ROBOTICS: KINEMATIC ANALYSIS OF GENEVA MECHANISM

M.A.A. JORDAN
PHYSICAL SCIENCE
REGION 4A, CAVITE CITY
ma.abigailjordan@ymail.com

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ABSTRACT

This study generally aims to determine the kinematics of Geneva Mechanism; to device a arbitrarily model of Geneva Mechanism; to analyze the angular velocity of Geneva Mechanism. The study does not cover the whole control system but rather confine on how the Geneva Mechanism activates as accounting machines. This study arbitrarily selected the 4 slot driven disk Geneva mechanism to understand the kinematics of this contraption. This study was analyze using purely vectorial measured with respect to the driven disk. The slotted disk moves a quarter turn displacement for every rotation of the driven disk. So, the driver disk rotates continuously while the slotted disk became idle, ¾ rotation of the driver disk. It shows that in a certain angle, there is a time that the driven (Disk S) is faster than the driver (Disk D). Disk D have to turn 4 times to make Disk S turn one time. And that makes it a good application of controls and as a counting device which means it is sequentially rotating

INTRODUCTION

Little were known to the laymen about the Geneva Mechanisms. People knowledgeable of these contraptions were the makers of clock works of Switzerland. Later were utilized in control escapements in which found way to the hands of hobbyist building radio controlled model planes, in the nineteen sixties. In the industry we find these mechanisms in packaging machines in the drug and medicine manufacturing, soft drinks and bottled beverages vending machines as the counting activators. Lately in the flight control of high altitude unmanned power gliders or drones in probing the ozone layer as well as military use. The study of Geneva Mechanism is objectively to define its application in robotics.

This study generally aims to determine the kinematics of Geneva Mechanism. Specifically, this study aims to device an arbitrary model of Geneva Mechanism and to analyze the angular velocity of Geneva Mechanism through the use of the model.

METHODOLOGY

In creating the improvised model of Geneva mechanism the ff. materials were used 3pcs. Of 2x1 card boards, one (1) piece of 4x6scrap moods and ply woods, 1 bottle of glue, a set of carpenter tools and calculator for computation purpose.

The geometric configuration or analyses of the Geneva Mechanism were made following the trigonometric relationship. Upon determining the radii of the respective disk and their centre distance, vector analysis of velocities of the two rotating bodies were made. Intermittentness of the oration of the driven slotted disk where noted together with its varying velocity.

The results were graphically presented to show the motion of the driven disk with respect to the driver disk. Construction of the model was made following the geometric configuration results. Mechanism with different number of slots was also geometrically configured.

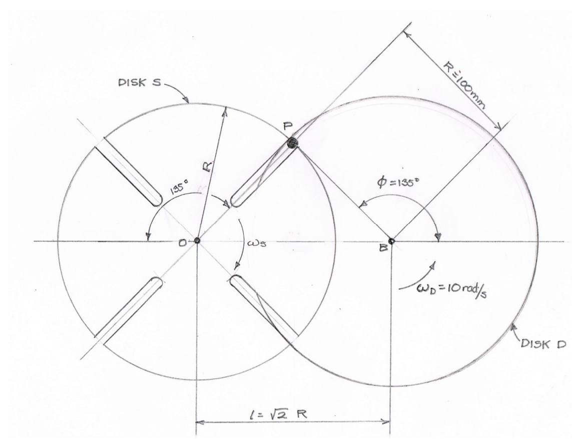

Figure 1. Arbitrary model of Geneva Mechanism.

RESULTS AND DISCUSSION

To visualize the results obtained, a model was constructed as shown in Figure 2 and the fast swinging of disk S relative to disk D was very impressible.

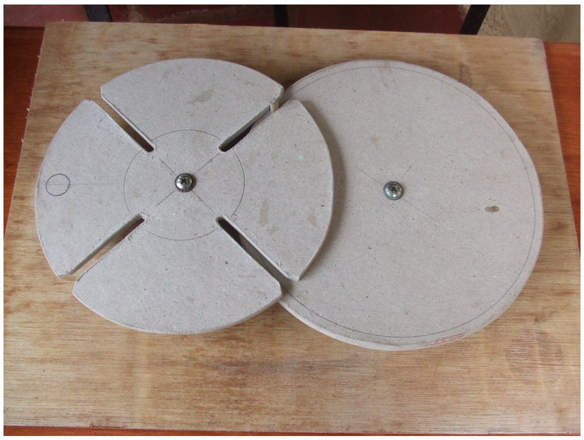

Figure 2. Model of Geneva Mechanism constructed

The results in Tables 1 and 2 provide a principle that as the pin P enters the slot of the disk S, the radius of the disk S becomes smaller and smaller as the angle of disk D becomes larger and as the pin P enters the slot. Computational analysis were made only from Φ angle 135° to 180° as from positon Φ 180° to 225° the results were noted to be symmetrical in the receding order.

Table 1. Measured and calculated values from the Geneva Mechanism model.

Angle of disk d (°)	R Radius of disk d (mm)	R Radius of disk s (mm)	β Angle of disk s (°)	γ (°)	Vp (mm/s)	Vp' (mm/s)
135	100	100	45	0	1000	0
140	100	91.29	44.76	5.24	1000	91.328
150	100	74.2	42.36	17.46	1000	303.03
160	100	58.5	35.78	34.22	1000	162.33
170	100	46.32	22.02	57.8	1000	847.86
180	100	41.42	0	0	0	0

Table 2. Measured and calculated values from the Geneva Mechanism model continuation.

