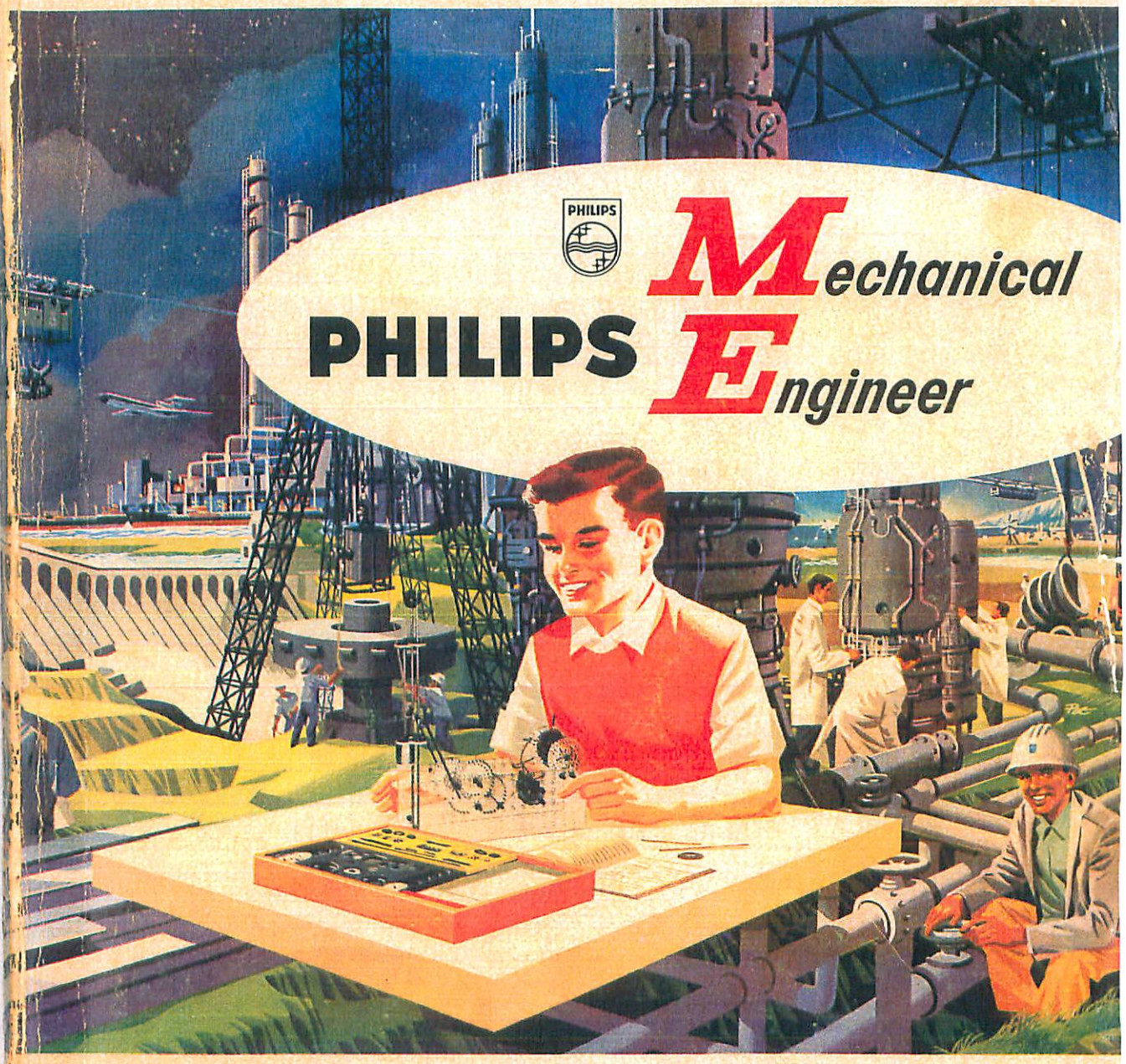


PHILIPS

PHILIPS Mechanical Engineer

instruction book

PREFACE

You are now the owner of a Philips Mechanical Engineer assembly kit - a kit with over 600 components enabling you to make as many mechanical constructions as you like.

In this book you will find 41 descriptions of assemblies - clocks, windmills, caterpillar-trucks, cranes and pumps, to name just a few. The number of constructions you can make depends on your skill and technical ingenuity. From the hundreds of components in the kit you can make hundreds of other assemblies.

In constructing several models you will learn a great deal about the wonderful powers used in techniques, such as elasticity, water-power, air pressure and gravity, as many of the models made from this assembly kit can be put to work with these sources of energy.

If you are already in the possession of a Philips Electronic Engineer kit, you will be able to make numerous electrically controlled models also.

We wish you lots of fun with your Philips Mechanical Engineer kit!

Mechanical Engineer

Instruction book

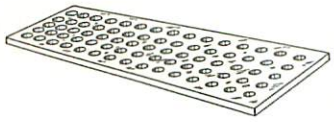
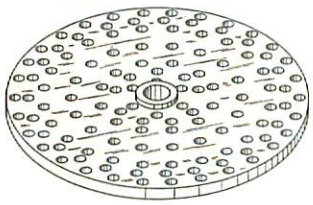
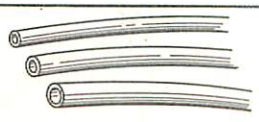
3122

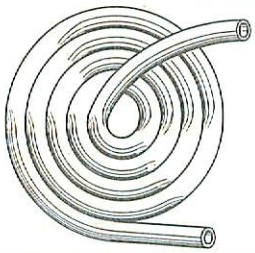
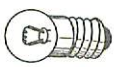
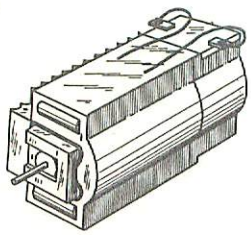
In this book, more than 40 models, which can be made from the ME-kit, are described and lots of others can be invented by yourself.
We are convinced that one of the clocks will be in service in your room for a long time. How beautiful the clock is going to look and how good it will work depends of course on the way you use the components in this assembly kit.
Damage to the plastic parts can be prevented by using the special tools from your kit only and not forcing anything, so never lose your temper. That is why we want to advise you to start with the simple models, which are given at the beginning of the chapter "Comprehensive Assembly Instructions".
Loosen the collets and clamping springs before moving a spindle and never try to push a collet into a hole from the wrong side.
When pushing the pins in or out wheels always lay them on the supporting tools. If the plastic components have become dirty, they can be cleaned with just water and soap.
Bearings can be greased with sewing machine oil if necessary.
However, be very careful and thrifty with the oil as oil and dust form a mud like layer which is not very nice and prevents the models from working correctly.
Be very careful never to spill oil on the rubber wheels as the rubber is affected by the oil.
If any components are missing do not try cutting spindles into smaller pieces. This will give trouble later on.

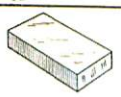
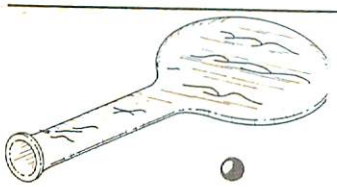
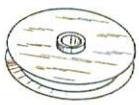
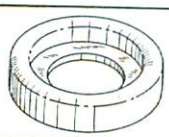
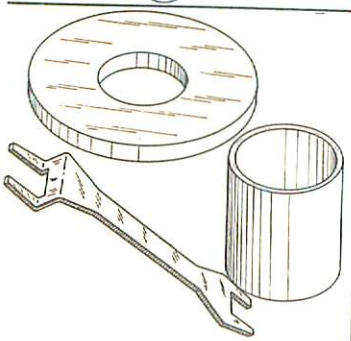
GENERAL page 7

GEARS page 24
SWITCHES page 35

MODELS page 39

	No.	Designation	Quantity	
	1	Plate	2	Transparent plastic plates with tapered holes to take collets and terminals. Used as frame and as base plate for models.
	2 3 4	Collet 2 mm Collet 3 mm Collet 4 mm	8 24 16	Black plastic tapered plugs with holes of 2, 3 or 4 mm diameter. Used for fixing spindles and bushes in tapered holes in wheels and plates.
	5 6	Large wheel Small wheel	12 10	Transparent plastic wheel with holes for pins and tapered holes in the centre to take collets. Used as gear wheel, ordinary wheel and structural unit. Same as above, but smaller and with fewer holes.
	7 8	Pin Long pin	280 30	Nickel-plated spring steel pins. May be inserted in plastic wheels to make these into gear wheels. Same as above, but longer.
	9	Spindle, 2x96	5	2 mm stainless steel spindle, 96 mm long.
	10 11 12 13 14	Spindle, 3x24 Spindle, 3x48 Spindle, 3x96 Spindle, 3x120 Spindle, 3x324	4 7 6 4 2	Hollow spindle made of nickel-plated brass, 3 mm dia. Uses: standard spindle in all normal cases; also as a rod, lever or conduit.
	15	Clamping spring	24	V-shaped spring of bright stainless steel. Used for fixing 3 mm spindles and bushes at right angles to each other.
	16 17 18 19 20 21	Bush, 1,5x8 Bush, 3x12 Bush, 3x24 Bush, 4x12 Bush, 4x24 Bush, 5x4	3 16 6 16 4 3	Thin-walled, silver-plated brass tube with crimped edge at one end. Available in six sizes.
	22 23 24	Washer 2 mm Washer 3 mm Washer 4 mm	24 16 6	Smooth nickel-plated brass washer. Holes of 2, 3 and 4 mm diameter. Used mainly as inserts in rotating models.
	25 26 27	Sleeving 2 mm Sleeving 3 mm Sleeving 4 mm	1.50 m 0.50 m 0.50 m	Black flexible plastic tube. Pieces are cut off for use as adjusting tubes on spindles.

	No.	Designation	Quantity	
	28	Plastic tube	0.50 m	Transparent plastic tubes. Used as valve chamber and gauge glass.
	29	Rubber hose	1 m	Thin-walled flexible rubber hose with an outside diameter of about 3.5 mm. Used for air and water.
	30	Cord	6 m	Thin flexible cord, very strong and resistant to wear. Used as hoisting cable and clock chain.
	31 32 33 34	Flex (red) Flex (black) Flex (green) Flex (grey)	1 m 1 m 1 m 1 m	Insulated electric flex in four colours. Used for building electrical circuits.
	35 36 37	Hairpin spring Large coil spring Small coil spring	12 16 5	These three types of steel wire springs are used for making electrical connections. They are also used occassionally in mechanical structures.
	38	Contact spring	6	This chromium nickel-steel wire spring is used for the assembly of electric switches and for spring mounting 3 mm standard spindles.
	39	Lamp	2	Standard tungsten lamp with small current consumption. Used for illumination of models or for warning purposes.
	40	Electric motor	1	D.C.-collector motor in transparent plastic housing for 6-12V.

	No.	Designation	Quantity	
	41	Magnet	2	Ceramic ferroxdur magnet. Used for mechanical electronic experiments.
	42	Rubber band	12	Black rubber bands. Used as fixing material and drive belt.
	43	Diaphragm housing	2	Round plastic box. With the diaphragm stretched on, is used as cylinder for pump or air motor.
	44	Balloon	2	The balloon is cut to pieces, the pieces being used as diaphragms for models operating with water or air.
	45	Ball	10	Nickel-plated steel ball. Used as suction and press valve in pump structures.
	46	Rubber plug	1	Soft rubber plug for connecting to water tap.
	47	Escapement	1	Black nylon lever. Used for balance and pendulum mechanisms.
	48	Pulley	4	Black plastic wheel with V-slot. Used as guide roller for cord and elastic.
	49	Tyre 60 mm	6	Rubber tyre to fit large wheel.
	50	Tyre 30 mm	2	Rubber tyre to fit small wheel.
	51	Pin insertion tool	1	Tool used for inserting and removing pins.
	52	Supporting ring	1	Nickel-plated steel disc. Used as supporting ring during the insertion of pins.
	53	Supporting pipe	1	Nickel-plated steel pipe. Used as a support during the removal of pins from wheels.
	54	Special spanner	1	Chrome nickel steel spanner. Used for tightening and loosening collets.

GENERAL

MORE ADVANCED DESIGN THEORY

ASSEMBLY OF THE VARIOUS PARTS

Building models with your ME 1200 building kit means putting various parts together in the correct way. That is all! In this chapter we will tell you briefly how this should be done, and this will help you to understand the drawings and building instructions of the next chapter. You will find that building is quicker and easier if you read the instructions carefully and start off with the models marked with an asterisk. These are the simplest models and they will teach you how to read the drawings and avoid mistakes.

Mounting-Plate (No. 1)

The plate (No. 1) is used in most models. The 75 holes in it are tapered, which means that the collets (Nos. 2, 3, 4), can be pushed into it from one side only. This side, which we call the top, is the side on which the letters J to X and figures 1 to 5 are embossed on the plate, along the edges. These letters and figures serve as a reference, like a chessboard. X1 refers to the hole on the right hand top corner, V4 is more to the left and lower down, etc. (A).

When fixing parts on the mounting plate make sure that you check the top for the reference letters and figures in order to prevent mistakes!

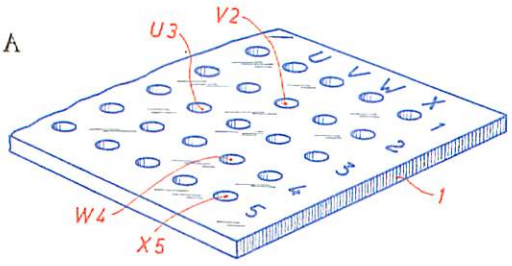
Collets (Nos. 2, 3, 4)

The collets are used to fix spindles and bushes of various diameters into the conical holes in the mounting-plates and wheels. These collets can only be pushed into the holes from the top (i.e. the side on which the letters and figures can be read).

Before being pushed into a hole they should be slipped over the spindle or bush which is to be fixed (B). The collets must be firmly fixed into the holes, and to ensure this the spanner (No. 54) must be used (C). This spanner fits the flat sides in the thick edge of the collet. Press the collet down with the spanner against the outer edges and at the same time move the latter to and fro a little, this enables the collet to be fixed firmly. The side of the spanner used depends upon how much room is available.

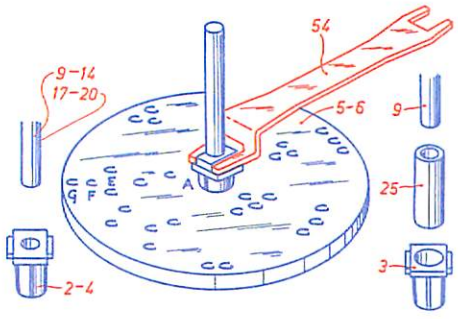
To remove a collet, slip the spanner around the inner flat edges of the collet. Again move the spanner to and fro and pull gently. In the case of the thinnest spindle, (2 mm), it is sometimes difficult to prevent slipping and in such a case push a short length of 2 mm plastic sleeving (No. 25) over the spindle and use a 3 mm collet (D).

A



C

B



D

Wheels (Nos. 5, 6)

Wheels, which are used in all models, come in two sizes, the larger (No. 5), with a diameter of 54 mm, and the smaller (No. 6) with a diameter of 24 mm. The wheels are provided with a large number of holes indicated by letters. The top side is the one from which the letters can be read, the under side has a small reinforcement rim at the centre. Wheel No. 5 contains one large tapered hole in the centre in which a collet can be pushed from the top and 126 smaller holes identified by capital letters and distributed over seven circles.

A 6 holes, B 9 holes,
C 12 holes, D 18 holes,
E 24 holes, F 27 holes,
G 30 holes.

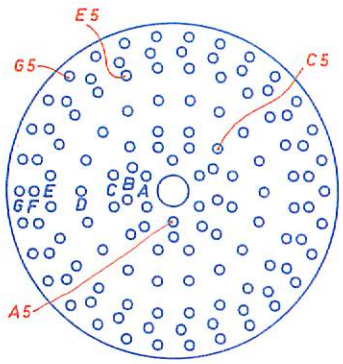
In the building descriptions the holes are indicated by one of the above letters and a figure (A). Turning clockwise the first hole past each letter is called 1, the next one 2, etc.

The small wheel (No. 6) contains the tapered centre hole and 27 small holes in three circles with 6, 9 and 12 holes, indicated by small letters a, b, c. Thus, if one of the descriptions says to insert a pin in hole B3, we automatically know that reference is made to a large wheel while b3 refers to a small wheel.

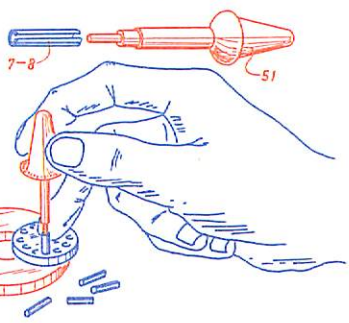
Pins (Nos. 7, 8)

The nickle-plated steel pins fit in the small holes of the wheels. We have to use the special insertion tool, the "pin-driver" (No. 51) and the supporting ring (No. 52) when inserting these pins into the wheels. These tools enable you to place the pins in the holes quickly and accurately, without either damage to pin or wheel or irritation because the wheel wobbles or a pin slips out of your fingers. The wheel should always be laid flat on the supporting ring. Whenever the top of the wheel is facing upwards, the downward-facing reinforcing edge should be made to fall inside the hole in the ring, otherwise the wheel will wobble. To insert a pin, place it on the pin-driver and retain it with the middle finger (B). Place it over the appropriate hole and apply a light pressure to make the pin glide into the hole (C). Ensure that you hold your pin-driver perpendicularly to the wheel and immediately above the hole. If not, and you use too much force, you will only succeed in damaging the hole, which will cause unreliable operation of the model you are building.

