IBM Model 15 Master Clock

Serial Number 555170

By Ernie Jenson & Dan Argento

Everyone is familiar with the company, IBM. The history of IBM started in 1911 when three companies which existed separately for twenty years were combined to form "Computing-Tabulating-Recording Company" and later renamed "The International Business Machine Corporation". The company was under the leadership of Thomas J. Watson who is regarded as the visionary who contributed so much to the success of IBM. One of the original three companies was "The International Time Recording Company of New York". It continued to operate in New York and became one of the divisions of IBM. They continued to label their products as "International" and both the master clock made in 1938 and the slave clock made in 1943 have the label of "International" on the face (Fig.1). The final models sold had IBM on the face of the clock. IBM sold the Time Equipment Division to Simplex in 1958 but continued to service the master clocks that were out in the field.

The main function of a master clock is to keep many slave clocks, one in each room of a school or factory, all exactly on the same time and for that time to be as accurate as the technology (in this case 1938) can provide. To accomplish this, the master clock sends a signal, in the form of, a powerful DC pulse to the slave clocks every minute. In the event of a power failure, the slave clock stops because the master clock stops generating signals. When the power resumes, the master clock will provides a synchronizing signal (power pulse), every hour, to the slave clock and the program controller. An optional program controller could be ordered which provided AC power signals to ring bells or buzzers in the rooms with the slave clocks to alert people to times for various events, such as the beginning of class and when the class is over. That's the example that we can all relate to; when we were in school!

The unique innovation incorporated into the Model 15 Master Clock is "The Self-Regulating System". It was marketed in 1924 and was advertised as the first system with definite provision for keeping secondary units (slave clocks) as well as the programmer in agreement with the master clock. Of course, we also need a cleverly designed slave clock that switches from Line A to Line B at the right time.

How the IBM Model 15 Clock Operates

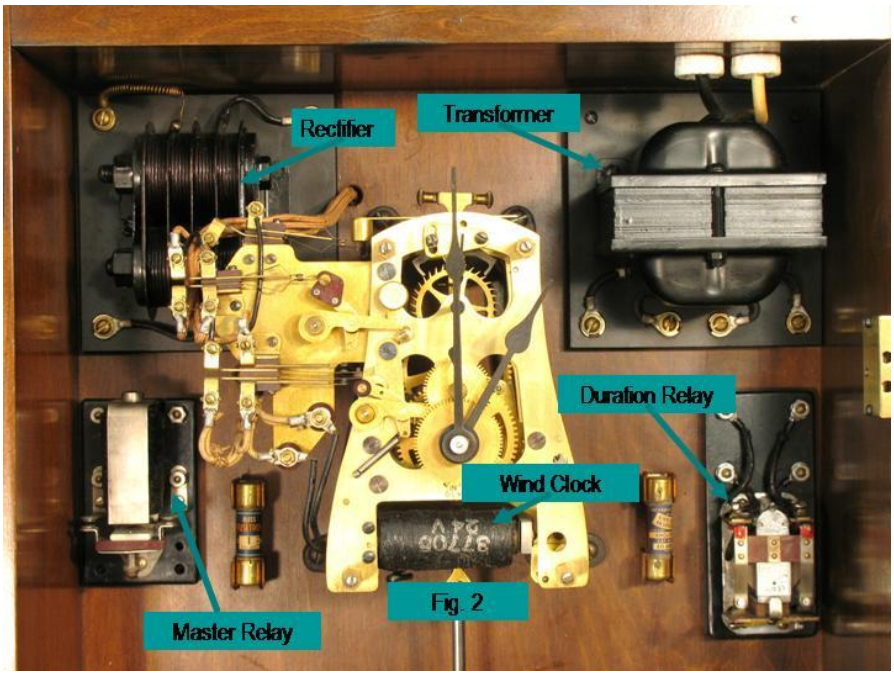


Fig. 2

The clock is a conventional, spring driven, heavy duty, time only, mechanical clock. The heavy pendulum swings at 72 beats per minute on an Invar rod and provides an accuracy of about one second per day according to the IBM literature. The electrically wound spring in the clock provides enough power for the clock to run for 12 hours without rewinding in the event of a power failure. However the clock is rewound every minute so as to provide for even power to the escapement and to keep the spring fully wound.

The clock has a large transformer connected to 110 volts AC (Fig. 2). The transformer has a number of taps that are available for different functions required to run the master clock, the slave clocks and, and ringing bells.

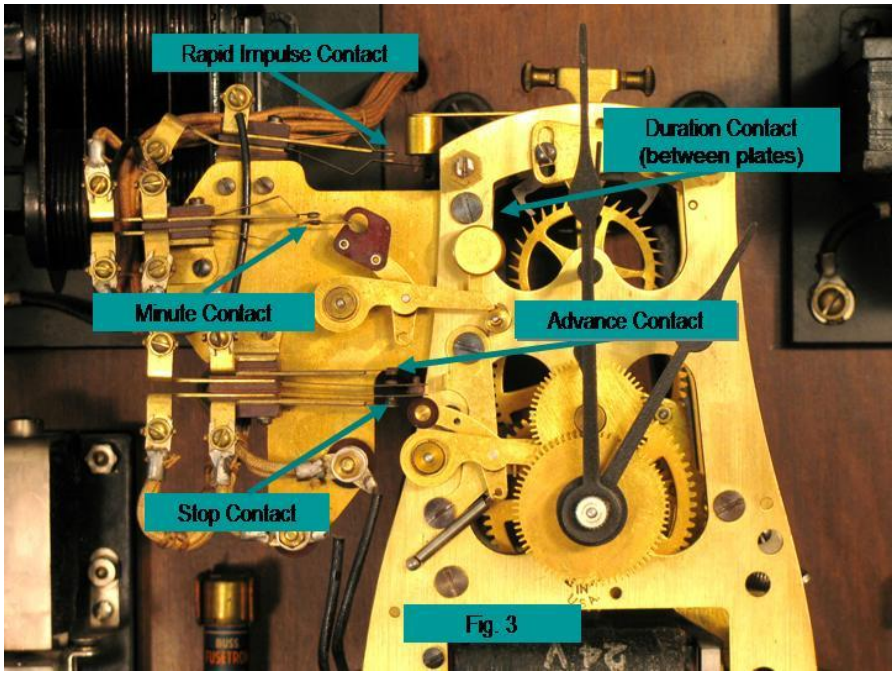
A small cam closes the Minute Contact (Fig.3) which closes the Master Relay (Fig. 2). This allows the transformer to supply current to the rectifier which converts AC to DC. This action happens every minute creating a 2 second DC pulse. This DC pulse advances the slave clocks, the program controller, and winds the master clock.

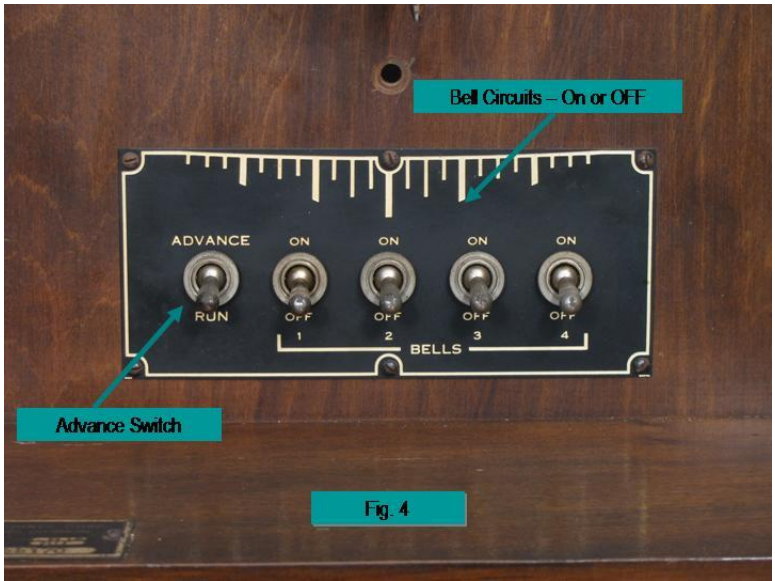
The IBM Master Clock communicates with the slave clock on three lines: Line A, B, & C. The minute pulses are sent to the slave clock on Line C. The return path to ground is Line A, & Line B. Line A returns directly back to the ground. Therefore, there is always a DC pulse transmitted over Line A & Line C. The return path to ground on Line B is

controlled by the master clock Stop Contacts (Fig. 3). The timely interruption of this line is what allows the synchronization to work along with the switching in the slave clock.

How the Synchronized Time Operates

In the event of a power failure the master clock will keep running 12 hours on spring power, but the slave clocks will stop and begin to fall behind the master. To handle this, the IBM Master Clock has a feature that will synchronize every slave clock once each hour when the power resumes. So, how does this synchronizing all happen? Each hour between 59'10" and 59'40", the master clock Advance Contact closes (Fig. 3). This redirects the Master relay AC current path through the Rapid Impulse Contact (Fig. 3), providing up to 20 extra pulses on Line C (one every 2 sec.). Depending on how far the slave clock is behind, these extra pulses will bring the slave clock into sync with the master clock. If the slave clock reaches 59'00" before all 20 pulses are sent, a rather clever switch in the slave disables any further pulses being received. The slave clock accomplishes this by opening the contacts to Line A and closing the contacts to enable Line B at 59'00" on the slave clock. At 60'00", the master sends out the next normal minute pulse and both the master and slave minute hands advance to 12 O'clock. The contacts, in the slave, keep closed and Line B remains enabled until the slave reaches 64'00". After the slave has receives normal minute pulses on Line B for 5 minutes, it then returns to Line A, its normal position. Note, if the slave is more than 20 minutes behind the master, it will accept all 20 pulses. It will repeat this process starting at 59'10" of the next hour. It should be noted that the master clock





can bring a slave into complete time sync only if the slave is less than 45 minutes behind. It can take up to three hours for the slave to be in sync. In the case when the slave is behind the master more than 45 minutes, only the minutes hand will be synchronized with the master clock. The hour hand will be one or more hours behind. To deal with this situation, a toggle switch is provided (Fig. 4), at the bottom of the clock, to manually close the Advance Contact and send out enough pulses to get all the slave clocks into the correct hour period. In 1955, IBM added a twelve hour correction system to the master clock, then being sold.

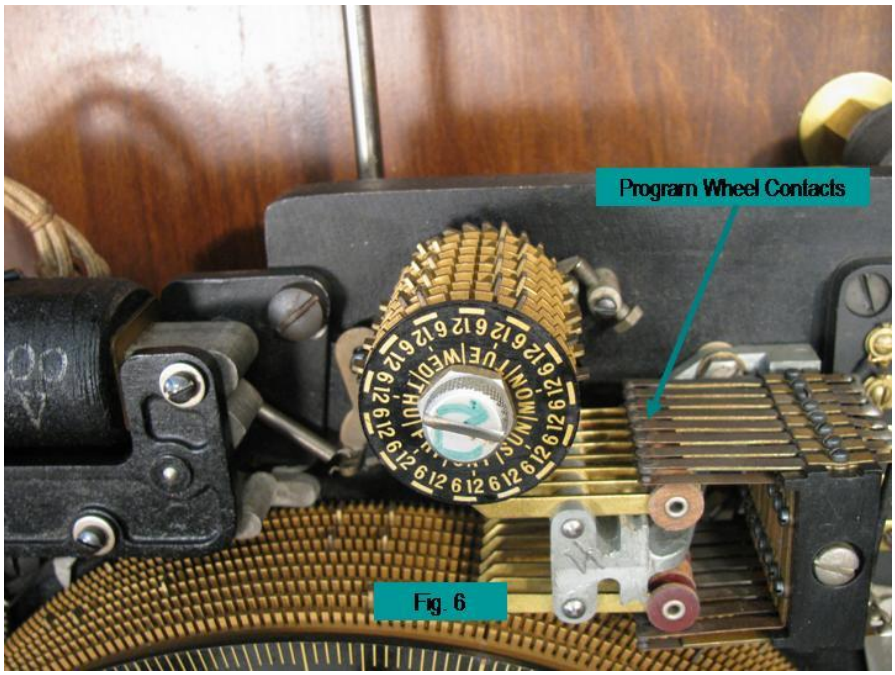
How the Program Controller Operates

There are eight large black discs on the programmer and eight small discs. Each large disc has a clip-slot for each minute of a 6-hour period. The large discs (Fig. 5) work in pairs to cover a 12-hour period of time. Since there are eight discs, it is possible to have four separate circuits covering 12-hour periods of time. This clock was configured with clips to provide signals to four separate bell circuits.


Fig. 5

Note: Two pairs of discs can be tied together to cover a 24 hour period of time if desired. That would allow for twice the period of time covered in a building but then there would be only enough discs for two circuits. Program controllers were available with up to twelve discs.

The small discs advances one clip-slot every 6 hours to select which discs in the large drum are on line during any 6-hour period. Looking at the small discs (Fig. 6), it can be seen that each of the first large discs, of a pair, comes on line at six in the morning each week day. The second disc of each pair comes on line at twelve in the afternoon each day. Since there are no clips in the small discs for, the first 6 hour period of the day and the last 6 hour period of the day, the large discs are not on line for that period. When the program controller disc is on line and advances to a clip, the clip will close a contact and cause a bell to ring.



After all the correct switches in the programmer are closed, allowing a bell to ring, the master clock closes the Duration Contact Fig. 3). This action closes the Duration Relay (Fig. 2) for 5 seconds. This is the heavy duty relay located on the right side of the movement. The Duration Relay enables the ringing of the bell by connecting the PFB (Power to Bell) line to the programmer contacts (Fig. 6). The Duration Contact (Fig. 3) has a cam mechanism which can be adjusted to control the duration of the bell ringing.

Note: I have noted the position of every clip and have determined that this clock was most likely used in a school, ringing bell for two different class groups. The third circuit was for ringing a bell in the office and a fourth one for maybe food prep.

(Attached are the schedules for the four circuits, a wiring diagram for the bells, a schematic, and a timing diagram.)

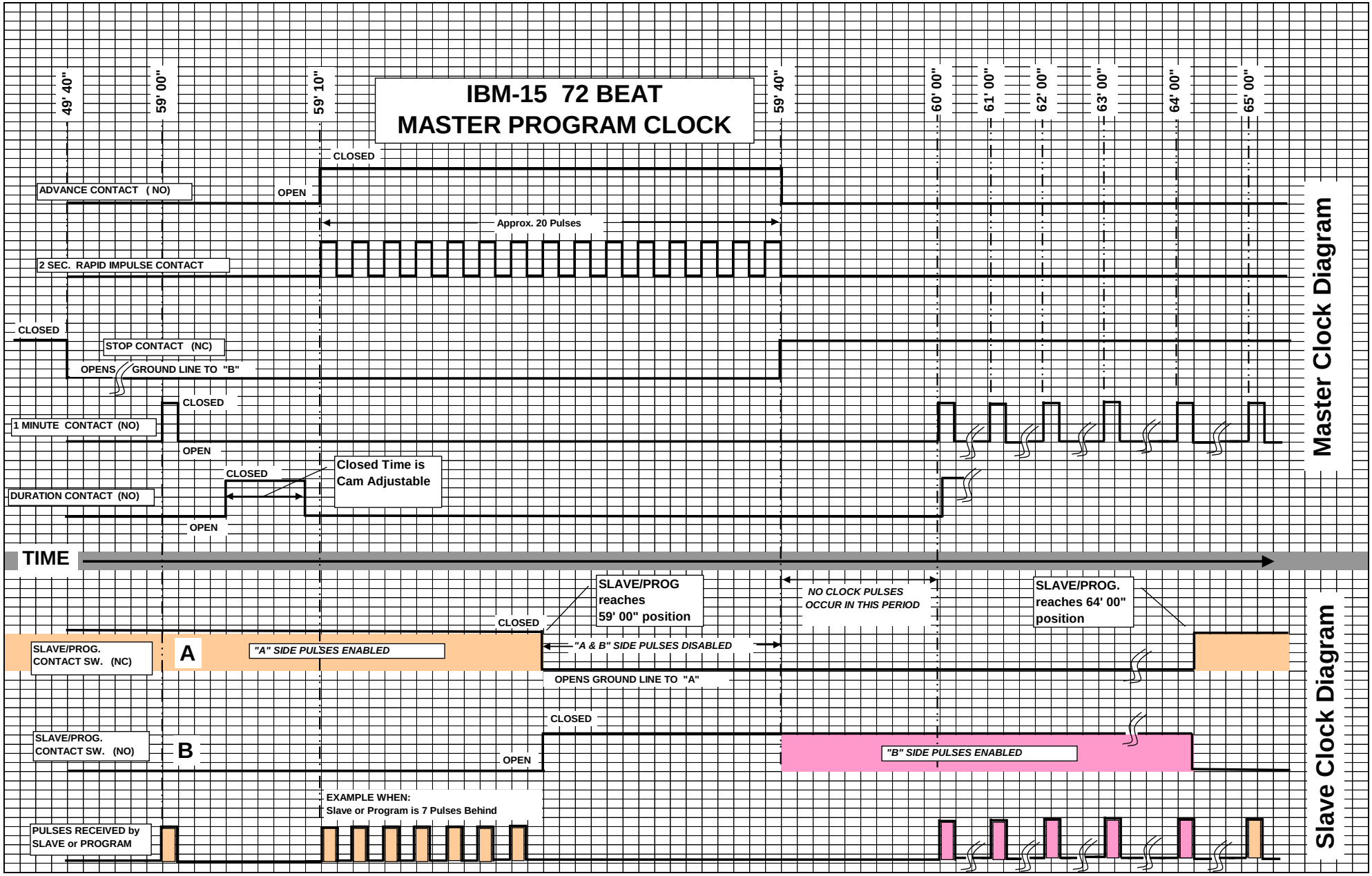
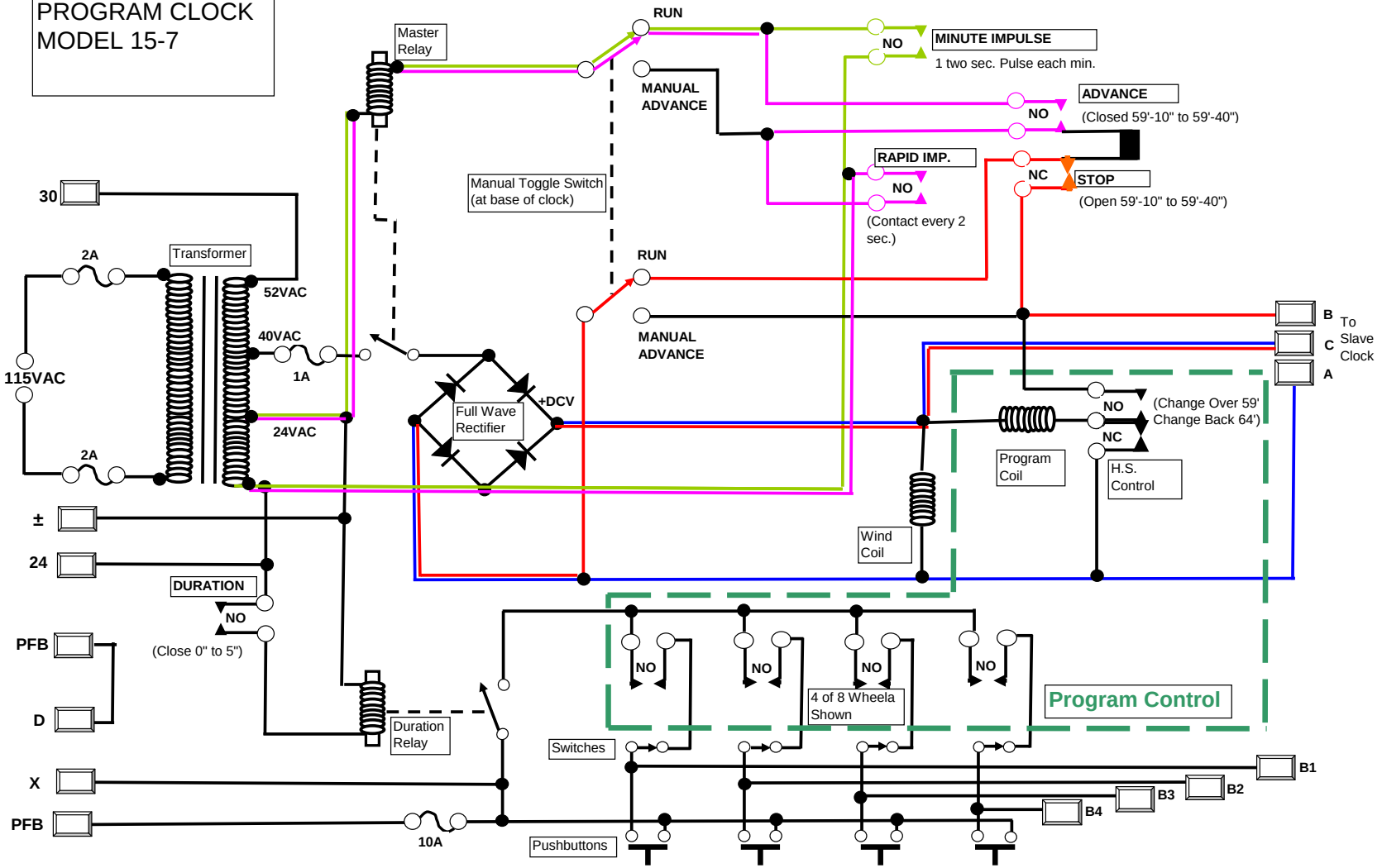

IBM-15 72 BEAT
MASTER PROGRAM CLOCK
49' 40"
59' 00"
59' 10"
59' 40"
60' 00"
61' 00"
62' 00"
63' 00"
64' 00"
65' 00"
ADVANCE CONTACT (NO)
CLOSED
OPEN
Approx. 20 Pulses
2 SEC. RAPID IMPULSE CONTACT
CLOSED
STOP CONTACT (NC)
OPENS GROUND LINE TO "B"
CLOSED
1 MINUTE CONTACT (NO)
OPEN
CLOSED
Closed Time is
Cam Adjustable
DURATION CONTACT (NO)
OPEN
Master Clock Diagram
TIME
SLAVE/PROG
reaches
59' 00" position
NO CLOCK PULSES
OCCUR IN THIS PERIOD
SLAVE/PROG.
reaches 64' 00"
position
CLOSED
SLAVE/PROG.
CONTACT SW. (NC)
A
"A" SIDE PULSES ENABLED
"A & B" SIDE PULSES DISABLED
OPENS GROUND LINE TO "A"
CLOSED
SLAVE/PROG.
CONTACT SW. (NO)
B
OPEN
"B" SIDE PULSES ENABLED
EXAMPLE WHEN:
Slave or Program is 7 Pulses Behind
PULSES RECEIVED by
SLAVE or PROGRAM
Slave Clock Diagram

Fig. 7

IBM 72 BEAT
MASTER
PROGRAM CLOCK
MODEL 15-7

Current Paths

Minute Pulse, Rapid Pulse, and Master Clock to Slave Clock Current Paths



DC Current Path to Slave when Slave is at 4'00" to 58'00" (Line A & Line C)
(If Slave is out of sync, it can receive up to an additional 20 minute pulses on Line A each hour)
DC Current Path to Slave when Slave is at 59'00" to 4'00" (Line B & Line C)
(If Slave is in sync, it recieves only 5 minute pulses on Line B each hour)
AC Current Path to generate the one-minute DC pulse
AC Current Path to generate the Rapid Impulse DC pulses (20 pulses)

Fig. 8

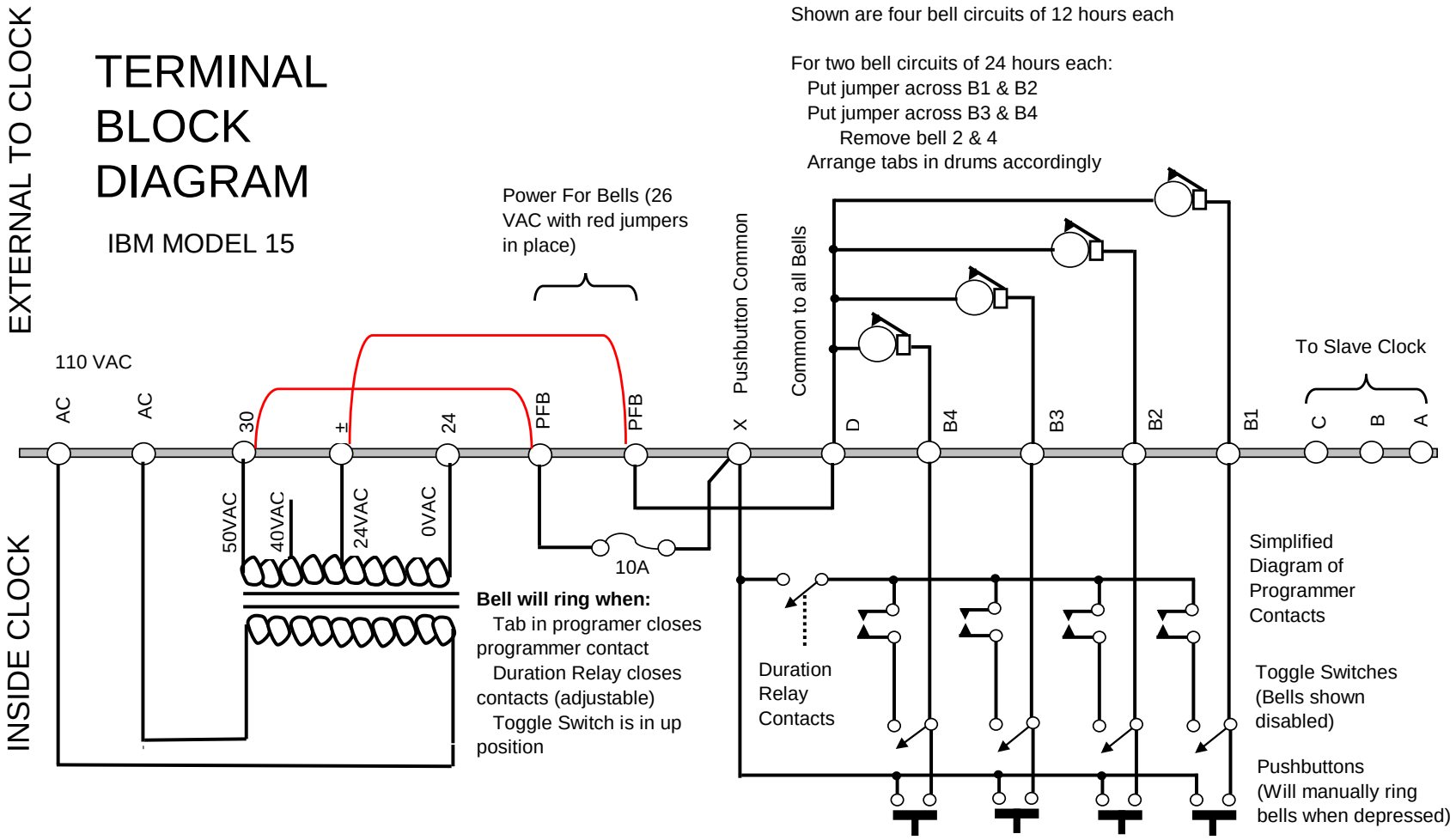
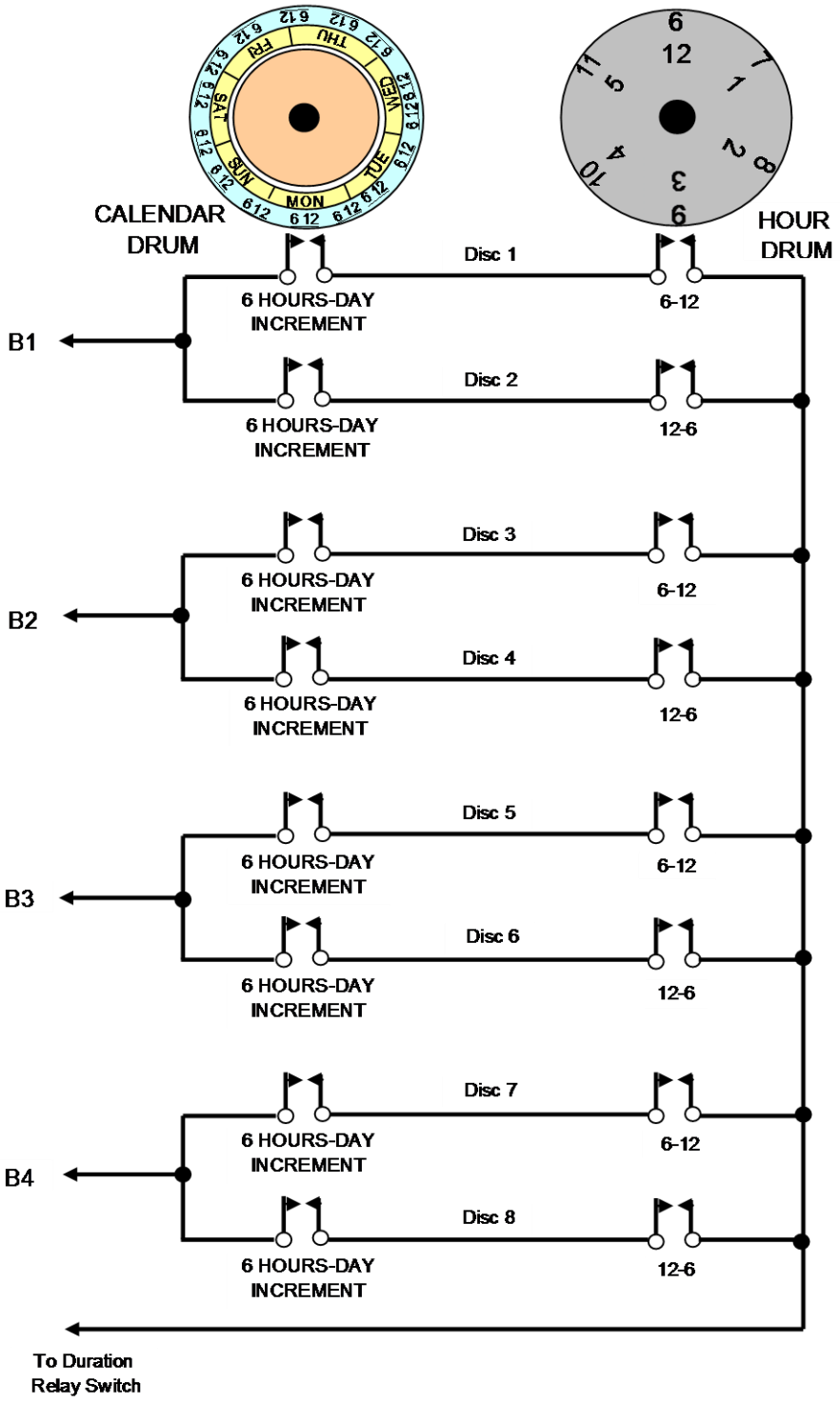

EXTERNAL TO CLOCK
TERMINAL BLOCK DIAGRAM
IBM MODEL 15
Shown are four bell circuits of 12 hours each
For two bell circuits of 24 hours each:
Put jumper across B1 & B2
Put jumper across B3 & B4
Remove bell 2 & 4
Arrange tabs in drums accordingly
Power For Bells (26 VAC with red jumpers in place)
Pushbutton Common
Common to all Bells
To Slave Clock
110 VAC
AC
AC
30
+
24
PFB
PFB
X
D
B4
B3
B2
B1
C
B
A
50VAC
40VAC
24VAC
0VAC
10A
INSIDE CLOCK
Bell will ring when:
Tab in programer closes programmer contact
Duration Relay closes contacts (adjustable)
Toggle Switch is in up position
Duration Relay Contacts
Simplified Diagram of Programmer Contacts
Toggle Switches (Bells shown disabled)
Pushbuttons (Will manually ring bells when depressed)

Fig. 9

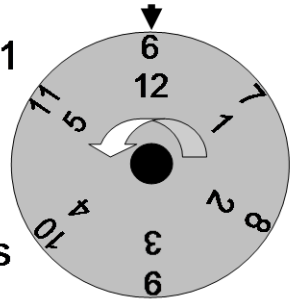


EVENT PROGRAMMER

Fig. 10

SCHOOL MASTER CLOCK BELL ALERT SYSTEM

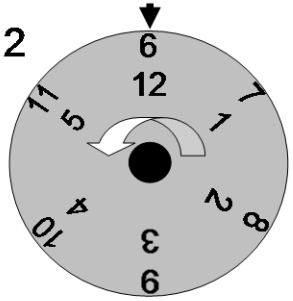
BELL SCHEDULE 1



TIMES	6AM-12PM DISK(1)
6:00AM	Open School Doors
8:55AM	} 5 Min. Warning
9:00AM	} Class Period
10:00AM	} 7 Min. + Get to next Class
10:07AM	} Class Period
11:00AM	} 7 Min. + Get to next Class
11:07AM	} Class Period
11:55AM	} 5 Min. + Get to Lunch
12:00PM	} 12PM-6PM DISK(2) - LUNCH
12:50PM	} 10 Min. + Get to next Class
1:00PM	} Class Period
2:20PM	} 6 Min. + Get to next Class
2:26PM	} Class Period
3:10PM	} Class Ends
3:20PM	

SCHOOL MASTER CLOCK BELL ALERT SYSTEM

BELL SCHEDULE 2

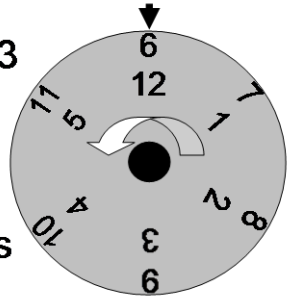


TIMES	6AM-12PM DISK(3)
8:55AM	} 5 Min. Warning
9:00AM	} Class Period
9:50AM	} 10 Min. + Get to next Class
10:00AM	} Class Period
10:40AM	} 10 Min. + Get to next Class
10:50AM	} Class Period
11:20AM	} 5 Min. + Get to Lunch
11:30PM	} 12PM-6PM DISK(4) - LUNCH
12:20PM	
12:30PM	} 10 Min. + Get to next Class
1:20PM	
1:30PM	} Class Period
2:00PM	
2:10PM	} 10 Min. + Get to next Class
3:15PM	} Class Period
3:20PM	} Class Ends

Fig. 11

SCHOOL MASTER CLOCK BELL ALERT SYSTEM

BELL SCHEDULE 3



6AM-12PM DISK(5)

Open School Doors

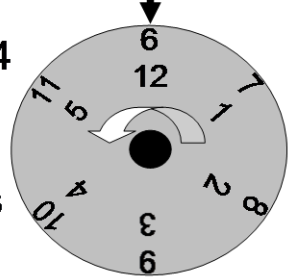
TIMES	
6:05AM	
6:15AM	
8:15AM	
8:20AM	Office Work Starts
9:15AM	
9:20AM	
10:15AM	Office Work
10:20AM	
11:15AM	
11:20AM	

12PM-6PM DISK(6) - Lunch

12:45PM	
12:50PM	5 Min. + Start Office Work
1:45PM	
1:50PM	
2:45PM	
2:50PM	Office Work, Meetings & Breaks
3:50PM	
3:55PM	
4:35PM	
4:45PM	Office Work Ends

SCHOOL MASTER CLOCK BELL ALERT SYSTEM

BELL SCHEDULE 4



6AM-12PM DISK(7)

Open School Doors

TIMES	
6:00AM	
8:15AM	
8:20AM	
8:40AM	
8:55AM	
9:00AM	
9:20AM	
10:00AM	Food Preparation etc. ?
10:07AM	
10:25AM	
11:07AM	
11:20AM	
12:00PM	

12PM-6PM DISK(8) - Lunch

12:20PM	
12:30PM	
12:45PM	
12:50PM	
1:00PM	
1:30PM	Food Clean Up etc. ?
1:50PM	
2:10PM	
2:25PM	
2:55PM	
3:55PM	

Fig. 12