# Design and Fabrication of Automated Urinal Flushing System Using Mechanical Elements With Disinfectant

**Dinesh Kumar Suppan, M.Saleem**

***Abstract*: *In India, One of the most important problem is Infected Public Toilets especially Urinals that no one worried about the Flushing of Urinals. Hence, the infected urinals cause diseases to the users by spreading infectious germs, therefore complete cleaning of urinals is essential to maintain the hygienic conditions. In this paper, to tackle this problem by the development of Urinal flushing system with a less usage of water. This flushing system is made of mechanical elements. Automatic flushing system is one of the essential technologies in India as it is used for maintaining hygienic conditions especially in public urinals. This flushing system does not require an electric power as making it highly useful and reliable in public places like garden and public urinals. Also, this system conserves the water and the electricity. In this setup, Rocker Disc is connected with the mechanical linkages for the flexibility of valve operations.***

***Keywords*: *Automation, Flush system, Mechanical elements, Disinfectant.***

## I. INTRODUCTION

In public toilets, due to the poor flushing and maintenance, unpleasant odor and uncomfortable environment are common. Uncleaned urinals cause diseases to the users by spreading infectious germs, therefore complete cleaning of urinals is essential to preserve good hygiene conditions.

Flushing may be available in one of the following types

- Manual handles
- Timed flush
- Automatic flush using electronic sensors
- Door-regulated flush
- Waterless urinals

Already available sensor based Automatic flushing system involves high fabrication cost due to electrical and electronic components when compared to the present prototype developed by the authors. To avoid these drawbacks we proposed a new method called Automated Urinal Flushing System Using Mechanical Elements With Disinfectant.

Our invention rightly tackles this problem by flushing measured quantity of water required for complete cleaning of the urinals thereby conserving the water. Our invention uses only mechanical elements and hence does not require any external energy.

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## II. LAYOUT OF AUTOMATED URINAL FLUSHING SYSTEM WITH DISINFECTANT

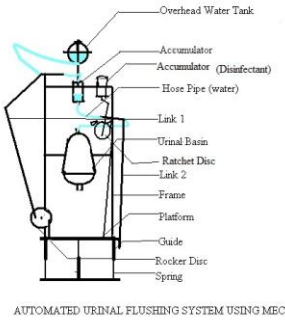


**Fig.1 Layout of Automatic Flush System**

***Mechanisms***

Rocker Disc is about 140 mm diameter MS Plate with a thickness of 3mm, which is connected with the mechanical links in order to actuate the ball valves for opening and closing of water flow. This is the heart of the automated urinal flushing system.

***Rocker Disc***

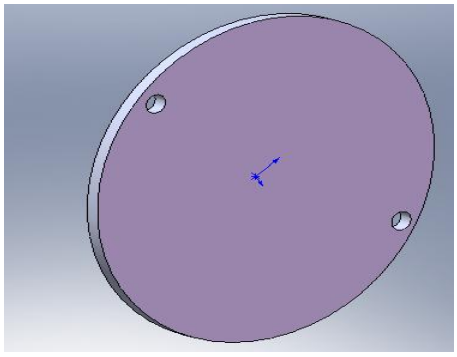

**Fig.2 Rocker disc which is rotated freely**

***Objectives***

- ✓ Conventionally, automatic flushing system uses sensors which get damaged easily.
- ✓ But this project requires no sensors and is economical too. It uses simple mechanism and hence the cost of development and installation will be less.
- ✓ 100% efficiency in cleaning the urinal can be achieved using this project.

- ✓ No expense related to installation and maintenance of electrical appliances is required.
- ✓ Using disinfectant will also eliminate the spreading of infectious diseases.

Existing microprocessor controlled electronic flushing system is costlier (approx. Rs.6900), requires continuous supply of power supply for operation and has poor reliability, therefore ensuring complete cleaning of urinal system is not possible and may either lead to extensive water consumption or no water flushing. Our invention uses only mechanical elements and the cost is very less of Rs.2660 only, which is about 300% cheaper.

