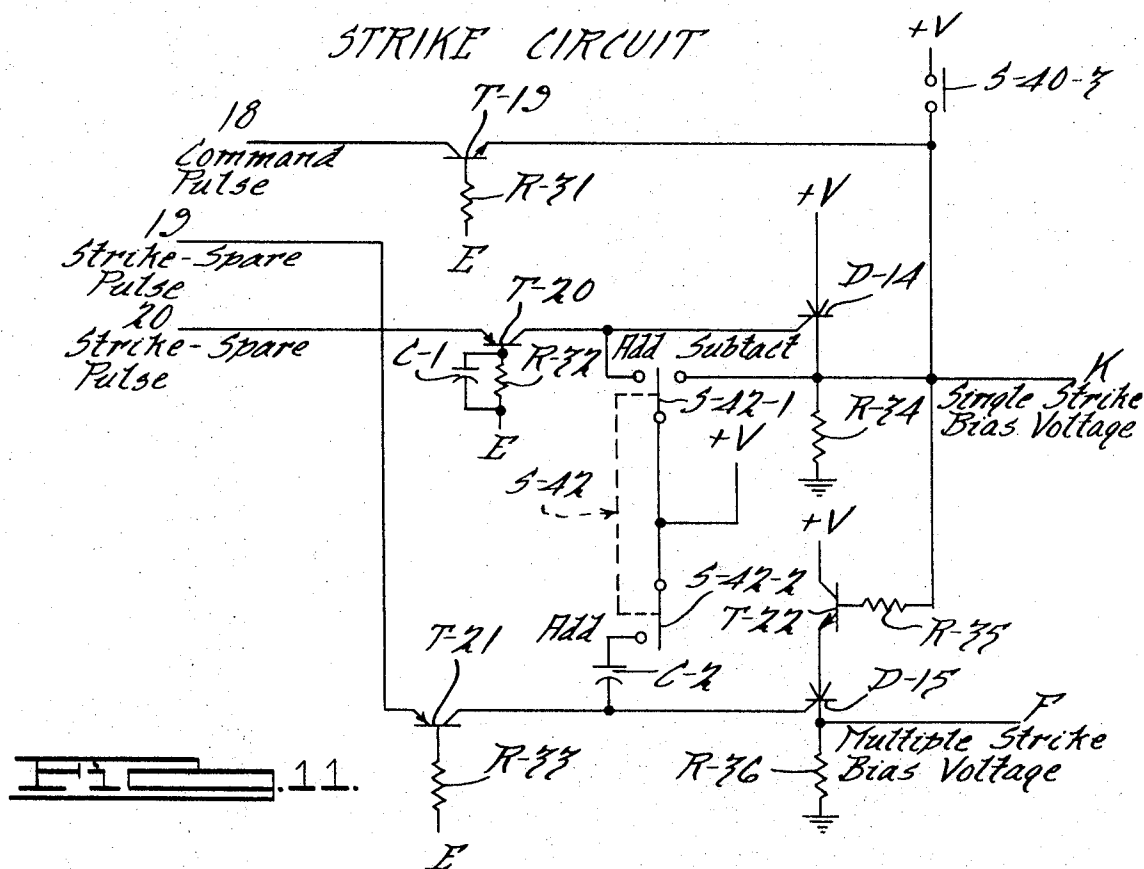
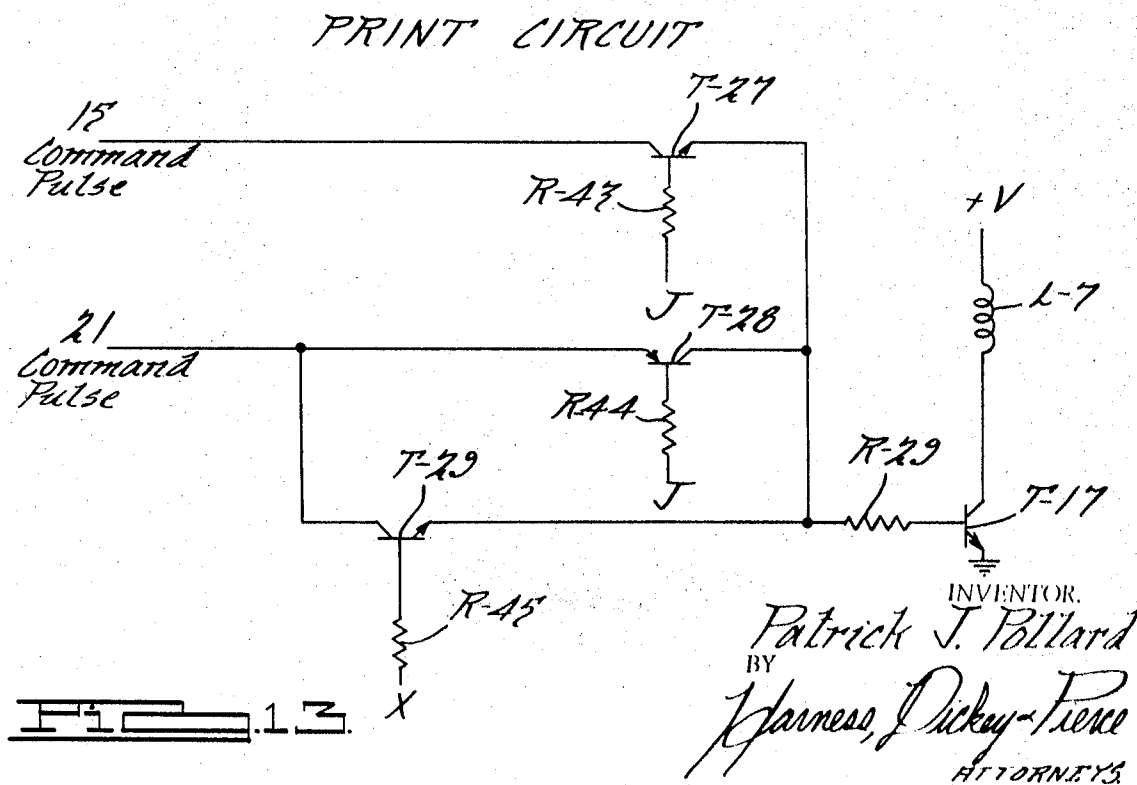
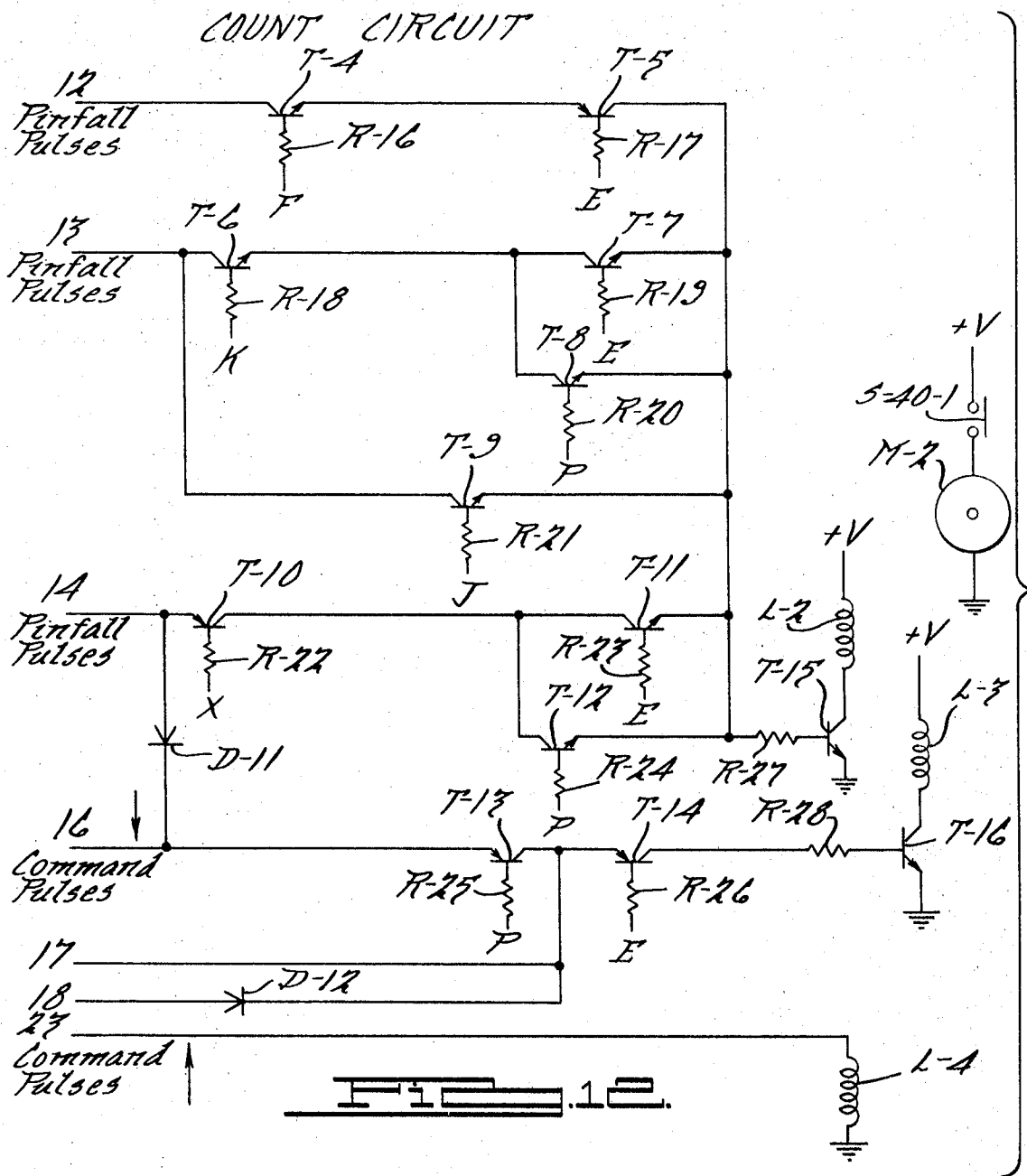


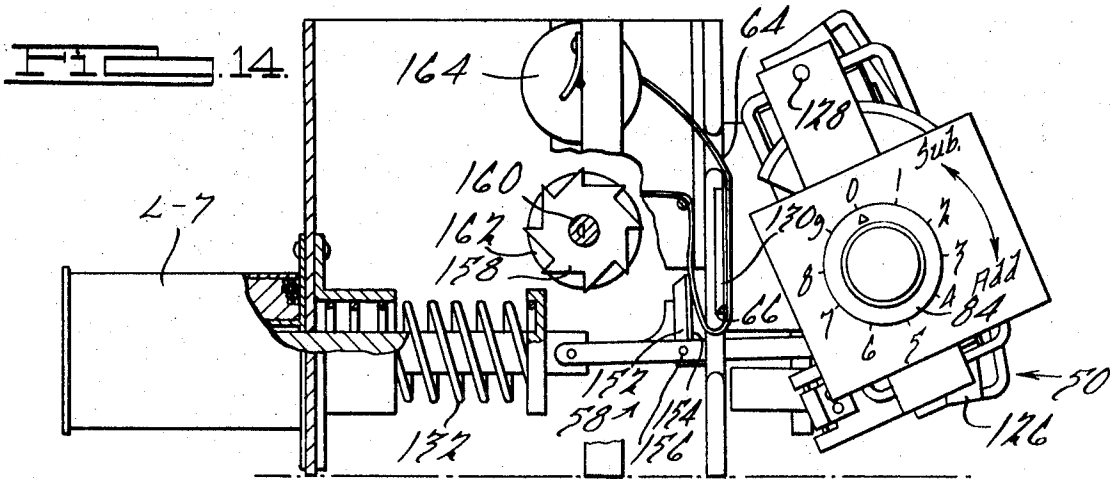
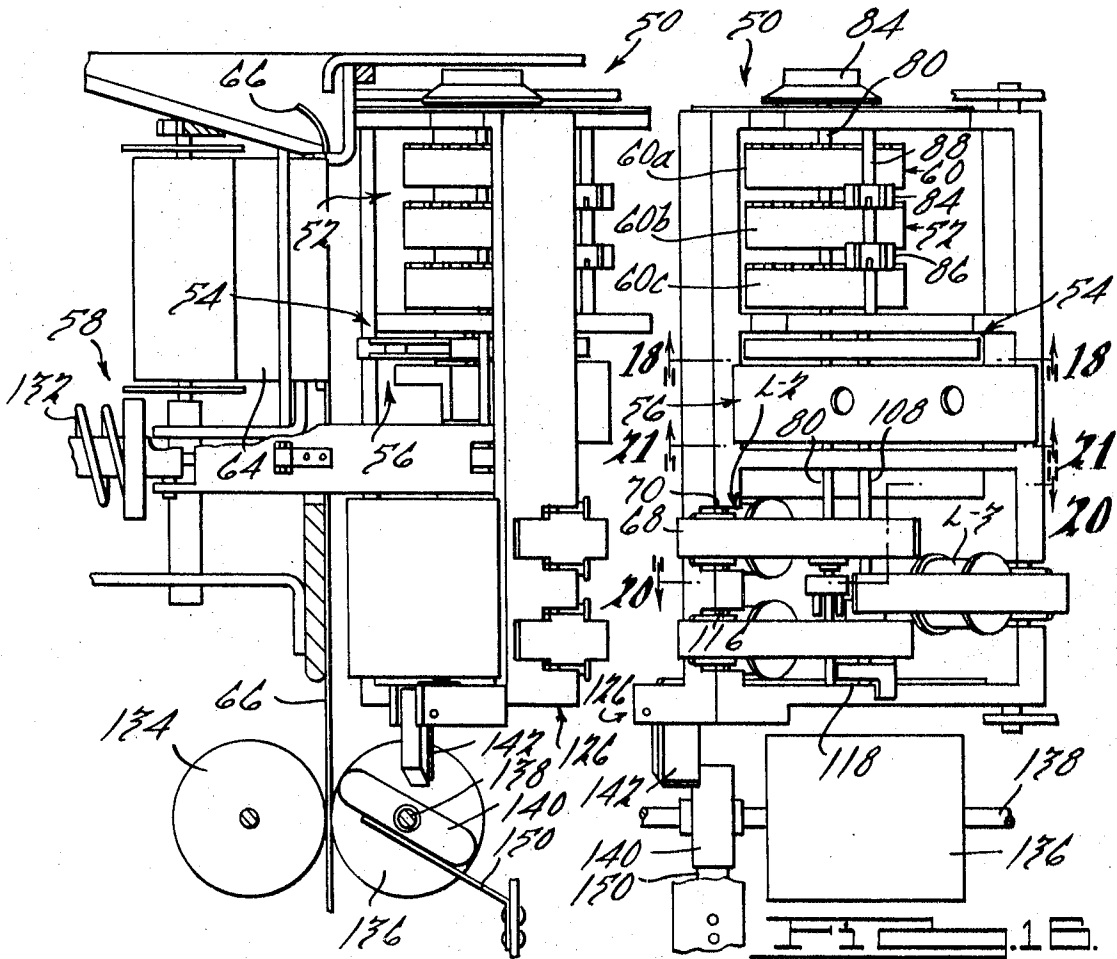
FIG. 10.

INVENTOR.
Patrick J. Pollard
 BY
Horness, Dickey & Pierce
 ATTORNEYS



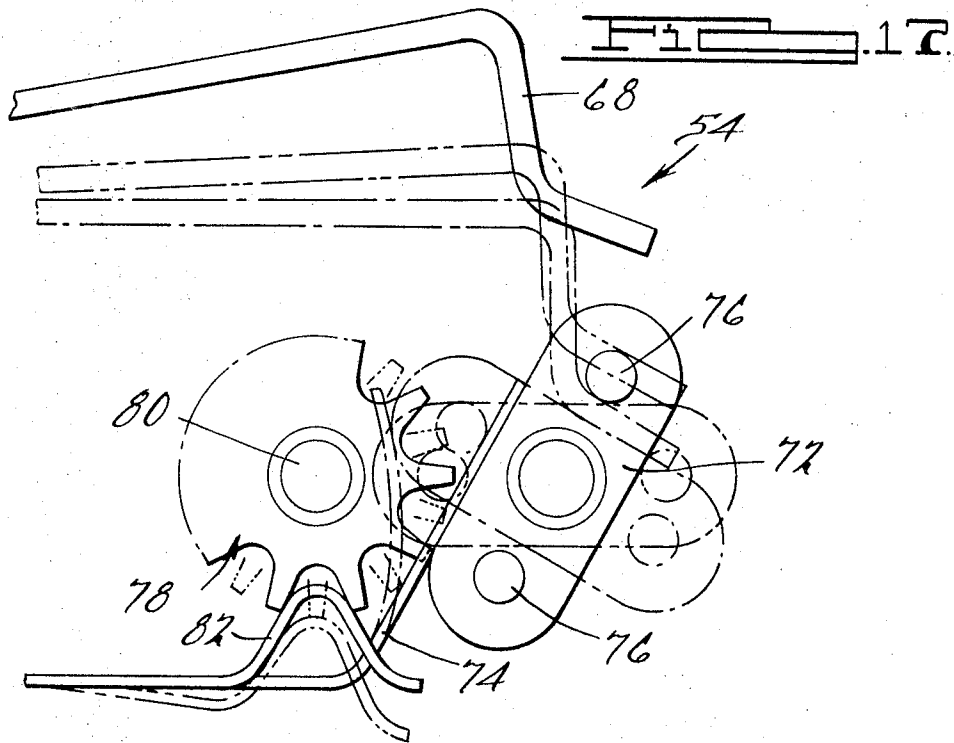
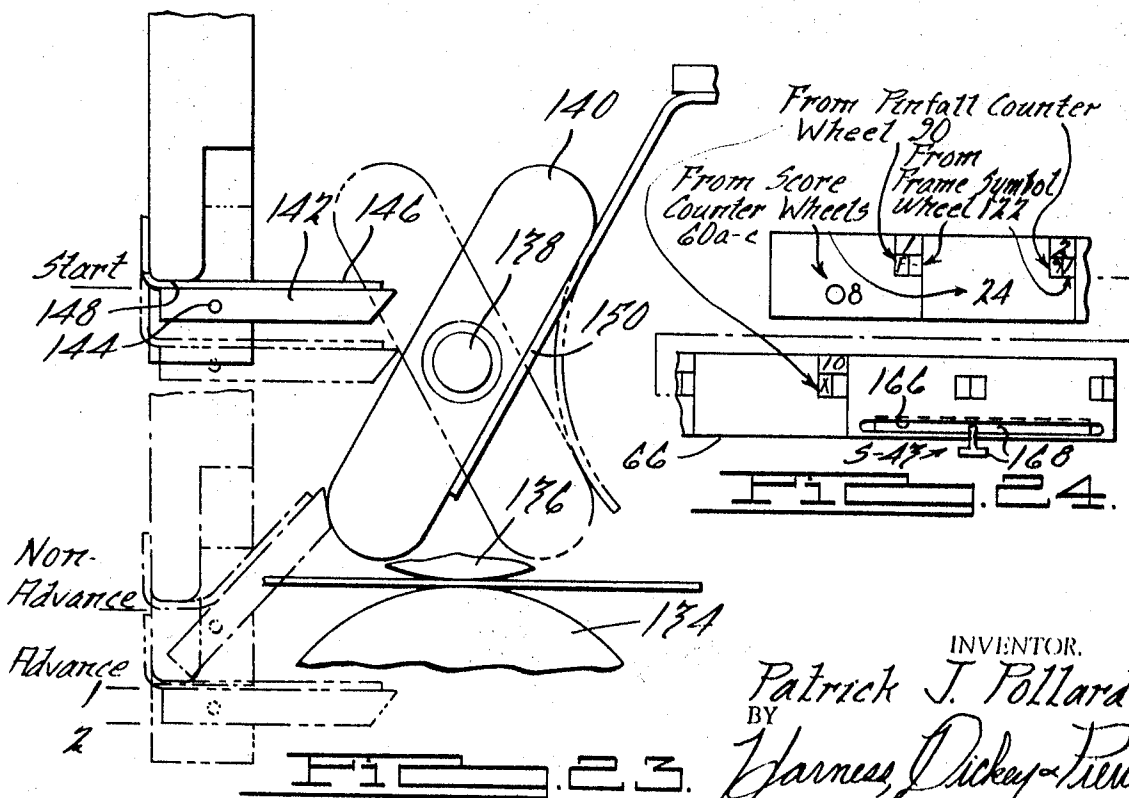


INVENTOR.
Patrick J. Pollard
 BY
Harness, Dickey & Pierce
 ATTORNEYS.

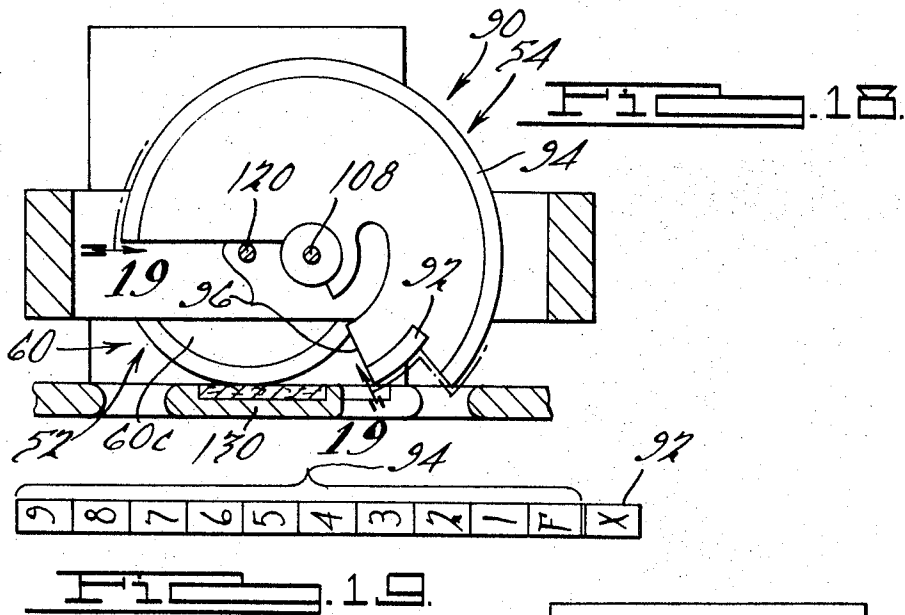
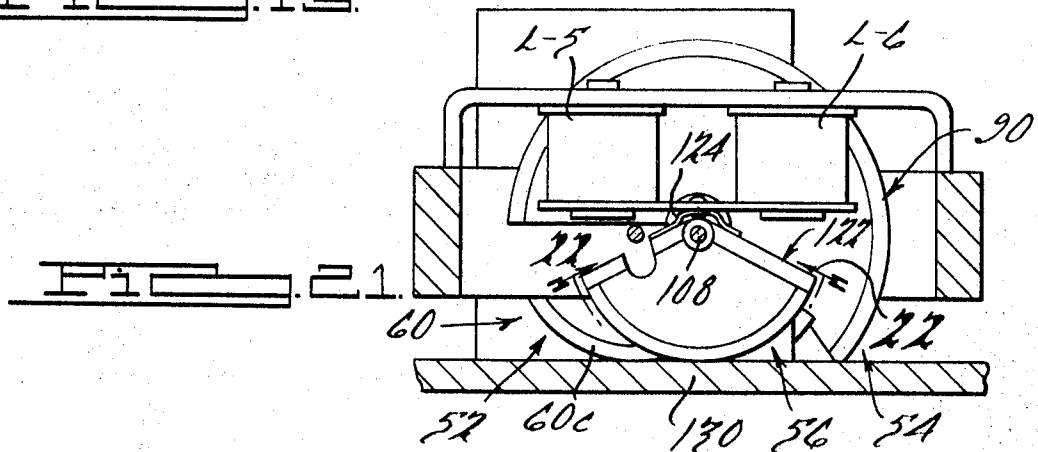
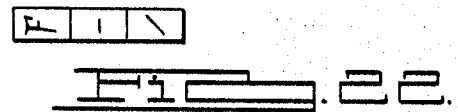
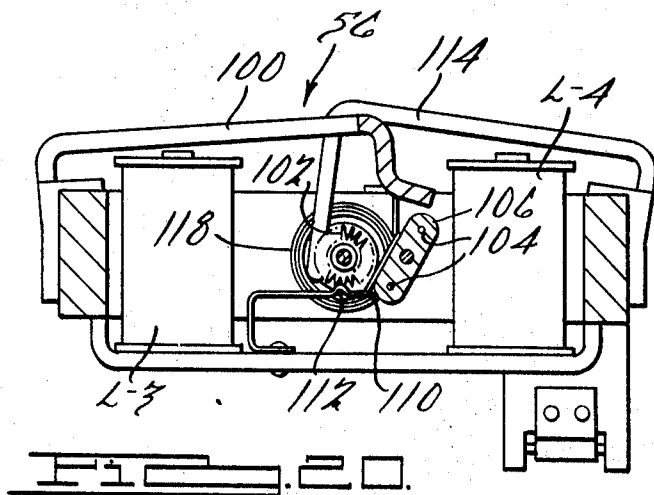


INVENTOR.

Patrick J. Pollard
BY
Harness, Dickey & Pierce
ATTORNEYS



INVENTOR,
Patrick J. Pollard
 BY
Harness, Dickey & Pierce
 ATTORNEYS



INVENTOR,
Patrick J. Pollard
 BY
Harness, Dickey & Pierce
 ATTORNEYS

BOWLING SCORE COMPUTER

The present invention relates to apparatus for computing and recording bowling scores.

It is a general object of the present invention to provide novel apparatus for computing bowling scores.

It is a general object of the present invention to provide novel apparatus for computing and/or recording bowling scores.

The present invention generally is an improvement upon the inventions shown and described in the U.S. Pat. No. 3,310,659, to Apostle, et al., issued Mar. 21, 1967.

Other objects, features and advantages of the present invention will become apparent from the subsequent description and the appended claims, taken in conjunction with the accompanying drawings in which:

FIG. 1 is a block diagram of the apparatus of the present invention for two lanes and including Detector, Signal Transmitter, Player Selector, Player Computer, and Counter-Printer Stages;

FIG. 2 is a block diagram of the Detector Stage;

FIG. 3 is a block diagram of the Player Computer Stage;

FIG. 4 is a block diagram of the Counter-Printer Stage;

FIG. 5 is a circuit diagram of the Detector Stage;

FIG. 6 is a circuit diagram of the Signal Transmitter Stage;

FIG. 7 is an elevational view with some parts shown in section and others broken away of a Signal Transmitter construction;

FIG. 8 is a circuit diagram of the Player Selector Stage;

FIG. 9 is a circuit diagram of the Frame Circuit of the Player Computer Stage;

FIG. 10 is a circuit diagram of the Spare Circuit of the Player Computer Stage;

FIG. 11 is a circuit diagram of the Strike Circuit of the Player Computer Stage;

FIG. 12 is a circuit diagram of the Count Circuit of the Player Computer Stage;

FIG. 13 is a circuit diagram of the Print Circuit of the Player Computer Stage;

FIG. 14 is a top elevational view with some parts in section and others broken away of the Counter-Printer, including the Pinfall Counter Section, the Frame Symbol Indicator Section, and the Printer Section of the Counter-Printer Stage;

FIG. 15 is a front view of the Counter-Printer of FIG. 14;

FIG. 16 is a right side view of the Counter-Printer of FIG. 14;

FIG. 17 is a view to increased scale of the actuating mechanism of the Pinfall Counter Section;

FIG. 18 is a sectional view to increased scale taken generally along the line 18-18 in FIG. 16 of the Pinfall Counter display wheel;

FIG. 19 is a developed view of the Pinfall Counter display wheel of FIG. 18, as viewed along the line 19-19;

FIG. 20 is a sectional view to increased scale taken generally along the line 20-20 in FIG. 16 of the actuating mechanism for the Pinfall Counter display wheel;

FIG. 21 is a sectional to increased scale taken generally along the line 21-21 in FIG. 16 of the Frame Symbol wheel and actuating mechanism therefor of the Frame Symbol Indicator Section;

FIG. 22 is a developed view of the Frame Symbol wheel of FIG. 21 as viewed along the line 22-22;

FIG. 23 is a view to increased scale of the Score Tape Advance Mechanism of the Counter-Printer of FIGS. 14-16; and

FIG. 24 is an elevational view of a Score Tape for use with the Counter-Printer and including a 10th Frame Signal device.

