STUDY OF MECHANISM USED FOR AUTOMATING THE MECHANICAL SYSTEM

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Abstract

Automation will no longer be seen only as automatic production, but as a complex of technologies that guarantee reliability, flexibility, safety, for humans as well as for the environment. In a world of limited resources, automation can provide the answer to the challenges of a sustainable development. The automation has the opportunity of making a greater and even more significant impact on society.In the study of project we have discussed about the various mechanisms used for automating the mechanical system. In today's competitive world improvement in productivity has become the need of an hour. Automation is one of the basic tool for improving the productivity. The same that is the necessity of automation and the various mechanisms used for automating the mechanical systems have been discussed. In all 60 mechanisms were studied which can be used for automating the mechanical system. These mechanisms categorized as per the conversion of type of motion into another. This categorization of all above mechanism has been compiled in the form of data base which will help the user for easy access of mechanisms according to their requirements. For this purpose, we make the arrangement by using software in which the users have to put his requirement. These requirements must be in the form of conversion of motion from one form to another; so that the user will get the output in less time and without much effort. Software has been developed in which the user can retrieve the mechanism as per the requirement and the conversion of motion from one form to another.

Key words- automation, mechanization,productivity.

Introduction:-

"Automation is defined as a technology concerns with the application of mechanical, electronics and computer-based system to operate and control the production"(1).For automating the mechanical system, the study of mechanisms is necessary. So, the project revals the various mechanisms used for automating mechanical systems. The automation in mechanical systems leads to increase in productivity. During study, 60 mechanisms were collected and studied which can be used for automating mechanical systems and categorized on the basis of conversion of motion from one form to another. This categorization of all mechanisms has been complied in the form of database which is nothing but a software, which will help for easy access mechanism according to user requirement for designing the automated mechanical system using combination of mechanism.In the industries, automation of the manufacturing operations holds the promise of increasing productivity of the labors. This means greater output per hour of labor input. Higher production rates are achieved with automation than with corresponding manual operations. Automated operations not only produce the part at faster rate than to their manual counterparts, but they produce parts with greater consistency and conformity to quality specifications.

1.1 Problems identified:-

In most of industries, it has been seen that the feeding of raw material is done manually. Now-a–days some industries also use automation in feeding; still it has limitation that they are not fully automated. Some worker participation is always required. Because of this 'degree of mechanization' is not maintained. The technology of 'degree of mechanization' is decided upon the principles of minimization of cost , improved productivity ,both qualitative and quantitative, improved accuracy, better safety, etc. which again is paused with higher initial investments, higher maintenance costs etc.

Following problems have been identified in manual operations:

1. Maximum time taken for component handling (loading and unloading) at workstations.
2. Feeding the job at workstation is of monotonous nature which does require any skill and causes fatigue to the worker
3. Decrease in productivity (quantitative and qualitative wise).
4. Some time the working conditions near the workstation are not favorable.
5. Decrease in repeatability and accuracy.
6. Higher rejection of products.
7. Maximization of production cost.

At the same time it is difficult and strenuous for an operator to work with a machine that has a natural set of directions of operation, to work on a project that has a set of natural movements that are misaligned with the operator's machine. Such work requires a continuous adjustment of several controls at the same time and is both tiring and confusing.

Automation is one of the vital tool for the above problems. It also helps to meet following requirements.

1. To increase labor productivity:-
2. To reduce the labor cost
3. To mitigate the effort of labor shortages
4. To reduce or eliminate routine manual and clerical task
5. To improve the workers safety
6 To accomplish process that cannot be done manually

1.2 Objectives:-

The objective is to study the various mechanisms used for automating the mechanical system by categorizing it as per the conversion of motions from one form to other and to compile them in the form of database; which will help the user for easy access of mechanisms according to their requirements for designing the automated mechanical system using combination of mechanisms.

1.3 Methodology:-

Basic idea begins with searching the various papers presented by different authors on automation which informs about the need of automation and also suggest various measures to be undertaken to increase productivity and also automation techniques.

1. To collect and study various research paper that emphasizes on the need of mechanisms for different automation techniques.
2. To study different types of mechanisms and to understand its application and utility for automating the mechanical system.
3. To categorize the studied mechanisms as per the type of motion from one form to another for easy access of the user.
4. Compilation of mechanisms in the form of database has been which is nothing but the software which will help the user to get the required mechanism in less time and without much effort.

LIRATURE REVIEW

It includes different papers on automation by different authors which put their views regarding the automation and mechanisms which will help to increase productivity of an industry. It also include a particular automatic system design for special purpose within an industry. At the same time study of various mechanisms from different books included which are related with automation with their application.

1Paper on "A Pivoting Gripper for Feeding Industrial Parts" by Brian Carlisle, Ken Goldberg, Anil Rao, Jeff Wiegley - In this paper describe a way to orient parts about an arbitrary axis by introducing a rotating bearing between the jaws of a simple gripper. Based on this mechanism, developing a rapidly configurable vision-based system for feeding parts. In this system, a camera determines initial part pose; the robot then reorients the part to achieve a desired final pose.

To automate the assembly of mechanical components, parts must precisely orient prior to packing or insertion. A parts feeder is a machine that orients parts. Currently, the design of parts feeders is a black art that is responsible for up to 30% of the cost and 50% of work cell failures *"The real problem is not part transfer but part orientation"*. Thus there is a demand for a parts feeder that can be reprogrammed rather than physically modified when geometry changes part.

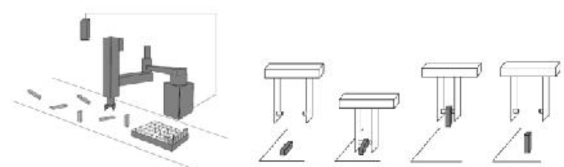

Figure : The figure shows 4 snapshots progressing from left to right. The gripper grasps the rectangular part along an axis offset from its center of mass, lifts it off the table, and uses the force ofgravity to rotate the part into a standing orientation.