***Comparison with existing electronic sensor flushing system***

| S.No | Parameter | Automatic Urinal Flusher (Electronic Sensor) | Our Invention |
|---|---|---|---|
| 1 | Cost | Rs. 6950/- | Rs. 2660/-* |
| 2 | Electricity | 220 V AC operated | Not required |
| 3 | Reliability | Low | High |
| 4 | Water Conservation | Yes | Yes |

**Table.1 Comparison with existing electronic sensor flushing system**

***A. Description of Components***

***Frame***

A Long L-Shaped frame made of mild steel which support and hold the whole parts involved in this project. At the Top of the frame the overhead tank is provided with the capacity of 2 Litres.

***SQUARE TUBE 304 MILD STEEL***

***Dimensions***

A: 1" SQ

B: .88" ID

C: .118" Wall

Material – Stainless Steel

Shape: Square Tube

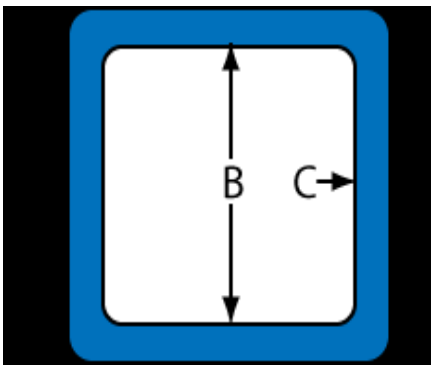


**Fig.3 Square Tube**

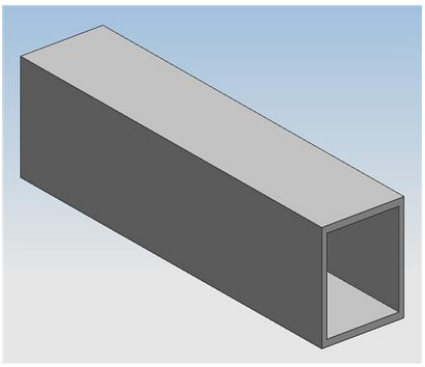

**Fig.4 Model of Square Tube**

***Reservoir Tank***

A Reservoir tank is mounted in the top of the frame, in fig 5 which is having 2 liters capacity of water tank having provision to supply water to the other parts through the hose pipe.

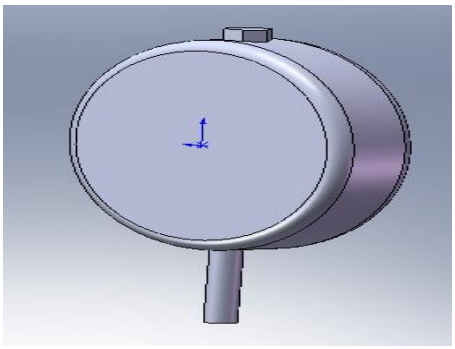

**Fig.5 Reservoir tank**

***Hose***

A Hose made of pv material which is used to carry the water from tank to the valves, accumulator, in the fig.6 finally is connected with the urinal basin.



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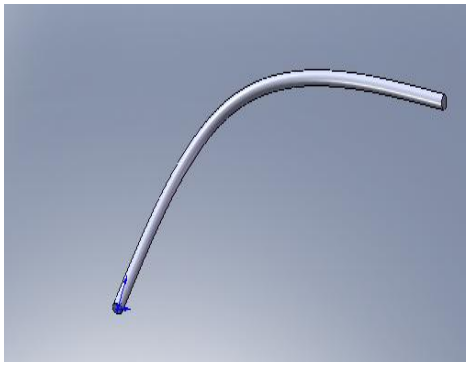

**Fig.6 sanitary hose pipe**

***Ball Valves***

A Ball Valves is actuated by the linkages. There is two ball valves one is open means at the same time other one is closed by the linkages this is achieved by rocker disc with the linkages.

