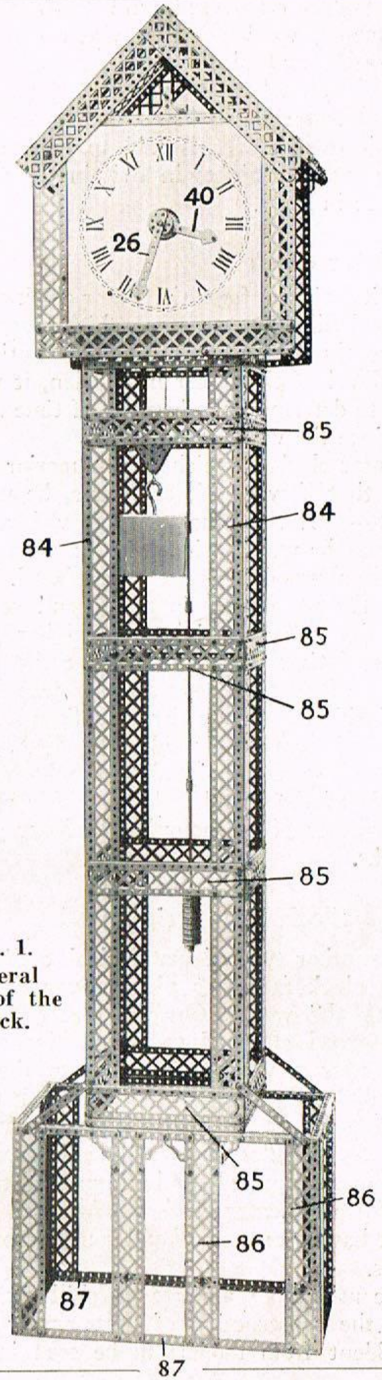

Fig. 1. General view of the Clock.

Meccano Grandfather Clock

A Full-size Model that keeps Accurate Time

SPECIAL FEATURES

Accurate time-keeping. Made entirely of Meccano Parts with the exception of the weight, a small flat spring about 1½″ long, and the dial. Special escapement and pallet movement. May be adjusted by altering length of pendulum, etc. Ratchet winding mechanism. Presents a handsome appearance and is suitable for hall or staircase.

IT is doubtful whether many of us appreciate the tremendous amount of work and thought that has been necessary to bring to perfection the mechanism of a clock. In these days clocks and watches are so numerous, and may be purchased for so little, that we forget the wonderful story that lies behind the measuring of time throughout the ages.

How many of us realize, for instance, that the accuracy of our time depends upon the observations of astronomers at Greenwich Observatory? Although it is very interesting to learn about the canals of Mars; about the wonderful clouds of Jupiter; or about the mountains of the Moon, a study of these objects does not comprise the entire duties of the Greenwich astronomers. They are more concerned in checking and keeping correct their master clocks that give the time to all the clocks in the country.

How Astronomers correct our Clocks

Every night the astronomers watch with a large telescope the passage of a star across a particular part of the sky, which passage denotes the correct time. In the telescope are several vertical lines, which are actually portions of a spider's web placed in the eye piece of the instrument. It is possible to calculate the exact instant when a star should pass each of these lines and the observer watches for this to take place. The star enters the field of view from the left and passes each of the lines in turn. When the observer sees that the star is on a vertical line he presses a key, which completes an electric circuit and the exact instant is marked on the cylinder of a recording machine.

The work of the astronomers enables us all to get up punctually; school to start to the minute, and express trains to depart "on the dot." Imagine

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the chaos that would result if the astronomers set the nation's clocks half-an-hour late! Half the nation would be up late, schools would be late, trains would be all wrong, and every one would be in a bad temper as a result!

Even greater confusion would result at sea, however, for a sailor cannot find the exact position of his ship unless he is provided with the correct time. He obtains this information by wireless, time signals being sent out at stated periods by the Eiffel Tower and other large stations. It is the astronomer who ensures that the radio signals are broadcast at the correct instant. In the case of the Eiffel Tower, for instance, transmissions are actually sent out by a master clock at Paris Observatory, the time of which is checked with the passage of different stars several times during the night.

It is hard to realize how the people of old were able to tell the time before watches and clocks were invented. They did so either by the Sun or the Moon, noting their positions in the heavens by day or night. In those days time was not measure by hours, minutes or seconds as it is to-day. Instead it was divided into years according to the apparent motion of the Sun among the stars, into months by the revolution of the Moon around the earth, and into days by the alternate light and darkness caused by the rising and setting of the sun.

Later the day was divided into equal portions by watching the movement of a shadow, for as the Sun moves through the sky the position of a shadow continually changes. The different positions were marked by pieces of wood or stone placed on the ground. A development of this early device was the familiar sun-dial, examples of which are still to be seen outside some old churches, or in old-world gardens. The earliest record of a sun-dial is in the Bible, where in the Second Book of Kings, Chap. XX, v. ii, we read of "the dial of Ahaz." The Sun does not always shine, however, and when it is cloudy sun-dials are useless.

As civilization spread and the lives of people became more ordered and regular there was an increasing demand for some other device for measuring time. This resulted in the introduction of the *Clepsydra,* or water clock, which is of great antiquity.