This feeder design combines machine vision with a high speed robot arm. The system is programmed based on the type of part to be fed. During operation, a collection of like parts are randomly scattered on a flat worktable where they are subject to the force of gravity. An overhead vision system determines the pose (position and orientation) of each part. The robot arm then picks up each part and moves it into a desired final pose. To be cost effective, fast, and highly precise, commercial assembly robots usually have only four degrees of freedom (4D.O.F.). However parts must be reoriented and repositioned through six degrees of freedom (6D.O.F.). To close this gap, they designed a gripper with a rotational pivot between its jaws to provide an extra degree of freedom. Since cost and weight are critical, the pivoting axis need not be actuated: it is possible to pick up each part along an axis offset from its center of mass and use on the force of gravity to rotate the part.This paper describes related work on parts feeders and robot gripper mechanisms. It further describes the pivoting mechanism in detail and experiments with a vision-based parts feeding system. Last, it discuss the advantages and disadvantages of the proposed system and describes avenues for future research [4].

1. Paper on "Low cost automation using electro pneumatic system an online case study in multistation part transfer drilling and tapping machine". Submitted at "24th International Symposium on Automation & Robotics in Construction (ISARC 2007) Construction Automation Group, I.I.T Madras" by M. Muthukkaruppan and K. Manoj.

Fig. Experimental setup of low cost automation

This paper discuss the case study and, comparison of productivity of a component using a real time multi stationed Automation Rotary Transfer Line used for Drilling, tapping and inspecting a standard block of size 50*50*75 mm with drill size diameter 5*20 mm long and tapping the drill by M6 machine tap. The clamping of the component, part transfer and feed of the drilling machine spindle is done using electro-pneumatics. The total logic of the system is based on low cost automation with the microcontrollers.[5]

CHAPTER - III

BASIC MECHANISM:-

Definition:-

The arrangement or relation of the parts of anything as adapted to produce an effect is called mechanism**.**

Introduction:-

This gives the information about basic mechanism used for actual development of any automatic mechanical system. It includes vary basic but important mechanism; with help of this many different mechanisms can be created. It also explains how this mechanism can work. The various basic mechanisms are as follows:

Kinematic chain [2]:-

- **Definition:-**

When the kinematic pairs are coupled in such a way that the last link is joint to the first link to transmit definite motion then it is called kinematic chain. For example, the crankshaft of an engine forms a kinematics pair with the bearings which are fixed in the pair, the connecting rod with the crank forms a second kinematic pair, the piston with the connecting rod forms a third pair and piston with the cylinder forms a fourth pair. The total combination of these links is a kinematic chain.If each link assumed to form two pairs with two adjacent links, then the relation between the number of pairs(p) forming a kinematic chain and the number of links (l)may be expressed in the form of an equation:

$$L = 2p - 4$$

Since in a kinematic chain each link forms a part of two pairs, therefore there will be as many links as the number of pairs.

Another relation between the number of links (l) and the number of joints (j) which constitute a kinematic chain is given by the expression:

$$J = 3/2\, l - 2$$

Inversions of mechanism:-

When one of the links is fixed in the kinematic chain it is called a mechanisms we can obtained as many mechanisms as the number of links in a kinematic chain it is called the mechanism. So we can obtain as many mechanisms as the number of links in a kinematic chain by fixing, in turn, different links in a kinematic chain. This method of obtaining different mechanism by fixing different links in a kinematic chain is known inversion of mechanism.

Following are the basic mechanisms [2]:-

1. **Single slider crank mechanism:-**

The single slider crank chain is the modification of basic four bar chain. It consists of one sliding pair and three turning pair. It is, usually, found in reciprocating steam engine mechanism. This type of mechanism converts rotary motion into reciprocating motion and vice versa. In a single slider crank chain as shown in the fig. the links 1 and 2, links 2and 3 and links 3and 4 form three turning pairs while the links 4 and 1 form a sliding pair.

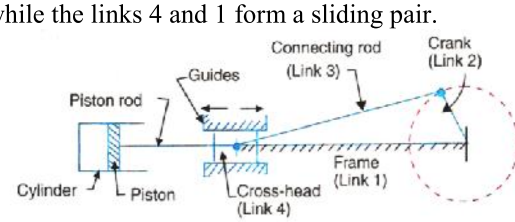

Fig. Single slider crank chain

The link 1 corresponds to the frame of the engine, which is fixed. The link 2 corresponds to the crank;

link 3 corresponds to connecting rod and link 4 corresponds cross head. As the crank rotates, the cross head reciprocates in the guides and thus the piston reciprocates in the cylinder.

2. Crank slider mechanism:-

Common to most reciprocating engines is a linkage known as a crank-slider mechanism. Diagramed in Figure 1, this mechanism is one of several capable of producing the straight-line, backward-and-forward motion known as reciprocating. Fundamentally, the crank-slider converts rotational motion into linear motion, or vice-versa. With a piston as the slider moving inside a fixed cylinder, the mechanism provides the vital capability of a gas engine: the ability to compress and expand a gas. Before delving into this aspect of the engine, however, let us examine the crank-slider mechanism more closely.

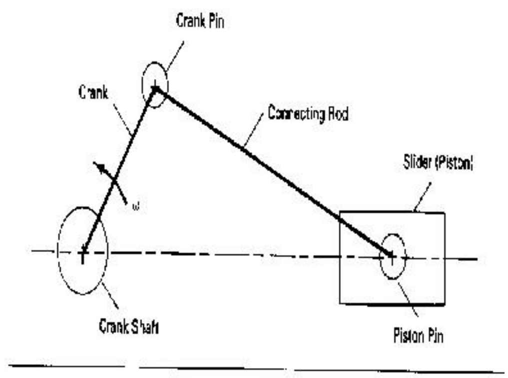

Fig1. Crank Slider Mechanism

It is evident from Figure 2 that, while the crank arm rotates through 180°, the piston moves from the position known as *top-center* (TC) to the other extreme, called bottom-center (BC). During this period the piston travels a distance, *S*, called the *stroke,* which is twice the length of the crank.For an angular velocity of the crank (ω) the crank pin A has a tangential velocity component ω *S*/2. It is evident that, at TC and at BC, the crank pin velocity component in the piston direction, and hence the piston velocity, is zero. At these points, corresponding to crank angle $\theta = 0°$ and 180°, the piston reverses direction. Thus as θ varies from 0° to 180°, the piston velocity accelerates from 0 to a maximum and then returns to 0. A similar behavior exists between 180° and 360°.The connecting rod is a two-force member; hence it is evident that there are both axial and lateral forces on the piston at crank angles other than 0° and 180°. These lateral forces are, of course, opposed by the cylinder walls. The resulting lateral force component normal to the cylinder wall gives rise to frictional forces between the pistons rings and cylinder. It is evident that the normal force, and thus the frictional force, alternates from one side of the piston to the other during each cycle. Thus the piston motion presents a challenging lubrication problem for the control and reduction of both wear and energy loss.

