TITIE : SMART PUBLIC RESTROOM

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LIST OF FIGURES

1.4 ADVANTAGES OF THE DEVELOPED MECHANISM

- No sensors or electronics involved.
- No human effort required.
- Mechanism is robust
- Economical

1.5 LITERATURE SURVEY

During the course of study, we came across various kind of toilet flushing project. The first project entitled 'Electronic Cistern Flushing' [1] in which the flushing is activated by electronic, pneumatic buttons or infrared sensors.

The second project entitled 'SCPK Flushing Package' [2] in which the flushing is activated by piezo or infra-red buttons.

The third project entitled 'Mechanical Direct Flushing' [3] which works without electric power but has a push button which the user may forget to press and sometimes hesitate to touch the button due to carelessness concerns.

Hence there is no such mechanical project that works complete automatically without electric power or sensor.

CHAPTER 2

DESCRIPTION OF PARTS USED

2.1 DESCRIPTION OF PARTS USED

The various essential parts that make the system run are:-

- Cistern
- Platform or Base
- Supporting Stand
- Coil Compression Sofa Spring
- Bolt and Nut
- Striking Lever with a Rubber at the End

2.1.1 Cistern: - The modern water closet or toilet utilizes a device to reserve and hold the correct amount of water required to flush the toilet bowl called cistern.

Design Considerations: Modern toilets use 6 to 9 L per flush, whereas older models were designed for flush water quantities of up to 20 L. There are different low-volume flush toilets currently available that can be used with as little as 3 L of water per flush.[4]

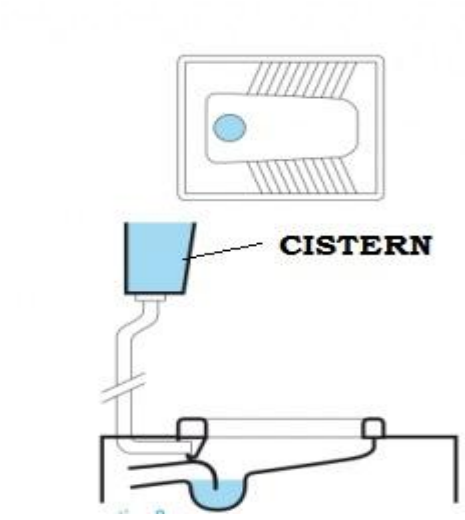
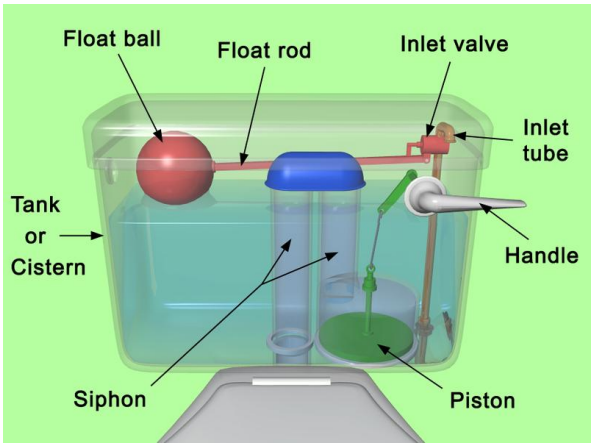


Figure 2.1: Position of Cistern above the Platform

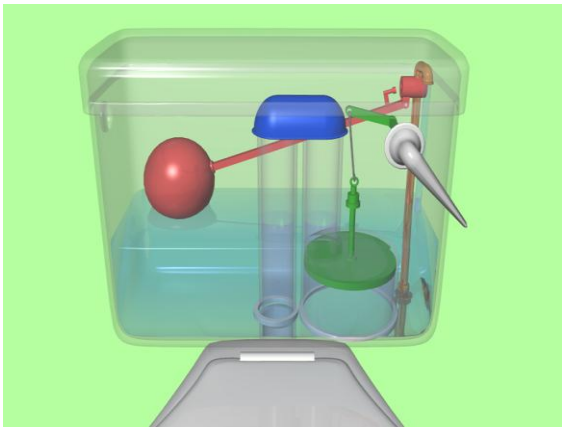
The tank contains some important parts which need to be described to understand the working [6] of a cistern.

