



# The Reverse Engineering of a Mechanical Alarm Clock

Prepared by  
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## Device description



ECM<sup>2</sup> 2

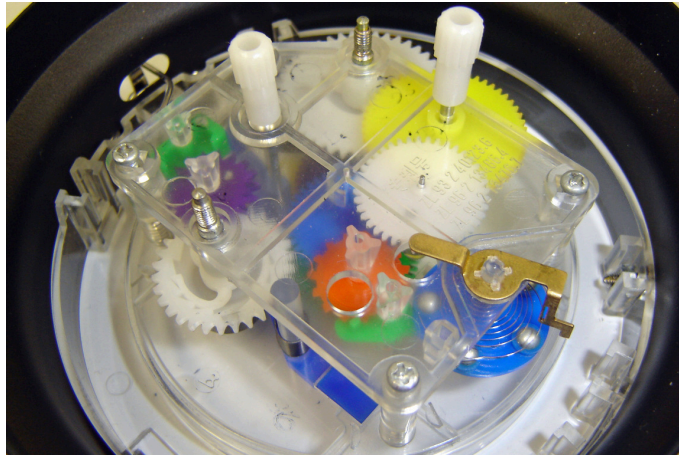
Front view



Back view



## Device description



ECM<sup>2</sup> 3

Internal gearbox



## The Client

- 19 year old college student
- Lost his hearing last year and is awaiting corrective surgery
- Has been arriving late to class or not at all
- Has no roommate to wake him
- Places his alarm clock across the room

ECM<sup>2</sup> 4



## Bill of Materials

Code	Name	Type	Material
1A, 1B	Alarm winding handle, time winding handle	Custom	AISI 1020 Carbon steel
2	Back panel	Custom	AISI 1020 Carbon steel
3A, 3B	Bell pins	Custom	AISI 1020 Zinc-plated carbon steel
4A, 4B	Bell nuts	Standard	See standard part table, Part A
5	Handle	Custom	AISI 1020 Chrome-plated carbon steel
6A, 6B	Bells	Custom	AISI 1020 Carbon steel
7	Hammer lock screw	Standard	See standard part table, Part B
8	Hammer lock	Assembly	Multiple materials
9	Hammer lock nut	Standard	See standard part table, Part A
10	Bell support arm	Custom	AISI 1020 Chrome-plated carbon steel
11A, 11B	Legs	Custom	AISI 1020 Zinc-plated carbon steel
12A, 12B	Leg nuts	Standard	See standard part table, Part A
13A, 13B	Leg washers	Standard	See standard part table, Part C
14A, 14B	Time adjustment knob, alarm adjustment knob	Custom	High density polyethylene
15	Face plate ring	Custom	High density polyethylene
16	Face plate	Custom	Glass, .07" Thickness

ECM<sup>2</sup> 5



## Standard Parts

Part	Specification	Material
A	Style 2, Metric hex nut – M 3 x ½	AISI 1020 Zinc-plated carbon steel
B	M 3 x ½, Type I Cross-recess head machine screw	AISI 1020 Carbon steel
C	Plain washer, 3 mm, narrow, soft	AISI 1020 Carbon steel
D	Standard taper pin - .045" Major diameter	AISI 1211 Steel
E	3-28 Type B, Type I Cross-recess Pan Head Tapping Screw	AISI 1020 Carbon steel
F	3-28 Type AB, Type I Cross-recess Pan Head Tapping Screw	AISI 1020 Carbon steel