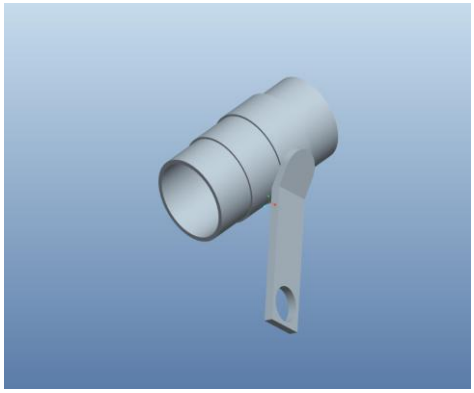

**Fig.7 Ball valve model**


**Fig.8 Appearance of ball valve**

***The External and Connection Dimensions***

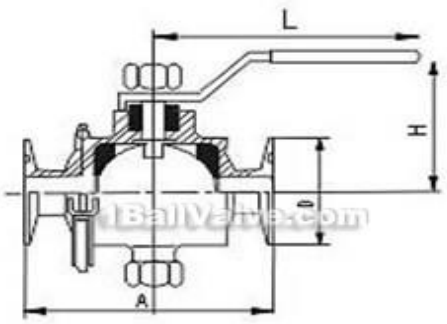


**Fig.9 Sanitary sleeve ball valve constructural diagram**

***Accumulator***

In fig.10 Accumulator is a tank having a capacity of 300 ml, the water from the overhead is stored in this accumulator when a person stands on platform the valve opens the water is stored from the overhead tank.

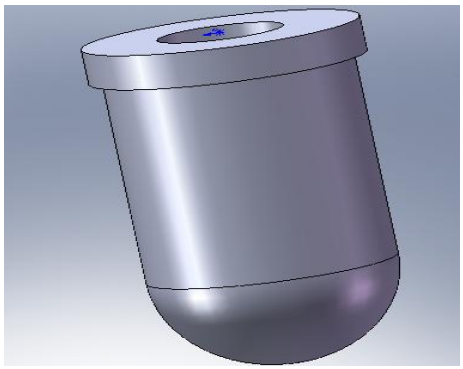

**Fig.10 Accumulator Model**

***Linkages***

A Linkages is made of MS plate and MS rod. in fig.11. The MS plate is specially made of design having of inclination with the proper dimension, then only its work properly. This is taken from the Theory of machines.

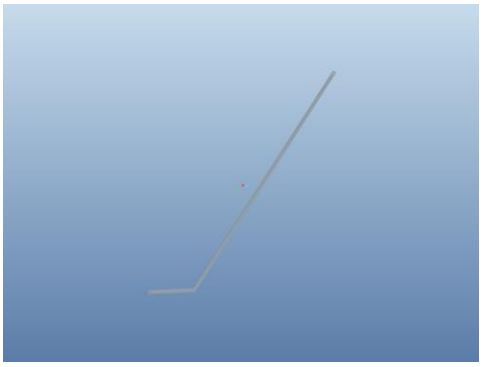

**Fig.11 Link**

***Urinal Basin***

In fig.12 A urinal basin is mounted in the middle of the frame, connection is given by the hose for flushing the urine in the basin.

**Fig.12 Urinal Basin (wall hung urinal-U-1300)**

***Platform***

A Platform is mounted on the frame in the bottom, this is the provision to stand and make use of it. In fig.13 Due to its gravitational weight the platform moves down by compressing the spring, when a person stands out from the platform the platforms automatically moves up due to the retraction of spring.

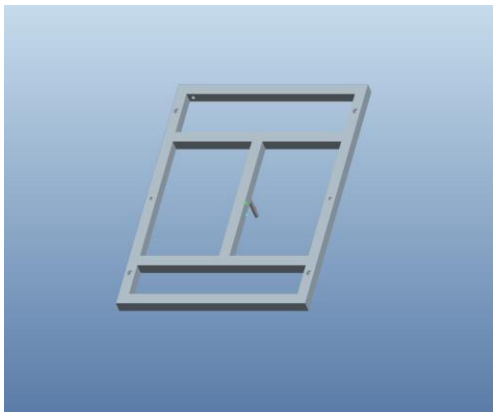

**Fig.13 Plat form**

***Bush***

In fig.14 A bush made of mild steel which is guide the platform for effective suspension MS bush is used.