- *Handle or button*: Its basically is a switch provided on the tank to flush when required.
- *Inlet valve:* The inlet valve controls the water supply coming into the tank. It lets water in when the tank is empty, and stops water coming in when the tank is full.
- *Float ball and float rod:* The float ball rises as the tank fills with water. As it rises, the float rod attached to it presses against the inlet valve. When the tank is full, the rod is pressing against the inlet valve hard enough to turn the water off. This stops the tank from overflowing.

Finally the tank empties quite quickly, and the float ball floats to the bottom. That means the float rod is no longer pressing against the valve, so water begins to flow into the tank, filling it up again. The water which left the tank cleans the bowl and carries the waste with it to the septic tank.



(a)



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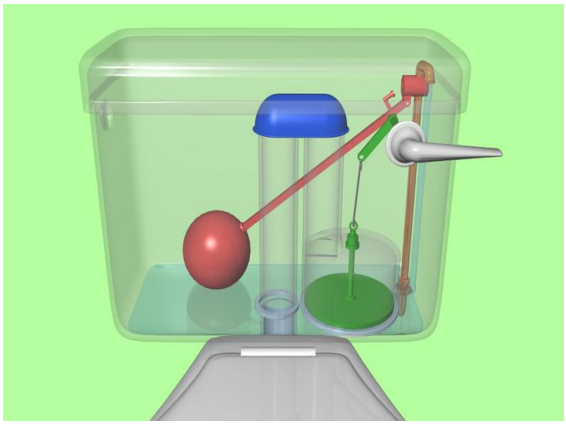

(c)

Figures 2.2 [5]: (a) Parts of a Typically Cistern System (b) A Toilet Cistern Emptying (c) A Toilet Cistern Empty

2.1.2 Platform or Base: - It is a wooden base consisting of two wooden plates connected with 12 springs in 3*4 arrays. It is provided with 4 bolts and 8 nuts that constraints the platform to move only in vertical direction.

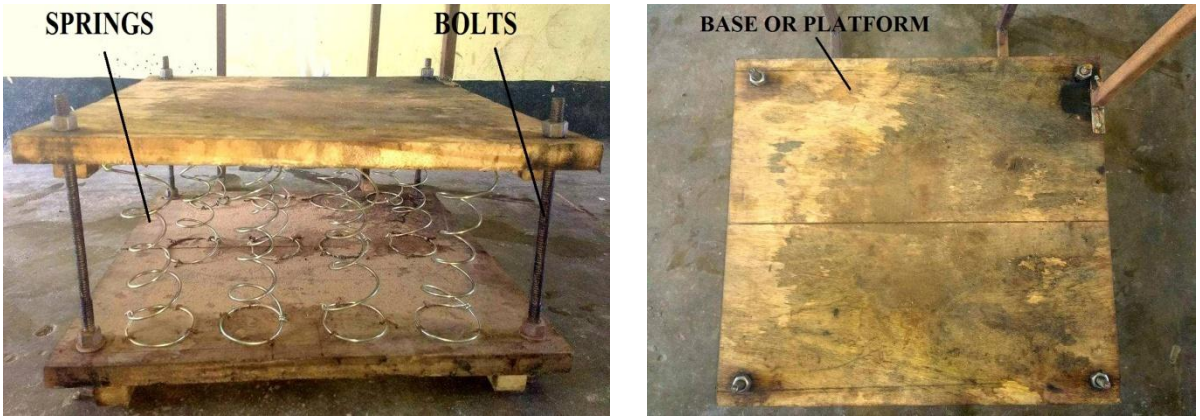

Figure2.3: Front View and Top View of the Platform

2.1.3 Supporting Stand: - Two square pipes that help the cistern (water reservoir) to hold 770 mm above the ground providing a potential head .This head is then converted to velocity of flow of water which is responsible for cleaning of the toilet bowl.

Figure 2.4: View of a Supporting Stand

2.1.4 Coil Compression Sofa Spring: - The spring which is used are locally termed as sofa spring. They are selected for their physical property. They are robust in nature and have long service life. It is highly tempered steel. The following images below show the spring used and their arrangement.