The block diagram of FIG. 1 illustrates the bowling score computer system for use with two lanes, herein referred to as A and B. A "Detector Stage" (shown in block diagram form in FIG. 2) for each lane senses the pinfall and converts it into a number of Pinfall Signals equal to the pinfall for use by the "Signal Transmitter Stage" individual to that lane. The "Signal

Transmitter Stage" (shown in block diagram form in FIG. 3) converts the Pinfall Signals into a proportional number of Pinfall Pulses and sends those pulses along with various Command Pulses to a "Player Computer Stage." While one "Detector Stage" and one "Signal Transmitter Stage" are required for each lane, one "Player Computer Stage" (10 total) is required for each player. A "Selector Stage" (10 total) for each player provides the necessary switching circuitry for connecting the individual "Player Computer Stage" to the "Detector Stage" and "Signal Transmitter Stage" for the desired bowling lane. A "Counter-Printer Stage" (shown in block diagram form in FIG. 4) for each player provides a printed record of the bowling score from information received from the "Player Computer Stage." While the block diagram of FIG. 1 a bowling score computer system having a capacity of 10 players, the flexibility of the overall system is such that additional stages may be added at any time.

DETECTOR STAGE

The primary function of the "Detector Stage" is to convert the electrical Pinfall Detector Signals from the Pinfall Detector into Pinfall Signals for use by the "Signal Transmitter Stage." The Pinfall Detector Signals are directly related to the pinfall occurring each time a ball is bowled. The secondary functions of the "Detector Stage" are:

1. to provide an electrical Strike-Spare Signal when the total pinfall for a frame bowled is 10;
2. to provide an electric Foul Signal when a foul occurs during the course of a bowling game; and
3. to provide an electrical Ball Signal each time a ball is bowled.

The purpose of the Strike-Spare, Foul and Ball Signals will be explained in relation to the circuits they affect at a later point. As noted, one "Detector Stage" is required for each lane.

CIRCUIT DESCRIPTION

The "Detector Stage" could be operative with either a digital or an analog Pinfall Detector Signal which indicates the number of pins knocked down. In the form to be shown and described a digital output is used.

The "Detector Stage" (see FIG. 2) comprises a Detector Circuit which, as shown in the circuit diagram of FIG. 5 includes a Frame Detector, Pinfall Detector, Foul Detector, and Ball Detector.

The circuit diagram of FIG. 5 illustrates a "Detector Stage" circuit utilizing a digital Pinfall Detector. The position of each bowling pin, i.e., standing or knocked down, determines the position of the associated single pole, double throw pinfall detector switch (indicated as PDS1-10), i.e., positions one or two. The number two position of each switch (representing a bowling pin knocked down) is connected to the corresponding gate of one of the controlled rectifiers D-1 through D-10. The movable arms of switches PDS1-10 are each connected to a positive direct potential V through a PNP transistor T-2 which is biased to be normally conductive by a base bias resistor R-3. The anodes of SCR's D1-D10 are connected to a positive direct current V through PNP transistor T-1 which is normally biased conductive by resistors R-1 and R-2 connected from base to ground. The cathodes of SCR's D1-D10 are connected to ground via load resistor R-6 through R-15 respectively. When bowling pins are knocked down, their associated pinfall detector switches PDS1-10 are moved to position two such that a positive Pinfall Detector Signal is connected to the corresponding controlled rectifier gate (via T-2). This, in turn, triggers the controlled rectifiers D1-10 thus establishing electrical Pinfall Signals at the appropriate ones of points 2-A through 11-A respectively, as a function of pinfall. The characteristics of controlled rectifiers are such that the Pinfall Signals are maintained after the detector switches return to their normal position (position one). The Pinfall Signals from the first ball thrown in a bowling frame are thus retained for

use when the scoring conditions of a game require such information. A PNP transistor T-3 is connected to positive direct potential V through one pole of a Foul Detector switch FDS2 and has its base connected to the potential V via resistor R-4 and conductor 20 which is connected to each of the No. one contacts of pinfall detector switches PDS1-10; conductor 20 is connected to ground via a load resistor R-5. Thus when any of the switches PDS1-10 is in the No. one position transistor T-3 is held nonconductive but will conduct when all of switches PDS1-10 are in the No. two position. When the total pinfall for a bowling frame in a game is ten (all the pinfall detector switches PDS1-10 are in position two the positive bias voltage is removed from the base of transistor T-3, allowing T-3 to conduct. The result is a Strike-Spare Signal at point 1-A which is used in various circuits of the "Player Computer Stage" in a manner to be described.

The controlled rectifiers are reset at the end of each frame in the following manner. The pinfall detector switches PDS1-10 are all returned to their No. one position at the end of each frame bowled. The Frame Detector (FIG. 2) comprises a normally opened switch FDS1 connected from positive potential V to the base of T-1 at the juncture of resistor R-1 and R-2. The Frame Detector provides an electrical Frame Pulse, via actuation of FDS1, at the end of each frame bowled. The Frame Pulse introduces a momentary positive voltage to the base of transistor T-1, biasing T-1 to cutoff. The anode supply voltage to controlled rectifiers D-1 through D-10 is thus momentarily blocked. The characteristics of the rectifiers are such that with no bias at the gate interruption of their anode voltage automatically resets the controlled rectifiers.

When a foul occurs during the course of a game, the Foul Detector, which comprises a switch FDS2, is automatically actuated (position two is closed, position one is opened). The Foul Detector will be maintained actuated until the signal provided therefrom has been used by the succeeding circuitry. Foul detector switch FDS2 is a single pole double throw switch having one pole (normally closed) and connected in the circuit of transistor T-3 and the other pole normally opened and connected to the base of transistor T-2 through bias resistor R-3. This results in positive voltage being applied at the base of transistor T-2, biasing T-2 to cutoff. Under this condition, the controlled rectifiers D-1 through D-10 are unaffected by the position of the pinfall detector switches since transistor T-2 has blocked the positive voltage to the switches PDS1-10. Thus, there are no pinfall signals appearing at points 2-A through 11-A as the result of bowling pins knocked down by a ball bowled when a foul has occurred. Position two of the foul detector switch also provides a Foul Signal at point 24-A (when a foul condition energizes the foul detector switch), the purpose of which will be explained in the discussion of the Spare Circuit in the "Player Computer Stage." Since upon the occurrence of a foul the positive voltage is blocked from the pinfall detector switches PDS1-10 by transistor T-2, the bias voltage normally appearing at the base of transistor T-3 is also blocked. To prevent T-3 from conducting under this condition, (which, if allowed, would establish a false Strike-Spare Signal at point 1-A), the positive voltage is removed from the emitter of transistor T-3 through the action of the foul detector switch FDS2 being actuated to open the No. one position and close the No. two position.

The Ball Detector which comprises a switch BD, is actuated each time a ball is bowled and is connected to positive potential V and provides a Ball Signal for use in the "Signal Transmitter Stage" in a manner to be described.

The Frame Detector produces a positive Frame Pulse at the end of each frame bowled. The frame detector switch FDS1 is a single pole, single throw switch which momentarily connects the positive supply voltage V to the base of transistor T-1 at the end of each frame bowled. There are a number of ways in which this switch could be actuated. Since it could, for example, be actuated by the associated pinsetter equipment by means known in the art no specific construction has been shown.

The Foul Detector would detect both a bowling ball that enters a lane channel and a player that crosses the foul line. Presently known foul line devices can easily be adapted for use as a part of the Foul Detector required by the "Detector Stage." In addition conventional sensing devices can be used to sense a bowling ball entering a lane channel.

The Ball Detector can be a switch actuated by the pinsetter equipment by means known in the art and hence no specific construction has been shown.

SIGNAL TRANSMITTER STAGE

The function of the "Signal Transmitter Stage" is:

1. to convert the steady state Pinfall Signals received from the "Detector Stage" into three sets of Pinfall Pulses for use by three sections of the Count Circuit in the "Player Computer Stage" (FIG. 3),
2. to convert the steady state Strike-Spare Signal to Strike-Spare Pulses for use by the various circuits in the "Player Computer Stage," and
3. to provide a series of sequential Command Pulses to the various circuits of the "Player Computer Stage."

As noted in the introduction, one "Signal Transmitter Stage" is provided for each lane.

CIRCUIT DESCRIPTION

The signal transmitter is shown in the circuit diagram of FIG. 6 and generally structurally shown in FIG. 7. The signal transmitter is a device having a series of single pole, single throw, normally open, reed switches (S-1-A through S-39-A) which are mounted to the periphery of a cylindrical stator member 22 and which are momentarily actuated (closed) by a rotating permanent magnet 24 located on a rotor 26. The switches S-1-A through S-39-A are generally actuated in numerical order (except for switch S-31-A) and are actuated in the sequence shown in FIG. 6. Once having been actuated (closed) by the presence of an appropriate magnetic field, the reed switches automatically return to their deactuated condition (open) upon the removal of that field. Each of the reed switches S-1-A through S-30-A has one end connected to one of the points 2-A through 11-A which carry the Pinfall Signals from the "Detector Stage"; each of the reed switches S-35-A and S-36-A have one end connected to point 1-A which carries the Strike-Spare Signal from the "Detector Stage," and each of the reed switches S-31-A through S-34-A and S-37-A through S-39-A is connected to a positive supply voltage V. The actuation of the switches is accomplished in a specific time sequence as established by the physical location of the switches and converts the various steady state voltages (Pinfall Signals, Strike-Spare Signal and positive supply voltage) into electrical pulses (Pinfall Pulses, Strike-Spare Pulses and Command Pulses, respectively), required by the "Player Computer Stage." This sequence occurs in the order illustrated (reading from top to bottom) in the circuit diagram of FIG. 6 or clockwise in FIG. 7. In each case, the output pulses from the signal transmitter at points 12-A through 23-A will be a positive, steady state direct potential with the duration of the positive pulse being determined by the time which the associated reed switches S-1-A through S-39-A are closed.

One cycle of operation of the "Signal Transmitter Stage" will be described. A low torque, low speed, continuous duty, AC motor drive assembly, M-1-A is coupled to the rotor 26 of the signal transmitter. The drive motor M-1-A is energized continuously but is prevented from rotating by the projection of the solenoid plunger P1 of solenoid S-L-1-A into a slot 28 in face of the signal transmitter rotor 26. When the coil L-1-A of solenoid S-L-1-A is energized, the plunger P1 is pulled out of the slot 28, allowing the motor M-1-A to rotate the signal transmitter rotor 26. After the solenoid coil L-1-A is deenergized, the plunger P1 will rest against the face of signal transmitter rotor 26. When the signal transmitter rotor 26 has completed one revolution, the solenoid plunger P1 drops back into the rotor face slot 28 preventing further rotation.

A permanent magnet 24 attached to the signal transmitter rotor 26, is designed to pass in front of and to thereby actuate each of the reed switches S-1-A through S-39-A during one cycle of the signal transmitter. A discreet time interval exists between the actuation of one reed switch and the automatic deactuation of the preceding adjacent reed switch as the permanent magnet 24 travels through one revolution. It should be noted that reed switches S-31-A and S-37-A are axially offset (see FIG. 6) and are located in line with a wider section 24a of the permanent magnet 24. This provides additional "on" time for these reed switches to serve a purpose to be presently described.

Looking now to the circuit diagram of FIG. 6, each of the points 2-A through 11-A are connected to three of the switches S-1-A through S-30-A i.e. 2-A connected to switches S-1-A, S-11-A, S-21-A, etc. The switches S-1-A through S-10-A S-11-A through S-20-A and S-21-A through S-30-A are commonly connected to points 12-A, 13-A and 14-A, respectively. Thus in one cycle or revolution of the signal transmitter the steady state Pinfall Signals at points 2-A through 11-A are converted into three identical groups of Pinfall Pulses appearing as discreet individual pulses at points 12-A, 13-A and 14-A. The duplication of Pinfall Pulses at points 12-A, 13-A and 14-A is necessary, as will be seen, for proper operation of the Count Circuit in the "Player Computer Stage" (FIG. 3). The Strike-Spare Signal at point 1-A is converted into the Strike-Spare Pulses which appear at points 18-A and 19-A and which are used in the various circuits of the "Player Computer Stage" in a manner to be described. Reed switches S-31-A through S-33-A and S-37-A through S-39-A are connected directly to the positive supply voltage to provide a series of Command Pulses at points 15-A through 17-A and 20-A through 23-A. The Command Pulses are used in the various circuits of the "Player Computer Stage" (FIG. 3) in a manner to be described. The Command Pulses at points 15-A through 18-A and 21-A through 23-A will occur once for each revolution of motor M-1-A; the other pulses, however, at the remaining points will only occur if a corresponding signal i.e. pinfall signal or Strike-Spare Signal is received from the detector stage.

The signal transmitter is cycled each time the coil L-1-A for solenoid S-L-1-A is energized through the actuation of the ball detector switch BD. This switch is actuated automatically each time a bowling ball is thrown during the course of a bowling game.

The size of magnet 24 and enlarged portion 24a will in conjunction with the speed of the rotor 26 determine the pulse width for the use of an electromechanical counter and printer (to be described) a longer pulse width is required for printing than for counting. For proper actuation of the electromechanical device specifically shown in the "Counter-Printer Stage" (FIG. 4) to register score information, as energized through the "Player Computer Stage" (FIG. 3), the pulses obtained through the action of the signal transmitter to provide counting and other scoring functions should have a minimum pulse duration of around 40 milliseconds; such a duration can be provided at all points except the points 15-A and 21-A. At the latter two points an increased minimum pulse duration of around 100 milliseconds is provided to give ample time for the electromechanical counter and printer to print the registered score information. Thus the magnet 24 by having the enlarged offset portion 24a can provide the necessary difference in pulse duration while still maintaining the time required for one revolution at a minimum.

SELECTOR STAGE

Only one "Detector Stage" and one "Signal Transmitter Stage" is provided for each lane; ten "Selector Stages" are provided and each is individual to and is connected with one of the ten "Player Computer Stages." The function of each of the ten "Selector Stages" is to permit the "Detector Stage" and the "Signal Transmitter Stage" from one of the lanes (A

or B) to be connected to the corresponding one of the ten "Player Computer Stages"; thus each "Selector Stage" allows the transfer of signals from the "Detector Stage" and pulses from the associated "Signal Transmitter Stage" to the "Player Computer Stage" with which it is individual.

CIRCUIT DESCRIPTION

As previously noted, ten "Selector Stages" (one for each player) are connected to common points in the "Detector Stages" and "Transmitter Stages" of Lanes A and B. The ten "Player Selector Stages" are connected to the points 12-A through 23-A in the "Signal Transmitter Stage" of Lane A and are similarly connected to corresponding points of the "Signal Transmitter Stage" of Lane B. Points 1-A and 24-A of the "Detector Stage" of Lane A and corresponding points of the "Detector Stage" of Lane B are also connected to each of the ten "Player Selector Stages." The circuit diagram for one "Player Selector Stage" is shown in FIG. 8. The switching transistors T-30 through T-43 are of the NPN type and control the transfer of signals and pulses appearing at points 1-A and 12-A through 24-A from the "Detector Stage" and "Signal Transmitter Stage" of Lane A to points P and 12 through 24 within the "Player Computer Stage" associated with the "Selector Stage." The switching transistors T-44 through T-57 control the transfer of signals and pulses appearing at points 1-B and 12-B through 24-B from the "Detector Stage" and "Signal Transmitter Stage" to Lane B to points P and 12 through 24 within the selected "Player Computer Stage" associated with that "Selector Stage." When selector switch S-44-A is actuated (closed), a positive bias voltage V is connected to a conductor 30 and to ground via a resistor R-75. The bases of each of the transistors T-30 through T-43 are connected to conductor 30 by biasing resistors R-46-R-59, respectively. By closing switch S-44-A and energizing conductor 30 the transistors T-30 through T-43 are placed into a conductive state allowing the signals and pulses at points 1-A and 12-A through 24-A (Lane A) to appear at the corresponding points P and 12 through 24, within the associated "Player Computer Stage." These signals and pulses will occur after each ball has been bowled. Similarly, transistors T-44 through T-57 (Lane B) are connected to positive potential V via biasing resistors R-60 through R-73, respectively, and conductor 32 and to ground via resistor R-76 and can be switched into a conductive state by actuating switch S-44-B.

The selector switches S-44-A and S-44-B could be designed with an interlocking device to prevent the inadvertent concurrent actuation and the simultaneous transferring of signals and pulses from the "Detector Stages" and "Signal Transmitter Stages" of both Lane A and Lane B.

PLAYER COMPUTER STAGE

The function of the "Player Computer Stage" is to utilize the various signals and pulses received from the "Detector Stage" and "Signal Transmitter Stage" for actuating the electromechanical devices of the associated "Counter-Printer Stage."

CIRCUIT DESCRIPTION

The "Player Computer Stage" has been subdivided into five basic circuits (see FIG. 3). The circuit diagrams for the Frame Circuit, Spare Circuit, Strike Circuit, Count Circuit, and Print Circuit are shown in FIGS. 9-13, respectively. As noted, ten "Player Computer Stages" (one for each player) are provided and each is associated with one of the "Player Selector Stages." The Count Circuit performs the function of counting the score attained; the score attained is represented by the number of Pinfall Pulses occurring at points 12, 13 and 14 and by the number of these which are counted by the Count Circuit which number is determined by the Frame Circuit, Spare Circuit, and Strike Circuit, which correspond to the score situation existing at that time i.e. spare, strike, etc. As will be

seen the score is directly represented by the number of pulses transmitted to a counter solenoid L-2 (see Count Circuit, FIG. 12).

Each of the transistors used in the "Player Computer Stage" functions as a switching device which has its conductive condition determined by an associated bias voltage. The presence or absence of these bias voltages are a function of a number of corresponding scoring conditions i.e. strike, spare, etc. Each of the various bias voltages is a positive potential and has been designated by an individual code letter located at the source of that bias. The code letter is likewise noted at the base of the switching transistors to be controlled by that bias. For convenience in studying the individual circuits within the "Player Computer Stage," an explanation of the code letters is given below:

Code letter	Positive bias at this point indicates—	Bias voltage source
E.....	Second ball condition of a frame, strike not bowled on first ball.	Frame circuit.
F.....	Two or more consecutive strikes bowled.	Strike circuit.
J.....	Spare bowled in a frame.	Spare circuit.
K.....	Strike bowled in a frame.	Strike circuit.
P.....	Ten (10) pins knocked down in a frame (this has been previously referred to as a "Strike-Spare Signal" at point 1-A in the "Detector Stage").	Detector circuit.
X.....	Spare or Strike bowled in tenth frame.	Frame circuit.

FRAME CIRCUIT

The function of the Frame Circuit is to provide a frame bias voltage E and a 10th frame bias voltage X under scoring conditions to be described. The Frame Bias Voltage E indicates that a strike was not bowled on the first ball in a frame. The above is true except for a 10th frame strike situation to be described. The 10th Frame Bias Voltage X indicates that the 10th frame has been bowled and sets up conditions to receive the extra scores encountered if a spare or a strike was bowled in the 10th frame. In the following description, circuit diagrams 9—13 should be considered together.

The Frame Circuit is shown in the circuit diagram of FIG. 9 and provides the Frame Bias Voltage E for the associated switching transistors T-5, T-7, T-11 and T-14 in the Count Circuit (FIG. 12); switching transistors T-18 in the Spare Circuit (FIG. 10); transistors T-19, T-20 and T-21 in the Strike Circuit; and transistor T-24 in the Frame Circuit. In the Frame Circuit of FIG. 9, a Command Pulse appearing at point 22 (for each ball bowled) will provide a trigger pulse to the gate of a controlled rectifier D-17. When the normally conductive transistor T-26 (connected between the positive source V and the anode of D-17) is conductive, this trigger pulse will render D-17 conductive to provide the Frame Bias Voltage at point E at the cathode of D-17 which is connected to ground via a dropping resistor R-42. The base of transistor T-26 is connected to the cathode of an SCR D-16 via resistor R-40 and to ground via resistor R-41 and will be rendered nonconductive when SCR D-16 is conducting. For a purpose to be seen a Frame Bias Voltage must and will appear at point E whenever it is necessary to bowl a second ball in a frame, i.e., in all scoring situations except a strike.

The transistor T-26 is controlled in order to prevent controlled rectifier D-17 from firing when a strike is bowled. SCR D-16 has its anode connected to positive supply V via the emitter-collector circuit of a PNP transistor T-25 which has its base connected to point 23 to receive a Command Pulse. The gate of SCR D-16 is connected to point 20 to receive a Strike-Spare Pulse via the emitter-collector circuit of PNP transistor T-23 which has its base connected to ground via resistor R-37 and resistor R-74 (in the 10th Frame Bias Voltage circuit). A Strike-Spare Pulse at point 20 provides a trigger pulse to controlled rectifier D-16 (through normally conducting transistor T-23) prior to the Command Pulse appearing at point 22. When the normally conductive transistor T-25 is on,

this trigger pulse will render D-16 conductive; with D-16 conductive a positive bias is placed at the base of transistor T-26 cutting it off and thereby blocking the supply voltage to the anode of controlled rectifier D-17. Thus, when a strike is bowled, the Command Pulse appearing at point 22 cannot fire D-17. The Command Pulse appearing at point 23 (which occurs after the pulses appearing at points 20, 21 and 22) cuts off transistor T-25 to momentarily block the supply voltage to controlled rectifier D-16, thus resetting D-16 and returning the Frame Circuit to its normal or original position.

In the case of a frame in which a strike is not bowled, after the second ball in that frame is bowled (Frame Bias Voltage E occurring after the first ball as previously described), the Frame Circuit must be returned to its original condition, i.e. SCR D-17 turned off. This is done by an NPN transistor T-24 (normally nonconducting) which connects Command Pulse point 21 to the emitter of T-23 via its emitter-collector circuit; the base of T-24 is connected to the Frame Bias Voltage E via resistor R-38. A Command Pulse appearing at point 21 provides a trigger pulse to D-16 (through transistor T-24 and normally conducting transistor T-23). The presence of Frame Bias Voltage E at the base of transistor T-24 renders this transistor conductive. The sequence of events occurring after the trigger pulse fires D-16 is the same as previously described in conjunction with the occurrence of a Strike-Spare Pulse at point 20.

It should be noted that the establishment of Frame Bias Voltage E occurs at the end of a signal transmitter cycle, i.e., Command Pulse at point 22, and is effective for scoring purposes during the next cycle until it is extinguished at the end of that next cycle, i.e. Command Pulse at point 21.

A 10th frame switch S-43 provides the 10th Frame Bias Voltage X for the associated switching transistors T-10 in the Count Circuit, T-23 in the Frame Circuit, and T-29 in the Print Circuit. Switch S-43 is connected to positive potential V and is normally opened and is actuated after the 10th frame has been bowled but before the additional ball (in the case of a spare scored in the 10th frame) or balls (in the case of a strike scored in the 10th frame) are bowled. The Tenth Frame Bias Voltage X appearing at the base of transistor T-23 renders that transistor nonconductive thereby assuring the occurrence of the Frame Bias Voltage E after the first extra ball is bowled. This is significant (as will be seen) only when the scoring condition dictates two extra balls and when the first of the two is a strike. The action of switch S-43 will be described in more detail in the "Counter-Printer Stage" discussion.

Controlled rectifier D-17 is manually reset by contacts S-40-4 of a start switch (not shown) which would be actuated by a player prior to starting a game; contacts S-40-4 are normally opened and when closed connect the cathode of SCR D-17 to positive supply V to turn D-17 off.

A zero center, single pole, double throw toggle switch S-45 is provided to correct a scoring error resulting in an incorrect indication (or absence) of Frame Bias Voltage E. The movable arm of switch S-45 is connected to positive potential V while one contact (add) is connected to the gate of SCR D-17 and another contact (subtract) is connected to the cathode of SCR D-17. By moving the arm to the "add" position, D-17 is triggered and the Bias E is provided; conversely, by moving the switch to the "subtract" position D-17 is extinguished removing the Bias E.

SPARE CIRCUIT

The function of the Spare Circuit is to provide a Spare Bias Voltage J indicating a spare was bowled and to provide energizing potentials for a spare symbol solenoid L-5 and foul solenoid L-6 under scoring conditions to be described; as will be seen the solenoids L-5 and L-6 control apparatus whereby the occurrence of either a spare or a foul is recorded.

The Spare Circuit, illustrated in the circuit diagram of FIG. 10, provides the Spare Bias Voltage J for the switching transistor T-9 in the Count Circuit, for the transistors T-27

and T-28 in the Print Circuit, and for energizing the spare symbol solenoid L-5 in the Spare Circuit. The Spare Bias J is provided at the cathode of an SCR D-13 which cathode is connected to ground through the coil for spare symbol solenoid L-5; the anode of SCR D-13 is connected to positive potential V while its gate is connected to the Strike-Spare Pulse point 19 via the emitter-collector circuit of an NPN transistor T-18; the base of T-18 is connected to Frame Bias E via a resistor R-30. Thus T-18 will normally be nonconductive but will conduct when the Frame Bias E occurs. The Strike-Spare Pulse appearing at point 19 provides a trigger pulse to the SCR D-13 (through transistor T-18). When SCR D-13 is conducting, the Spare Bias Voltage J is produced and spare symbol solenoid L-5 is energized. The presence of Frame Bias Voltage E (occurring under the conditions described in the Frame Circuit discussion) at the base of transistor T-18 renders that transistor conductive; thus controlled rectifier D-13 will be triggered (and Spare Bias Voltage J produced) only when a spare is bowled.

The Command Pulse at point 18 (for each ball bowled) resets the SCR D-13 (through a blocking diode D-18) by momentarily applying the positive supply voltage to the cathode of the SCR D-13. Blocking diode D-18 prevents the Spare Bias Voltage J from affecting the circuitry of the Strike Circuit connected to point 18. Since the Command Pulse at point 18 (resetting D-13) occurs prior to the Strike-Spare Pulse at point 19, when a spare is bowled, the Spare Bias Voltage J and the energization of spare symbol solenoid L-5 will be maintained until after the first ball of the following frame is bowled and the Pinfall Pulses have been transmitted to the Count Circuit. This is done for a purpose to be described in the discussion of the "Counter-Printer Stage." SCR D-13 can be manually reset by contacts S-40-2 of the start switch (previously referred to); contacts S-40-2 are normally opened and connect the positive supply V to the cathode of SCR D-13; when S-40-2 is closed SCR D-13 is rendered nonconductive, resetting it.

SCR D-13 may be alternately triggered on or reset off by the zero center, single pole, double throw, toggle switch S-41. Switch S-41 has its movable arm connected to the positive supply V and has one contact (add) connected to the gate of SCR D-13 and another contact (subtract) connected to the cathode of D-13. Thus switch S-41 can be used to manually produce a Spare Bias Voltage J (add position) or to reset D-13 (subtract position) in the event that an error involving a spare scored should occur during the course of a bowling game. The spare symbol solenoid L-5 is, of course, energized when controlled rectifier D-13 is fired.

The foul symbol solenoid L-6 is energized by the Foul Signal appearing at point 24 from the "Detector Stage" of the lane to which the "Player Computer Stage" is connected. The action of solenoids L-5 and L-6 will be explained in the "Counter-Printer Stage" discussion.

STRIKE CIRCUIT

The function of the Strike Circuit is to provide a Single Strike Bias Voltage K when one strike has been bowled and a Multiple Strike Bias Voltage F when two or more strikes in succession have been bowled; the Bias Voltage K and F serve purposes to be described.

The Strike Circuit illustrated in the circuit diagram of FIG. 11, provides the Single Strike Bias Voltage K for the associated switching transistor T-6 in the Count Circuit and the Multiple Strike Bias Voltage F for the associated switching transistor T-4 in the Count Circuit. When 10 pins are knocked down by the first ball bowled in a frame the Strike-Spare Pulse appearing at point 20 provides a trigger pulse to a controlled rectifier D-14 through a normally conducting transistor T-20. SCR D-14 has its anode connected to the positive supply V and its cathode connected to ground via resistor R-34 and will be rendered conductive by a positive pulse from point 20 through the emitter-collector circuit of transistor T-20 which

is connected to the gate of D-14. When rectifier D-14 is conducting the Single Strike Bias Voltage K is produced. Transistor T-20 is of the PNP type and has its base connected to the Frame Bias Voltage E via a resistor R-32 and capacitor C-1 connected in parallel. The presence of Frame Bias Voltage E (occurring under the conditions described in the discussion of the Frame Circuit, i.e. no strike on the first ball) at the base of transistor T-20 renders that transistor nonconductive; thus controlled rectifier D-14 will be triggered (and bias K produced) only when a strike is bowled. In the event of a spare (all pins knocked down with second ball in the frame) a Strike-Spare Pulse will occur at points 19 and 20; no Single Strike Bias Voltage K should be produced in response thereto. The Frame Bias Voltage E at T-20 prevents D-14 from producing the Bias Voltage K, however, the Bias Voltage E on the next ball bowled will be removed prior to occurrence of Strike-Spare Pulse at point 20. The RC circuit (resistor R-32 and capacitor C-1) at the base of transistor T-20 maintains that transistor cutoff for a preselected interval after Frame Bias Voltage E has been extinguished. This interval is provided to prevent a Strike-Spare Pulse (after a spare is bowled) at point 20 from firing controlled rectifier D-14 and improperly indicating a strike (bias K).