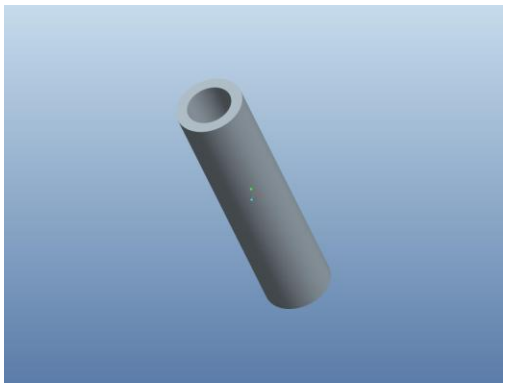

**Fig.14 Bush**

***Spring***

A compression spring made steel having 15 turns the spring and bush is separated by 3 mm washer.

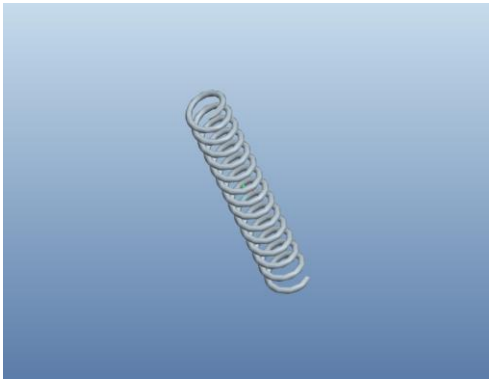

**Fig.15 Spring**

***B. Design Calculation for Spring***

$$\text{Deflection, } \delta = \frac{64WR^3n}{Gd^4} \text{ ----------(1)}$$

Where load, W = 50 Kg
R = 6 mm
N = 12
G = 80000 N/mm$^2$
d = 2 mm
By substituting the above values in equation (1), we get

$$\delta = \frac{64\times490.5\times6^3\times12}{80000\times2^4}$$

$\delta$ = 63.56 mm
Deflection per spring ($\delta$) = 15.89 mm
Springs are in parallel,
So, $K = K_1+K_2+K_3+K_4$

$$\text{Stiffness (K)} = \frac{\text{Load}}{\text{Deflection}}$$

$$K = \frac{490.5}{63.56} = 7.717 \text{ N/mm}$$

$$K = \frac{7.717}{4} = 1.929 \text{ N/mm}$$

$$\text{Spring Index (C)} = \frac{D}{d}$$

$$C = \frac{12}{2} = 6 \text{ mm}$$

For Spring index, C = 6, the Wahl stress factor($K_s$) is 1.25 from graph (Refer PSG Data Book)

$$\text{Wahl stress factor } (K_s) = \frac{4C-1}{4C-4} + \frac{0.615}{C}$$

$K_s$ = 1.2525
Spring end condition is squared and ground,
Total coils ($N_t$) = n+2 = 12+2 = 14 mm
Solid length = $N_t \times d = 14 \times 2$ = 28 mm


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Compressed length (Total axial gap) = $(N_t - 1)$ × gap between the adjacent coils

= (14-1) × 2.5 = 32.5 mm

Free length = Soild length + total axial gap + δ

= 28 + 32.5 + 15.89 = 76.39 mm.

$$\text{Pitch} = \frac{\text{free length}}{N_t - 1}$$

$$= \frac{76.39}{(14-1)} = 5.876 \text{ mm}$$

$$\text{Rate of spring (K)} = \frac{Gd^4}{8D^3 N}$$

$$= \frac{80000 \times 2^4}{8 \times 12^3 \times 12} = 7.71 \text{ N/mm}$$

For Squared and ground ends,

no of active turns (N) = $N_t - 2$

N= 14-2=12

Based on the above observation, both the theoretical and graphical values of $K_s$ are same.

