ME 302
Unique Number: 17445
Lab Instructor: Wood
Fall 2017

The Rockin' Boffins

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Project Proposal

Customer's Perspective:

The customer will be looking for a reasonably priced, handheld, and aesthetically pleasing kitchen grinder. The kitchen grinder should be easy to use, durable, and versatile with the kinds of spices it can grind. It should also be lightweight and compact as well as easy to clean and maintain. It can come in different colors as well to appeal to different customers. They are looking for quality in terms of durability and effectiveness for the price they are paying for it.

Engineer's Perspective:

One of the engineers' primary concerns is the choice of materials for each of the parts. The selection of materials determines not only the manufacturing processes involved and the cost of producing the parts, but the durability of the system and the necessary maintenance on the customer's side. Another area of consideration is the design itself, particularly its efficiency in the given task and aesthetic value, both of which make the product more desirable to the end user. The ease of maintenance is also an important point to address in the design process, as it influences the ultimate longevity of the product, an important concern for the customer. Insufficient durability of the parts could require additional support services to provide replacement parts or warranties. Finally, the engineers must consider the ease of using the product for the end user. An intuitive, comfortable, and safe design can provide a better experience in using the product. One particular ease-of-use concern that this product reflects is the motion necessary to actuate the grinding mechanism.

Specifications include:

- Size of the tool
- Distance between grinding surfaces and adjustability
- The mechanism to transfer the motion of the actuator into motion of the grinding surfaces
- Required maintenance and support services
- Materials for each individual part

Functional Requirements of the Device:

Filling of the grinder - To fill the grinder, the consumer must open the front door and pour in their desired species. The front door is visible to the consumer by an outdent on the grinder. The pulling down of the outdented latch causes the door to rotate about a pin, opening the grinder.

Grinding of spices - The back and forth motion of the ratchet, exerted by the consumer, activates a ratchet and pawl mechanism. This mechanism turns the inner grinding ring, made up of a smaller and larger grinding shaft. The smaller and larger grinding shaft are both chiseled to break the spice into smaller pieces and grind to a desired size. The two shafts are designed to rotate in different directions simultaneously without any locking motion.

Adjustment of grinding size - The consumer turns the bottom knob counter-clockwise for a coarse grind, a clockwise turn will create a more fine grind. The rotation of the bottom knob adjusts the

distance between the two grinding shafts. The distance between the shafts is proportional to the size of the grind.

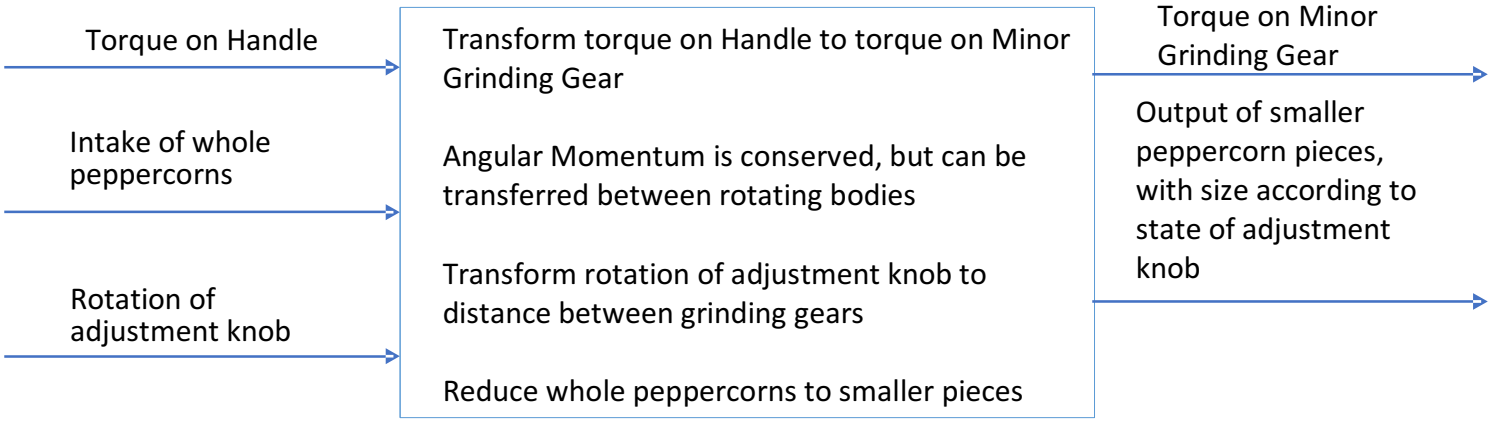
Anticipated Subsystems

Ratcheting Handle - The product contains a ratcheting handle that reduces the overall necessary effort for grinding peppercorns. The ratcheting motion of the device reduces strain on the human wrist. The mechanism consists of a handle, intertwined with a gear and pawl. As the user provides a force onto the handle, the gear rotates in a continuous rotary motion. The handle acts as a second class lever, providing the necessary force for rotational movement on the gear. Once the handle reaches its maximum angular displacement, the pawl "catches" the gear and enables the user to reset the handle back to its original condition.

Grinding Mechanism - The product utilizes a grinding mechanism in order to break down the peppercorns into smaller pieces for customer use. The grinding mechanism consists of two grinding wheels and a screw. The angular displacement of the ratchet handle results in rotational movement of a gear. The gear provides a force onto a screw that rotates the grinding wheels. The grinding wheels have multiple wedges rotated around their axis. The wedges on the grinding wheels break down the peppercorns as it travels through the wheels itself.

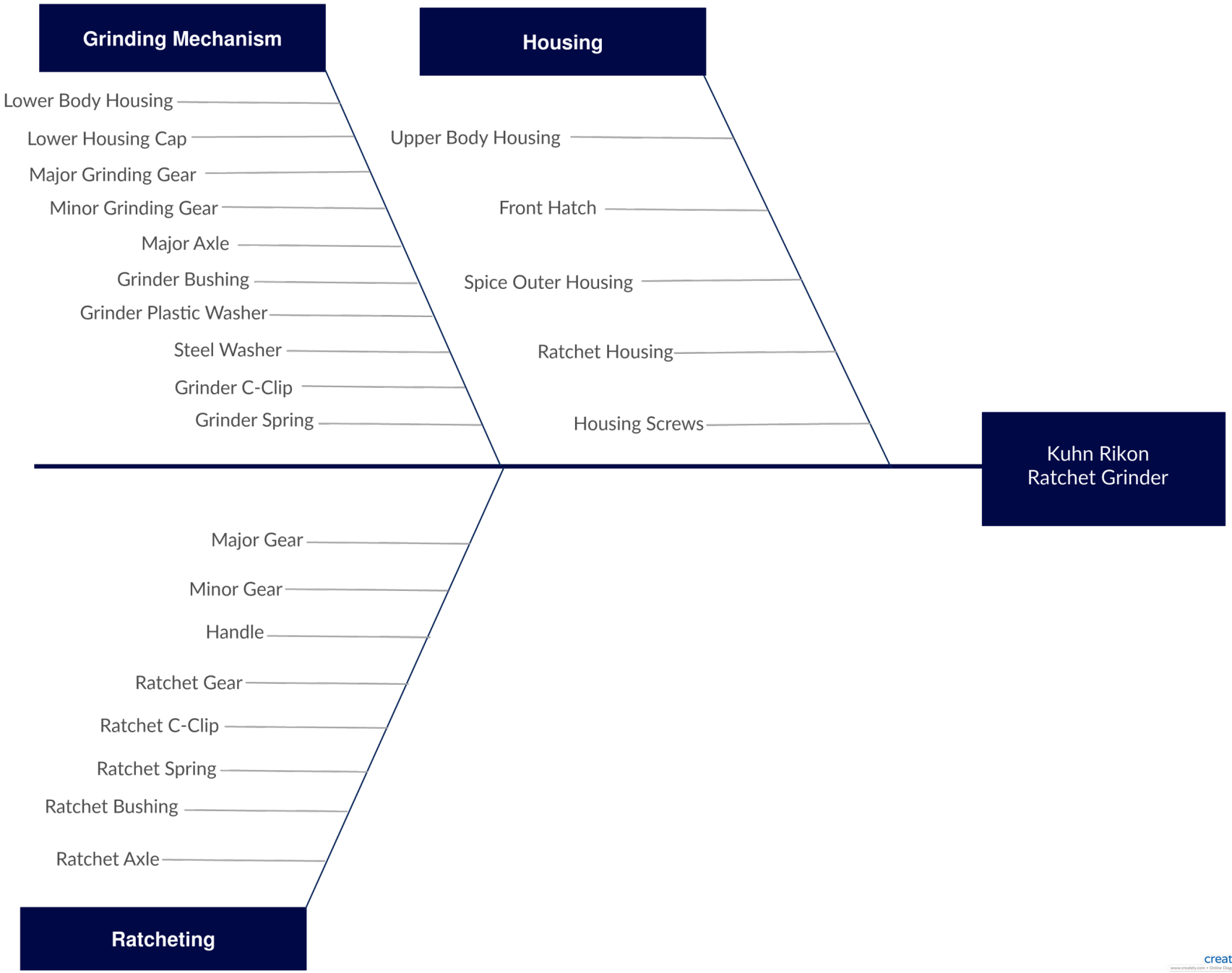
Housing - The housing subsystem will contain the peppercorns. It will provide the necessary volume to contain a suitable amount of peppercorns for customer use.

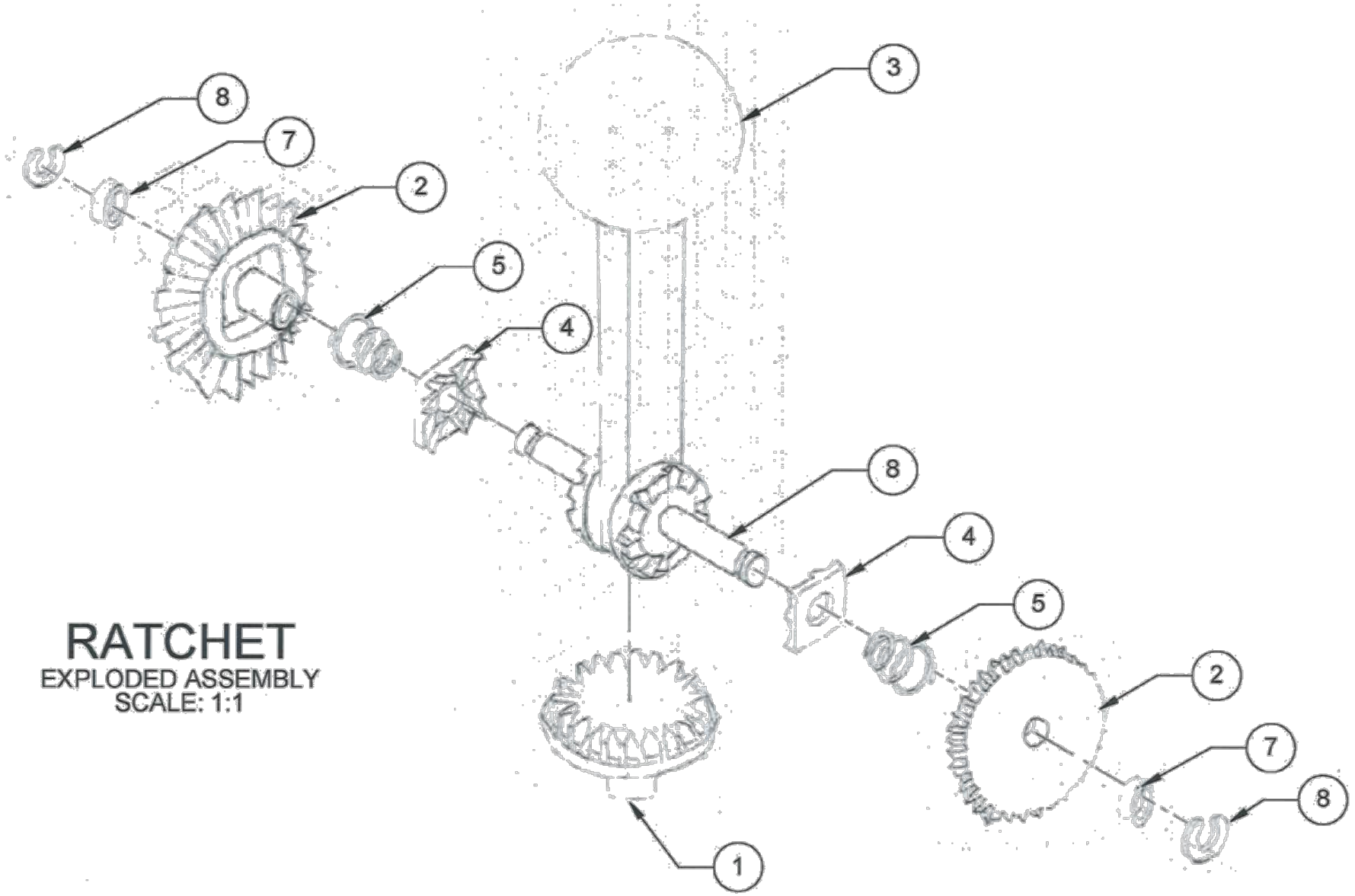
Kuhn Rikon Ratchet Grinder Black Box Diagram



Dissection Notes

1. Remove the front hatch from the upper body housing on the Ratchet Grinder
2. Loosen the glue bond of the spice outer housing, located between the lower body housing and the upper body housing
3. Once the glue bond is loosened, remove the spice outer housing from the upper body housing and the lower body housing
4. After removal of the spice outer housing, access the four screws located within the empty cavity of the upper body housing.
5. Remove the four screws, detaching the ratchet housing from the upper body housing
6. This completes the dissection of the housing subsystem
7. Release the ratchet housing from the upper body housing, allowing access to the ratchet subsystem
8. Remove the entire ratchet subsystem from the housing subsystem, allowing individual access to the components
9. Detach the major gear from the ratchet assembly
10. Remove the two ratchet c-clips from the ratchet axle, allowing access to the minor and ratchet gears, ratchet bushing, and ratchet spring.
11. In chronological order, remove: the two ratchet bushings, the two minor gears, the two ratchet springs, and finally the two ratchet gears.
12. The remaining components, handle and ratchet axle, are integrated within each other – eliminating the need for further dissection
13. Finally, the disassembly of the grinding mechanism requires the removal of the grinding c-clip from the major axle.
14. The removal of the grinding c-clip enables the removal of further components from the major axle; the components are all concentric on the major axle.
15. Remove the grinder plastic washer then the steel washer from the major axle
16. In chronological order, remove: the lower body housing, major grinding gear, the lower housing cap, grinder spring, minor grinding gear, and the grinder bushing. All the components can slide off of the major axle.
17. The lower housing body and lower housing cap can be separate from each other using either hot water or hot air; this weakens the bond of the glue, allowing disassembly.
18. Once the lower housing body and lower housing cap are separated, the major grinding gear can be freely removed.
19. The dissection is now complete.