The multiple Strike Bias Voltage F is produced at the cathode of an SCR D-15 when it is conducting. The cathode of SCR D-14 is connected to the base of an NPN transistor T-22 via resistor R-35. The collector-emitter circuit of T-22 connects the positive supply V to the anode of SCR D-15. When controlled rectifier D-14 is conducting, the resulting Single Strike Bias Voltage K places T-22 in a conductive state, thus establishing one of the necessary conditions for the firing of the controlled rectifier D-15 which has its cathode connected to ground via resistor R-36. The other condition necessary to fire D-15 is a trigger pulse applied to its gate (through normally conductive transistor T-21) as a result of a Strike-Spare Pulse at point 19. PNP transistor T-21 connects the Strike-Spare Pulse point 19 to the gate of SCR D-15 through its collector-emitter circuit and has its base connected to Frame Bias Voltage E via resistor R-33 and serves the same purpose in relation to D-15 as transistor T-20 does to D-14 and hence prevents the improper indication of a strike. The sequential order of the Strike-Spare Pulses appearing at points 19 and 20 is such that controlled rectifier D-15 cannot be fired until the second consecutive strike is bowled i.e. until after the Bias Voltage K has been established. When rectifier D-15 is conducting the Multiple Strike Bias Voltage F is produced.

The Command Pulse at point 18 will reset controlled rectifier D-14 through a normally nonconductive NPN transistor T-19 by momentarily applying the positive supply voltage to the cathode. T-19 connects the Command Pulse point 18 to the cathode of D-14 through its collector-emitter circuit; the base of T-19 is connected to Frame Bias Voltage E via resistor R-31. When D-14 is reset (bias K removed) transistor T-22 is cut off thereby blocking the supply voltage to the anode of controlled rectifier D-15 and thus resetting it. The presence of Frame Bias Voltage E (occurring under the conditions described in the Frame Circuit discussion i.e. no strike bowled on the first ball) is necessary at the base of transistor T-18 to render that transistor conductive and permit D-14 to be reset. As long as D-14 is conducting (Bias K produced) it means that a strike has been bowled and D-15 is conditioned to produce Bias F if a next strike is bowled. As noted, D-15 is reset when D-14 is reset.

The Command Pulses and Strike-Spare Pulses of the Frame and Strike Circuits are arranged to occur in a selected sequence whereby once the bias voltages K and F have been established, they will not be extinguished until the next succeeding cycle of the "Signal Transmitter Stage" after which the Frame Bias Voltage E has been established. Thus the controlled rectifier D-14 (bias K) and hence rectifier D-15 (bias F) are reset after the second ball is bowled in the frame following a strike scored.

Controlled rectifier D-14 (and hence D-15) is manually reset by contacts S-40-3 of the start switch previously noted; contacts S-40-3 are normally opened and connect the positive supply V to the cathode of SCR D-14 whereby closure of contacts S-40-3 extinguishes D-14. D-14 may be alternatively triggered (add) or reset (subtract) by contacts S-42-1 on the zero center, double pole, double throw, toggle switch S-42; switch S-42 has a second set of contacts S-42-2 ganged to operate with contact S-42-1. The movable arm contact S-42-1 is connected to the positive supply V while one contact (add) is connected to the gate of SCR D-14 while the other contact (subtract) is connected to the cathode of SCR D-14. Thus SCR controlled rectifier D-15 may be triggered by contacts S-42-2 on the switch S-42 through capacitor C-2 and may be extinguished by contact S-42-1 in the "subtract" position (since, with D-14 off, D-15 is extinguished). Contact S-42-2 has its movable arm connected to move with the arm of contacts S-42-1 and is connected to the positive potential V and has one contact (add) connected to the gate of SCR D-15 through capacitor C-2. The contact S-42-2 is provided to close prior to contact S-42-1 in the "add" position; this coupled with the transient pulse action of capacitor C-2 insures D-15 to be energized only when D-14 is on prior to actuation of switch S-42. Thus, switch S-42 can be used to produce or extinguish both the Single Strike Bias Voltage K and the Multiple Strike Bias Voltage F.

COUNT CIRCUIT

The function of the Count Circuit, as conditioned by the Frame, Spare, and Strike Circuits, is to translate pinfall information as received from the "Signal Transmitter Stage" into the proper electrical pulses for use by the associated "Counter-Printer Stage" in recording the bowling score. This is done by the number of pulses transmitted to the score counter solenoid L-2.

The Pinfall Pulses from the "Signal Transmitter Stage" through the "Player Selector Stage" are received at points 12, 13 and 14 of the Count Circuit, which is illustrated in the circuit diagram of FIG. 12. The transfer of these Pinfall Pulses to score counter solenoid L-2 is controlled by the operative condition of the associated switching transistors T-4 through T-12. Transistors T-4 through T-12 are conditioned by the various bias voltage (E, F, J, K, P and X) previously described. The score counter solenoid L-2 is utilized (as will be seen in the discussion of the "Counter-Printer Stage") to register the bowling score as the game progresses. More specifically, the Pinfall Pulses received at point 12 are transferred to solenoid L-2 under the following score condition:

1. The Pinfall Pulses resulting from the first ball bowled following two consecutive strikes; these pulses are transferred through normally nonconductive transistor T-4 (rendered conductive by Multiple Strike Bias Voltage F) and normally conductive transistor T-5. Transistor T-4 is an NPN type with its base connected to the Multiple Strike Bias Voltage F via resistor R-16; transistor T-5 is a PNP type with its base connected to the Frame Bias Voltage E via resistor R-17. The emitter-collector circuits of T-4 and T-5 are serially connected between point 12 and a resistor R-27 at the base of a power transistor T-15; T-15 is an NPN transistor with its collector connected to the positive potential V via the solenoid L-2 and with its emitter connected to ground. T-4 is normally nonconductive and will conduct the pulse at point 12 only when the Multiple Strike Bias Voltage F has been applied to its base; T-5 is normally conductive and will be rendered nonconductive by the application of the Frame Bias Voltage E to its base. As long as T-4 and T-5 are conductive all of the Pinfall Pulses at point 12 will be connected to solenoid L-2.

The Pinfall Pulses received at point 13 are transferred to solenoid L-2 under the following score conditions:

1. The Pinfall Pulses resulting from the first ball bowled after a spare; these pulses are transferred through normally nonconductive transistor T-9 (rendered conductive by the Spare Bias Voltage J);

2. The Pinfall Pulses resulting from the second consecutive strike and all successive strikes thereafter; these pulses are transferred through normally nonconductive transistor T-6 (rendered conductive by the Single Strike Bias Voltage K) and normally nonconductive transistor T-8 (rendered conductive by the Strike-Spare Signal at point P);

3. The total Pinfall Pulses (other than a strike) resulting from a frame bowled after a strike; these pulses are transferred through normally nonconductive transistor T-6 (rendered conductive by the Single Strike Bias Voltage K) and normally nonconductive transistor T-7 (rendered conductive by Frame Bias Voltage E.)

The transistor T-6, T-7, T-8, and T-9 are NPN types. Transistor T-9 connects the Pinfall Pulses from Point 13 to transistor T-15 via its collector-emitter circuit which is rendered conductive by the presence of the Spare Bias Voltage J at its base via resistor R-27. Transistor T-6 connects the Pinfall Pulses from point 13 to transistor T-15 via its collector-emitter circuit in series with the collector-emitter circuit either of transistor T-7 or T-8. T-6 is rendered conductive by the presence of the Single Strike Bias Voltage K at its base via resistor R-18 while T-7 and T-8 are rendered conductive by the presence of the Frame Bias Voltage E and Strike-Spare Signal P, respectively, at their bases via resistor R-19 and R-20, respectively.

The Pinfall Pulses received at point 14 are transferred to solenoid L-2 under the following score condition:

1. The total Pinfall Pulses (other than a strike) resulting from a frame bowled; these pulses are transferred through normally conductive transistor T-10 and normally nonconductive transistor T-11 (rendered conductive by Frame Bias Voltage E).

The transistor T-10 is of the PNP type and has its collector-emitter circuit connected in series with the collector-emitter circuit of transistor T-11, which series circuit connects the Pinfall Pulses at point 14 to transistor T-15 and solenoid L-2. Transistor T-10 is normally conductive and will be rendered nonconductive by the application of the Tenth Frame Bias Voltage X at its base via resistor R-22. Transistor T-11 is normally nonconductive and will be rendered conductive by the presence of the Frame Bias Voltage E at its base via resistor R-23. Again, both T-10 and T-11 must be conductive for the Pinfall Pulses at point 14 to be transmitted to solenoid L-2 through the described circuit.

With the count Circuit operating in the above described manner, the number of individual Pinfall Pulses actuating solenoid L-2 will be equal to the numerical value of the score as the game progresses.

- Transistor T-15 is a normally nonconductive NPN power transistor and is used to energize solenoid L-2 as a result of each of the Pinfall Pulses that are allowed to pass thereto through switching transistors T-4 through T-12. A score counter reset motor M-2 is energized by the set of contacts S-40-1 on the start switch which contacts are normally opened and connect the positive potential V to motor M-2 and thence to ground. The action of solenoid L-2 and the function of motor M-2 will be explained in the "Counter-Printer Stage" discussion.

- The Pinfall Pulses received at point 14 and also the Command Pulse at point 16 are transferred to a pinfall counter solenoid L-3 through normally conductive PNP transistors T-13 and T-14. In addition Command Pulses at points 17 and 18 are transferred to solenoid L-3 through the normally conducting transistor T-14. The solenoid L-3 is utilized to register first ball pinfall information, i.e. strike, foul, pinfall, in the "Counter-Printer Stage" in a manner to be described therein. Transistor T-13 and T-14 have their collector-emitter circuits connected in series between Command Pulse point 16 and resistor R-28 at the base of power transistor T-16. Transistor T-16 is of the NPN type and is normally nonconductive and has its collector-emitter circuit in series with the positive supply V, coil L-3 and ground. Transistors T-13 and T-14 are normally conductive and will be rendered nonconductive by the presence of Strike-Spare Signal P and

Frame Bias E, respectively, at their basis via resistors R-25 and R-26, respectively. Pinfall Pulses from point 14 are connected to transistor T-13 and T-14 via diode D-11.

Transistor T-16 is a power transistor used to energize solenoid L-3 as a result of each of the Pinfall Pulses and Command Pulses from points 14, 16, 17 and 18 to its base. The blocking diode D-11 is used to prevent the positive Command Pulse appearing at point 16 from affecting the score counter solenoid L-2. The Command Pulse from points 17 and 18 are connected to the emitter of transistor T-14 and hence these will be transmitted to T-16 and solenoid L-3 solely through transistor T-14. A blocking diode D-12 is used in series with point 18 to prevent positive Pinfall Pulses appearing at point 14 and Command Pulses appearing at points 16 and 17 from affecting the reset circuitry of the Spare and Strike Circuits which are also connected to point 18. A pinfall counter reset solenoid L-4 is actuated by the Command Pulse (from the signal transmitter) that appears at point 23. The action of solenoid L-4 will be explained in the discussion of the "Counter-Printer Stage." Thus the Count Circuit will provide to the solenoid L-2 a number of Pinfall Pulses corresponding to the score attained by the bowler up to that point in the game and will provide to the solenoid L-3 pinfall information indicating the score attained on the first ball in each frame, i.e. strike, foul, pinfall.

PRINT CIRCUIT

The function of the Print Circuit is to provide electrical print pulses to the "Counter-Printer Stage" to perform printing functions to be described in the discussion of that stage.

The Print Circuit, illustrated in FIG. 13, controls the energization of the print solenoid L-7. The print solenoid L-7 when energized causes the Printer Section in the "Counter-Printer Stage" to print; this section and its actuation by the Print Circuit will be described in the discussion of the "Counter-Printer Stage." The print solenoid L-7 is serially connected to the positive potential V and to ground via the collector-emitter circuit of an NPN power transistor T-17. T-17 is normally nonconductive and will be rendered conductive by a positive pulse at its base via resistor R-29.

Solenoid L-7 is energized by the Command Pulse appearing at point 21 through the normally conductive PNP transistor T-28; alternatively solenoid L-7 is energized by the same pulse through normally nonconducting NPN transistor T-29 (rendered conductive by the 10th Frame Bias Voltage X). Transistor T-28 has its collector-emitter circuit connected between point 21 and R-29 and will be rendered nonconductive by the presence of Spare Bias Voltage J at its base via resistor R-44. Transistor T-29 has its collector-emitter connected between point 21 and R-29 and will be rendered conductive by the presence of 10th Frame Bias Voltage X at its base via resistor R-45.

The Command Pulse appearing at point 15 energizes the print solenoid L-7 through normally nonconductive NPN transistor T-27 (rendered conductive by Spare Bias Voltage J) in a time sequence that enables the peculiar scoring situation presented by a spare bowled to be properly recorded. In this regard it should be noted that the Command Pulse appearing at point 15 occurs between the Pinfall Pulses occurring at points 13 and 14 (see "Signal Transmitter Stage" circuit diagram, FIG. 6). The relationship of the Command Pulses appearing at points 15 and 21 relative to the action of the Print Section in the "Counter-Printer Stage" will be described in the discussion of that stage. The transistor T-27 has its collector-emitter circuit connected between point 15 and R-29 and will be rendered conductive by the presence of the Spare Bias Voltage J at its base via resistor R-43.

COUNTER-PRINTER STAGE

Function

The function of each of the 10 "Counter-Printer Stages" is to convert the scoring information received from the "Player Computer Stage" with which it is associated into a permanent progressive record of the bowling score, visible to the player as the game is played. The "Counter-Printer Stage" includes a counter-printer assembly which is comprised of four electromechanical sections (see FIG. 4), the Score Counter section, the Pinfall Counter section, the Frame Symbol Indicating section, and the Printer section. The details of the assembly are shown in FIGS. 14-23. The assembly is generally indicated by the numeral 50 (see FIGS. 14-16). Looking now to FIGS. 14-16 the Score Counter section is indicated by the numeral 52, the Pinfall Counter section is indicated by the numeral 54, the Frame Symbol Indicating section is indicated by the numeral 56 and the Printer section is indicated by the numeral 58.

SCORE COUNTER SECTION

Description

The function of the Score Counter Section 52 is to register the total numerical bowling score during the progress of the game; this numerical score is equal to the number of pulses received by the score counter solenoid L-2 (see Count Circuit FIG. 12 and FIG. 16). As previously described the score counter solenoid L-2 is energized once for each of the Pinfall Pulses received from the "Signal Transmitter Stage" as controlled by the condition of switching transistors T-4 through T-12.

A standard bidirectional counter mechanism 60 having three score counter display wheels 60a, b and c is used to register the total bowling score as the game progresses. The numerical characters of the display wheels 60a-c are raised to cause printing when impressed on a print ribbon 64 and a score tape 66 in a manner to be described. The sequential operation of the score counter section 60 is shown in FIG. 17. When score counter solenoid L-2 is energized, a score counter actuator arm 68 is pulled down toward solenoid L-2 against the force of a torsion spring shaft 70. The actuator arm 68 strikes a rotatably mounted score counter advance cam 72 rotating the cam 72 from its initial position (solid lines (17), FIG. 17) against the counteracting force of a flat score counter advance spring 74. The advance cam 72 has a pair of diametrically opposed pins 76 which are engageable with teeth of an advance gear 78 which is secured to a score counter main shaft 80. As the advance cam 72 rotates one of the pins 76 engages the teeth of advance gear 78 causing it and the main shaft 80 to rotate (see dot-dashed lines of FIG. 17 showing positional sequence). The cam 72 and gear 78 are designed to obtain the desired angular travel (36°) of the score counter main shaft 80 each time the cam 72 is rotated 180°. In operation, energization of solenoid L-2 causes actuator arm 68 to be pivoted with the tension spring shaft 70 into engagement with cam 72 pivoting cam 72 (through the dot-dot-dash position) and moving the advance spring 74 to a biasing position (into the dot-dash position); arm 68 moves cam 72 over center such that at the full end of the actuating stroke (dot-dash position) the bias of spring 74 urges the cam 72 to complete its rotation; when solenoid L-2 is deenergized spring shaft 70 returns arm 68 to its original position and the bias of advance spring 74 completes the 180° rotation of the cam 72. The three score counter display wheels 60a, b, and c are supported on the main shaft 80 and are mechanically interconnected in a conventional manner by counter gears 84 and 86 mounted on a counter shaft 88 whereby each 36° advance of the advance gear 78 and hence each energization of the solenoid L-2 increases the registered count by one digit. The wheel 60c provides the "ones" counter, 60b the "tens" and 60a the "hundreds," and each revolution of 60c provides a 36°

advance of 60b, etc. As will be noted later, the numerical count registered at any time, is in a position to be printed. Thus, the terms "registered position" and "print position" will be used synonymously. A detent spring 82 is used to engage the teeth of gear 78 to insure positive and accurate positioning of the score counter display wheels 60a, b, and c.

The score counter display wheels are reset by the reset motor M-2 (shown only in count diagram, FIG. 12) coupled to the score counter main shaft 80 by means known in the art, whereby upon energization the score counter display wheels 60a, b, and c are rotated back to zero. The contacts S-40-1 (FIG. 12) of the start switch energize the reset motor M-2.

A score counter control knob 84 is attached to one end of the score counter main shaft 80. If a pinfall error should occur in the recorded score, the player may correct the score by rotating the control knob 84 in increments equal to the number of pins in error. The direction in which the control knob 84 is rotated determines whether pins are added or subtracted. The numbers in the score counter dial faceplate not only aid the player in making score corrections but also provides a visual indication of the last digit in a bowling score at any phase of the game.

PINFALL COUNTER SECTION

The function of the Pinfall Counter Section 54 is to register the pinfall information of the first ball bowled in a frame, i.e. strike, foul, or pinfall count. In addition this section determines the scoring information to be printed on each print cycle; the print cycle will be discussed in conjunction with the Printer Section.

The Pinfall Counter Section 54 utilizes a pinfall counter display wheel 90 of unique design and is shown in FIG. 18. Wheel 90 has a small diameter portion 92 which contains the strike symbol (X) and a larger diameter portion 94 which contains the foul symbol and the numerical characters one through nine (in that order). All the characters on this wheel are raised to facilitate printing in a manner to be described. A portion of the wheel 90 has a segment 96 cut away for clearance purposes. It is important to note that both the small and large diameter portions are greater in diameter than the score counter wheels (60a-c), for a purpose to be described in the Printer Section.

The mechanism used to actuate the pinfall counter display wheel 90 is similar to the actuator mechanism of the Score Counter Section 52 previously described and is shown in FIG. 20. As the pinfall counter actuator arm 100 is actuated by the pinfall counter solenoid L-3 (see Count Circuit FIG. 12) the advance gear 102 is rotated by one of a pair of diametrically opposed pins 104 on the advance cam 106. This gear 102 and hence the pinfall wheel 90 coupled thereto is rotated one increment for each pulse received by solenoid L-3 as the result of pulses at points 14, 16, 17 and 18. The gear 102 and pinfall wheel 90 are fixed to the pinfall counter main shaft 108 which is laterally offset relative to the score counter main shaft 80 for a purpose to be described in the discussion of the Printer Section. The advance spring 110 and detent spring 112 serve similar function to springs 74 and 82, respectively of the pinfall actuator mechanism shown in FIG. 17. In the initial or unrotated position the pinfall wheel 90 has the cutaway portion 96 in the registered or print position. For clearance purposes, at this time, the strike symbol or small diameter portion 92 is removed two increments therefrom. Thus upon the occurrence of a strike the two Command Pulses at points 17 and 18 (see Count Circuit FIG. 12) will cause the pinfall counter wheel 90 to register the strike symbol (X).

Upon the occurrence of a foul a Command Pulse at point 16, in addition to Command Pulses at points 17 and 18, is transmitted to the solenoid L-3 advancing the foul symbol (F) on the large diameter portion of the pinfall counter wheel to the registered or print position.

Upon obtaining a pinfall other than a strike or a foul the Pinfall Pulses at point 14, as well as Command Pulses at points

16, 17 and 18 are transmitted to the solenoid L-3 to advance the proper numerical symbol to the registered or print position.

As described in the discussion of the Count Circuit (FIG. 12) solenoid L-3 will be energized only on the first ball bowled in a frame.

The pinfall wheel 90 is reset in the following manner. When the pinfall counter reset solenoid L-4 is energized, the pinfall reset actuator arm 114 (coupled with solenoid L-4 in a manner similar to arm 100 with solenoid L-3 and arm 68 with solenoid L-2) is pulled down toward solenoid L-4, against the force of a pinfall counter spring shaft 116. The actuator arm 114 in its actuated position moves the pinfall counter detent spring 112 away from the pinfall counter advance gear 102. This allows the bias of a pinfall counter reset spring 118, secured to the gear 102 and wheel 90 and the supporting housing thereof to return the display wheel 90 to its original position. A mechanical stop 120 is provided to establish the reference or zero position of the pinfall wheel 90. The solenoid L-4 (see Count Circuit FIG. 12) is energized by the Command Pulse occurring at point 23 each time the signal transmitter is cycled; thus the pinfall wheel is returned to its initial position at the end of the cycle of the signal transmitter (FIG. 6) following the first ball bowled in a frame. As will be seen, the scoring information on pinfall wheel 90 is printed prior to the occurrence of Command Pulse 23.

FRAME SYMBOL INDICATOR SECTION

The function of the Frame Symbol Indicator Section 56 is to register the scoring condition of a second ball bowled in a frame, i.e., spare, foul, or error (less than all pins knocked down).

The operation of the Frame Symbol Indicator Section 56 can best be seen in FIG. 21. The frame symbol display wheel 122 of this device is pie shaped or a sector of a circle pivotally supported on the pinfall main shaft 108 and is used to register an error (-), a spare (/) or a foul (F) (oriented as shown in FIG. 22) as a result of the second ball bowled in a frame. The frame symbol display wheel 122 has a radius the same as that of the score counter wheels 60a-c. A frame symbol centering spring 124 operates on opposite sides of the wheel 122 and maintains the frame symbol wheel in a position that registers the error symbol (-) when both the spare solenoid L-5 and the foul solenoid L-6 are deenergized. When spare solenoid L-5 is energized the display wheel 122 is rotated (pulled toward solenoid L-5) thus registering the spare symbol (/) on the frame symbol display wheel 122. Solenoid L-5 is energized through a Strike-Spare Pulse occurring at point 19 as the result of a spare. The action of the foul solenoid L-6 is similar to that of the spare solenoid L-5 described above. Solenoid L-6 is energized by the Foul Signal transmitted to point 24 from the "Detector Stage" and rotates the wheel 122 until the foul symbol (F) is registered.

PRINTER SECTION

The function of the Printer Section 58 is the following:

1. to print the score registered by the score counter display wheels 60a-c, the pinfall counter display wheel 90, and the frame symbol indicator wheel 122;
2. to advance the score tape 66;
3. to advance the print ribbon 64; and
4. to provide the tenth frame signal (X).

The Printer Section 58 includes three mechanisms:

1. the Print Mechanism (FIGS. 14-16),
2. the Score Tape Advance Mechanism (FIGS. 14-16 and 23); and
3. the Print Ribbon Advance Mechanism (FIGS. 14-16).

The Print Mechanism is used to print scoring information registered by the score counter display wheels 60a-c, the pinfall counter display wheel 90, and the frame symbol indicator wheel 122 and to provide the actuating force necessary for the Score Tape Advance Mechanism and the Print Ribbon Ad-

vance Mechanism. The Score Counter Section 52, Pinfall Counter Section 54, and Frame Symbol Indicator Section 56 are mounted to a counter-printer carriage 126. The carriage 126 is designed to pivot about a counter-printer shaft 128 toward a stationary print backup pad 130 when solenoid L-7 is energized as the result of a Command Pulse appearing at points 14 or 21 (as explained in the Print Circuit discussion). The carriage 126 is returned to its original position by the force of the print solenoid return spring 132 when print solenoid L-7 is deenergized. The actuating force for the score tape advance mechanism and the print ribbon advance mechanism is provided by the force of the solenoid spring 132 in returning the carriage to its initial position.

The score counter display wheels 60a-c and frame symbol display wheel 122, while located on separate shafts (80 and 108 respectively), are designed to simultaneously strike the backup pad 130 (see FIG. 21). The orientation of the resultant printed scoring information on the score tape 66 is illustrated in FIG. 24. The pinfall display wheel 90 is designed to control the total travel of the counter-printer carriage 126 (see FIG. 18) and thereby controls both the information recorded on the score tape 64 and the advancing of the score tape 66 and the print ribbon 64. As previously described in the Pinfall Counter Section 54, the pinfall counter wheel 90 has three separate portions capable of being located in the print position. With the cutaway portion 96 of the pinfall wheel 90 in the print position, the counter-printer carriage 126 upon actuation of print solenoid L-7 causes the score counter wheels 60a-c and the frame symbol wheel 122 to apply force against the backup pad 130. With the small diameter portion 92 of the pinfall wheel 90 in the print position, the counter-printer carriage 126 upon actuation of the solenoid L-7 causes the strike symbol on the small diameter portion 92 to apply force against the backup pad 130. Since the small diameter portion 92 is larger than both the count wheels 60a-c and the frame symbol wheel 126, only the strike symbol will be printed. For the same reason, with the large diameter portion 94 of the pinfall wheel 90 in the print position, only the information on the pinfall wheel 90 will be printed. It is important to note that the travel of the counter-printer carriage is considerably less with the large diameter portion of the pinfall wheel in the print position than with either the small diameter portion 92 or cutaway portion 96 in the print position. These differences in counter-printer carriage travel are utilized by the Score Tape Advance Mechanism in a manner to be described.

The Score Tape Advance Mechanism is used to advance the score tape 66 on a per frame basis and into a position such that the frame which has previously been printed is visible to the player. Referring now to FIGS. 14-16 and 23, a pair of score tape cylinders 134 and 136 frictionally engage and upon rotation advance the score tape 66 over the print backup pad 130. Fixed to the shaft 138 of the cylinder 136 is a score tape advance cam 140. A score tape pall 142 is pivotally fixed to the counter-printer carriage 126 to rotate in one direction only and engages the advance cam 140 as the counter-printer moves toward the backup pad 130 to perform the print operation. During this movement the pall 142 is pivoted about its support 144 against a fixed, flat return spring 146. The sequence of operation is shown in FIG. 23. Thus the score tape 66 will not move during the print operation. When the counter-printer carriage 126 has traveled a sufficient distance toward the print backup pad 130, the score tape pall 142 will be pivoted and moved beyond the end of the advance cam 140 and spring 146 will return pall 142 to its original position. Since the score tape pall 142 (by engagement with a stop shoulder 148) cannot pivot in the opposite direction, the advance cam 140 will be rotated by the pall 142 on the return stroke of the carriage 126. The required distance for advancing the tape 66 is traveled by the counter-printer carriage 126 only when the cutaway portion 96 or the small diameter portion 92 (strike symbol) of the pinfall counter wheel 90 is in the print position. The sequence of operations of the Score Tape Advance Mechanism is shown in FIG. 23. In the start position

the components of the advance mechanism are shown in solid lines; this indicates the position prior to movement of carriage 126. Next is shown the travel of the counter-printer carriage 126 to a nonadvance position as limited by the large diameter portion 94 of the pinfall counter wheel 90. Note in this position the score tape pall 142 is not moved beyond the advance cam 140 and hence the score tape 66 will not be advanced for this print operation. Thus on the printing of first ball information (other than a strike), the score tape 66 will not be advanced. The counter-printer carriage 126 can move to tape advance positions one and two at which the tape 66 will be advanced (shown in dot-dash lines). The carriage 126 will move to the number two position when the cutaway portion 96 of the pinfall counter wheel 90 is in the print position. Upon the return stroke of the counter-printer carriage 126, the pall 142 will rotate the advance cam 140, advancing the score tape 66. Note that upon the return stroke, when the pall 146 has rotated the advance cam approximately 90°, the force of an advance spring 150 at this point causes the advance cam 140 to complete 180° of rotation (similar to the action of spring 74 and cam 72 and spring 110 and cam 106). The diameter of the score tape cylinders 134 and 136 is such as to advance the score tape 66 one frame for 180° of rotation.