A



B



C

Unless otherwise stated, the pins must always be placed in the wheels with the slots facing towards the spindle.

The same tool, No. 51, is used to remove the pins from the holes. Place the wheel on the supporting pipe No. 53 with the pins to be removed pointing downwards. The pin-driver in then inserted into the pin and pushed down as far as it will go. The pin will then drop out the wheel (A). Remember to keep the tool vertical on the wheel and that only slight pressure is necessary.

To place a 2 mm washer on a pin place the 2 mm washer on a 3 or 4 mm one. Then press the pin into the 2 mm washer with the pin-driver. If then the pin is pressed into a wheel the washer will rest against this. If the washer is to be away from the wheel, the pin must be pressed further down into the ring. Then lay the ring on a 3 or 4 mm bush.

Double Wheels

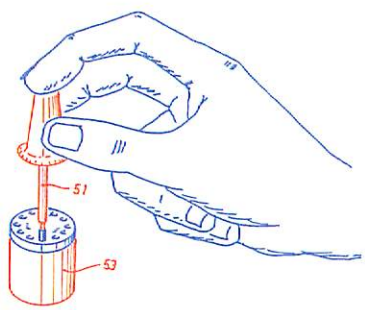
Double wheels are made from two wheels joined together by a number of pins. The wheels must be placed with their undersides facing each other. This is necessary as the collets have to be inserted from the top sides. All double wheels, whether used as drive wheels or caterpillar wheels, are common in that the two wheels have an equal space in between them.

In order to achieve this, we proceed as follows: Place a wheel on the supporting ring No. 52 in such a way that it is halfway under the wheel placed upside down into which the pins are to be pushed (B). One by one the pins are pressed through the holes until they just touch the supporting ring No. 52. They then extend about 3 mm above the top of this wheel.

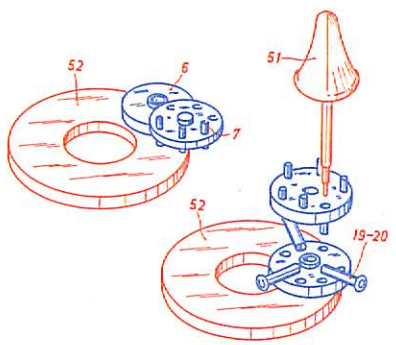
When all the pins have been placed in position, press back one with the top of the wheel. Then hold this wheel with its top upwards above the second wheel which must lie upside down (C).

Carefully use the pin-driver to press the pin into one of the holes of the second wheel. To obtain the required spacing between the

A



B



C

two wheels, three 4 mm bushes No. 19 or 20 (with the riveted edge projecting from the wheel) are placed on the bottom wheel. All the remaining pins are then pressed through into the corresponding holes of the bottom wheel.

It is, of course, necessary to ensure that the pins line up with the holes in the bottom wheel. In the case of a double wheel where pieces of rubber hose are used on the pins, e.g. in the clocks, the short length of hose should, of course, be pushed across the pins before they are pushed through into the second wheel (A).

Dismantling follows the same procedure as above, but in reverse. Firstly put three bushes No. 19 or 20 between the two wheels. Next place the double wheel onto the supporting tube (B). Take care that you place the double wheel onto the supporting tube in such a way that none of the pins can be pushed against this tube. Then push all the pins out of the top wheel. Finally, after removing the top wheel, the pins are pushed out of the bottom wheel.

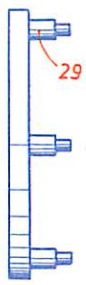
If for double wheels the long pins (No. 8) have to be used, then, instead of the bushes, R6 (penlite) batteries are used for spacing the wheels apart.

Gear Wheels

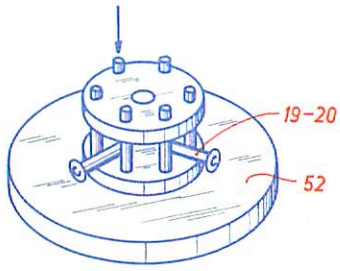
Gear wheels are not difficult to make and their construction has actually been described in the paragraph on pins. The construction drawings show clearly how many pins have to be inserted and in which holes. Do not forget that the slots must be facing the shaft, unless otherwise stated.

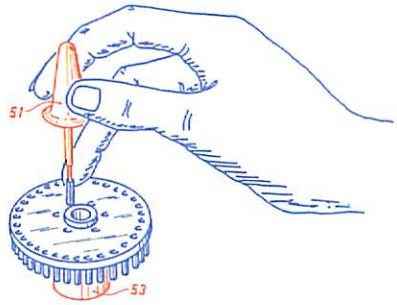
When double gear wheels have to be made, the pins must be inserted in a certain sequence. As a rule there are more pins on one side of a double gear wheel than on the other. Start with placing the wheel on the supporting ring No. 52. Complete the circle with the most pins first. This must usually be done from the top of the wheel (follow the construction drawing) as here the head of the collet remains accessible for the collet spanner. This might be impossible if the smaller circle was fitted on the top. Once the largest circle of pins has been completed the wheel can be turned over, placed on the supporting tube and from the other side, the small circle of pins can be made (C).

A



B





C

Spindles (Nos. 9 to 14)

The solid stainless steel spindles of 2 mm diameter can be pushed into the hollow nickel plated spindles or bushes of 3 mm diameter. Provided the shafts have not been bent or dented the thin spindles will turn smoothly in the 3 mm shafts. The 3 mm shaft in turn can be pushed into the 4 mm bushes (Nos. 19, 20) in which they can turn easily (A).

In this way we can have up to three concentric spindles, which can all turn independently, and use is made of this in some clocks with a central second hand.

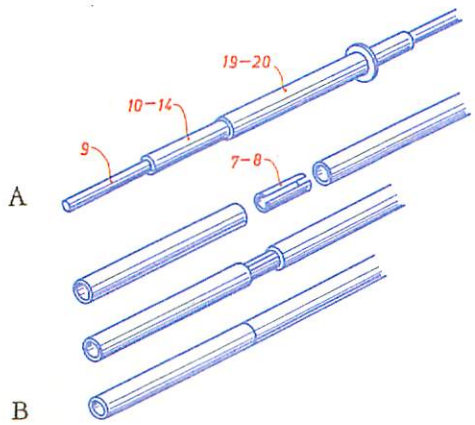
It is possible to make a very long spindle by joining two 3 mm spindles together by means of a pin No. 7 or No. 8 (B). To remove the pin when disassembling use one or several 2 mm shafts one after the other. Spindles of 2 mm can also be joined together by means of a pin.

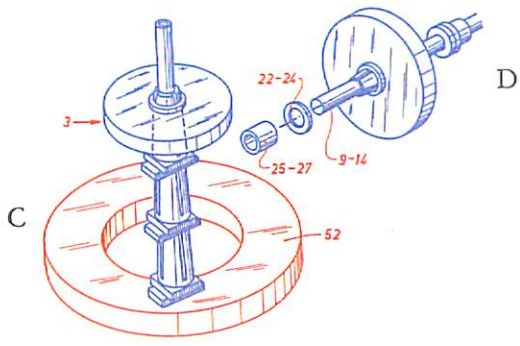
Wheels on Shafts

In the building instructions an arrow has been drawn against each wheel. The same arrows are repeated along the shafts where the wheels are to be fitted. Each arrow carries a number and each shaft can be divided into a number of positions, 1 being the position of the first collet that can be placed on the shaft, 2 that of the second collet, etc. Thus an arrow with a 5 signifies the 5th position. When a wheel has to be mounted in position 3 then proceed as follows (C).

First push three collets onto the spindle. Rest it on the supporting ring with the lowermost collet also resting on this ring and push the wheel onto the uppermost collet and tighten this with the key. Remove the other two collets.

When previously prepared spindles and wheels are fitted in a frame, movement of the spindles lengthways must be prevented. They are locked by pushing a washer (Nos. 22, 23 or 24) along the spindle and then a short length of plastic sleeving (Nos. 25, 26 or 27) (D). The 2 mm piece of sleeving can be stretched slightly by pushing them onto one of the tapered ends of the spanner and after a little while they shrink to their original size.





Spindles on Wheels

A 3 mm spindle can also be fixed at a right angle to a wheel at a hole other than the central one. A pin is first pressed into the appropriate hole and then a spindle is pressed over it (A). To remove the pin later on one or more 2 mm spindles must be used.

It is also possible to mount a spindle parallel to a wheel when it can be used as a lever. This is done by placing it between two pairs of pins. If the pins are so inserted that the slots point away from the spindle, this will be firmly held. (B) This is made use of for the assembly of a lever in a rotary switch. If, however, the slots are facing one another the spindle will have some play (C) e.g. when required for the front axle of a steerable car or the pendulum drive of a clock.

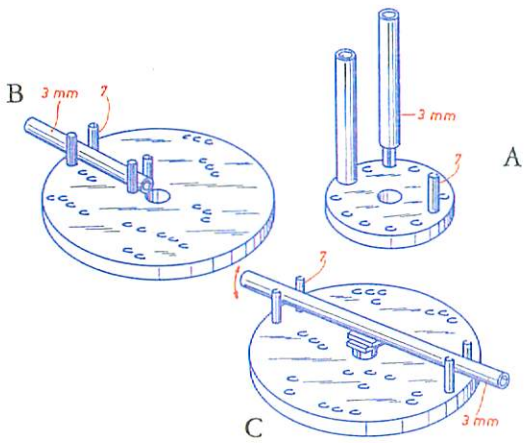
Clamping Springs (No. 15) for Fixing Spindles to Spindles

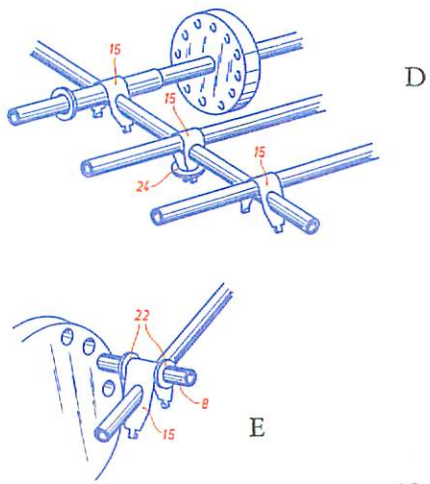
Spindles and bushes of 3 mm diameter can be fixed perpendicular to one another by means of the clamping springs. The clamping spring is compressed in two fingers of one hand while the spindle is pushed through the two holes in the spring with the other hand. Still compressing the clamping spring, push the other spindle or a bush through the round corner of this spring. When both parts are in the desired position release the spring (D). Never try to move a spindle without fully compressing the spring.

If several clamping springs are to be fitted simultaneously they can be kept compressed by pushing 4 mm washers across the projecting lugs, until everything is in position, when the washers can be removed.

The clamping springs are also used for crank assemblies. A long pin is inserted in a wheel with 2 mm washers pushed onto it. The spring is placed across the pin between the washers and a 3 mm spindle is inserted in the holes (E).

(N.B.) The spindle in the round corner of the spring will move more easily lengthwise than the one pushed through the holes. The spindle most likely to shift should, therefore, be inserted in the holes.





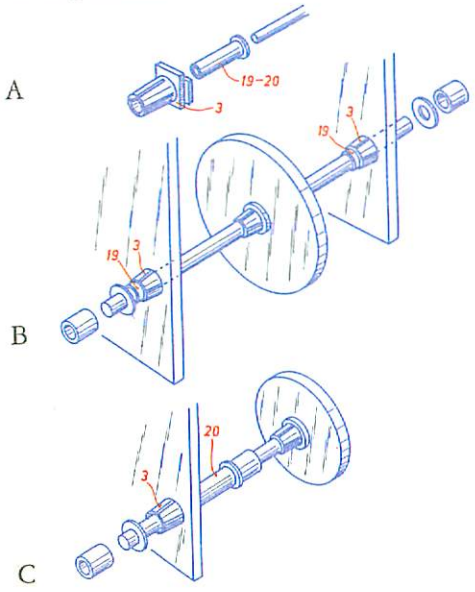
Bushes (Nos. 16 to 21) as Bearings

The bushes (Nos. 16 to 21) are mainly used as bearings for spindles. They are fixed in the plate by pushing the bush into the thick end of a collet unless otherwise stated (A). The 5 mm bushes, however, fit straight into the holes in the plate and are used e.g. as bearings for 4 mm bushes.

When a spindle needs two bearings, the short bushes (No. 17, 19) are used (B). When, however, only one place is available for seating the spindle this should by done by means of a bush (No. 18, 20) (C).

The bushes are also used where a wheel has to rotate freely around a spindle. They are inserted in the end of a collet which, in turn, is inserted in the wheel from the top.

The 3 x 12 mm bushes can be used as bearings for 2 mm spindles. They can also be fixed on to stationary spindles by means of clamping springs (see page 11). When mounted on two parallel, stationary spindles they can be used to hold a rotating 2 mm spindle. It is of the utmost importance that they are exactly in line with each other. Bearings may be lubricated with a little sewing machine oil if absolutely necessary.



Cutting to Length

The flex, rubber hose, plastic sleeving and cord are supplied in a greater length than is needed for the various models. If pieces are cut off carelessly you will waste too much material. Use a spindle of the correct length or take the spacings between the holes in the assembly plate as a measure. These are 15 mm apart so 4, 8 and 14 spacings correspond to 60, 120 and 210 mm respectively.

Flex

A suitable series of standard lengths would be 4 x 60 mm, 4 x 120 mm, 1 x 210 mm.

Rubber Hose

Keep one piece of 420 mm for making the table clock; divide the rest into two pieces of 60 mm, two of 90 mm and two of 120 mm. This will leave you some hose which can be cut into short pieces for use on pulleys and pins.

The hose often has to be pushed onto a 3 mm spindle or a 4 mm bush. You will find it easier to do this if you moisten the end of the bush slightly. Short pieces can be fitted more easily if first pushed on to the pin-driver and from there pushed onto the spindle or bush.

It is important that oil or grease is not allowed to come into contact with the rubber hose. It should also be stored in the dark and occasionally rubbed with some talcum powder - this will prevent it from perishing prematurely.

Plastic Sleeving

Two 550 mm lengths of the 2 mm sleeving (No. 25) have to be kept for the caterpillar truck, also reserve two pieces of 90 mm and two of 150 mm of the 3 mm sleeving (No. 26).

Cord

A 2 m length should be kept intact for use in the weight-driven clocks.

YOU HAVE NOW LEARNED ALL THE DETAILS NECESSARY FOR BUILDING THE MODELS A1, A2, B1, B2, B3, C1, C2, C3 AND E1.

Clocks E2, E3 and E4 can also be built but: FIRST ACQUIRE SOME EXPERIENCE BY BUILDING ONE OR MORE OF THE MODELS LISTED ABOVE.

PUMPS

Diaphragm Pump

The diaphragm pump works using principles similar to the piston pump. The petrol pump in your father's car is a diaphragm pump. It lends itself more easily to small constructions, it has less friction and there is little risk of leakage. Its principal parts are the drive rod and the diaphragm housing.

The drive rod (A). This consists of two small wheels (No. 6) with the under sides facing each other and kept apart by two 20 mm pins (No. 8), placed in the holes a1 and a7. The 3 mm drive shaft, whose length depends on the model, is fixed by means of a collet in the central hole of one wheel.

Diaphragm. Cut the neck off one of the balloons and cut the balloon along the fold to obtain two fairly flat pieces of rubber.

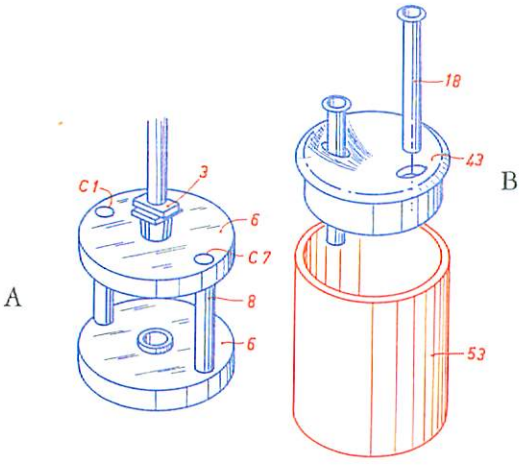
Diaphragm Housing (B). Push two 3 x 24 mm (No. 18) bushes through the two holes in the diaphragm housing (No. 43). Place this onto the supporting tube (No. 53).

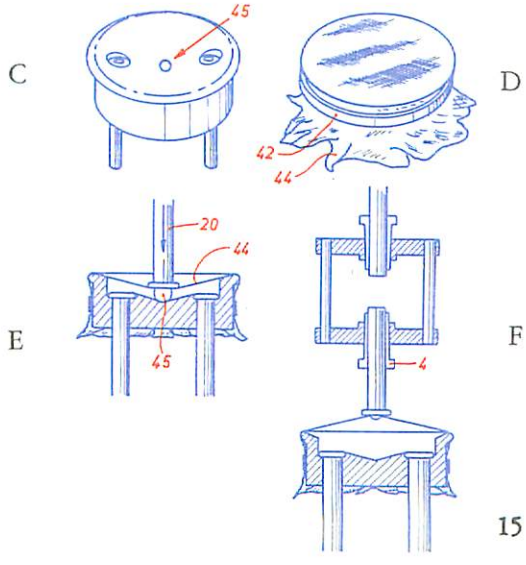
The Diaphragm. First lay a steel ball (No. 45) on the diaphragm housing (C). Fix the diaphragm across the housing with a rubber band which should not be too tight (D).

The diaphragm should not crinkle yet not be taut. Then secure it by means of a second rubber band which should be quite taut. Remove the first rubber band.