Taper pin

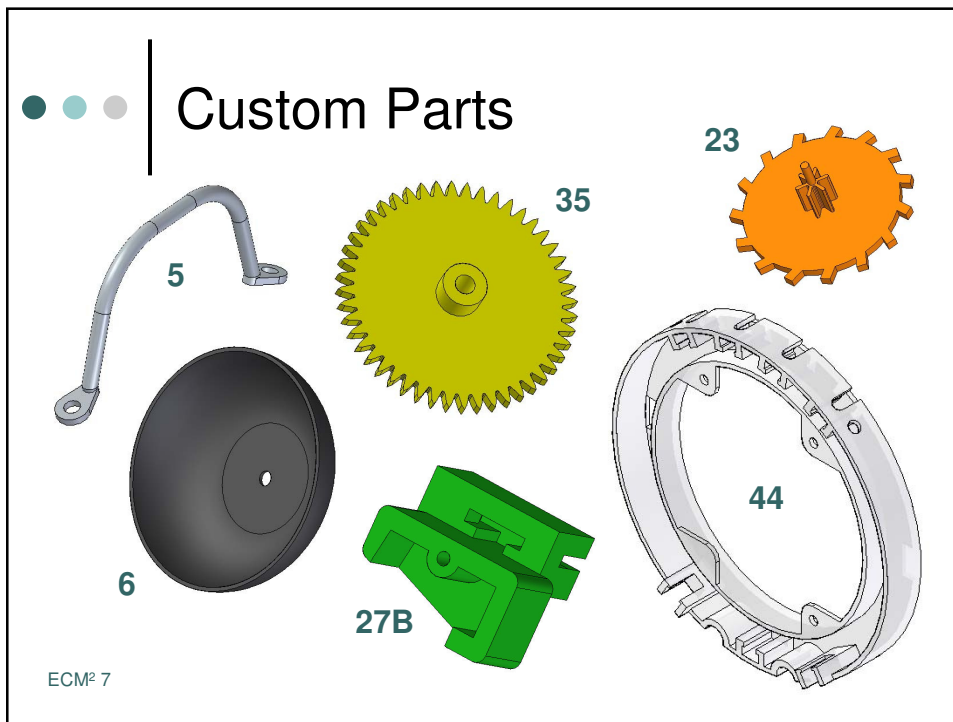


Washers



Self tapping screws

ECM<sup>2</sup> 6



● ● ● | Assembly Instructions

- Place the yellow *alarm time dial gear* (35) on the shaft of the *alarm time dial* (34). The side of the *alarm time dial gear* (35) with the curving protrusion should face the *alarm time dial* (34).
- Insert the *alarm time dial* (34) and the yellow *alarm time dial gear* (35) through Hole E on the front side of the *gearbox front panel assembly* (44). As shown in Figure 7, the shaft of the *alarm time dial* (34) should pass through the cutout in the blue *alarm trigger* (36) before passing through Hole E.

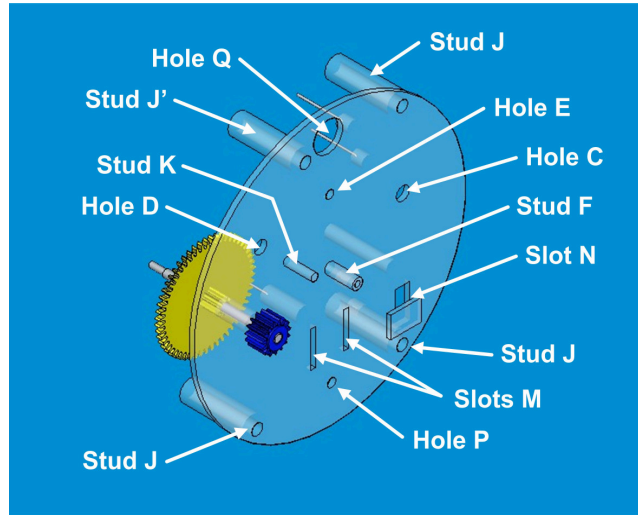
Figure 7 – Assembly step 8

Figure 8 – Assembly step 9

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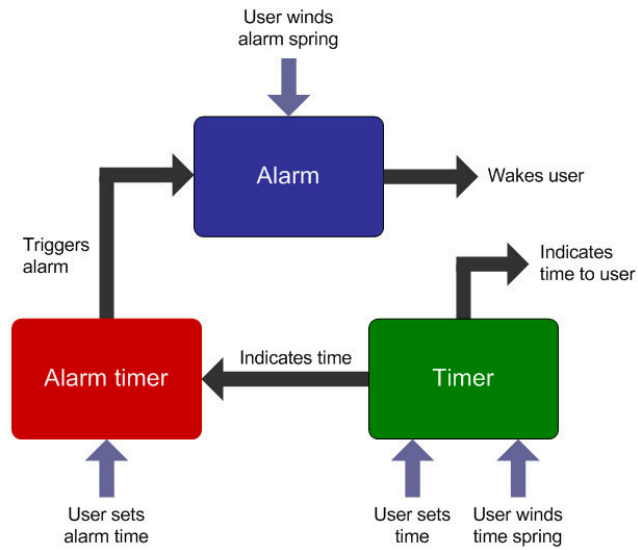
## Assembly Instructions