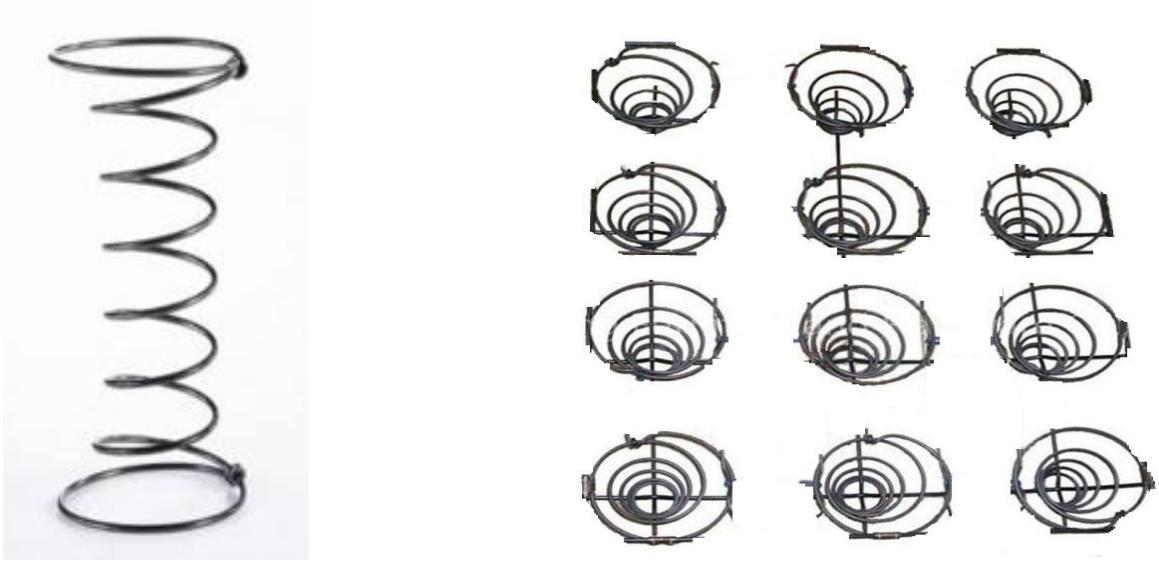

Figure 2.5: Compression Coil Spring and its Arrangement in the System

2.1.5 Bolt and nut :- A bolt is a form of threaded fastener with an external male thread while a nut is a type of fastener with a threaded hole.There are 4 bolts used in the 4 corners of the platform to constrain the motion in one direction and nut is provided to limit the motion in upward direction.

Figure2.6: View of nut, bolt and washer in assembly

2.2 MATERIAL USED AND THERE DIMENSIONS

Table shows the six major components that make the system run. The material and dimensions of the components are shown below:

Table 2.1: Material Specifications

NAME	DIMENSIONS	MATERIAL
CISTERN	430×290×120 mm	POLYPROPYLENE
BASE or PLATFORM	540×490 mm	WOOD
SUPPORTING STAND	770 mm	MILD STEEL
SPRING	6 inch	TEMPERED STEEL
STRIKING LEVER WITH RUBBER END	Striking Lever Length= 110mm	MILD STEEL
	Rubber Length= 45mm	
	Thickness= 5mm	
BOLTS (Full Threaded)	Length= 9 inch	MILD STEEL
	Diameter= 12mm	

2.3 COST ANALYSIS

The total cost incurred in the model is illustrated in the table below:

Table 2.2: Cost of Model

MATERIAL	**COST(Rs)**
SPRING	140
CISTERN	300
BOLT	110
WOOD	500
WELDING	1000
STAINLESS STEEL SQUARE PIPES	800
MISCELLANEOUS	500
TOTAL	**3350**

CHAPTER 3

CONSTRUCTION

Construction of the system is simple and efficient. It does not have any complicated arrangement. The operation of the arrangement is fully mechanical. Steps involved in fabricating are:

3.1 MAIN PARTS USED IN THE CONSTRUCTION

- Platform Making
- Cistern Fitting
- Motion Transmitting Lever

3.1.1 Platform Making

Platform is made of wood. It is a replica of originally used Indian toilet. In our design of platform we have used 12 numbers of springs, rectangular wood (54 x 49) cm in the figure given below. This platform is arranged by attaching 4 bolts of 9 inch length and 12 mm diameter each, these are attached at four corner of wood. In the middle of the two wood pattern springs are arranged in parallel arrangement in three rows.

