Zie onderaan op deze blz.

number of exhibit is indicated in margin

TEXT OF FILM RELATING TO EXHIBITS BUILT FROM MECCANO PARTS IN THE EVOLUON, SECTION "PRELUDE TO TECHNOLOGY"

This is the Evoluon, a permanent exhibition of science and technology; the part we are in is devoted to a demonstration of how mechanical energy is transferred from one rotating shaft to another.

exh.no. 11 Here you see one of the simplest forms of transmission, consisting of two similar gears. If we turn one of the shafts, the other one turns at the same speed, but in the opposite direction. We call that a transmission ratio of one to minus one.

exh.no. 12 On the left a slightly more complicated transmission of the same type is shown, also with gears. But here the gears are of unequal size. The small gear drives the big one, which turns at a slower speed. The reduction in this case is 1 to 5. Since the shafts turn in opposite directions, we should properly call the ratio 1 to minus 5.

In this display we have examples of belt and pulley transmissions.

exh.no. 13 The one on the right has a ratio of 1 to 1; the pulleys are of equal size and they turn in the same direction.

exh.no. 14 The one in the middle gives a reduction ratio because the driven wheel has a larger diameter than the one that drives it.

exh.no. 15 In the one on the left the belt is crossed, giving a transmission ratio of 1 to minus 1 because the pulleys turn in opposite directions.

Here you see transmissions between shafts at an angle to each other.

exh.no. 20 The first is a 1-to-1 transmission with the shafts perpendicular.

exh.no. 21 The second is similar, but has a reduction ratio of 2-and-a-half to 1.

exh.no. 19 And this is a transmission between a worm and a wheel, in this case with a reduction ratio of 1 to 50. The worm is, so to speak, a gear with only one tooth.

exh.no. 21a Beneath the worm and wheel you see an example of two perpendicular shafts coupled by pulleys; the ratio is 1 to 1.

exh.no. 16 Here are two shafts coupled by cranks and a connecting rod. There is a difficulty about doing this. If we use a single crank on each shaft, the transmission will have a dead point. To eliminate it we would have to add a second crank to each shaft. But there is another way out. What we have done is to introduce a third shaft with a crank of its own, and to couple the three cranks with an equilateral triangle. There is still a dead point between two of the shafts, but in this case we are taking the output from the third. It turns at the same rate as the input shaft, and in the same direction, so the transmission ratio is one to plus one.

In 1969 hebben we in het Evoluon een smalfilm met geluid gemaakt van de Meccano exhibits in het Voorspel der Techniek met gesproken tekst. Die stuurden we naar Meccano in Liverpool. Ze hebben de film gezien, maar slaagden er niet in om de tekst hoorbaar te maken. Ze hebben er nooit commentaar op geleverd. Ons idee was ze te laten zien hoe goed Meccano in tentoonstellingen kan worden gebruikt.

exh.no. 17 This shows a 1 to minus 1 transmission with cranks and a connecting rod. Its ratio is 1 to minus 1 because the shafts turn in opposite directions. You can see why that is. In the horizontal direction the movement of the two cranks is kept equal by the sliding frame.
In the vertical direction, the movements are made equal and opposite by the green connecting rod pivoted on the frame. Since the pivot point moves with the frame, it is always midway between the ends of the two cranks, so their vertical displacements are always equal and opposite. Thus, as one shaft turns to the right, the other turns through exactly the same angle to the left.

exh.no. 18 This is a combination of two of the transmissions we looked at before. Here we have a frame with an input and an output shaft. These two shafts are coupled by transmission ratios of one-to-plus-one and one-to-minus-one in series with each other. If we keep the frame from turning, the input and output shafts rotate in opposite directions. In fact, we have a differential. In this version the output shaft is actually fixed and the frame is free to rotate. If we drive the input shaft, the frame turns in the same direction but at half the angular velocity: so this is a transmission without gears, giving a ratio of two to one.