The position of the piston with respect to the crank centerline is given by

$$x = (S/2)\cos\theta + L\cos Ø \quad [ft \mid m] \quad \ldots\ldots (1)$$

where, $yA = (S/2)\sin\theta = L \sin Ø$ can be used to eliminate Ø to obtain

$$X/L = (S/2L)\cos\theta + [1-(S/2L)^2 \sin^2\theta]^{½}$$

Thus, while the axial component of the motion of the crank pin is simple harmonic,

$XA = (S/2)\cos\theta$,

the motion of the piston and piston pin is more complex.

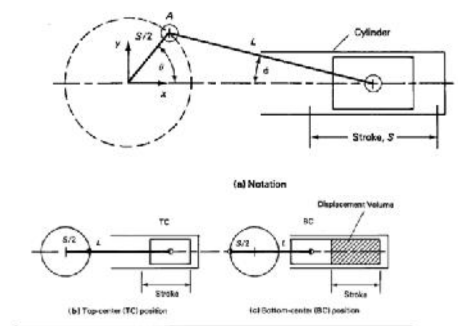

Fig.2 Geometry and notation for the crank slider.

It may be seen from Equation (2), however, that as *S/L* becomes small, the piston motion approaches simple harmonic. This becomes physically evident when it is recognized that, in this limit, the connecting rod angle 'Ø' approaches 0 and the piston motion approaches the axial motion of the crank pin. Equations (1) and (2) may be used to predict component velocities, accelerations, and forces in the engine. The volume swept by the piston as it passes from TC to BC is called the piston displacement, disp. Engine displacement, DISP*,* is then the product of the piston displacement and the number of cylinders, DISP = (*n*)(dips). The piston displacement is the product of the piston cross-sectional area and the stroke. The cylinder inside diameter (and, approximately, also the piston diameter) is called its *bore*. Cylinder bore, stroke, and number of cylinders are usually quoted in engine specifications along with or instead of engine displacement. It will be seen later that the power output of a reciprocating engine is proportional to its displacement. An engine of historical interest that also used the crank-slider mechanism is discussed in the next section.

3. Crank and lever mechanism:-

A part of mechanism of a beam engine which consists of four links, as shown in figure. In this mechanism, when the crank rotates about the fixed center A, the liver oscillates about a fixed center D. The end E of liver CDE is connected to piston rod which reciprocates due to the rotation of cranks. In other words, the purpose of these mechanisms is to convert rotary motion into reciprocating motion.

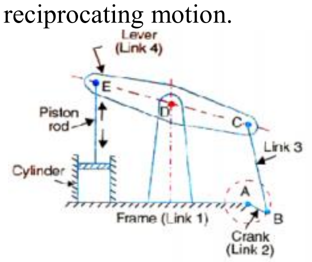

Fig. Beam engine

4. Double crank mechanism:-

The mechanism of coupling rod of a locomotive which consist of four links as shown in figure. In this mechanism, the links AD and DC (having equal lengths) act as cranks and are connected to the respective wheel. The links CD acts as a coupling rod and the link AB is fixed in order to maintain a constant center to center distance between them. This mechanism is meant for transmitting rotary motion from one wheel to other wheel.

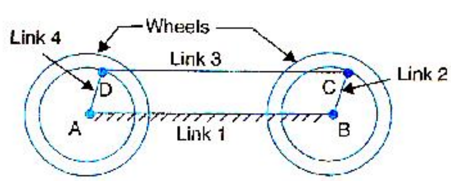

Fig. Coupling rod of a locomotive

Classification of Mechanisms (according to motion)[3] :-

Introduction:-

The various mechanisms have been classified and categorized on the basis of conversion of motion one form to another.

4.1 CONVERSION OF ROTARY MOTION INTO OSCILLATING MO1TION:-

4.2 CONVERSION OF ROTARY MOTION INTO ROTARY MOTION:-

4.4 CONVERSION OF OSCILLATING MOTION INTO REVERSING MOTION:-

4.5 CONVERSION OF ROTARY MOTION INTO RECIPROCATING MOTION:-

4.6 CONVERSION OF RECIPROCATING MOTION INTO ROTARY MOTION:-

4.7 CONVERSION OF ROTARY MOTION INTO LINEAR MOTION

4.8 CONVERSION OF ROTARY MOTION INTO RECTILINEAR MOTION:-

4.9 CONVERSION OF DIFFERENT MOTIONS ACCORDING TO FEEDING

4.10 DIFFERENTIAL MOTIONS

4.11 SPECIAL MACHANISMS

DETAILS OF MECHANISM [3] :-

Introduction:-

The classified mechanism of previous chapter is to be explaining in detailed as follows:

5.1 CONVERSION OF ROTARY MOTION INTO OSCILLATING MOTION:-

5.1.1 Special cam mechanism (right hand threaded cam for converting rotary into oscillating motion):-

A simple mechanism for converting rotary into oscillating motion consist of a cylinder having a right and left hand thread and half-nut made as shown in fig. This mechanism was incorporated in a specially constructed printing press for the purpose of imparting a reciprocating motion to the rollers which assist in a distributing the ink. A similar arrangement can be used in numerous other applications, when the speed of rotation is not too high and the load is not too great.

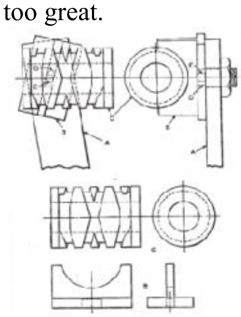

Fig. Cylinder Cam C with Right and Left- hand Threads Designed tReverse Direction of Travel of Half-nut B at Each End of Stroke, thus Imparting an Oscillating Motion to Lever A

In the application referred to, three rollers were used for distributing the ink. The two outside rollers were operated by a double rocker arm actuated by the crank arm A, which is fitted with a half-nut B. The right-hand and left-hand threaded C at one end of a rotating shaft serves to oscillates or move the end arm A forward and back. The center link distributing roller is moved by a single rocker arm driven by another threaded cylinder similar to the one shown at C. The rocker arms are pivoted and carry ball-bearing pins that work against the flanges of spools on the ink-distributing rollers. Thus, as rocker arms move back and forth, they transmit the required motions to the ink-distributing rollers.