Diaphragm Coupling (E). Take a 4 x 24 mm bush (No. 20) and place it, flange down, exactly in the centre of the diaphragm. Press down until the diaphragm with ball holds firmly in the bush. If the ball cannot be fixed properly, put an extra piece of balloon between bush and ball. If the ball still will not fit remove the diaphragm and push the bush onto it outside the housing.

Mounting. Mount the diaphragm housing on to the model with collets or clamping springs, supporting the bushes (No. 18) through the diaphragm by hand, if necessary. Then fix the 4 x 24 bush on the drive rod using a collet No. 24 (F). Further consult the Building Instructions.



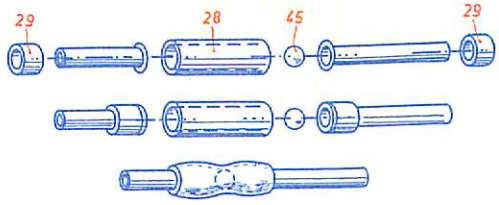


Valves

A pump must contain valves in order to ensure that the water pumped up cannot flow back during the return movement of the diaphragm. The inlet and outlet valves are, however, of the same construction.

They consist of a length of plastic tubing (No. 28), a steel ball (No. 45) and two connecting pieces made of bushes or spindles.

The length of plastic tubing is shown on the construction drawings. The ball fits into this tube and the valve is sealed by pushing small pieces of rubber hose on to the 3 mm bushes or spindles before these are pressed into the plastic tube.



YOU NOW HAVE THE KNOWLEDGE FOR MAKING THE MODELS B4, B5, B6, D1, D2 AND D3.

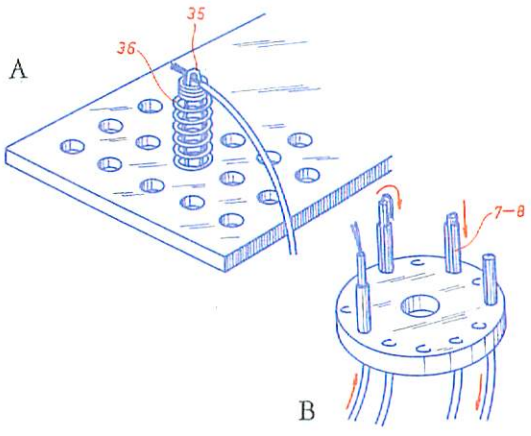
IN THE REMAINING MODELS ELECTRICAL CIRCUITS ARE USED, THE KNOWLEDGE FOR THIS IS FOUND IN THE NEXT CHAPTER.

CONNECTING UP

The red, black, grey and green flex (Nos. 31 – 34) serve for electrical connections. For each connection the appropriate length of flex has to be cut off and about 5 – 10 mm of the insulation stripped from the ends. Cut the insulation all round with a knife and then pull it off the wire. Do not cut the insulation right through or several strands of wire will be cut or break off in use.

Wire terminals (A) consist of a hairpin spring (No. 35) which is pushed through a hole in the mounting plate from one side and a large coil spring (No. 36) is firmly pushed over this from the other side. Twist the bared end of the flex, push the coil spring down, insert the wire end and then let go of the coil spring again.

To connect the flex to a pin, first straighten the stripped end, then push the flex right through (B). Next fold the bare strands back along the insulation. Push the flex back in the pin so that the folded core is clamped between the pin and the insulation. The bare core should not be pushed to the side of the slot in the pin but opposite to it.



A

B

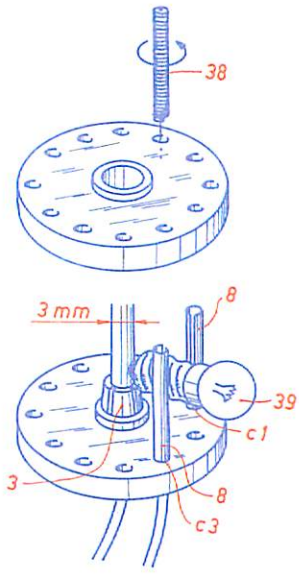
THE CONTACT SPRINGS (No. 38)

The contact spring (No. 38) is used mainly in switches. As a rule, it is pushed into a 3 mm spindle, a 2 mm washer or the pin-hole of a wheel. The pushing as well as the removing should be done, turning counter clockwise (C).

LAMP FITTING

To make a fitting for a lamp, take a small wheel (No. 6) and fix a 3 mm spindle or bush (as indicated in the construction drawing) by means of a collet No. 3 (D). This spindle or bush should protrude about 6 mm below the wheel. Then insert two long pins (No. 821) into the holes c1 and c3 from below as shown. The slots must face each other. Connect one wire to one of the pins in the manner described at the left of this page and another wire to the spindle or bush in the same way. Finally fit the lamp.

Should this burn out, a replacement should be of the 6 Volt, 0.05 A type, such as is used in the rear lights of bicycles.



C

D

BATTERY HOLDERS

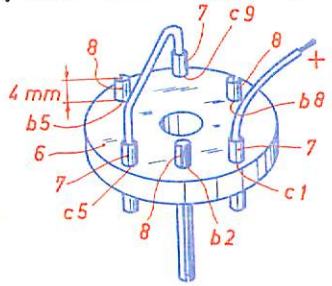
The type of dry cell we use is known internationally as the R6 (penlite), and is also used in small transistor radios. It has a length of 50 mm and a diameter of 14 mm. It supplies a voltage of 1.5 V, which is not enough for our purpose and for this reason we always use 6 or 3 plus 3. These are connected in series giving 9 V in total.

Battery Holder for Three R6 Penlite Cells

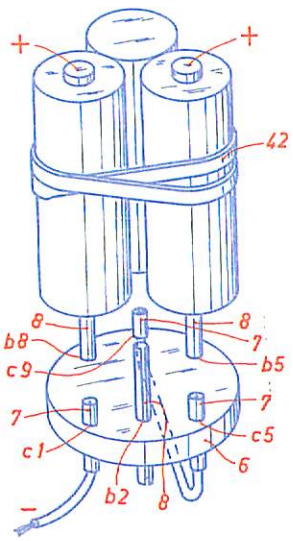
This holder is used where there is not enough space available for a 6 cell holder. For each holder take two small wheels (No. 6) and insert pins (No. 7) from the underside of the wheels into the holes c1, c5 and c9 until they protrude 4 mm (the thickness of the ring No. 52) from the top (A) Similarly insert three long pins (No. 8) into the holes b2, b5 and b8 until they too protrude 4 mm, with the slots facing outwards. Slide a piece of 2 mm sleeving over the long pins to avoid a short-circuit of the batteries Interconnect the pins c5 and c9 with a short length of wire. Bunch three cells together by wrapping a rubber band (No. 42) twice round them. One of the cells must be upside down. Place one wheel with contact c1 on the positive pole of the right hand cell, the other (bottom) wheel with contact c5 against the same cell (B). Then stretch rubber bands around opposite ends of the long pins. The leads of the battery holder are fitted into the pins inserted in the holes c1.

This battery holder is fixed by inserting a 3 x 96 mm spindle in the centre holes of the wheels, using a collet at one end only.

A



B



Battery Holder for Six R6 Penlite Cells

First place pins in the undersides of two large wheels (No. 5) with the slots facing outwards (C).

Large pins (No. 8) go in C1, C3, C5, C7, C9, C11, E2, E5, E10, E13, E18 and E21. Short pins (No. 7) in E1, E6, E9, E14, E17 and E22.

Then push 2 mm washers (No. 21) on six pins (No. 7) (see page 10). Insert these, again in the underside of the wheels, in holes D3, D9 and D15. Next place short pins in the holes D6, D12 and D18 to protrude 4 mm (thickness of supporting ring (No. 52) above each wheel.

Take one wheel fitted in this way and connect a red wire to the pin in D3 from the top (this will be the positive lead) and a black wire to the pin in D6 (see page 19). Also interconnect D9 with D12 and D15 with D18 using grey or green wire. The second wheel is provided with interconnections from D3 to D18, D6 to D9 and D12 to D15 (D).

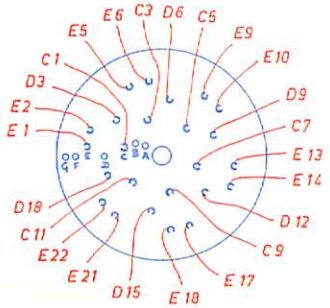
The two wheels are then fixed by means of collets to a 3 x 96 mm spindle, with their undersides facing each other, and about 60 mm apart. The contact in D3 in the first wheel (red wire) should be directly opposite contact D18 in the other.

Next cut 6 pieces of plastic tubing (No. 28) each 4 mm long and these are pushed halfway over the positive (+) pole of each cell (E). Into the free end of the tubing screw the end winding of a coil spring (No. 36). The cells are then ready to be placed in the battery holder. Push the coil springs over the pins with the washers. Place each cell in position by inserting it at an angle, compressing the coil spring with the positive pole and then pushing the negative pole into place (F).

As cells of various makes are not always of quite the same length, it may be necessary to change the distance between the wheels to fit the cells.

For some circuits the full battery voltage of 9 V is not required. Then an interconnection is replaced by two separate leads which are jointly connected to a terminal.

C



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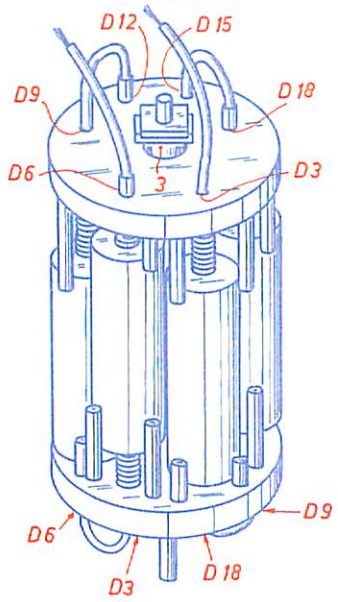
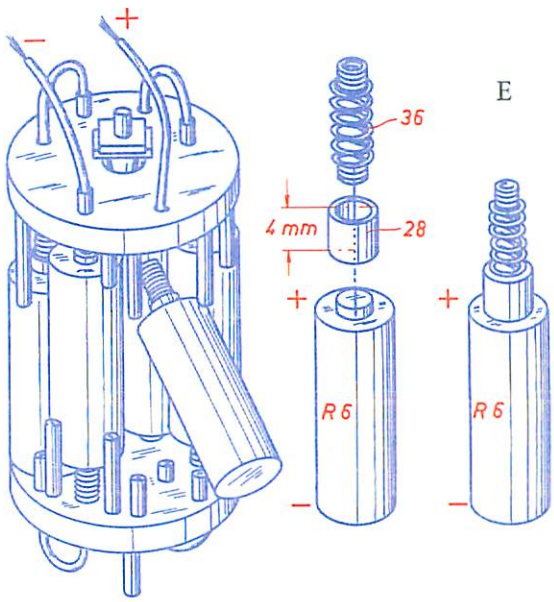


F



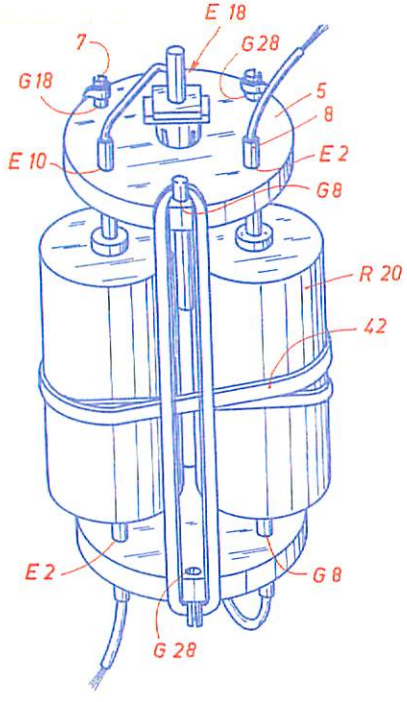
Battery Holder for Three R20 Flashlight Cells

The R20 flashlight cell is often used in torches. Because of its greater size (33 x 60 mm), it will last much longer than the R6 cell and is more economical to use. Unfor-

tunately though it is too large and too heavy for most of our models, but is useful in some stationary ones.

The design is similar to that of the battery holder for three R6 cells (page 18). Use large wheels (No. 5). Pins (No. 7) are inserted in the holes E2, E10 and E18 and protrude 4 mm at the top (G). In one of the wheels pins (No. 7) are also fitted, with the slots outward, in G8, G18 and G28, protruding 4 mm at the top. The other wheel is provided with pins (No. 8) in D5, D11 and D17, again protruding 4 mm at the top and with the slots outward. This wheel is also fitted with a 3 x 96 spindle which must protrude 10 mm from the collet. The pins E10 and E18 are interconnected to the two pins in E2. The wheels should be positioned with the pins in E2 and E10 exactly opposite each other. The pin in E2 of the top wheel should make contact with the right-hand one of the two positive poles.

G



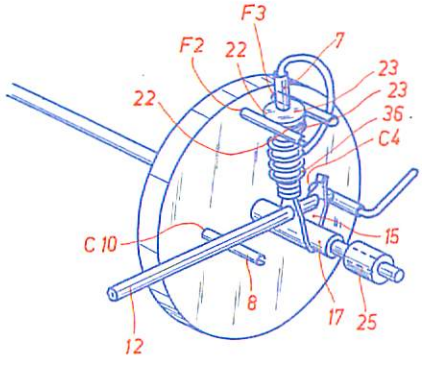
The On/Off Switch

This switch can be easily built on the top wheel of the battery holder for six R6 cells. Insert pins (No. 8) in the holes C4, C10, F2 and F3, the latter two with the slots facing each other (A). Push a washer (No. 22) about 3 mm onto a pin (No. 7) and fix this washer, together with two washers (No. 23), in the slots in the pins inserted in F2 and F3, with the shortest end of the pin pointing towards the centre of the wheel.

Now fix 3 x 12 bush (No. 17) to the end of a 3 x 48 mm spindle with the aid of a clamping spring (No. 15). This bush rotates in the centre of the wheel round the spindle of the battery holder. If this is a 3 mm spindle, the bush must be fixed to a long pin which has been inserted in the spindle first. The bush must be locked with a piece of sleeving (No. 25).

When a coil spring (No. 36) is inserted between one leg of the clamping spring (the one nearest to the free part of the 3 x 48 spindle) and the pin fixed with the washers, the switch is ready to be connected in accordance with the building instructions. (For

A



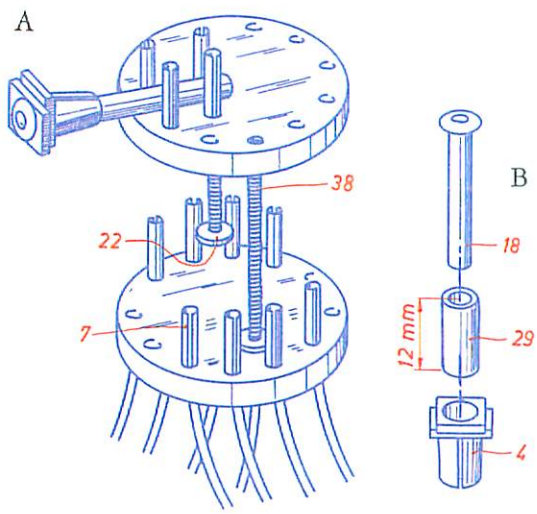
instance: the red lead from pin D3 on the battery holder is connected to the pin with washers and a lead from the long pin in C4 to the model.)

Rotary Switch

Rotary switches can usually be set to more than two different positions. Different types are used in the various models, but here we shall restrict ourselves to a general description which should enable you to read the drawings of the building instructions. The rotary switch consists of two wheels both mounted on the same spindle, one of them is stationary and the other is able to rotate. The stationary wheel may, for instance, be fixed to the shaft with a collet, the rotary wheel may have a bush inserted into its collet and is kept at the correct distance from the stationary wheel by a second bush. The stationary wheel contains the pins to which the leads are connected and these pins form the fixed contacts for the spring (A).

The rotating wheel is fitted with contact springs (No. 38) with washers (No. 22) pushed on to them (see page 17 fig. c). These washers form the movable contacts. They always rest against two pins at a time and thus interconnect them and, therefore, the leads connected to them. The slots in these pins should always face outward!

Illustration (B) shows the construction of the lever.



THE MOTOR (No. 40)

The normal operating voltage of the motor is 9 V. It will still work at less than 6 V, but will then develop little power. The voltage should never exceed 12 V and should always be supplied by batteries. Connecting it to the mains circuit is very dangerous and even by way of a transformer damage can result.

The motor will rotate in either direction, depending on which way the battery is connected.

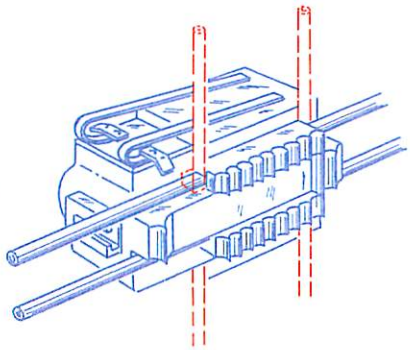
Important!

Never apply too much pressure to the motor spindle. When pushing a pin or piece of hose on to the spindle hold the motor upright and rest the back of the spindle on something solid. Cords of cord transmissions must not be run more tightly than is necessary and to protect the battery never brake the motor by putting your hand on it. Also switch off the current if a fault occurs in a working model.

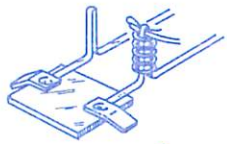
Mounting.