exh.no. 22 Now we come to a more familiar kind of differential - with gears. This is the kind you will find between the driving wheels of a motor car, and in that case this shaft is the one that is driven by the motor. Each of the other two shafts drives one of the wheels.
When you turn to the right, for example, the wheel on the left has to run faster than the one on the right. Let us suppose that the bend is so sharp that the right hand wheel stands completely still; then this one remains stationary, this one is driven by the motor, and, as you see, the left hand wheel turns. If we stop the left hand wheel, then the right one turns. Thus the differential divides the motion between the two half-shafts. But it also does something else besides dividing the energy between two shafts. Look: if we hold the right hand shaft and turn the left one, the middle one makes a certain number of revolutions. If we hold the left hand shaft and turn the right one, the middle one also turns. Actually, the number of revolutions that the middle shaft makes is equal to the sum of the revolutions of this one and that one.

exh.no. 23 Here we see another form of geared differential. In the last example the gears were perpendicular to each other, but now they are all parallel.

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There are four of them, and each one has nineteen teeth. Otherwise, the way it works is the same. If we compare this with the type found in a motor car, then this is the driven shaft and, if we hold the right hand shaft, the left one turns; and if we hold the left hand one, the right one turns. So, again we can say that the number of revolutions of this shaft is equal to the sum of revolutions made by this shaft and that one.

exh.no. 24

This example shows the idea carried a bit farther. If the horizontal shaft shown here makes one revolution, this shaft makes 3 revolutions, and that one over there 7 revolutions. This transmission is made entirely of similar gears, each of them having 38 teeth. The reason that we can derive ratios different from a 1-to-1 ratio is that we have added the revolutions - instead of multiplying them. Once the shaft starts to turn, we are able to derive other motions from it which we can add to the motion it already had. In that way we go from 1 to 3, then we add another 2 to make 5, and so on. So we are able to make transmissions with ratios other than 1 to 1, but with similar gears throughout.

exh.no. 25

In this machine you can see an application of these principles. It is a drawing machine that produces about one figure a minute; then the pen lifts, the paper transports, the pen goes down again, and it draws a new figure. All figures are different. The pen is driven by two linkages, and each linkage is driven by a crank from a separate gear-set. As they turn, each one introduces a new reduction ratio between the main shaft - which you can see in the middle, between the two gear-sets - and the cranks that drive the linkages. One of the gear sets have five positions and the other six, and every time a new drawing is to be made each of them is shifted by one position. So, we have to run through a total of 30 drawings before we have the same combination of gear ratios again. But during that time, the phase relation of the two cranks that drive the pen linkage changes; also, a special mechanism changed the amplitude of their motion, so that in the end all the drawings are different. Soon the drawing will be finished. Then we can take a closer look at the movement of the gear set. We can never tell in advance what the drawing will be like, it is a complete surprise; that is one reason why this machine always attracts much attention.
Now we see the gear sets turning; one crank has stopped moving and so has the other. Now the gear sets turn to new positions; in each of them a new countershaft is introduced between the central shaft and the one that drives the crank. Now they are both running again and a new drawing is started.

exh.no. 43

This machine helps you to understand how a television picture is made. When you look at a television set you see 25 pictures a second, but after one twenty-fifth of a second each picture disappears. That is as it should be, for every picture has to make way for the next one. Here it takes much longer to draw a complete picture: it takes ten minutes. But that enables you to watch and see just how the picture is built up line by line.
There are two machines. In the one on the right a black and white picture is scanned by an electric eye. And in the one on the left a pen is poised just above a blank piece of paper. Whenever the electric eye sees a black point in the picture under it, the pen is lowered and makes a black mark on the paper.
In that way the whole picture is being built up, dot by dot and line by line. The biggest problem that had to be solved, of course, was synchronizing the two machines. Here it has been done in such a way that if they are turned off and then on again, they are automatically brought back into synchronism - just as in television transmission and reception.

If the pen moves to the left, the movement is practically linear with time. This has been realized by means of planet gearing. It adds a small second harmonic component to a common sinussoidal motion in such a way that one flank of the sine curve is made practically linear.