The half-nut B is made from a T-shape, the thickness of the stem being equal to the width of the thread groove. The stem is formed to a concave shape to feed the counters of the root dia. Of the thread, while its over-all length made somewhat greater than the outside dia. of the thread. Its minimum length must be such as to more than spoon the gap made by the crossing of the right- and left- hand threads. At the center of the T- shaped bar is an elongated hole D, which slides over pin E attached to the crank- arm. Thus, pin E causes the crank to rock back and forth with the longitudinal travel of the nut. An elongated hole is necessary for pin E, since the arm swings in an ark while the nut travels in a straight line.When the half nut approaches the end of its travel in one direction, its axis is on an angle with the center line of the shaft. This angle is equal to the pitch angle of the screw. In order to reverse the travel, the axis of the half-nut must pivot about pin E until it is in the proper angular position for the reverse traverse motion imparted by the thread of the opposite hand lead.The last thread on the cylinder C is cut back a sufficient distance to allow the half- nut to pivot, and the "following" edge where thread ;runs out at the end is filed back sufficiently to allow the nut to clear this surface and the end flange. The nut is also beveled at the edge where it enters the thread. The threaded cylinder C and the half nut B are shown separately in the views to the left.This mechanism operates smoothly, having a short dwell at each end of the stroke while nut reverse and picks up the opposite thread. In the printing press application the two outside rollers are operated by a double rocker arm which causes them to move an equal amount in opposite directions. It is desirable to introduce as much variety as possible into the motion of the three rollers in order to smooth out the ink more effectively. For this reason, the leverage for the crank- arm of the center; roller is made somewhat different from that for the outside rollers. In this case, the length of the thread on the cam for actuating the crank-arm of the center roller is longer than that of the cam for the outside rollers. With this arrangement, the center roller continuously varies its position in relation to the outer rollers.

5.2 CONVERSION OF ROTARY MOTION INTO ROTARY MOTION:-

5.2.1 Adjustable Dial Type Of Tripping Mechanism:-

The automatic tripping mechanism shown in fig. was designed for drilling machines and may be adjusted to disengage the downward feeding motion of the drill at any depth up to 14 inches. The feeding movement is transmitted through the drill spindle from shaft A, through warm gearing, to shaft B which has a pinion engaging the rack on the spindle quill. The automatic disengagement of the feed is controlled by the engagement of pawl H with liver N. the distance that the spindle feeds downward before the feed is tripped is regulated by graduated adjustable dial I. the graduation on this dial indicate 1/32 inch of the spindle travel, and one complete revolution represents 7 inches of the spindle travel. The pawl H is so designed that it can be set to allow two revolutions of the dial before engaging liver N.The operation of the mechanism is as follows: If the feed is to be tripped automatically in 7 inches or less, pawl H is set as indicated by the dotted lines at K; if it is desired to trip the feed at a distance greater than 7 inches, pawl H is turned to the position shown by the full lines. For example, if it should be required to automatically trip the feed at a depth of 3 inches, the knurled nut L would first be loosened and the graduated dial I turned until the figure 3 on it was opposite the mark on pointer J, after which nut L would be tightened. The pawl H would then be set in the position shown by the dotted lines, with the result that , when the drill had travelled 3 inches, The surface M would come in contact with the side N of the trip arm and disengage the feed. On the other hand, if it were required to drill to a depth of 9 inches before the feed was automatically tripped, the dial I would be set with figure 2 opposite the mark on pointer J, and pawl H would be turned to the position shown by the full lines. With the pawl in this position, the contact of surface O with liver N would not throw out the feed, as the pawl, being loose on its stud, would simply turn and pass the tripping arm without moving it.

After the pawl had passed the arm, it would then be in the position shown by the dotted lines, that is, with the end in contact with a projecting sleeve, as at K, thus preventing further rotary movement, so that, when it again came around to the tripping lever, the feed would be disengaged. If the knurled nut L is loose, the feed cannot be automatically tripped at any point.

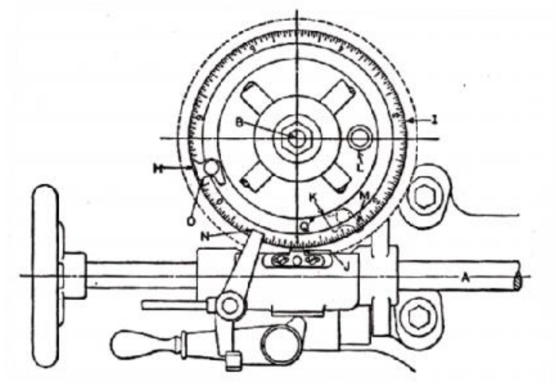

Fig. Automatic Feed-tripping Mechanism having Graduated Adjusting Dial for Controlling Times of Disengagement

5.3 CONVERSION OF RECTILINEAR MOTION INTO INTERMITTENT MOTION:-

5.3.1 Overload relief mechanism:-

A release mechanism that was relies for a feed slide subjected to the jamming but that can be also being applied to the various type movements as shown in fig. Oscillating shaft A transmit reciprocating movement to the link B connected to the feed slide through the lever C. it slip feet on the shaft, but it is prevented from turning by a locking arrangement consisting of lever D, locking bar E, locking plate F secured to a projection on a lever C, and spring G. At the outer end of lever D, which is keyed to the shaft, is pivoted to bar E. A tooth in this bar engages a notch in a plate F and is held in this spring G.

Normally, the entire mechanism is locked together and rocks back and forth with this shaft. However if link B becomes overloaded, lever C will stop oscillating and shaft A will merely turn in a hub bore of this lever. Lever D, being keyed to the shaft, will continue to oscillate and cause tooth on bar E to ride out of the notch and slide along the now stationary plate F. the tooth will continue slide back and forth along this plate and in and out of the notch until the overloads on the link B is removed. When this is done, the tooth will engage the notch and the entire mechanism will ones more function as a unit. An electric stud H is a provided so that the angular position of lever C can be adjusted to vary the position of link B at the beginning at end of its stroke.