ECM<sup>2</sup> 9



## Functional Analysis

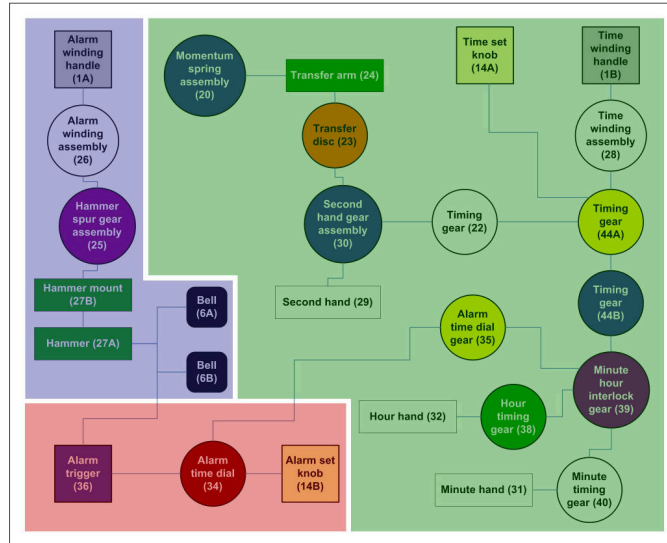


ECM<sup>2</sup> 10



# Device Schematic

- Alarm
- Alarm timer
- Timer



ECM<sup>2</sup> 11



# Functional Decomposition

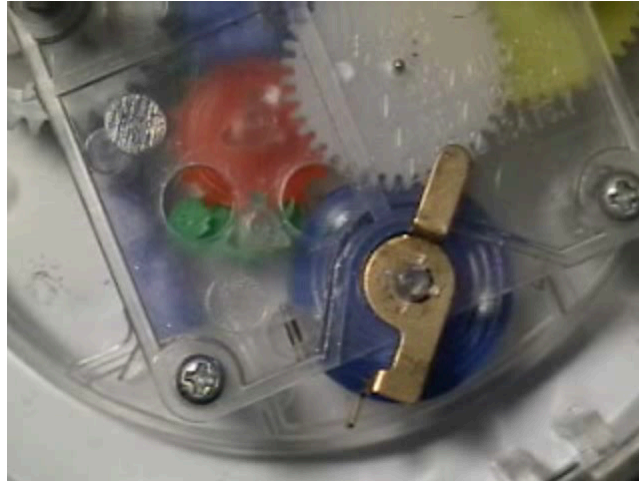
Device	Inputs		Function	Output	
	Specific	General		Specific	General
Alarm winding handle (1A)	Rotational motion	Mechanical energy	Winds alarm winding spring, transfers motion from user to alarm winding assembly (26)	Rotational motion	Mechanical energy
Alarm winding assembly (26)	Rotational motion	Mechanical energy	Stores energy to power alarm mechanism	Rotational motion	Mechanical energy
Hammer gear assembly (25)	Rotational motion	Mechanical energy	Transfers motion from alarm winding assembly (26) to hammer assembly (27)	Rotational motion	Mechanical energy
Hammer assembly (27)	Rotational motion	Mechanical energy	Oscillates hammer (27A) between bells (6)	Oscillating motion	Mechanical energy
Bells (6)	Oscillating motion	Mechanical energy	Resonate, produce sound	Sound	Compression waves
Momentum spring assembly (20)	Rotational motion	Mechanical energy	Counts each second	Oscillating motion	Mechanical energy
Green transfer arm (24)	Oscillating motion	Mechanical energy	Transfers motion of momentum spring assembly (20) to orange transfer disc (23)	Oscillating motion	Mechanical energy
Orange transfer disc (23)	Oscillating motion	Mechanical energy	Transfers motion from green transfer arm (24) to second hand gear assembly (30)	Rotational motion	Mechanical energy
Second hand gear assembly (30)	Rotational motion	Mechanical energy	Transfers motion from orange spur gear (23) to second hand (29) and white timing gear (22)	Rotational motion	Mechanical energy