The motor is usually suspended on two 3 mm spindles inserted through two of the four channels which are provided in the cover (A). In some cases the motor may be held

A



B



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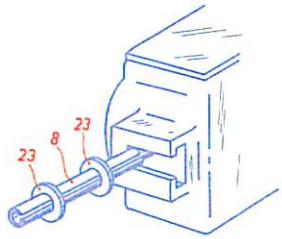

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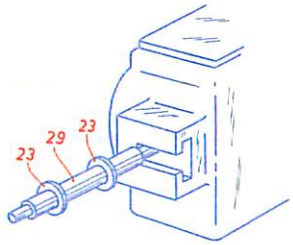
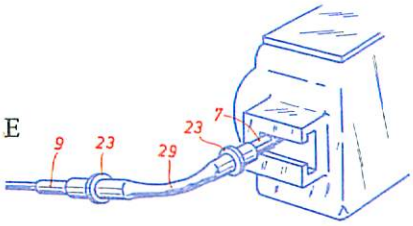
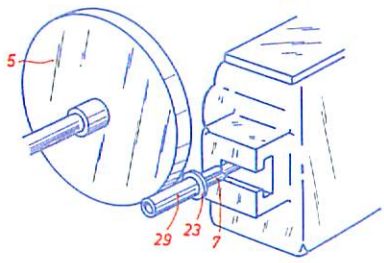


E



F



against two parallel spindles by means of a rubber band (No. 42).

Connecting the Motor

To connect the flex to the motor, its connecting leads are folded double over a distance of about 8 mm and short springs (No. 37) pushed over them (B). The end of the flex is then clamped between the folded strip and the spring. It is advisable to fold the bare core back against the insulation, in the same way as for the pins, otherwise the flex may slip out.

The Coupling of the Motor

The simplest way to couple the motor spindle to a model is to push a pin (No. 7 or 8) with two washers (No. 2) on to the spindle and to use the pin as a pulley for cord transmission (C). This gives the highest possible transmission ratio that can be obtained, although the cord sometimes tends to slip on the smooth pin.

To reduce slipping a piece of rubber hose is pushed over the pins (D). This is secured by two washers (No. 23). First push the hose halfway onto the pin, then place the washers on the protruding end of the hose and finally push the whole onto the spindle.

A Flexible Coupling

A flexible coupling with a 2 x 96 mm spindle placed roughly in line with the motor spindle may be obtained by pushing a pin onto the ends of both spindles and connecting them with a piece of rubber hose (A). The hose is fixed to the pins with two washers (No. 23).

Mounting a Wheel

It is difficult to mount a wheel directly on the short motor spindle. To do this push a pin onto the spindle and a bush (No. 17) on top of it. The wheel can then be fixed with a collet (No. 3).

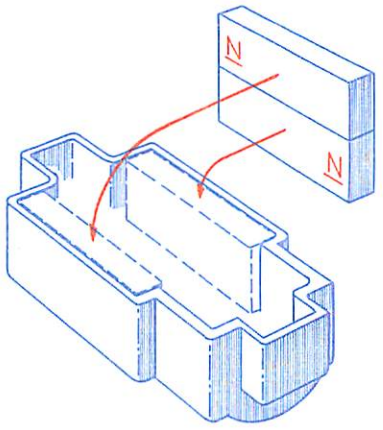
Friction Transmission

To make a friction transmission a 12 mm long piece of rubber hose is fitted with a washer (No. 23) on to a pin (No. 7) so that the hose projects about halfway from the pin (F). The latter is then pushed on the motor spindle. By letting the projecting end of the hose run against the periphery of a large wheel, the transmission ratio will be greater than obtainable with a cord and rubber pulley.

The Design of the Motor

A great advantage of this motor is that it can also be used as a generator and it is used in this way in various models.

Furthermore, it can be dismantled and then reassembled, but it is not advisable to do this unnecessarily. If dismantling is, nevertheless, necessary because of dirt in the motor or for other reasons, then first pay attention to how everything fits together and note the position of the bearings and the springs. The position of the magnets is also very important (A). When bringing the long, narrow faces of the magnets together, note whether they attract or repel each other. If they attract, they are in the position in which they are to be fitted in the motor.

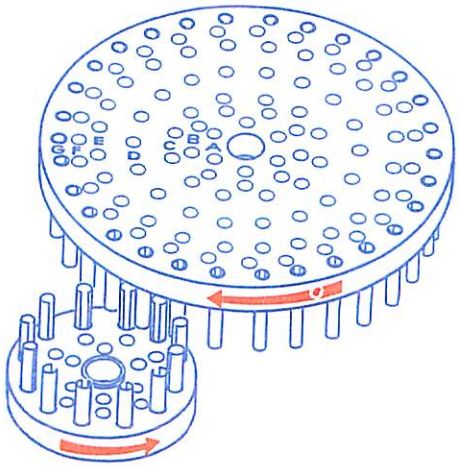


A

If they repel, one of the magnets must be turned round, otherwise the motor will draw too much current and will pull very badly. The bearings of the motor are selflubricating. No lubrication is required until the motor has been running for more than 200 hours, say, or when it is very dirty and has to be cleaned with a cloth or brush, then use a little sewing machine oil and ensure that no oil penetrates the inside of the motor and particularly not on the brushes or commutator.

MORE ADVANCED DESIGN THEORY

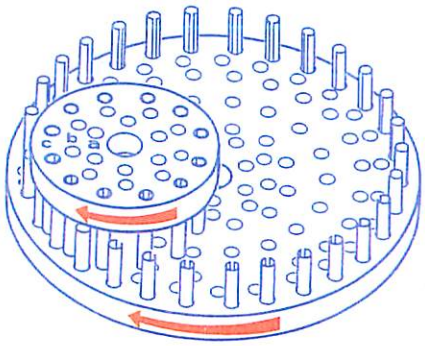
We assume that you will not be satisfied merely to reproduce the described models but that you will want to design your own. And no doubt you will also want to know how the more intricate machines that you are making work exactly. This is where this chapter will be of help to you, as here we shall tell you, amongst other things, how gear wheels are calculated and how to make the switches for models in which the electric motors are used and give you a great deal of information which will be very useful to you. Let your imagination run freely and use this chapter as a guide.



A

GEARWHEEL TRANSMISSION

Gearwheel transmissions are used to increase or reduce speeds (revolutions per minute) and torques. They are extremely important in equipement such as cars, for example (gears) and in most of the models which you can build with the ME-kit.

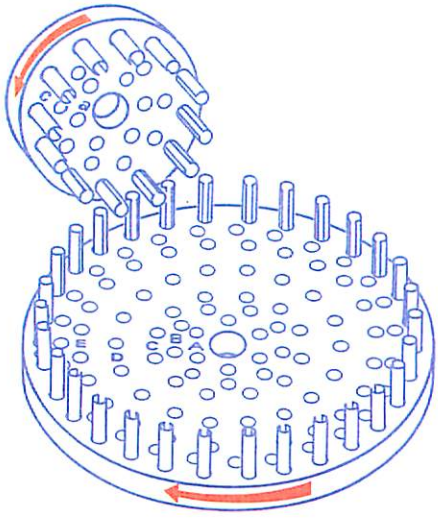


B

The *normal, straight gearwheel transmission* shown in Fig. A is used most. The wheels turn on two parallel spindles and the pins on one wheel mesh from the outside with those on the other wheel.

The second method is known as the *internal gear transmission* and is shown in Fig. B. It is again based on two wheels which turn on two parallel spindles, but here the pins on one wheel mesh with pins on the other wheel, but from the inside.

There is yet a third method, the *transmission with bevel gears* (Fig. C), in which two wheels turn on spindles whose axes are at right angles to each other. It is remarkable in this respect that whereas all the three transmissions can be obtained with the same type of pin wheel, three different types of



C

the much more modern gearwheel are required.

The transmission ratio is determined by the number of pins used. The most important property of two meshing gearwheels is the *transmission ratio.* This can be calculated very easily by dividing the number of pins on the driving wheel by that on the driven wheel. For example, if the driving wheel has 6 pins and the driven wheel 30, the transmission ratio will be 6 : 30 or 1 : 5. This means that the driving wheel must rotate five times to cause the driven wheel to rotate once.

With several gearwheel transmissions working one after the other, the ratio of each pair can be calculated. By multiplying the transmission ratios, the overall transmission ratio is obtained.

Pin wheels for intermittent drives

By omitting one or more pins from the driving wheel it is possibe to change the transmission ratio. If, using the wheel with 30 pins of our last example, we take away five of the six pins on the other wheel, the transmission ratio will be 1 : 30.

A wheel from which a number of pins are omitted is called an intermittant drive.

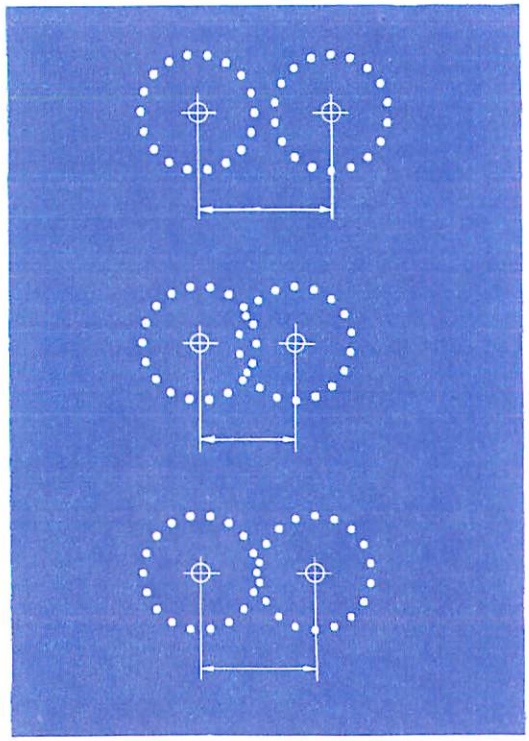
Intermittent-drive pin wheel

Such a pin wheel may be used only if the driven wheel remains stationary while the place or places from which the pins have been omitted pass by. This is done by making the driven wheel run less smoothly by applying extra friction to it.

Position of the spindles

The spindles must be positioned correctly to ensure that the pin wheels mesh properly. If they are spaced too far apart, the pins will not touch each other; if they are too close together, the pins will seize up (Fig. D). As the problem is different for the various methods of transmissions, it must be discussed separately for each of these transmissions.

D



A. Normal transmission

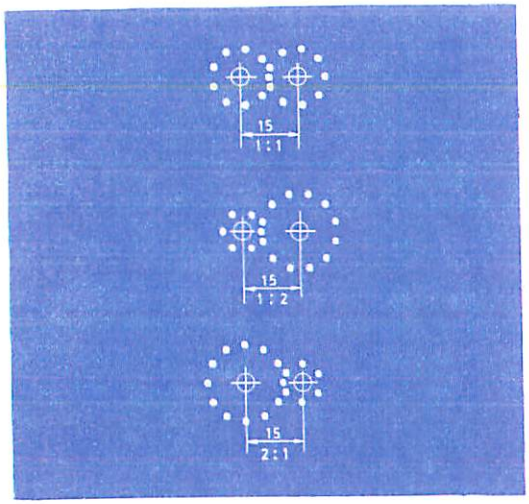
The spindle of one wheel runs parallel to that of the other wheel. The two spindles will usually be fixed at both ends in a plate, the holes in which are spaced 15 mm apart. The distance between the two spindles will therefore be 15, 30 or 45 mm.

At a distance of 15 mm only two small wheels can be used. The total number of pins in both wheels is then 18. This may be divided, so that each wheel contains 9 pins in which case the transmission ratio is 1 : 1 (Fig. E) or 6 pins may be inserted in one wheel and 12 in the other.

If the driving wheel carries the 6 pins the transmission ratio will be 1 : 2, if it carries the 12 pins: 2 : 1.

The large wheels can be and usually are used if the spindles are spaced 30 mm apart. A

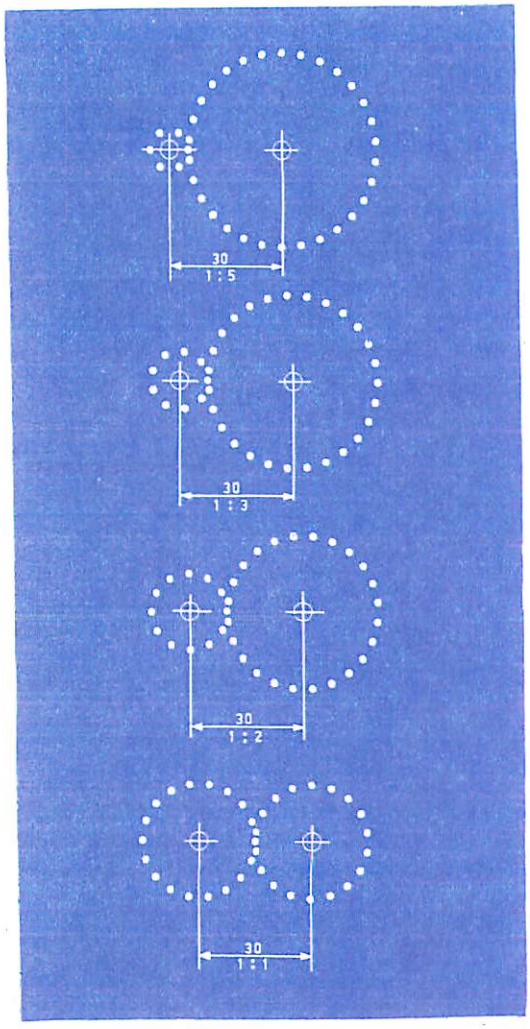
E



combination of a large and a small wheel may, of course, be used, if desired. The total number of pins is now twice as great as before, that is 36.

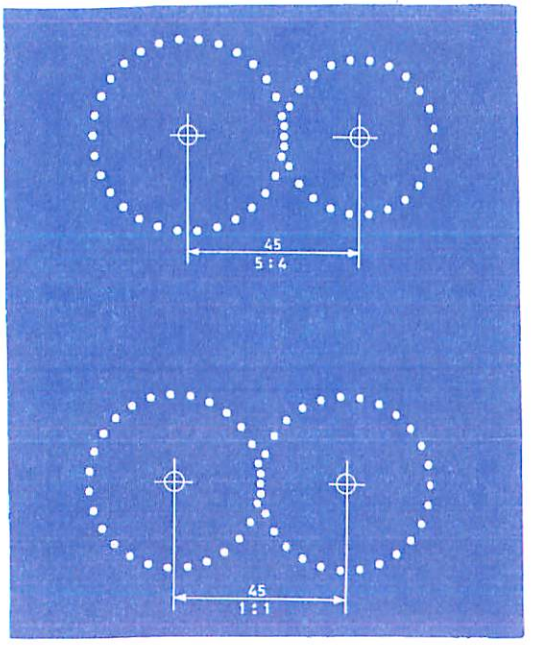
This opens up many more possibilities, namely:

6 and 30, 9 and 27, 12 and 24 and 18 and 18 (Fig. F), giving transmission ratios of 1 : 5, 1 : 3, 1 : 2 and 1 : 1 respectively if the first wheel is the driving one, or 5 : 1, 3 : 1, 2 : 1 and 1 : 1 with the second wheel functioning as drive. At a spacing of



F

3 x 15 = 45 mm between the spindles, two large wheels must always be used. The total number of pins is then 3 x 48 = 54 and the number of variations two, namely 30 and 24,



G

and 27 and 27 (see (Fig. G), giving transmission ratios of 4 : 5, 5 : 4 and 1 : 1, depending on which wheel functions as drive.

With the spindles fixed by means of bushes and clamping springs instead of in plates, the spindles may be spaced any distance apart, thereby providing a great variety of transmission ratios.

B. Internal gear transmission

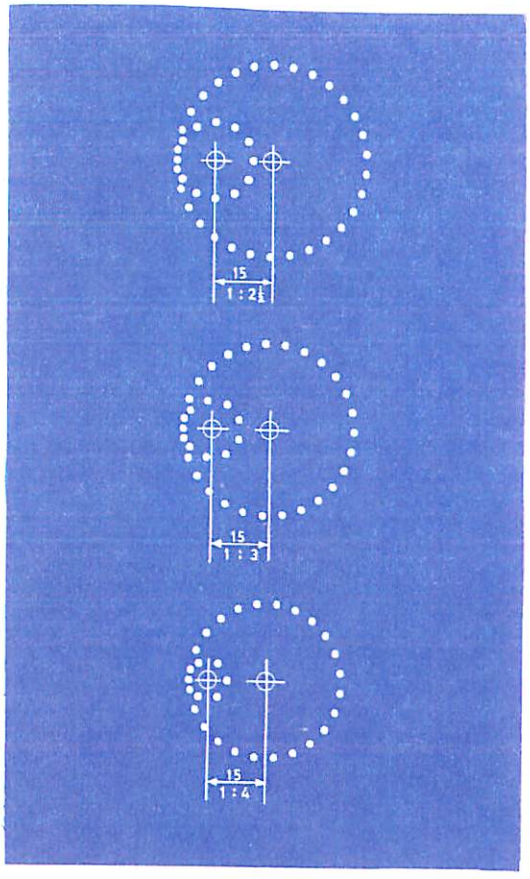
This always involves a large wheel, whose spindle may be fixed in bearings at both ends, and a small wheel whose spindle can be fixed at one end only, since, the larger wheel prevents it from being fixed at the other end (Fig. H). The distance between the spindles is then 15 mm. Since the difference in the number of pins must amount to 18 in this case, the following transmissions are available: 30 and 12, 27 and 9, 24 and 6, giving transmission ratios of 1 : 2 - ½, 1 : 3, 1 : 4 respectively and vice versa, depending on which wheel is the driven one.