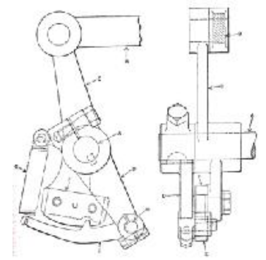

Fig. Arrangement for Automatically Disengaging a Driving Lever from
it's Shaft when the Load becomes Excessive

5.4 CONVERSION OF OSCILLATING MOTION INTO REVERSING MOTION:-

5.4.1 Reversing mechanism:-

In a special electrical switch testing machine an oscillating motion of one shaft is converted to a reversing motion in another shaft, the latter alternating at each reversal between the two speeds of 60 and 30 revolutions per minutes.The shaft X (fig.), on which the segment gear A is keyed, is the oscillating member. The shaft T, to which the irregular motion is transferred, turns in the machine bearing (not shown) and serves as a pivot for the arm B. Gears O and P, located under this arm, are keyed on the shafts U and Y and are connected by the three gears S, V and G. the concentric grooves E and D , milled in the segment gear , are joint at both ends to from one continuous groove and serves as a guide for the cam roll C in the end of arm B. dogs R and N, which engage the projection Q on the arm, are fastened securely to the segment gears. Latches J and M swing on shoulder- screws, and normally bear against pins I and K, due to the tension of the coil springs.

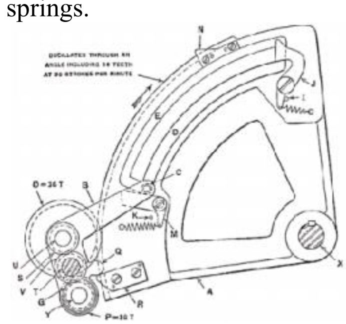

Fig. Mechanism for Converting Oscillating Motion into Reversing Motion

In the position shown in the illustration, the segment gear A is oscillating in the direction of the arrow, and the dog R, against lug Q is about to swing the arm B around shaft T. A further upward movement of dog R will throw gear O out of engagement with the segment gear. However, just before the teeth of gear O have become disengaged, a partial engagement of teeth in gear P and segment A takes place. While gears O and P are being shifted, roller C swings up to the beginning of the groove E. when the roll reaches this position, the oscillating segment A has come to the end of its upward stroke and is about to return. The latch M closes the end grooves and prevents the roll from dropping back to groove D when the segment reverses.The roll now follows groove E and serves to hold gear P in a mesh with segment A until dog N comes in a contact with lug Q. this disengages gear P, after which gear O engaged with segment A again. In the mean time, roll C has force latch J to one side and is swung down to the end of groove D, being prevented from coming out of this groove by the return of latch J. the roll, running in groove D, serves to hold O in a mesh during the return stroke of segment. This complete one cycle of movement.Because of the difference in the number of teeth between gears O and P, as noted in the illustration and the arrangement of gear train, the uniform oscillation of segment A will result in one clockwise revolution of shaft T for every up stroke of the segment, while the down stroke will result in two counter clockwise revolution of the shaft. With some slide modification in the design, shaft T may be made to revolve at varying speed other than described and in the same direction instead of reversing. This may be done by varying the number of teeth in the gears and adding idler between any two of the gears S, V or G.

5.5 CONVERSION OF ROTARY MOTION INTO RECIPROCATING MOTION:-

5.5.1 Pumping Mechanism:-

The piston of the pump shown in Fig. has, in addition to rectilinear movement, a rotary motion. This pump was designed for pumping water of other liquids containing foreign materials, such as weeds, pieces of rope, paper, etc, which might enter the pump cylinder. Instead of using suction or discharge valves which would become clogged and cause trouble, the opening and closing of the ports is controlled by the rotary movement of the piston, and any foreign materials of the kinds mentioned are sheared off by the edges of the ports. The rectilinear motion of the piston is obtained from a crank.

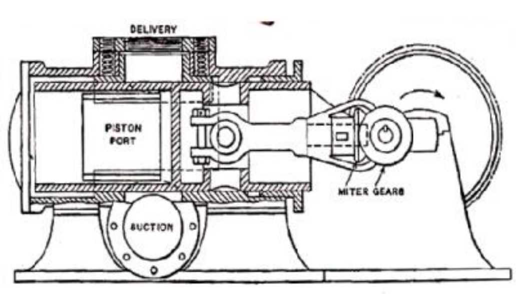

Fig. Piston Having Combined Rectilinear and Rotary Movements

A miter gear keyed to the end of the crankpin meshes with a mating gear keyed to the end of the connecting-rod, so that, as the piston is moved in and out, it is also given a rotary motion. The piston is of the trunk type with an opening at both ends and a partition in the center. The head end at the left of the partition contains a port which alternately registers with the suction and delivery ports. When the piston is in the position shown, both ports are closed, but, as soon as the pump rotates in the direction indicated by the arrow, the suction port begins to open. When the crank has moved 90 degrees, the piston port will be exactly over the suction port and, when the opposite dead center is reached, both ports will again be closed. When the crank is on the bottom quarter or at the center of the return stroke, the piston port will be opposite the delivery port.

5.6 CONVERSION OF RECIPROCATING MOTION INTO ROTARY MOTION:-

5.6.1 Feeding mechanism (by air cylinder):-

A feeding mechanism operated by an air cylinder was required to convert the constant reciprocating movement of the air piston into an intermittent movement on the outward stroke.

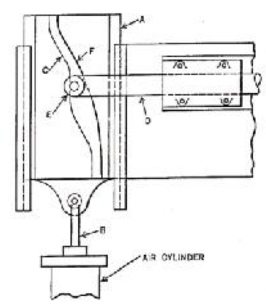

Fig. Mechanism for Converting a Constant Reciprocating Movement into an Intermittent Movement

This movement was to be at right angles to that of piston. On the return stroke, the motion was to be continues and at a constant speed. The mechanism for obtaining these movements is shown diagrammatically in fig... The reciprocating piston B is attached to the slide A. slide A has a cam groove with the side C formed with a dwell to impart the required intermittent movement to the feeding plunger D on the outward movement of the piston.