ECM<sup>2</sup> 12



## Functional Analysis

Movement of  
the momentum  
spring  
assembly

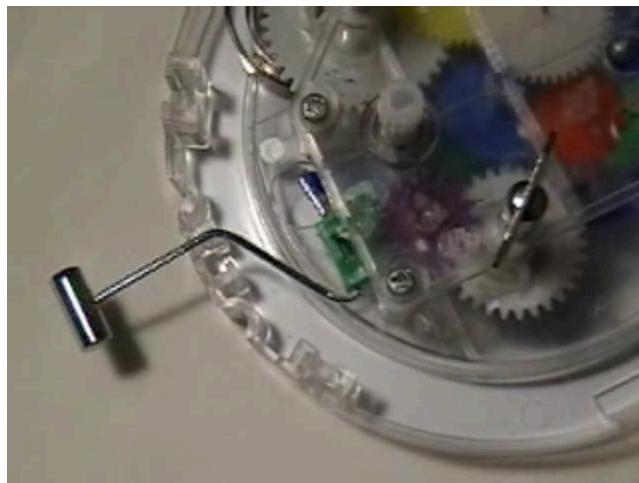


ECM<sup>2</sup> 13



## Functional Analysis

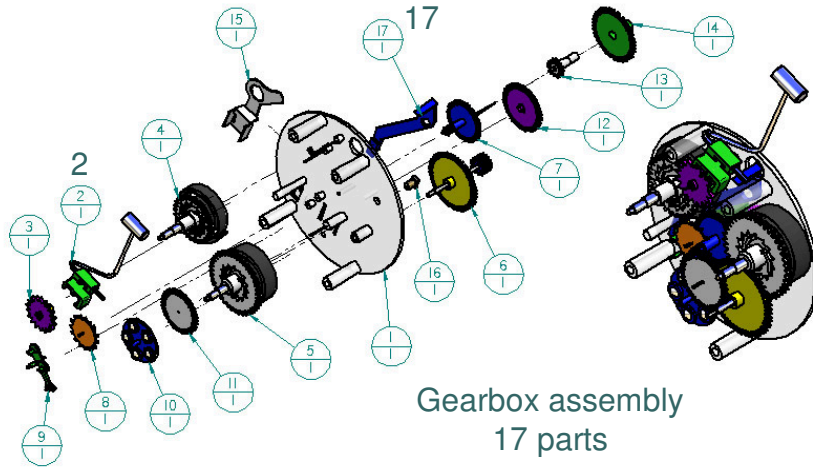
Triggering the  
alarm  
mechanism



ECM<sup>2</sup> 14



## Exploded Assembly View

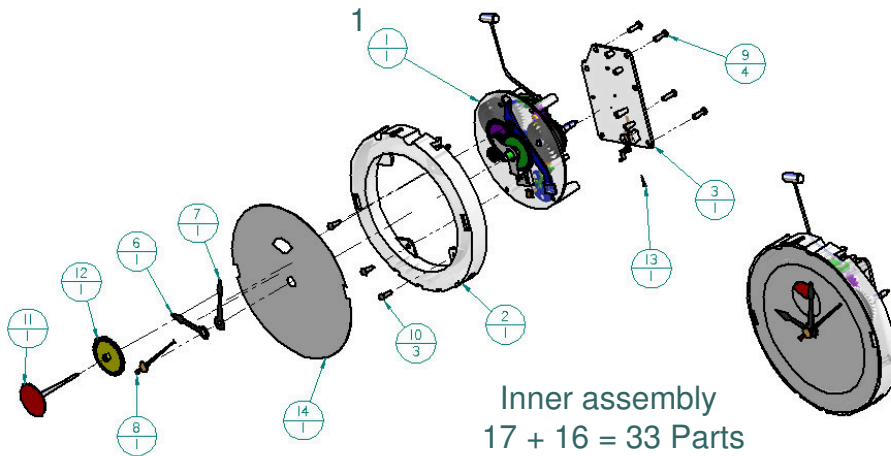


Gearbox assembly  
17 parts

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## Exploded Assembly View



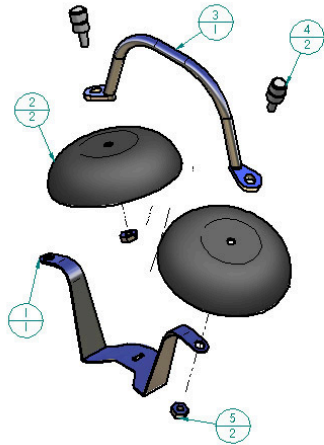
Inner assembly  
 $17 + 16 = 33$  Parts

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## Exploded Assembly View



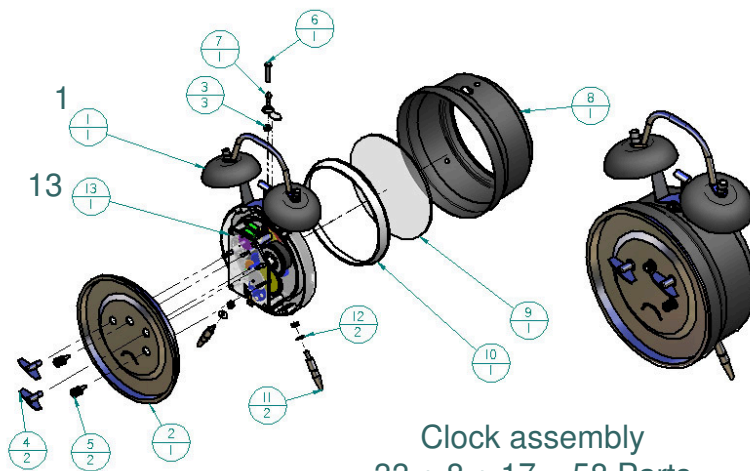
Bell assembly  
8 Parts

Item Number	Part Number	Title	Material	Quantity
1	10	Bell support arm	AISI 1020 Chrome-plat ed carbon steel	1