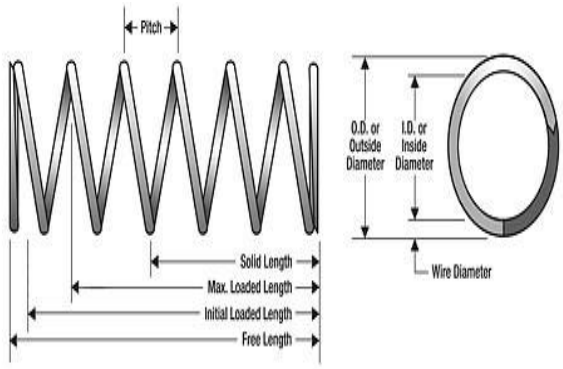


**Fig.16 Compression spring**

***Frame Design***

In fig.17 Frame designing is done by the following procedure

1. Mark as per the dimension of square tube
2. Cut the square tube for the required dimension
3. By using arc welding make taka (temporary) joint
4. After checking by using try square we do welding (permanent) joint.

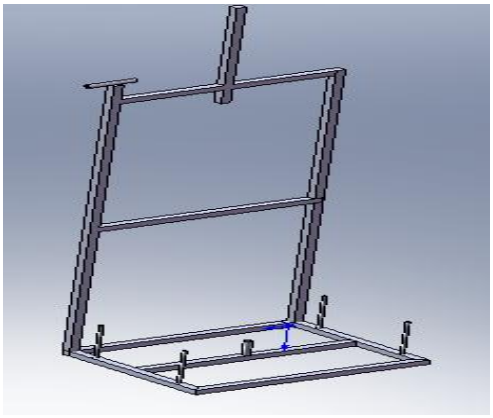

**Fig.17 Frame design**

***Rocker Disc***

Rocker disc is made of MS plate having of thickness is low 3 mm and the diameter about 140 mm. in fig.18 the arrangement is attached in the frame and the disc is freely rotated. This is very important part because when we apply load this only suddenly actuate and pull down the small link and push up the link in order to open the ball valve.

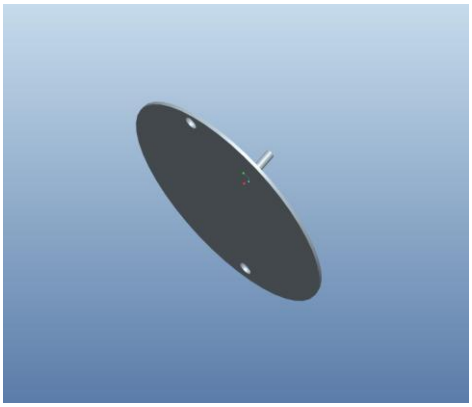

**Fig.18 Rocker disc**

***Links***

In fig.19 and is taken from Design of Machine Elements Link is made of MS plate having 3mm thickness and welded with certain degree of angle for effective action of opening the ball valve the joints is bolt & nut so it is freely transmit the motion

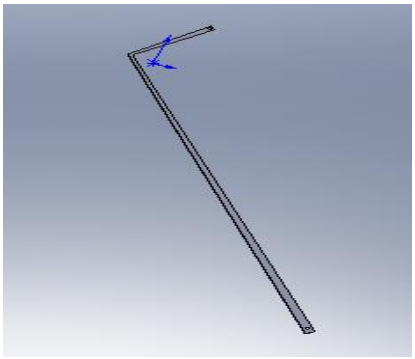

**Fig.19 Link**

***C. Ratchet & Pawl Mechanism***

***Ratchet***

Ratchet is a disc which rotates freely when the link pull due to the platform down it will start to rotate.

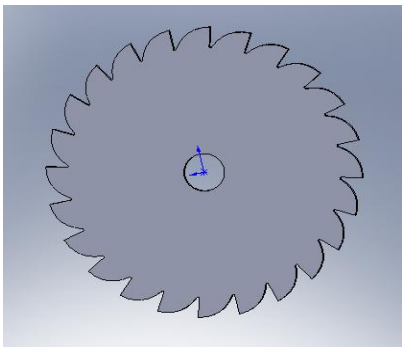

**Fig.20 Ratchet**

***Pawl***

Pawl is a device which lock for every certain degree of rotation.