The counter-printer carriage 126 will move to the advance position number one when the small diameter portion 92 (strike symbol) of the pinfall counter wheel 90 is in the print position. With the carriage 126 moved to the advance position number one, the advance cam 140 will be rotated by the pall 142 on the return stroke to advance the score tape 66.

The Print Ribbon Advance Mechanism is used to advance the print ribbon 64 over the score tape 66 as it passes over the print backup pad 130. The Print Ribbon Advance Mechanism employs a pall 152 and pall spring 154 combination similar to that used in the Score Tape Advance Mechanism. The print ribbon advance pall 142 is pivotally mounted on a support 156 to the linkage of the print solenoid. When the print solenoid L-7 linkage travels toward the print backup pad 130, the pall 152 pivots away from a toothed ribbon advance gear 158 which is ratcheted to a shaft 160 supporting the ribbon takeup spool 162. As the solenoid linkage returns to its normal position, the pall 152 engages the ribbon advance gear 158, causing it to rotate and in turn causing the ribbon takeup spool to rotate whereby the ribbon 64 is removed from the ribbon feed spool 164 and passed over the score tape 66 and over the backup pad 130.

As explained in the Frame Circuit description of the "Player Computer stage," the Tenth Frame Bias Voltage X is required after the 10th frame has been bowled out before the additional ball or balls are bowled. The score tape illustrated in FIG. 24, is provided with a slot 166 in the tape at a point easily related to the 10th frame. A leaf spring-type switch S-43 is mounted in such a way that its contacts 168 are normally separated by the score tape. When the 10th frame has been bowled and the score tape advances, the switch contacts close through the slot 166 on the score tape 66 to provide the Tenth Frame Bias Voltage X.

COUNTER-PRINTER STAGE SUMMARY

Note that the system of the present invention including the Counter-Printer Stage is actuated by the associated apparatus and circuitry provides a means for automatically tabulating the bowling score information. The Counter-Printer provides a per frame indication of the bowling score and by printing the information noted above on the tape 66 records and retains this indication for each frame whereby the score accumulated in each frame will be preserved and can be obtained. The information printed on tape 66 will provide a permanent record whereby the score can be reconstructed at any stage of the game; in this regard note that no electronic storage need be resorted in order to obtain score reconstruction; thus electronic power interruption, etc. will not result in loss of the score record. In addition the score counter wheels 60a-c will

mechanically have the total score obtained at each frame. Thus the Counter-Printer Stage will provide a permanent per frame indication of the score permitting complete score reconstruction.

PLAYER PROCEDURE FOR USING THE BOWLING SCORE COMPUTER SYSTEM

The procedure to be followed by a player in using the bowling score computer system as follows:

1. Advance each of the score tapes to a "start" line (not shown); by moving the associated paper advance control;
2. Push each of the "start" buttons (controlling switches S-40-1, S-40-2, S-40-3, etc.) for each player to reset all circuits in the "Player Computer Stages"; and
3. Push the proper selector button (S-44-A or S-44-B, FIG. 8) for the lane to be used prior to bowling each frame.

PLAYER PROCEDURE FOR CORRECTING A BOWLING SCORE ERROR

The procedure for correcting errors is as follows:

Pinfall Error

1. Rotate the score counter control knob 84 (FIGS. 14-16) in the direction indicated (clockwise to add, counter-clockwise to subtract) a number of increments equal to the pins to be added or subtracted and reposition the score tape 66 when required;

2. Actuate error switch S-45 (Frame Circuit, FIG. 9) as required; and

3. Actuate frame detector switch FDS1 (Detector Stage, FIG. 5) and actuate proper pinfall detector switches, PDS1-PDS10 (FIG. 5).

Strike Error

1. Repeat procedure for pinfall error, and
2. Actuate the strike toggle switch S-42 (Strike Circuit, FIG. 11) as required.

Spare Error

1. Repeat procedure for pinfall error,
2. Actuate the spare toggle switch S-41 (FIG. 10) in the direction indicated to add or subtract a spare.

OPERATIONAL SEQUENCE OF THE BOWLING SCORE COMPUTER SYSTEM

The time sequence of events in the operation of the bowling score computer system as described is set forth below:

1. The player pushes the proper selector button (S-44-A or S-44-B, FIG. 8) for the lane to be bowled; this connects all the points from the "Detector Stage" and "Signal Transmitter Stage" for that lane to the corresponding points within the "Player Computer Stage" and "Counter-Printer Stage" for that player;

2. The player bowls;

3. If a foul is committed a Foul Signal (24-A, FIG. 5) is immediately obtained preventing any pinfall information as a result of that ball from being transmitted to the "Signal Transmitter Stage" (FIG. 6); this occurs if the player should cross the foul line or if his bowling ball should enter either of the lane channels;

4. The pinsetter rack picks up the pins standing and (a) the Pinfall Detector (switches PDS1-PDS10, FIG. 5) in the "Detector Stage" is actuated, and (b) if a strike or spare has been bowled and no foul has been committed, a Strike-Spare Signal (1-A, FIG. 5) is obtained;

5. The Ball Detector (BD, FIG. 5) in the "Detector Stage" is actuated; this occurs after the Pinfall Detector (switches PDS1-PDS10) is actuated; and the Signal Transmitter (FIG. 6), in the "Signal Transmitter Stage" is actuated, i.e. the rotor assembly of the signal transmitter is started for one revolution or cycle;

6. The Pinfall Pulses are transmitted (from signals 2-A through 11-A and point 12-A) to point 12 in the Count Circuit (FIG. 12) of the "Player Computer Stage";

7. The Pinfall Pulses are transmitted (from signals 2-A through 11-A and point 13-A) to point 13 in the Count Circuit of the "Player Computer Stage";

8. A Command Pulse (from +V and point 15-A) is transmitted to point 15 in the Print Circuit (FIG. 13) of the "Player Computer Stage";

9. The Pinfall Pulses are transmitted (from signals 2-A through 11-A and point 14-A) to point 14 in the Count Circuit of the "Player Computer Stage";

10. A Command Pulse (from +V and point 16-A) is transmitted to point 16 in the Count Circuit of the "Player Computer Stage";

11. A Command Pulse (from +V and point 17-A) is transmitted to point 17 in the Count Circuit of the "Player Computer Stage";

12. A Command Pulse (from +V and point 18-A) is transmitted to point 18 in the:

- a. Count Circuit (FIG. 12),
- b. Spare Circuit (Reset) (FIG. 10), and
- c. Strike Circuit (Reset) (FIG. 11);

13. A Strike-Spare Pulse (from signal 1-A through point 19-A) is transmitted to point 19 in the:

- a. Spare Circuit (FIG. 10, spare solenoid L-5 is energized and Spare Bias Voltage J is provided at this point when a spare is bowled), and
- b. Strike Circuit (FIG. 11, Multiple Strike Bias Voltage F is provided at this point when the second consecutive strike is bowled);

14. A Strike-Spare Pulse (from signal 1-A through point 20-A) is transmitted to point 20 in the:

- a. Strike Circuit (FIG. 11, Single Strike Bias Voltage K is provided when a strike is bowled), and
- b. Frame Circuit (FIG. 9, Reset);

15. A Command Pulse (from +V and point 21-A) is transmitted to point 21 in the:

- a. Frame Circuit (FIG. 9, Reset), and
- b. Print Circuit (FIG. 13);

16. A Command Pulse (from +V and point 22-A) is transmitted to point 22 in the Frame Circuit (FIG. 9, Frame Bias Voltage E is provided at this point when another ball must be bowled in the current frame);

17. A Command Pulse (from +V and point 23-A) is transmitted to point 23 in the:

- a. Frame Circuit (FIG. 9, Reset), and
- b. Count Circuit (FIG. 12, Reset);

18. The Signal Transmitter (FIG. 6) in the "Signal Transmitter Stage" completes that cycle and automatically stops;

19. The pinsetter rack completes its cycle; and

20. The Frame Detector (FDS1, FIG. 5) in the "Detector Stage" is actuated; this occurs only when a frame has been completed.

CHARTS OF SCORE CONDITIONS

The following functional diagrams in charts illustrate how the various score conditions are recorded. Only that portion of the circuitry in the "Player Computer Stage" that directly affects the electromechanical devices of the "Counter-Printer Stage" is illustrated. Each functional diagram represents the condition of that circuitry as a result of the sequence of events occurring when one ball is bowled.

The functional diagrams 1-36 represent the count circuit (FIG. 12) and the print circuit (FIG. 13) under various scoring conditions. The points a, b, c, d, f and g in the diagrams 1-36 correspond to the same points in FIGS. 12 and 13 with the same lettered points being commonly connected.

The functional diagrams 1-3 represent the sequential circuit conditions existing and scoring information printed or recorded for the following series of bowling score frame events:

Frame 10	Extra ball(s)
Strike	Strike on first ball; strike on second ball.

FUNCTIONAL DIAGRAM 1

Frame 10th
 9th Frame Score 100
 1st Ball 10 Pins (Strike)
 2nd Ball _____
 3rd Ball _____

Score Tape 66

10 _____
 X _____

Score Printed

No. of Pulses T-4 T-5 No. of Pulses
 12 (10) X - (0) f L-6 (Foul)
 T-6 F T-7 E Condition
 13 (10) a X b (0) f

K E T-8
 b (0) f

LEGEND:

— Conductive
 X Nonconductive

T-9 a (0) f
 J T-27

15 (1) X (0) g
 J T-10 T-11

14 (10) - c X (0) f
 X E

D-11 T-12 c (10) f (10)
 P

L-2

Score
 Counter
 Display
 110

16 (1) T-13 T-14 d (2)
 X P E

L-3

Pinfall
 Counter
 Display
 X

17 (1) d

L-5

(Spare)
 Condition

18 (1) D-12 d

21 (1) T-28 - (1) g
 J

T-29

X (0) g
 X

L-7

(print)
 Condition
 Energized

23 (1) (1)

L-4

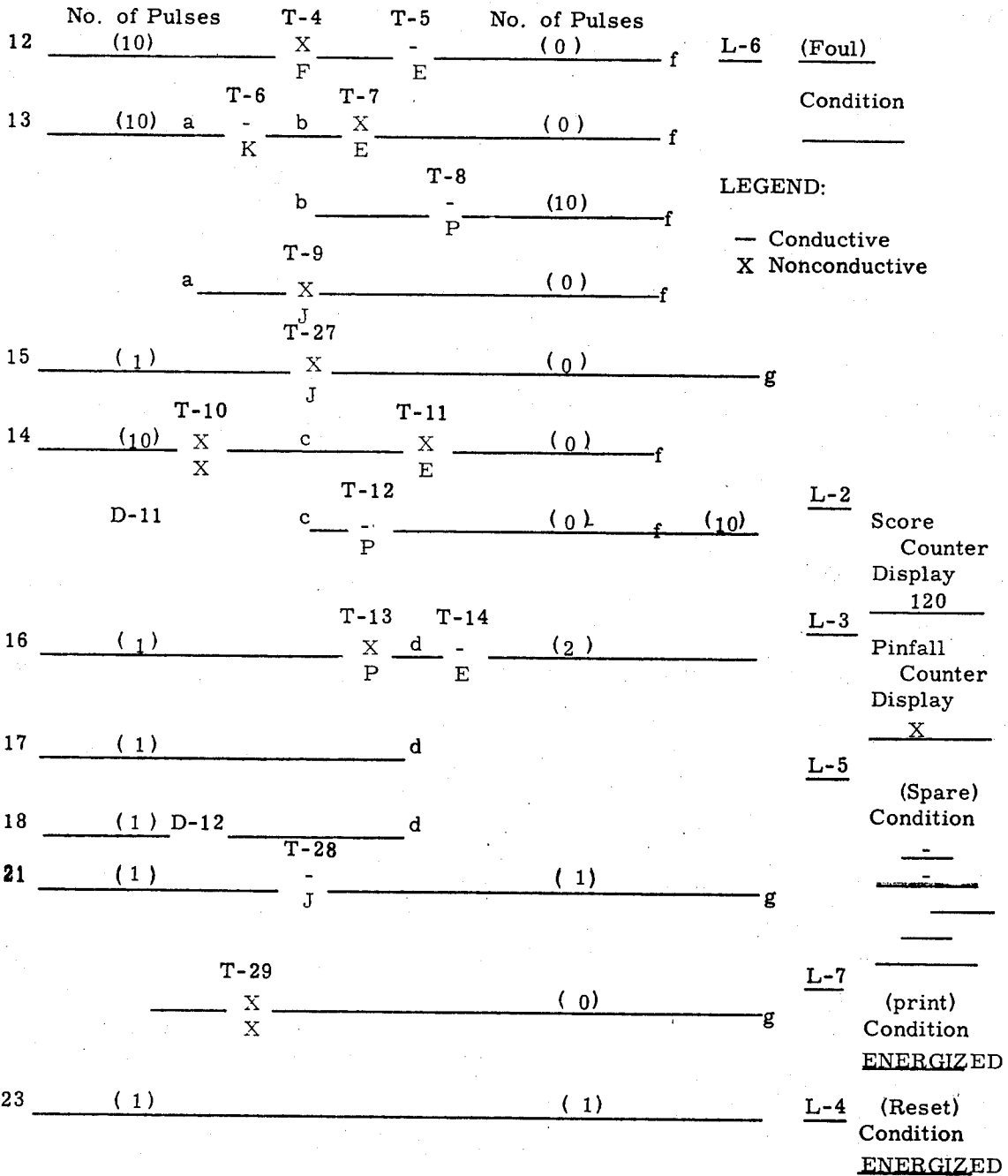
(Reset)
 Condition
 Energized

FUNCTIONAL DIAGRAM 2

Frame 10th
 9th Frame Score 100
 1st Ball 10 PINS (STRIKE)
 2nd Ball 10 PINS (STRIKE)
 3rd Ball PINS

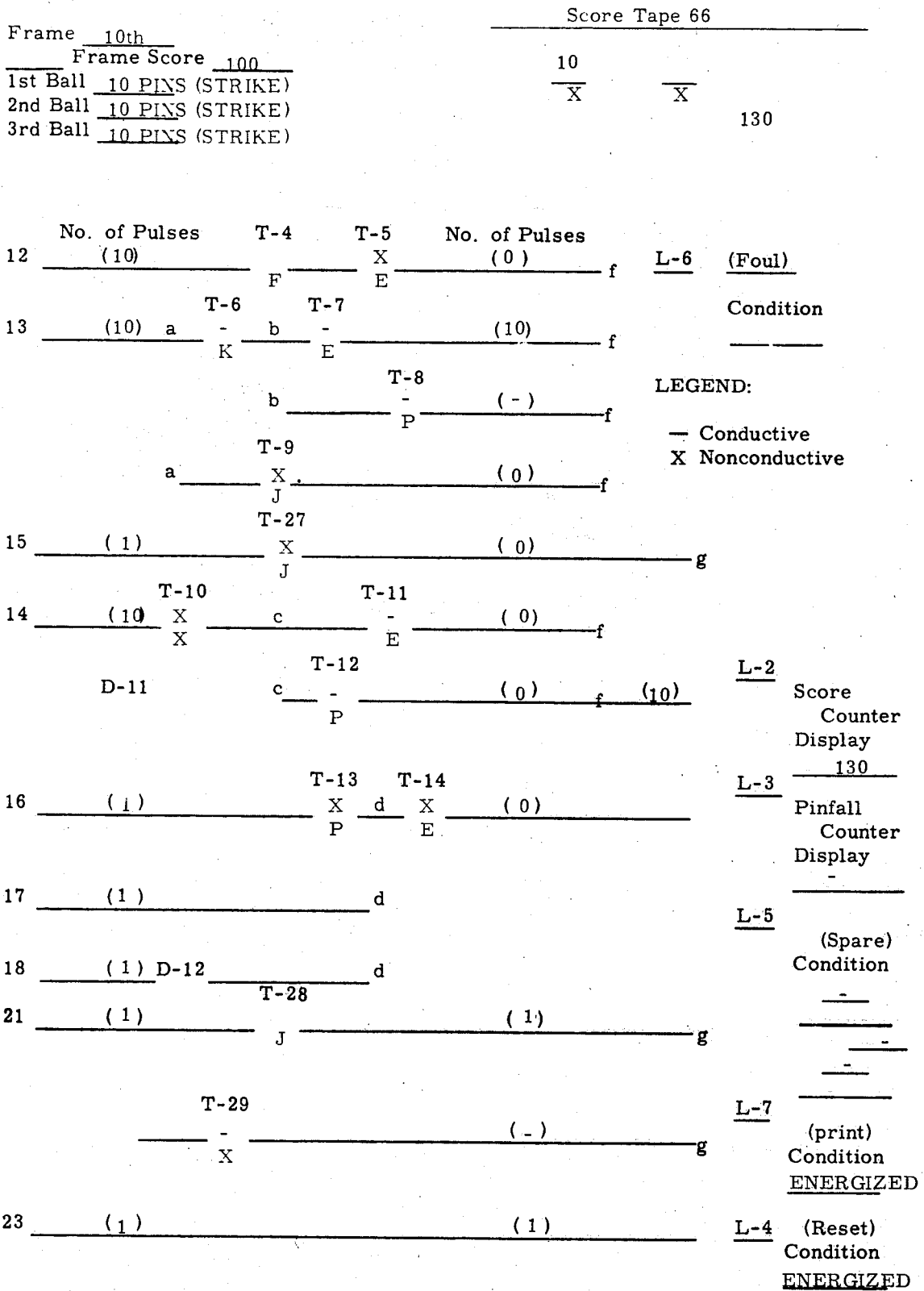
Score Tape 66

10
 X X



LEGEND:

- Conductive
 X Nonconductive

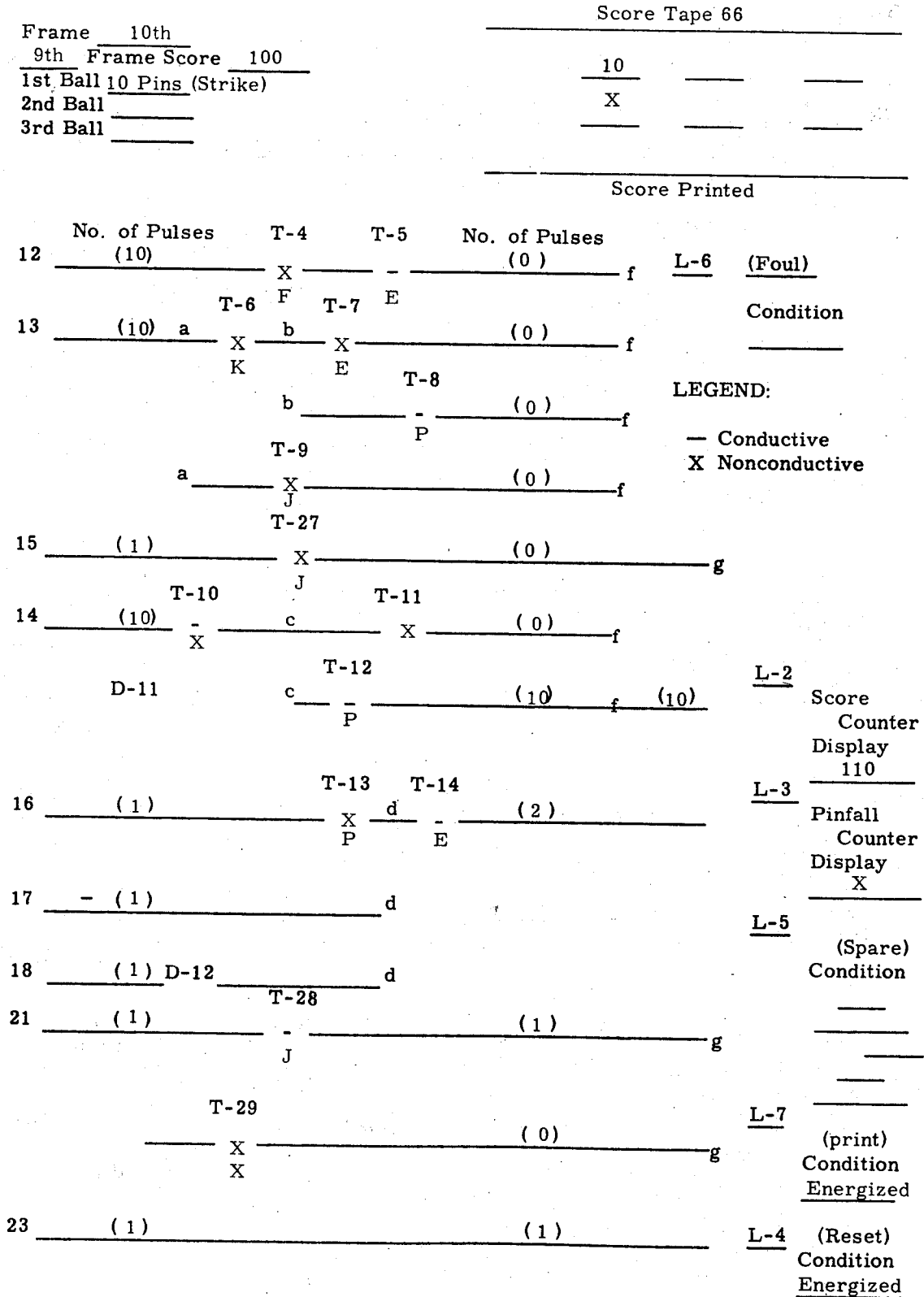
FUNCTIONAL DIAGRAM 3

The functional diagrams 4-6 represent the sequential circuit conditions existing and scoring information printed or recorded for the following series of bowling score frame events:

Frame 10	Extra ball(s)
Strike.....	6 plus on first ball; 4 pins on second ball (spare).

5

FUNCTIONAL DIAGRAM 4



FUNCTIONAL DIAGRAM 5

Frame 10th

9th Frame Score 100

1st Ball 10 Pins (Strike)

2nd Ball 6 Pins

3rd Ball

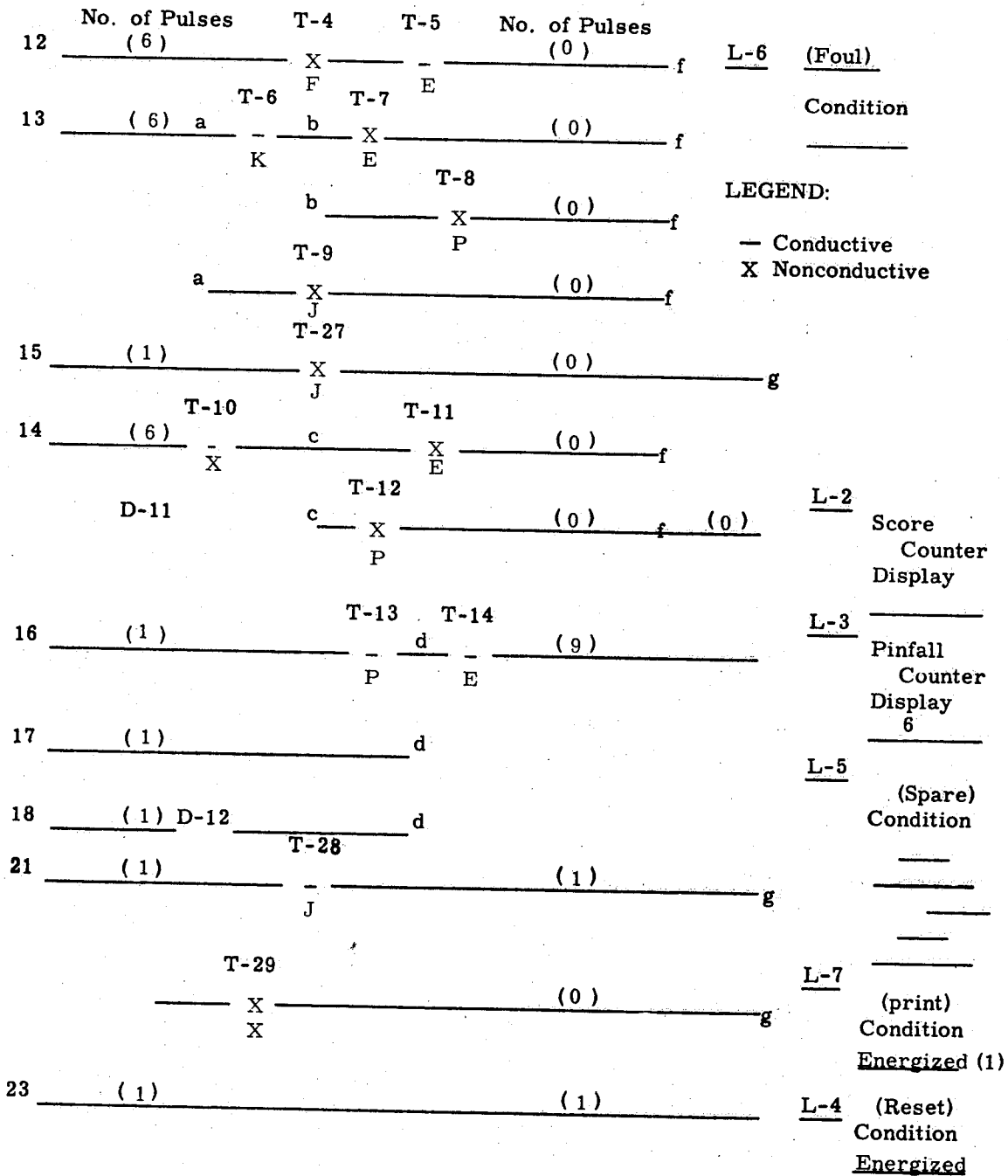
Score Tape 66

10

X

6

Score Printed

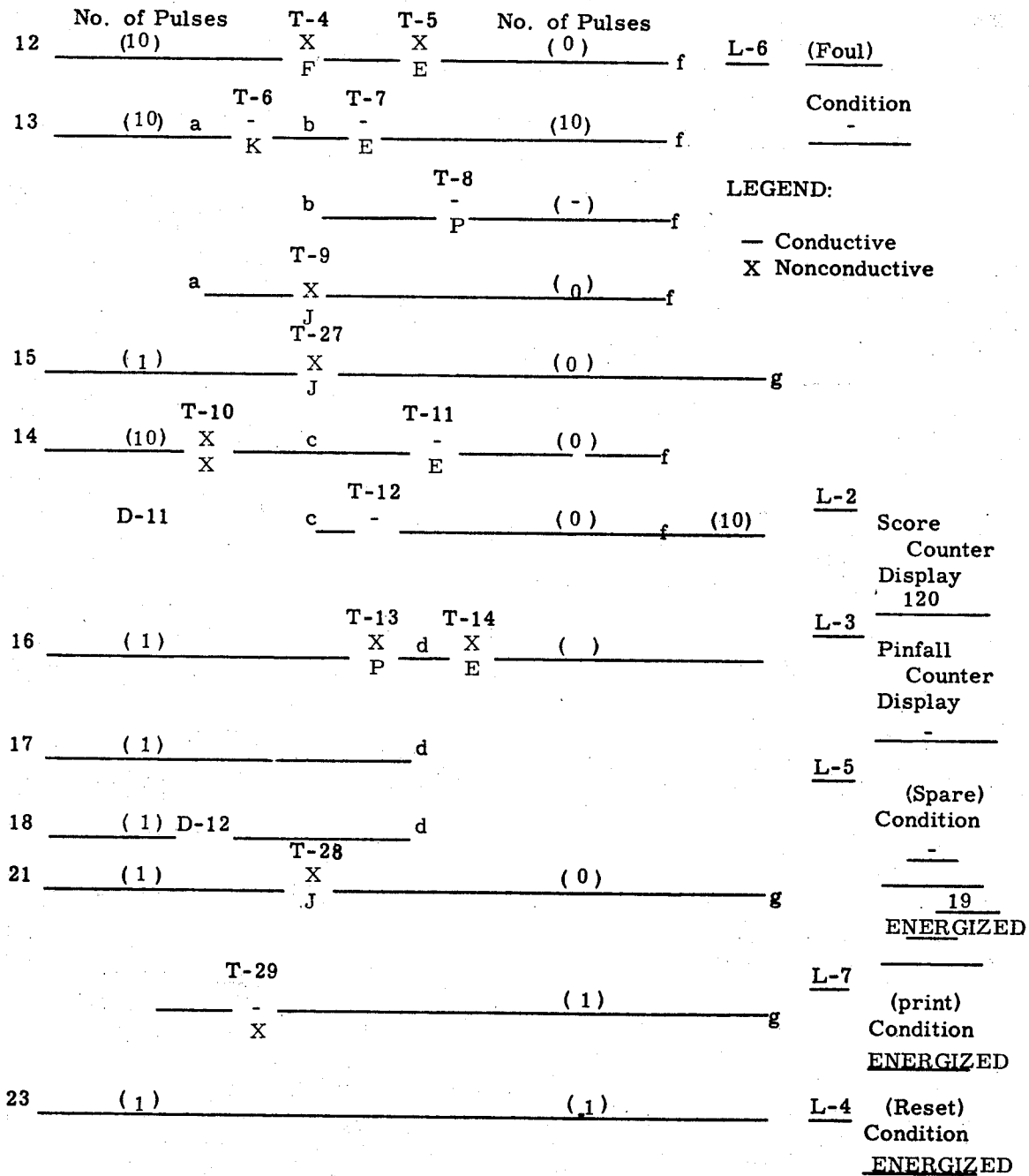


FUNCTIONAL DIAGRAM 6

Frame 10th
 9th Frame Score 100
 1st Ball 10 PINS (STRIKE)
 2nd Ball 6 PINS
 3rd Ball 4 PINS (SPARE)