On the return movement, the side F of the cam groove returns the plunger D to the starting position without the intermittent motion required on the outward movement. There is sufficient friction in the mechanism to keep the roller E of the plunger D in a contact with side C and F on the outward and inward movements, respectively. Automatically operated air valves control the dwell at the end of each stroke. The speed of feeding and return movements of a plunger D is governed the rate at which air is admitted to the cylinder by the air valves.

5.7 CONVERSION OF ROTARY MOTION INTO LINEAR MOTION:-

5.7.1 Table Feed Mechanism (Designed to eliminate manual Re-Engagement):-

On a special grinding machine, the work – table was driven by a screw geared to the power source. At the termination of the working cycle, a

Clutch dog was disengaged to permit the operator to return the table manually by means of a hand wheel on the feed-screw. As the table movement was fairly slow, it was frequently impossible for the operator to engage the clutch immediately upon the completion of the loading cycle because the mating teeth were not in position for engagement. A period of several seconds was lost many times an hour in this way, making it advisable to change the feed mechanism to obtain an increase in production.

The design shown in Fig. provided the desired results. A drive-shaft A*,* which rotates in the direction indicated by the arrow and has a worm C mounted on it, is supported by two bearings B attached to a stationary part of the machine. Worm C meshes with a worm-gear D, which rotates freely on its supporting stud. The worm-gear also meshes with the screw E on the opposite side, screw E being supported by member F attached to the table H.

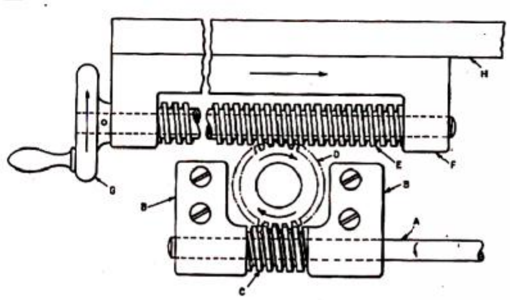

Fig. Table feed mechanism that eliminates manual re-engagement of the clutch and feed screw

During the working cycle, shaft A transmits rotary motion to the worm-gear D, in the direction indicated by the arrows, through the worm C. This provides linear motion to table H, since screw E does not rotate, but acts as a rack. On completion the working cycle, the screw E is rotated by hand wheel G, in order to move table H in the opposite direction. While this is taking place, worm-gear D continues to rotate.While being loaded, the table slowly moves toward the working position, as it is still connected with the drive-shaft through the worm-gearing. Should the loading be completed before the table H has reached the working position, the hand wheel G can be turned in a direction opposite to that in which it was turned previously to accelerate the table movement. As none of the parts are disengaged at any time, there is no waiting period, resulting in a considerably shortened cycle.

5.8 CONVERSION OF ROTARY MOTION INTO RECTILINEAR MOTION:-

5.8.1 Conveyer Mechanism:-

The mechanism for driving a conveyer is shown in Figure. This conveyer consists of a pair of endless chains between which the conveyor buckets are carried. These buckets are hung on pivots, so that they are kept in an upright position by gravity. The chains are equipped with wheels which run on tracks. The chain and buckets are propelled along the tracks on indicated by the arrow, by a system of rotating pawls which receive their motion from a large gear D. Each pawl, in turn, engages one of a series of pins on the chain and, after having pushed the conveyor ahead, the pawl is raised by cam C and the next pawl repeats the operation. When a pawl, as at A, is passing through the lowest arc of its travel, the conveyor is propelled forward. The pawl shown at B has passed the lowest point, and it gradually lags behind the conveyor, so that the end of the pawl is readily lifted out of engagement without inference. As will be seen, the inner end of pawl B is in contact with the cam surface which controls its position.

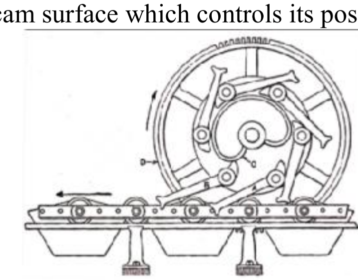

Fig. Arrangement for Obtaining Rectilinear Motion from Revolving Pawls

5.9 CONVERSION OF DIFFERENT MOTION ACCORDING TO FEEDING:-

5.9.1 Jam Proof Feeding Mechanism:-

Figure presents an interesting material handling the system advancing small parts onto a feed track. The system posses merits because of the manner in which feed rate control to prevent any part from jamming on the track. In this instance, small round head screw blanks are being fed into a threading machine.A shallow pan A holds a batch of screw. The pan rotates about 40 rpm around an inclined axis. The pan rotates, the screw are directed onto a fork B, where some of the screw will align themselves and hang by their heads at its other end, the fork is hinged to the feed track C, the slots of which forms a continuation with that of fork.The fork intermittently raised to the position shown by blank lines, where the screw on the fork slide onto feed track. This movement of the fork originates from a cam rotating on the bottom of a vertical stem D joined to the fork by link E. as the cam rotates slowly, it intermittently raises the stem then lets the stem fall down, the fork is also intermittently raised or lowered.

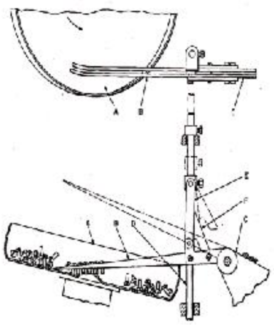

Fig. When a track is not congested, the fork can drop into the
pan to pick up screw

When the pan is fully, each time the fork is raised it may be deliver more screw than can be accommodated on feed track. Consequently, there may be a serious jam on the track, if it were not for a feeling finger F which is incorporated in the mechanism. This finger is fixed to the stem.

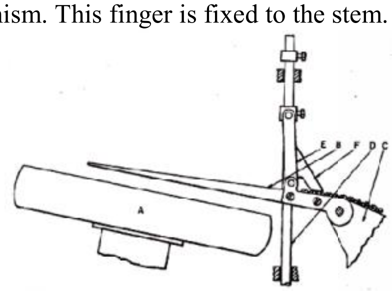

Fig. When a track is not congested, the feeling figure prevents
the fork from dropping into pan

If the line screw in the track extends back onto fork then the down stroke of the stem is a rested when the figure strikes hits of the screw. This is the stem and the forks are linked together, the fork does not swing completely down into the pan until the congestion on the track has ended. Then, as in finger can enter the track during the reciprocation of the stem, the fork can drop into the pan in order to pick up more screw.