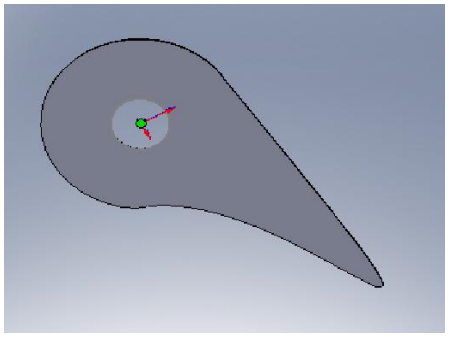

**Fig.21 Pawl engage with ratchet**

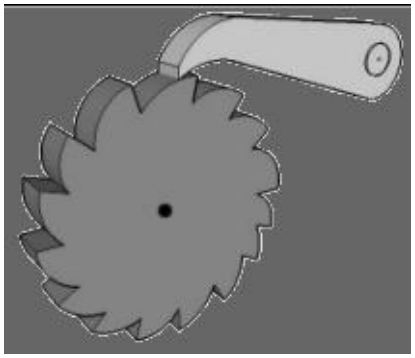

**Fig.22 Ratchet & Pawl**

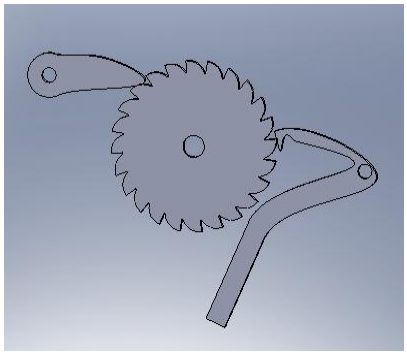

**Fig.23 Ratchet and Pawl Mechanism**

***Linkages with Ratchet & Pawl***

The linkages which pull down due to platform arrangement the ratchet gets start to rotate after one tooth the pawl will lock the ratchet movement.

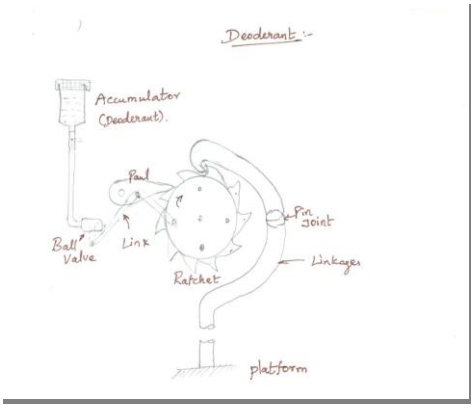


**Fig.24 Linkages with ratchet & pawl**

With this arrangement accumulator (deodorant) is connected. When ratchet & pawl rotates in full revolution ¼th position the ball valve is open due to link is connected with this deodorant is flowed to the urinal basin.

***Design Calculation***

The following parameters are to be considered in designing of ratchet pawl mechanism

Module (m) = 5mm

Width of ratchet (b) = 12.5 mm

Diameter of pawl ($D_P$) = 14.47mm

Length of pawl (L) = 31.4mm

By using the above dimensions we made the ratchet and pawl.

***D. Assembling Procedure***

Assembly step 1 (Fig.25): In this platform is mounted on the frame by the spring, washer and bush. The platform which is movable, up and down.

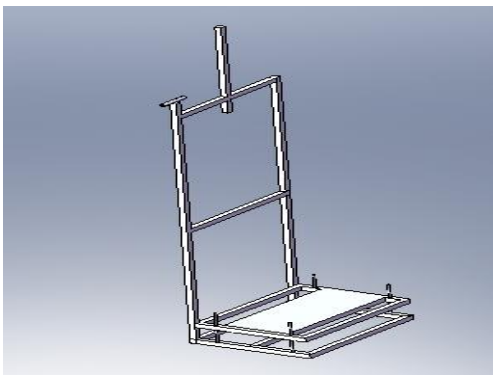

**Fig.25 Assembly step 1**

Assembly step 2 (Fig.26): In this the urinal basin is mounted on center of the frame using Bolts & nuts.