Grinding Mechanism
Housing
Lower Body Housing
Lower Housing Cap
Major Grinding Gear
Minor Grinding Gear
Major Axle
Grinder Bushing
Grinder Plastic Washer
Steel Washer
Grinder C-Clip
Grinder Spring
Upper Body Housing
Front Hatch
Spice Outer Housing
Ratchet Housing
Housing Screws
Kuhn Rikon
Ratchet Grinder
Major Gear
Minor Gear
Handle
Ratchet Gear
Ratchet C-Clip
Ratchet Spring
Ratchet Bushing
Ratchet Axle
Ratcheting

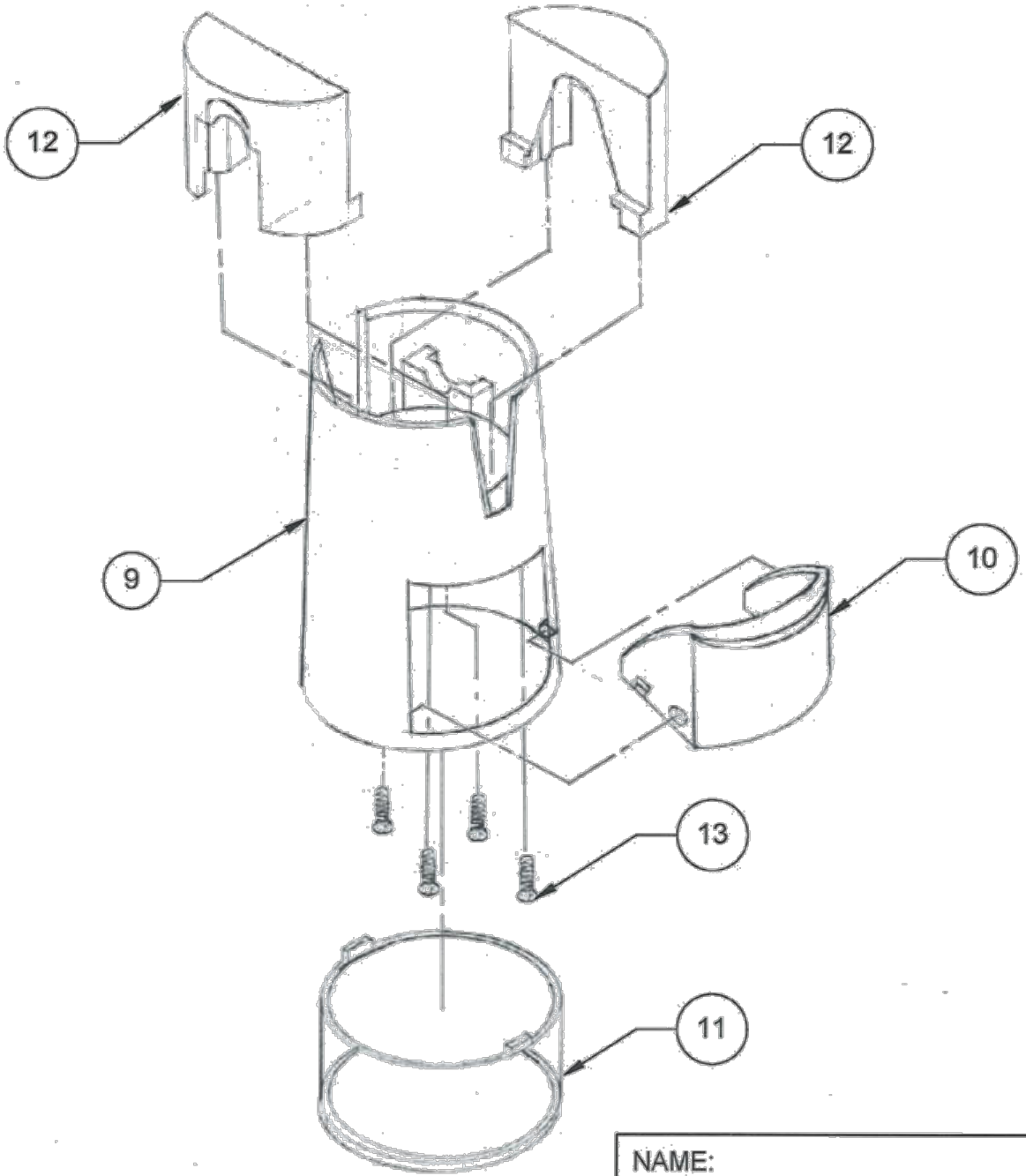


RATCHET

EXPLODED ASSEMBLY
SCALE: 1:1

NAME:	DESK:	SEC:	GRADE:

ENGINEERING *DESIGN* GRAPHICS



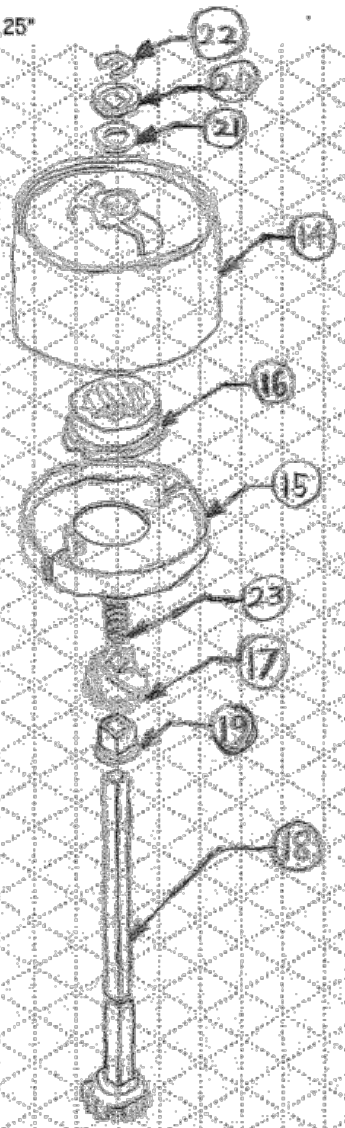
HOUSING

EXPLODED ASSEMBLY
SCALE: 2:3

NAME: DESK: SEC: GRADE:

ENGINEERING *DESIGN* GRAPHICS

GRID DIVISION: 0.25"



GRINDING MECHANISM

EXPLODED ASSEMBLY

SCALE 1:2

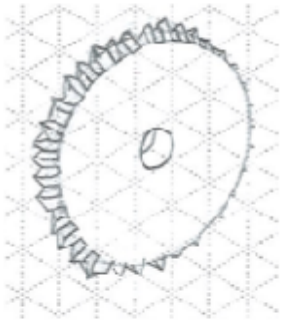
ENGINEERING DESIGN GRAPHICS	NAME: GONZALEZ, NICHOLAS	DESK: 21	SEC: [illegible]	GRADE:

Parts List

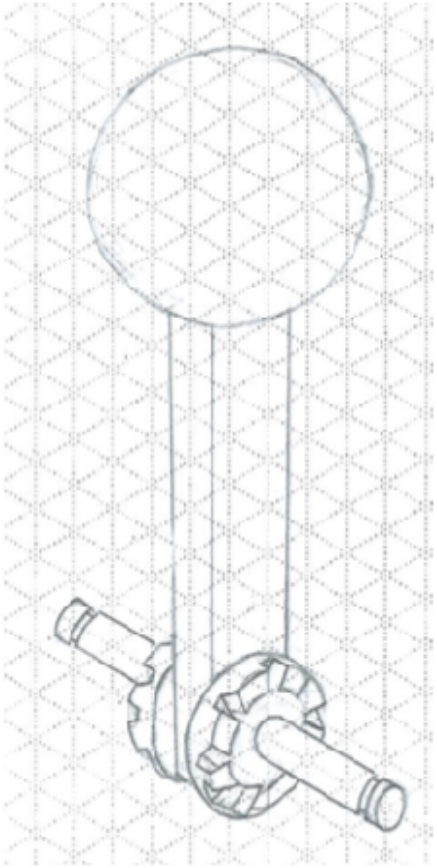
Part Number	Item	Number Required	Material
1	Major Gear	1	ABS Plastic
2	Minor Gear	2	ABS Plastic
3	Handle	1	ABS Plastic
4	Ratchet Gear	2	ABS Plastic
5	Ratchet Spring	2	Steel
6	Ratchet C-Clip	2	Aluminum
7	Ratchet Bushing	2	Brass
8	Ratchet Axle	1	Aluminum
9	Upper Body Housing	1	ABS Plastic
10	Front Hatch	1	ABS Plastic
11	Spice Outer Housing	1	Acrylic Plastic
12	Ratchet Housing	2	ABS Plastic
13	Housing Screws	4	Aluminum
14	Lower Body Housing	1	ABS Plastic
15	Lower Housing Cap	1	ABS Plastic
16	Major Grinding Gear	1	Ceramic
17	Minor Grinding Gear	1	Ceramic
18	Major Axle	1	Stainless Steel
19	Grinder Bushing	1	ABS Plastic
20	Grinder Plastic Washer	1	ABS Plastic
21	Steel Washer	1	Steel
22	Grinder C-Clip	1	Aluminum
23	Grinder Spring	1	Steel

② MINOR GEAR
SCALE: 1:1
MATERIAL: ABS PLASTIC

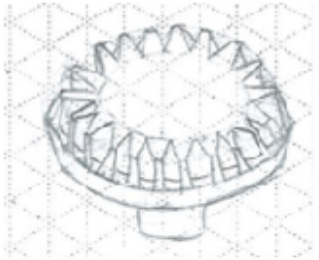
MINOR GEAR
AUXILIARY VIEW



③ HANDLE
SCALE: 1:1
MATERIAL: ABS PLASTIC

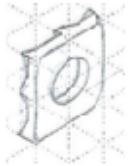


① MAJOR GEAR
SCALE: 1:1
MATERIAL: ABS PLASTIC



④ RATCHET GEAR
SCALE: 1:1
MATERIAL: ABS PLASTIC

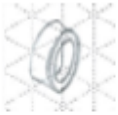
RATCHET GEAR
AUXILIARY VIEW



⑤ RATCHET SPRING
SCALE: 1:1
MATERIAL: STEEL

⑥ RATCHET C-CLIP
SCALE: 1:1
MATERIAL: ALUMINUM

⑦ RATCHET BUSHING
SCALE: 1:1
MATERIAL: BRASS

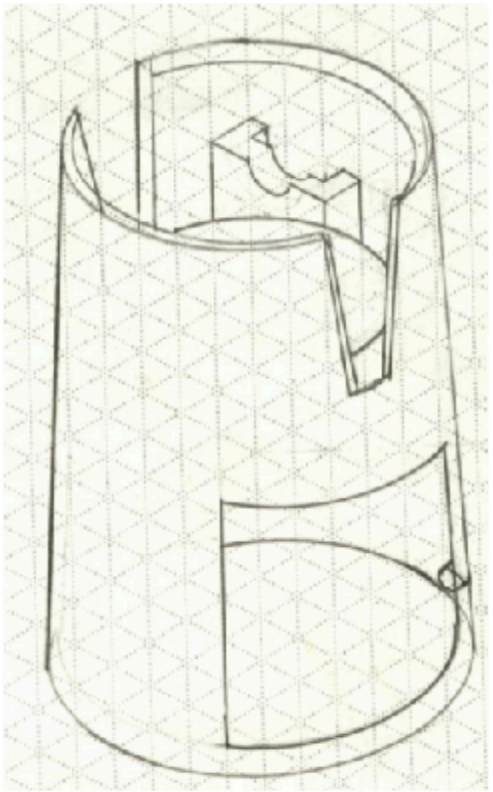


⑧ RATCHET AXLE
SCALE: 1:1
MATERIAL: ALUMINUM

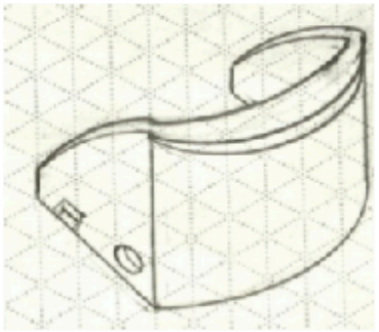
NAME:	DESK:	SEC:	GRADE:	

ENGINEERING *DESIGN* GRAPHICS

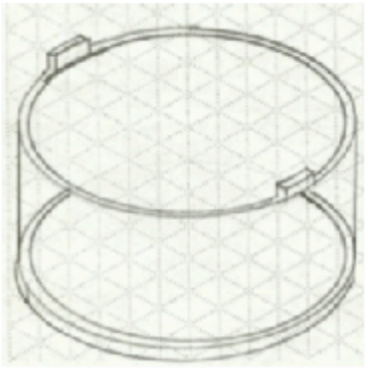
⑨ UPPER BODY HOUSING
SCALE: 1:1
MATERIAL: ABS PLASTIC



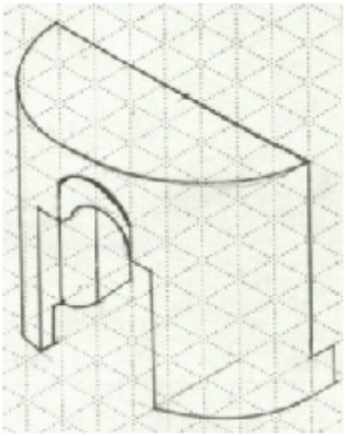
⑩ FRONT HATCH
SCALE: 1:1
MATERIAL: ABS PLASTIC



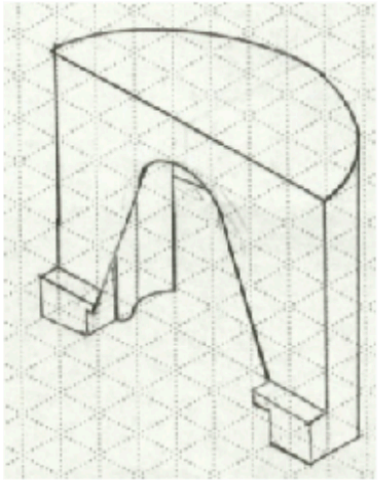
⑪ SPICE OUTER HOUSING
SCALE: 1:1
MATERIAL: ACRYLIC PLASTIC