Score tape 66

10 6/
 X
 120



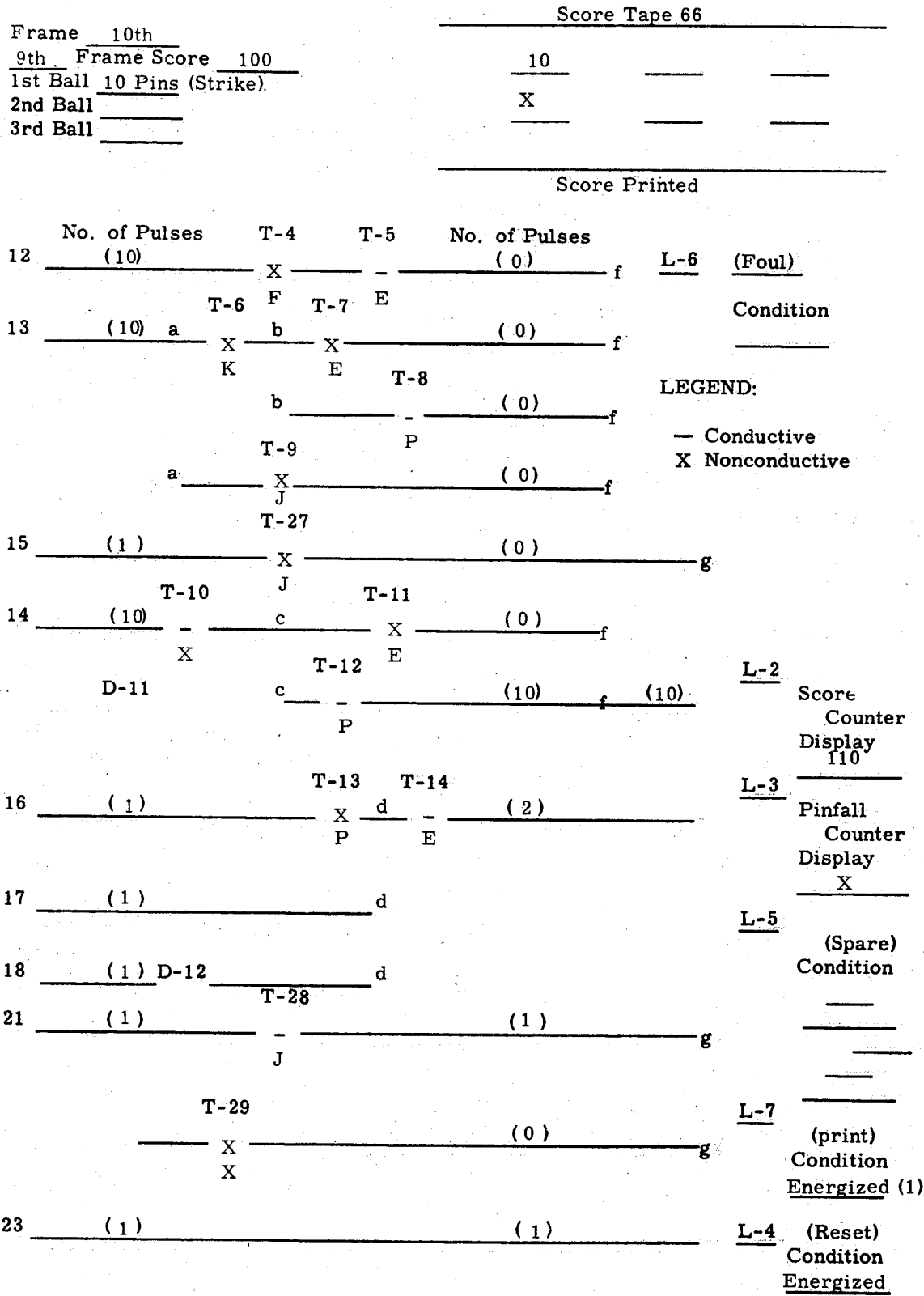
LEGEND:

- Conductive
 X Nonconductive

The functional diagrams 7-9 represent the sequential circuit conditions existing and scoring information printed or recorded for the following series of bowling score frame events:

Frame 10	Extra ball(s)
Strike	4 pins on first ball; 2 pins on second ball.

FUNCTIONAL DIAGRAM 7

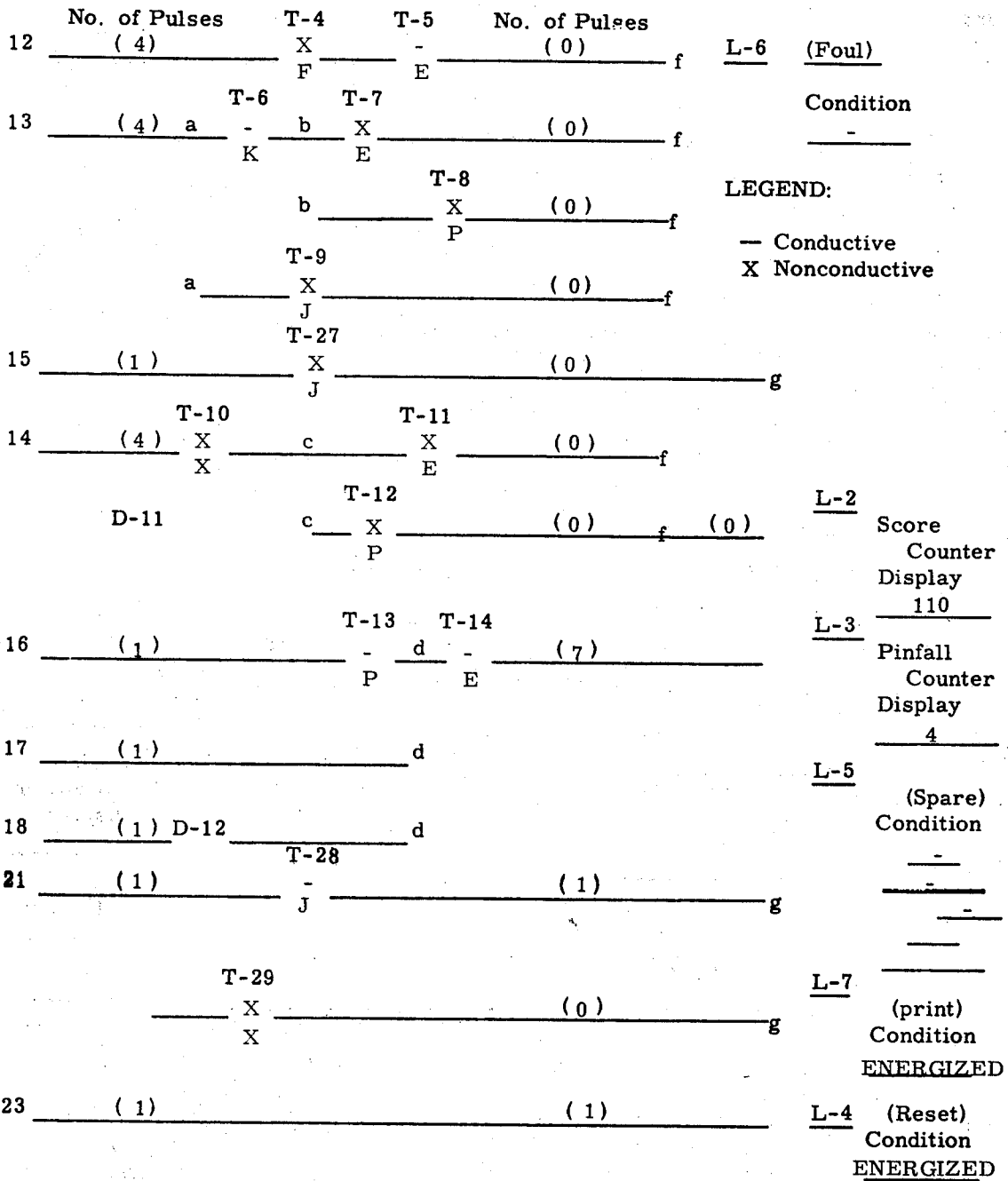


FUNCTIONAL DIAGRAM 8

Frame 10th
9th Frame Score 100
 1st Ball 10 PINS (STRIKE)
 2nd Ball 4 PINS
 3rd Ball PINS

Score Tape 66

10
 X 4



LEGEND:

- Conductive
 X Nonconductive

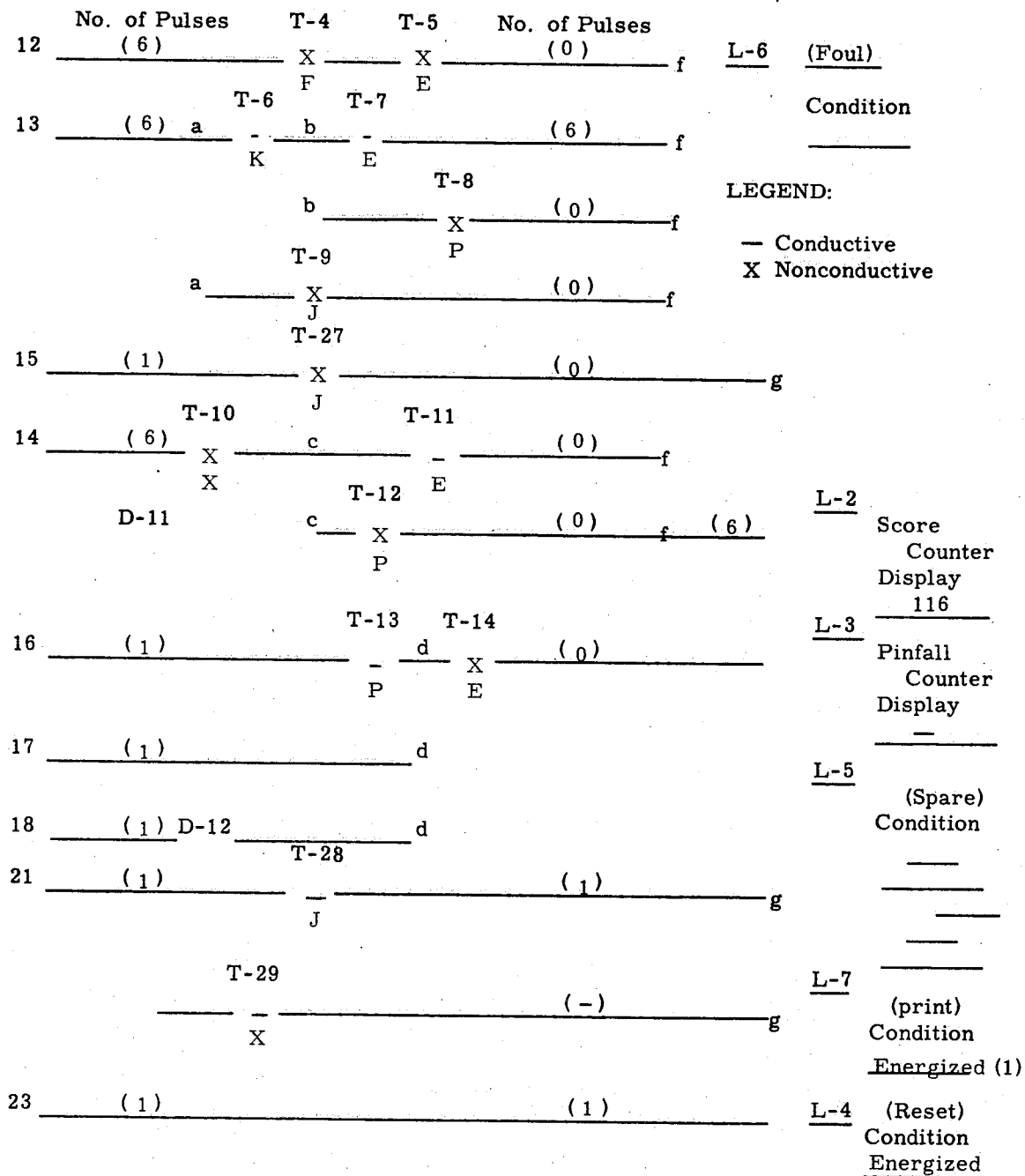
FUNCTIONAL DIAGRAM 9

Frame 10th
 9th Frame Score 100
 1st Ball 10 Pins (Strike)
 2nd Ball 4 Pins
 3rd Ball 2 Pins

Score Tape 66

10		
X	116	4

Score Printed



LEGEND:

— Conductive
 X Nonconductive

The functional diagrams 10-13 represent the sequential circuit conditions existing and scoring information printed or recorded for the following series of bowling score frame events:

Frame..... 1	2
Strike-Foul-Spare.....	Error.
Strike on first ball (foul).....	5 pins on first ball.
10 pins on second ball (spare).....	3 pins on second ball.

FUNCTIONAL DIAGRAM 10

Frame 1
 Frame Score _____
 1st Ball 10 Pins (Foul)
 2nd Ball _____
 3rd Ball _____

Score Tape 66

1	2	3
F		

Score Printed

No. of Pulses	T-4	T-5	No. of Pulses	L-6	(Foul)
12 (0)	X	-	(0)	f	
	F	E			
13 (0) a	X	X	(0)	f	
	K	E			Condition Energized

LEGEND:

— Conductive
 X Nonconductive

No. of Pulses	T-6	T-7	T-8	No. of Pulses	L-2	Score Counter Display
13 (0) a	X	X	X	(0)	f	00
	K	E	P			
		b	X	(0)	f	
	T-9		P			
	a	X	X	(0)	f	
	J					
15 (1)	T-10	X	X	(0)	g	
	J					
14 (0)	c	X	X	(0)	f	
	Δ	E				
	D-11	c	X	(0)	f (0)	
		P				

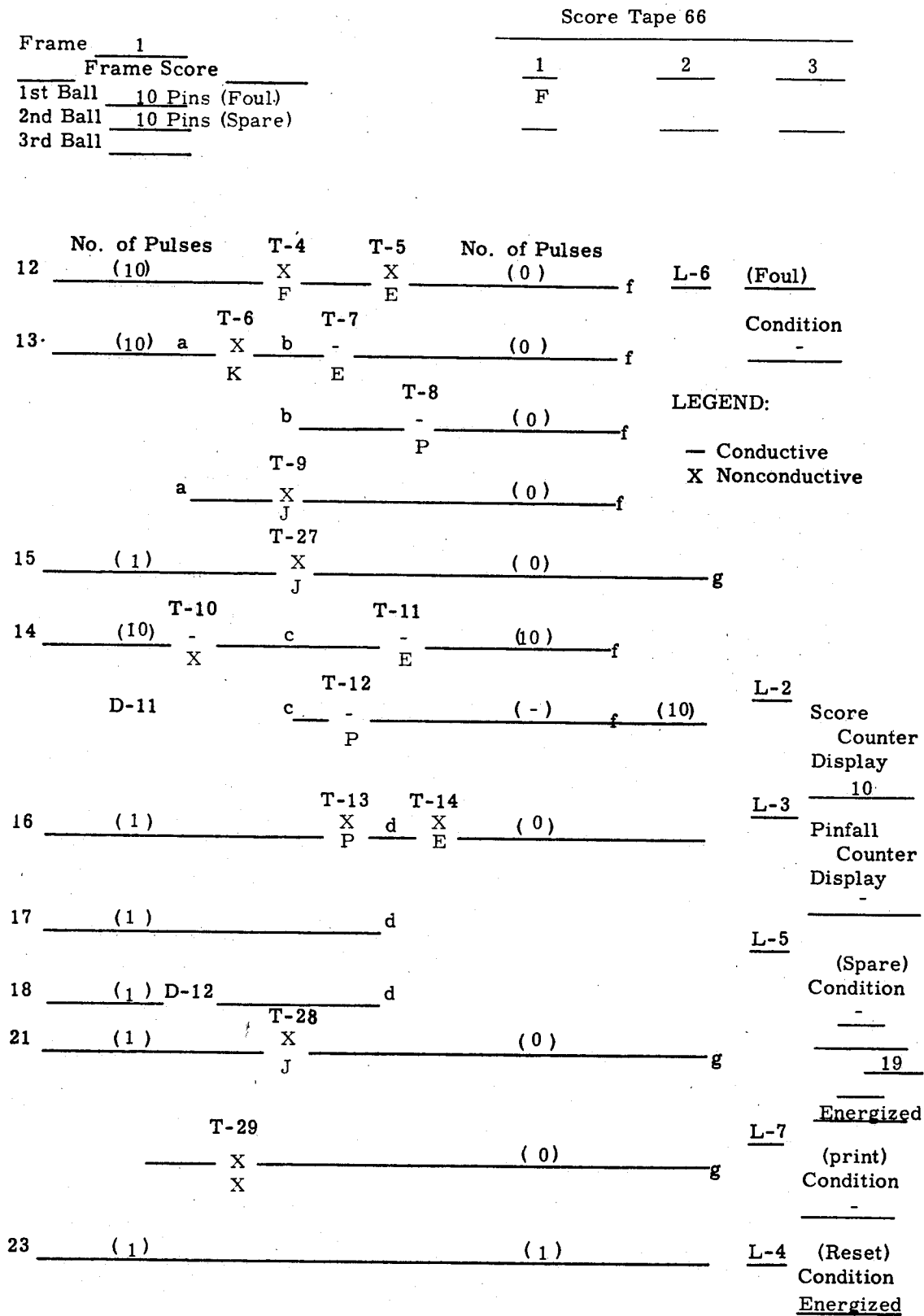
No. of Pulses	T-11	T-12	T-13	T-14	No. of Pulses	L-3	Pinfall Counter Display
16 (1)	d	X	X	X	(3)	F	
		E					
	P						

No. of Pulses	T-13	T-14	No. of Pulses	L-5	(Spare) Condition
17 (1)	d	X	(1)		
18 (1) D-12	d	X	(1)		
21 (1)	J	X	(1)		

No. of Pulses	T-12	T-13	T-14	No. of Pulses	L-7	(print) Condition Energized (1)
17 (1)	d	X	X	(0)	g	
18 (1) D-12	d	X	X	(1)		
21 (1)	J	X	X	(1)		

No. of Pulses	T-13	T-14	No. of Pulses	L-4	(Reset) Condition Energized
23 (1)	X	X	(1)		

FUNCTIONAL DIAGRAM 11



12	No. of Pulses (5)	T-4	T-5	No. of Pulses (0)	f	L-6	(Foul)
		X	-				
		F	E				
13	(5) a	T-6	T-7	(0)	f		Condition
		X	X				
		K	E				
			T-8				
		b	X	(0)	f		
			P				
		T-9					
	a	-		(5)	f		
		J					
		T-27					
15	(1)	-		(1)	g		
	*(Print spare symbol & "15" in 1st frame)		J				
		T-10					
14	(5)	c	T-11	(0)	f		
		X	X				
			E				
		T-12					
	D-11	c	X	(0)	f	(5)	
			P				
16	(1)	T-13	T-14	(8)			
		-	d				
		P	E				
17	(1)		d				
18	(1) D-12		d				
		T-28					
21	(1)	J		(1)	g		
	(Print "5" in box of 2nd frame)						
		T-29					
		X		(0)	g		
		X					
23	(1)			(1)			

LEGEND:

- Conductive

X Nonconductive

L-2

Score

Counter

Display

(15*) 15

L-3

Pinfall

Counter

Display

5

L-5

(Spare)

Condition

Energized

Point 18

Deenergized

L-7

(print)

Condition

Energized

L-4

(Reset)

Condition

Energized

FUNCTIONAL DIAGRAM 13

Frame 2
 Frame Score _____
 1st Ball 5 Pins
 2nd Ball 3 (Error)
 3rd Ball _____

Score Tape 66

1	2	3
F	5 -	
15	23	

12 No. of Pulses (8) T-4 X F T-5 X F No. of Pulses (0) f L-6 (Foul)
 13 (8) a T-6 X b T-7 - (0) f Condition
 K E

LEGEND:

— Conductive
 X Nonconductive

b T-8 X (0) f P
 T-9 a X (0) f J
 T-27 15 (1) X (0) J g
 T-10 14 (8) - c T-11 - (8) f X E
 D-11 T-12 c X (0) f P (8)

L-2 Score Counter Display 23

T-13 T-14 16 (1) - d X (0) P E

L-3 Pinfall Counter Display

17 (1) d

L-5 (Spare) Condition

18 (1) D-12 d

T-28 21 (1) - (1) g J

L-7 (print) Condition Energized

T-29 X (0) g X

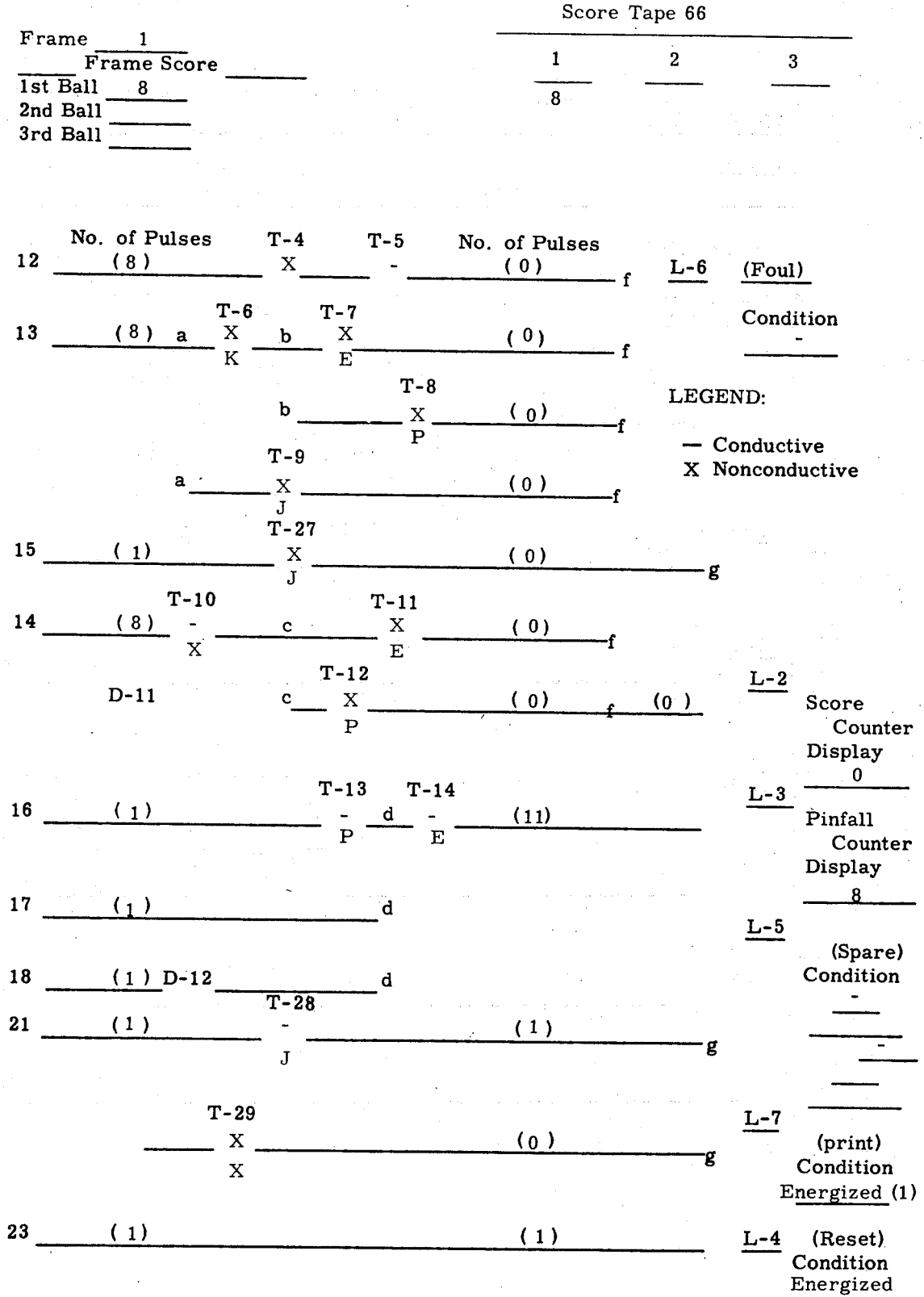
23 (1) (1)

L-4 (Reset) Condition Energized

The functional diagrams 14—19 represent the sequential circuit conditions existing and scoring information printed or recorded for the following series of bowling score frame events:

Frame... 1	2	3
Spare-Foul..... 8 pins on first ball. 2 pins on second ball (foul).	Error-Foul..... 7 pins on first ball. 2 pins on second ball (foul).	Error-Foul..... 8 pins on first ball (foul). 6 pins on second ball.