3.1.2 Cistern Fitting

Cistern is fitted by attaching metal plate with lower part of the platform. It is given a minimum height of 760 mm. To the cistern a continuous water supply line is connected. Cistern contains a floating ball and manually pressed handle .When water in the container crosses maximum limit floating ball prevents further flowing of water in the inlet. When handle is pressed discharge of water occurs.

3.1.3 Motion Transmitting Lever

It is a square hollow pipe which is attached on the upper part of the platform by making a bracket and thereby screwing it up. This motion transmitting lever is connected to another small thin lever by arc welding. This thin lever is drilled and attached to the cistern frame with the help of a screw. At the end portion of the lever a synthetic rubber band is used having thickness 5 mm .The end portion of the thin lever having synthetic rubber at the end touches the handle and pressed it whenever people gets off from the platform.

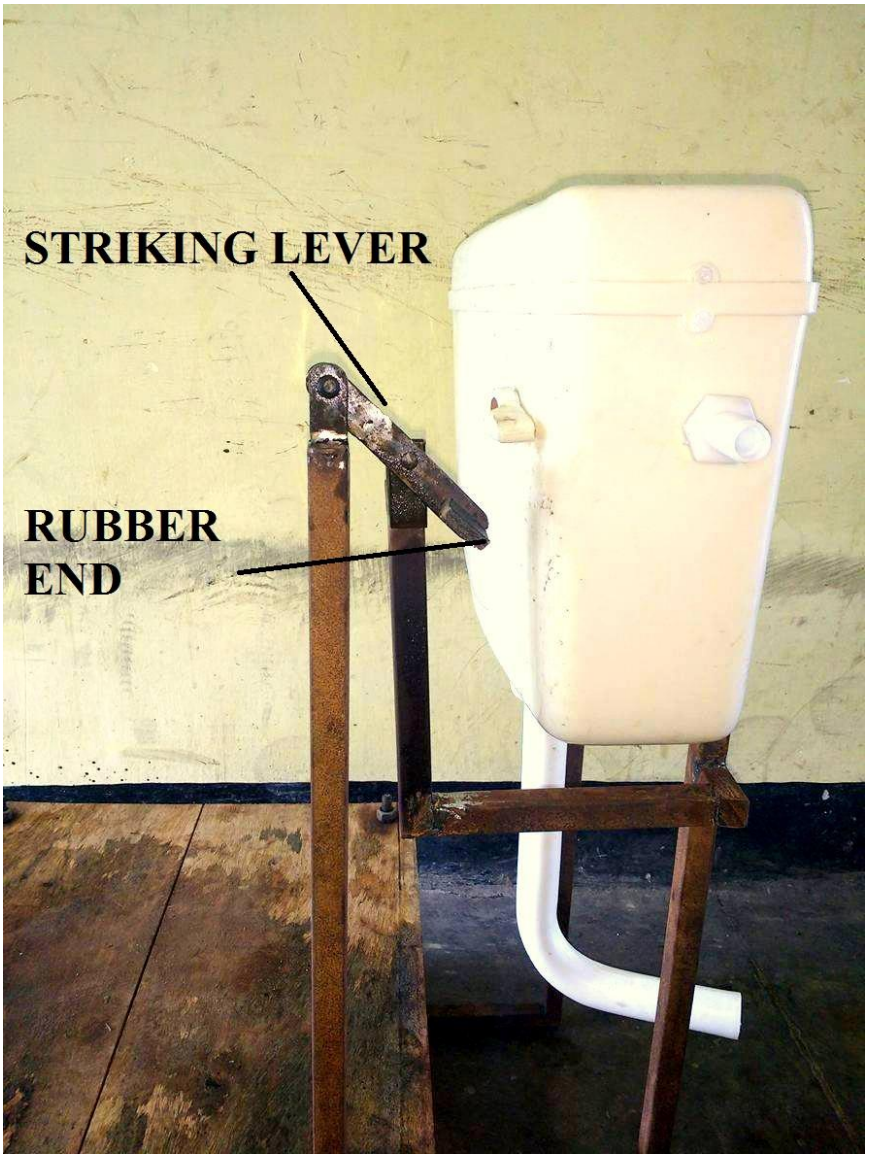

Figure 3.1: View of the Lever

CHAPTER 4

WORKING OF SMART TOILET FOR AUTOMATIC FLUSHING

4.1 WORKING PRINCIPLE

The working principle of the mechanism is very simple which uses only mechanical means (such as springs, levers etc.) for its functioning. The wooden platform is consisting of two halves, one movable and the other fixed, both having springs between them. It mainly works on the principle of spring compression and expansion. When force is applied on spring, it gets compressed and after removal of the force, because of spring stiffness it provides a reaction force in opposite direction. The vertical steel pipe attached to the upper half of the base also moves up and down along with it. As a result due to lever mechanism the flexible element attached to the tip of the lever moves up crossing the cistern handle. All the arrangements work together and provide us automatic flushing from cistern.