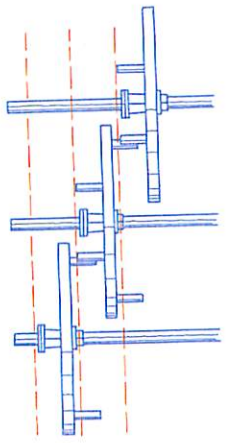
C. Bevel gear transmission

The spindles are arranged at right angles to each other, so that only one of them can be extended. The other should then be arranged in the same plane, in other words, if this were to be extended it should intersect the first one.

Unless this is done accurately, the transmission will not function properly.

H





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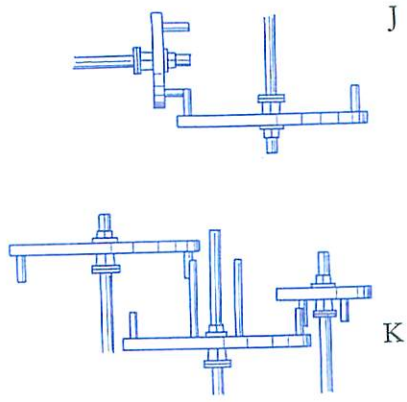


J

K

Position of the wheels on spindles

With a normal or internal gear transmission the distance between the wheels must be 12 mm. The 10 mm long pins protrude 7 mm from the wheels, which are 3 mm thick.

The pins in the one wheel should always be kept at 2 mm from the other wheel, so that the pins mesh with each other over a length of 5 mm. The distance between the wheels is then $7 + 2 = 9$ mm and since a wheel is 3 mm thick, the next wheel is always 12 mm away. This is exactly the length of a collet (Fig. I). Hence, as indicated by the broken lines in the figure, the collet of one wheel starts at the place where the collet on the spindle carrying the preceding wheel ends.

This means that the collet for each subsequent wheel must be moved one place further along the spindle. This agrees with what we have said before about positioning components on spindles with the aid of loose collets. With bevel gear transmissions the wheels must be positioned on the spindles in such a way that only the tops of the pins come in contact with each other - see Fig. J.

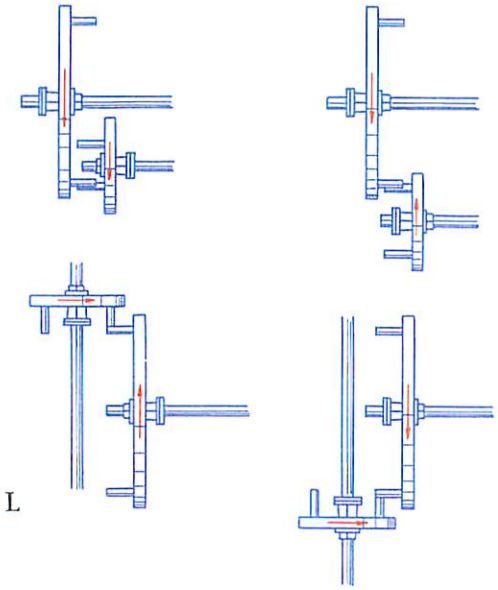
Multiple gearwheels

High transmission ratios can be obtained by means of several stages of gearwheels which can be linked in various ways. It is important to use the least possible number of stages however since the more wheels that are used, the higher the friction and hence the loss.

For the same reason we use thin spindles for fast-running, as a thin spindle is less subject to wear than a thick one.

The number of gearwheels can be limited by using *multiple-type gearwheel* in many of which pins are inserted in both sides. As already mentioned earlier, the use of a small pin circle at the side at which the collet is inserted in the wheel should, of course, be avoided, as we would be unable to reach it with the special spanner.

In another type of multiple gearwheel, both the rings of pins protude from the same side. One ring consists of long pins in this case. The advantage of this type is that it takes up less room, as clearly shown in Fig. K. Furthermore, one wheel may then be used simultaneously as gearwheel and pulley or brake drum.



L

Direction of rotation

The two wheels rotate in opposite directions with normal gearwheel transmission, but in the same direction with internal gearwheel transmission (Fig. L). The figurs show further that bevel gear transmissions enable two gearwheels to rotate in either direction, hence offering a choice.

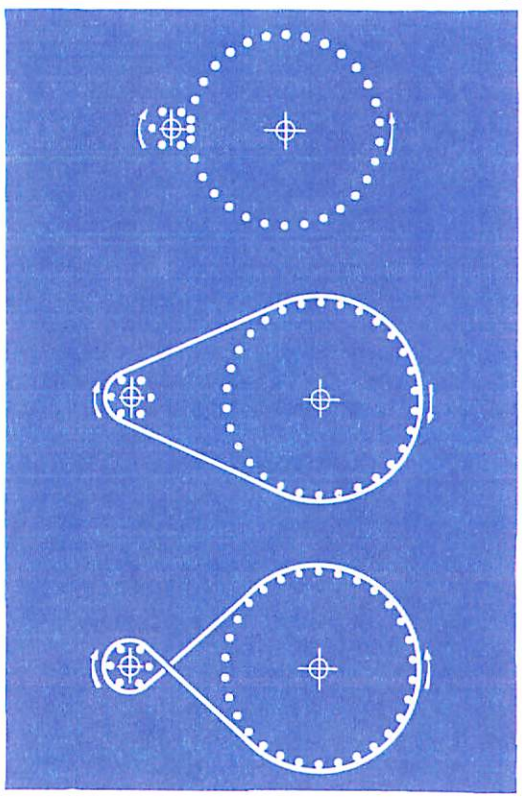
PULLEY TRANSMISSIONS

Pulleys are wheels over which a piece of string or rubber band is run. Various ways are possible. The black pulleys in the kit (No. 23) cannot be fixed to a spindle and thus are suitable only as guide rollers for cord or elastic. For transmissions, therefore, we have to make up pulleys from the normal wheels and spindles. There are exceptions, however. Let us consider a normal, straight gearwheel transmission with 30 and 6 pins. The two spindles thus rotate in opposite directions with a transmission ratio of 1 : 5. The spindles are now pushed further apart and a rubber band is placed over both wheels.

Although the pins no longer touch each other, the wheels are still linked together - by means of the rubber band. The transmission ratio is unchanged at 1 : 5, for this is determined by the peripheries of the two pin circles and these are still the same. As shown on Fig. A, the direction of rotation depends on the manner in which the rubber band is placed round the wheels.

It is unnecessary to insert a pin in each hole in a circle in large-diameter pulleys, it is sufficient to place a pin in every third hole in the two largest circles and in every other hole in the three smaller circles. In circles containing 6 or 9 holes, a pin must be inserted in each one, however. With pulley transmissions it is obvioussly necessary to ensure that the cord does not run off the wheels while these are rotating.

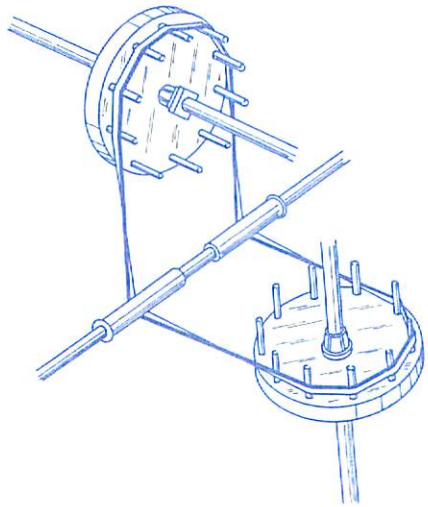
A



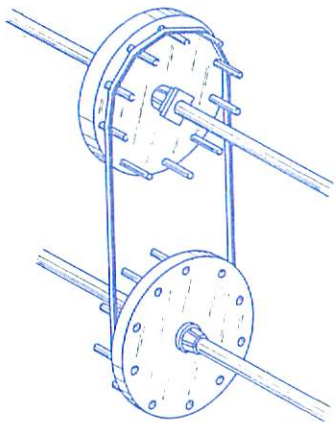
In the arrangement shown in Fig. B this is simply done by placing the wheels with the pins facing in opposite directions, so that one wheel prevents the cord from moving in one direction and the other does the same in the other direction. In cases where this is inadequate, one of the pulleys must be made up of two wheels.

For a bevel belt drive such as shown in Fig. C, fixing bushes rotating on a spindle can be used as guide rollers.

The great advantage of pulley transmissions is that they are virtually noiseless and require no lubrication; in fact, rubber must on no account come into contact with oil. Against this is the disadvantage that the friction tends to be higher, giving rise to greater losses than with gearwheel transmissions and that a certain amount of slip always takes places, depending on the load, so that the transmission ratio is not completely accurate. Pulley transmissions are therefore, never used in equipment which must run accurately at a given speed, such as clocks. In other cases a certain amount of slip is welcomed. We mention the back wheels of a car, for example, where the outer wheel must rotate faster than the inner one with the car going round a bend. The pulley transmission with rubber bands is ideal for this purpose.



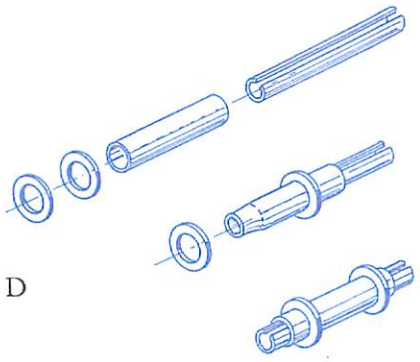
C



B

Slip between the cord and the pulley may be reduced by increasing tension of the cord or the friction between the cord and the pulley. The tension can be increased by using a smaller rubber band or pushing the spindles further apart. The best method consists in increasing the wheel diameters, however, as the rubber band is then stretched more tautly and the frictional forces function over a larger diameter, so that slip occurs only at higher loads.

Slip may further be counteracted by increasing the friction between the cord and the pulley. If we used a piece of string as drive,



D

this could for example, be replaced by a rubber band, whereas an ordinary wheel could be replaced by a wheel with pieces of rubber hose pushed round the pins. Although a rubber band can be allowed to run direct round a spindle, this spindle however has a very low friction. A higher friction can be obtained simply by pushing a piece of rubber hose on the spindle. It fits tightly only round 3 mm spindles, however, whereas we are also concerned with 2 mm spindles.

We are thinking here particulary of the spindle of the electric motor. By pushing a pin over the spindle first, we are increasing the diameter straight away to 2.4 mm (Fig. D). To ensure that the piece of hose remains in position, we push two 3 mm washers on the hose which also has the advantage that the string remains in its position. Take a fairly long piece of 2 mm hose and make an oblique cut at one end. Push two 3 mm washers onto the hose. (The oblique cut will make this easier). Then push the hose complete with washers onto the pin which is already attached to the motor spindle. Cut off the excess hose.

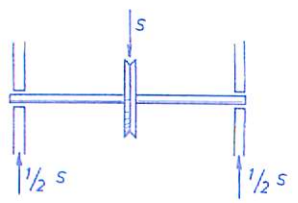
SPINDLES AND BEARINGS

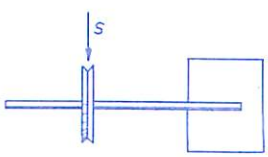
As mentioned, the kit contains thin steel spindles and thicker, hollow brass spindles. To fit them into bearings, a large number of different bushes are provided while the thin spindles can also be passed through the hollow ones. Bearings are supports provided to hold a revolving spindle in its correct position. As a certain amount of play should be present, however this "clearance" should not be too small or the spindle would jam, yet not too large, or the spindle would move about too much in the bearing and prevent models from working satisfactorily. In most cases the spindle will exert a certain force on the bearing, known as the bearing load and this is what causes friction and wear when the spindle revolves. The effect of bearing clearance and wear can be reduced by making the load as light as possible.

With pulley transmission, for example, the rubber band applies an extra load (tension S) in the lateral direction. Bearings can be used to support the spindles in various ways.

In the figures A to D, the forces acting

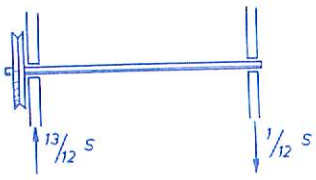
A



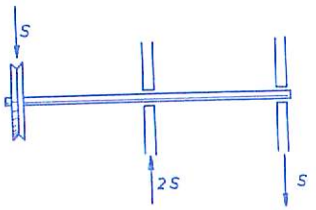


B

C



D



on the spindle are represented by arrows, indicating not only the direction, but also the size of the force. The longer the arrow the greater the force. In mechanics this arrow is known as a *vector*.

For a spindle to be light-running, the total bearing load has to be as small as possible.

Since the load on bearings has to be kept as small as possible, it would be best to place the two bearings on either side of the pulley or to fit the bearing on the pulley itself and fix the spindle. (Figs. A and B). In some cases it may be necessary to fit two bearings on one side of the pulley; these should then be mounted as far apart as possible. (Fig. C). With the bearings arranged as shown in Fig. D, the overall bearing load will be 3 times the tension S; this method is thus hardly suitable where the spindle has to be light-running.

The friction and the amount of wear also depend on the material of which the spindle and the bearing are made. Because of the material of which the thin, hardened spindle is made, this is very suitable for fitting into the hollow spindle or in the bushes. If this spindle were to be supported in a small hole in one of the plastic wheels, it would wear to a much greater extent, since the material for the wheels was chosen in the first place for its strength and transparency and not for its suitability to function as a bearing.

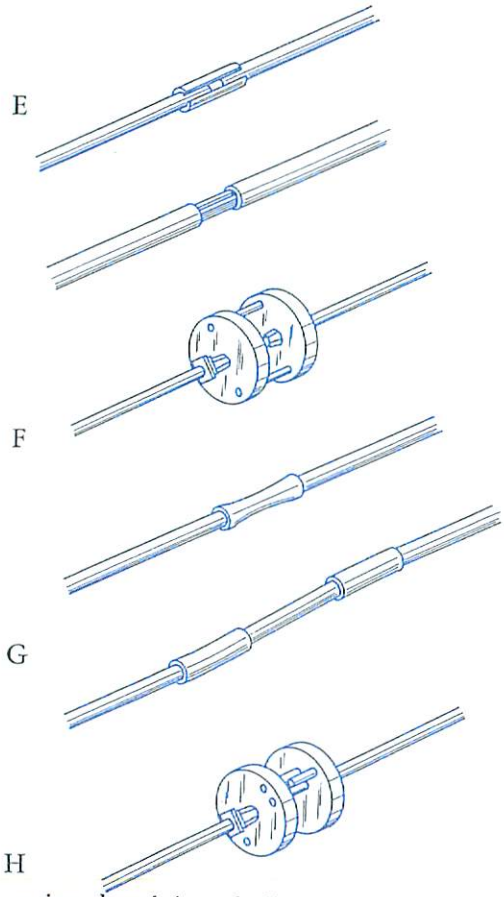
Some plastics have very good friction and wear properties, one of the best known of which is nylon. The escapement of a clock, for example, against which a pin comes to rest millions of times, is now often made of a special kind of nylon.

LUBRICATION

Friction and wear can be considerably reduced by lubricating the parts. Always use a thin, good quality oil such as used in sewing machines and never apply too much, for this will only result in the oil penetrating to places where it serves no useful purpose. Moreover, oil and dust combine into a substance which causes more wear than without any oil applied at all. Take particular care that the oil remains clear of rubber components. An electric motor is better not lubricated, for oil inside electric motors can give rise to sparking and this will ultimately result in the motor breaking down.

COUPLINGS

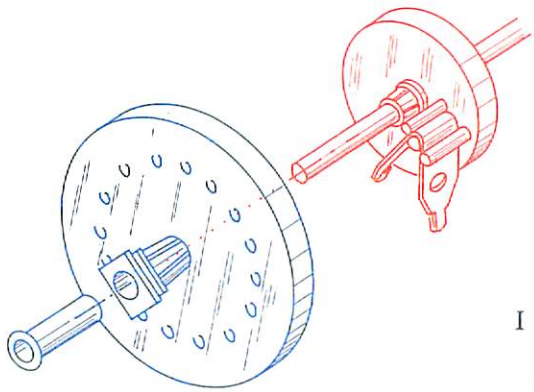
A coupling is generally used to link two objects together. In our case it refers to the various means by which two spindles can be connected together. A coupling is also used for extending a spindle, if it is found to be too short. If two spindles have to be connected to each other as firmly as possible, we use a fixed coupling (Fig. E), comprising a



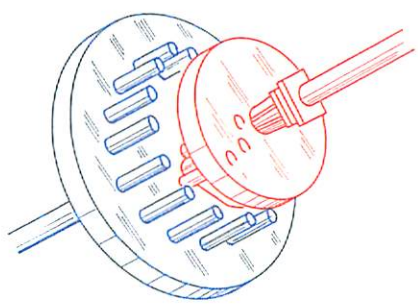
spring dowel in a hollow spindle, a spring dowel round a thin spindle, or wheels connected with spring dowels (Fig. F). If long spindles revolve at high speed, they must be supported in several places with bearings to prevent wobble. In this case it is better to support the two spindles separately and link them by means of a flexible coupling (Fig. G). The simplest example of a flexible coupling is a piece of rubber hose between two spindles, possibly two pieces of hose separated by a short unsupported spindle.

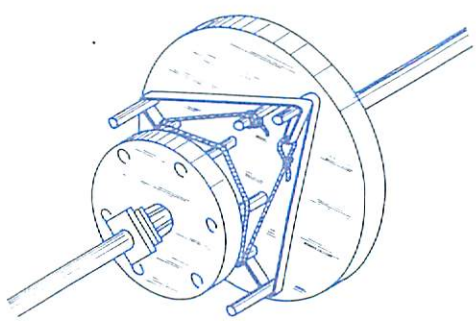
Couplings capable of withstanding greater forces may consist of two pin wheels the pin circles of which mesh with each other (Fig. H).