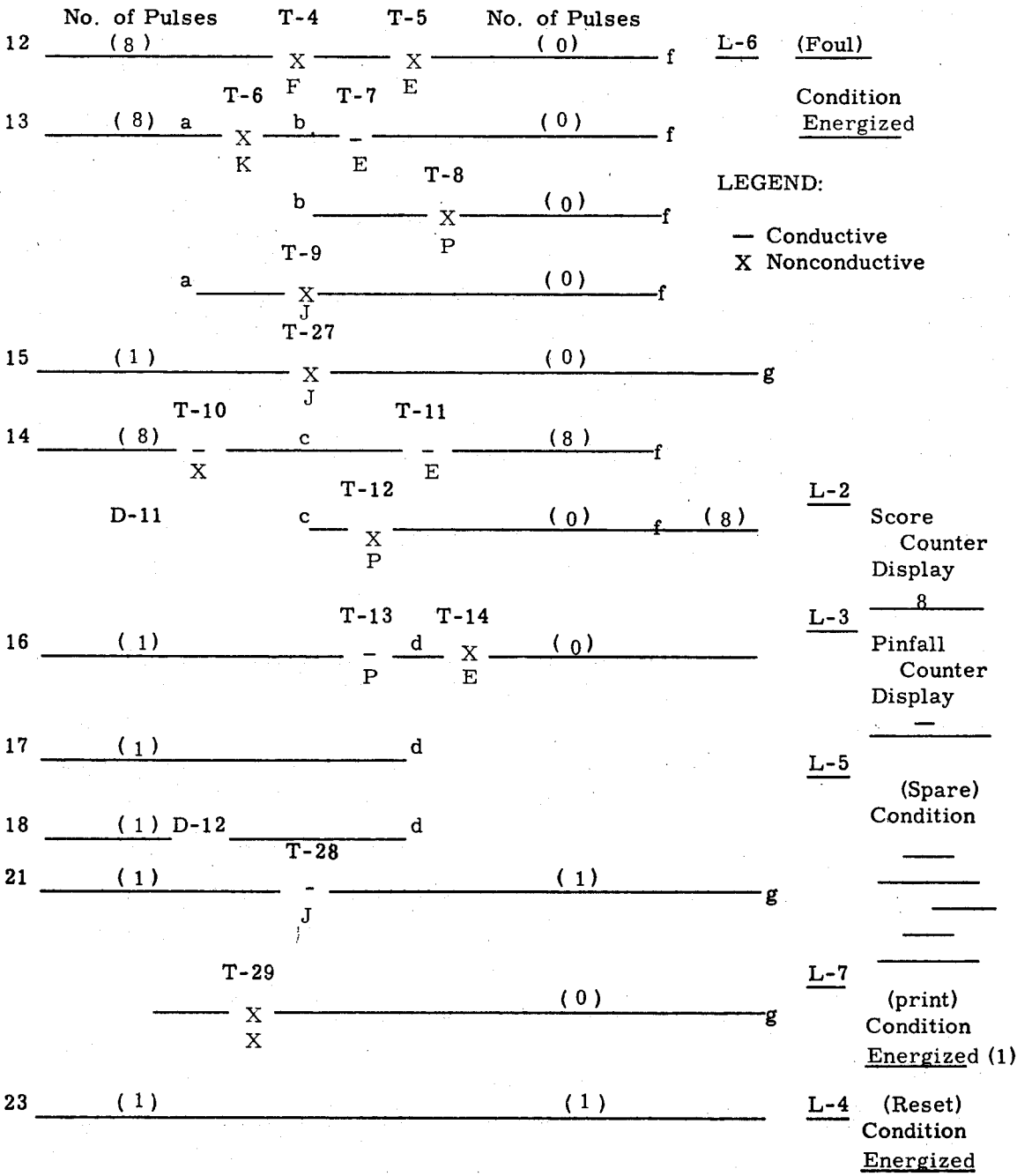
FUNCTIONAL DIAGRAM 14



FUNCTIONAL DIAGRAM 15

Frame 1
Frame Score
1st Ball 8 Pins
2nd Ball 2 Pins (Foul)
3rd Ball

Score Tape 66			
	1	2	3
08	8 F		
Score Printed			



FUNCTIONAL DIAGRAM 16

Score Tape 66

Frame 2
 Frame Score _____
 1st Ball 7 Pins
 2nd Ball _____ Pins
 3rd Ball _____

1	2	3
8 F	7	

08

	No. of Pulses	T-4	T-5	No. of Pulses		
12	(7)	X F	- F	(0)	f	L-6 (Foul)
13	(7) a	T-6 X K	T-7 X E	(0)	f	Condition -

LEGEND:

— Conductive
 X Nonconductive

		b	T-8 X P	(0)	f	
		a	T-9 X J	(0)	f	
15	(1)		T-27 X J	(0)	g	
14	(7)	T-10 -	c	T-11 X E	(0)	f
		D-11	c	T-12 X P	(0)	f (0)

L-2
 Score Counter Display
 8

16	(1)		T-13 -	d	-	(10)
			P	E		

L-3
 Pinfall Counter Display
 7

17	(1)		d
----	-----	--	---

L-5
 (Spare) Condition
 -

18	(1)	D-12	d
----	-----	------	---

21	(1)		T-28 -	(1)	g
			J		

-
 -
 -

		T-29 X	(0)	g
		X		

L-7
 (print) Condition Energized

23	(1)		(1)
----	-----	--	-----

L-4
 (Reset) Condition Energized

FUNCTIONAL DIAGRAM 17

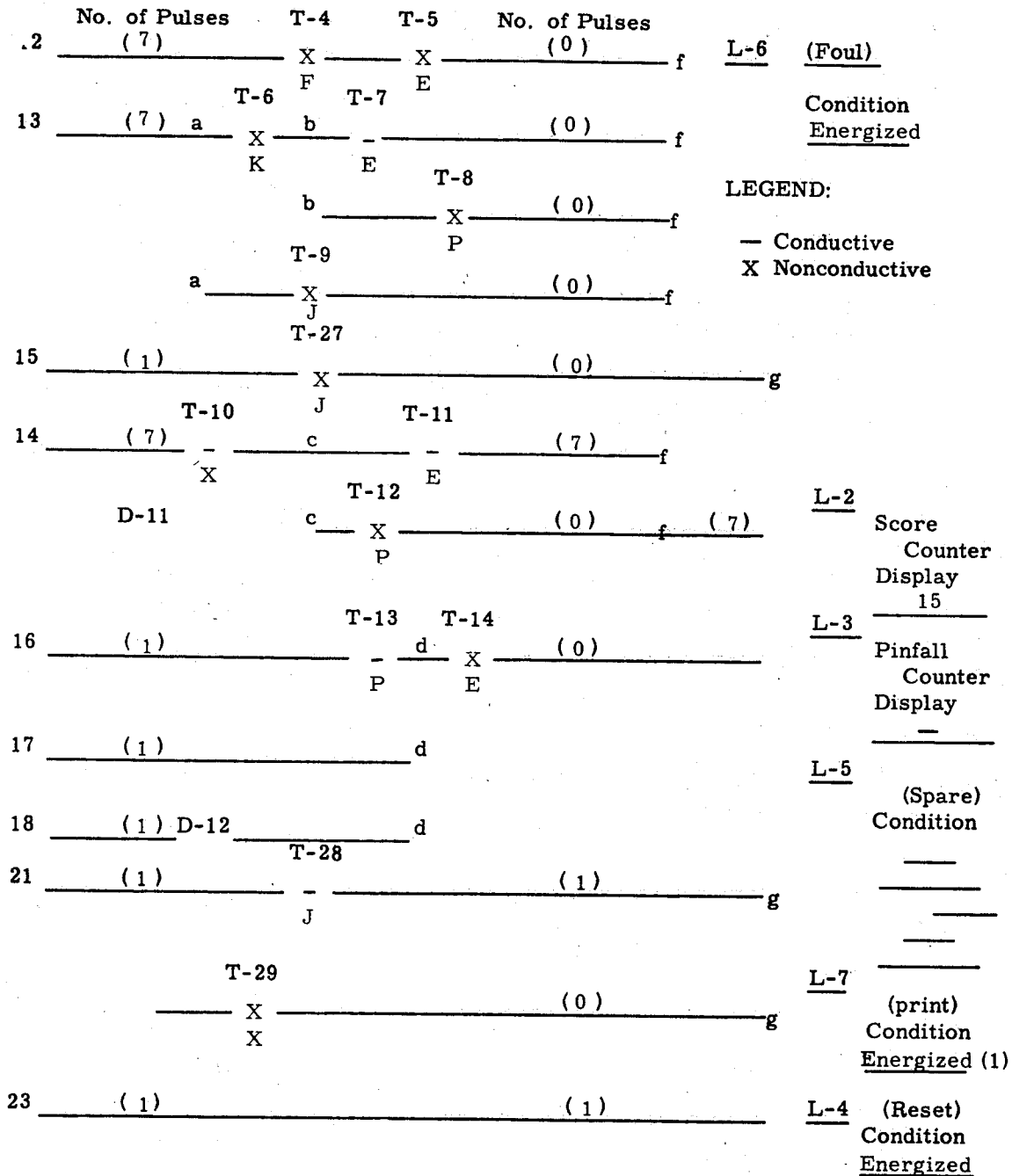
Frame 2

Score Tape 66

Frame Score _____
 1st Ball 7 Pins _____
 2nd Ball 2 Pins (Foul) _____
 3rd Ball _____

	1	2	3
08	8 F	15 7 F	

Score Printed



FUNCTIONAL DIAGRAM 18

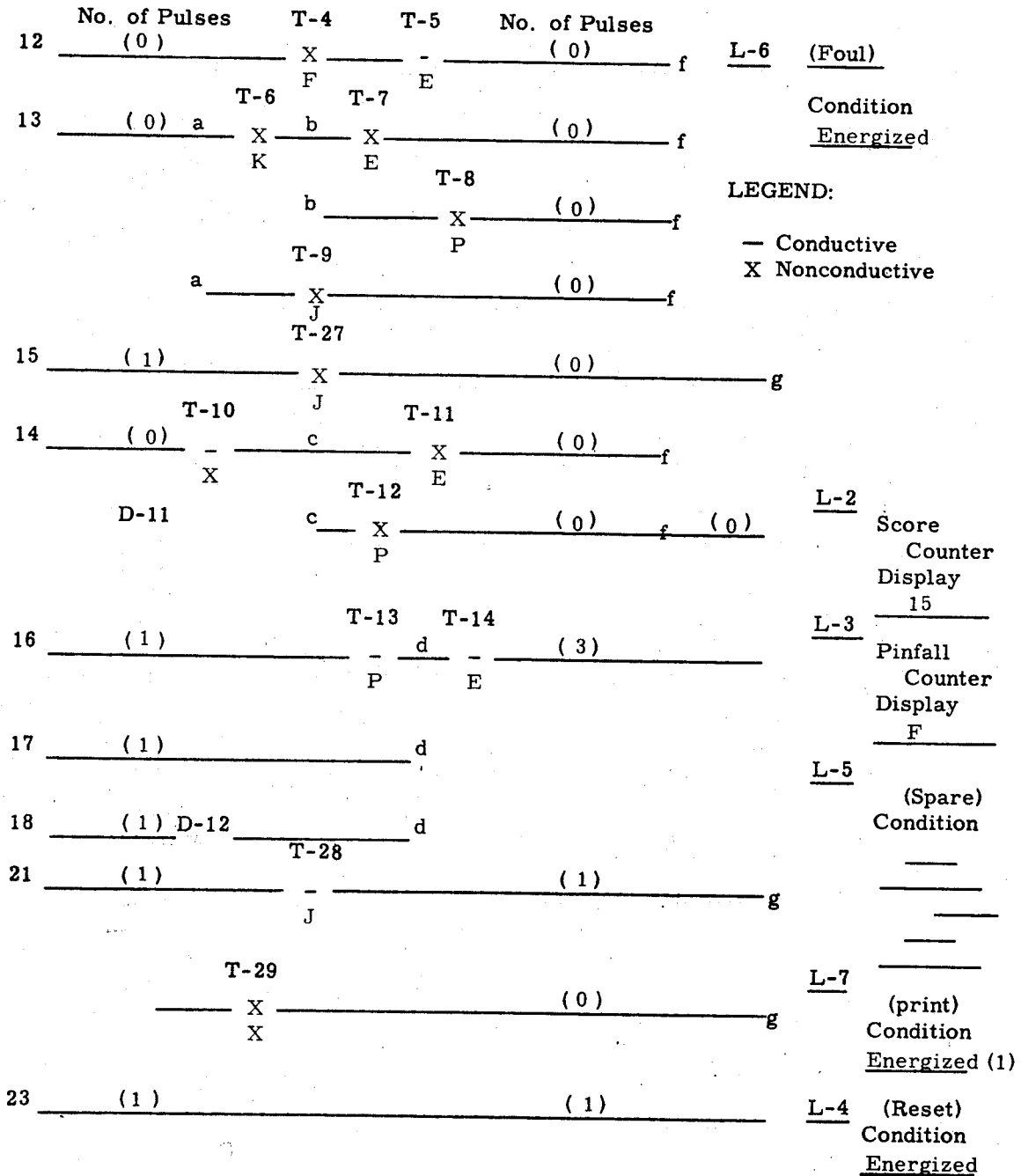
Frame 3

Score Tape 66

Frame Score
1st Ball 8 Pins (Foul)
2nd Ball
3rd Ball

1		2		3	
08	8 F	15	7 F		F

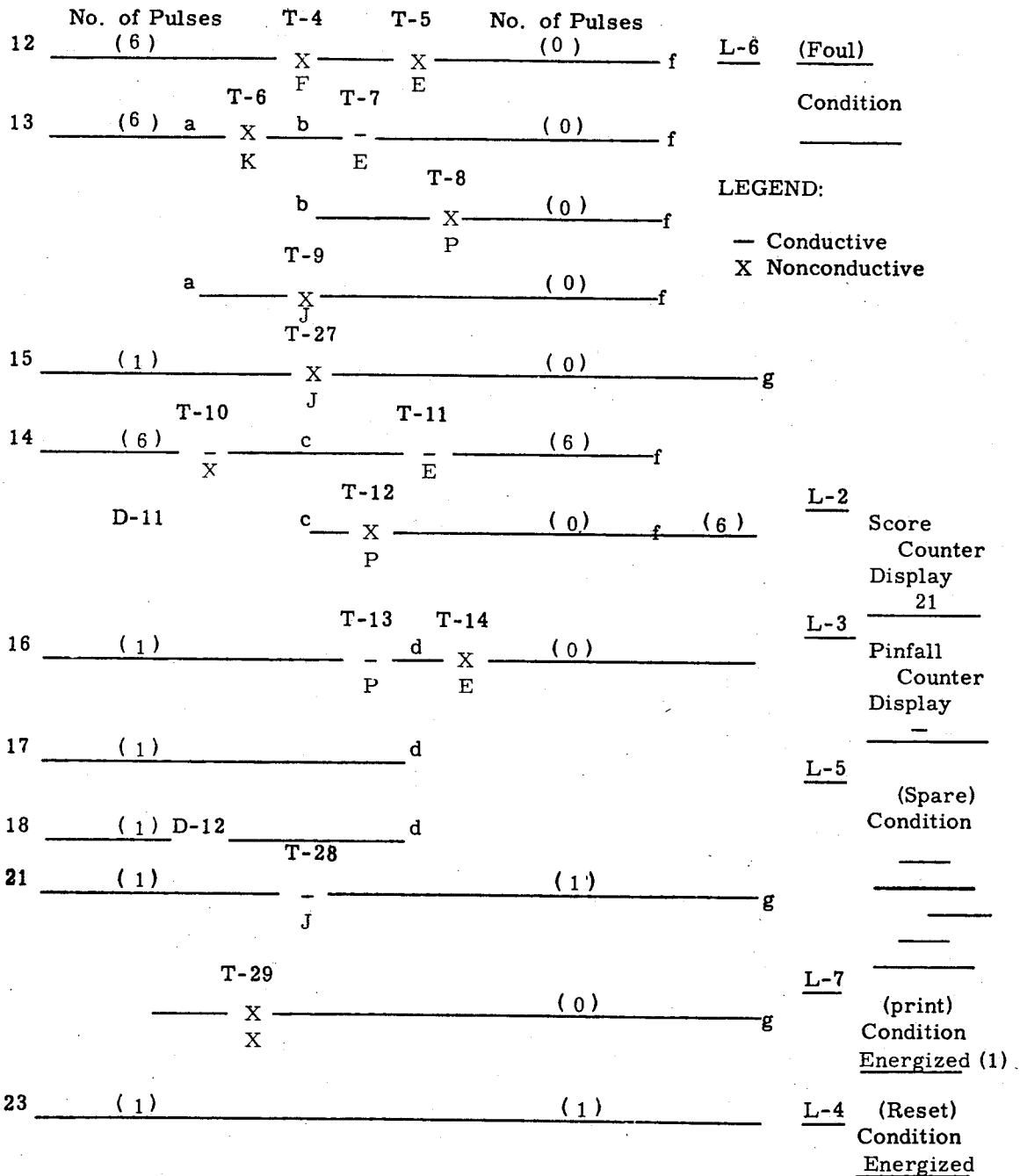
Score Printed



FUNCTIONAL DIAGRAM 19

Frame 3
 Frame Score _____
 1st Ball 8 Pins (Foul)
 2nd Ball 8 Pins
 3rd Ball _____

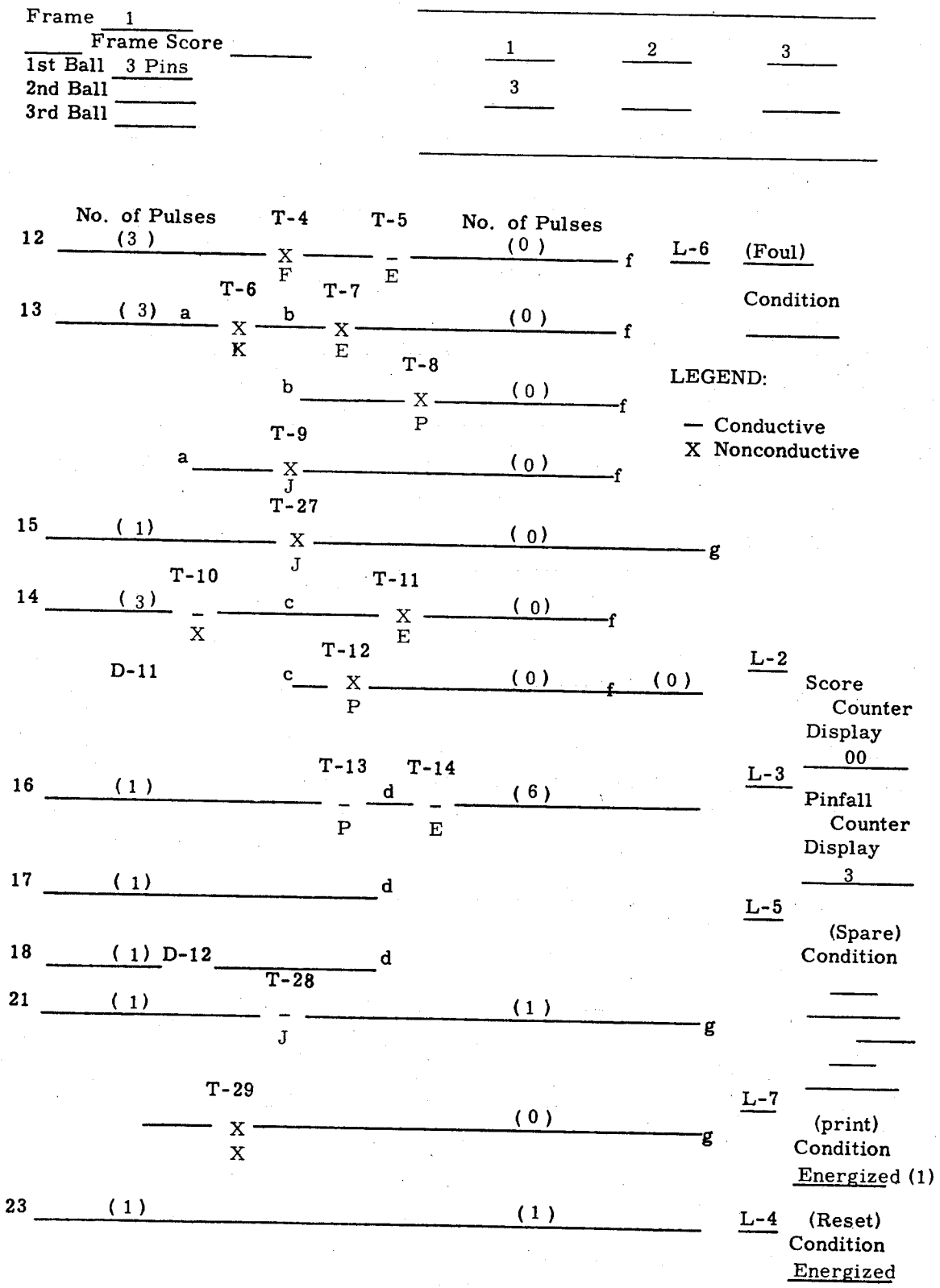
Score Tape 66									
1			2			3			
08	8	F	15	7	F	21	F	-	
Score Printed									



The functional diagrams 20-24 represent the sequential circuit conditions existing and scoring information printed or recorded for the following series of bowling score frame events:

Frame	1	2	3
Spare	(3 pins on first ball)	(6 pins on first ball)	(3 pins on second ball)
Strike	(7 pins on second ball)		
Error		(6 pins on first ball)	(3 pins on second ball)

FUNCTIONAL DIAGRAM 20



FUNCTIONAL DIAGRAM 21

Frame 1
 Frame Score _____
 1st Ball 3 Pins
 2nd Ball 7 Pins (Spare)
 3rd Ball _____

Score Tape 66

1	2	3
3		

12 No. of Pulses (10) T-4 X F T-5 - F No. of Pulses (0) f L-6 (Foul)
 13 (10) a X b X (0) f Condition
 K E

T-6 T-7
 b - (0) f
 P

LEGEND:

- Conductive
 X Nonconductive

T-8
 a X (0) f
 J

15 (1) T-27 X (0) g
 J

14 (10) T-10 - c T-11 - (10) f
 X E

D-11 T-12 c - (-) f (10)
 P

16 (1) T-13 X d T-14 X (0)
 P E

17 (1) d

18 (1) D-12 d

21 (1) T-28 X (0) g
 J

T-29 X (0) g
 X

23 (1) (1)

L-2
 Score
 Counter
 Display

10

L-3
 Pinfall
 Counter
 Display

1

L-5
 (Spare)
 Condition

-

19

L-7
 Energized

(print)
 Condition

-

L-4 (Reset)
 Condition
 Energized

FUNCTIONAL DIAGRAM 22Frame 2

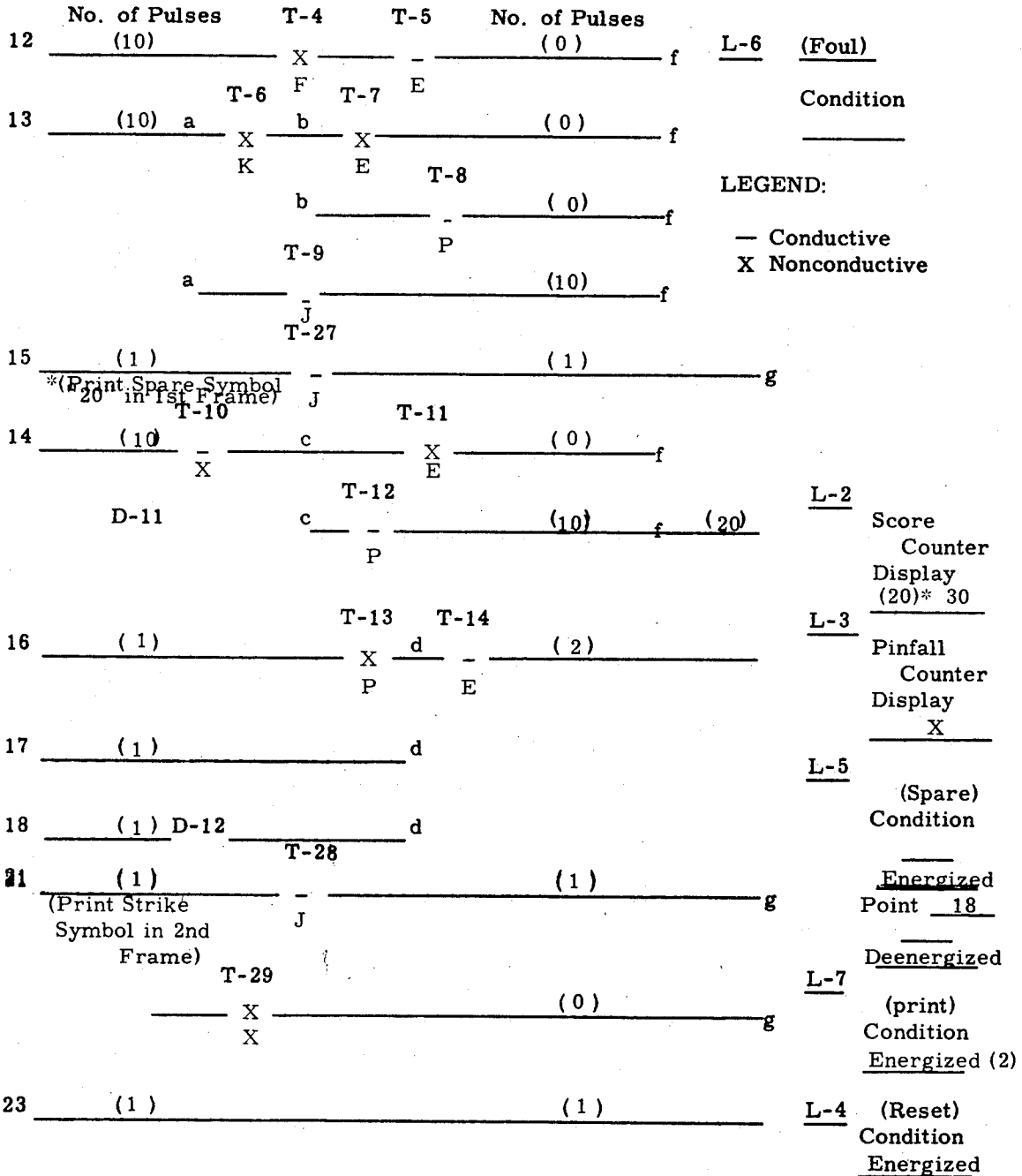
Frame Score

1st Ball 10 Pins (Strike)2nd Ball 3rd Ball

Score Tape 66

	1	2	3
20*	3 /	X	

Score Printed



FUNCTIONAL DIAGRAM 23

Score Tape 66

Frame 3
 Frame Score _____
 1st Ball 6 Pins
 2nd Ball Pins
 3rd Ball

1	2	3
3 /	X	6
20		

	No. of Pulses	T-4	T-5	No. of Pulses		
12	(6)	X	-	(0)	f	L-6 (Foul)
		F	F			
13	(6) a	X	X	(0)	f	Condition
		K	E			

LEGEND:

— Conductive
 X Nonconductive

		b	X	(0)	f	
		T-8	P			
	a	X		(0)	f	
		T-9	J			
		T-27				
15	(1)	X		(0)	g	
		J				
14	(6)	c	X	(0)	f	
		X	E			
	D-11	c	X	(0)	f	(0)
		P				