2	6	Bell	AISI 1020 Carbon steel	2
3	5	Handle	AISI 1020 Chrome-plat ed carbon steel	1
4	3	Bell pin	AISI 1020 Zinc-plated carbon steel	2
5	4,912	Style 2, Metric hex nut - M 3 x 1/2	AISI 1020 Zinc-plated carbon steel	2

ECM<sup>2</sup> 17



## Exploded Assembly View



Clock assembly  
 $33 + 8 + 17 = 58$  Parts

ECM<sup>2</sup> 18



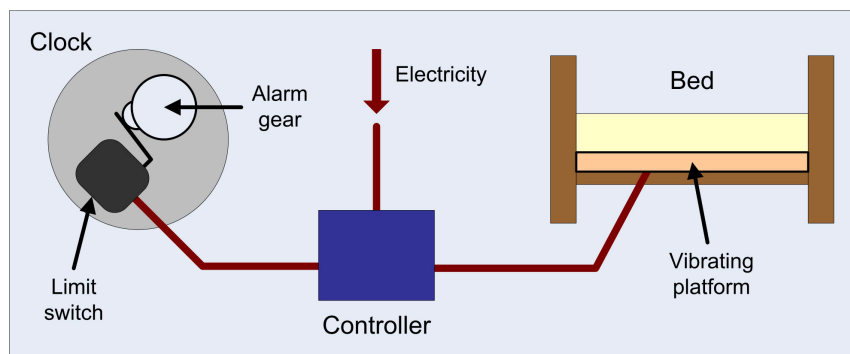
## Modification Brainstorming

	Clock	Vibrating Platform	Strobe Light	Heat Blanket	Electrical Stimulation
Cost	S	-	-	-	-
Size	S	-	S	-	S
Reliability	S	S	-	S	S
Weight	S	-	-	-	-
Customer Appeal	S	S	S	-	-
Durability	S	S	+	S	S
Efficiency	S	+	+	+	+
Side Effects	S	-	-	-	-
Easy Installation	S	-	S	S	S
Portability	S	-	S	S	S
Easy to Use	S	S	S	S	S
Power Requirement	S	-	-	-	-
<b>Pluses</b>	0	1	2	1	1
<b>Same As</b>	12	4	5	5	6
<b>Minuses</b>	0	7	5	6	5

ECM<sup>2</sup> 19



## Device Modification

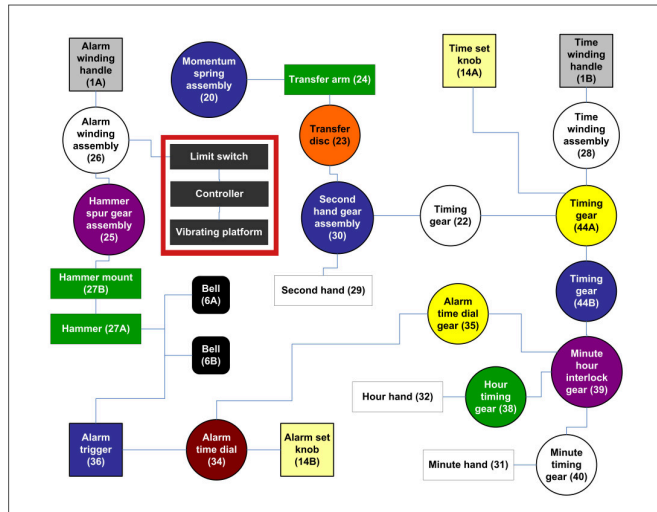


Modification concept diagram

ECM<sup>2</sup> 20



## Modified Schematic



ECM<sup>2</sup> 21



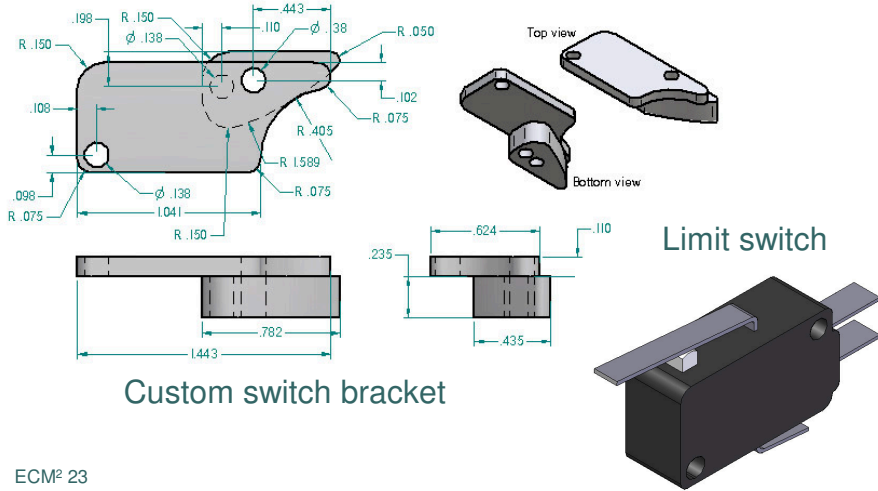
## Modified Decomposition

Device	Inputs		Function	Output	
	Specific	General		Specific	General
Alarm winding handle (1A)	Rotational motion	Mechanical energy	Winds alarm winding spring, transfers motion from user to alarm winding assembly (26)	Rotational motion	Mechanical energy
Alarm winding assembly (26)	Rotational motion	Mechanical energy	Stores energy to power alarm mechanism and triggers limit switch	Rotational motion	Mechanical energy
Limit switch	Rotational motion	Mechanical energy	Completes circuit, sends signal to vibrating platform controller	Electrical signal	Information/ Electrical energy
Hammer gear assembly (25)	Rotational motion	Mechanical energy	Transfers motion from alarm winding assembly (26) to hammer assembly (27)	Rotational motion	Mechanical energy
Hammer assembly (27)	Rotational motion	Mechanical energy	Oscillates hammer (27A) between bells (6)	Oscillating motion	Mechanical energy
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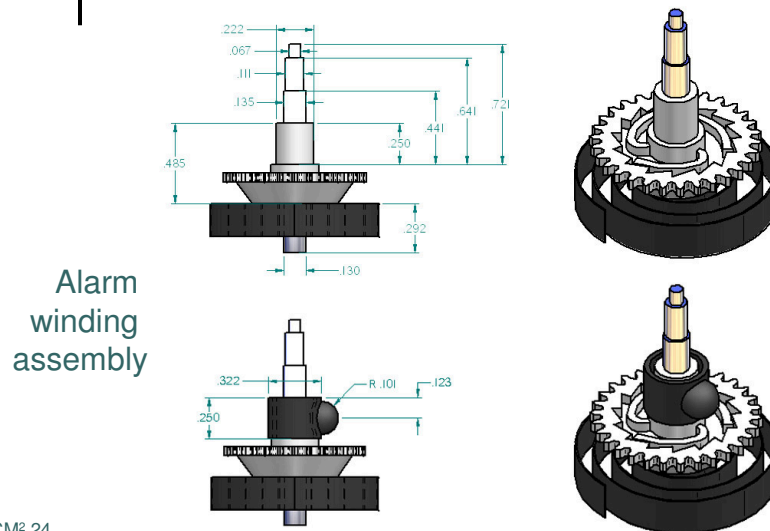
ECM<sup>2</sup> 22



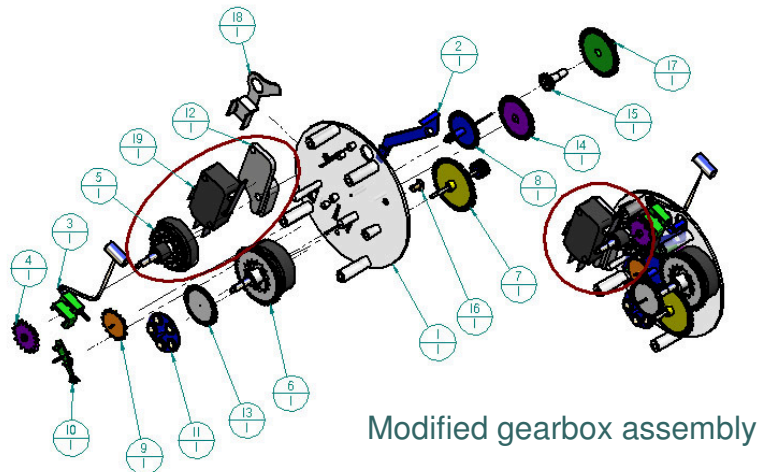
## Device Modification



## Device Modification

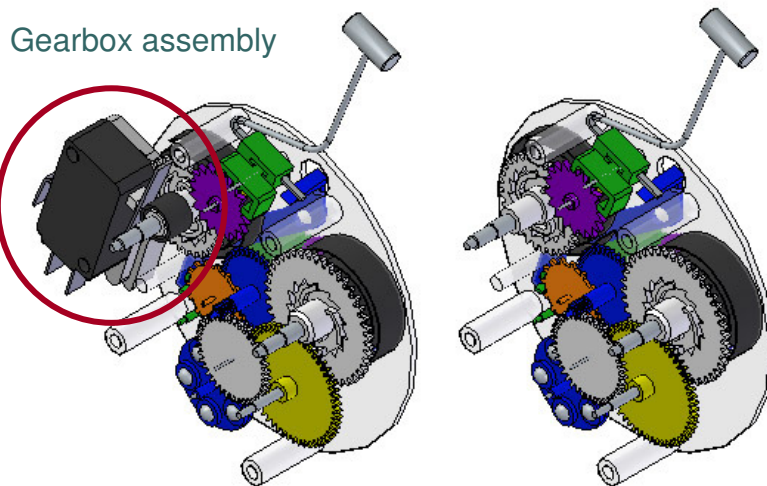


● ● ● | Modified Exploded View



ECM<sup>2</sup> 25

● ● ● | Device Modification

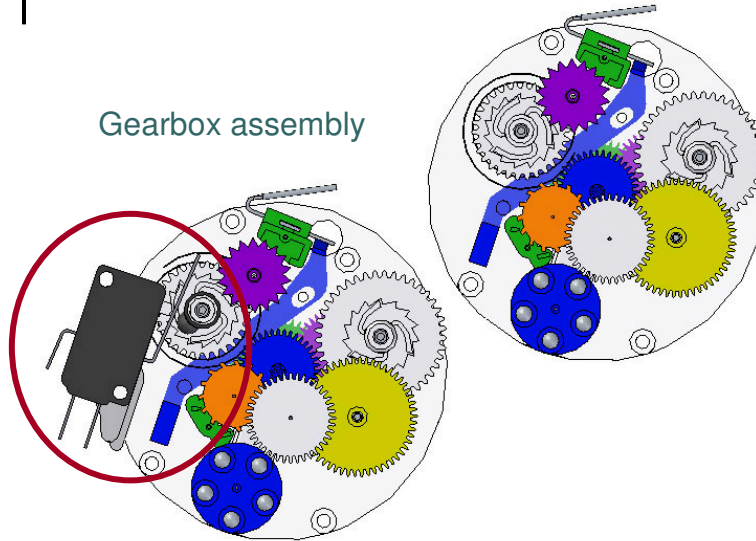


ECM<sup>2</sup>



## Device Modification

Gearbox assembly



ECM<sup>2</sup> 27



## Conclusion

- Meeting the needs of the client
  - Vibration wakes the client
  - Easy to deactivate and reset
  - Clock may be placed across room

ECM<sup>2</sup> 28