The great advantage of flexible couplings is that the bearing of one spindle need not be exactly in line with that of the other, in contrast to fixed couplings, where the whole would then twist and revolve only with difficulty. Then we have the free-wheel coupling as used in bicycles, by means of which the spindle is engaged in one direction only. This can be made into a ratchet by allowing a pawl to run over the pins of the pin wheel (see Fig. I). It can be silenced by winding a few turns of string round one of the pin



I

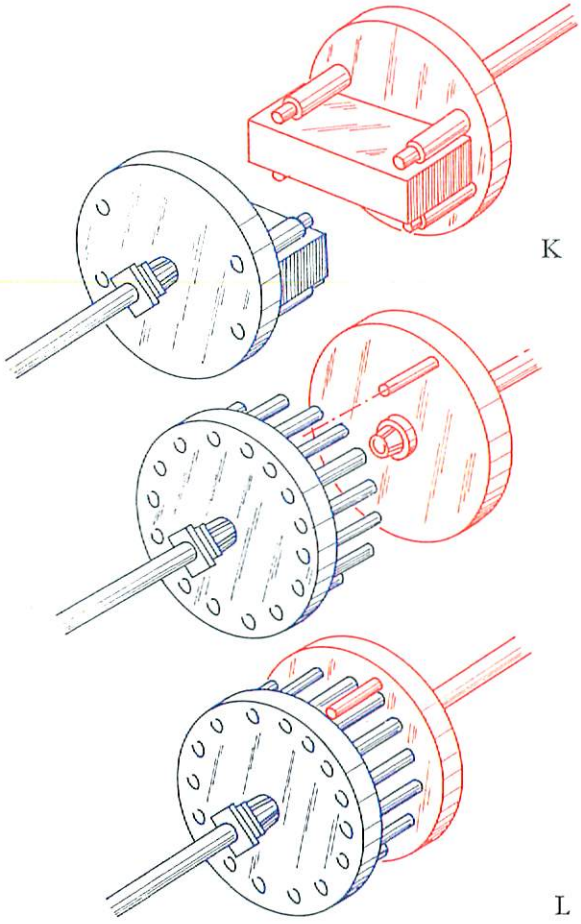




J

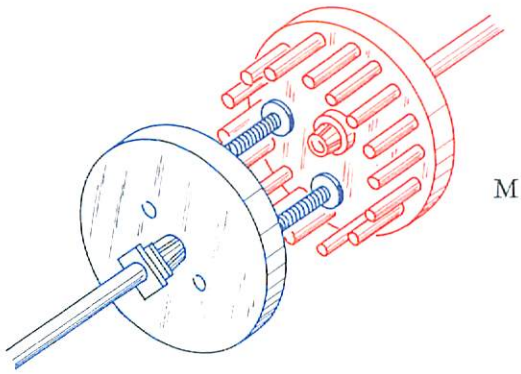
circles (Fig. J). If one end of the string is fixed to the free-running wheel and the other end is tied with the aid of a rubber band to the same wheel, the spindle and wheel will rotate together in one direction, but slip with respect to each other in the other direction.

With both ends of the string connected to the wheel by way of a rubber band, we obtain a *sliding coupling*. With this coupling, the spindle is engaged on slight loading, but lags on heavy loading. The loading limit can be adjusted by altering the tension of the string.



K

L



M

If two spindles are to be coupled through a wall which is not to be drilled, we use a *magnetic coupling*. This enables a mechanism immersed in water, for example, to be driven through the side or the bottom (Fig. K). Finally we have the *sliding mesh gearbox* by which two spindles may be engaged or disengaged as required. The simplest example of such a coupling is the *clutch* (Fig. L). One wheel is provided with a complete circle of pins; in the corresponding circle in the other wheel only one pin is inserted, with the opening facing outwards. As the two wheels are moved closer together, the pins mesh and the clutch is said to be "engaged". If one of the wheels is moved aside, the pins no longer mesh and the clutch is said to be "disengaged". A special type of clutch is that known as the *centrifugal clutch* which is explained with the aid of (Fig. M).

The left-hand wheel contains two springs (No. 38) with washers (No. 22) pushed on to the ends. With increasing revolutions, the washers will be pushed further outwards until they engage with the pins on the right-hand wheel, with which contact will then be maintained. The clutch has thus engaged itself automatically. The clutch will disengage when the revolutions drop below a certain number.

MAKING SWITCHES

When designing new models you may find that none of the switches described in the Building Instructions will meet your requirements. In this case you will have to design one yourself following the basic construction of a rotary switch as described on page 21 and the seven-step procedure outlined below.

Step 1. Draw the circuit diagram

Step 2. Write down, one below the other, what the switch must do in its various positions.

Step 3. Write the required connections next to the switch positions (see Example 1 below).

Step 4. Calculate how many moving contacts are necessary

Step 5. Calculate how many electrical and mechanical pins are necessary.

Step 6. Make a drawing of the switch

Step 7. Work out the connections to the electrical pins.

Note: On the basis of the number of electrical and mechanical pins which are necessary (Step 5) choose a circle of holes and reproduce it on a piece of paper by inserting the sharp point of a pencil through each hole. You will then have a circle of dots on your piece of paper. You should now circle the dots which correspond to the positions of the electrical pins.

The moving contacts should be shown by rings 'resting' against the circles representing the pin positions (Fig. A).

It is important that pins are placed in all the holes of the circle otherwise the moving contacts become disengaged. This means filling up with mechanical pins any holes not needed by electrical pins.

Electrical pin: A pin to which a wire is attached. These are shown as blue circles on the diagrams.

Mechanical pin: A pin to which a wire is not attached. These are shown as red circles in the diagrams.

Here are some examples of how you can use the procedure given above to design and construct switches to meet your own requirements.

Example I. Reversing switch for a motor

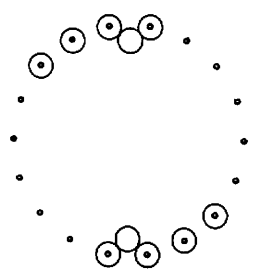
Step 1. The circuit diagram is shown in fig. B.

STEP 2		*STEP 3*
Function	*Switch position*	*Connections*
Motor counter-clockwise	1	ac + bd
Off	2	None required
Motor clockwise	3	ad + bc

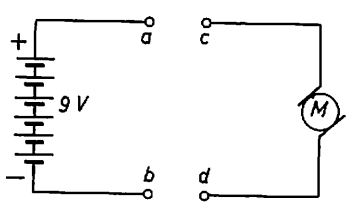
Step 4. In the positions 1 and 3 two sets of two pins each have to be interconnected. As this can be done with two rings only, two moving contacts are required.

Step 5. With two moving contacts and three switch positions six spacings (2 x 3) between

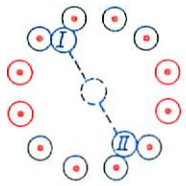
A



B



C



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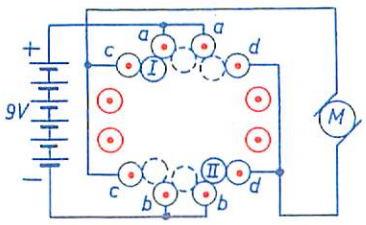


pins are required and thus eight pins (fig. C. Hence ring a or b of a small wheel could be used, were it not that the moving contacts will not have enough space to move freely, therefore the smallest ring on which we can build a rotary switch is circle c (or C) which has 12 holes and sufficient room for the moving contacts.

For the purpose of this example the construction of the switch is based on circle C.

Step 6. Reproduce circle C on a piece of paper and mark the electrical and mechanical pin positions. Then show the moving contacts as in switch position 1, marking the rings I and II (fig. C).

Step 7. Draw up a table like the one below showing which electrical pins the terminals have to be connected.

Position	*Contact I*	*Contact II*
1	ac	bd
2	none	none
3	ad	bc
undesirable connections	cd	cd [1]
order of connection	$\overline{c}\ \underline{a}\ \overline{a}\ \underline{d}$	$\overline{d}\ \underline{b}\ \overline{b}\ \underline{c}$ [2]

[1] By connecting c and d the motor would be short circuited.

[2] The horizontal bars above or beneath the letters indicate the connections.

Other orders are also possible, try and find some!

The complete switch with connections is shown in fig. D.

Example II. Reversing switch for a motor where the motor works as a brake.

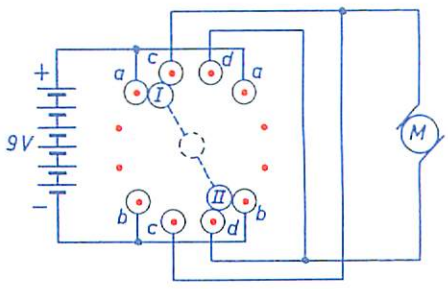
The difference between this and the switch in Example I is that in the off-position the motor is short circuited and then acts as a brake. The circuit diagram is the same as in the previous example. Steps 2 and 3 give the following table:

STEP 2		*STEP 3*
Function	*Position*	*Connections*
motor anti-clockwise	1	ac + bd
brake	2	cd
motor clockwise	3	ad + bc

Step 5. Is identical to that of the previous example.

Step. 6. Is identical to that of the previous example.

E



Step 7.

Position	*Contact I*	*Contact II*
1	ac	bd
2	cd	(cd)
3	ad	bc
Order	$\overline{a}\,\underline{c}\,\underline{d}\,\overline{a}$	$\overline{b}\,\underline{d}\,\underline{c}\,\overline{b}$

In position 2 only one conncetion between the terminals c and d is required but there is no objection to the use of a double connection. The switch and its connections are shown in fig. E.

Example III. Design of a 5-position switch. This switch has 5 settings.

1. off.
2. two lamps in series with the motor.
3. one lamp in series with the motor.
4. two lamps in parallel.
5. motor connected directly to battery.

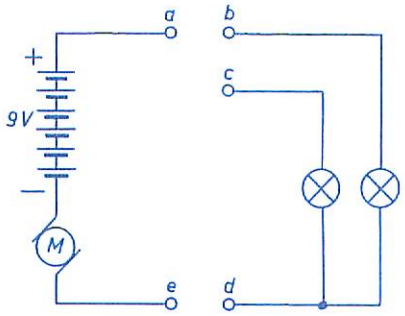
The speed of the motor is thus increased in stages by reducing the resistance of the circuit.

Step 1. The circuit diagram is shown in fig. F.

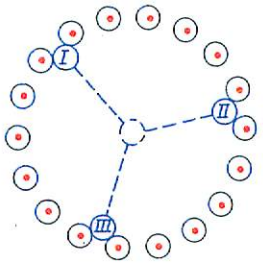
STEP 2		*STEP 3*
Function	*Switch position*	*Connection*
off	1	None
2 lamps in series	2	ab + ce
1 lamp	3	ab + de
2 lamps in parallel	4	abc + de
straight to battery	5	ac

Step 4. In switch position 4 three pins abc have to be connected. This requires two moving contacts. However, since it is also necessary to include the connection de, a third moving contact is required.

F

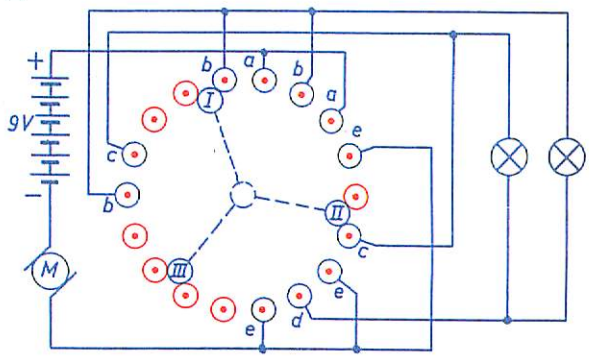


G



Step 5. The number of spacings between pins that is necessary is 15 (switch position x moving contacts.) The switch thus has to be built on ring D of a large wheel, (18 holes). See fig. G.

H



Step 6.

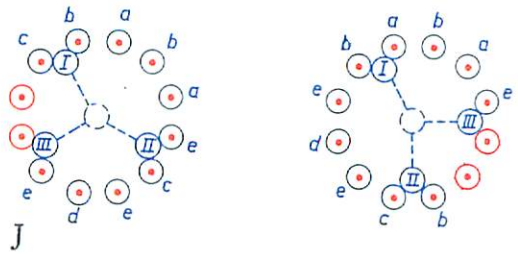
Position	*Contact I*	*Contact II*	*Contact III*
1	none	none	none
2	ab	ce	none
3	ab	de	none
4	ab	de	bc or ac
5	ae	none	none
order	$\overline{b}\ \underline{a}\ \overline{b}\ \underline{a}\ \underline{e}$	$\overline{c}\ \underline{e}\ \overline{d}\ \underline{e}\ \underline{x}$	$\overline{x}\ \underline{x}\ \overline{b}\ \underline{c}\ \underline{x}$ or $\overline{x}\ \underline{x}\ \overline{a}\ \underline{c}\ \underline{x}$

x = mechanical pin.

The switch with its connections is shown in fig. H.

Example IV. A switch similar to the one in example 3 can also be made on a small wheel using the 12 holes of circle c.

To do this you should disregard step 5 and for Fig. G reproduce the 12 dots of circle c (fig. J). You then draw one ring representing the moving contact which has to make the most connections, this is contact I as can be seen in step 6 of example 3. You should then write in the order of connection shown under Contact I of step 6 of example 3 (b, a, b, a, e) against the first 5 pins to the right of Contact I (see fig. J). The next moving contact that is drawn is the one which has to make most of the remaining connections. This is contact II which is placed 5 spacings away from contact I. According to the table shown in step 6, exxample 3 you should now place letters against the next 4 pins (example 3, step 6, Contact II). You will now notice that in position 1 there is a connection between terminal c and e. This does not, however, result in anything happening for reasons that can be seen by referring to fig. F. Finally a suitable position has to be found for moving contact III. The only job it has to do is to make contact between terminals b and c in position 4. For the pin b, the one next to contact I in position 1 can be used, and you should therefore use the pin immediately to the left for terminal c. Contact III should thus be 3 spacings away from contact I. In some switch positions further contacts between electrical pins can be made.



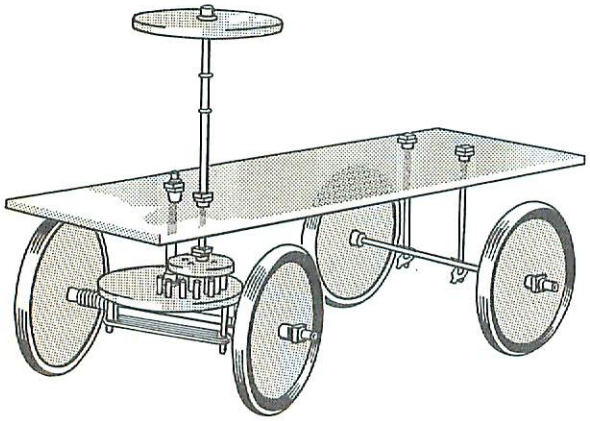
J

The 'additional' contacts however do not affect the operation of the circuit. An example of this is the connection ab which is made by contact III in switch position 5.

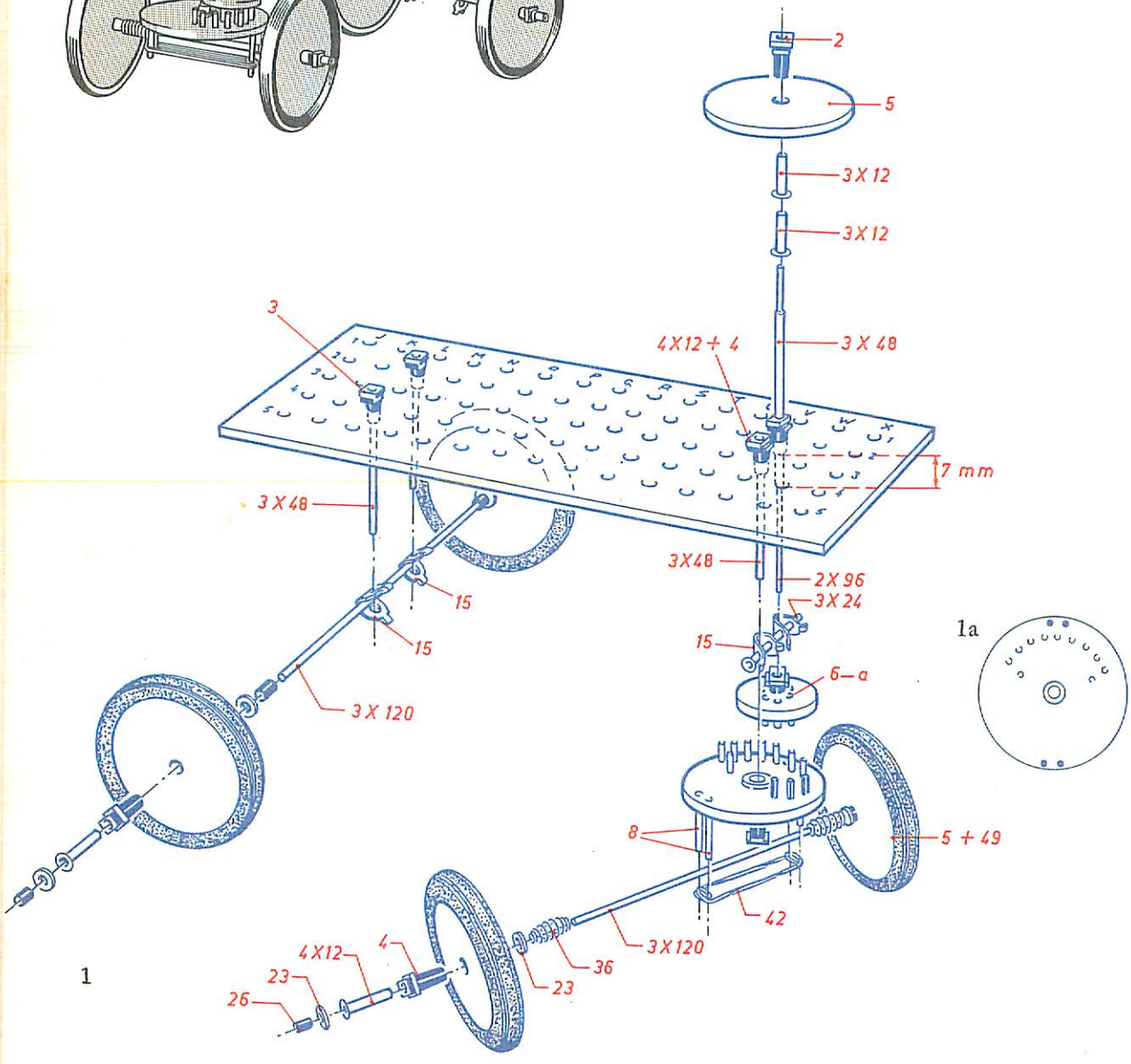
Important: Prior to using switches of your own design you should check all connections against your circuit diagram. It is possible that you will find other connections between electrical pins beyond those which you planned. Such connections should have no effect on the circuit (for example connection ab, made by contact II in switch position 5 of Example 4) or they could interfere with the correct functioning of the circuit.