5.9 DIFFERENTIAL MOTIONS:-

5.10.1 Epicyclic Trains Of Bevel And Spur Gearing Mechanism:-

Most differential motions are derived from combinations of bevel or spur gearing. The epicyclic bevel gear train illustrated by diagram A, is applied to many mechanisms of the differential type, and its action under different conditions should be thoroughly understood. The shaft a has mounted on it two bevel gears b and c and an arm d. The arm is attached to the shaft and carries a pinion e which meshes with each gear and is free to revolve upon the arm. There are several conditions that can exist with a gear train of this kind.

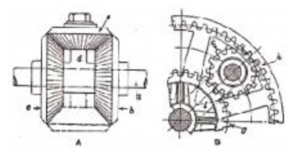

Fig. Epicyclic Trains of Bevel and Spur Gearing

First, assume that gear b is stationary and c loose on the shaft. If the shaft and arm d is resolved, motion will be transmitted from arm d to gear c, through pinion e, and gear c will makes two turns for every one of arm d and in same direction as the arm. If gear b should rotate instead of being stationary, this motion of gear c and it would also makes a difference weather gear b turned in same direction as the arm or in an opposite direction.Second, suppose the preceding conditions are reversed and one of the bevel gears b or c is revolved while the other gear remains stationary, and that arm d carrying the bevel pinion constitutes the driven element. With only one gear revolving, the arm will turn in a direction corresponding to that of the gear and at half its speed. If both gears rotate in same direction at different speeds, the arm will follow in that direction and with a speed, the arm will follow in that direction and with a speed intermediate between the two. If the gears are driven in the opposite directions at different speeds, the arm will follow the more rapidly moving gear, and if the speeds are equal, pinion e will revolve upon the arm, but the latter will remain stationary.Third, assume that arm d remains stationary and gears b and c are loose on the shaft. If gear b is the driver, the pinion e will simply transmit motion to gear c in the opposite direction, the three gears in this case forming a simple train with pinion e acting as the idler. The force tending to rotate arm d will be twice the force transmitted from gear b to gear c.

5.10.2 Differential Motion Mechanism:-

The Chinese windlass shown by the diagram C, is simple example of a differential motion. The hoisting rope is arranged to unwind from one part of drum or pulley onto another part differing somewhat in diameter. The distance that the load or hook moves for one revolution of the compound hoisting drum is equal to half the difference between the circumferences of the two drum sections.

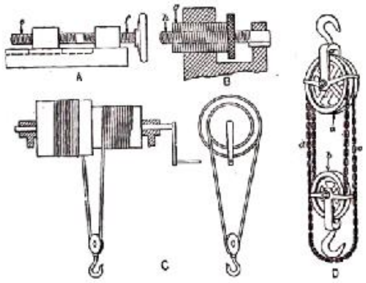

Fig. (A and B) Differential Screws ;(C) Chinese Windlass; (D) Differential Hoist

The well-known differential chain hoist illustrated at D operates on the same general principle as the Chinese wind-lass. The double sheave a has two chain grooves differing slightly in diameter, and an endless chain passes over these grooves and around a single pulley b. This pulley b and the hook attached to it is raised or lowered, because, for a given movement, a greater length of chain passes over the larger part of sheave a than over the smaller part. It the upper sheave is revolved by pulling down on the side d of the chain that leads to the groove of smaller diameter, the loop of chain passing around pulley b will be lengthened, thus lowering the pulley; the opposite result will be obtained by pulling down on chain c which leads up to the larger diameter of the sheave

5.11 SPECIAL MECHANISMS:-

5.11.1 Speed Changing Mechanism:-

For controlling modern speed- change mechanism that incorporate sliding gears or jaw-clutch couplings, hydraulic systems are being widely used. Generally the gears of such mechanism run at a speed that is too high to permit changing the speed under operating conditions. To overcome this difficulty, either slow-motion features are embodied in the design or provision is made to prevent the gears from being shifted prematurely, that is, before the speed has been reduced to a rate suitable for the purpose.An automatic hydraulic control system that meets the requirements mentioned is shown in Fig. (Note that the views in Fig. are in accordance with the European system of projection.) This system is of conventional type, using an oil pump which serves to lubricate the gearing or the machine driven by it. As for instance, a machine tool. It also supplies oil under the pressure required to affect the control. The system is composed mainly of a small gear type or plunger type auxiliary pump *B* which has its driving shaft C coupled to a constant-speed shaft of the gearing; a spring-loaded control valve D; and a throttle E.

When the gearing is in operation, oil drawn by the auxiliary pump through bore Q *is* carried through bore S into cylinder P. The oil lifts control valve D against the action of spring J so that the stream of oil coming from the main pump (not shown) and entering the system at orifice F is permitted to pass through annular space H and flow freely at orifice K to effect the lubrication. The additional amount of oil supplied by pump *B* is also fed to the lubricating pipe through passages L and M. The oil pressure can be varied by means of set-screw O after removing plug N.

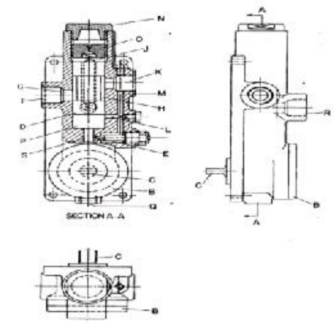

Fig. Hydraulic mechanism assures smooth shifting of gears

When the gear mechanism is stopped by disengaging a clutch between the driving motor and the gearing, less oil is supplied by pump B and the control valve D will then drop because of the pressure exerted by spring J. This is accomplished at a rate which depends upon the adjustment of spring J and throttle E. Oil coming through cylinder P is then allowed to escape through passage M into the lubricating pipe. In moving downward, control valve D opens the pressure pipe N. As the main pump continues running, the oil it supplies is fed through a distributor II to pistons for moving the gears. Thus, smooth shifting is insured.