L-2

Score
 Counter
 Display
 30

16	(1)	d	(9)	
		P	E	

L-3

Pinfall
 Counter
 Display
 6

17	(1)	d	
----	-----	---	--

L-5

(Spare)
 Condition

18	(1)	D-12	d
----	-----	------	---

21	(1)	T-28	(1)	g
		J		

L-7

(print)
 Condition
 Energized

	T-29	X	(0)	g
		X		

23	(1)	(1)	
----	-----	-----	--

L-4

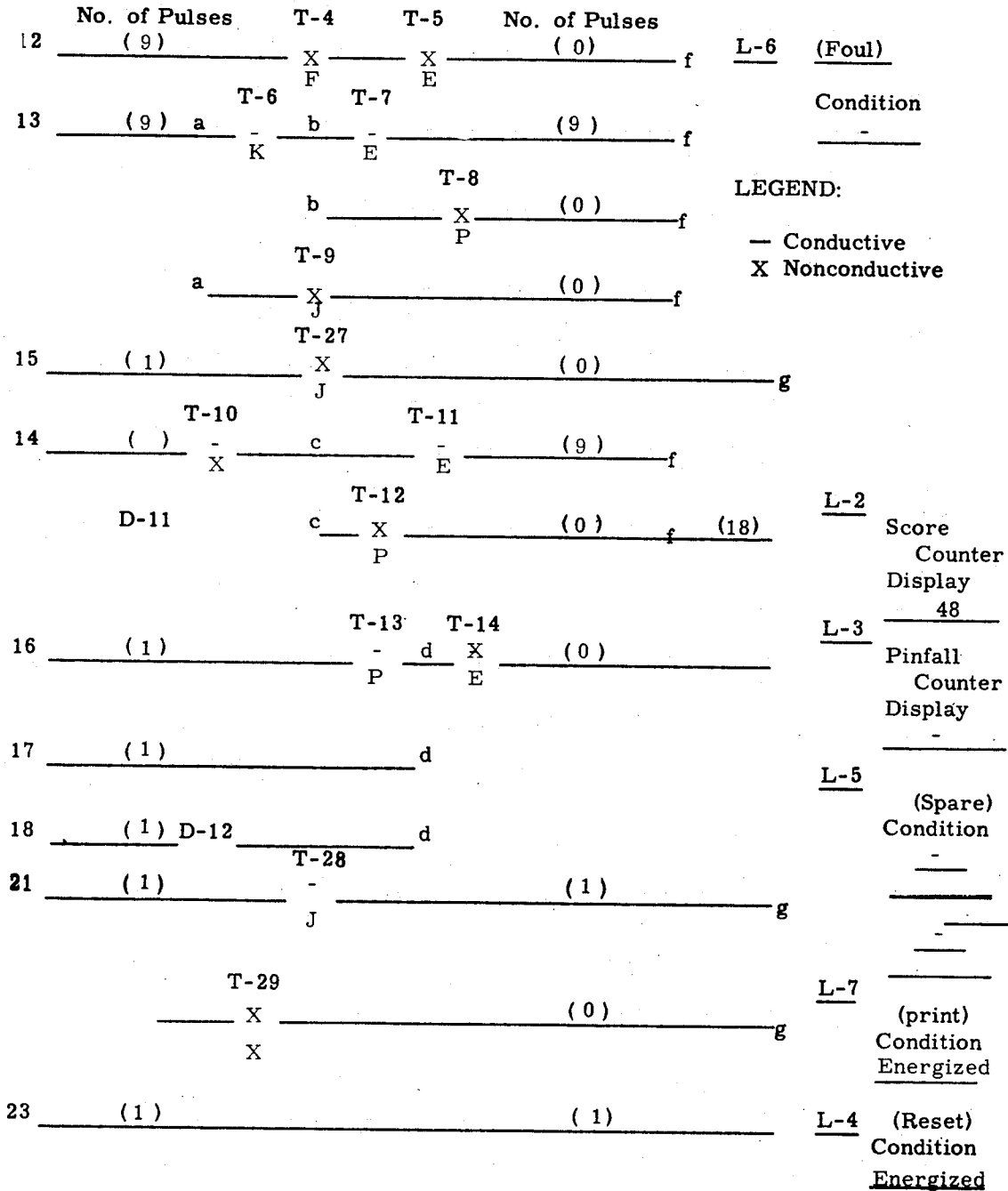
(Reset)
 Condition
 Energized

FUNCTIONAL DIAGRAM 24

Score Tape 66

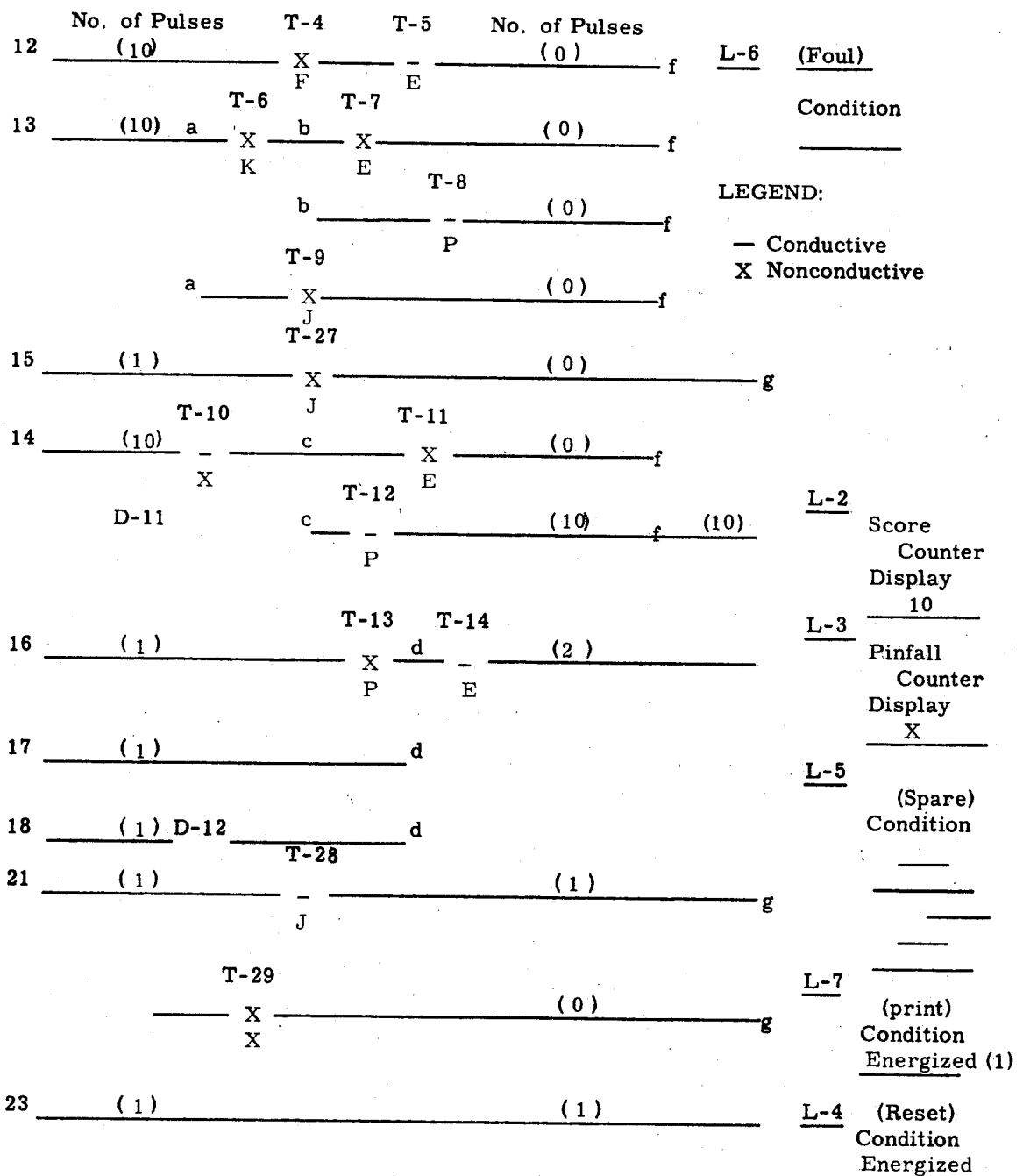
Frame 3
 Frame Score _____
 1st Ball 6 Pins
 2nd Ball 3 Pins
 3rd Ball _____

1	2	3
3 /	X	6 -
20		48

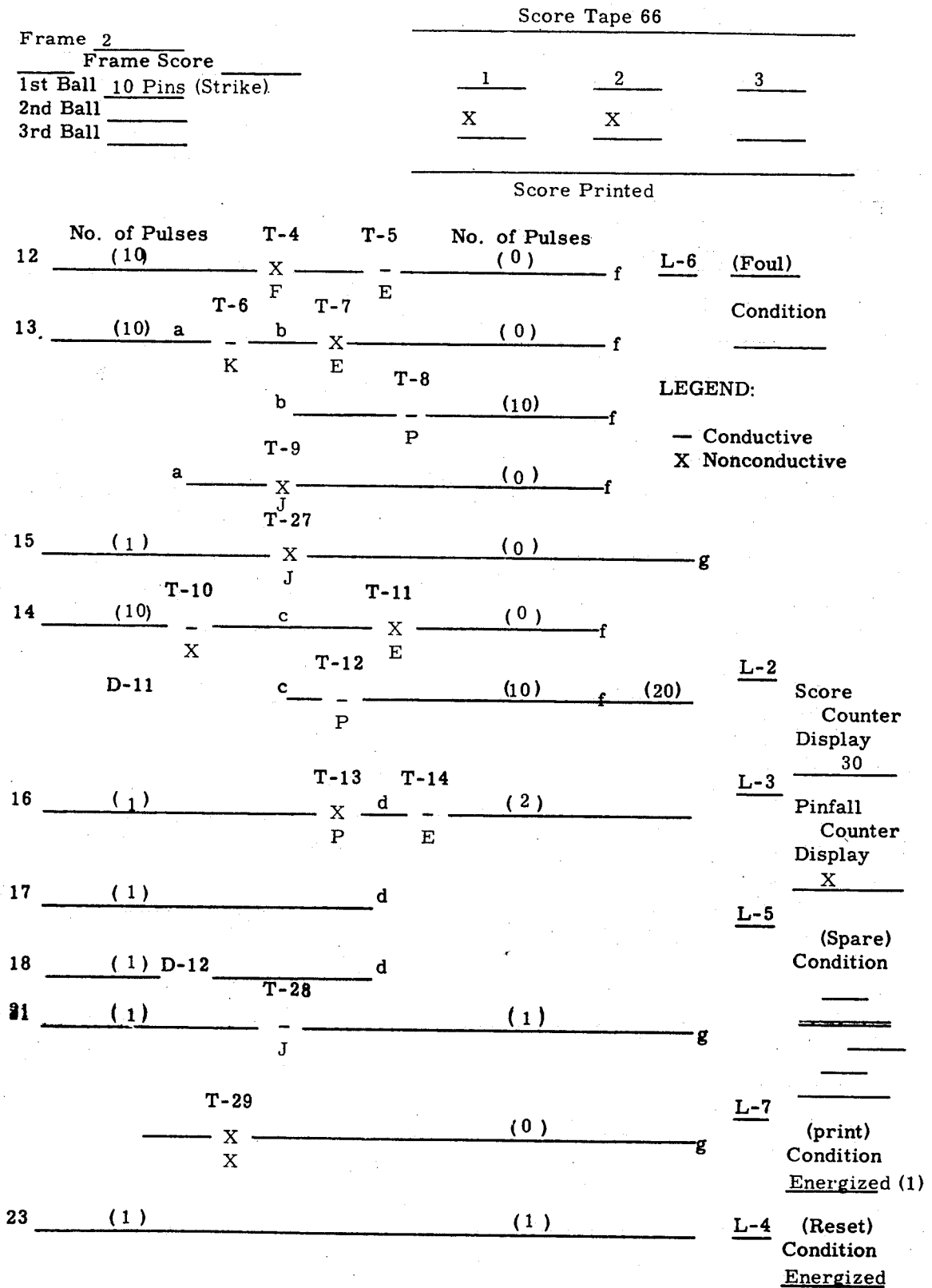


Frame.....1	2	3
Strike.....	Strike.....	Error. (8 pins on first ball). (1 pin on second ball).

Frame <u>1</u> Frame Score _____ 1st Ball <u>10 Pins</u> (Strike). 2nd Ball _____ 3rd Ball _____	<hr/> Score Tape 66 <hr/> <table border="0" style="width: 100%;"> <tr> <td style="width: 33%; text-align: center;">1</td> <td style="width: 33%; text-align: center;">2</td> <td style="width: 33%; text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">X</td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> </table> <hr/> Score Printed _____	1	2	3	X			_____	_____	_____
1	2	3								
X										
_____	_____	_____								



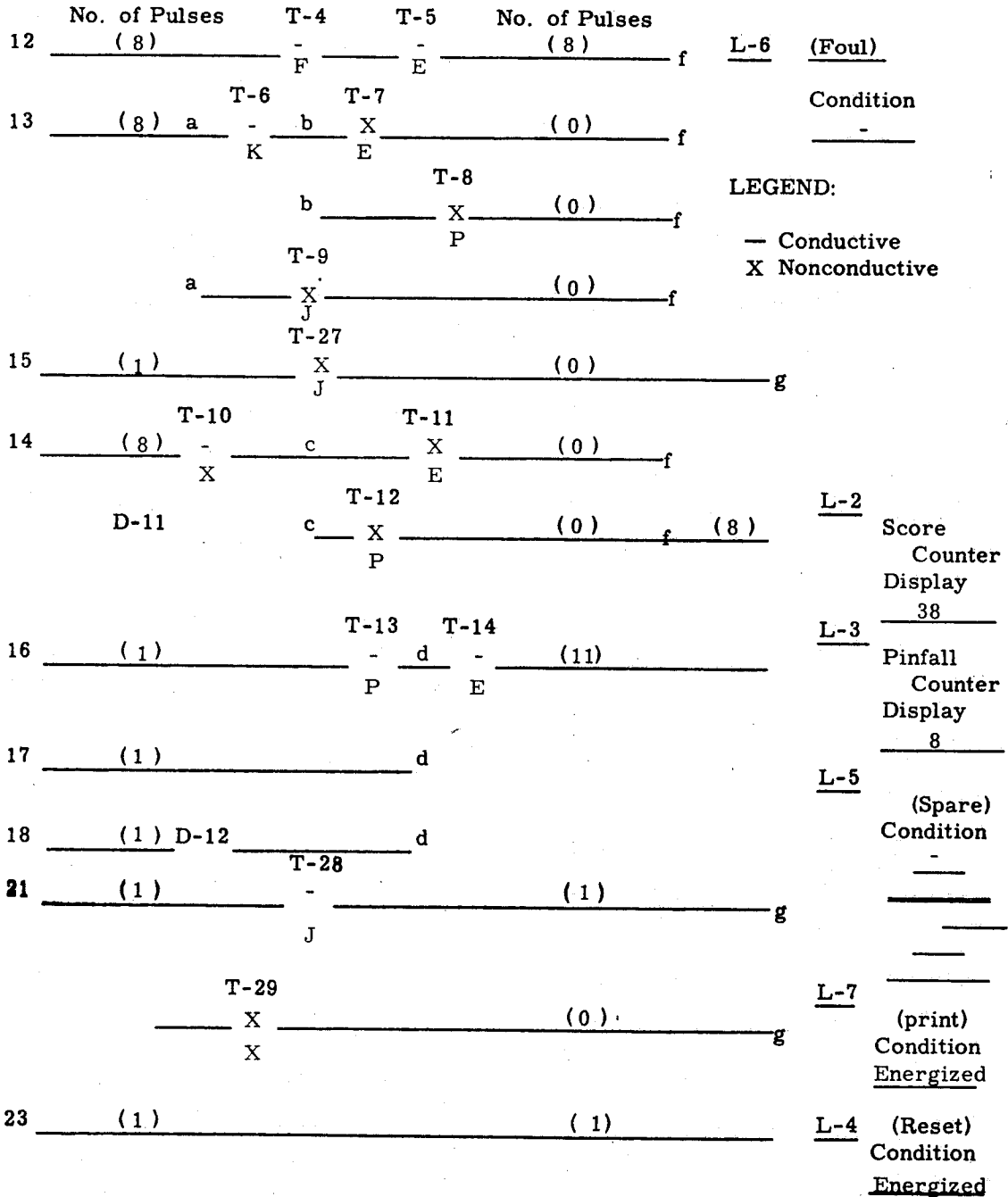
FUNCTIONAL DIAGRAM 26



FUNCTIONAL DIAGRAM 27

Frame 3
 Frame Score _____
 1st Ball 8 Pins
 2nd Ball _____ Pins
 3rd Ball _____

Score Tape 66		
1	2	3
X	X	8
SCORE PRINTED		



FUNCTIONAL DIAGRAM 28

Frame 3
 Frame Score _____
 1st Ball 8 Pins
 2nd Ball 1 Pin (Error)
 3rd Ball _____

Score Tape 66

1	2	3
X	X	8 -

Score Printed

	No. of Pulses	T-4	T-5	No. of Pulses		
12	(9)	-	X	(0)	f	L-6 (Foul)
		F	E			
13	(9) a	T-6	T-7	(9)	f	Condition
		K	E			

LEGEND:

— Conductive
 X Nonconductive

		b	T-8	(0)	f	
			P			
		T-9		(0)	f	
	a	X	J			
		T-27				
15	(1)	X		(0)	g	
		J				
14	(9)	T-10	T-11	(9)	f	
		X	E			
	D-11	T-12		(0)	f	(18)
		c	X			
			P			
16	(1)	T-13	T-14	(0)		
		P	E			
17	(1)		d			
18	(1)	D-12	d			
		T-28				
21	(1)	J		(1)	g	
		T-29		(0)	g	
		X				
		X				
23	(1)			(1)		

L-2

Score
 Counter
 Display
 56

L-3

Pinfall
 Counter
 Display

L-5

(Spare)
 Condition

L-7

(print)
 Condition
 Energized (1)

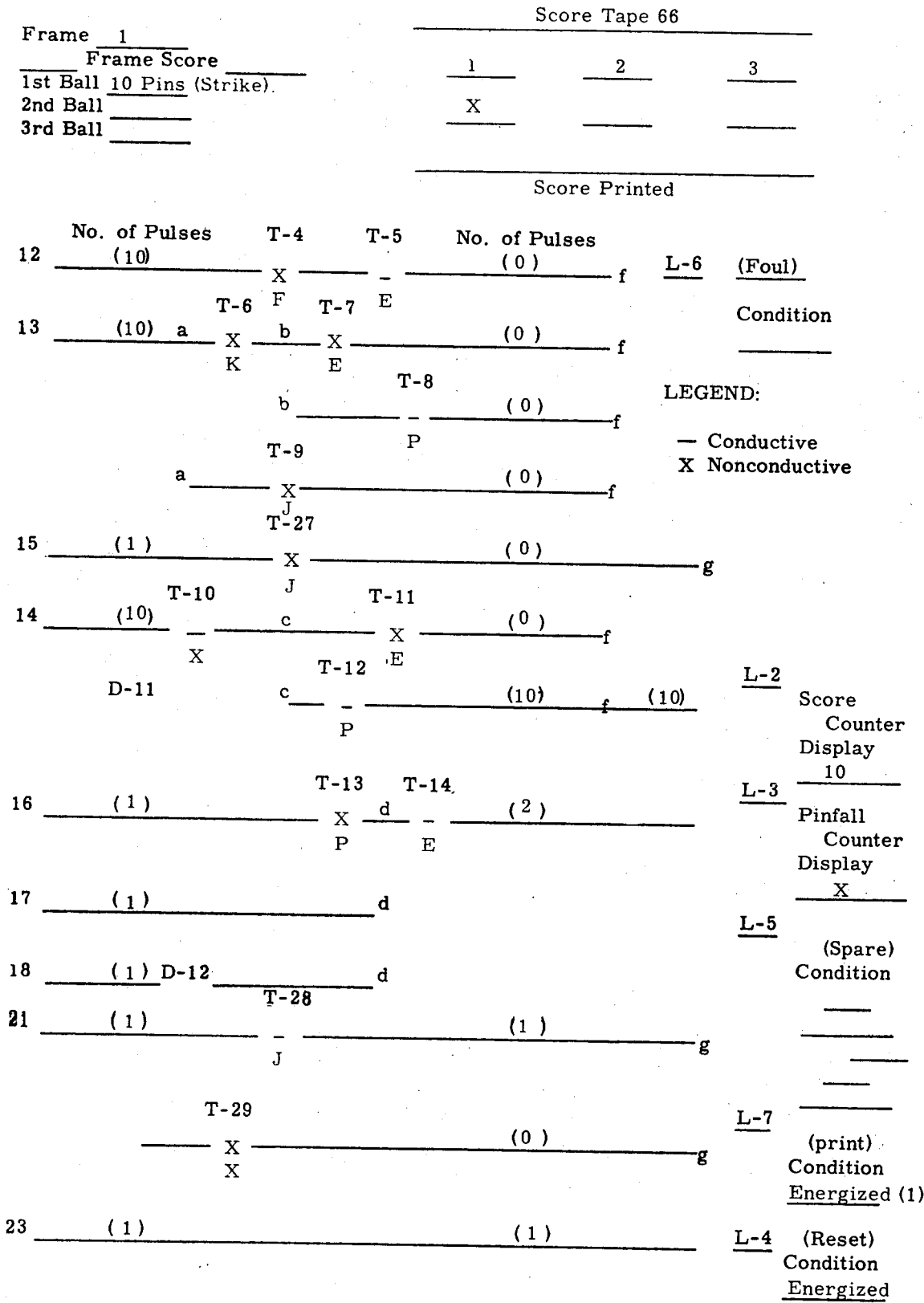
L-4

(Reset)
 Condition
 Energized

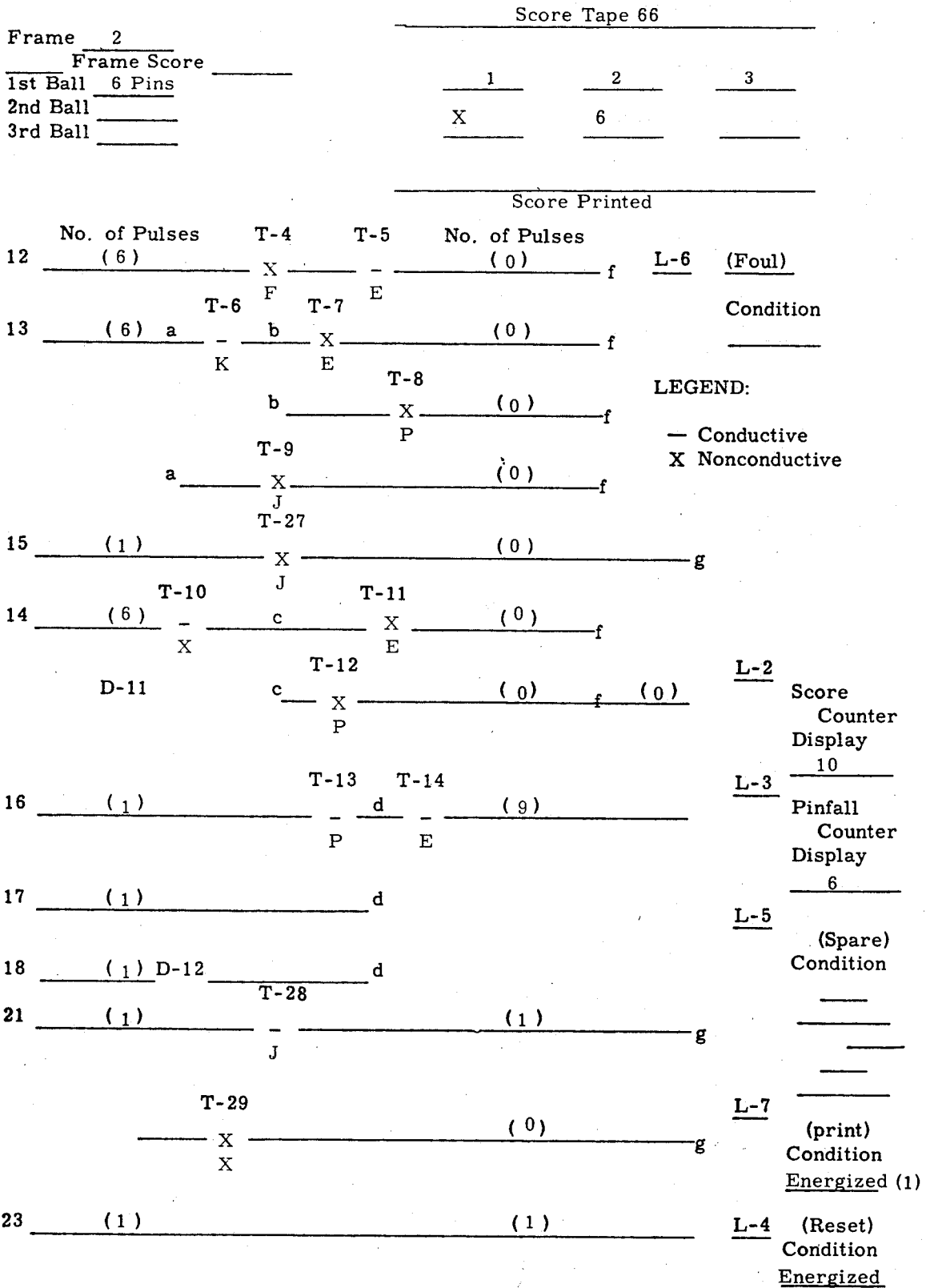
The functional diagrams 29—33 represent the sequential circuit conditions existing and scoring information printed or recorded for the following series of bowling score frame events:

Frame...	1	2	3
Strike...		Spare	Error.
	(6 pins on first ball).	(7 pins on first ball).	(7 pins on first ball).
	(4 pins on second ball).	(1 pin on second ball).	

FUNCTIONAL DIAGRAM 29



FUNCTIONAL DIAGRAM 30



FUNCTIONAL DIAGRAM 31Frame 2

Frame Score _____

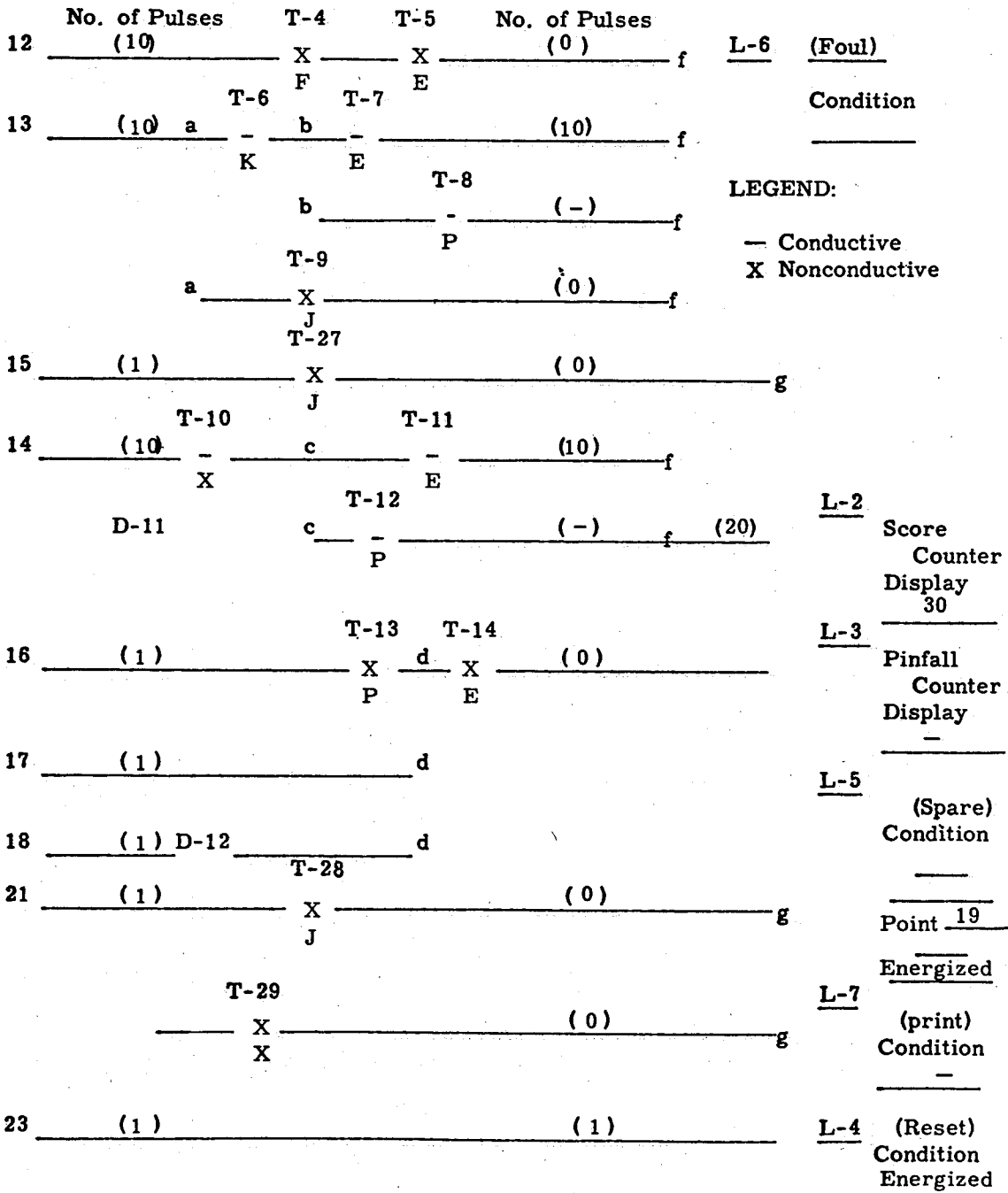
1st Ball 6 Pins2nd Ball 4 Pins (Spare)