ASSEMBLY INSTRUCTIONS

A1 - STEERABLE CAR



This is a very interesting model. It is an independent construction, but it will also be used as a base for many other models. Also those who design vehicles of their own will find this car a most suitable starting point.



1

1a

Order of assembly

1. Back-axle with wheels.
2. Front axle assembly and wheels.
3. Steering column with pinion.
4. Steering damper.
5. Finishing off of the steering and mounting of the back axle.

1. Push on both ends of a 3 x 120 mm spindle (13) a short length of sleeving (26) and a 3 mm washer (23). In two large wheels insert a 4 x 12 bush (19) with a 4 mm collet (4) (page 8, fig. B and C). Push these wheels on the shaft with the rear sides facing. They are kept in position by means of two washers (23) and two pieces of sleeving (26). The wheels must run lightly.

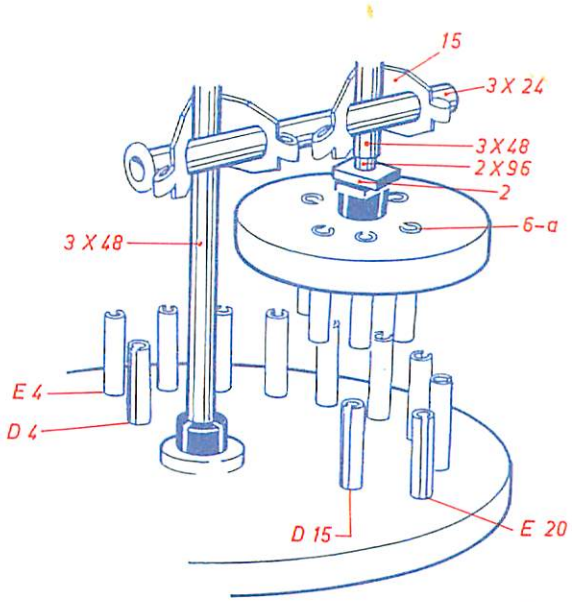
2. The only difference between back and front axle is that in the case of the front axle the innermost pieces of sleeving have been replaced by coil springs (36).

The pivot consists of a large wheel with pins inserted as shown in fig. 1 a. The eleven short pins (7) (page 9 fig. B and C) are placed in the lower side of the wheel with the slits pointing outwards in the holes E20, 21, 22, 23, 24, 1, 2, 3, 4, D4 and D15. At the top four long pins (8) are inserted in the holes G30, G1, G15 and G16 with the slits facing each other (page 11, fig. C). This wheel has to be mounted on a 3 x 48 spindle (11) by means of a collet (3) at position 1 (see page 13, fig. C).

3. In hole V2 of the mounting plate a spindle 3 x 48 (11) has to be fixed by means of a collet (3) in such a way that the spindle protrudes 7 mm from underneath. In hole V3 a bush 4 x 12 (19) is fixed bij means of a collet (4). In the bottom side of a small wheel six pins are inserted in the circle a, with the slits facing the centre of the wheel. This wheel is mounted on a 2 x 96 spindle (9) at position 1 by means of a collet (2). This spindle is inserted from underneath in the spindle which passes through V2. The shaft of the front-axle assembly is pushed through the bush in V3.

4. The steering damper consists of a bush 3 x 24 (18) and two clamping springs (15). The clamping spring which is nearest to the flange of the bush is temporarily blocked by means of a 4 mm washer (Fig. 2) (page 13, fig. D).

5. Part of the steering column extends above the spindle, which is fixed in V2. On this free end we push two bushes 3 x 12 (17), after which the steering wheel is secured on the axle, by means of a collet (2). By fixing this collet at the right spot it is achieved that the pins of the small gear wheel stay clear from the pivot by about 2 mm. Next two 3 x 48 spindles (11) are pushed from underneath in the holes L2 and L4 ofthe mounting plate, on these the rear axle is fixed, by means of collets (3) and clamping springs. Finally, the front axle is placed in-between the four long pins of the pivot (fig. 3) and secured by means of a rubber band (42).



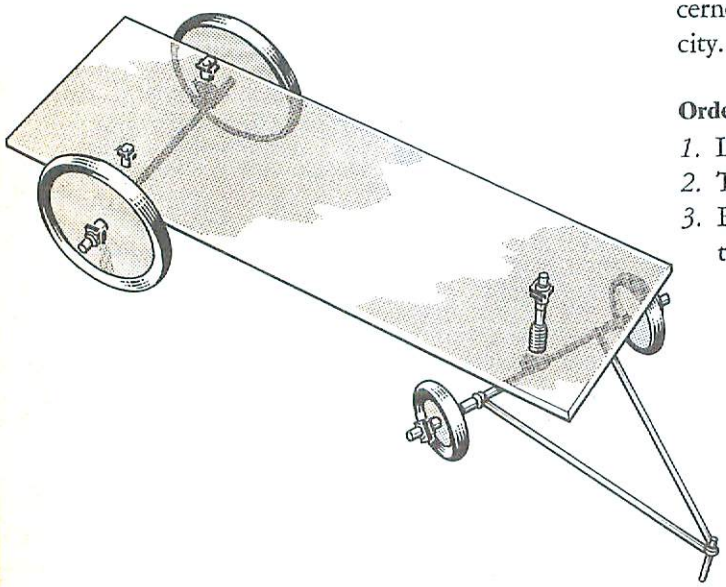
2

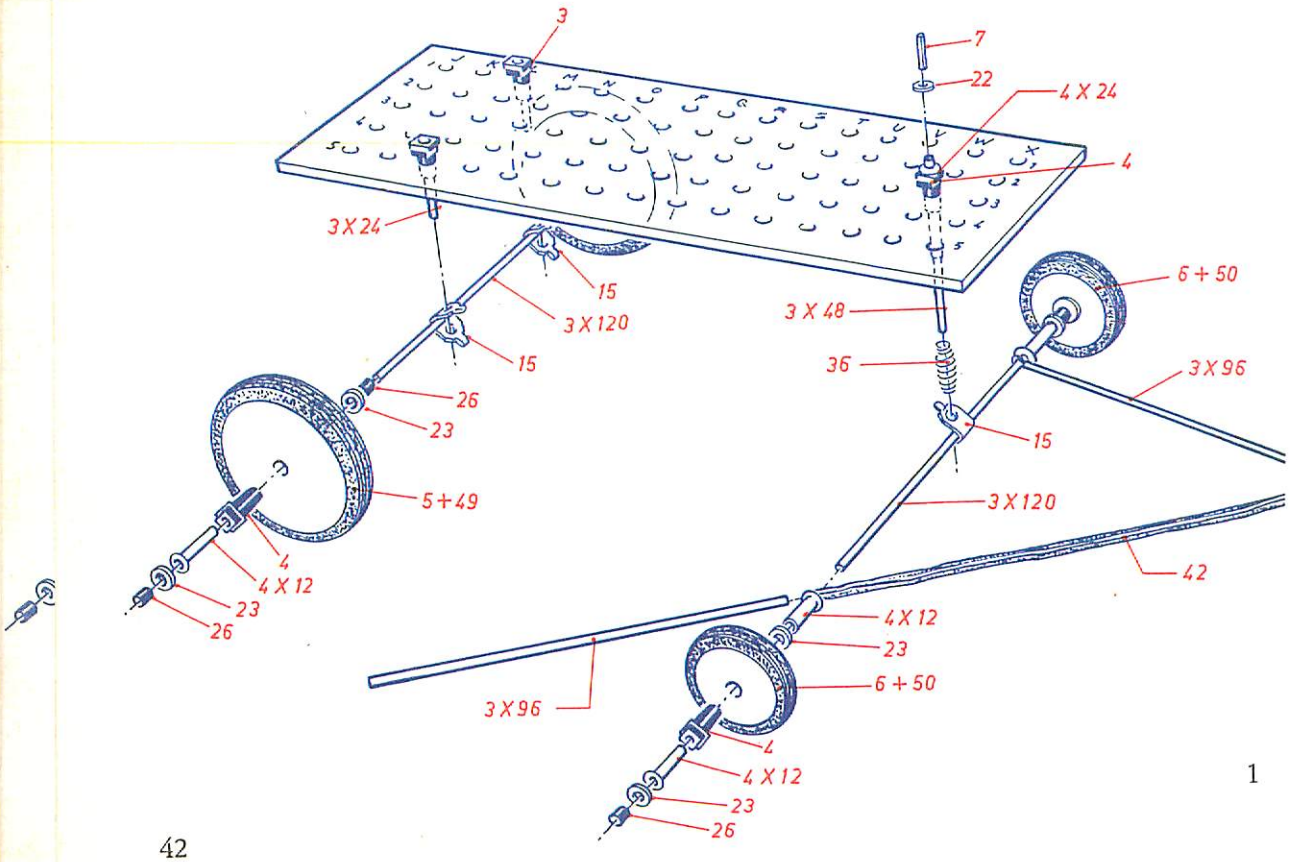
A2 - TRAILER

When we have built one or the other vehicule and have sufficient parts left, this trailer can be hooked behind the truck or car concerned to increasse the load carrying capacity.

Order of assembly

1. Loading platform.
2. The back axle.
3. Front wheels, with steering axle and towing hook.

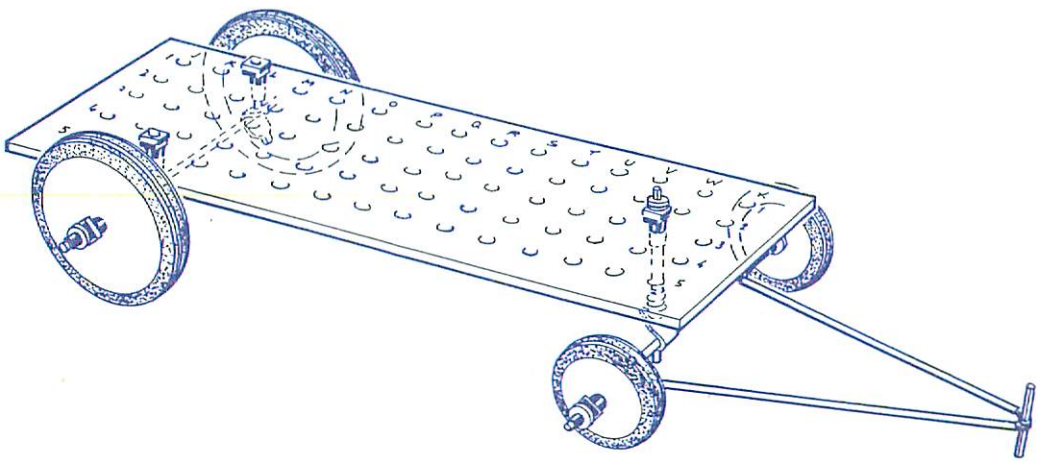




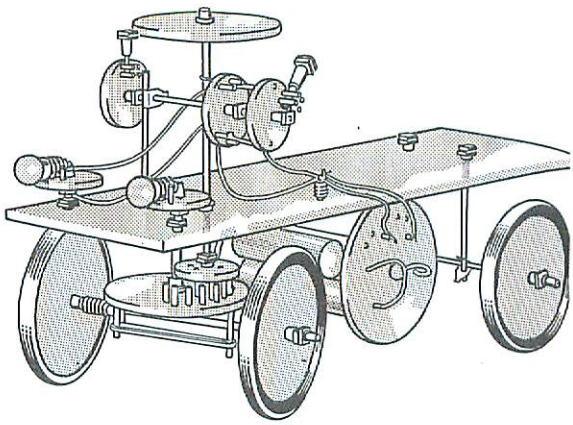
1. In the holes L1 and L5 of the mounting plate 3 x 24 spindles (10) are fixed by means of collets (3). In this respect see page 8 fig. A, B and C. By means of a collet (4) a bush 4 x 24 is inserted in hole 3.

2. Take a 3 x 120 spindle and push on both ends a piece of sleeving (29) and a 3 mm washer. Then on each side a wheel with a 4 x 12 bush and a collet (4) (page 8, fig. B and C). The wheels are secured by means of a 3 mm washer and a piece of sleeving (29). The wheels are slightly wider apart than in the previous model. Fix the back axle by means of clamping springs on the 3 x 24 spindles in L1 and L5.
The wheels must be able to revolve freely. Rubber tyres are fitted.

3. Push a 2 mm washer on a pin (see page 10) and push this pin into a spindle 3 x 48. This spindle is then pushed into the bush in W3. Underneath the mounting plate a coil spring and next a clamping spring are pushed on to this spindle. Through the clamping spring a spindle 3 x 120 is pushed. Through two spindles 3 x 96 a rubber band (42) is pulled by means of a piece of string. These are the pull rods. At one end the pull rods are kept together by pushing a long pin (8) through the ends of the rubber band. At the other side the ends of the rubber band are placed around the front axle. Next the front wheels are mounted on this axle, by means of two 4 x 12 bushes, two rings (23) and two pieces of sleeving (26).



A3 - CAR WITH BRAKE AND HEADLIGHTS



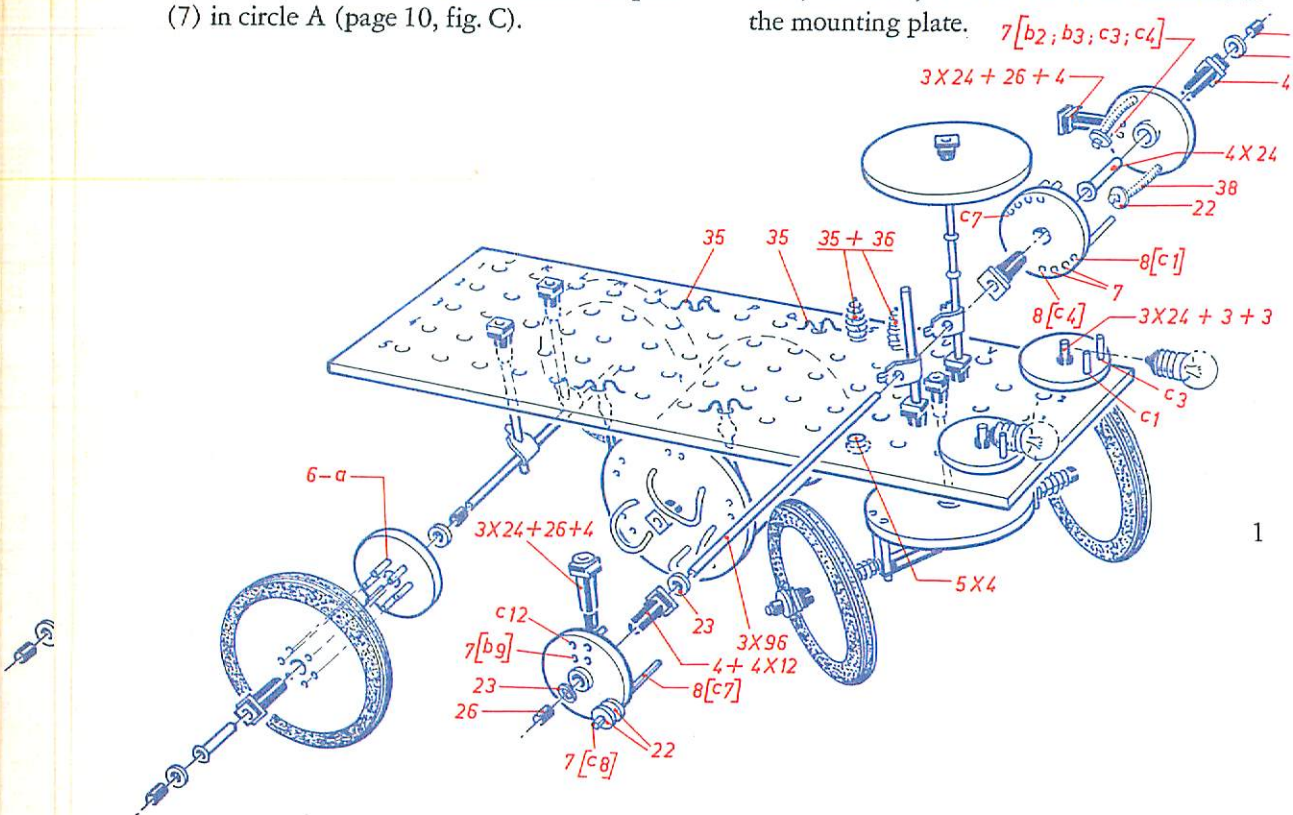
This is the first extension of the car with steering wheel (page 40) to which a battery holder, rotary switch, brake mechanism and two lamp holders have been added.