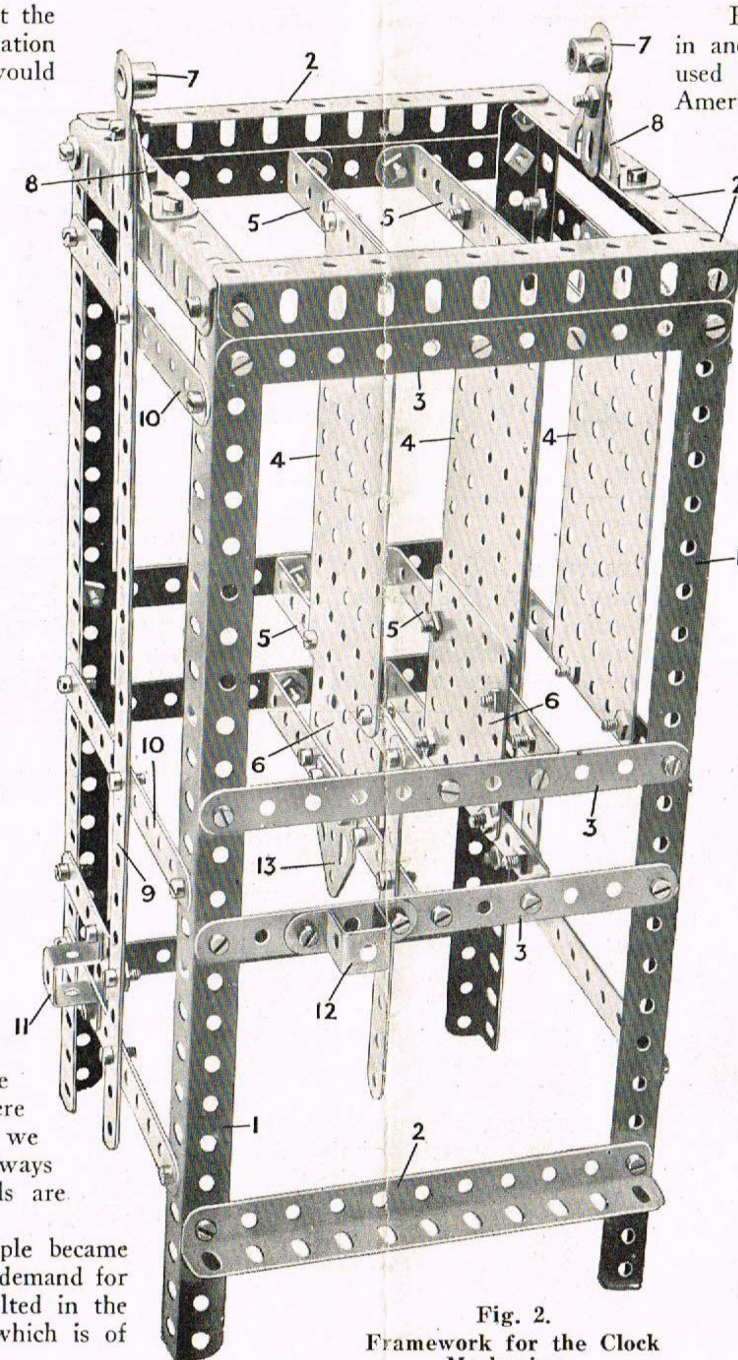


Fig. 2.
Framework for the Clock Mechanism.

From old models discovered, and from references in ancient documents, we know that water clocks were used by the Greeks, and also by the Indian tribes of America. Julius Cæsar, when he invaded Britain in B.C. 55, found water clocks in use among the natives, and with these clocks is said to have observed that the summer nights in Britain were shorter than those in Italy.

The Water Clock

In its original form the water clock consisted of a vessel filled with water, which was allowed to escape through a small hole. By noting how far the level of the water had fallen, it was not difficult to determine the interval of time that had passed since the vessel was filled.

Water clocks—which were superior to sun-dials in that they could, of course, be used day or night—were subsequently improved, and in a later form the water dripped into a second vessel in which a wooden figure was placed. As the level of the water rose in the second vessel the wooden figure floated higher and higher, and the intervals of time were thus more easily noticed.

Soon afterwards hour symbols were painted on the inside of the vessel and a figure with an outstretched arm was used as a float. As the figure rose the arm pointed to the hour on the inner side of the vessel. This movable arm was the forerunner of the hour hand of our present-day clocks.

How the Clock Face Originated

In another type of water clock a dial similar to a clock face was placed over the vessel containing the water. On the water floated a piece of wood attached to which was a string running over a wheel connected to the hands on the dial. The water was allowed to drip from the vessel so that it took exactly a day to empty. As the floating wood sank lower and lower the string pulled the hand around the dial. In this form of water clock the face had 24 figures, but having only one hand could record only the hours.

A considerable amount of skill was exercised in the construction of these water clocks, as is evident from models to be seen in many of our museums. Some of these models are of very beautiful design and clever craftsmanship. One famous example in brass was sent in the year 800 by the King of Persia to the Emperor Charlemagne. In this clock twelve figures of horsemen marched out of twelve windows one by one according to the hour. When twelve hours had passed the figures returned again, closing the windows after them as they marched back.

Measuring Time with Sand

About the year 330 A.D. sand glasses were introduced. These were glass vessels shaped something like a figure 8, the waist of which only allowed the sand placed in the top half of the glass to run through grain by grain. It required an hour to run from the top to the lower half of the glass, after which the glass had to be turned upside down again so that the next hour could be measured by the sand running back again. Although it was not difficult to roughly ascertain how much of the hour had gone by the quantity of sand that had fallen, the great disadvantage of sand-glasses was that people often forgot to turn them back after the hour was run, and so lost the correct time! Then again unless they were attended to continually during the night, the time was lost and the hours could only be counted from the time at which the owner of the glass awakened and started off the sand-glass! Because of these disadvantages it is not surprising to learn that sand-glasses were not in use for very long.

Another early method of measuring time was by burning long candles, made to burn for a certain number of hours. These candles had divisions down their sides, each mark showing when an hour had passed. They were very unreliable,