⑫ RATCHET HOUSING
SCALE: 1:1
MATERIAL: ABS PLASTIC



RATCHET HOUSING
AUXILIARY VIEW



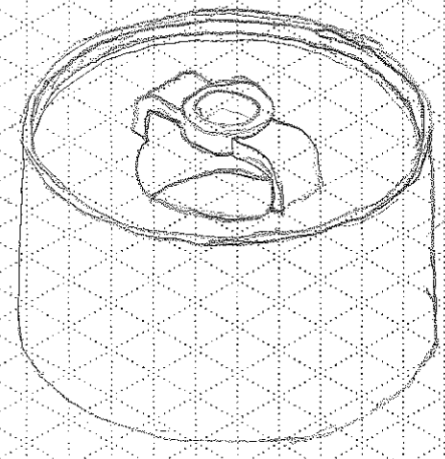
⑬ HOUSING SCREWS
SCALE: 1:1
MATERIAL: ALUMINUM

NAME: DESK: SEC: GRADE:

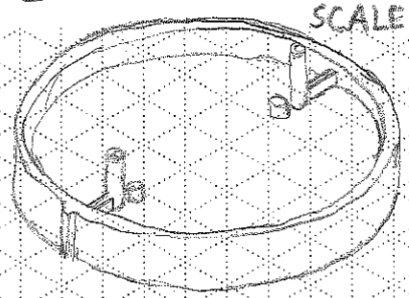
ENGINEERING *DESIGN* GRAPHICS

GRID DIVISION: 0.25"

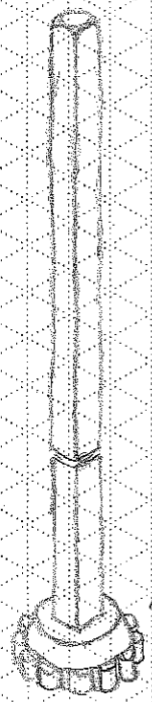
(14) LOWER BODY HOUSING
SCALE 1:1



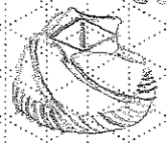
(15) LOWER HOUSING CAP
SCALE 1:1



(18) MAJOR AXLE
SCALE 1:1



(17) MINOR GRINDING GEAR
SCALE 1:1

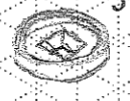


(16) MAJOR GRINDING GEAR
SCALE 1:1

(23) GRINDER SPRING
SCALE 1:1

(21) STEEL WASHER
SCALE 1:1

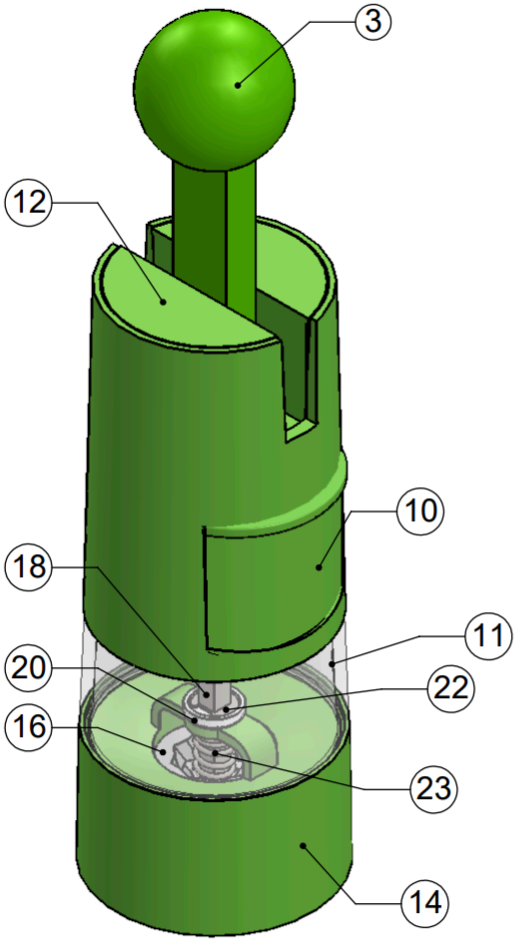
(20) GRINDER PLASTIC WASHER
SCALE 1:1



(19) GRINDER BUSHING
SCALE 1:1

(22) GRINDER C-CLIP
SCALE 1:1

ENGINEERING DESIGN GRAPHICS	NAME: GONZALEZ, NICHOLAS	DESK: 21	SEC: 12445	GRADE:



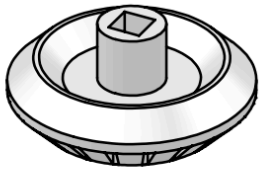
KUHN RIKON RATCHET GRINDER ASSEMBLY

SCALE 2:3

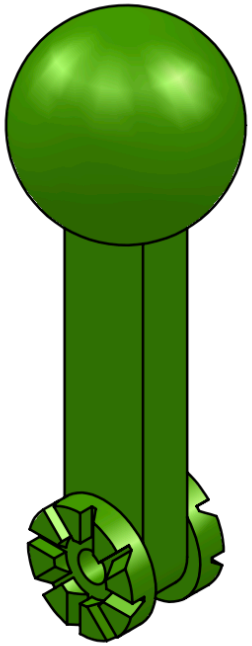
NAME: GONZALEZ, NICHOLAS	DESK: 21	SEC: 17445	GRADE:	

ENGINEERING *DESIGN* GRAPHICS

1 MAJOR GEAR
SCALE: 1:1
MATERIAL: ABS PLASTIC

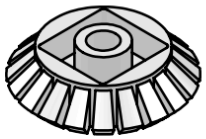


3 HANDLE
SCALE: 1:1
MATERIAL: ABS PLASTIC

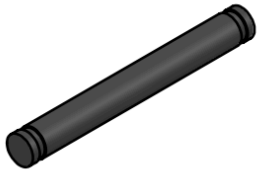


4 RATCHET GEAR
SCALE: 1:1
MATERIAL: ABS PLASTIC

2 MINOR GEAR
SCALE: 1:1
MATERIAL: ABS PLASTIC



8 RATCHET AXLE
SCALE: 1:1
MATERIAL: ALUMINUM

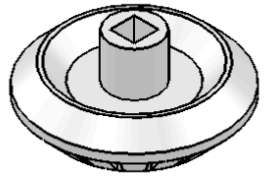


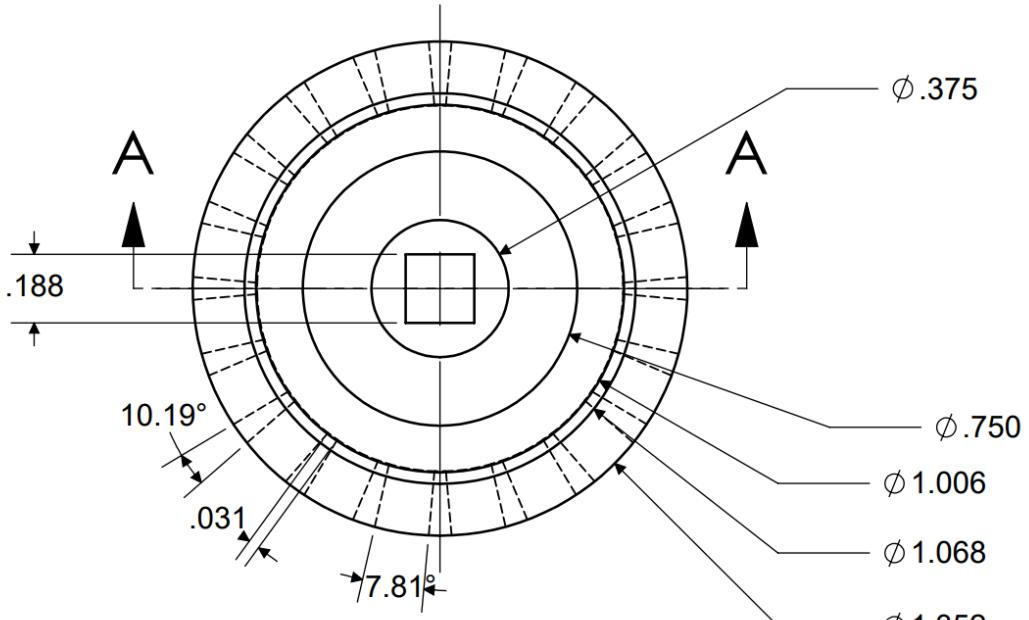
NAME: DESK: SEC: GRADE:

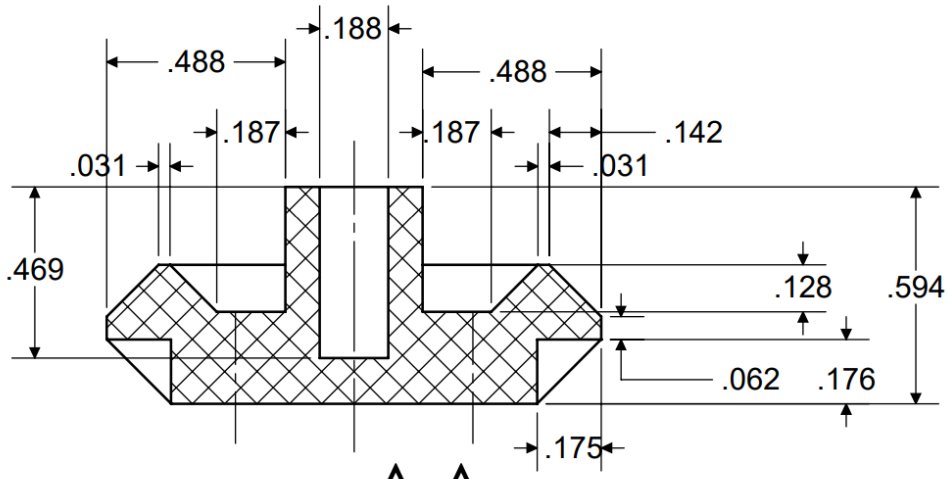
ENGINEERING *DESIGN* GRAPHICS

MAJOR GEAR

MATERIAL : ABS PLASTIC







SECTION A-A

SCALE 2 : 1

NAME: DESK: SEC: GRADE:

ENGINEERING *DESIGN* GRAPHICS

Mass properties of MAJOR GEAR
Material: ABS Plastic
Configuration: Default
Coordinate system: -- default --

Density = 0.0368 pounds per cubic inch

Mass = 0.0139 pounds

Volume = 0.3760 cubic inches

Surface area = 5.1892 square inches

Center of mass: (inches)
X = 0.0000
Y = 0.1866
Z = 0.0000

Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.

Ix = (0.0000, 0.0000,1.0000)	Px = 0.0015
Iy = (1.0000, 0.0000,0.0000)	Py = 0.0015
Iz = (0.0000, 1.0000,0.0000)	Pz = 0.0027

Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.

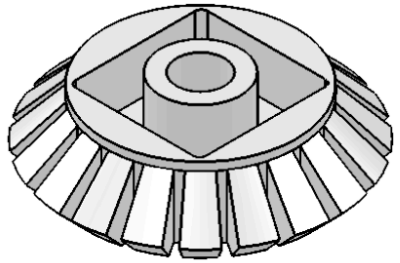
Lxx = 0.0015	Lxy = 0.0000	Lxz = 0.0000
Lyx = 0.0000	Lyy = 0.0027	Lyz = 0.0000
Lzx = 0.0000	Lzy = 0.0000	Lzz = 0.0015

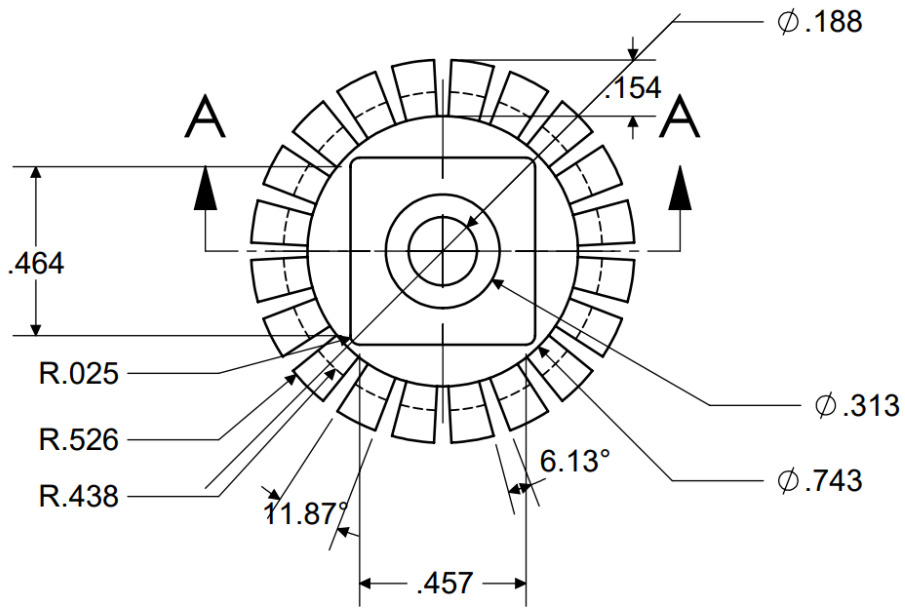
Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.

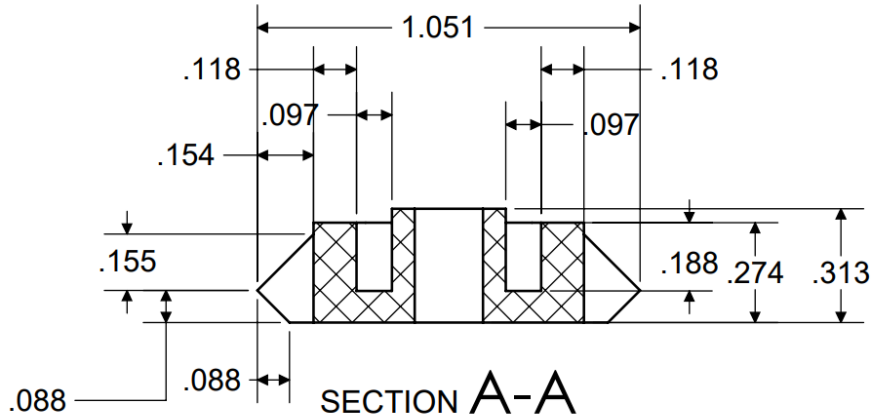
Ixx = 0.0020	Ixy = 0.0000	Ixz = 0.0000
Iyx = 0.0000	Iyy = 0.0027	Iyz = 0.0000

MINOR GEAR

MATERIAL : ABS PLASTIC







SECTION A-A

SCALE 2 : 1

NAME:	DESK:	SEC:	GRADE:	

ENGINEERING *DESIGN* GRAPHICS

Mass properties of MINOR GEAR
Material: ABS Plastic
Configuration: Default
Coordinate system: -- default --

Density = 0.0368 pounds per cubic inch

Mass = 0.0044 pounds

Volume = 0.1207 cubic inches

Surface area = 3.5216 square inches

Center of mass: (inches)
X = 0.0000
Y = 0.1139
Z = 0.0000

Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.

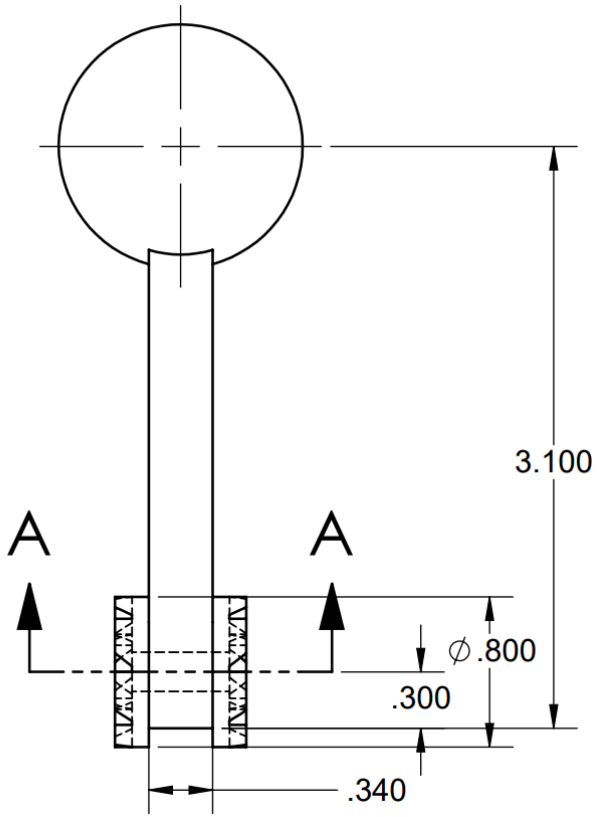
Ix = (1.0000, 0.0000,0.0000)	Px = 0.0003
Iy = (0.0000, 0.0000, -1.0000)	Py = 0.0003
Iz = (0.0000, 1.0000,0.0000)	Pz = 0.0005

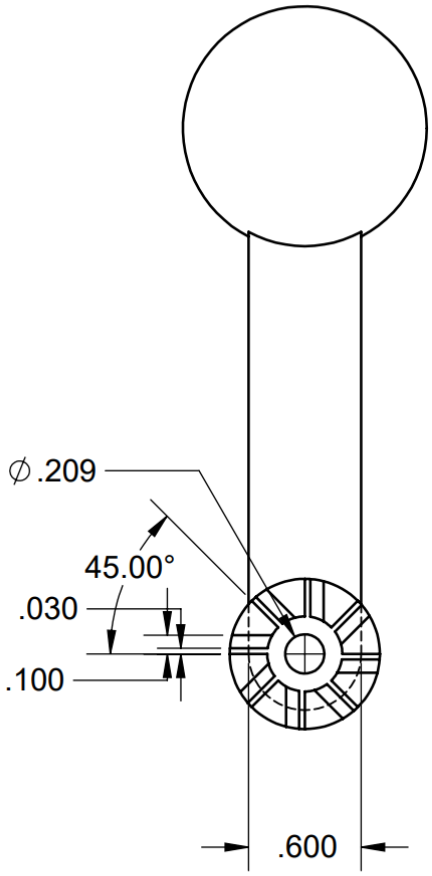
Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.

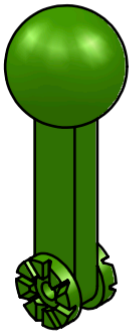
Lxx = 0.0003	Lxy = 0.0000	Lxz = 0.0000
Lyx = 0.0000	Lyy = 0.0005	Lyz = 0.0000
Lzx = 0.0000	Lzy = 0.0000	Lzz = 0.0003

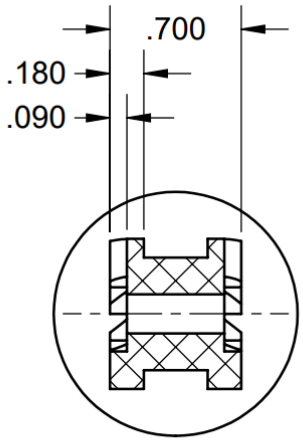
Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.

Ixx = 0.0003	Ixy = 0.0000	Ixz = 0.0000
Iyx = 0.0000	Iyy = 0.0005	Iyz = 0.0000
Izx = 0.0000	Izy = 0.0000	Izz = 0.0003









SECTION A-A
SCALE 1 : 1

3 RATCHET HANDLE

SCALE: 1:1
MATERIAL: ABS PLASTIC

NAME:	DESK:	SEC:	GRADE:	

ENGINEERING *DESIGN* GRAPHICS

Mass properties of RATCHET HANDLE
MATERIAL: ABS Plastic
Configuration: Default
Coordinate system: -- default --

Density = 0.0368 pounds per cubic inch

Mass = 0.0650 pounds

Volume = 1.7650 cubic inches

Surface area = 12.0841 square inches

Center of mass: (inches)
X = 0.0000
Y = 2.0965
Z = 0.0000

Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.

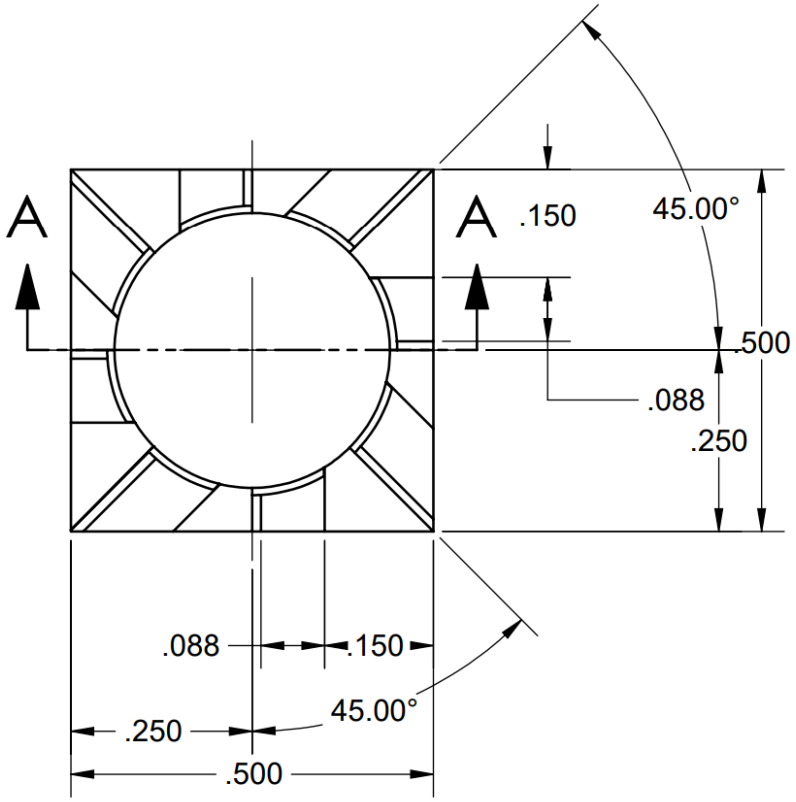
Ix = (0.0000, 1.0000, 0.0000)	Px = 0.0084
Iy = (-1.0000, 0.0000, 0.0000)	Py = 0.0804
Iz = (0.0000, 0.0000, 1.0000)	Pz = 0.0807

Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.

Lxx = 0.0804	Lxy = 0.0000	Lxz = 0.0000
Lyx = 0.0000	Lyy = 0.0084	Lyz = 0.0000
Lzx = 0.0000	Lzy = 0.0000	Lzz = 0.0807

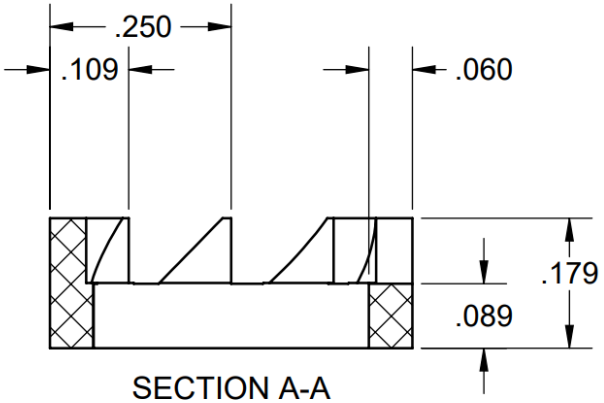
Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.

Ixx = 0.3663	Ixy = 0.0000	Ixz = 0.0000
Iyx = 0.0000	Iyy = 0.0084	Iyz = 0.0000
Izx = 0.0000	Izy = 0.0000	Izz = 0.3666

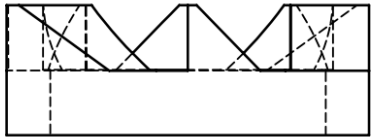


4 RATCHET GEAR

SCALE: 4:1
MATERIAL: PLASTIC



SECTION A-A



NAME: DESK: SEC: GRADE:

ENGINEERING *DESIGN* GRAPHICS

Mass properties of RATCHET GEAR
MATERIAL: ABS Plastic
Configuration: Default
Coordinate system: -- default --

Density = 0.0368 pounds per cubic inch

Mass = 0.0006 pounds

Volume = 0.0158 cubic inches

Surface area = 0.7462 square inches

Center of mass: (inches)
X = -0.0003
Y = -0.0003
Z = 0.0625

Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.

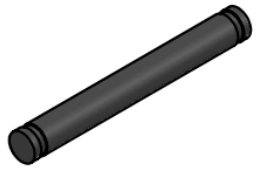
Ix = (0.7227, 0.6912, -0.0009)	Px = 0.0000
Iy = (-0.6912, 0.7227, 0.0000)	Py = 0.0000
Iz = (0.0006, 0.0006, 1.0000)	Pz = 0.0000

Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.

Lxx = 0.0000	Lxy = 0.0000	Lxz = 0.0000
Lyx = 0.0000	Lyy = 0.0000	Lyz = 0.0000
Lzx = 0.0000	Lzy = 0.0000	Lzz = 0.0000

Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.

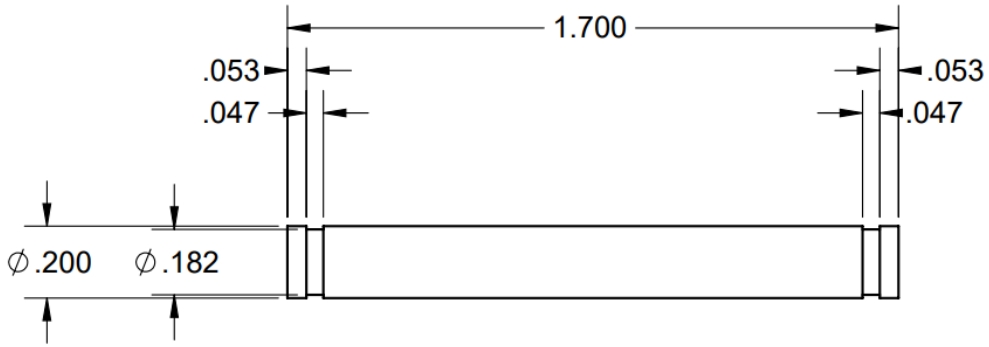
Ixx = 0.0000	Ixy = 0.0000	Ixz = 0.0000
Iyx = 0.0000	Iyy = 0.0000	Iyz = 0.0000
Izx = 0.0000	Izy = 0.0000	Izz = 0.0000



8

RATCHET AXLE

SCALE : 2:1
MATERIAL: STEEL



NAME:	DESK:	SEC:	GRADE:	

ENGINEERING *DESIGN* GRAPHICS

Mass properties of RATCHET AXLE
MATERIAL: Alloy Steel
Configuration: Default
Coordinate system: -- default --

Density = 0.2782 pounds per cubic inch

Mass = 0.0147 pounds

Volume = 0.0529 cubic inches

Surface area = 1.1472 square inches

Center of mass: (inches)
X = 0.0000
Y = 0.0000
Z = 0.0000

Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.

Ix = (0.0000, 0.0000, 1.0000)	Px = 0.0001
Iy = (0.0000, -1.0000, 0.0000)	Py = 0.0035
Iz = (1.0000, 0.0000, 0.0000)	Pz = 0.0035

Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.

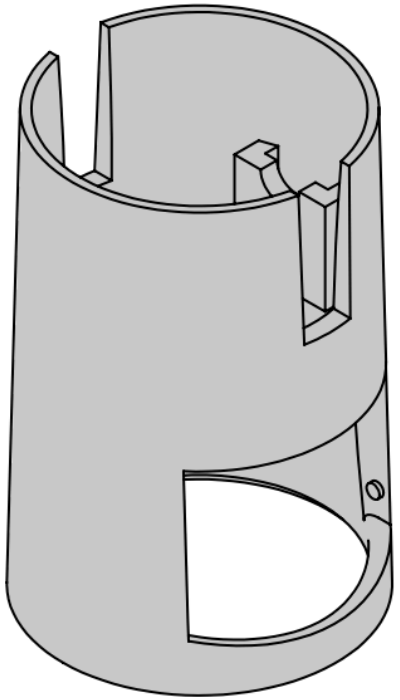
Lxx = 0.0035	Lxy = 0.0000	Lxz = 0.0000
Lyx = 0.0000	Lyy = 0.0035	Lyz = 0.0000
Lzx = 0.0000	Lzy = 0.0000	Lzz = 0.0001

Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.

Ixx = 0.0035	Ixy = 0.0000	Ixz = 0.0000
Iyx = 0.0000	Iyy = 0.0035	Iyz = 0.0000
Izx = 0.0000	Izy = 0.0000	Izz = 0.0001

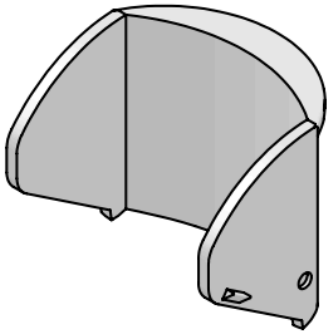
⑨ SPICE OUTER HOUSING

SCALE: 1 : 1
MATERIAL: ABS PLASTIC



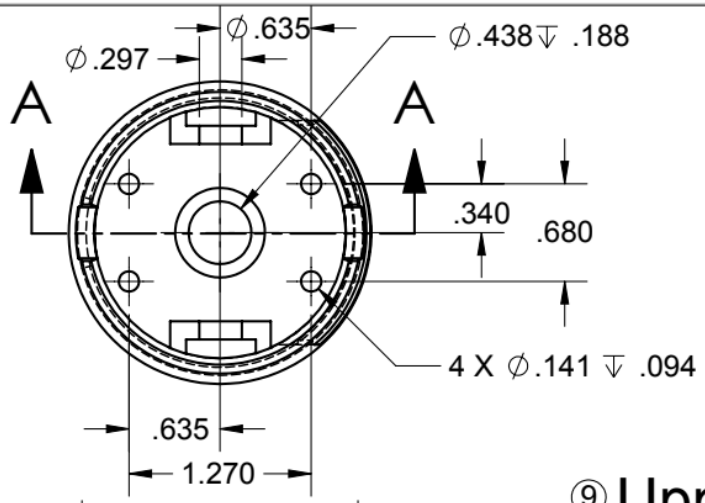
⑩ FRONT HATCH

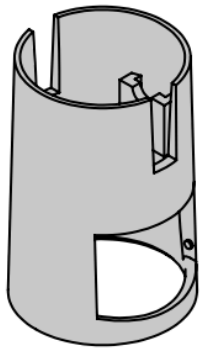
SCALE: 1 : 1
MATERIAL: ABS PLASTIC



NAME: DESK: SEC: GRADE:

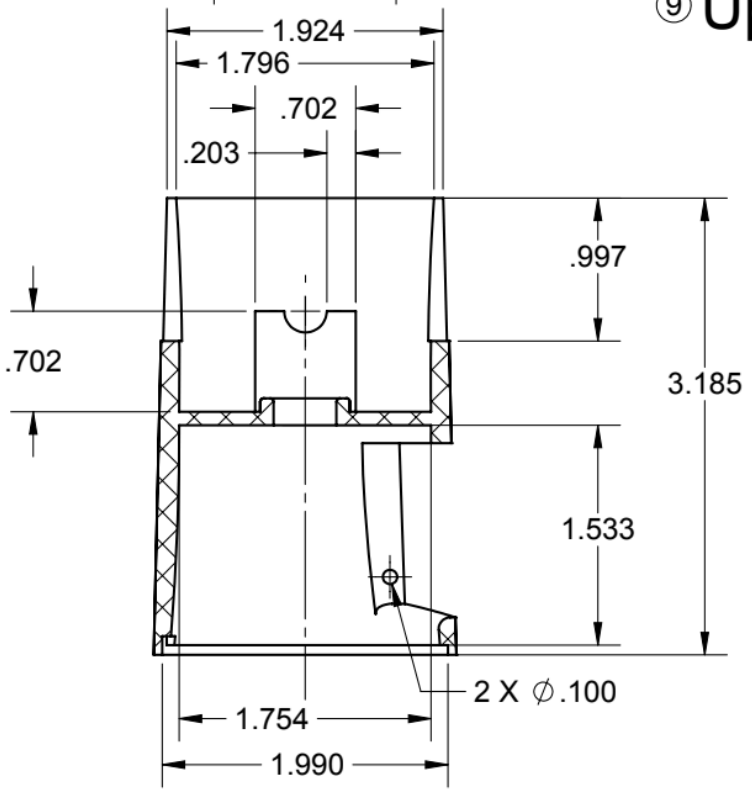
ENGINEERING *DESIGN* GRAPHICS



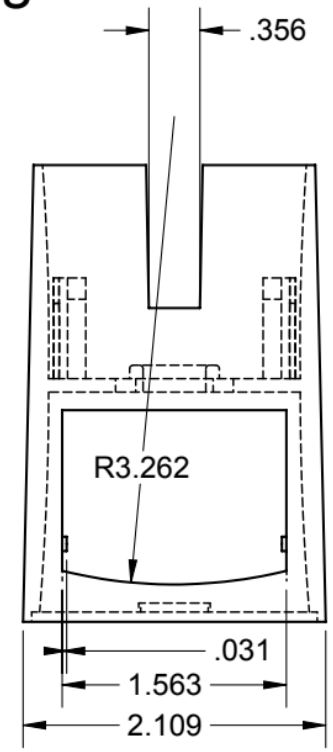


⑨ Upper Body Housing

SCALE: 4 : 5
MATERIAL: ABS PLASTIC



SECTION A-A
SCALE 4 : 5



NAME:	DESK:	SEC:	GRADE:	

ENGINEERING *DESIGN* GRAPHICS

Mass properties of UPPER BODY HOUSING
Material: ABS Plastic
Configuration: Default
Coordinate system: -- default --

Density = 0.0368 pounds per cubic inch

Mass = 0.0864 pounds

Volume = 2.3449 cubic inches

Surface area = 41.6818 square inches

Center of mass: (inches)
X = -0.1068
Y = 1.5840
Z = 0.0000

Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.

Ix = (0.2355, 0.9719, 0.0000)	Px = 0.0706
Iy = (0.0003, -0.0001, 1.0000)	Py = 0.0858
Iz = (0.9719, -0.2355, -0.0003)	Pz = 0.0984

Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.

Lxx = 0.0969	Lxy = 0.0064	Lxz = 0.0000
Lyx = 0.0064	Lyy = 0.0721	Lyz = 0.0000
Lzx = 0.0000	Lzy = 0.0000	Lzz = 0.0858

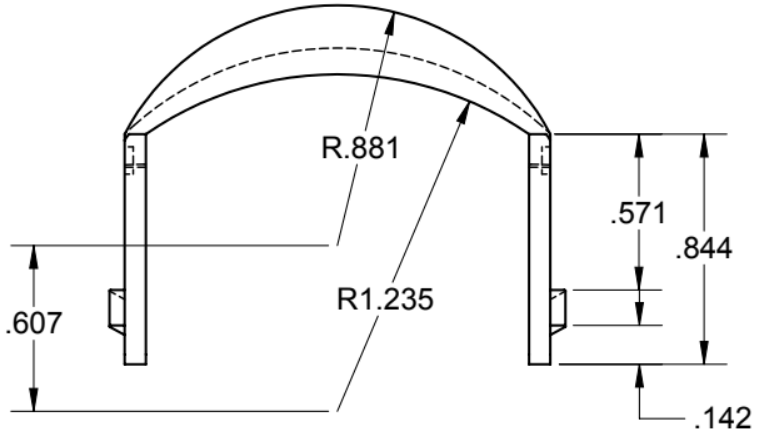
Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.

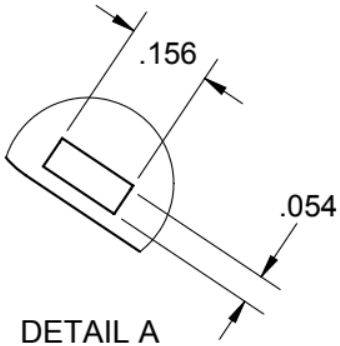
Ixx = 0.3137	Ixy = -0.0082	Ixz = 0.0000
Iyx = -0.0082	Iyy = 0.0731	Iyz = 0.0000
Izx = 0.0000	Izy = 0.0000	Izz = 0.3035

⑩ FRONT HATCH

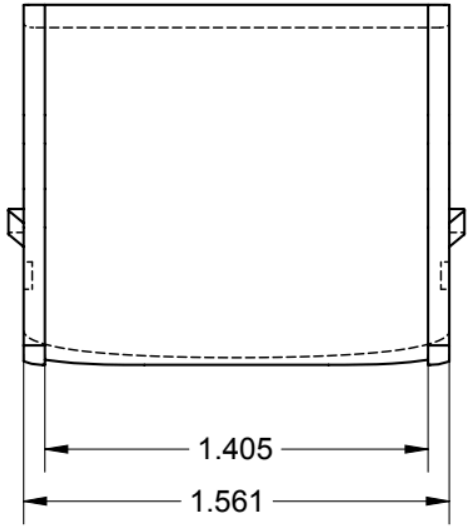
SCALE: 3 : 2

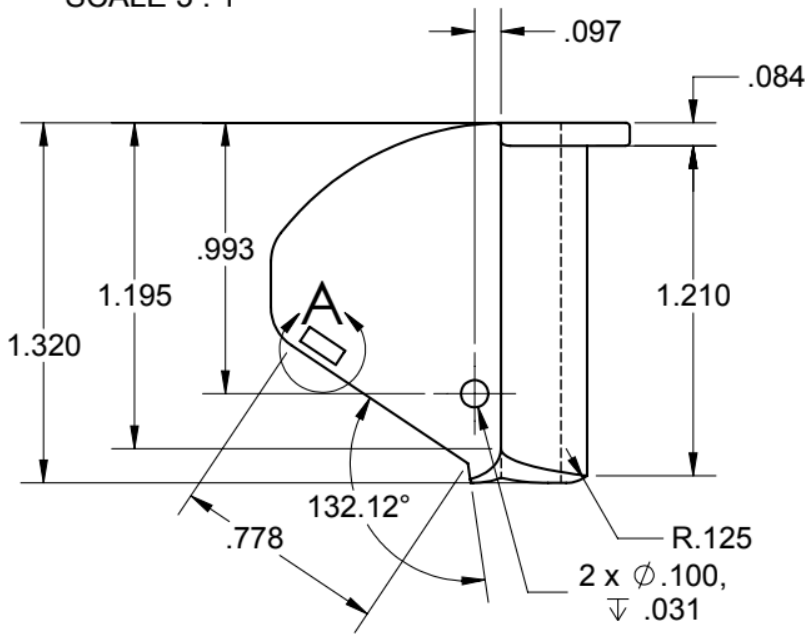
MATERIAL: ABS PLASTIC





DETAIL A
SCALE 3 : 1





NAME:	DESK:	SEC:	GRADE:

ENGINEERING *DESIGN* GRAPHICS

Mass properties of Front Hatch
Material: ABS Plastic
Configuration: Default
Coordinate system: -- default --

Density = 0.0368 pounds per cubic inch

Mass = 0.0112 pounds

Volume = 0.3038 cubic inches

Surface area = 8.2993 square inches

Center of mass: (inches)
X = -0.0003
Y = -0.6000
Z = 0.0143

Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.

Ix = (1.0000, 0.0004, -0.0003)	Px = 0.0026
Iy = (-0.0004, 0.9995, -0.0311)	Py = 0.0046
Iz = (0.0002, 0.0311, 0.9995)	Pz = 0.0050

Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.

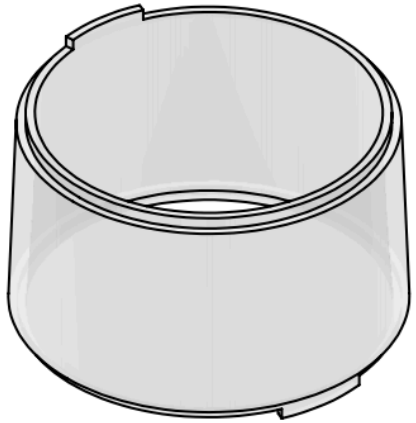
Lxx = 0.0026	Lxy = 0.0000	Lxz = 0.0000
Lyx = 0.0000	Lyy = 0.0046	Lyz = 0.0000
Lzx = 0.0000	Lzy = 0.0000	Lzz = 0.0050

Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.

Ixx = 0.0066	Ixy = 0.0000	Ixz = 0.0000
Iyx = 0.0000	Iyy = 0.0046	Iyz = -0.0001
Izx = 0.0000	Izy = -0.0001	Izz = 0.0091

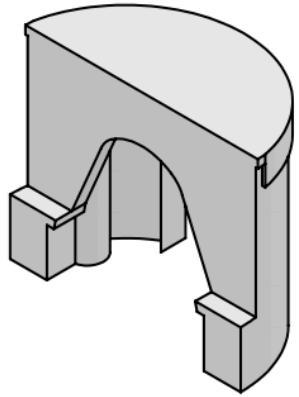
⑪ SPICE OUTER HOUSING

SCALE: 1 : 1
MATERIAL: ACRYLIC PLASTIC



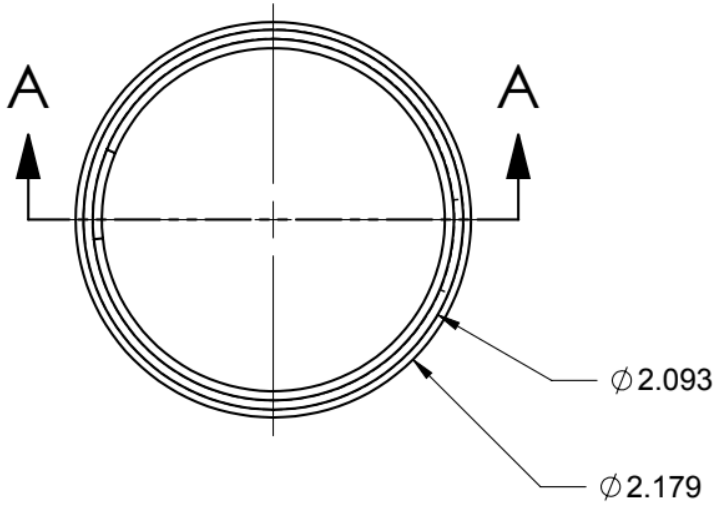
⑫ RATCHET HOUSING

SCALE: 1 : 1
MATERIAL: ABS PLASTIC



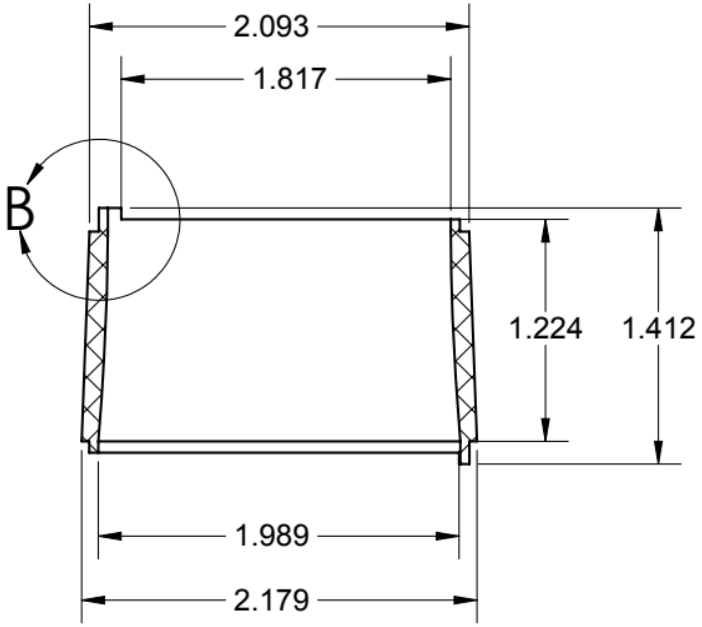
NAME:	DESK:	SEC:	GRADE:	

ENGINEERING *DESIGN* GRAPHICS

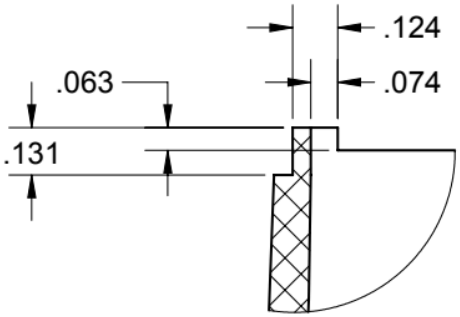


⑪ SPICE OUTER HOUSING

SCALE: 1 : 1
MATERIAL: ACRYLIC PLASTIC



SECTION A-A



DETAIL B
SCALE 2 : 1

NAME:	DESK:	SEC:	GRADE:	

ENGINEERING *DESIGN* GRAPHICS

Mass properties of SPICE OUTER HOUSING
Material: Acrylic Plastic
Configuration: Default
Coordinate system: -- default --

Density = 0.0434 pounds per cubic inch

Mass = 0.0353 pounds

Volume = 0.8134 cubic inches

Surface area = 17.7833 square inches

Center of mass: (inches)
X = 0.0002
Y = 0.5828
Z = 0.0000

Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.

Ix = (0.9907, -0.0065, 0.1361)	Px = 0.0225
Iy = (0.1361, 0.0001, -0.9907)	Py = 0.0226
Iz = (0.0065, 1.0000, 0.0010)	Pz = 0.0364

Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.

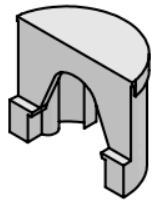
Lxx = 0.0225	Lxy = -0.0001	Lxz = 0.0000
Lyx = -0.0001	Lyy = 0.0364	Lyz = 0.0000
Lzx = 0.0000	Lzy = 0.0000	Lzz = 0.0226

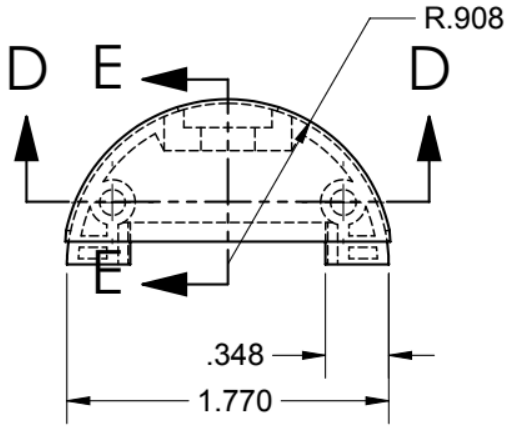
Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.

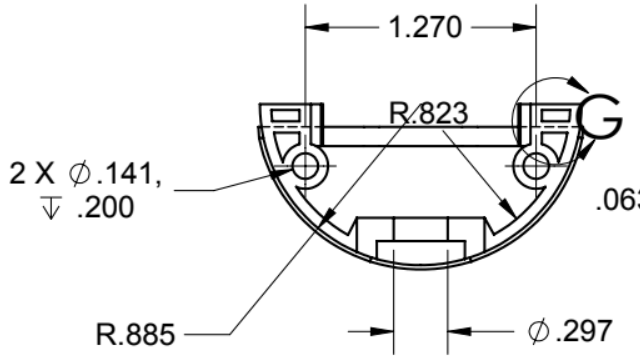
Ixx = 0.0345	Ixy = -0.0001	Ixz = 0.0000
Iyx = -0.0001	Iyy = 0.0364	Iyz = 0.0000
Izx = 0.0000	Izy = 0.0000	Izz = 0.0346

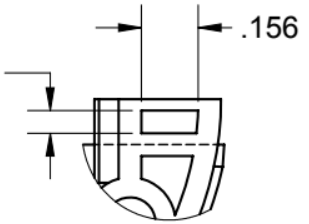
⑫ RATCHET HOUSING

MATERIAL: ABS PLASTIC
SCALE: 1 : 1

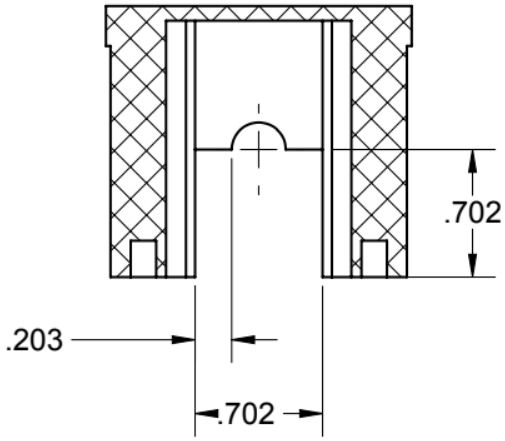




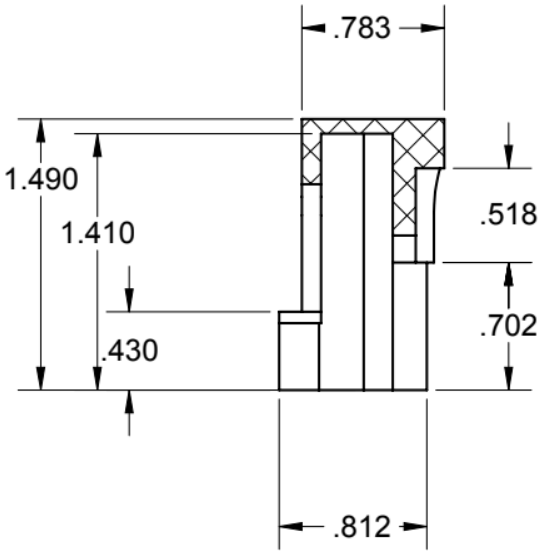




DETAIL G
SCALE 2 : 1



SECTION D-D



SECTION E-E

NAME:	DESK:	SEC:	GRADE:	

ENGINEERING *DESIGN* GRAPHICS

Mass properties of Ratchet Housing
Material: ABS Plastic
Configuration: Default
Coordinate system: -- default --

Density = 0.0368 pounds per cubic inch

Mass = 0.0229 pounds

Volume = 0.6206 cubic inches

Surface area = 12.0168 square inches

Center of mass: (inches)
X = -0.8849
Y = -0.5867
Z = 0.4707

Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.

Ix = (1.0000, -0.0002, -0.0001)	Px = 0.0056
Iy = (0.0002, 0.9894, -0.1453)	Py = 0.0085
Iz = (0.0002, 0.1453, 0.9894)	Pz = 0.0118

Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.

Lxx = 0.0056	Lxy = 0.0000	Lxz = 0.0000
Lyx = 0.0000	Lyy = 0.0086	Lyz = -0.0005
Lzx = 0.0000	Lzy = -0.0005	Lzz = 0.0117

Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.

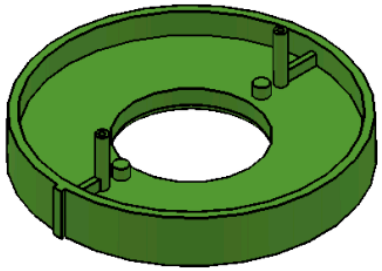
Ixx = 0.0185	Ixy = 0.0119	Ixz = -0.0095
Iyx = 0.0119	Iyy = 0.0315	Iyz = -0.0068
Izx = -0.0095	Izy = -0.0068	Izz = 0.0375

(19) GRINDER BUSHING
SCALE 1:1
MATL: ABS PLASTIC

(22) GRINDER C-CLIP
SCALE 1:1
MATL: STAINLESS STEEL

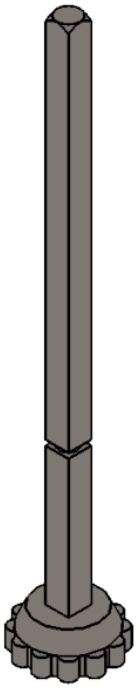
(15) LOWER HOUSING CAP
SCALE 1:1
MATL: ABS PLASTIC

(20) GRINDER PLASTIC WASHER
SCALE 1:1
MATL: ABS PLASTIC



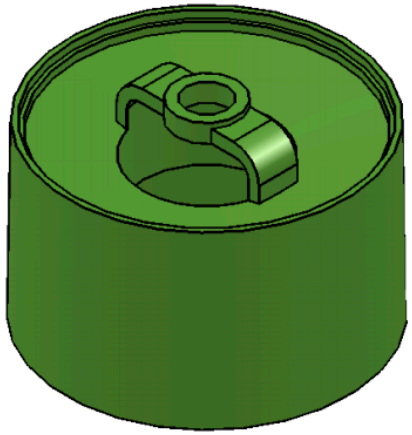
(23) GRINDER SPRING
MATL: STAINLESS STEEL
SCALE 1:1

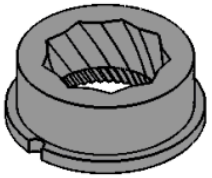
(21) STEEL WASHER
SCALE 1:1
MATL: STAINLESS STEEL



(18) MAJOR AXLE
SCALE 1:1
MATL: STAINLESS STEEL

(14) LOWER BODY HOUSING
SCALE 1:1
MATL: ABS PLASTIC



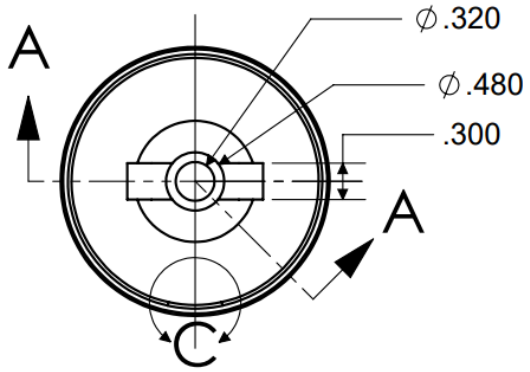


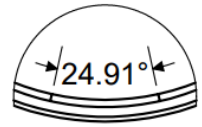
(16) MAJOR GRINDING GEAR
SCALE 1:1
MATL: PORCELAIN

(17) MINOR GRINDING GEAR
SCALE 1:1
MATL: PORCELAIN

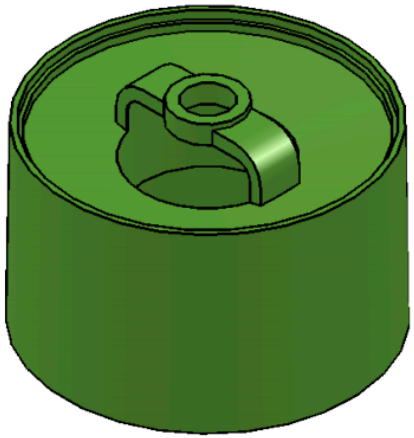
NAME: GONZALEZ, NICHOLAS	DESK: 21	SEC: 17445	GRADE:

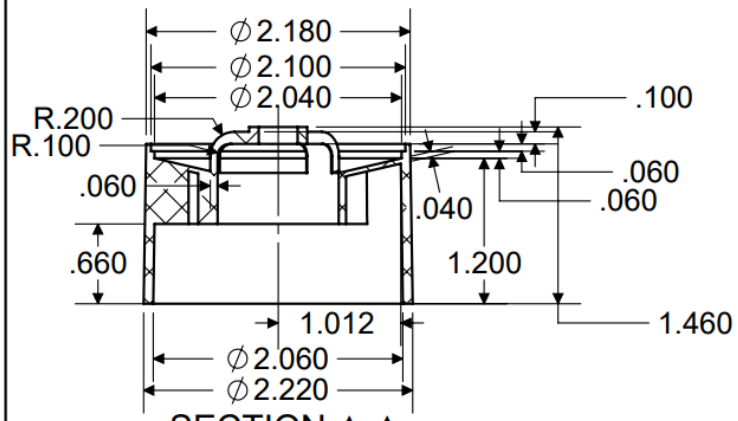
ENGINEERING *DESIGN* GRAPHICS



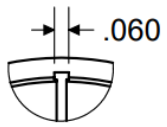


DETAIL C
SCALE 2 : 1.5





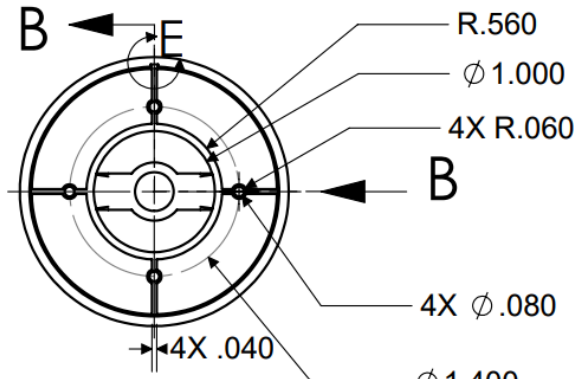
SECTION A-A
SCALE 1 : 1.5

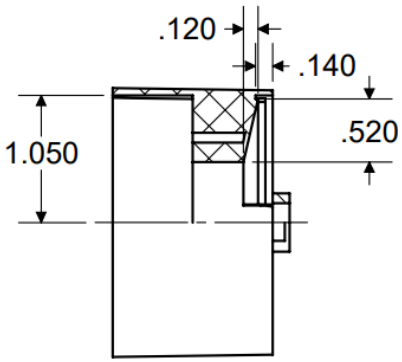


DETAIL E
SCALE 2 : 1.5

⑭ LOWER BODY HOUSING

MATERIAL: ABS PLASTIC
SCALE 1:1





SECTION B-B
SCALE 1 : 1.5

NAME: GONZALEZ, NICHOLAS	DESK: 21	SEC: 17445	GRADE:	

ENGINEERING *DESIGN* GRAPHICS

Mass properties of LOWER BODY HOUSING
Material: ABS Plastic
  Configuration: Default
  Coordinate system: -- default --

Density = 0.0368 pounds per cubic inch

Mass = 0.0344 pounds

Volume = 0.9346 cubic inches

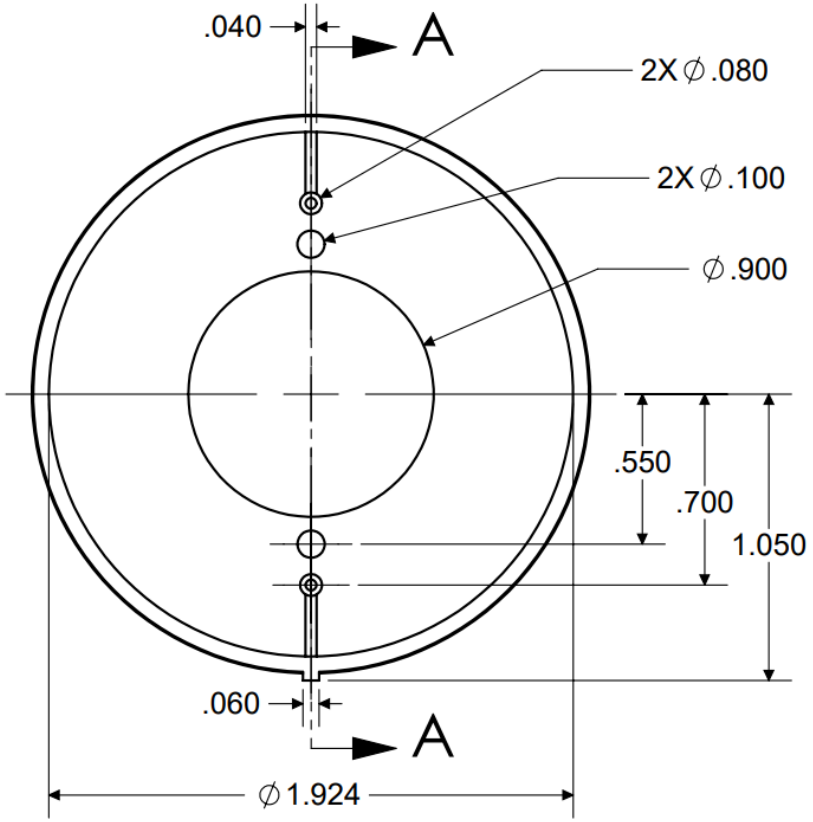
Surface area = 29.4326 square inches

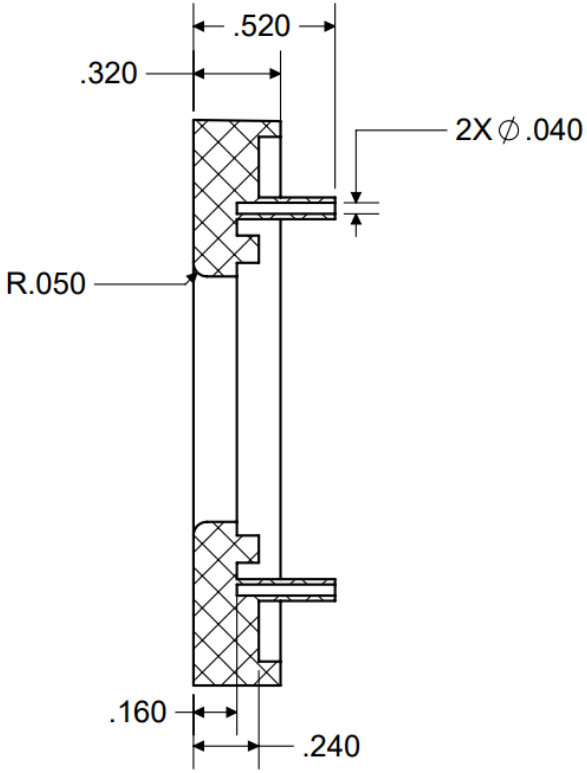
Center of mass: (inches)
  X = 0.0000
  Y = 0.7485
  Z = -0.0023

Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.
  Ix = (1.0000, 0.0000, 0.0000) Px = 0.0211
  Iy = (0.0000, 0.0004, -1.0000) Py = 0.0213
  Iz = (0.0000, 1.0000, 0.0004) Pz = 0.0325

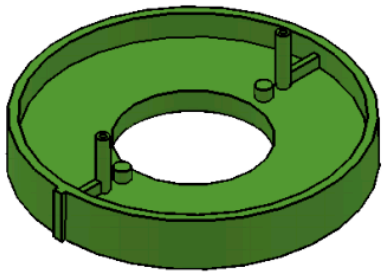
Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.
  Lxx = 0.0211 Lxy = 0.0000 Lxz = 0.0000
  Lyx = 0.0000 Lyy = 0.0325 Lyz = 0.0000
  Lzx = 0.0000 Lzy = 0.0000 Lzz = 0.0213

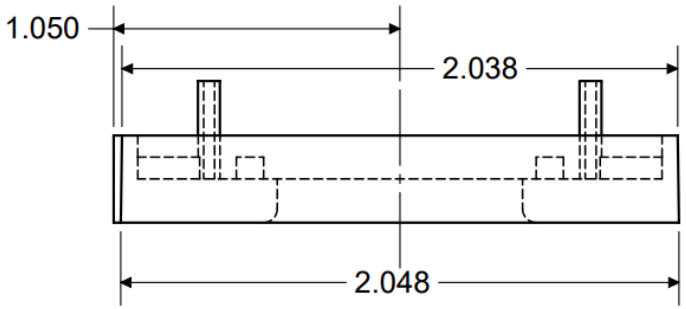
Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.
  Ixx = 0.0404 Ixy = 0.0000 Ixz = 0.0000
  Iyx = 0.0000 Iyy = 0.0325 Iyz = -0.0001
  Izx = 0.0000 Izy = -0.0001 Izz = 0.0406





SECTION A-A
SCALE 3:2





⑮ LOWER HOUSING CAP

MATERIAL: ABS PLASTIC
SCALE 1:1

NAME: GONZALEZ, NICHOLAS	DESK: 21	SEC: 17445	GRADE:

ENGINEERING *DESIGN* GRAPHICS

Mass properties of LOWER HOUSING CAP
Material: ABS Plastic
  Configuration: Default
  Coordinate system: -- default --

Density = 0.0368 pounds per cubic inch

Mass = 0.0180 pounds

Volume = 0.4873 cubic inches

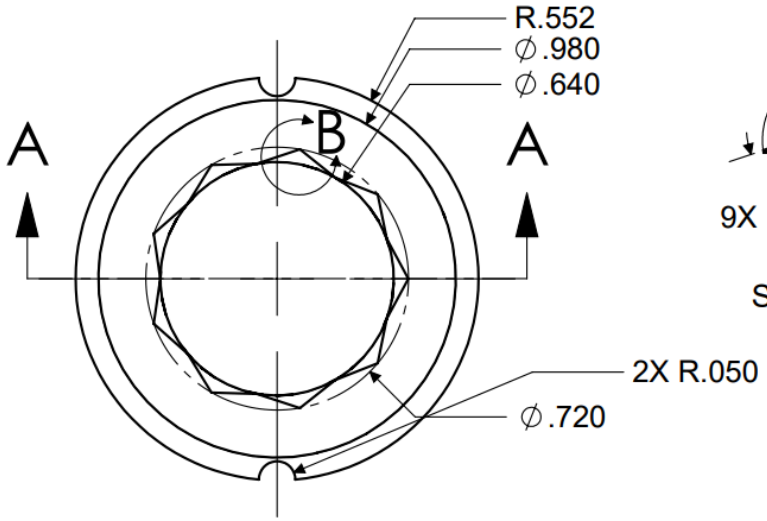
Surface area = 9.1055 square inches

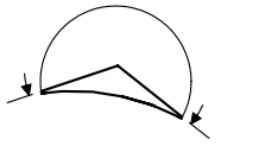
Center of mass: (inches)
  X = 0.0000
  Y = 0.4815
  Z = 0.0012

Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.
  Ix = (0.0000, 0.0002, 1.0000) Px = 0.0060
  Iy = (1.0000, 0.0000, 0.0000) Py = 0.0062
  Iz = (0.0000, 1.0000, -0.0002) Pz = 0.0120

Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.
  Lxx = 0.0062 Lxy = 0.0000 Lxz = 0.0000
  Lyx = 0.0000 Lyy = 0.0120 Lyz = 0.0000
  Lzx = 0.0000 Lzy = 0.0000 Lzz = 0.0060

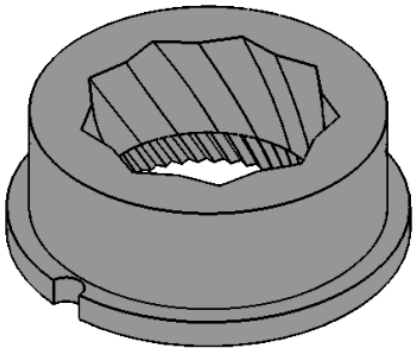
Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.
  Ixx = 0.0103 Ixy = 0.0000 Ixz = 0.0000
  Iyx = 0.0000 Iyy = 0.0120 Iyz = 0.0000
  Izx = 0.0000 Izy = 0.0000 Izz = 0.0102





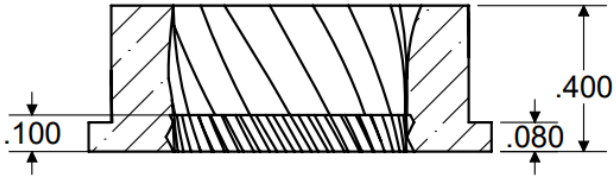
9X 123.10°, EQ SP.

DETAIL B
SCALE 4 : 1

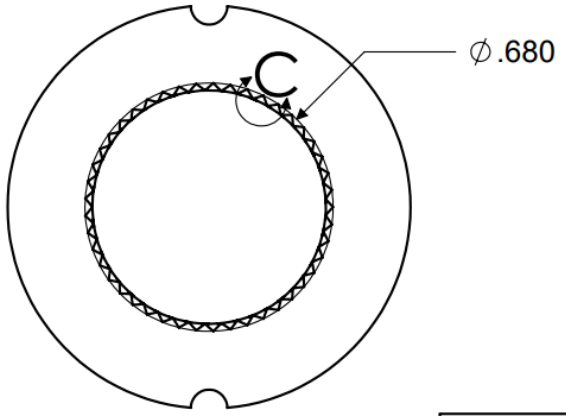


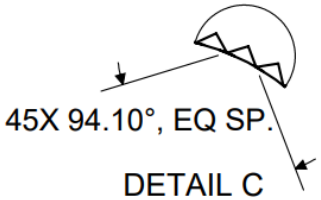
⑯ MAJOR GRINDING GEAR

MATERIAL: PORCELAIN
SCALE 2:1



SECTION A-A
SCALE 2:1





45X 94.10°, EQ SP.

DETAIL C
SCALE 4 : 1

NAME: GONZALEZ, NICHOLAS	DESK: 21	SEC: 17445	GRADE:	

ENGINEERING *DESIGN* GRAPHICS

Mass properties of MAJOR GRINDING GEAR
Material: Ceramic Porcelain
Configuration: Default
Coordinate system: -- default --

Density = 0.0831 pounds per cubic inch

Mass = 0.0151 pounds

Volume = 0.1817 cubic inches

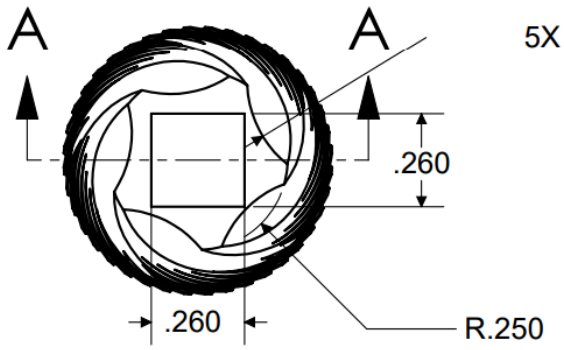
Surface area = 3.4260 square inches

Center of mass: (inches)
X = 0.0000
Y = 0.0851
Z = 0.0000

Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.
Ix = (1.0000, 0.0000, 0.0034) Px = 0.0016
Iy = (0.0034, 0.0000, -1.0000) Py = 0.0016
Iz = (0.0000, 1.0000, 0.0000) Pz = 0.0028

Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.
Lxx = 0.0016 Lxy = 0.0000 Lxz = 0.0000
Lyx = 0.0000 Lyy = 0.0028 Lyz = 0.0000
Lzx = 0.0000 Lzy = 0.0000 Lzz = 0.0016

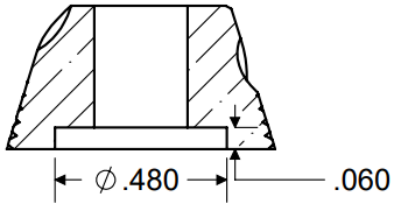
Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.
Ixx = 0.0017 Ixy = 0.0000 Ixz = 0.0000
Iyx = 0.0000 Iyy = 0.0028 Iyz = 0.0000
Izx = 0.0000 Izy = 0.0000 Izz = 0.0017



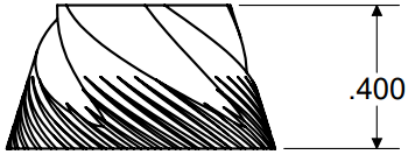
5X R.300, EQ SP.

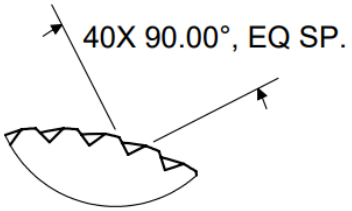
⑰ MINOR GRINDING GEAR

MATERIAL: PORCELAIN
SCALE 2:1

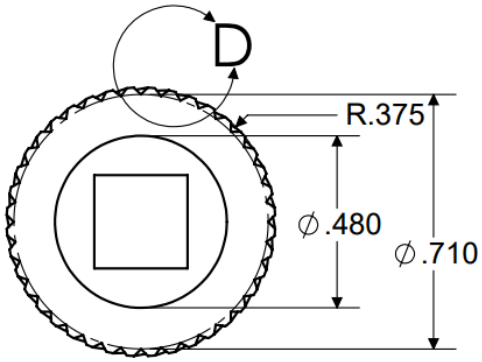


SECTION A-A
SCALE 2:1





DETAIL D
SCALE 4 : 1



NAME: GONZALEZ, NICHOLAS	DESK: 21	SEC: 17445	GRADE:	

ENGINEERING *DESIGN* GRAPHICS

Mass properties of MINOR GRINDING GEAR
Material: Ceramic Porcelain
Configuration: Default
Coordinate system: -- default --

Density = 0.0831 pounds per cubic inch

Mass = 0.0069 pounds

Volume = 0.0826 cubic inches

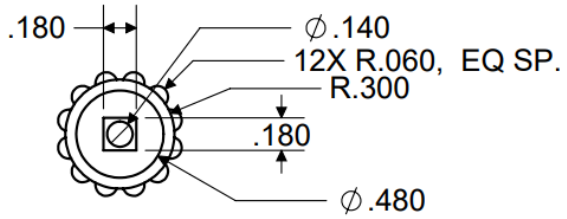
Surface area = 1.8902 square inches

Center of mass: (inches)
X = 0.0000
Y = 0.1677
Z = 0.0000

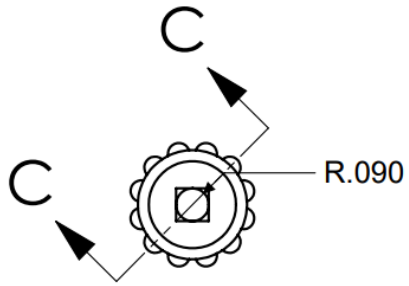
Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.
Ix = (0.7183, 0.0000, -0.6957) Px = 0.0003
Iy = (-0.6957, 0.0000, -0.7183) Py = 0.0003
Iz = (0.0000, 1.0000, 0.0000) Pz = 0.0004

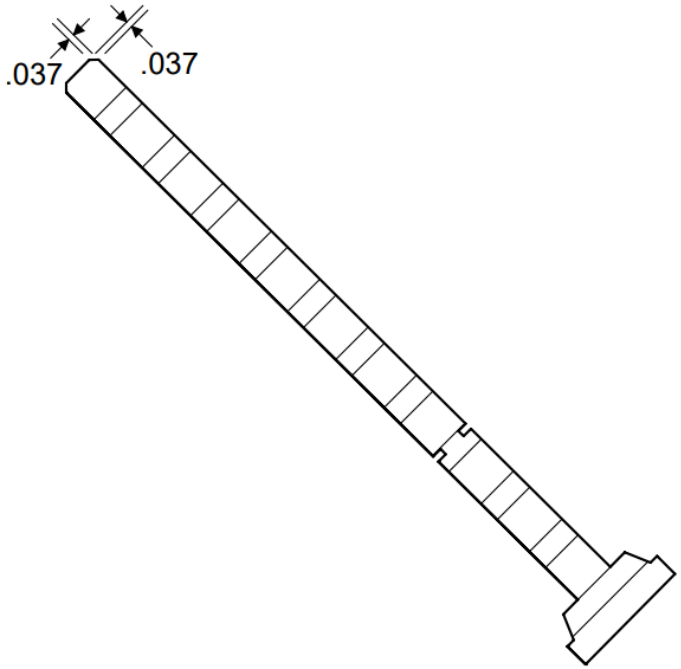
Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.
Lxx = 0.0003 Lxy = 0.0000 Lxz = 0.0000
Lyx = 0.0000 Lyy = 0.0004 Lyz = 0.0000
Lzx = 0.0000 Lzy = 0.0000 Lzz = 0.0003

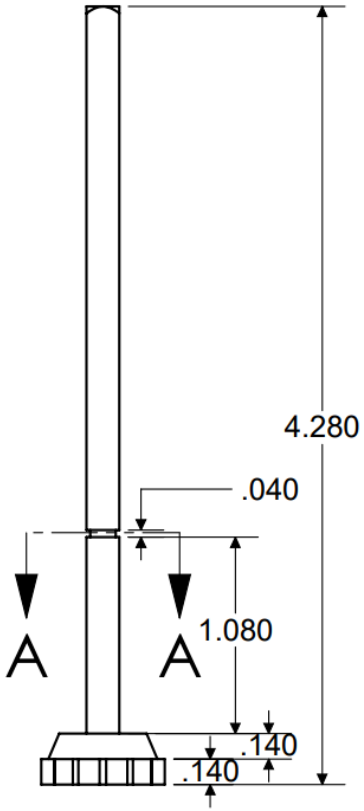
Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.
Ixx = 0.0005 Ixy = 0.0000 Ixz = 0.0000
Iyx = 0.0000 Iyy = 0.0004 Iyz = 0.0000
Izx = 0.0000 Izy = 0.0000 Izz = 0.0005

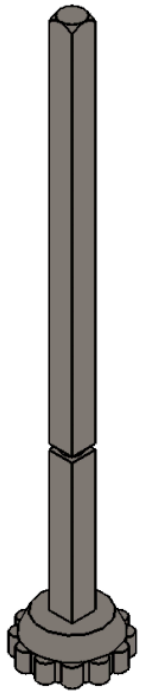


SECTION A-A
SCALE 1 : 1









(18) MAJOR AXLE

MATERIAL: STAINLESS STEEL
SCALE 1:1

SECTION C-C
SCALE 1 : 1

NAME: GONZALEZ, NICHOLAS	DESK: 21	SEC: 17445	GRADE:	

ENGINEERING *DESIGN* GRAPHICS

Mass properties of MAJOR AXLE
Material: AISI 316 Annealed Stainless Steel Bar
  Configuration: Default
  Coordinate system: -- default --

Density = 0.2890 pounds per cubic inch

Mass = 0.0603 pounds

Volume = 0.2085 cubic inches

Surface area = 4.0943 square inches

Center of mass: (inches)
  X = 0.0000
  Y = 1.1789
  Z = 0.0000

Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Taken at the center of mass.
  Ix = (0.0000, 1.0000, 0.0000) Px = 0.0013
  Iy = (-0.7071, 0.0000, 0.7071) Py = 0.1168
  Iz = (0.7071, 0.0000, 0.7071) Pz = 0.1168

Moments of inertia: (pounds * square inches)
Taken at the center of mass and aligned with the output coordinate system.
  Lxx = 0.1168 Lxy = 0.0000 Lxz = 0.0000
  Lyx = 0.0000 Lyy = 0.0013 Lyz = 0.0000
  Lzx = 0.0000 Lzy = 0.0000 Lzz = 0.1168

Moments of inertia: (pounds * square inches)
Taken at the output coordinate system.
  Ixx = 0.2005 Ixy = 0.0000 Ixz = 0.0000
  Iyx = 0.0000 Iyy = 0.0013 Iyz = 0.0000
  Izx = 0.0000 Izy = 0.0000 Izz = 0.2005

Ratchet Handle - Acrylonitrile Butadiene Styrene Plastic

Kuhn Rikon Ratchet Grinder reinvented the traditional grinder, designed to perform spice grinding with the operation of a ratcheting motion, making the Ratchet Handle an essential part of the product. The handle is composed of three main parts, the top sphere, the shaft and the gear cogs. The sphere at the top of the handle contributes to the grinder's ergonomic design, helping the consumer maintain a sufficient and comfortable grip to execute the ratcheting motion. The handle's shaft made to increase the range in motion of the ratchet, which adds ease to its use. The gear teeth at the bottom of the handle allow the ratchet gears to fasten, initializing the grinding subsystem of the spice grinder.

The Ratchet Handle is made up of Acrylonitrile Butadiene Styrene (ABS) Plastic, a thermoplastic made by the polymerization of acrylonitrile and styrene on a diene base. ABS plastic used for its hardness, high melting point and ability to be an electric insulator, making it a commonly used material by manufactures. The material is durable and hard enough to endure the continuous and repetitive use throughout the spice grinding operation. The material also allows the manufacturer to work with a range of surface gloss levels, improving the appearance and sleekness of the product.

The part was designed and developed by the company Kuhn Rikon, using Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM). A exothermic reaction between butadiene, water, an emulsifier and a catalyst are used to form the polybutadiene base. The base is then further polymerized, but with styrene and acrylonitrile in a nitrogen atmosphere on a diene backbone. The final step is adding in antioxidants, lubricators, stabilizers and pigments to achieve the desired hardness, durability and appearance. The handle is shaped using a plastic injection molding method. The ABS plastic is heated to a high temperature until melted, it is then injected into the handle mold at a high pressure. The high pressure injection ensure that

the material maximizes the volume of the mold, pushing out any air bubbles. The mold is then capped to main the pressure until the material fully solidifies.

Fink, Johannes Karl. *"Acrylonitrile-Butadiene Styrene Polymers ."* Handbook of Engineering and Speciality Thermoplastics: Polyolefins and Styrenics, vol. 1, Scrivener Publishing LLC, 2010, pp. 211–256.

Van Nostrand's Scientific Encyclopedia. Ed. Glenn D. Considine. Vol. 3. 10th ed. Hoboken, NJ: Wiley-Interscience,2008. p4498-4499.

Staff, Creative Mechanisms. "Creative Mechanisms Blog ." Everything You Need To Know About Acrylic (PMMA), www.creativemechanisms.com/blog/injection-mold-3d-print-cnc-acrylic-plastic-pmma.

Spice Outer Housing - Poly(methyl methacrylate) "Acrylic Plastic"

The Kuhn Rikon Ratchet Grinder is an innovation of standard spice grinders. Utilizing a ratchet grinding mechanism, the Kuhn Rikon Ratchet Grinder removes the necessity for rotational movement in order to grind the various spices. An integral component to the Kuhn Rikon Ratchet Grinder, the Spice Outer Housing contains the various spices for grinding. The Spice Outer Housing is composed of acrylic plastic; it is cylindrical in shape and transparent. The transparent material allows the consumer to see the type of spice and the amount of spice left in the Spice Outer Housing.

Acrylic plastic is utilized in the construction of the Spice Outer Housing for its strength and its availability. Classified as a thermoplastic, acrylic plastic has a melting point of 160 degrees Celsius; once at that melting point, the plastic does not burn but is in a liquid phase. The liquid properties of acrylic at its melting point allows them to be easily molded during an injection molding process. Unlike polycarbonates, acrylic plastic is an economic substitute; it requires less money and manufacturing time to produce. In addition, acrylic plastic is relatively light compared to glass; thus, it has the transparent characteristics of glass but does not suffer in weight.

The Spice Outer Housing was designed and developed by Kuhn Rikon using Computer-Aided Design and injection molding. Acrylic plastic is a polymer that is formed by reacting the monomer, methyl methacrylate, with a catalyst, an organic peroxide. Using a process called bulk polymerization, the monomer and catalyst are poured into a mold and heat is applied to start the reaction. Once the reaction has finished, the finished acrylic sheets are then used in injection molding. Kuhn Rikon uses a CAD software to design the injection mold tool; the mold is used to repeat and reproduce the Spice Outer Housing. Once the mold has been designed and tested, it will be installed within the injection molding machine. The acrylic plastic is heated until

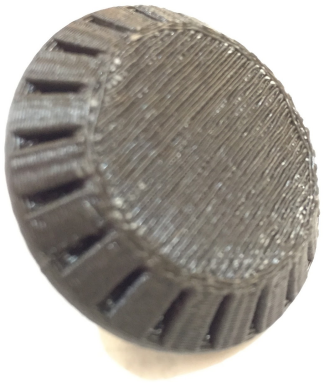
melting point is achieved; once the plastic has the properties of a liquid, it is then injected into the mold. This process occurs under high pressure as it reduces the air bubbles and maximizes the material volume within the mold. The mold is then capped until the material has completely solidified and cooled.

Citations:

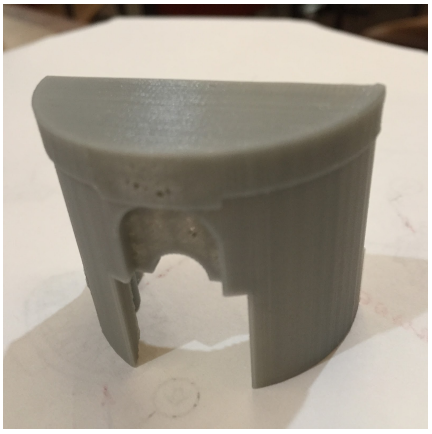
Gale Research, How Products are Made, http://www.madehow.com, 1994. (TS 145 H67)

Staff, Creative Mechanisms. “Creative Mechanisms Blog .” Everything You Need To Know About Acrylic (PMMA), www.creativemechanisms.com/blog/injection-mold-3d-print-cnc-acrylic-plastic pmma.

Rapid Prototyping



Major Gear



Ratchet Housing

Minor Grinding Gear

Handle

Ratchet Grinder Re-Design

Part of the Ratchet Grinder's housing subsystem is made up of the upper body housing, the lower body housing, the spiece housing and the front door. Currently, the three parts are connected to one another using a glue lubricant. However, the subsystem could be improved by connecting the upper body housing, the spiece housing and the lower body housing using a threaded screw.

The spice outer housing would have an external thread and the lower body housing and the upper body housing would have internal threads. This will eliminate the the need for the glue lubricant, as it is only used for this purpose. Implementing a thread into the housing subsystem will allow consumers to easily dismantle the grinder into its three subsystems. Allowing the user to remove large pieces of specie that may be obstructing the grinding gears. In addition, the separation of the grinder's housing components will make it easier for the grinder to be thoroughly cleaned.

Re-Design of the Kuhn Rikon Lower Housing Cap

The lower housing cap on the Kuhn Rikon Ratchet Grinder is designed to contain and position the major grinding gear so that it is concentric with the axle and the minor grinding gear. Positioning the three components in a concentric manner ensures that the linear force applied by the ratchet handle directly translates to rotational movement, providing the necessary force to grind the spices.

The construction of the lower housing cap consists of ABS plastic; a tough material that is shock-resistant. The material of the lower housing cap prevents cracks or stress fractures when dropped, improving the life-expectancy of the product. In addition, the lower housing cap lacked any sharp edges or points; the overall smooth composition of the part prevents any cause of injury for the consumer.

Although the lower housing cap shared certain positive traits of design, it also lacked the ability for easy removal and cleaning. During the disassembly process, the lower housing cap was bound to the lower body housing by friction; the tight bond made it near-impossible to dismantle the assembly.

Thus, in order to improve on the design, screws or a set of plastic notches could be utilized to attach the lower body housing cap to the lower body housing. The utilization of screws or notches would allow the consumer to dismantle the whole assembly. Access to the major and minor grinding gear would allow the consumer to clean the gears and to remove clogged or stained materials from the entire bottom assembly. Access to the major grinding gear would also allow for replacement in case of damage, or use of a different gear for a finer grind. The target audience consists of chefs and amateur cooks; by adding a disassembly feature to the lower housing cap, the consumer can utilize a multifarious selection of spices without worry of cleaning or clogging.