5.11.2 Transfer Mechanism (Handling Mechanism Turns Strips in Transfer):-

In processing fiberboard strip for a fire lighting device, an interesting materials-transfer mechanism is used. This mechanism picks up the strip as it leaves the saw table, rotates it 90 degree so that a combustible fluid can be injected into one edge, then rotates it another 90 degrees for ejection.

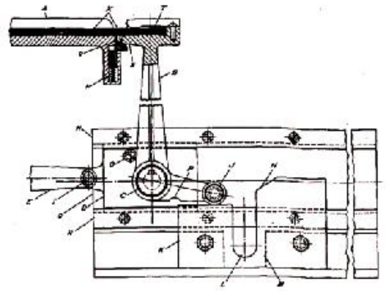

Fig. When bell crank B starts swing, roller J rides over the
lower horizontal surface of guide plate K

In the Fig. several strip is advanced manually between raised guides into the fingerlike end of the long leg of a bell crank B.The bell crank is keyed to a stud C free to revolve on a rectangular slide D. Connecting-rod E, pivoting at F, reciprocating the slide in body casting G. The opposite end of the connecting-pit shown) is actuated by a conventional eccentric disc. is T-shaped in vertical section, so that it can be re-l by keeper plates H.

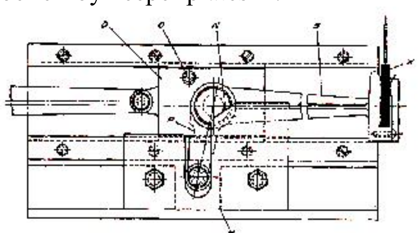

Fig. A momentary dwell of eccentric disc permits injection
of combustible fluid

The short leg of the bell crank forms an angle of 102 degrees Lifelong leg. At its end, it carries a roller J projecting over font of the body. The roller operates over the upper edge K fast pup H to the fron of the body.When the slide moves to the right, the bell crank carries along one of the fiber board strips, moving until roller J contacts the right-hand wall of slot L in the guide plate. The roller then is forced down in the slot, approximately 0.005 inch wider than the roller diameter. Meanwhile the bell crank, swinging on stud C, rotates the strip 90 degrees, Fig. A clearance channel M accommodates the short leg of the bell crank.Now there is a momentary dwell of the eccentric disc to allow the combustible fluid to be injected. Then, continued movement of the slide in the same direction raises the roller out of the slot, first onto an adjacent 40-degree incline N, then onto the higher straight edge of the guide plate. Simultaneously, the strip is rotated downward 90 degrees more, Fig. After the strip is ejected, the slide moves to the left, and the bell crank returns to its initial position.Pin O (pressed into the slide) offers B positive stop for the bell crank, bearing against the long leg at the start of the cycle, and against a recess P in the short leg when the bell crank reaches the position shown in Fig. A small, vertical slide Q, Fig., prevents the strips remaining on the extension from being pushed off once the long leg is loaded and the bell crank starts its swing. This slide is in a lip on the extension bottom, and a spring R keeps it raised, once the bell crank swings away, so that the end of the slide slightly intersects the path of the strips.At the start of the cycle, a projecting surface S of the long, leg depresses the slide, and the foremost strip is advanced into the leg. There the strip is retained by a leaf spring T. To release the strip when it has reached the position shown in Fig. a forked ejector plate U is actuated by separate mechanical means at the proper instant.

5.11.3 Instant Release Latch Mechanism:-

On an automatic machine, a bowl shaped part must be tipped 90 degrees from a horizontal resting position over a transfer bar to vertical position in a cradle on the same transfer bar. The part is first moved of the bars into the position over a get which picks up the part and rotate it 90 degree into bars. The problem in designing the equipment was to provide some means of latching the part to the tipping gate during rotation and releasing it into the transfer cradle at the precise movement that the part reaches its vertical position. The tipping gate returns to its stating position. Such a latch mechanism is shown in the fig.

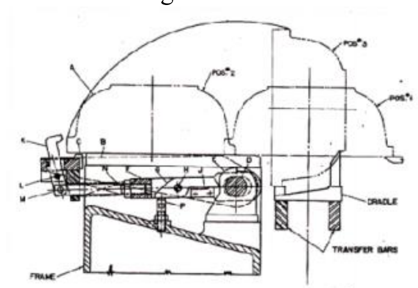

Fig. Instant-released mechanism which facilitate a work indexing movement

The work piece A is moved from position one over transfer bar over position two above tipping gate B. the tipping gate permits work piece A to drop a few degree below the horizontal plane, so that work piece may pass over button C which prevents the part from sliding down the tipping gate during indexing. The tipping gate is rotated by shaft D, which passes through a latch operating cam E, that is fixed to a frame member. Shaft D also passes through elongated slots in the clevis end of the latch operating link assembly F, which is straddles cam E. the cam follower G, located between the clevis legs of the link assembly F, is followed to pivot freely on pin H, but cannot pivot further than stop J in a clockwise direction.Latch K pivots on pin L which is fixed to a tipping gate. The end of the link assembly passes through a clearance hole in tipping gate, is forked to the straddle latch K which pivots on pin M. The rotating motion of the tipping gate is imparted to the link assembly through pin M. as the tipping gate rotates, cam follower G backed up by block J rides up on the high lob of cam E. The resulting motion compresses spring N and closes latch K.Part A is now latch securely to the tipping gate B during dwell position of cam E. At the presses movement part reaches its vertical position, the cam follower reaches a step in a cam E, and compressed spring N forces open latch K, instantly freeing the part from the tipping gate. The part is left resting in its transfer cradle, as the tipping gate return to the starting position. However cam follower G, which had hooked itself over stop in cam E, pivots on pin H, at the tipping gate rotates. This allows it to pass over high lob of the cam. As the tipping gate finally comes to rest as its starting position, the cam follower G reset by button P. the latch mechanism is now ready to start next cycle.

Conclusion:-

The detailed study of different mechanisms has been carried out and they are classified on the basis of different motions and the details have been discussed for the user to understand and develop the automated mechanical system as per the requirement.All the mechanisms are compiled in the form of database; which will help the user for easy access of mechanisms according to their requirements. For user friendly access, to get details of mechanisms, the software is developed which will give the quick reference to the mechanism as per the conversion of motion from one form to other for automation .

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