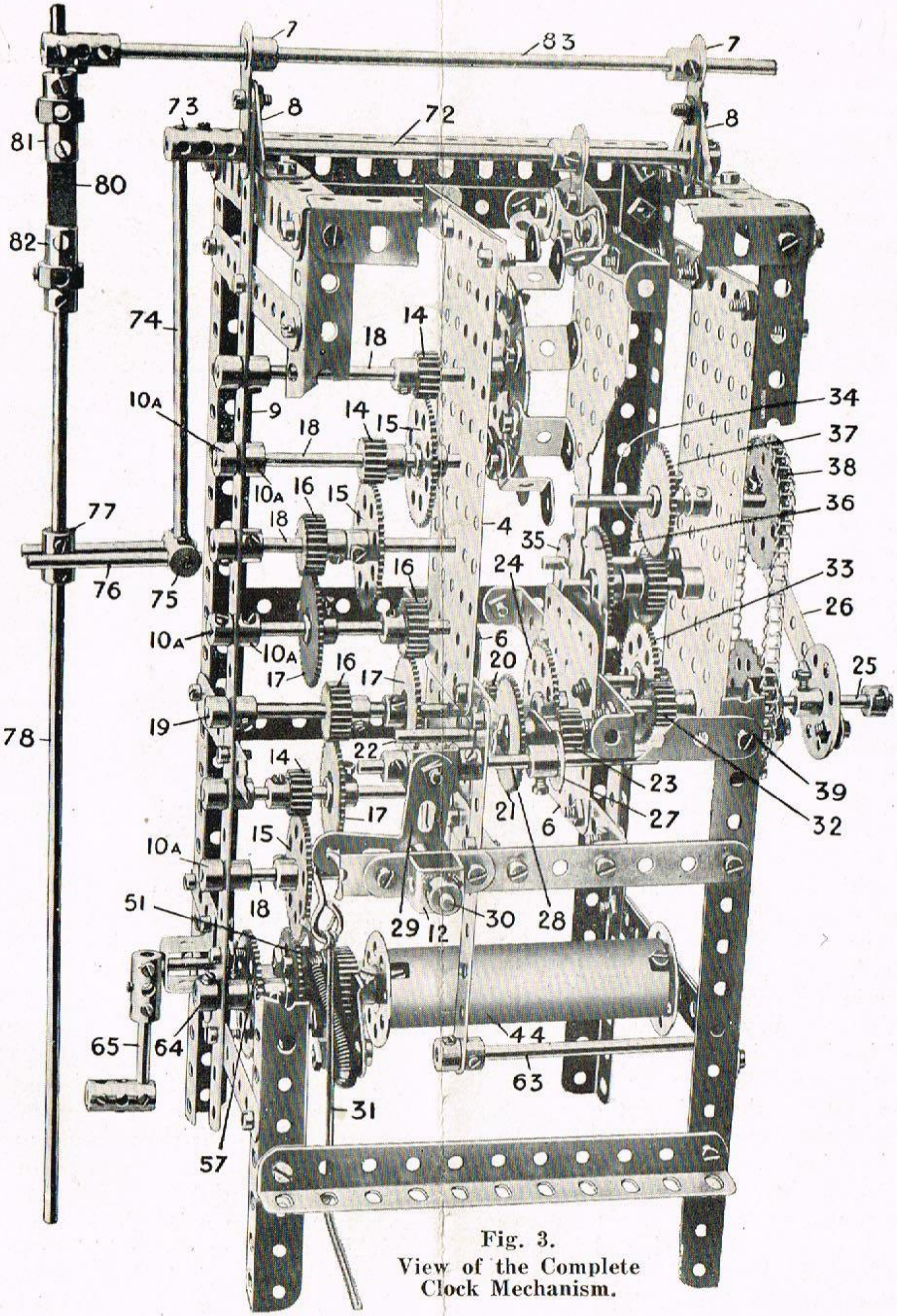


Fig. 3.
View of the Complete Clock Mechanism.

however, for the slightest draught would alter the rate at which the candles burned, causing them to measure time incorrectly.

Candle Clocks were used at the time of Alfred the Great. While he was a fugitive in his own country the King vowed that if ever he were restored to his kingdom he would devote a third of his time to the service of God. Later when he achieved his desire, he ordered a number of candles to be made so that he might divide his time in accordance with his vow. The candles burned for exactly four hours and were lighted one after another by one of Alfred's Chaplains, who also gave the King due warning of the passing of the hours.

Neither sun-dials, water clocks, sand-glasses nor candles solved the problem of accurately measuring time. This did not become an accomplished fact until the invention of the weight-driven wheel clock.

It is impossible to say exactly when this type of clock commenced to supersede the ancient time measures. Many vague allusions to wheel clocks occur at a very early period, but whether these were some form of water clock or whether they were actually wheel and weight clocks seems doubtful.

To a certain extent wheel clocks were a development of water clocks, in the later models of which a water wheel took the place of the empty vessel and the floating piece of wood. The water dropped on to the paddles of the wheel, driving it round, and every time the wheel made a complete circle a gong was struck. It is believed that the Greeks introduced mechanical movements to take the place of the gong and also that they connected the wheel with a series of cogs, thereby moving

Fig. 4. The Pendulum.

an indicator on a dial.

Later a falling weight took the place of the dripping water so it was in this way that the weight-driven clock first came into existence: some believe that credit for its invention is due to Archimedes, the famous mathematician, who lived in the third century B.C. but whether or not he really did invent the type we do not know.

The First Wheel Clocks

Although there is no record earlier than 1120 A.D. in which a weight-driven clock definitely is described, there seems to be little doubt that weight clocks were used in the monasteries of Europe in the 11th century. Probably these clocks had no dial or hands, but only struck a bell at certain hours to call the monks to prayer. This was an improvement on the previous methods, however, for until then it was necessary for one of the monks to watch the stars in order to know when it was time to waken his brethren for early morning prapers.

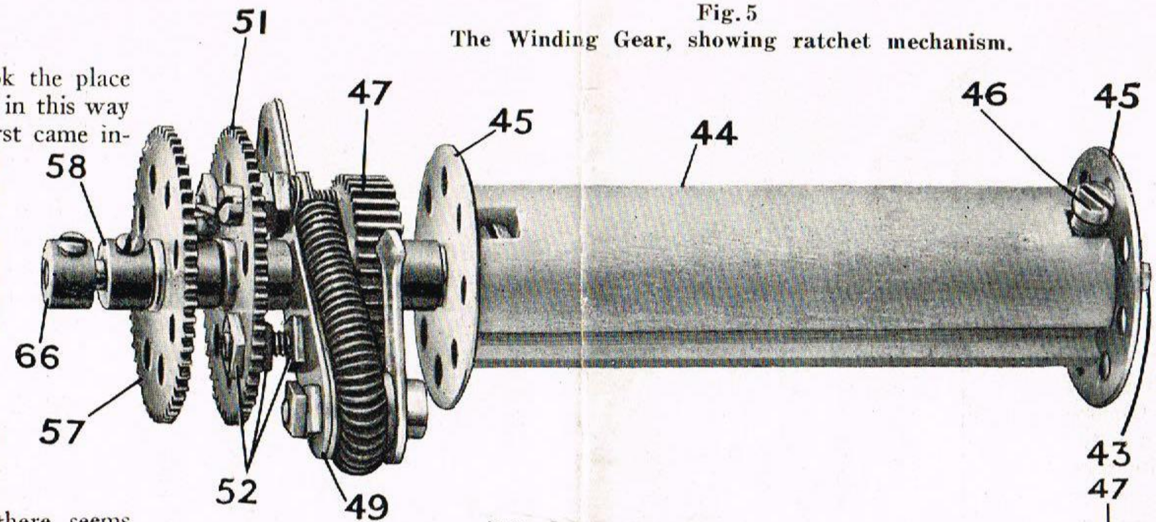


Fig. 5
The Winding Gear, showing ratchet mechanism.