3rd Ball _____

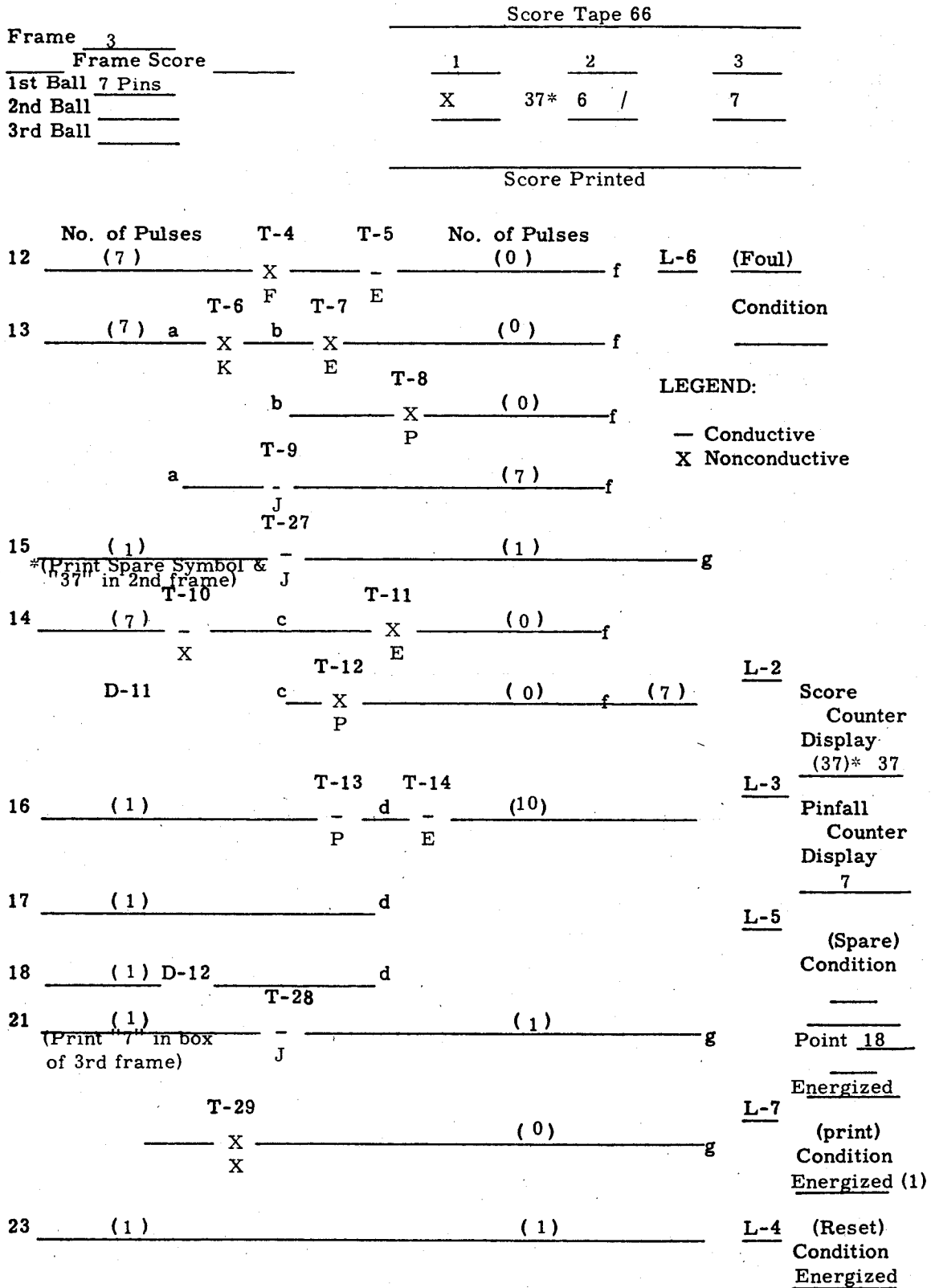
Score Tape 66

1	2	3
X	6	

Score Printed



FUNCTIONAL DIAGRAM 32



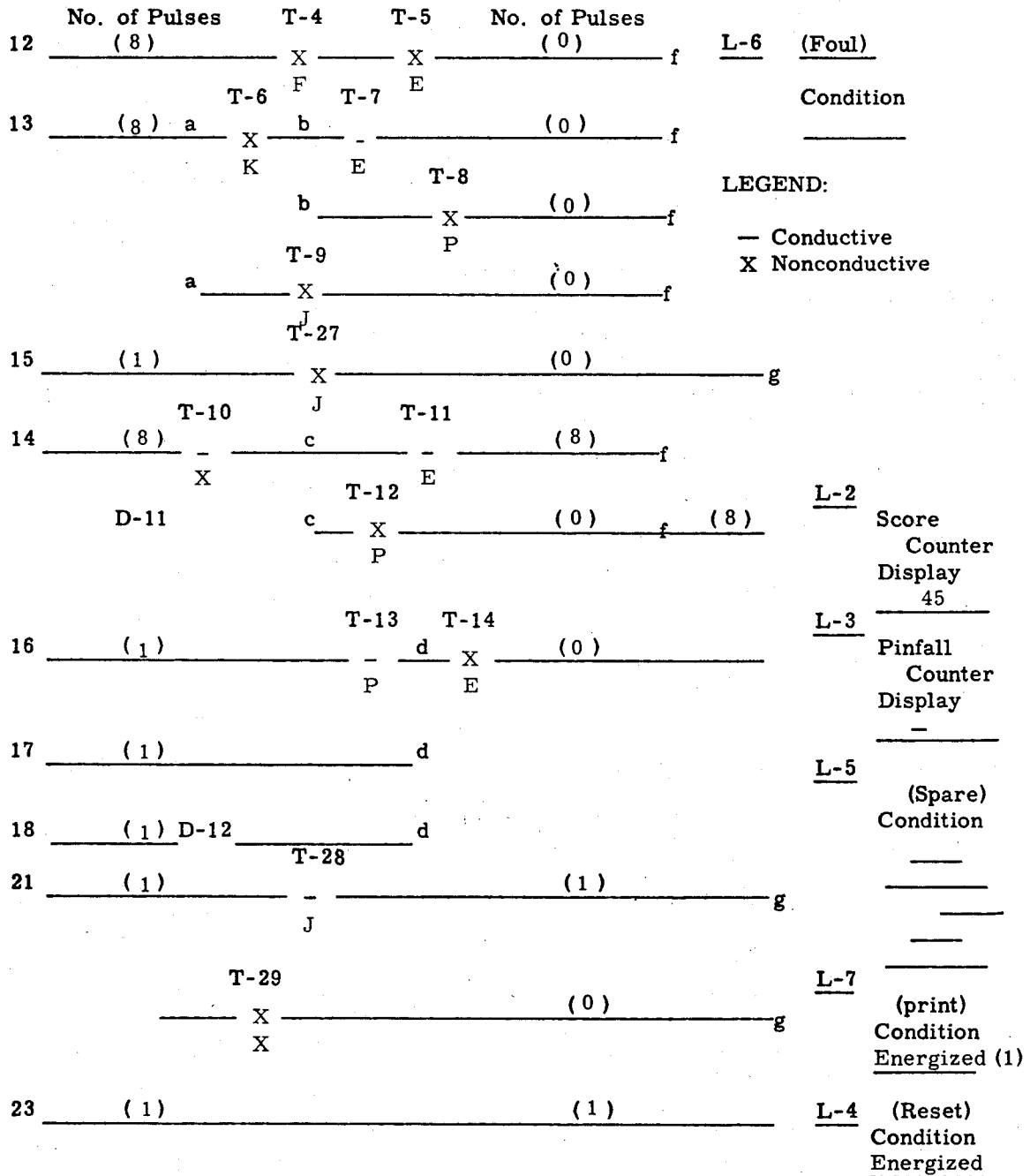
FUNCTIONAL DIAGRAM 33

Frame 3
 Frame Score _____
 1st Ball 7 Pins
 2nd Ball 1 Pin (Error)
 3rd Ball _____

Score Tape 66

1	2	3
X	37	6 / 45 7 -

Score Printed



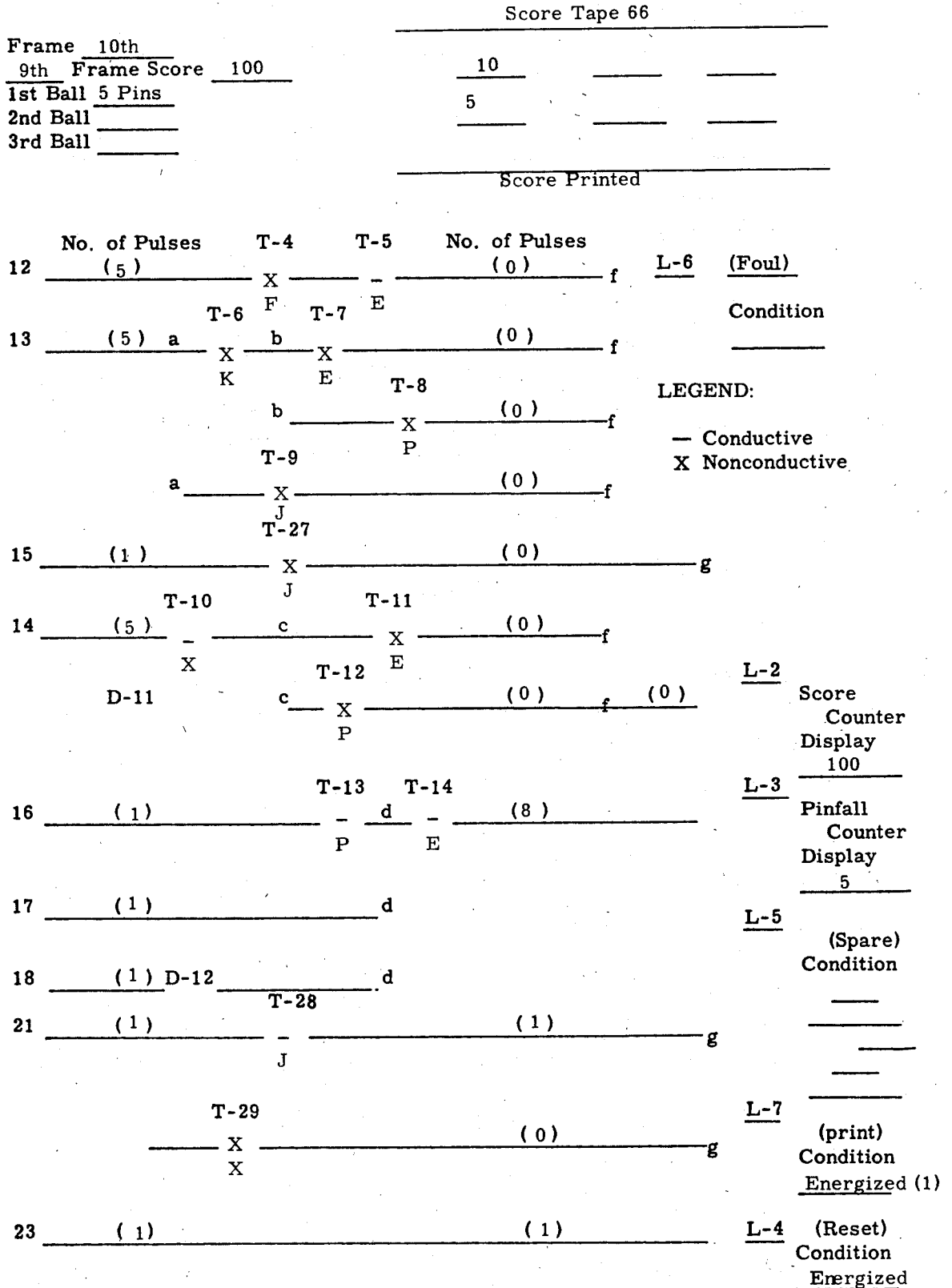
LEGEND:

— Conductive
 X Nonconductive

The functional diagrams 34-36 represent the sequential circuit conditions existing and scoring information printed or recorded for the following series of bowling score frame events:

Frame 10	Extra ball(s)
Spare.....	
5 pins on first ball.....	7 pins.
5 pins on second ball.....	

FUNCTIONAL DIAGRAM 34



FUNCTIONAL DIAGRAM 35

Frame 10th
 9th Frame Score 100
 1st Ball 5 Pins
 2nd Ball 5 Pins (Spare)
 3rd Ball

Score Tape 66

10
 5

Score Printed

12 No. of Pulses (10) T-4 X T-5 X No. of Pulses (0) f L-6 (Foul)
 F E
 T-6 T-7
 13 (10) a X b (0) f Condition
 K E

T-8
 b (0) f
 P

LEGEND:

— Conductive
 X Nonconductive

T-9 X (0) f
 J
 T-27
 15 (1) X (0) g
 J

T-10 T-11
 14 (10) c (10) f
 X E
 T-12
 D-11 c (—) f (10)
 P

L-2

Score
 Counter
 Display
 110

L-3

Pinfall
 Counter
 Display

T-13 T-14
 16 (1) X d X (0)
 P E

17 (1) d

L-5

(Spare)
 Condition

18 (1) D-12 d

T-28
 21 (1) X (0) g
 J

Point 19

Energized

T-29

X (0) g
 X

L-7

(print)
 Condition

23 (1) (1)

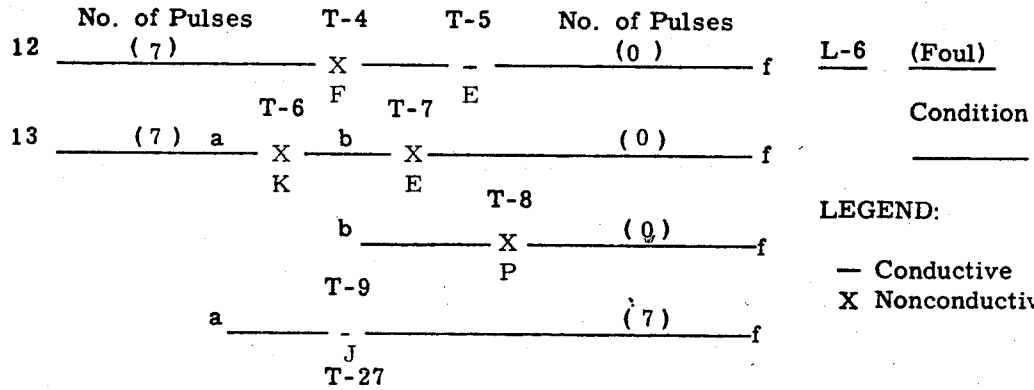
L-4

(Reset)
 Condition
 Energized

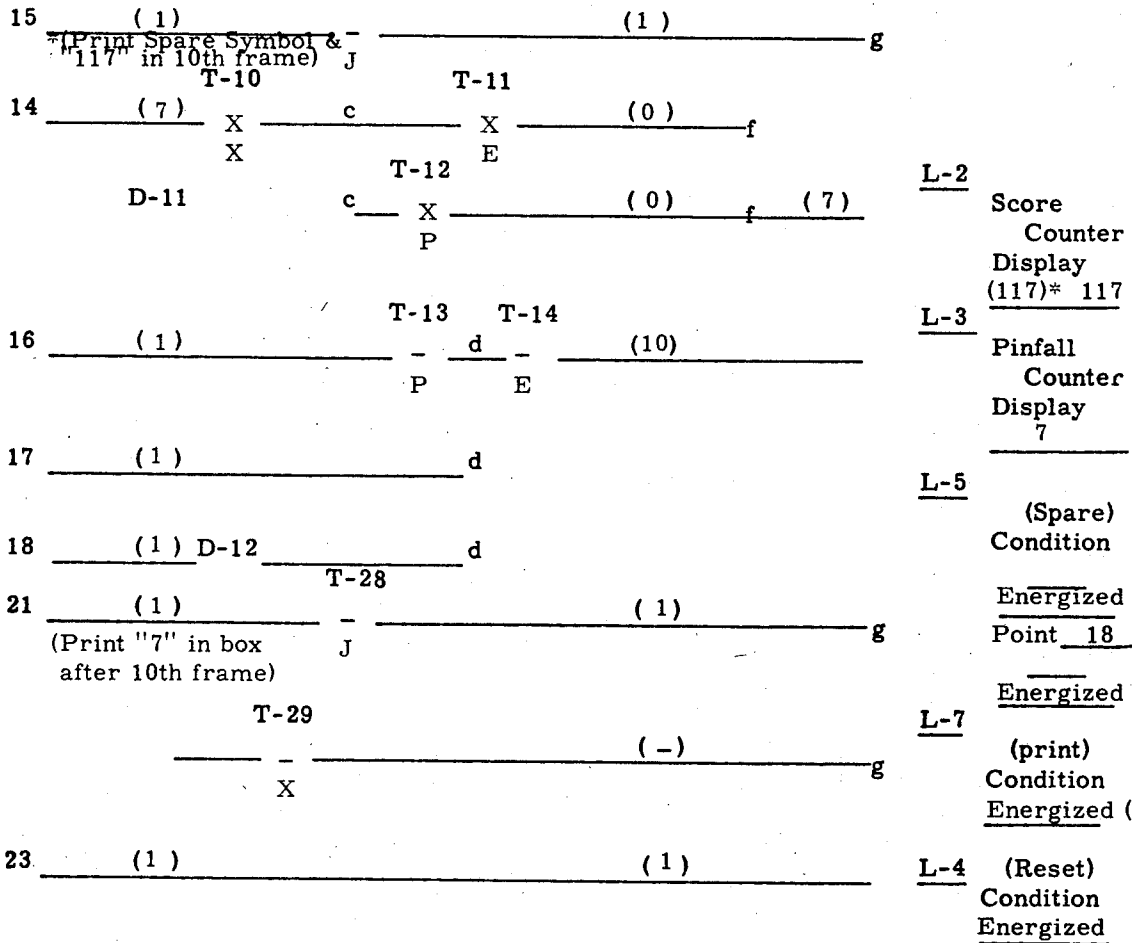
FUNCTIONAL DIAGRAM 36

Frame 10th
9th Frame Score 100
1st Ball 5 Pins
2nd Ball 5 Pins (Spare)
3rd Ball 7 Pins

Score Tape 66			
	10		
117*	5 /		
Score Printed			



LEGEND:
— Conductive
X Nonconductive



While it will be apparent that the preferred embodiment of the invention disclosed is well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What I claim is:

1. A system for automatically tabulating bowling information comprising pinfall indicating means for providing a signal having a magnitude in accordance with the total number of pins knocked down during the course of one frame and after each ball bowled in that frame, totalizing circuit means connected with said pinfall indicating means to receive pinfall information for accumulating a score in accordance with pinfall information, and foul detecting means providing a foul signal responsively to the commission of a foul for effecting the pinfall information received by said totalizing circuit means such that said accumulation in said totalizing circuit means is of the proper bowling score attained, said system including memory means for providing a first ball signal having a magnitude in accordance with the total number of pins knocked down by the first ball in that frame and means for connecting said memory means to said totalizing circuit means in response to said foul signal occurring on the second ball bowled in a frame for accumulating only first ball pinfall information; said memory means including a controlled rectifier for each pin being settable to a conductive state in accordance with the standing or fallen condition of the respective pin, said conductive condition being retained for use by said totalizing circuit in response to said foul signal occurring on the second ball bowled in a frame; said pinfall indicating means including a switch means for each pin for indicating said pin condition; and a source of electrical current connectable to said switch means, said switch means being adapted to deliver said source of electrical current to said controlled rectifiers so as to establish the conductive state thereof according to said pin condition when said switch means is connected to said source, said foul detecting means signal being operative to prevent the connection of said source of electrical current to said switch means to prevent said change in conductive state of said controlled rectifiers in response to said foul signal occurring on the second ball bowled in a frame.

2. The system of claim 1 including plurality of signal generators.

3. The system of claim 1, with said totalizing circuit means comprising counter-printer means for providing a printed output of the score.

4. The system of claim 3 in which said printed output comprises an individual score tape for each player.

5. The system of claim 3 in which said printed output comprises a score tape with said counter-printer means having means for printing an indication of the score attained by the first ball bowled in a frame.

6. The system of claim 5 with said counter-printer means having symbol means for printing the occurrence of a spare.

7. The system of claim 3 in which said printed output comprises a score tape with said counter-printer means having first ball means for printing the score attained by the first ball bowled in a frame and having symbol means for printing symbols indicating the occurrence of a spare or strike.

8. The system of claim 7 with said symbol means printing symbols indicating the occurrence of a foul or an error.

9. The system of claim 3 in which said printed output comprises a score tape with said counter-printer means comprising means including a plurality of print wheels for recording and printing the total score attained after each ball bowled in a frame and means including a first ball score wheel for recording and printing an indication of the total score attained on the first ball, said first ball score wheel having a plurality of print positions and at least one nonprint position and means for preventing said print wheels from printing when said first ball score wheel is in said print positions.

10. The system of claim 9 with said counter-printer means comprising symbol wheel means including a symbol wheel for

printing an indication of the occurrence of a spare.

11. The system of claim 10 with said first ball score wheel providing an indication of a foul or a strike on the first ball bowled in a frame and with said symbol wheel providing an indication of a foul or an error on the second ball bowled in a frame.

12. The system of claim 9 including indexing means for indexing said score tape with said first ball score wheel in said nonprint position and in at least one of said print positions.

13. The system of claim 12 with said first ball score wheel providing an indication of the numerical score attained or the occurrence of a strike on the first ball bowled and with said indexing means indexing said score tape with said first ball score wheel in the strike indicating position and being responsive to said first ball score wheel in the numerical indicating position for not indexing said score tape.

14. The system of claim 12 including 10th frame signal means for providing a 10th frame signal indicating that the game is in the tenth frame, said 10th frame signal means including indicating means on said score tape.

15. The system of claim 1 with said pinfall indicating means comprising means having a first condition for receiving and retaining the pinfall for the first and second balls bowled in a frame and a second condition in response to said foul signal occurring on the second ball bowled for not receiving the pinfall for the second ball and retaining the pinfall from the first ball.

16. The system of claim 15 with said pinfall indicating means comprising no more than one set of 10 controlled conduction devices.

17. A system for automatically tabulating bowling information for a plurality of bowlers comprising: pinfall indicating means for providing a first signal having a magnitude in accordance with the number of pins knocked down during the course of one frame and after each ball bowled in that frame and a second signal having a magnitude in accordance with the number of pins knocked down on the first ball thrown in a frame; three generator means each operatively connected with said pinfall indicating means and providing a first output signal having a magnitude in accordance with the magnitude of said first signal from said pinfall indicating means and a second output signal having a magnitude in accordance with the magnitude of said second signal and with each said first output signal having the same magnitude and said second output signal having the same magnitude, said three generator means being disposed in a time-phased relationship such that said each said first output signal and said each said second output signal therefrom is provided sequentially; counter-printer means for providing an indication for each of the plurality of bowlers responsively to each of said first and said second output signals received from selected ones of said three generator means; foul detecting means providing a foul signal responsively to the commission of a foul by any of the plurality of bowlers; computer means individual to each of the plurality of bowlers, and operatively connected with said counter-printer means, said foul detecting means, and operatively connected with a first of said strike generator means for transmitting, upon actuation, to said counter-printer circuit means from said first generator means under the following condition: said first output signal from said first generator means after two strikes or more in sequence by that one of the plurality of bowlers with which said computer means is individual, and operatively connected with a second of said generator means for transmitting, upon actuation, to said counter-printer circuit means from said second generator means under the following conditions: (1) said first output signal from said second generator means after the second ball thrown succeeding a strike if the first ball thrown after said strike is not a strike, (2) if a strike has been registered, said first output signal from said second generator means on the very next ball thrown if a strike is registered on said next ball, and (3) said first output signal from said second generator means occurring on the very next ball thrown after a spare, and operatively connected with a third of said generator means for transmitting, upon actua-

tion, to said counter-printer means under the following conditions: (1) said first output signal occurring on the first ball thrown in a frame if a strike is obtained on said first ball, and (2) said first output signal occurring after the second ball in a frame, and operatively connected with said second generator means for transmitting said second output signal from said second generator means in place of said first output signal from said second generator means in response to said foul signal from said foul detecting means occurring on the second ball thrown in a frame, and operatively connected with said third generator means for transmitting said second output signal from said third generator means in place of said first output signal from said third generator means in response to said foul signal from said foul detecting means occurring on the second ball thrown in a frame: said computer means including means preventing the transmission of any of said first and said second output signals from said three generator means in response to said foul signal from said foul detecting means occurring on a first ball thrown in a frame, and means for providing a frame signal responsively to the completion of a frame by that bowler with whom said computer means is individual; means for actuating said computer means after each ball thrown; plater selector means selectively actuable for connecting a selected one of said computer means to said three signal generator means.

18. The system of claim 17 with said counter-printer means comprising: means for providing a printed output of the score, said printed output comprising an individual score tape for each player, a plurality of print wheels for recording and printing the total score attained after each ball bowled in a frame and means including a first ball score wheel for recording and printing an indication of the total score attained on the first ball, said first ball score wheel having a plurality of print positions and at least one nonprint position and means for preventing said print wheels from printing when said first ball score wheel is in said print positions, said first ball score wheel providing an indication of a foul or a strike on the first ball bowled in a frame, symbol wheel means including a symbol wheel for providing an indication of a spare, foul or an error on the second ball bowled in a frame, and indexing means for indexing said score tape with said first ball score wheel in said nonprint position and in at least one of said print positions.

19. The system of claim 18 with said first ball score wheel having a strike symbol, foul symbol and numerical symbols 1 through 9 on a portion thereof with the strike, foul and numerical symbols being in said print positions to be printed on said score tape with the strike symbol being radially offset from the foul and numerical symbols and with said symbol wheel containing a foul symbol, spare symbol, and an error symbol, said symbol wheel being supported to print with said print wheels.

20. The system of claim 19 including signal transmitting means comprising said three generator means and further comprising means for providing a plurality of command pulses after each ball, each said computer means responsive to said command pulses to provide a print signal causing said counter-printer means to print, a strike signal to index the strike symbol on said first ball score wheel into a print position, a spare signal to index the spare symbol on said symbol wheel into a print position, a first ball foul signal to index the foul symbol on said first ball score wheel into the print position and a second ball foul signal to index the foul symbol on said symbol wheel into the print position.

21. A system for automatically tabulating bowling information comprising pinfall indicating means for providing a signal having a magnitude in accordance with the total number of pins knocked down during the course of one frame and after each ball bowled in that frame, totalizing circuit means connected with said pinfall indicating means to receive pinfall information for accumulating a score in accordance with pinfall

information, and foul detecting means providing a foul signal responsively to the commission of a foul for effecting the pinfall information received by said totalizing circuit means such that said accumulation in said totalizing circuit means is of the proper bowling score attained, said system including memory means for providing a first ball signal having a magnitude in accordance with the total number of pins knocked down by the first ball in that frame to said totalizing circuit means in response to said foul signal occurring on the second ball bowled in a frame for accumulating only first ball pinfall information; said memory means including at least one controlled rectifier being settable to a conductive state in accordance with the standing or fallen condition of at least one pin, said conductive condition being retained for use by said totalizing circuit in response to said foul signal occurring on the second ball bowled in a frame: said pinfall indicating means including switch means including a switch for each pin for indicating said pin condition, a source of electrical current connectable to said switch means, said switch means being adapted to deliver said source of electrical current to said controlled rectifier according to the pin condition of at least one pin, said foul detecting means signal being operative to prevent said source of electrical current from changing the conductive state of said controlled rectifier in response to said foul signal occurring on the second ball bowled in a frame, said totalizing circuit means including at least one controlled rectifier having a control terminal and an additional pair of terminals, the conductive state between said additional pair of terminals being determined by the bias level at said control terminal, at least one of said terminals being connected in a manner to receive an output signal and to control the accumulation of the score attained in each frame in accordance with said conductive state of said controlled rectifier, said controlled rectifier being maintainable in a conductive state for accumulation of said score, said totalizing circuit means further including means for recording and retaining said indication for each frame whereby the score accumulated in each frame will be preserved and can be obtained, and means responsive to said signal from said pinfall indicating means for providing said output signal to said one terminal of said controlled rectifier.

22. A system for automatically tabulating bowling information according to claim 21 wherein said means providing said output signal to said totalizing circuit means provides a plurality of pulses in accordance with said pinfall indication, wherein said signal from said pinfall indicating means controls the conductive state of said controlled rectifier, said conductive state determining the transmission of said pulses, and wherein said totalizing circuit means includes a counter-printer receiving transmitted pulses for counting said pulses to accumulate said score in each frame and for printing said score in each frame.

23. A system for automatically tabulating bowling information according to claim 22 including at least three of said controlled rectifiers for controlling the transmission of said pulses, a first of said controlled rectifiers for transmitting said pulses in accordance with the occurrence of a strike, a second of said controlled rectifiers for transmitting said pulses in accordance with the occurrence of a spare, and third of said controlled rectifiers for transmitting said pulses in accordance with the occurrence of a pinfall less than the full number of pins in each frame.

24. The system of claim 21 for tabulating bowling information for a plurality of players with said totalizing circuit means including independent and separate counter means for each of the players for recording and retaining for each frame said indication for that frame in accordance with the bowling score whereby the score accumulated in each frame can be obtained.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,585,374

Dated June 15, 1971

Inventor(s) Patrick J. Pollard

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 14, delete "a" and substitute therefor --illustrates a--

Column 4, line 47, delete "S1-34-A" and substitute therefor

--S-34-A--

Column 17, line 7, delete "14" and substitute therefor --15--

Column 18, line 36, delete "142" and substitute therefor --152--

Column 18, line 44, after "spool" insert --162--

Column 19, line 8, after "system" insert --is--

Column 95, line 24, delete "plater" and substitute therefor --player--

Signed and sealed this 13th day of June 1972.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents