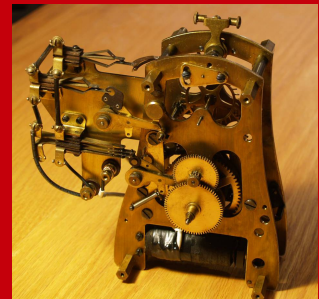# INTERNATIONAL TIME MACHINES

ITR Master Clock
History, Technology & Design
from the *Early Industrial Age*
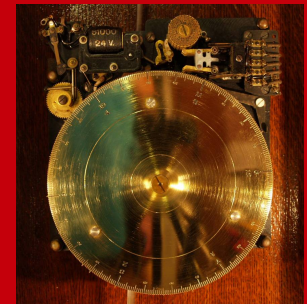
Dave Dietrich, 2015

# Table of Contents

For 100s of thousands of years man had little ability, and perhaps little reason, to keep track of time throughout the day. Sundials, 'water clocks' and other inventions were ineffective.

While a student at the University of Pisa in 1588, Galileo pondered the swinging motion of the lamp in the cathedral. In 1602 he wrote friends on the pendulum and it's swing mathematics.

In 1641, Galileo documented for the first time 'isochronism': a pendulum will swing with the same frequency, with a large arc or a small arc. The time it takes to swing back and forth is determined by the length of the pendulum's rod (distance from top of pendulum rod to the bob).
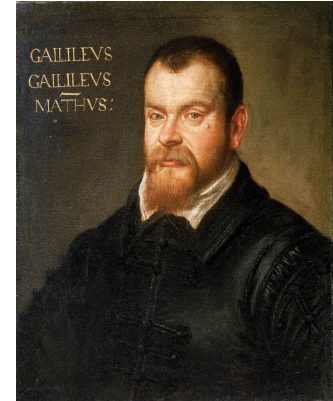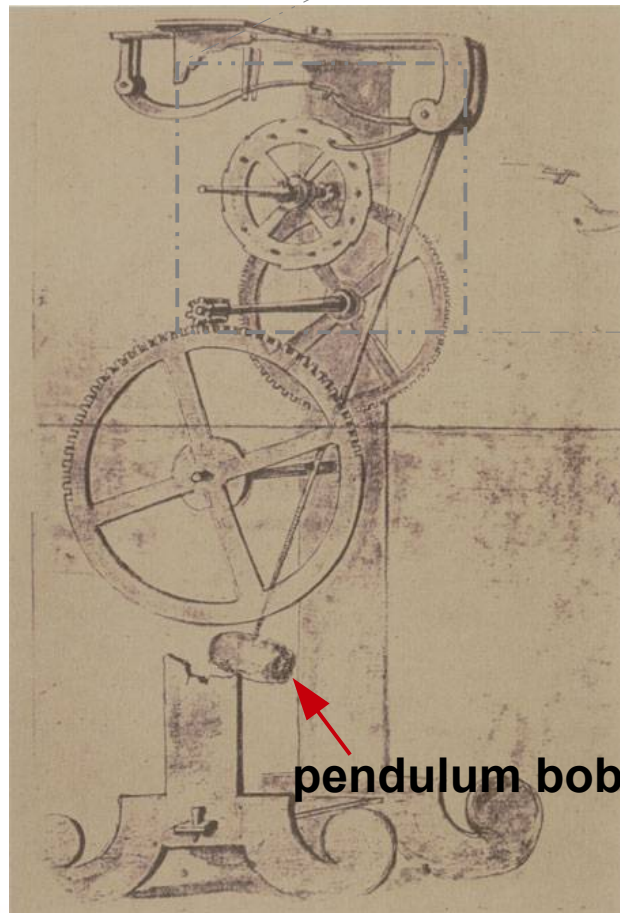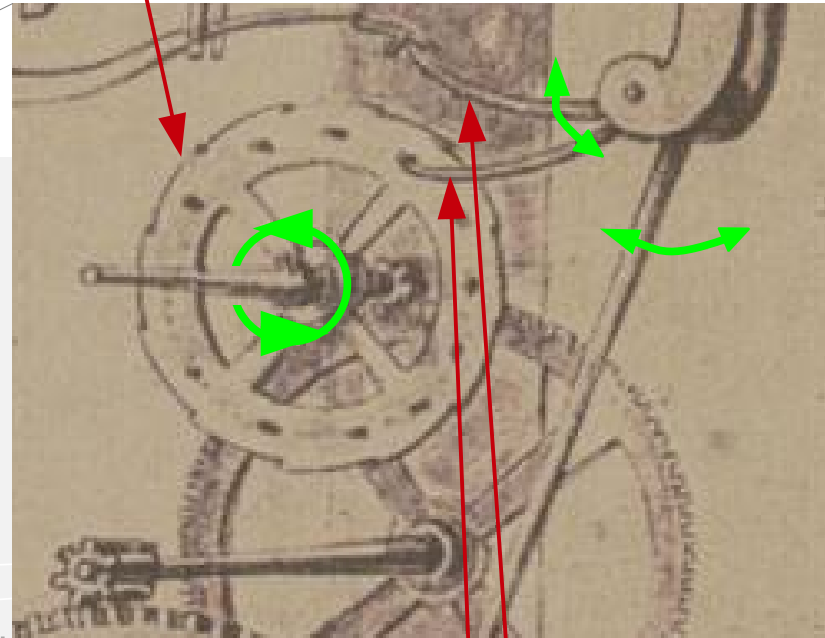
Galileo Galilei
1564-1642

**Big Arc
1 second**

**Small Arc
1 second**

**Short Pendulum
1/2 second**

3
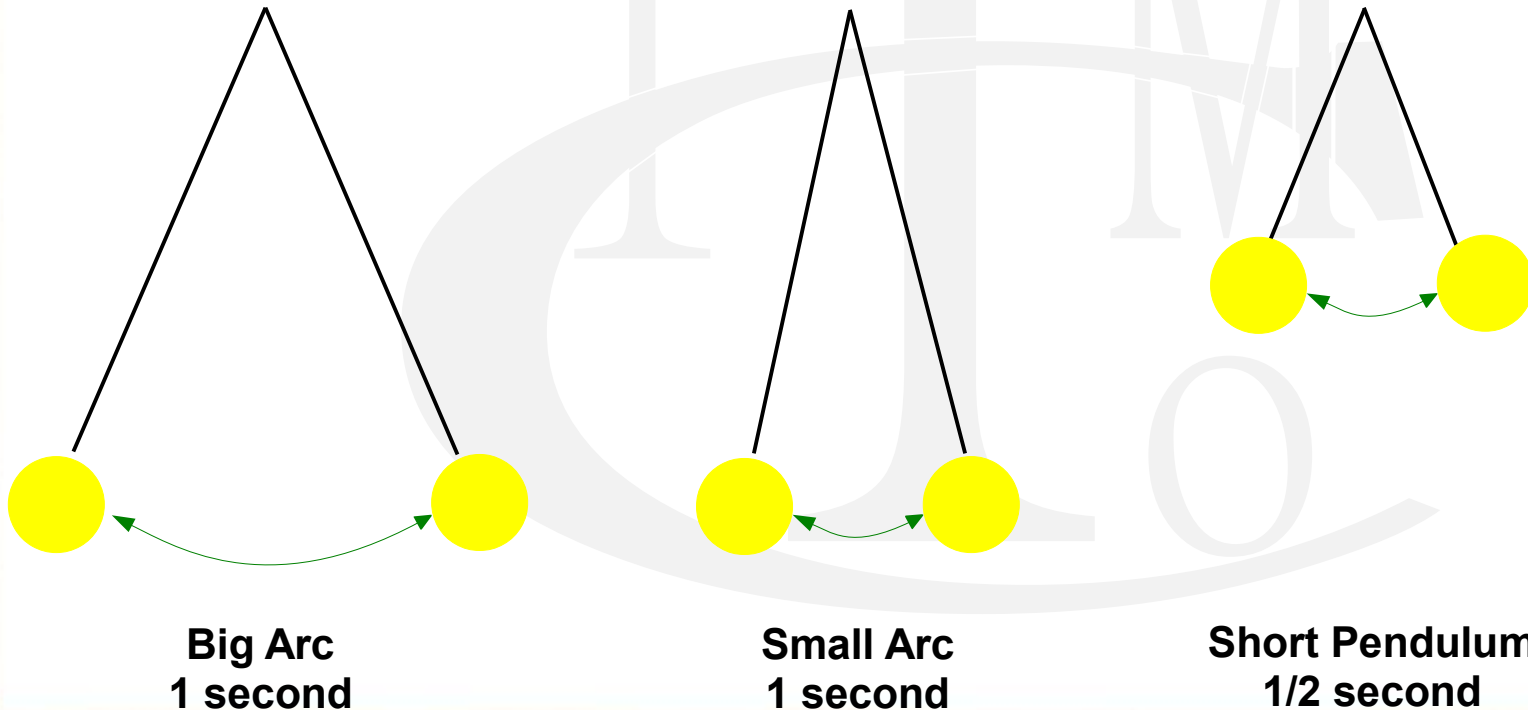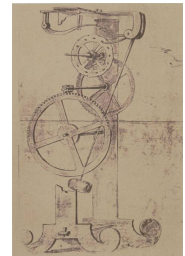
Galileo's clock used the pendulum's swing to control the speed while giving a little 'push' to the pendulum to keep it going.

Escape Wheel with pins

Pallets
(arms to catch pins, connected to pendulum rod)

pendulum bob

When old and blind, Galileo designed the first pendulum clock on paper, but he did not build one. The key innovation was the Escape Wheel and Pallets which allow the regular swing of the pendulum to limit the speed of rotation of gears which would turn the clock's hands. They worked together to turn the pendulum cadence into a time keeping machine.
The pendulum clock design was easy to produce, and was the most accurate time keeper until the 1930s.

In the 1800s farming was the primary way of life as it had been
for thousands of years before. Little technology was found in daily life.

With the birth of the railroad it became
necessary for time keeping to become
accurate and readily available.
The proliferation of clocks in modern life
is attributed to the railroad.

Where trains leave
every hundred seconds

Hamilton Watch
"The Watch of Railroad Accuracy"

HAMILTON WATCH COMPANY, Lancaster, Pennsylvania

In the late 1800s and early 1900s, people moved near factories to get steady work. For the first time in history, the tracking of 'labor hours' became important, demanding accuracy and efficiency.

Automation in time keeping first appeared in the UK in the 1870s and in the USA in the late 1880s with the Dey Time Register (similar to photo, lower left) and the Bundy Key Recorder next page). The photo on the left is a motorcycle factory in the UK, and the women are lined up to 'clock in' using a dial recorder. The men used a different recorder on the left. The time recorders of the late 1800s recorded the employee number and times of entry / exit on a paper roll inside the clock.

Each employee was assigned a numbered button on the large wheel into which they inserted the pointer during entry or exit, signing in or out.

Watchman's Clocks & key station


Willard Bundy

Bundy Key Recorder

Willard Bundy was a jeweler who also made watchman's clocks in his store in upstate New York. The watchman's clock had been in use for decades in Europe and in the US. The watchman would carry the clock around to different key stations, and the inserted key would record the time and key location inside the watchman's clock, proving he made his rounds. In 1878, Willard patented a Key Recorder clock which was the same recording concept but in a wall clock. Employees coming to work would take their key from the rack and insert it in the clock, recording their start time, and again at the end of the day to clock out. It was the world's first 'time recorder' patent.

Willard's brother Harlow Bundy formed and led Bundy Time Recorder in 1889 to market the Key Recorder. In 1893, Harlow Bundy featured the Recorder at the Chicago World's Fair, and he sold 3,000 Recorders by year end.

Bundy Key Recorder

1893 Chicago Worlds Fair

Harlow Bundy &
Bundy Time Recorder Co.
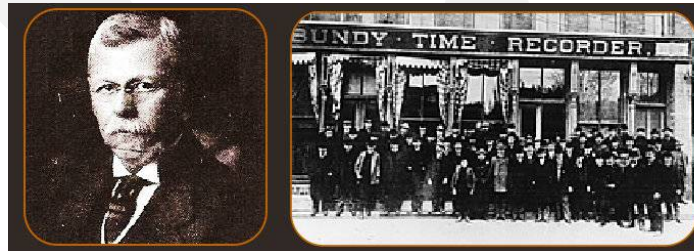
Bundy exhibit at Worlds Fair (recreation)

Employee Time Card

ITR 'Rochester Time Recorder'

One issue with the first time recorders was the inability of employees to see their clock-in / clock-out times, because they were printed inside the clock.

With the next generation of time recorder each employee had a time card to log their start / end / lunch hours. It was part of the daily routine.

The time card was patented in 1894, competing with the dial recorders and key recorders. Bundy Manufacturing, who owned the key recorder patents, acquired the time card patents in 1900 and formed International Time Recording Company, which became IBM in 1924.

ITR's "Rochester Card Recorder" became the industry standard for four decades.
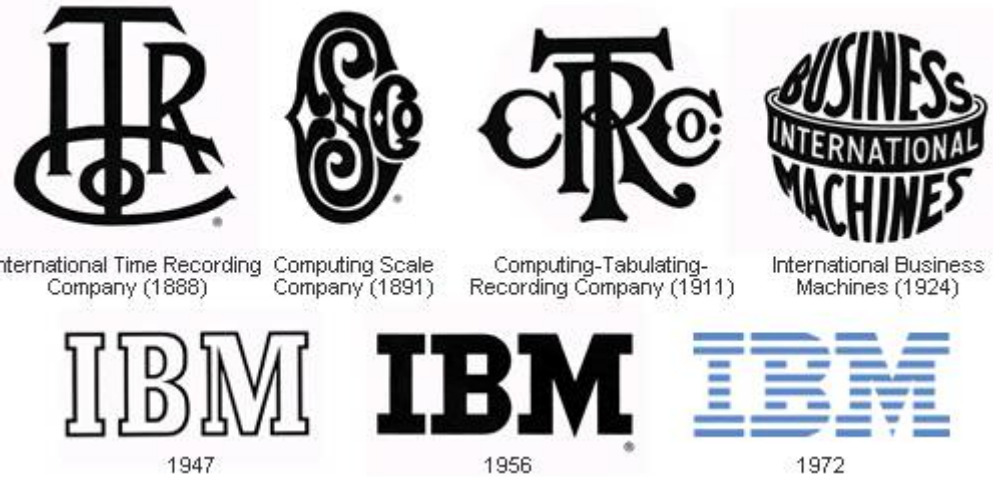
Bundy Manufacturing was formed in 1889. Under the leadership of Harlow Bundy, the company expanded in many ways, creating the foundation for IBM.
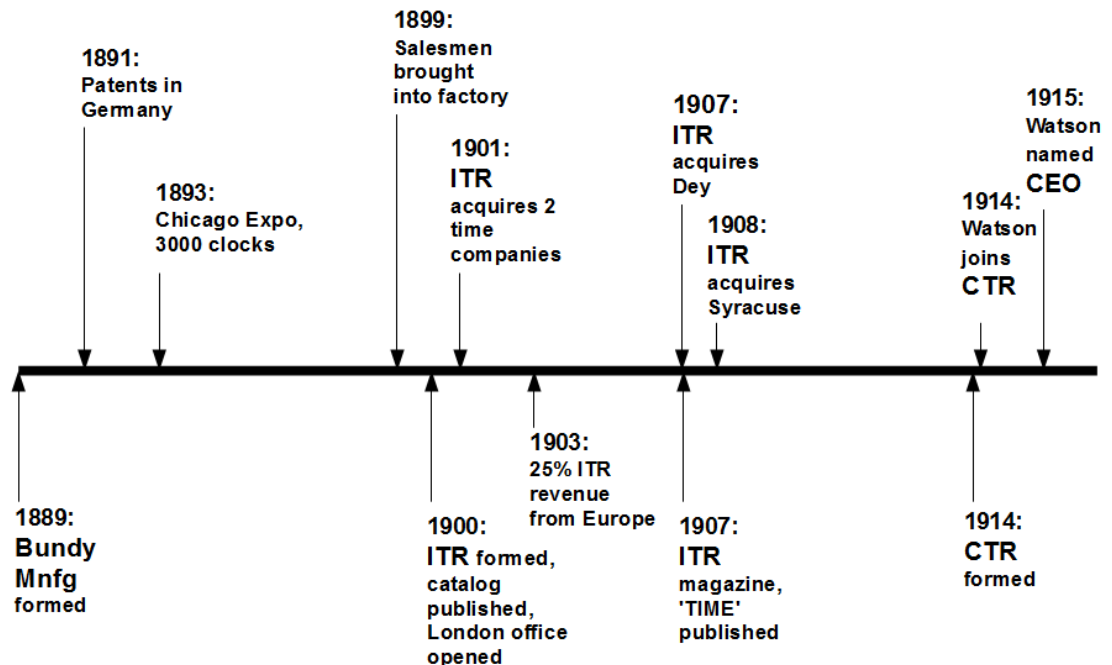In 1900, Harlow formed International Time Recording, and bought two companies, including the time card recorder patents.

ITR became a truly international business with offices in Europe and Canada. By 1903, a quarter of ITR's business was outside of the USA. Harlow was a marketing and sales leader, with aggressive ad campaigns and a well trained, highly motivated sales force. For 26 years, Harlow Bundy was the General Manager of the companies he created.

With the 'Rochester' card recorder, ITR built the market and led the time recorder business.

International Time Recording Company (1888) Computing Scale Company (1891) Computing-Tabulating-Recording Company (1911) International Business Machines (1924)

IBM 1947   IBM 1956   IBM 1972

Milestones in Building early IBM

1891: Patents in Germany

1893: Chicago Expo, 3000 clocks

1899: Salesmen brought into factory

1901: ITR acquires 2 time companies

1907: ITR acquires Dey

1908: ITR acquires Syracuse

1914: Watson joins CTR

1915: Watson named CEO

1889: Bundy Mnfg formed

1900: ITR formed, catalog published, London office opened

1903: 25% ITR revenue from Europe

1907: ITR magazine, 'TIME' published

1914: CTR formed

ITR Clock Technology

The following pages show the technology progression of ITR clocks.

It begins with the clock time-keeping mechanism invented by Galileo in the 1600s which has been at the heart of clocks for four centuries.

Pages showing ITR card recorders and master clocks intermixed with close-ups of the technologies built into them show how technology evolved to automate business through time controlled networks.
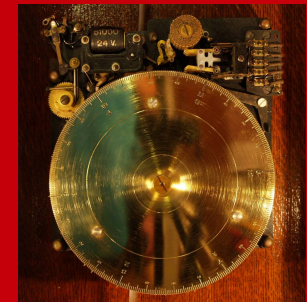
Clock Movement: Pendulum, Pallets and Escape Wheel

The heart of nearly every clock for hundreds of years is the escape wheel & pallets.

The escape wheel has jagged teeth, and is linked to most gears within the movement. The power source (e.g., spring or weights) would connect to spin the escape wheel. On this ITR clock, the red second hand is on the axel (or pinion) of the escape wheel. The minute and hour hands were connected to the escape wheel by gears.
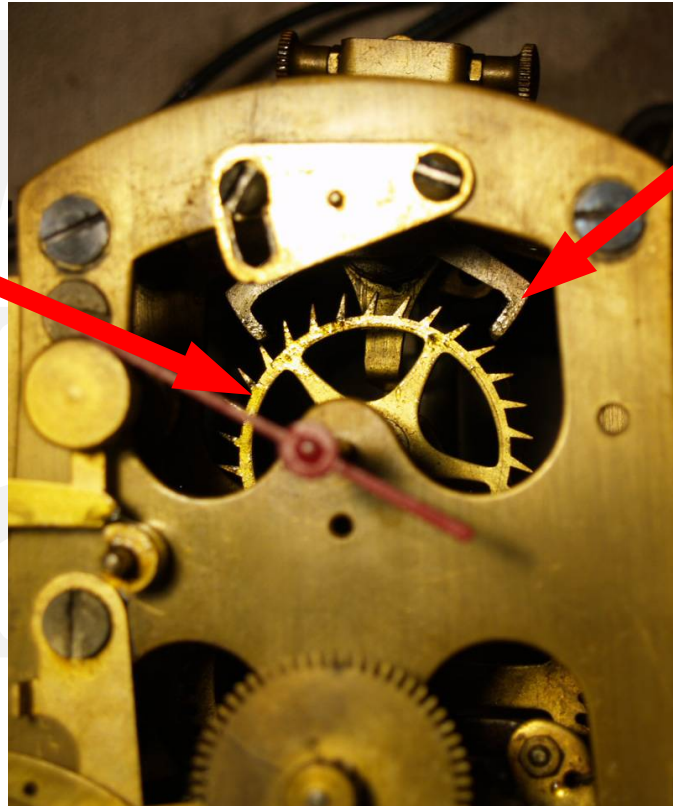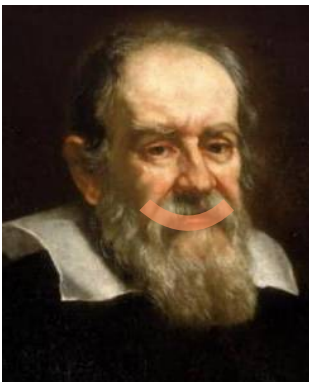

The pallets are the teeth on the ends of the verge. They are connected to the pendulum, and rock above the escape wheel. The protruding tooth on one side would stop the escape wheel from spinning, until the momentum from the pendulum lifts it back up and the other tooth engages. This process **regulates the spin speed** of the escape wheel, and through gearing, the hands on the clock
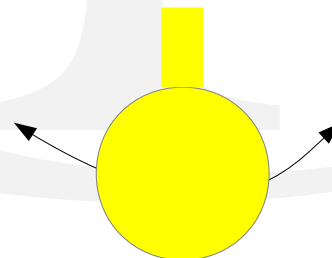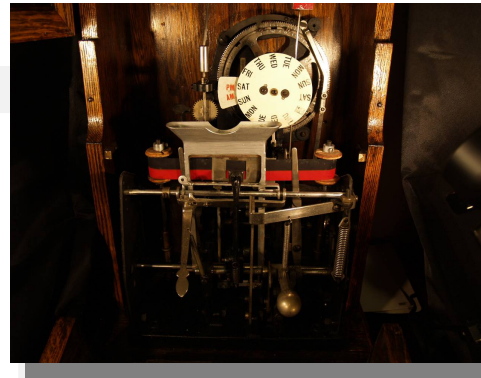
As the escape wheel slides by the lifting tooth, it gives the tooth a kick to **keep the pendulum swinging**.

International Time Recording – Rochester Time Clock
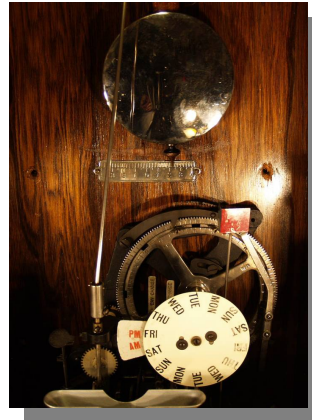
**Nickel Pendulum &
Recorder Drive Shaft**
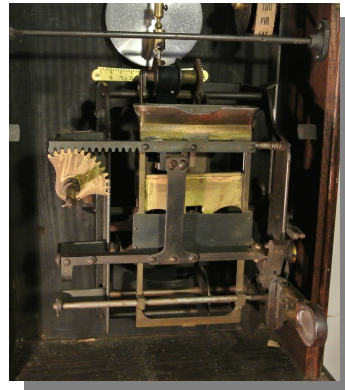

**Time Card
Recording Mechanism**

**'ITR of Endicott' Mark
Original Font**

Year: 1920e   Serial: na   Dimensions: 40"Hx15"Wx12"D

Bundy Manufacturing was renamed International Time Recording of Endicott, NY. ITR time clock technology improved with their punch clock, and ITR became the market leader in factories and office buildings around the world. More employees would become familiar with the technology, and business benefits helped drive the economy. The industrial age boom required accurate and reliable devices to track hourly workers. This ITR time clock is driven by two large, strong springs located in the clock movement behind the dial. The supervisor would wind them weekly. The brass movement would regulate time via the pendulum, and also turn the vertical shaft in front of the pendulum. This shaft would operate the time card mechanism in the lower unit. As the shaft turned, wheels with time-of-day and day-of-week would turn, and be imprinted on the worker's card when the front lever is struck.

Restored and repaired by Dave Dietrich 2012

W. H. Bundy Time Recorder

Time Card
Recording Mechanism

Reverse Paint Label

Dial & Movement

Year: 1918e Model: 225 Serial: 12355 Dimensions: 50"Hx18"Wx12"D

Willard Bundy invented the key recorder, but his brother Harlow Bundy was the driving force behind their company, Bundy Manufacturing. Willard left after a falling out with Harlow, and started WH Bundy and competed with brother Harlow's ITR with this time clock. Simplex bought WH Bundy in 1916. Simplex went on to purchase the time recording division of IBM in 1956. Many people confuse WH Bundy with the Bundy Manufacturing Company which became ITR in 1901.
Like the ITR Rochester Time Recorder, this WH Bundy/Simplex was one of the earliest punch card time recorders and would be found in factories or other buildings where employees would 'clock in' and 'clock out'. Each employee would have a time card, usually kept alongside the clock. Upon arrival in the morning, the worker would insert their time card in the slot, and press the lever on the front. This would imprint the time-of-day on their card, and this process would be repeated at day's end. Bookkeepers would use the card to calculate hourly payroll. For many of the workers of the day, it was the highest form of technology they had seen and used. For employers, it automated the process, reduced costs and improved accuracy of the time keeping process.

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ITR's Marketing of the business benefits.......

*"Points out your Unprofitable Employes.....
...it is the same old story over and over again with the tardy ones"*

1920s: ITR transition from employee time clocks to...
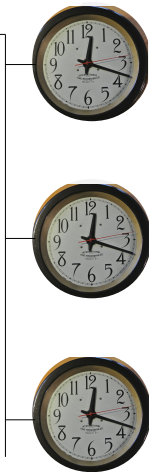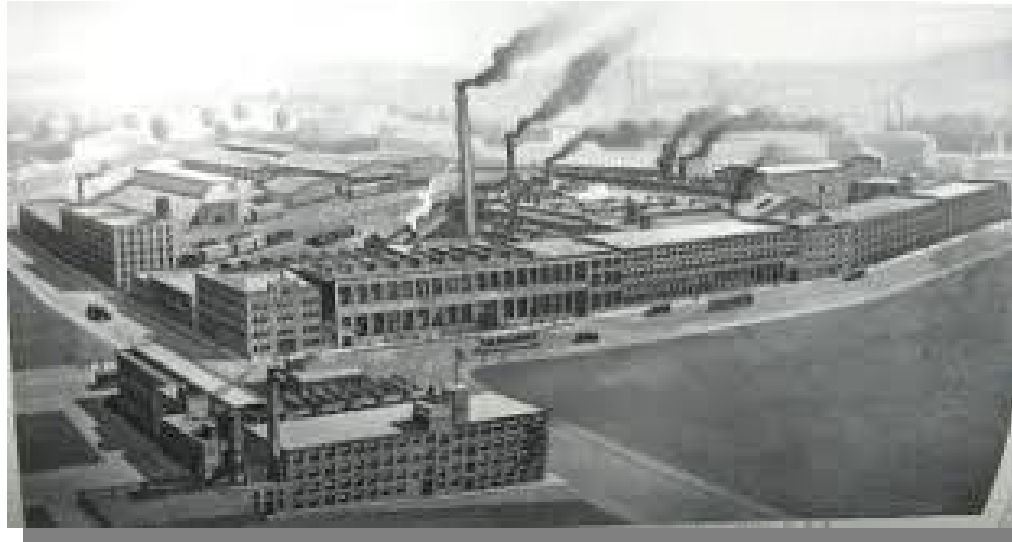
Building & Site Automation

Accurate & Synchronized Network of Clocks

Industry grew, and companies needed to synchronize the card recorders and wall clocks.

A 'Master Clock' with pendulum would keep accurate time and synchronize 'slave clocks'. Most Master Clocks were also self winding, to improve accuracy.

15

International Time Recording: Master Clock Series - Model 13

Brass Pendulum & Beat Bar

Self Winding Movement

Distinctive Dial Wood Bezel

Year: 1920s   **Serial: na**   **72 bpm Dimensions: 47"Hx15"Wx7.5"D**

The Model 13 was at the forefront of clock technology, with innovations which would last three decades. It's clock movement and dial were radical d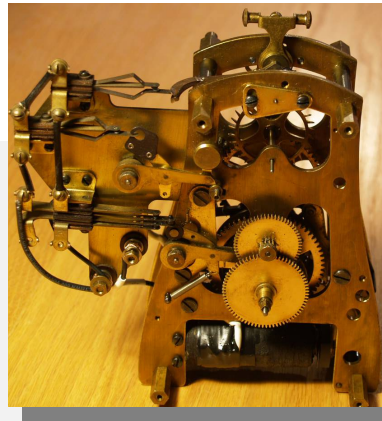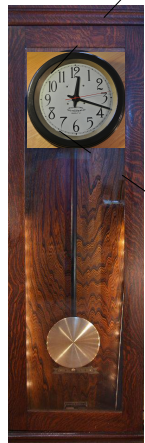epartures from the clocks over the prior four centuries. Time keeping is regulated by a pendulum as it was still the most accurate, but the Model 13 was a 'self winding' clock. Every minute, the clock would wind itself by an electro-magnet which would wind the main spring. The Model 13 was used in factories, office buildings, schools, etc., to synchronize other clocks throughout the facility, known as 'slave clocks'. Slave clocks were not very accurate time keepers by themselves. The Model 13 would send an electric pulse to the slave clocks to synchronize them, enabling its accuracy to be shared across the network. This new movement would be used by ITR/IBM for over 30 years, largely unchanged. The floating dial, with wood bezel trim, was very distinctive in 1920, and would be found on ITR clocks for decades. The Model 13 was a smaller version of what would be the standard ITR Master Clock case size and 60bpm.

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ITR's Master Clock: Synchronizing a Network

ITR's Master Clock movement linked it's mechanical clock accuracy to remote 'Slave' clocks through electric pulses. As the clock gears turned, electric contacts would be opened or closed, sending electric pulses to slave clocks.
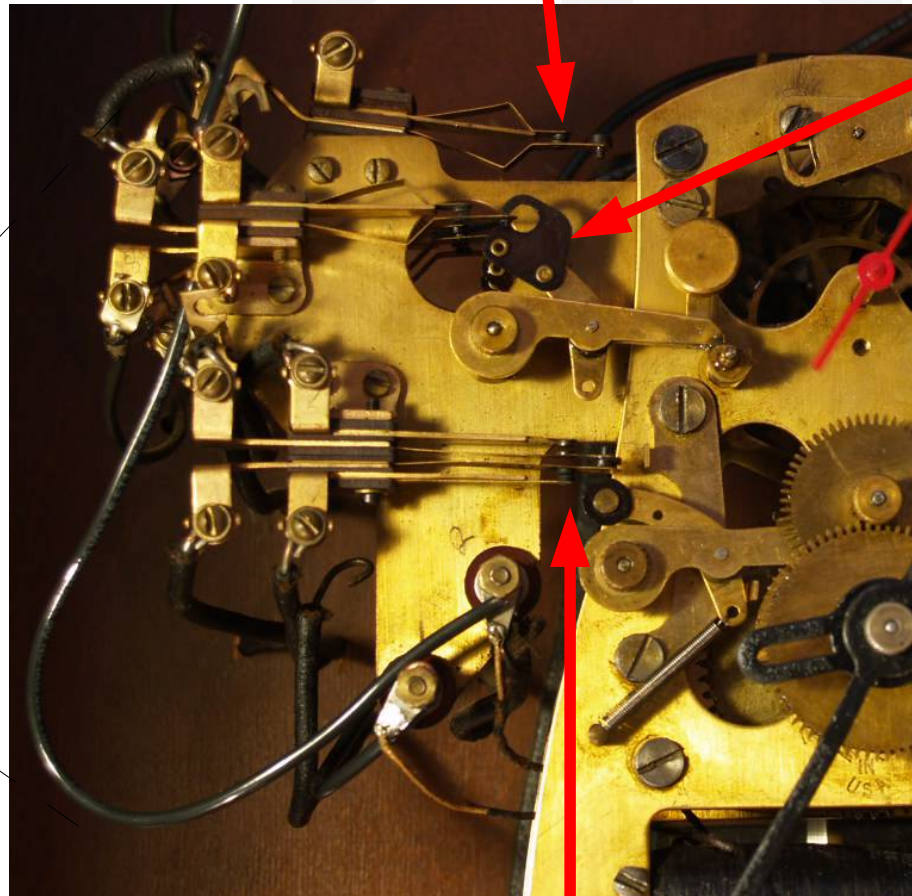
Electric Pulse every Second

Electric Pulse every Minute
(energizes magnet rewind)

MASTER

Electric Pulse every Hour
(synch Slave clocks)

SLAVEs

17

ITR Self Winding Movement:
Spring Driven, Magnet Rewind

1) Cam turns with movement, closes contacts every minute

2) When contacts close, wire coil magnet is energized

3) Plate is attracted to magnet
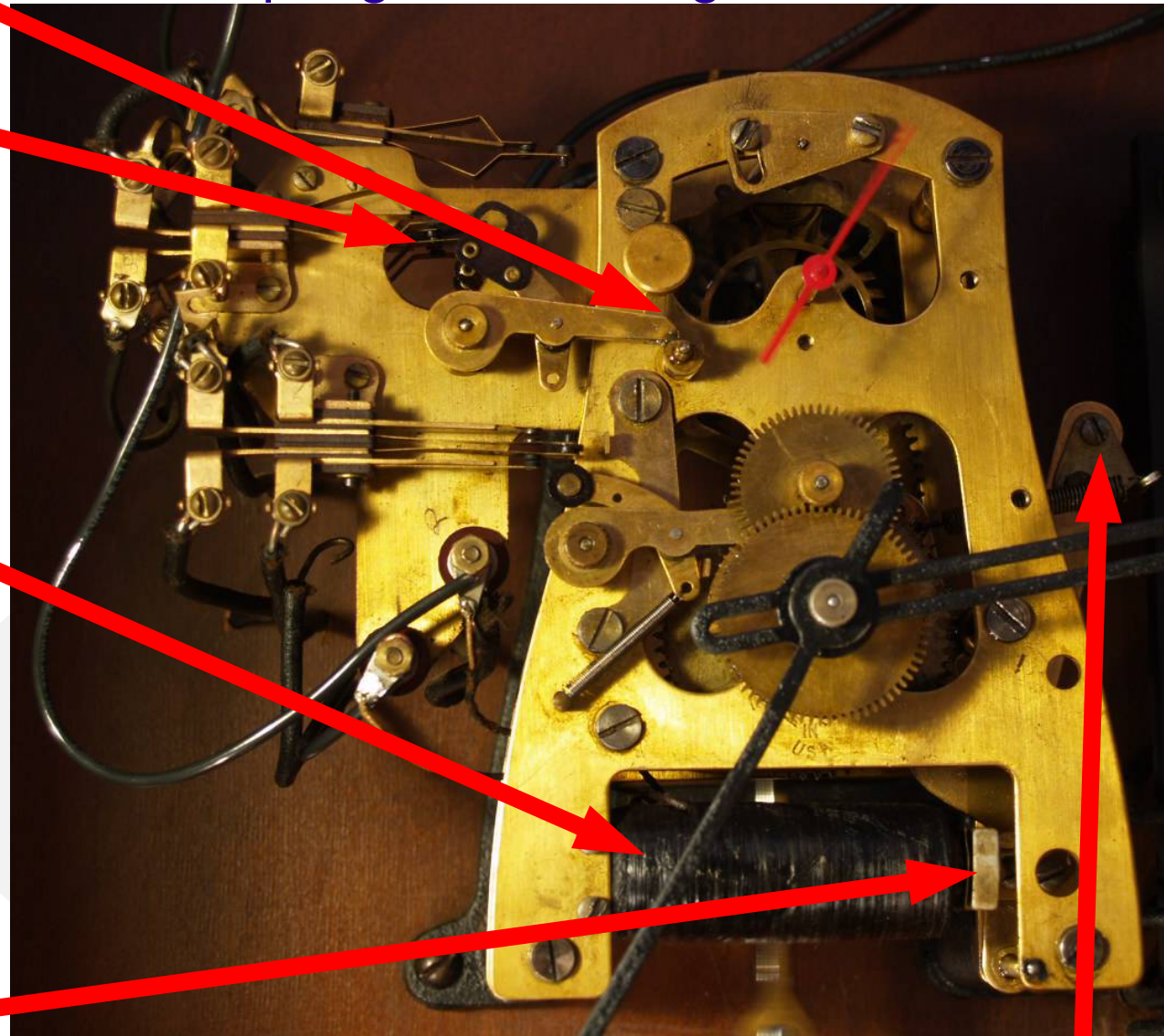
4) Plate movement winds spring

Self Winding: Magnet Rewind – closeup

1) Cam turns with clock movement

2) two arms ride on the cam, lifted up and down

3) arm closes contacts for 4 seconds every minute, sending electricity to electro-magnet

International Time Recording: Master Clock – Model 262

Brass Pendulum & Beat Bar

Motor rewind of weights
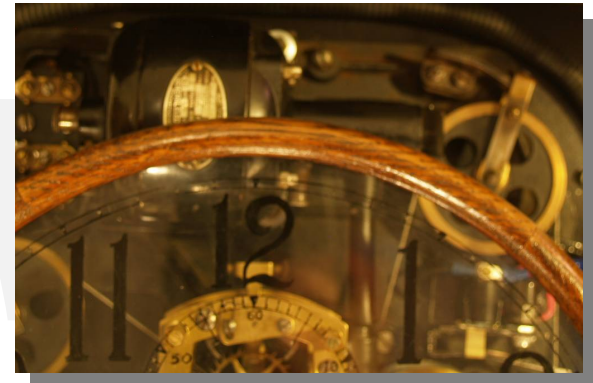
GE Motor

Year: 1926 Serial: 317215   Dimensions: 65"Hx16"Wx8"D
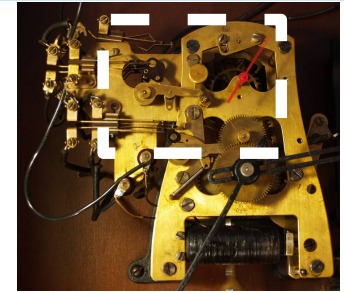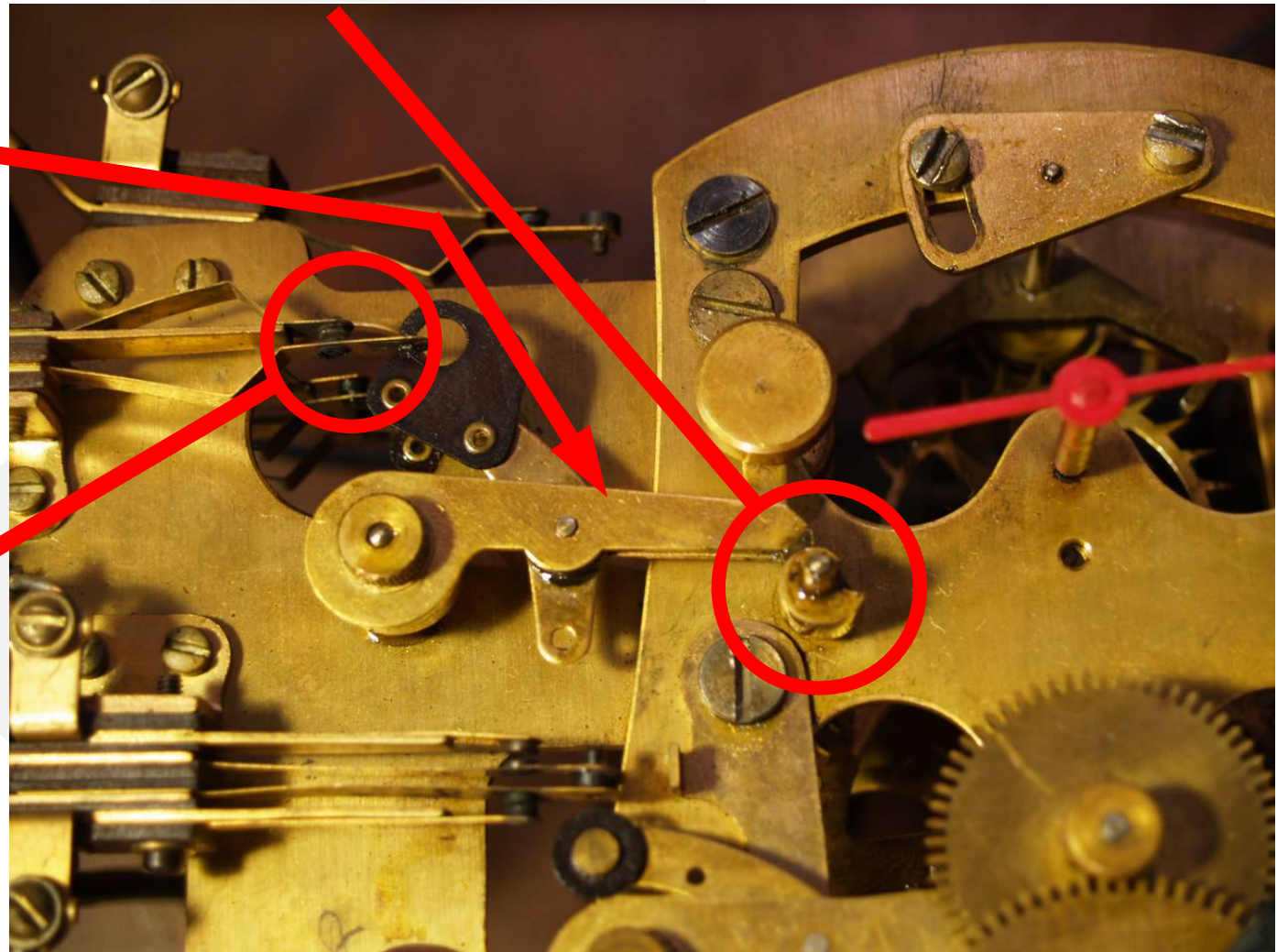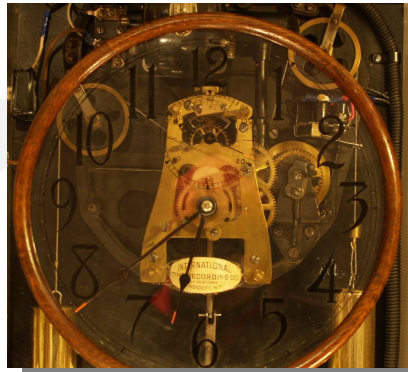

Standard 262

The ITR Model 262 was one of the first 'self winding' master clocks which used brass weights to run the movement. A pendulum provided time keeping accuracy due to its length. Generally, weight driven clocks are more accurate than spring driven (either hand wound or self winding) because the weights put a consistent pressure on the movement. Weight driven clocks were around long before spring driven, but what made the ITR unique is an electric motor (pictured on right) which would re-wind the weights every several days.

On the clock pictured, a plexiglass face was used to provide a view into the movement and rewind mechanism which works well and is fascinating to watch. See next page.

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Self Winding: Weight Driven, Motor Rewind

The ITR weight driven self winding clock was very accurate industrial clock. An electric motor would wind up the weights:
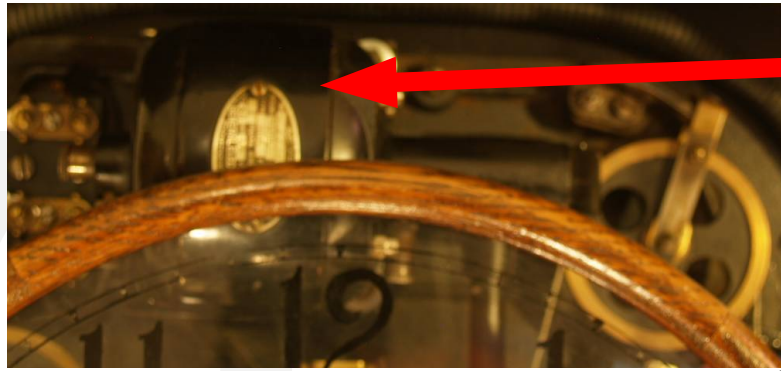
1) GE Electric motor activated ~2-3 days
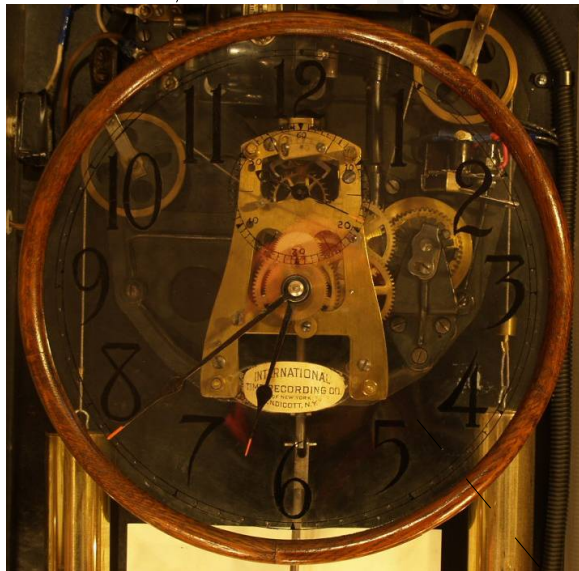
2) Gears wind weights up
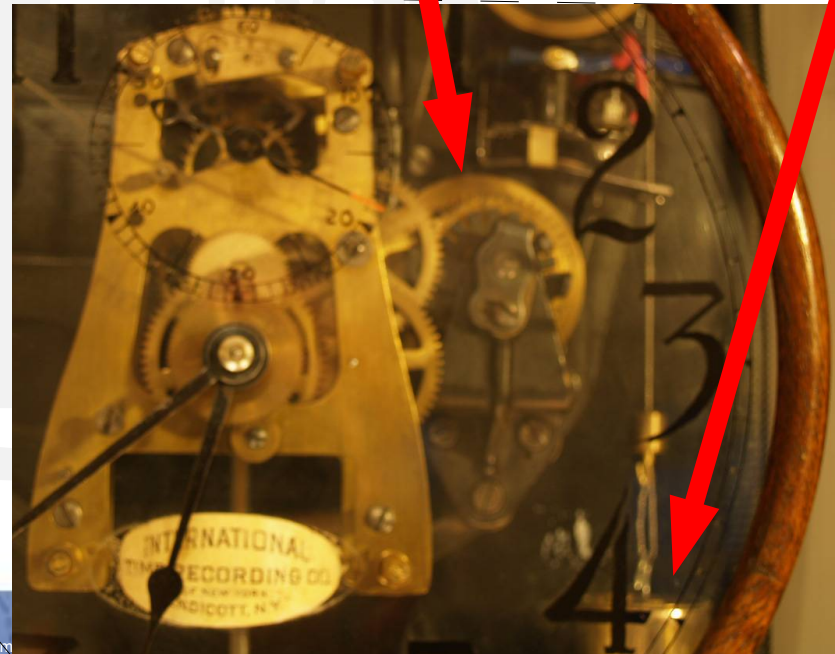
International Time Recording: Weight Driven Master Clock
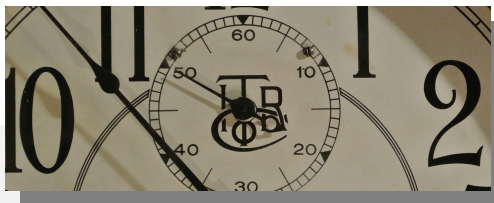
ITR Mark / Logo
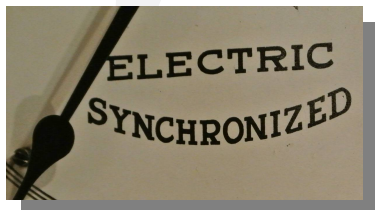
One of the first Masters
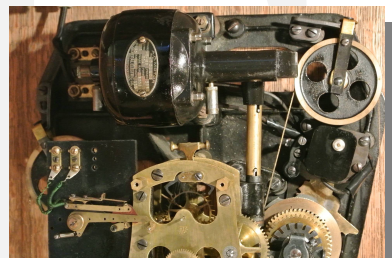
Motor Wound

Brass Pendulum Bob & Quater-Sawn Back Board

Weight Driven Movement

Pre-Restoration Condition

Year: 1918est Serial: unknown   Dimensions: 63"Hx19"Wx8"D

INTERNATIONAL: Master Clock – Model 16
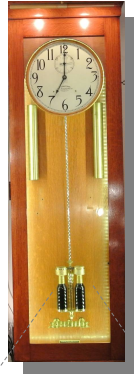
Original Holder

Mercury Vials

Motor Wound

Weight Driven

Year: 1930	Serial: 398793	Dimensions: 63"Hx19"Wx8"D

This ITR Master Clock was built in 1930. It included options which made it the most accurate clock available from ITR. The weight driven movement was more accurate than spring driven, and it was also self-winding. The original GE motor, pictured above the dial, winds the weights up every 2-3 days.

This clock also featured a pendulum with a Mercurial Bob. Vials filled with mercury (pictured on left) compensated for temperature changes in the building, accurate within 10 seconds per month. To avoid handling mercury, the collector is running with two glass bottles (pictured in center). This clock is in superb condition with original finish, warm colors and pristine mechanical condition.

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International Time Recording: Master Clock – Style E-60
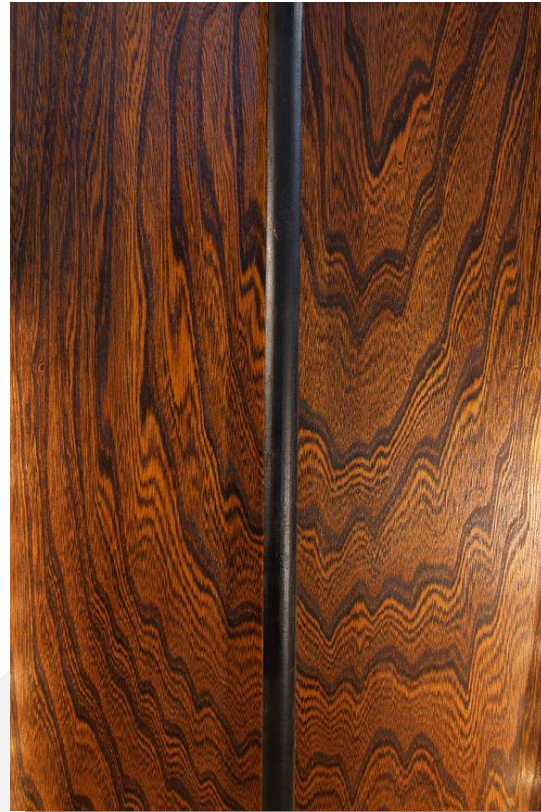
Beautiful, quarter sawn oak case back.
One solid piece & wood grain design
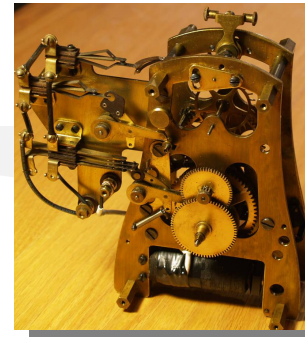
Brass Movement, magnet rewind

Original Font Dial, oak wood bezel

Year: 1924 Serial:276255
Dimensions: 63"Hx21"Wx8"D

This Master clock was built in 1924 for The York Dispatch Publishing Co. It's one of the first of the 'long case' (over five feet tall) self-winding clocks made by ITR. The 44"-long pendulum and heavy brass bob improved its accuracy tremendously, and it synchronized 'Slave' clocks. The dial face is in great shape, despite being 90 years old. But the real beauty is the oak wood patterns in the back of case and in the door frame.

Quarter sawn boards are sawed in a certain way to provide greater stability and size with less warping and shrinkage. Sometimes the grain produces a decorative effect.

Brass Pendulum & Beat Bar

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INTERNATIONAL: Master Clock – Model 13 - 7
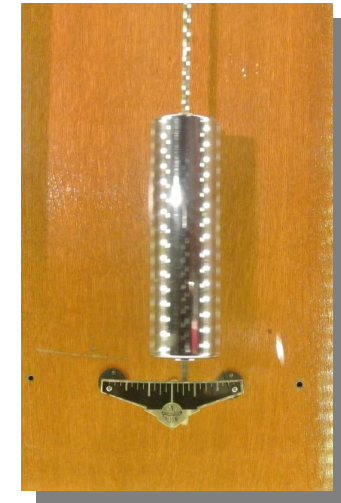
Invar Bob

Quarter Sawn Oak

Year: 1929 Serial: 365459   Dimensions: 63"Hx19"Wx8"D

Another ITR Master Clock made by International Time Recording Company, which later became IBM. Manufactured in Endicott, New York, in 1929, this Master Clock could synchronize other clocks located throughout the building. It was an accurate time keeper, within 20seconds per month. The craftsmanship of the woodwork is highlighted by the quarter sawn door frame which with its distinctive striping. Exceptional tone and warmth of clock case. Great condition for 86 years old.

1928e: ITR adds programmable control to their master clocks
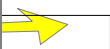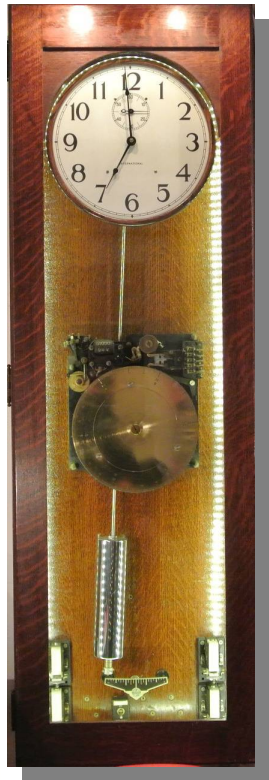
Building & Site Automation

Accurate & Synchronized Network of Clocks

ITR added the ability to program electric circuits to switch on/off at day / time preset but easily changeable.

Lighting, Alerts & Machine Control

This enabled businesses to automate lighting and machines, sound whistles and more at precise time-of-day.

INTERNATIONAL Programmable Timer 1930s

Programmable Timer
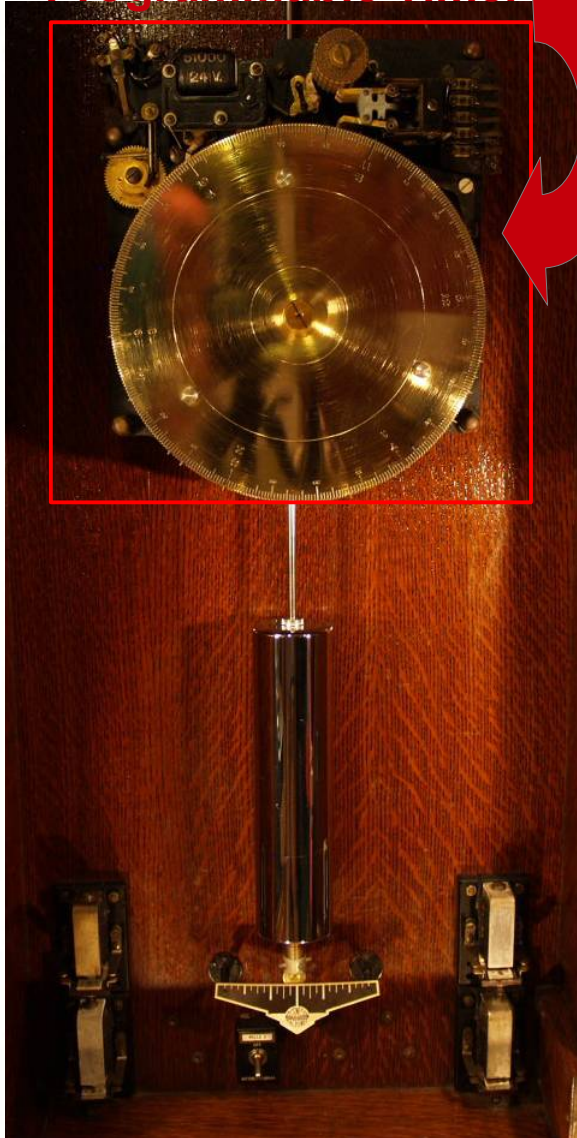
Building control took a big step forward with International's development of the Programmable Timer.

Up to 10 circuits could be programmed with on/off days and times. Lights, horns, machines, and other devices could be programmed by the owner.

Each disc controlled a circuit, with arms which rode on top controlling the contact points for the circuit. The discs would turn using electric pulses from the movement and a magnet / plate assembly similar to what's found in the movement to wind the main spring.
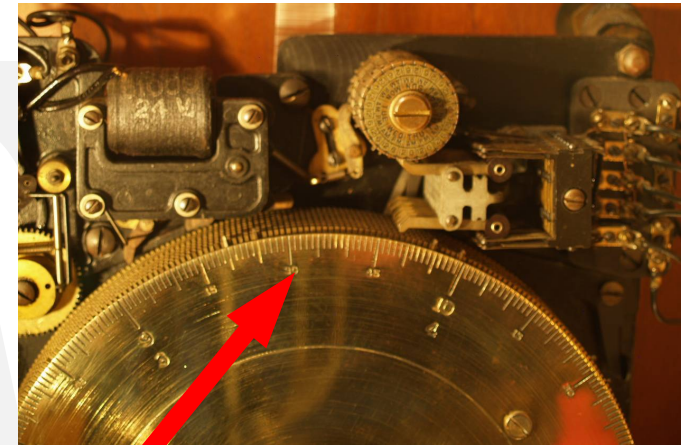
On/off Time

On/off Day   contacts
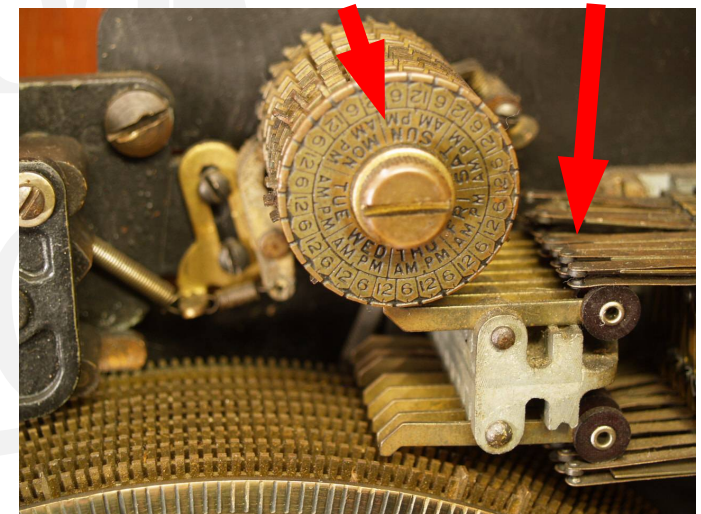
INTERNATIONAL: Master Program Clock – Model 17-7
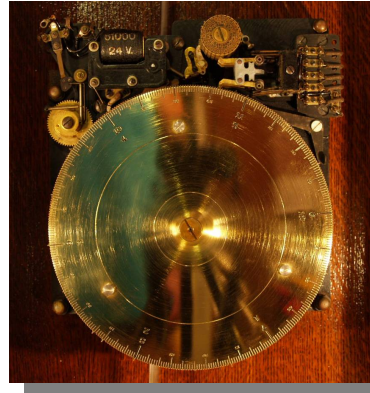
Programmable Timer
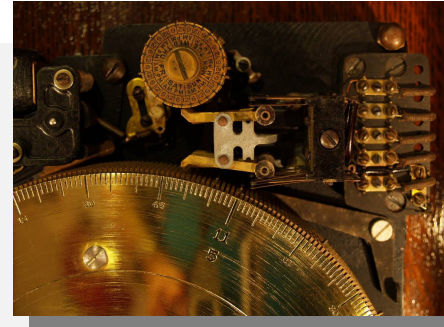
Timer switches

New Font and Mark

Year: 1934 Serial: 470981, Graham dead beat, 60 bpm, Invar Pendulum, Programmable (metal disc type)   Dimentions: 58"Hx19"Wx8"D

This Model 17 is unique, in that it was 'programmable' to control on/off cycles of a building's lights, power, bells, etc. as well as being a Master Clock. The Model 17 would send an electric pulse to slave clocks around the facility to synchronize them, but its accuracy was greatly improved with the new Invar pendulum, weighing 50% more than prior ITR Master clocks. A new IBM Globe logo is on the beat bar. Also a new look on the dial, with a new font and INTERNATIONAL logo (dropping Time Recorder), but the classic quarter sawn case and floating dial look remains.

Restored and repaired by Dave Dietrich 2013

Copyright: International Time Machines, LLC, 2015

INTERNATIONAL: Master time control series – Model 18

Circuit Control Panel

Classic Dial and Font

Pins on Discs to set on/off times & days

Year: 1928   **Serial: 359767**   **Dimensions: 63"Hx19"Wx8"D**

The Model 18 was unique, in that it was 'programmable'. It is a very early use of the term, a forerunner of today's technology. The clock would control the operations of electric lights, bells, machines, etc., and on/off times would be programmed on the metal discs. There are 10 discs, one for each device. The user would insert pins on the edge of the disc to start/stop the device, and the disc would turn to open and close the circuits around the factory or office building.

INTERNATIONAL: Master Program Clock – Model 17-7

Programmable Timer

Brass Bob & Beat Bar

New Font and Mark

Year: 1934 Serial: 463772, Graham dead beat, 60 bpm, Brass Pendulum, Programmable (metal disc type)   Dimentions: 58"Hx19"Wx8"D

Like the prior Model 17-7, these clocks were 'programmable' to control on/off cycles of a building's lights, power, bells, etc. as well as being a Master Clock. The Model 17 would send an electric pulse to slave clocks around the facility to synchronize them.
A new IBM Globe logo is on the manufacturers plate.
This clock was restored by Larry Gann, Alabama, in 2014. It will be used to test and control slave clocks, bells, lights, etc., since the wiring is new.

Restored and repaired by Larry Gann, Alabama, 2014
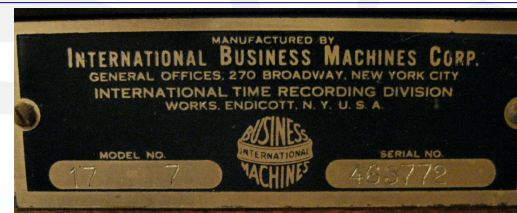
INTERNATIONAL: Master time control series – Model 18?

**Paper Tape
Programmable Control**

Mercurial Pendulum

Year: 1928?	Serial:	Dimensions: 63"Hx19"Wx8"D

This ITR Master Clock uses a paper tape which is rotated past contact points which open and close depending on the holes punched in the tape.
It also has a Mercurial Pendulum, complete with mercury in glass vials. These pendulums were the most accurate time keepers, since the mercury expansion/contraction compensated for the rod length changes with temperature change. This clock also has beautiful, quarter sawn wood.

Un-Restored

INTERNATIONAL: Master Program Clock – Model 15 MC
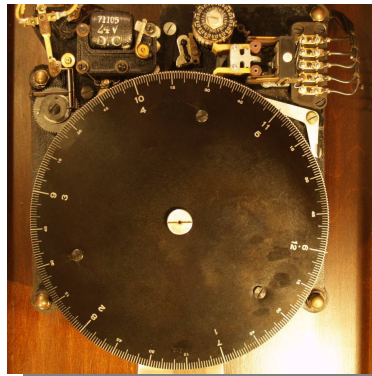
Programmable Timer
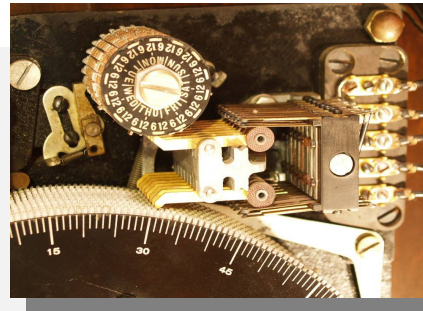
Timer switches

Original Font & New Mark

**Year: 1946** Serial: 789875HH Dimensions: 43"Hx17"Wx8"D

The Model 15 is a self-winding, master clock. Time keeping is regulated by a pendulum as it was still the most accurate clock movement in its day. Every minute, the clock would wind itself through the use of an electro-magnet rewinding. The Model 15 could be found in factories, office buildings, schools, etc., to keep time accurately and synchronize other clocks throughout the facility. The Model 15 was also programmable, and offered facility control in a smaller cabinet and lower price. The Model 15 clock would control the operations of electric lights, bells, machines, etc., and on/off times would be programmed on the metal discs. There are 10 discs which would would turn to open and close circuits around the factory or office building.

Restored and repaired by Dave Dietrich 2013

INTERNATIONAL Programmable Timer (1940s)

In the 1940s, International also made available this lower cost timer. Same engineering, but without the expensive brass.
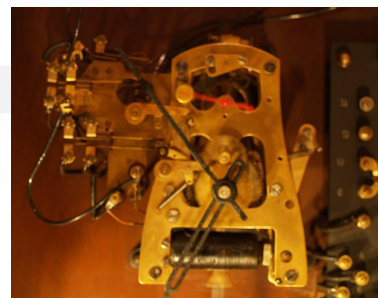
Up to 10 circuits could be programmed with on/off days and times. Lights, horns, machines, and other devices could be programmed to operate at the desired times, by the user.
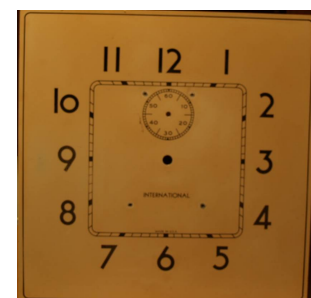
33
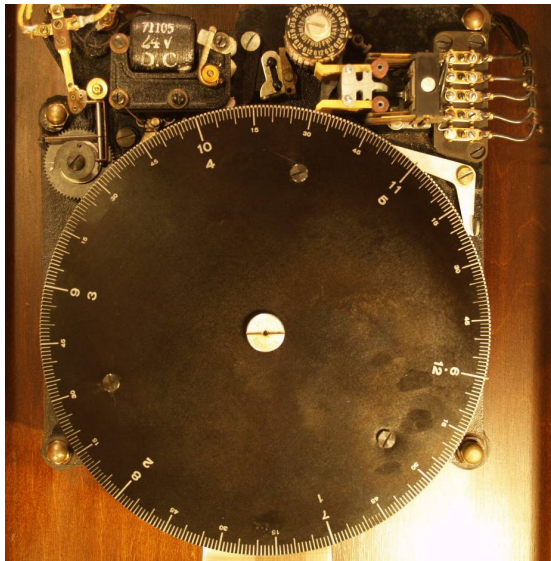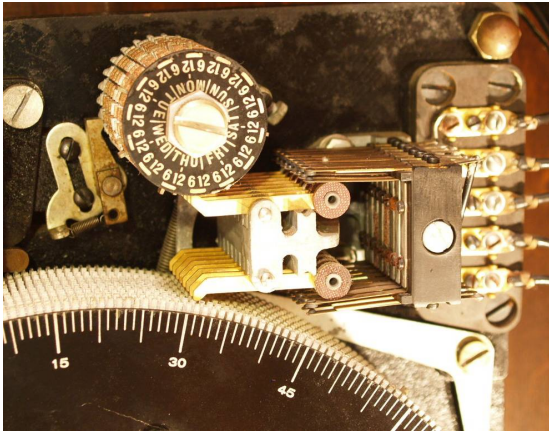
INTERNATIONAL: Master Program Clock – Model 25

Programmable Timer

Magnet Movement

Art Deco Dial

Year: 1947 Serial: 87028?P   Dimensions: 63"Hx19"Wx8"D

The Model 25 is one of the last International / IBM electro-mechanical clocks. Its accuracy is regulated by a pendulum, but it rewound itself and controlled building circuits (lights, bells, machines, etc.) by electro-magnets. This Model 25 still uses the Invar pendulum, and also has a 110VAC to 24VDC transformer. Additionally, the brass disc control for building circuits allowed for 10 devices to be turned on and off at desired days / times. The dial has been removed in the photo on the left to display the movement, but the dial face is shown on top right photo. It's rather bland compared to early International faces. The Model 25 originally sold for $145 with a $30 upgrade for Invar pendulum.

INTERNATIONAL: Master Clock – Model

Electric motor self-winding movement

Invar Pendulum

'IBM Radio Time' wireless remote clock synchronization

Year: 1957 Serial: Dimensions: 63"Hx19"Wx8"D

Manufactured by IBM in 1957, this was the last generation of 'INTERNATIONAL' clocks, after 70 years. The clock was wound every minute by an electric motor attached to the movement. However, the time-keeping mechanism was still mechanical with the pendulum providing its accuracy. It was a 'Master Clock' in that it provided precise time-of-day to remote clocks located around the building or campus. While the remote clocks were electric, a radio wave from the Master Clock would synchronize the remote clocks, a forerunner of wireless data networks.

Owned / Installed at:
IBM Poughkeepsie

The ITR / INTERNATIONAL Mark and Font

	MARK	**FONT / BEZEL**
ITR TIME CLOCK	 • Classic ITR look • First ITR logo: 	• Distinctive, artistic • Collectors praise ITR look • Nickel bezel, painted dial
EARLY SELF-WINDING MASTER	 • Unchanged	• Not bold-faced, finer lines • Beautiful wood bezel, matching case
BUILDING AUTOMATION	 • INTERNATIONAL logo: • IBM globe logo on beat bar: 	• New font: block style • More industrial / Less ornate
ITR's LAST GENERATION MECHANICAL CLOCK MOVEMENT	 • Unchanged • INTERNATIONAL logo	• Retro early ITR font • Metal bezel

The ITR / INTERNATIONAL Pendulums

ITR TIME CLOCK nickel — 16", 2.1 lb
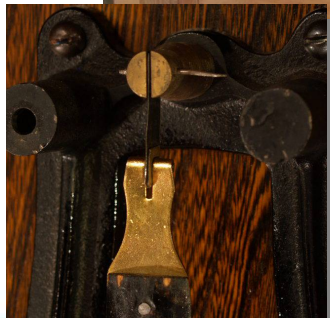
EARLY MASTER brass — 44", 5.0 lb

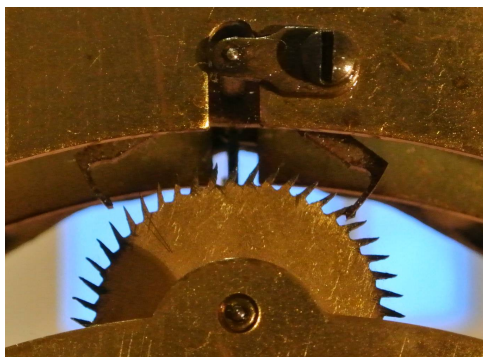**BUILDING AUTOMATION** Invar — 45", ~15 lb
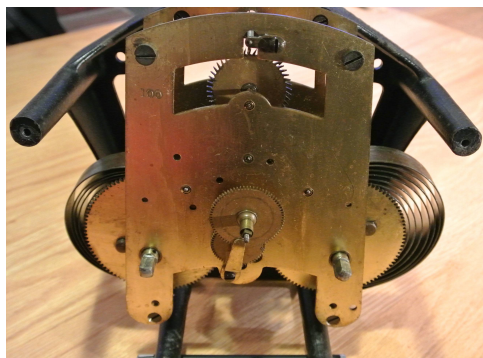
LAST MECHANICAL CLOCK — 31", 5.0 lb

'Suspension Spring' hanger for pendulum, allowing smooth, low resistance swing
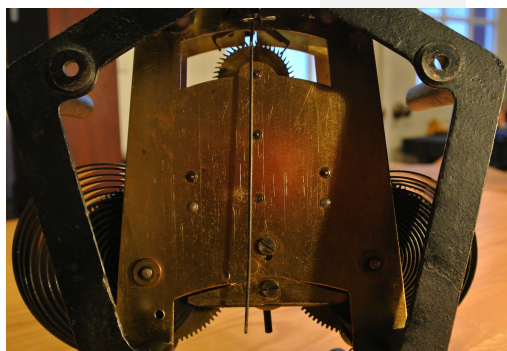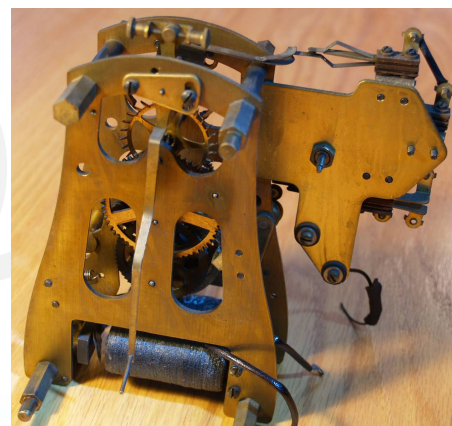
ITR Time Clock Movement
1900-1920

INTERNATIONAL Master Mvt.
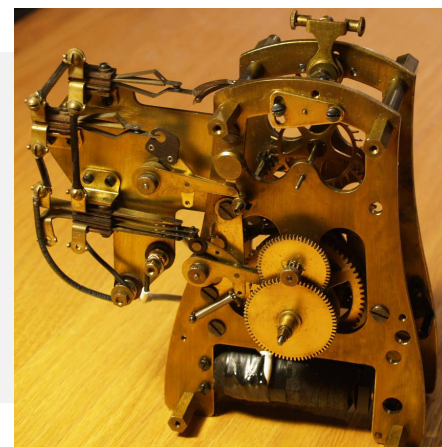## 1920-1958

**Escape Wheel &
Verge with Palletts**

Front / Dial Side

Rear / Pendulum Side
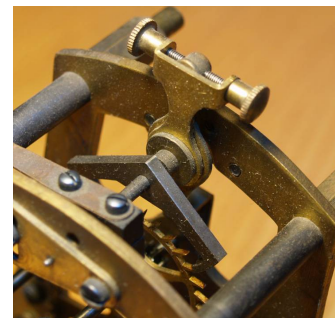
In summary, the 1900s brought massive changes in the work force and automation.....the drivers of the industrial age.

ITR's clock technology was at the forefront of industrial automation. Payroll information collection, synchronization of a facility's clock network and programmable on/off operations of lighting, alerts, machinery, etc. enabled business growth in the early 1900s.

For five decades, ITR and IBM applied clock technology to modernize the business world. It's a legacy which lives on today.

Inside

INTERNATIONAL TIME MACHINES

ITR Master Clock technology, design and craftsmanship from a century ago.

Provided business data capture, workforce synchronization and programmable control networks.

Timeless works of art.

Clocks restored and collected by
Dave Dietrich, 2015

Backup / Other Info

INTERNATIONAL: Master Clock – Model ?, pre-restoration

ITR Mark

Motor Wound

**Brass Pendulum Bob &
Quater-Sawn Back Board**

Year: 1918est Serial: unknown   Dimensions: 63"Hx19"Wx8"D

INTERNATIONAL: Master Clock – Model 16

Motor Wound

Weight Driven

Mercurial Bob

Year: 1930 Serial: 398793   Dimensions: 63"Hx19"Wx8"D

Pre-restroration