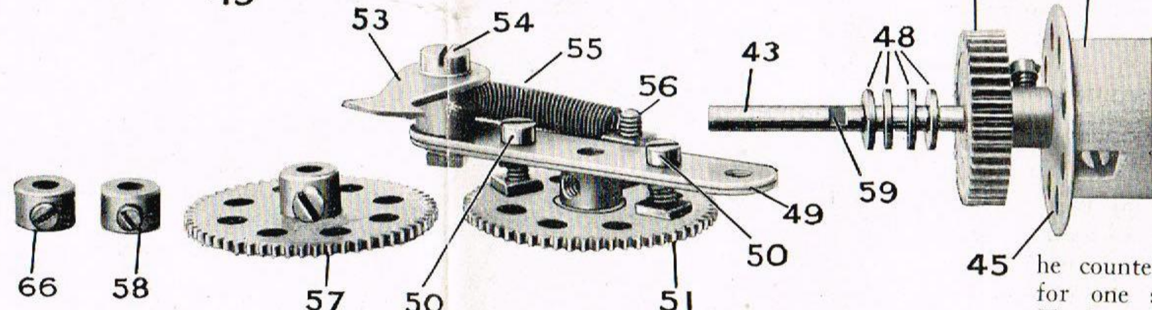


Fig. 6. Component parts of Ratchet Winding Mechanism.

The wheel clock was perfected by a German named Henry de Wyck. A rope with a weight attached was wound round a cylinder or barrel which resembled the roller of a household mangle. As the weight dropped, the barrel revolved, moving the clock hand through a train of gear wheels. In his early models de Wyck found that as the weight dropped the speed at which the wheels revolved became faster and faster. When the end of the rope was reached the barrel was actually thrown off its spindle! He persevered in his experiments, however, and succeeded in overcoming the difficulty. He did so by fitting a series of spikes to a small wheel, and by means of a mechanism that resembled a pawl and ratchet, he checked the revolutions of the barrel. The King of Frances, Charles V, heard of de Wyck's wonderful clock and asked for one to be made for his palace. Thus it was that the first mechanical clock constructed in France was made by a German citizen.

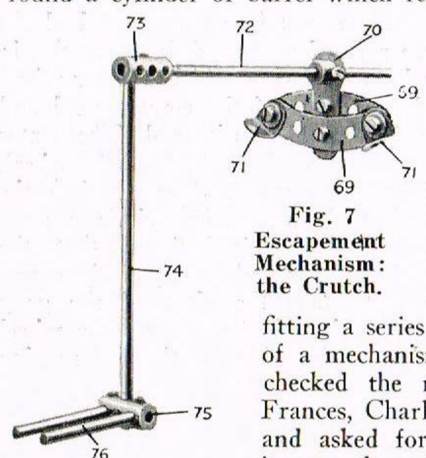


Fig. 7
Escapement Mechanism: the Crutch.

Discovery of the Pendulum

Shortly after de Wyck's success the whole principle of clock-making was revolutionized by the discovery of the pendulum by the famous Italian, Galilei Galileo, then a youth of 18 years. One day in the Cathedral at Pisa, he noticed the regular movements of a hanging lamp that had been set moving while being lighted. Galileo was struck by the fact that the motion of the lamp never seemed to vary and he decided to test its accuracy. Watches were unknown then, so holding his pulse he counted the time required for one swing of the lamp. To his amazement he found that the lamp always required the same amount of time to complete one swing although the swings were becoming gradually of less extent each moment.

Convinced of the value of his discovery Galileo soon completed a model of the lamp by fixing a weight to the end of a long bar of metal, and it was not long before he had adopted this pendulum to work an astronomical clock.

Solving a Mystery

Once the principle had been established, pendulum clocks became common, and at last the world had a fairly accurate means of keeping time. The next step was to improve the clocks so that they were even more accurate.

In this connection there was one particular trouble to overcome, which was to understand why the clocks always went faster in winter than in summer. In these days very little was known about the various properties and peculiarities of metal, and it was a long time before the mystery was solved.

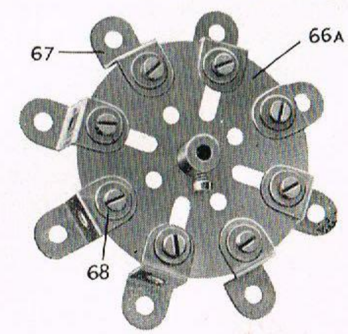


Fig. 8. Escapement Mechanism: the Pallet.

Popular opinion had it that in some unknown manner the sun affected the clocks in summer. In the main this idea was quite correct, of course, for the difference in the clock's speed was actually due to the expansion or contraction of the metal of which it was constructed. In the hot days of summer the metal expanded, the pendulum rod become longer and the pendulum required longer to make its beat. In the winter the reverse was the case, and then the clocks always ran a little fast. When more knowledge was obtained about metals, and when their different rates of expansion and contraction were discovered, the mystery was solved.

The difficulty was overcome in a most ingenious manner. The heavy metal weight of the pendulum was replaced with a vessel filled with mercury. Although the pendulum rod continued to expand and lengthen during the summer the mercury in the jar also expanded, rising higher and higher in its containing vessel. This rising of the mercury had exactly the same effect as raising the weight further up the pendulum rod, a procedure that, as everyone knows, causes the pendulum to beat more quickly. The mercury therefore automatically compensated for the alteration in the length of the pendulum rod and the clock was able to keep perfect time without attention at any season of the year.

So accurate is this method of compensation by mercury that it is used at the present time in astronomical clocks. It may also be seen sometimes in the clocks that register correct time at large watch-makers and jewellers' shops. By the invention of the mercury compensating device, pendulum clocks were more or less perfected, though several minor improvements were afterwards made in the gearing and the method of indicating the hour.

The first pendulum clocks were of the "grandfather" type. It is interesting to note that the Meccano Clock and other present-day clocks are constructed on exactly the same principle as the early clocks.

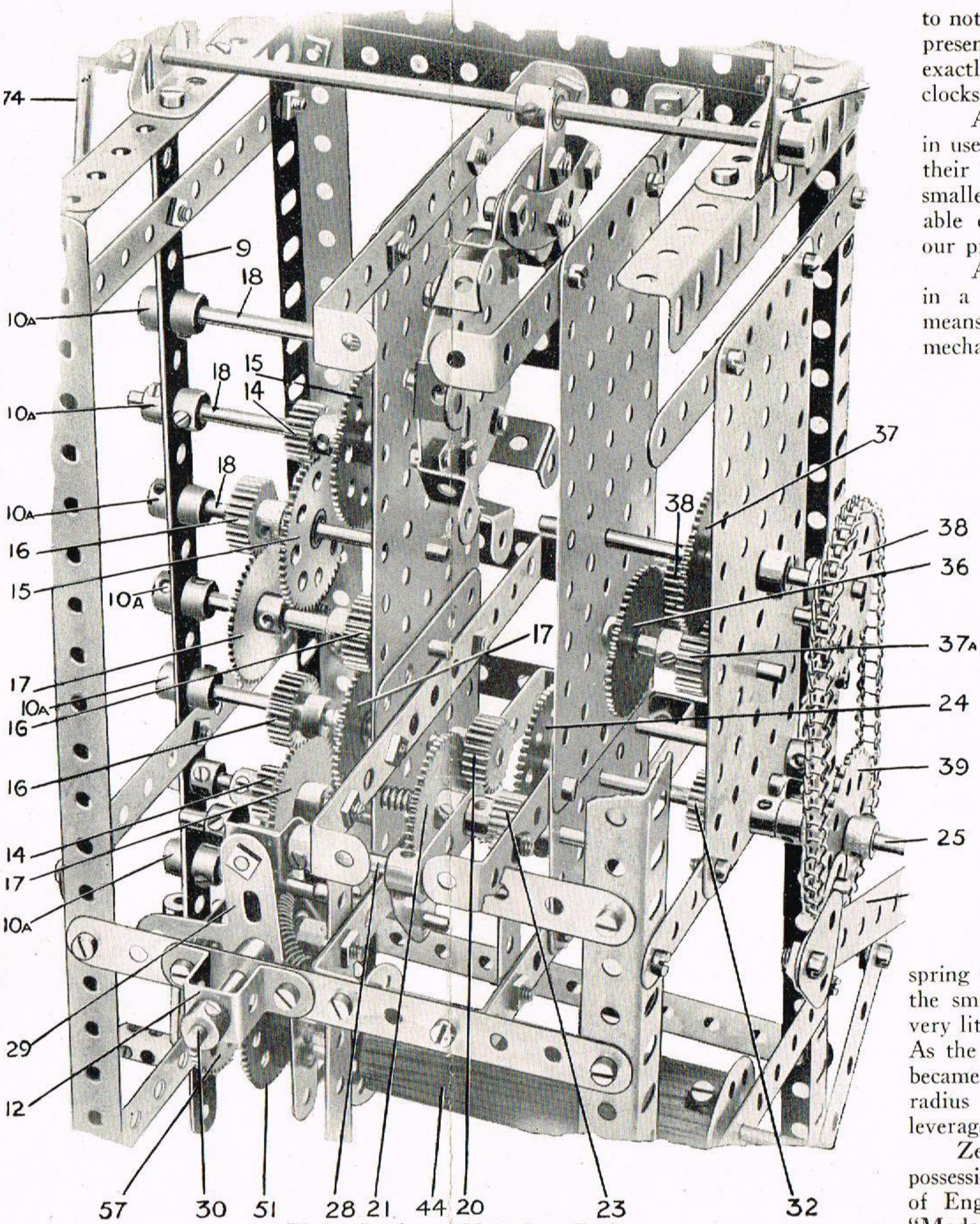


Fig. 9. Section of Main Gear Train.

After "Grandfather" clocks had been in use for some time, clock-makers turned their attention to the construction of smaller clocks. These were called "portable clocks," and it is from them that our present day watches originated.

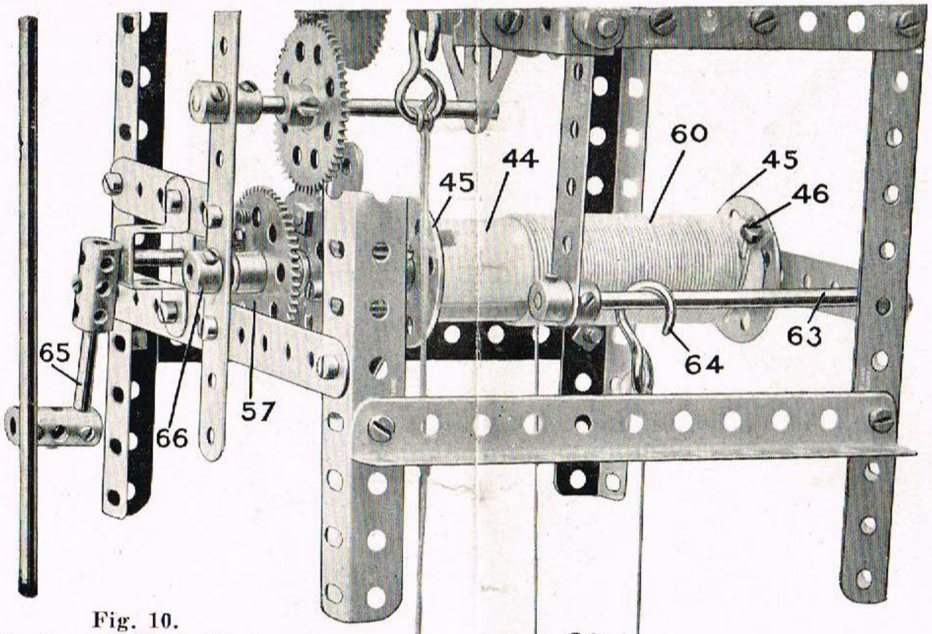
As it is impossible to use a pendulum in a small portable clock some other means had to be found for driving the mechanism. About 1500 Peter Hele of Nuremberg found that a coiled spring might be used instead of a weight, for both store up energy of a similar nature. Trouble was soon met, however, as it was found that as the spring uncoiled it lost its tension and the speed of the wheels became slower and slower.

In 1525 Jacob Zech, of Prague, brought forward a solution to this difficulty. He placed the mainspring in a drum, which revolved as the spring uncoiled. To the drum was attached one end of a string of cat-gut, which was wound on to a conical roller called the "fusee." When the spring was fully wound, the chain lay at the small end of the fusee, where it had very little leverage on the clock mechanism. As the mainspring unwound, and its force became less, the chain came off a larger radius of the fusee, and thus a greater leverage was obtained by the spring.

Zech's first clock is now in the possession of the Society of Antiquaries of England. It is inscribed in Bohemian "Made in Prague by Jacob Zech in 1525," has a spring as motive power with barrel and fusee, and is the oldest portable clock in existence.

In these portable clocks, or watches as they afterwards became, a small flywheel, actuated by a hair-spring, was used in place of a pendulum. Its regular movement allowed the main spring to unwind a little at equal intervals in exactly the same manner as the pendulum allows the weight to fall a little at each swing in the heavier types of clock. The differences in temperature were overcome by Thomas Earnshaw, who invented the compensating balance. This uses the unequal expansion of different metals so as to keep the leverage of the rim of the wheel constant.

There must have been hundreds of disappointments before all the difficulties of clock-making were solved and many years of patient study and careful work had to be expended over each new problem as it arose. Unfortunately, space will not allow any description of the many famous clocks in existence, but we hope that this rough outline of the history of clock-making will add further interest to the construction of the Meccano model Grandfather Clock.



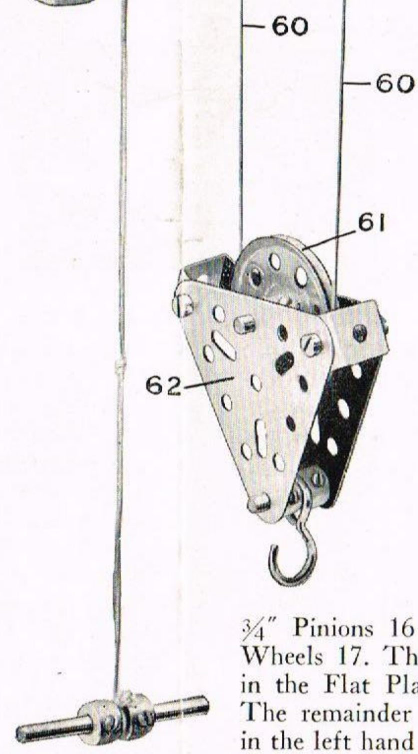


Fig. 10.
Section of Clock Mechanism showing winding gear and weight pulley.

The Meccano Model

The following instructions will enable any Meccano boy to build a real Grandfather Clock with Meccano. When finished the clock stands over 6 ft. in height, and if carefully adjusted it will keep accurate time. With the exception of an 18 lb. weight, the dial, and a small piece of flat spring with which to suspend the pendulum, the clock is made entirely of Meccano parts.

The splendid Meccano model should have a wide appeal not only on account of its mechancial interest, but also because it will render real service in the home. It also affords an excellent demonstration of the principles governing clock mechanism, etc.

It is quite certain that among the hundreds of models that can be constructed with Meccano, very few, if any, excel the Meccano Clock from the point of view of general interest and excellence of construction.

Any clock mechanism is a wonderful piece of work, but we are so familiar with clocks of all kinds and descriptions that we seldom appreciate them properly. The principles involved are perfectly simple, however, and as soon as the Meccano boy commences to build the model he will find that clock-making is not nearly so difficult as he had imagined.

Frame of Mechanism

The construction of the model should be commenced by building the frame that carries the gear trains. This frame is shown in Fig. 2, and as will be seen it consists of four 12½" Angle Girders 1, connected by 5½" Angle Girders 2 and 5½" Strips 3.

Three 5½" by 2½" Flat Plates 4 are bolted at their ends to 5½" by ½" Double Angle Srtpis 5, and are extended at their lower ends by 2½" by 2½" Flat Plates 6. It will be noted that the lower Double Angle Strips 5 are inserted between the Plates 4 and 6, and that the Plates 6 overlap Plates 4 by two holes. Two Cranks 7 are bolted to Trunnions 8 on the top of the frame and form the bearings for a Rod that supports the pendulum.

A 12½" Strip 9 is bolted vertically to one of the Trunnions 8 and to 5½" Strips 10 to form bearings for the main gear train. A Double Bent Strip 11 is bolted on the left side of the frame to form a bearing for the winding handle 65 (Fig. 3), and a second Double Bent Strip 12 forms a bearing for the shift gear that disconnects the driving train from the gearing of the hands so as to allow the fingers of the clock to be re-set when desired. A Flat Trunnion 13 (Fig. 2) is bolted below the left Flat Plate 6 so as to form the bearing for the lowest 3" Rod of the Clock train 18 (Fig. 3).

No difficulty should be experienced in completing the frame, for the positions of the other Strips, etc., are shown clearly in Fig. 2.

The Main Gear Train

After the frame has been constructed the next part for attention should be the main gear train, which is shown in Fig. 3. This consists of three ½" Pinions 14 that are in engagement with the 57-teeth Gear Wheels 15. Three ¾" Pinions 16 are secured on the Rods 18 and engage the 50-teeth Gear Wheels 17. The top Rod 18 is 3½" long and one of its ends is journalled in the Flat Plate 4 while the other end is carried by the Strip 9, Fig. 2. The remainder of the Rods 18 are each 3" long. They pass through holes in the left hand plates 4 and 6 and the 12½" Strip 9 (Fig. 2) and are held in position by Collars 10a that are secured to the Rods on each side of the Strip 9. No Collars are necessary, therefore, at the other ends of the Rods.

On the end of the 3½" Rod 19 is a ¾" Pinion 20, which is shown more clearly in Fig. 9. This Pinion gears with a 50-teeth Gear Wheel 21 fixed on the 2" Rod 22, which Rod is so placed as to be free to slide in the vertical Plates 6 (Fig. 2).

Carried on the 2" Rod 22 is also a ½" Pinion 23 geared with a 57-teeth Wheel 24 on a 4½" Rod 25. The minute hand of the Clock is carried on the end of the 4½" Rod 25, as is clearly shown at 26 (Fig. 3). The web of a Crank 27 (Fig. 3) engages the 2" Rod 22, the Crank being bolted to a 3½" Rod 28 that carries a Double Bracket bolted to a Bell Crank 29 and pivoted on a Rod 30. The latter is carried in the Double Bent Strip 12.

This part of the mechanism is very intricate and it will well repay the builder to study carefully the illustrations before proceeding with the construction, and so obtain a clear idea as to the general layout of the gear trains and the purpose that is served by each wheel. Great care should also be taken to see that each shaft and wheel is in perfect alignment, as much depends on the free running of the gear trains.

Adjujsting the Hands

The reference numbers given here refer to Fig. 3, which clearly shows the gear trains. A cord 31 is connected to the Bell Crank 29 and by pulling on this cord, the Rod 28 is caused to slide and move the gear 21 in or out of engagement with the Pinion 20. This releases the driving train from the Clock hands and thus enables the hands to be adjusted freely.

In order to drive the hour hand from the minute hand Rod 25, a ½" Pinion 32 on the Rod 25 drives a 57-teeth Gear 33 mounted on a 2" Rod.

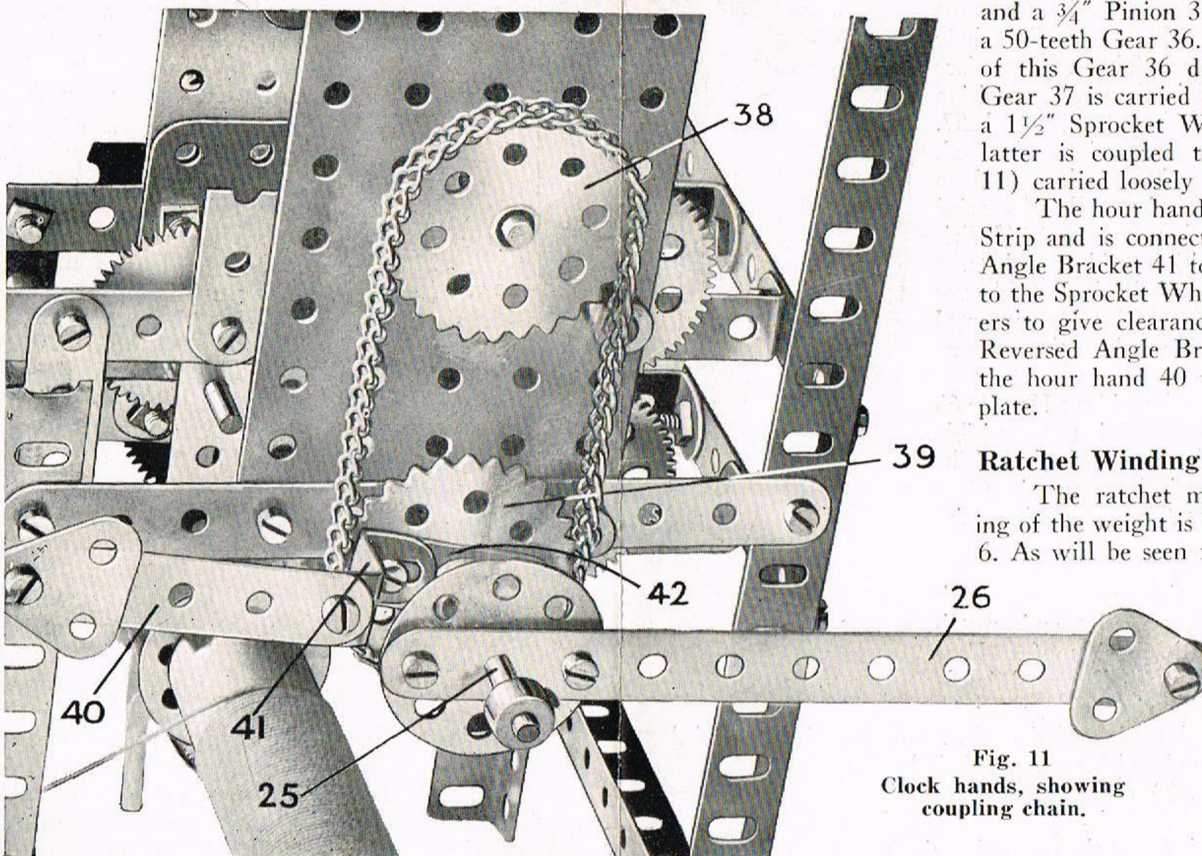


Fig. 11
Clock hands, showing coupling chain.

This Gear 33 engages a second 57-teeth Gear 34 and a ¾" Pinion 35 on the Rod of Gear 34 drives a 50-teeth Gear 36. Another ¾" Pinion on the Rod of this Gear 36 drives a 50-teeth Gear 37. The Gear 37 is carried on a 2½" Rod on which also is a 1½" Sprocket Wheel 38 (Figs. 3 and 9). The latter is coupled to a similar Sprocket 39 (Fig. 11) carried loosely on the Rod 25.

The hour hand 40 (Fig. 11) consists of a 2½" Strip and is connected by means of a ½" Reversed Angle Bracket 41 to a 1½" Strip 42. This is bolted to the Sprocket Wheel 39 and spaced by two Washers to give clearance for the Sprocket Chain. The Reversed Angle Bracket 41 is necessary to enable the hour hand 40 to be brought clear of the dial plate.

Ratchet Winding Mechanism

The ratchet mechanism permitting the winding of the weight is built up as shown in Figs. 5 and 6. As will be seen from the diagrams the complete ratchet element is made by passing a 6" Rod 43 (Fig. 6) through a Wood Roller 44, the ends of which are clamped between Bush Wheels 45 secured on the Rod. The bosses of the Bush Wheels are inserted in the ends of the Wood Roller and the bolts 46 engage in the end notches of the roller to key the latter to the Bush Wheels.

A 1" Gear Wheel 47 is bolted on the Rod 43 with its boss close against the end Bush Wheel 45. Four Washers 48 are then placed on the Rod. After this the element shown in the centre of Fig. 6 is passed over the Rod 43. This element is made up as follows. Two 2½" Strips 49 are bolted by ¾" Bolts 50 to a 57-teeth Gear Wheel 51, lock nuts 52 being fitted on the bolts on each side of the Gear Wheel 51 and also beneath the Strips 49. A Pawl 53 is pivoted at 54 in the end hole of the Strips 49 and a Spring 55 is connected to the Pawl boss by a screw and also to a ¾" Bolt 56 carried on the Gear Wheel 51.

After the assembly, the complete element is slipped over the Rod 43. It is loose thereon, and the Pawl engages with the teeth of the Gear Wheel 47 (see Fig. 5). It will be noticed that the old style Meccano Pawl is used in conjunction with a 1" Gear Wheel, but the new Pawl and Ratchet Gear (part Nos. 147 and 148) may be used equally well in their place.

Non-slipping Device

A 57-teeth Gear Wheel 57 (Fig. 5) is passed over the Rod of the Roller and secured thereon, and a Collar 58 (Fig. 5) is fastened against the outside of the Wheel 57. In order that the latter may not slip on the Rod 43 when taking the whole of the strain in winding the heavy weight, a flat surface 59 (Fig. 11) is filed on the Rod in the correct position for engagement by the screw of the Gear Wheel 57. This gives the Gear Wheel 57 a secure grip on the Rod.

A Meccano Wire Line 60 (Fig. 10) is wound on the Wood Roller 44 and passed round a Pully 61 carried in the pulley block 62. This is made up of two 2½" Triangular Plates bolted together with Double Brackets.

The other end of the Line 60 is hooked at 64 over the Rod 63. After the Wood Roller 44 has been inserted in its place, another Collar 66 is secured on the extreme end of Rod 43 (Fig. 5).

The winding of the Clock is effected by a Handle 65 (Figs. 3 and 10) provided with a ½" Pinion (not visible in the photograph) that engages the Gear Wheel 57. The Roller 44 drives the main gear train by reason its Gear Wheel 51, which engages the first Gear 15 of the train.

The Escapement Wheel and Pallet

Next proceed to construct the escapement. This consists of an escapement wheel or pallet and crutch mechanism. The former (Fig. 8) consists of a Face Plate 66a to which are attached eight ½" Reversed Angle Brackets 67. To make these quite rigid they must be pressed hard up against the circular edge of the Plate and then bolted tightly in position. Washers 68 should be placed beneath the bolt heads.

The pallet mechanism (Fig. 7) should be constructed from two 2½" reversed Curved Strips 69 bolted one on each side of the web of a Crank 70. Angle Brackets 71 are bolted in the end holes of the Curved Strips that form the crutch.

The Crank 70 is bolted on a 6" Rod 72 (Fig. 3) and a 5" Rod 74 is secured to a Coupling 73 carried on the end of the Rod 72. At the lower end of this is a Coupling 75 carrying two 2" Rods 76, which engage against two Collars 77 on the pendulum Rod 78.

The Pendulum

As shown in Fig. 4, the pendulum consists of three 11½" Rods 78a, 78c and 78d and a 5" Rod 78b connected by Couplings. The complete pendulum is connected to the lower end of the 11½" Rod 78 (see Fig. 3). The pendulum weight 79 is made up of ten Flanged Wheels. A light spring 80 connects the Strip Couplings 81 and 82, the Coupling 81 being connected to the 8" Rod 83 which is secured in the bosses of the Cranks 7. This spring is not a Meccano part: a strip of thin brass, or part of an old clockwork spring, about 1½" long and ¼" wide, will serve admirably for the purpose. The spring is necessary in order to provide for a perfectly easy swinging movement of the pendulum.

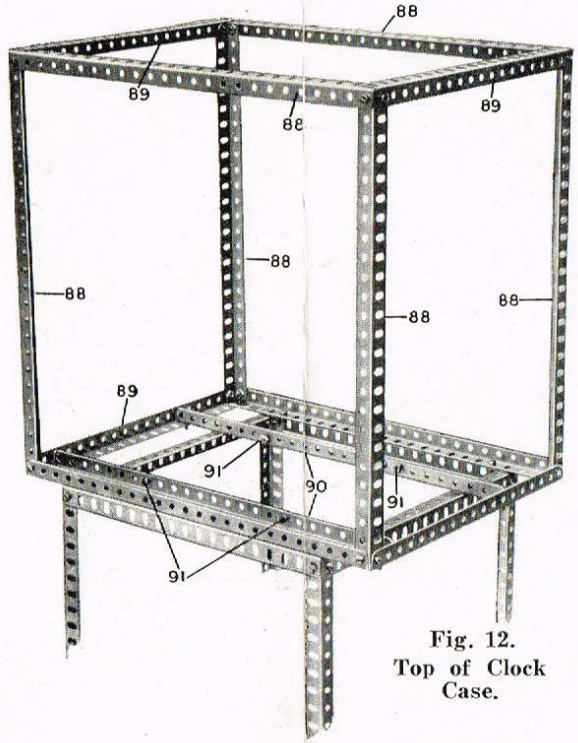


Fig. 12.
Top of Clock Case.

Constructing the Clock Case

The clock case may now be built. It consists of two vertical 24½" Angle Girders at each corner, overlapped three holes. To these are secured 12½" Braced Girders 84 (Fig. 1) connected by 9½" horizontal Braced Girders 85. The base consists of 12½" vertical Braced Girders 86 and horizontal 18½" Angle Girders 87.

We now come to the construction of the head of the clock. The frame for this is shown very clearly in Fig. 12. It is built up of 12½" Angle Girders 88 at the front and back and connected by 9½" Angle Girders 89. The lower ends of the vertical Angle Girders (Fig. 2) of the works casing are secured by bolts 91 to the 12½" Angle Girders 90. These rest on the top of the side Angle Girders of the main frame.

The dial should be secured by bolts to the Braced Girders, as indicated in Fig. 1 and then the works casing should be placed in position from the rear.

The hour and minute hands next are secured in place at the front of the dial and the model is complete. After the final assembly of the Clock parts, the mechanism may be wound up and the Clock set in motion.

It will perhaps be found necessary to make several little adjustments before smooth operation of the different parts is secured. Special attention should be paid to the pendulum and probably experiments will have to be made in order to ascertain the exact position required for the weight 79, for any slight alteration to the position of this weight will make a great difference in the timing of the clock and until the right position is found the clock will either gain or lose time.

Parts Required for Clockwork Movement.

1 of No. 1		4 of No. 12		2 of No. 18b		20 of No. 38		2 of No. 72		2 of No. 126
15 ” 2		4 ” 13		10 ” 20		1 ” 43		2 ” 76		1 ” 126a
1 ” 2a		1 ” 13a		1 ” 21		2 ” 45		2 ” 77		1 ” 128
2 ” 4		2 ” 14		3 ” 24		5 ” 48d		2 ” 90		1 ” 141
1 ” 5		3 ” 15a		5 ” 25		3 ” 57		10 ” 94		1 ” 147a
1 ” 6		9 ” 16		6 ” 26		35 ” 59		2 ” 95a		
2 ” 6a		1 ” 16b		5 ” 27		4 ” 62		1 ” 106		1 18-lb. weight
4 ” 8		1 ” 16a		8 ” 27a		9 ” 63		1 ” 109		1 dial
6 ” 9		8 ” 17		1 ” 31		2 ” 63b		2 ” 111		1 piece flat spring
3 ” 11		2 ” 18a		108 ” 37		3 ” 70		9 ” 125		(about 1½" long)

Parts Required for Clock Case and Frame

4 of No. 2	341 of No. 37
2 ” 3	8 ” 38
8 ” 7	4 ” 97
4 ” 7a	8 ” 98
14 ” 8	51 ” 99
12 ” 8a	24 ” 99a
4 ” 9	4 ” 108
10 ” 12	