4.2 WORKING OF EVERY ITEM USED IN OUR SYSTEM

- Platform working
- Cistern working
- Lever working

4.2.1 Platform Working

Platform is nothing but spring mass system arrangement. It is the main part of our developed project where people will sit for toilet and thus compressing the spring attached in it. So when the person lifts off from the platform because of spring stiffness platform will try to comeback to original position and thus allowing an upward automatic movement of the platform.

4.2.2 Cistern Working

The cistern contains a handle, an inlet valve and a float rod with float ball at the end. The inlet is mainly controlled by float ball whereas outlet is controlled by handle

attached on the cistern. When handle is pressed in downward direction outlet valve opens and discharge takes place.

4.2.3 Lever Working

There are total two levers attached on our system which do the function on the following manner:-

- *Motion transmitting lever*: Motion transmitting lever is directly attached on the upper part of platform. Upward motion of platform is first transmitted to motion transmitting lever which pushes the 2^{nd} lever attached on it in upward direction and net effect is converted into downward direction.
- *Lever with synthetic rubber at the end*: The lever having synthetic rubber at the end is connected by bolt joint to the motion transmitting lever. The end this lever is grooved and synthetic rubber is attached which touches the handle of the cistern. Thus handle of the cistern is pushed in downward direction by rubber and providing an automatic flush from the cistern.

4.3 DIFFERENT POSTIONS OF LEVER

Following figures illustrate different load condition and their respective position of lever.

Figure 4.1: Position of Lever When Load is not applied

Figure 4.2: Position of Lever When Load is applied

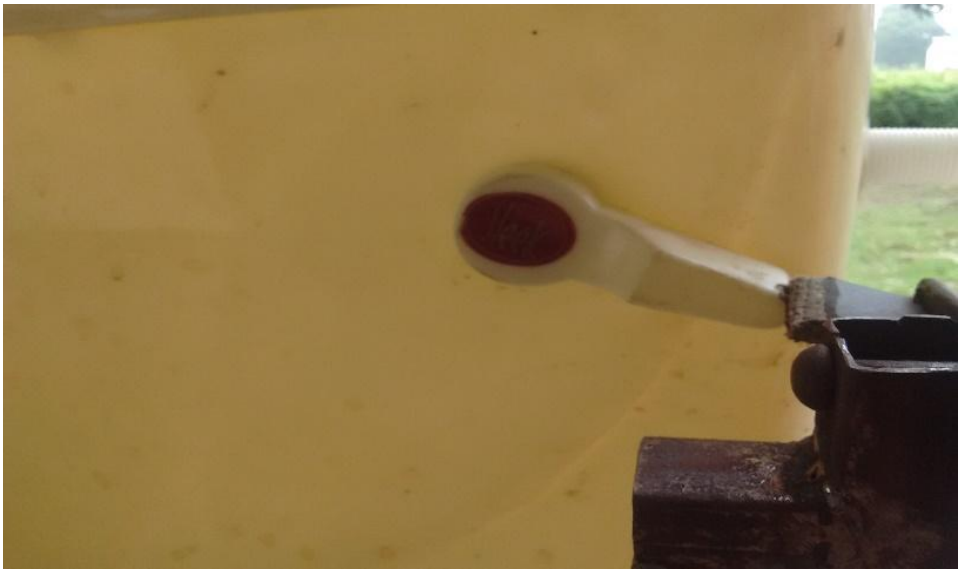

Figure 4.3: Position of Lever While the Load is removed

CHAPTER 5

CALCULATIONS AND RESULTS

5.1 DIFFERENT PARAMETERS INVOLVED

While developing the mechanism some experiments were performed to calculate the spring stiffness (which are used in the platform), minimum deflection for varying load, discharge capacity, flow velocity etc. which were required for constructing the mechanism. The calculations and the results are presented in the following tables.

5.1.1 Experiment for Determination of Spring Stiffness

The experiment was performed by placing different loads on the upper half of the platform and then measuring the corresponding deflection .The spring stiffness is obtained by the formula**:**

Spring Stiffness (k) = Force/deflection

EQUIVALENT SPRING CONSTANT:

In the platform the springs are arranged in 3*4 arrays. All the springs are connected in parallel so the equivalent spring constant of the arrangement can be obtained as follows:

Let the spring constant of each spring be K and the equivalent spring constant is K_1.

Therefore,

$K_1 = 12 \times K$
Hence, $K = K_1/12$

TABLE 5.1: Spring Stiffness Calculation

SL. NO.	FORCE (kg)	DEFLECTION (cm)	SPRING STIFFNESS(kg/cm)
1	30	5.8	5.17
2	40	7.7	5.19
3	50	9.6	5.2
4	55	10.5	5.23
5	60	11.5	5.21

Calculations:

Average spring stiffness, K_1= (5.17+5.19+5.2+5.23+5.21) ÷5 = 5.2 kg/cm

Spring stiffness of each spring, K= 5.2/12

= 0.433 kg/cm

Minimum deflection corresponding to a load of 20 kg= 20/5.2=3.85 cm

5.1.2 Flow Velocity Calculation

Table 5.2: Average Discharge Calculation

SL.NO.	DISCHARGE ($m^{3)}$	TIME TAKEN(sec)	AVERAGE TIME (sec)	RATE OF DISCHARGE(m^3/sec)
1	11×10^{-3}	12.3	60.3/5 =12.06	.000912
2		11.7		
3		11.9		
4		12.1		
5		12.3		

Cross sectional area at the outlet = $\pi/4 \times .03^2 = .000707\ m^2$

Average outlet flow velocity = Rate of discharge/Area at the outlet

= 0.129 m/s

CHAPTER 6

DIFFERENT VIEWS OF THE MODEL

In this chapter we have provided different views of the overall project. They are shown below.

Figure 6.1: Front View of the Model

Figure 6.2: Rear View of the Model

Figure 6.3 Right Hand Side View of the Model

Figure 6.4: Left Hand Side View of the Model

CHAPTER 7

CONCLUSION

7.1 CONCLUSION

The entitled project ***Development of a Smart Toilet for Automatic Flushing*** aims to achieve a more cleaner and hygienic public toilet system in rural, semi urban and urban areas in the near future. We want to broadcast the project as a public welfare initiative. In rural areas, there is scarcity of electric power and hence our design will be best suitable. This design utilizes the weight of the person in flushing the toilet and hence is a rather simple mechanism. This project is aimed to contribute to the Central Government Scheme of "Swachh Bharat Abhiyan" where each and every citizen of the nation is entitled to have a cleaner and hygienic future.

7.2 FUTURE SCOPE

The present work is successful in the view that the proposed mechanism has been successfully designed and demonstrated; but there is still a lot of room for further improvement which may include the following:

- In the project, the platform is unstable, i.e. it does not hold still when a person mounts or dismounts it. Therefore it could be made more stable by providing bushing instead of bolts to constraint the motion.
- The currently constructed platform is a wooden one and can be replaced with a steel platform so that welding the lever would be easier rather than to screwing it up.
- The levers can be arranged in other suitable positions to make the working more efficient.
- The metal attachment that is used to work the flush switch can be replaced by more efficient methods like by another lever arrangement with fulcrum or a cam.
- With more testing and calculation, the design of the developed mechanism can be improved further and implemented in the concerned areas.

REFERENCES

[1] http://www.wallgate.com/products/wc-toilet-urinal-flushing-range/electronic-cistern-flushing-range

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[3] http://www.wallgate.com/products/wc-toilet-urinal-flushing-range/mechanical-direct-flushing-range

[4] http://www.sswm.info/category/implementation-tools/wastewater-treatment/hardware/user-interface/flush-toilet

[5] http://www.sswm.info/sites/default/files/toolbox/TILLEY%20et%20al%202014%20Schematic%20of%20two%20different%20cistern%20flush%20toilets.png

[6] https://en.wikibooks.org/wiki/Wikijunior:How_Things_Work/Flush_Toilet