ω_D Angular velocity of disk D (rad/s)	A_D acceleration of disk D (mm/s^2)	ω_S Angular velocity of disk S (rad/s)	A_p acceleration of disk S(mm/s^2)
10	10000	0	0
10	10000	1.0	91.29
10	10000	4.08	1235.16
10	10000	9.612	5404.85
10	10000	18.3	15512.10
10	10000	24.14	24137.07

The slotted disk moves a quarter turn displacement for every rotation of the driven disk. So, the driver disk rotates continuously while the slotted disk became idle, ¾ rotation of the driver disk. It shows that in a certain angle, there is a time that the driven (Disk S) is faster than the driver (Disk D). Disk D have to turn 4 times to make Disk S turn one time. The relative velocities and displacements in the arbitrary designated set-up of Geneva Mechanism are shown in Figure 3.

Applications of the Principles

Robotics

Engineers can modify the ratio of dwell time to motion time by staggering the driver pins or combining the Geneva mechanism with chain drives or gear trains. Every slots of the driven can have a corresponding action for the robot or machines to move.

Airplanes

On the present day NASA developed unmanned power glider or drones for the research of the ozone layer. As part of the flight controlling mechanism the Geneva mechanism was also utilized. The slots and velocity is the principle behind that makes the unmanned airplanes move to a direction.

Nuclear Bomb

Geneva Mechanism is used in nuclear bombs. It needs timing and controls to let the two isotopes explode. The angular velocity and timing is the principle use in it.

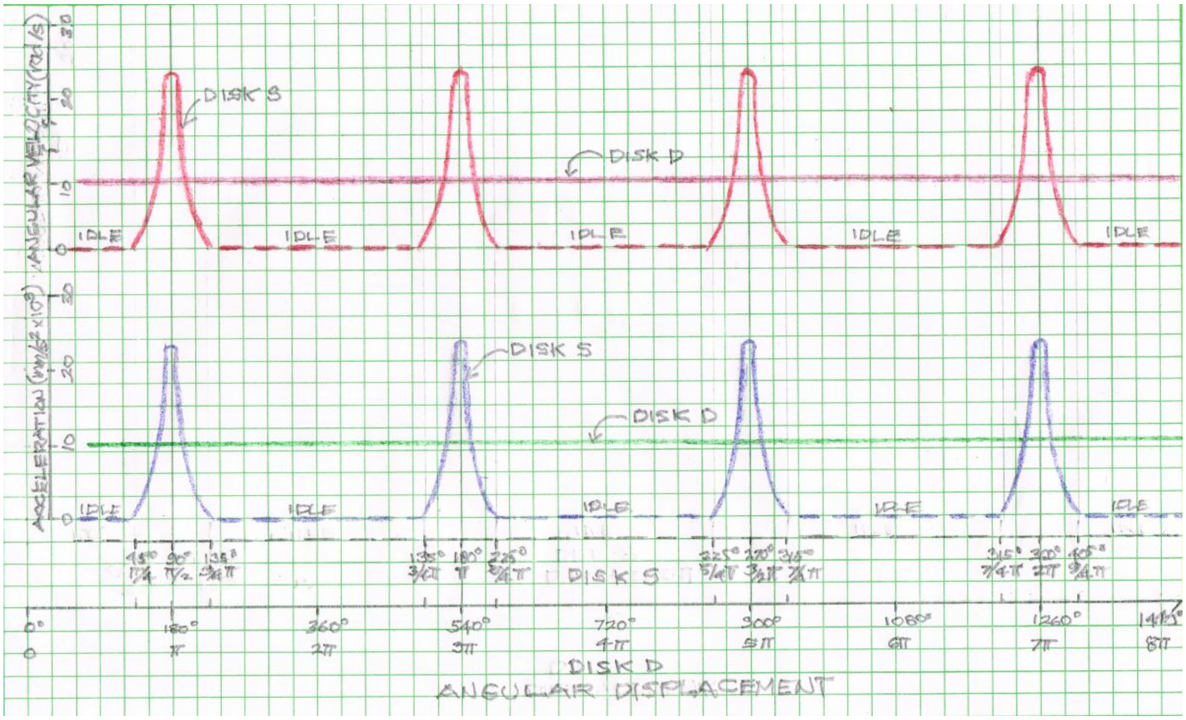

Figure 3. Relative motion of Disk D and Disk S in Geneva Mechanism.

CONCLUSION

Many combinations can be devised on the Geneva Mechanism by decreasing or increasing the number of slots in disk S but spacing showed be synthesized.

The graph in appendix 2 of the motion of disk S relative to disk D find there very applicable as a counting mechanism or for control escapements. Each slot serves as one control position to activate a control switch on otherwise. The number of slots shall be the total number of control sequences.

Innovation applications of Geneva Mechanisms are in:

Every slots of the driven disk can have a corresponding control on action for the robot or machines to move (Craig, 1989). Such robotic are the automatic vendo machines, medicine packaging machines, robotic manipulator, etc.

It started in the military in the 1950's, teenager whose hobby was building model planes. The Geneva Mechanism was part of escapement for the flight control at the present NASA developed and is still developing unmanned power glider or drones for the research of the ozone layer (Alonso and Finn, 1992). As part of the flight controlling mechanism the Geneva mechanism was also utilized. The U.S. Ordinance makes use of such unmanned drones in delivering way heads to precise target.

Geneva mechanism can be constructed to different sizes too as they were first used in clock mechanism.

RECOMMENDATION

It is recommended to make proto types of miniature models of different Geneva Mechanism unit having different number of slots and driven by miniature DC electric motors to prove its versatile and innovative uses.

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