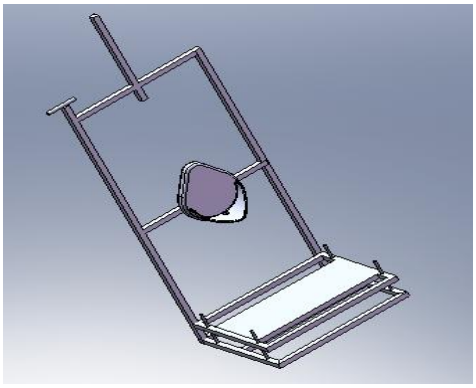

**Fig.26 assembly step 2**

Assembly step 3 (Fig.27): In this the reservoir is mounted on the top of the frame which is having of 2 litre capacity.

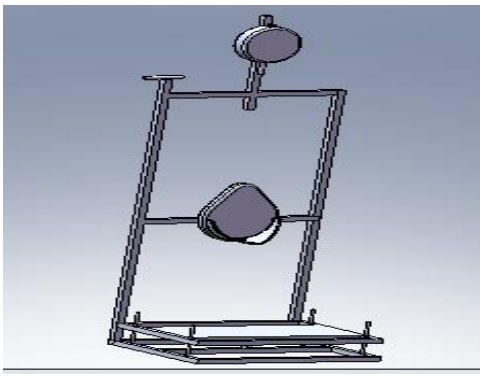

**Fig.27 Assembly step 3**

Assembly step 4 (Fig.28): In this all the parts are mounted and the valves are fitted and hose pipe is fixed to the valves. This is final assembly of automated urinal flushing system using mechanical elements solid work model.

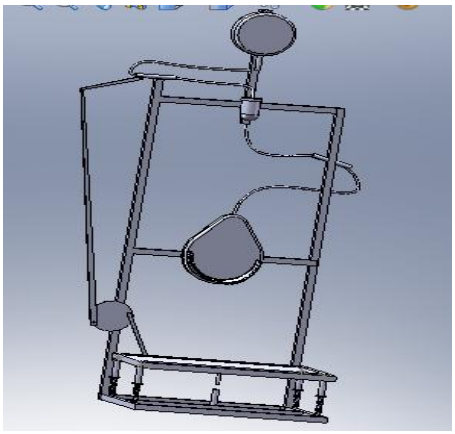

**Fig.28 Assembly step 4**

Assembly step 5 (Fig.29): In this the accumulator containing disinfectant is mounted in the setup as shown in the below figure so that the flushing of water with deodorant would happen at the same time.

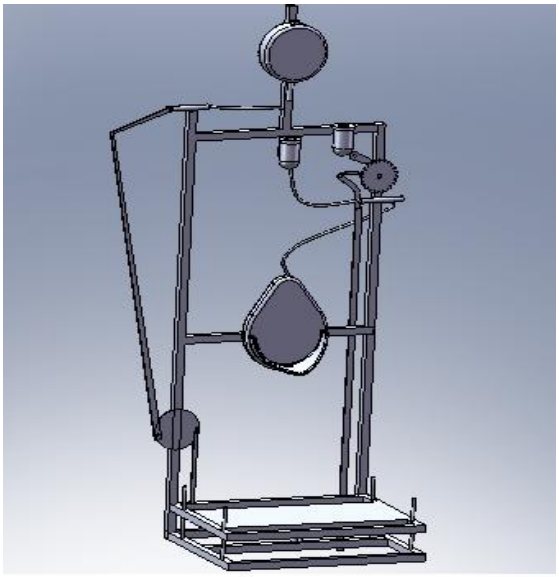

**Fig.29 Assembly step 5 final (Soild works model with disinfectant)**

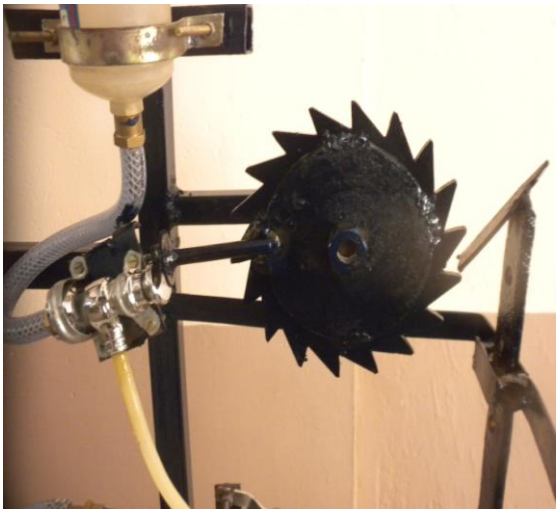

**Fig.30 Automated Flushing with disinfectant**

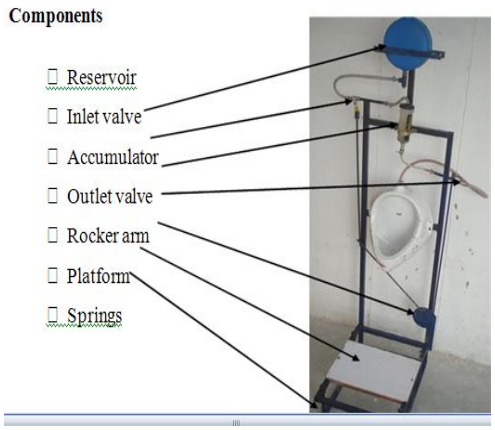


**Fig.31 Components of Automatic flush system**

The fabricated urinal flushing system is shown in the below figure:

**Fig.32 Fabricated model of Automatic Urinal Flushing System**

***E. Working Procedure***

**Fig.33 Clock wise rotation of Rocker arm, Opens the inlet valve**

**Fig.34 Anti clock wise rotation of rocker arm -opens the outlet valve**

1. When a person stands on the platform provided, the springs get compressed the rocker disc & the link get operated. Now the inlet valve, connected to the accumulator opens and the outlet valve, which connects the accumulator and the urinal basin closes. Both the valve actions take place simultaneously.

2. The inlet ball valve opens due to the clockwise rotation of the rocker arm. The water from the overhead tank gets accumulated in the accumulator of 350 ml of capacity.

3. When the user steps down, the inlet valve closes and the rocker arm moves in anti-clockwise direction opening the outlet valve thereby flushing the urinal.

4. Conventionally, automatic flushing system uses sensors which get damaged easily. But this proposal requires no sensors and is economical too. It uses simple mechanism and hence the cost of development and installation will be less.

5. 100% efficiency in cleaning the urinal can be achieved using this proposal.

6. No expense related to installation and maintenance of electrical appliances is required.

7. This is placed where ever if we wants for example gardens, parks, hospitals, exhibition, hotels, etc.,

## III. CONCLUSION

This project is developed for the satisfaction of societal needs as well as save the water. This type of Urinal flush system can be placed in the Public places to provide a clean, hygienic and flexibility use of toilets, in addition to save the water with huge amount. It is fabricated with a help of mechanical elements and no electrical and electronic components can be used. The main advantages of flushing system are cost reduction, less usage of water and clean environment.

## REFERENCES


1. Smith, William F.; Hashemi, Javad (2006). Foundations of Materials Science and Engineering (4th Ed.). McGraw-Hill. ISBN 0-07-295358-6
2. Bhandari, V B (2007), Design of Machine Elements, Tata McGraw-Hill for studying various machine elements
3. Ashby, Michael F. (2005). Materials Selection in Mechanical Design (3rd Ed.). Elsevier. ISBN 0-7506-6168-2 for studying various machine elements
4. RS Khurmi and JK Gupta, Theory of Machines; S.Chand and Company Ltd., New Delhi. For studying linkages.
5. http://patft.uspto.gov/netacgi/nph-Parser?Sect2=PTO1&Sect2=HITOFF&p=1&u=/netahtml/PTO/searchbool.html&r=1&f=G&l=50&d=PALL&RefSrch=yes&Query=PN/6478314.
6. http://www.ridoutplastics.com/physpropofac.html is verified for accumulator.
7. www.museumstuff.com/learn/topics/Klann_Linkage is verified for links.
8. [8] W.H.O Report - Rapid needs assessments – water sanitation and hygiene to study for Literature Survey


## AUTHORS PROFILE

**Dinesh Kumar Suppan** is currently working as an Assistant Professor in the Department of Mechanical Engineering. His area of research includes Design and Analysis, Machining of materials, Optimization techniques, Welding, Metallurgy. He has published papers in reputed journals.

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