Order of assembly

1. The car.
2. The brake mechanism.
3. The battery holder.
4. The switch.
5. The lamp holders.

1. This car is identical to model A1 (page 40) with the exception of the right-hand back wheel, which, in this case, consists of a large wheel, to which a small wheel has been fixed at the rear by means of six pins (7) in circle A (page 10, fig. C).

Hair pin springs are fitted in the holes S1 and T1 of the mounting plate (page 17, Fig. A). In V4 a 3 x 48 spindle is inserted and in U5 a 5 x 4 bush. The spindle extends from the top of the mounting plate. The bush, however, is inserted from underneath the mounting plate.



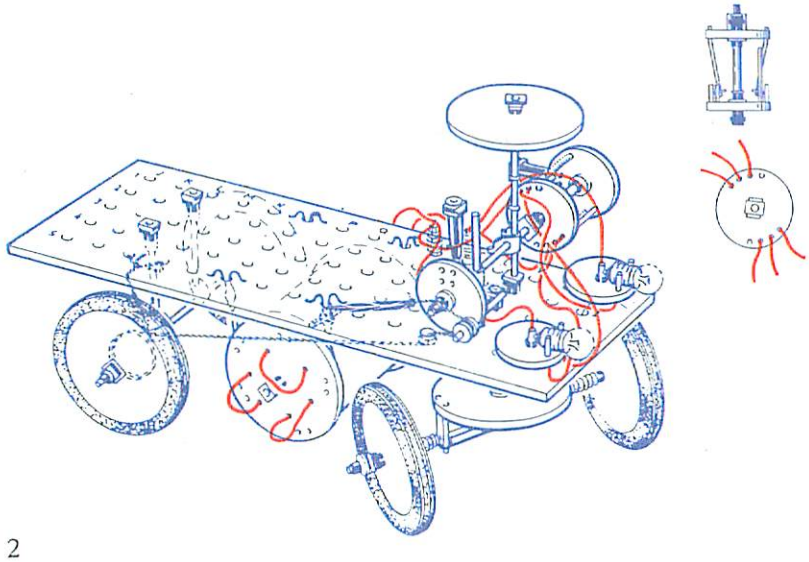
1

2. The brake lever consiste of a small wheel with pins in the holes b8, b9, c11 and c12. These pins extend from the top side; the slots should not face each other. From underneath in c8 a pin (7) is inserted on which two 2 mm washers have been pushed with a distance in between of about 2 mm. In c7 a long pin is pushed from above.
Furthermore, a 4 x 12 bush is fixed by a collet (4) in the central hole. The lever, which consits of a 3 x 24 bush over which a piece of sleeving and a cone (4) have been pushed, is inserted in between the four pins in b8, b9, C11 and C12. A 3 x 96 spindle is fixed to the spindles in V2 and V4 by means of clamping springs. It must protrude about 15 mm at V4. On to this end a 3 mm washer and the brake lever are pushed. This latter is secured by means of a short piece of sleeving. Next a piece of string about 35 cm long is inserted from above through hole L5 and then passed through M5, after which a knot is laid. This string passes downward over the edge of the mounting plate, twice round the brake drum, through the bush in V5 and next over pin c8 of the brake lever. The end is tied to a rubber band, which is pushed through hole R5 and secured by a long pin (8).

3. The battery holder for six R6 cells has been described on pages 18 and 19. Suspend the battery holder underneath the mounting plate by means of two rubber bands, which are fixed with hairping springs through the holes O1, O5, R1 and R5. Connect the positive battery lead to the terminal in R1 (60 mm, red). The negative lead is connected to the terminal in T1 (90 mm, black).

4. The construction of the rotary switch has been described on page 21, figs. A and B. To the stator the following leads are connected: In pin c1 90 mm black, c2 16 mm black, c7 90 mm red, c8 90 mm green, c9 120 mm green. This switch is mounted in the usual manner on the spindle which also carries the brake lever. The pin in c2 of the stator must be right above the hole V1.

5. The lamp fittings have been described on page 17, fig. D. They are mounted in X1 an



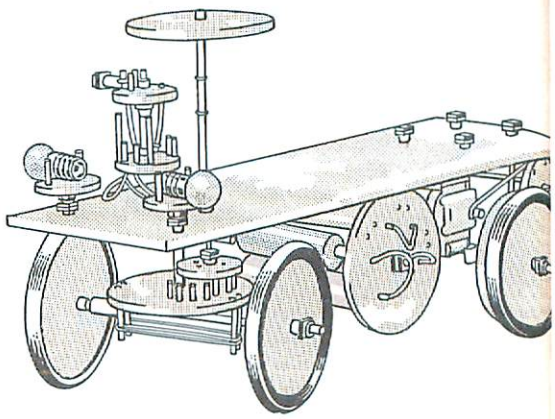
2

X5. Each one is fixed to the mounting plate by means of a spindle 3 x 24 and two collets (3). One of the collets goes in the mounting plate, the other in the lamp fitting with their heads touching. In the top ends of each 3 x 24 mm spindle a short pin (7) is inserted. Make the following connections:

Switch Pin	*Flex Colour*	*To*
c2	black	terminal T1
c1	black	c3 rigthhand fitting
c9	green	c1 righthand fitting
c8	red	c1 lefthand fitting
c7	green	terminal R1

The terminal in T1 is connected to the spindle in X1 (90 mm, black) and the terminal R1 to the spindle X5 (90 mm, red). The rotor of the switch can now be pushed on the spindle and secured by means of a piece of plastic sleeving.

A4 - ELECTRIC CAR



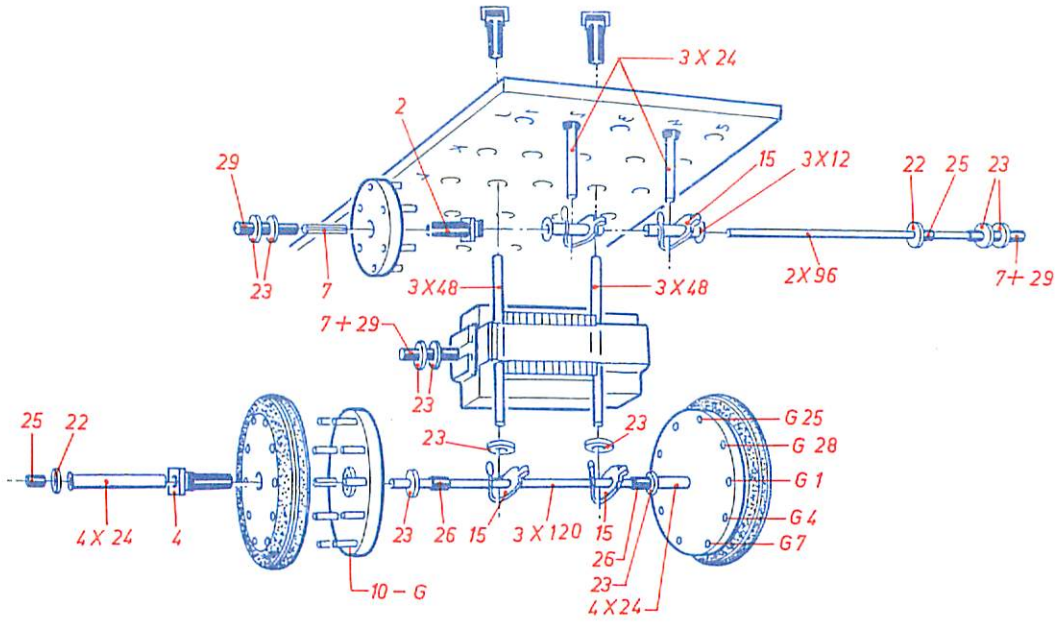
This model is again derived from the car A1. The important difference is that it contains an electromotor to move it. The switch serves as reverse gear and contact switch. By reversing the connections of the motor we can make the car run forward or in reverse.

Order of assembly

1. The car.
2. Motor suspension.
3. Back spindle.
4. Intermediate spindle.
5. Battery holder.
6. Switch.
7. Wiring.

1. The front wheels with the steering are identical to those in model A1. The assembly is again fixed in holes V2 and V3 of the mounting plate. In the holes S5, T4, U3 and U5 terminals are fitted by inserting from underneath a hairpin spring through each of these holes, and from above a large coil spring.

2. The motor spindle is first fitted with a pulley as described on page 22 (fig. D)

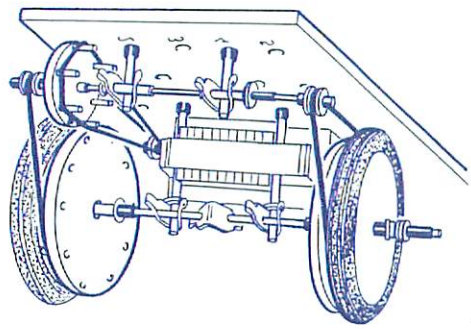


This pulley consists of a pin (8), a piece of hose (29) and two 3 mm washers (23). Then push two spindles 3 x 48 through the motor as indicated in fig. 2. One end these spindles are fixed to the mounting plate by collets in the holes L2 and L4. Next 3 mm washers (23) are pushed across the other ends of the spindles, the washers are kept in place by means of short lengths of 3 mm sleeving.

3. By means of two clamping springs a 3 x 120 spindle is fixed to the spindles in L2 and L4. In this way the motor is properly secured. Over both ends of this spindle a piece of sleeving (26) and a washer (23) are pushed. Next two double wheels have to be made (page 10, figs. B and C), which consist of two large wheels with ten pins divided regularly over circle G. These double wheels are fixed to the shaft by means of a collet and a 4 x 24 bush (20). They are secured by means of a washer (23) and a piece of sleeving.

4. Spindles 3 x 24 have to be fixed in the holes J2 and J4 by means of collets (3). Next, on these spindles, ,mount bushes 3 x 12 by means of clamping springs in such a way that the flanges of the bushes point towards the sides of the car. Then in a small wheel push from above six pins in the odd-numbered holes of circle c.

Fix this idler wheel on a 2 x 96 spindle position 7 (page 10, Fig. C) by means of a 2 mm collet, and then push this spindle through the two bushes underneath J2 and J4. A 2 mm washer against the flange of the bush in J4 and a piece of sleeving (25) prevent this spindle from moving sideways. At both ends of this spindle a pulley is fitted, each consisting of a piece of rubber hose (29) and two 3 mm washers. This is done in the same way as was the case with the motor pulley (page 22) and is made easier if assembled before the spindle is brought into its position. Then fit three rub-



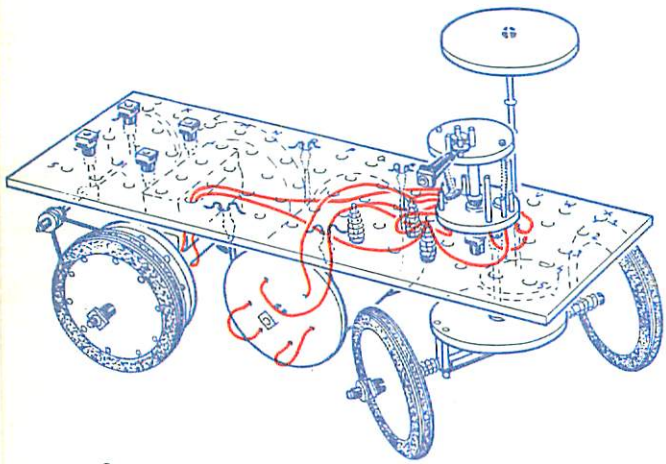
2

ber bands around the wheels and spindles (Fig. 2).

5. Battery holder (see page 19).
This is the normal battery holder for six R6 cells. The red positive lead should be connected to the terminal in S5 and the black negative lead to the terminal in T4.

6. The switch is the one described on page 21. The stator carries short pins in c4, c5, c9, c10, c11 and c12 (slots pointing outwards) and long pins in c3 and c6. Leads 60 mm long are connected to c3 (black), c4 (green), c5 (grey), c6 (black), c9 (red), c10 (grey), c11 (green) and c12 (red). The stator is fixed in hole V4 by means of two collets and a 3 x 48 spindle. The rotor is placed on the spindle without any fixing, so that it can be removed and thus serves as the contact key of the car.

7. To the motor terminals two pieces of flex, 210 mm in length, are connected (grey and green). All green leads are inserted in U5, all grey leads in U3, the black ones in T4 and the red ones in S5 (see fig. 3).



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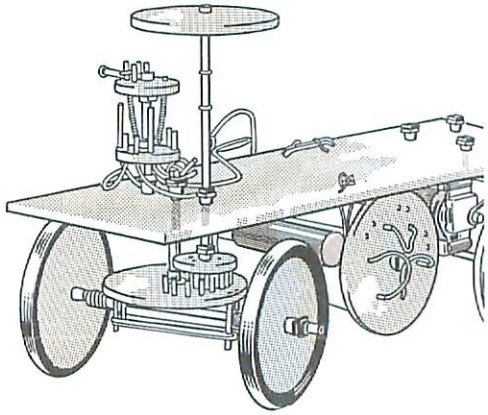
A5 - ELECTROCAR WITH FLASHING DIRECTION INDICATORS



This is a further extension of the previou described model. We refer to that descripti and indicate below only the differences construction.

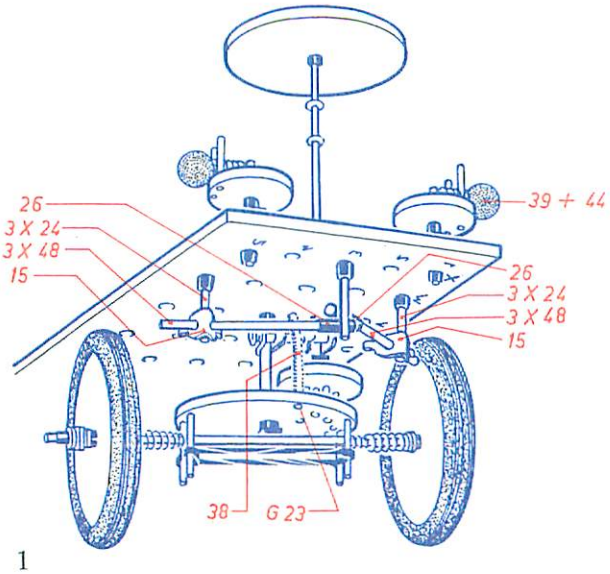
Order of assembly

1. The electrocar.
2. The lamp fittings.
3. The contacts.
4. Wiring.

1. First build the electric car according the description of model A4.

2. See fig. 1. Make two lamp fittings (p 17, fig. D) and mount these by means o bush 3 x 24 and two collets (3) in the h X1 and X5 of the mounting plate. To m lamps red pull a piece of balloon over e lamp and fix it with a piece from the ball neck.

3. Place a contact spring in hole G23 the large wheel of the pivot for the fr axle. Then, by means of collets (3), pl 3 x 24 spindles in W1, W5 and X3. Fi 3 x 48 spindle on the spindles in W1 W5 by means of clamping springs. Fit sl lengths of sleeving to the ends of these spi les so as to prevent electrical contact betw



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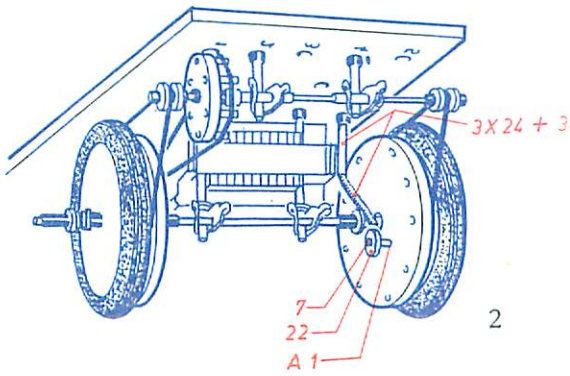

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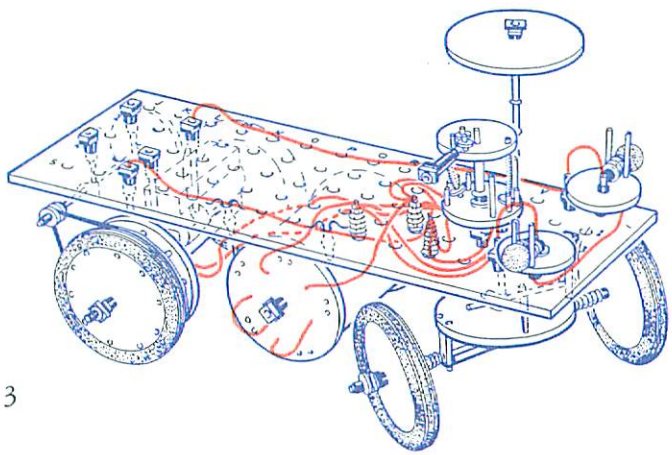
them. Then take a 3 x 24 spindle; at one end insert a pin (7) and at the other end a contact spring. The end carrying the pin is inserted, together with a collet (3), in hole L5 of the mounting plate. In hole A1 of the righthand back wheel a pin (7) carrying a washer (22) is inserted. The contact spring in the spindle in L5 will normally rest against the back axle but the contact is interrupted every time the pin in hole A1 passes.

4. The contact spring in G23 of the front axle assembly is connected by means of 120 mm of grey flex to the terminal in U3, pass this lead through the spindle in V3. Connect W5 to X5 (60 mm green) and do the same with W1 and X1. Interconnect the pins in c1 of the lamp fittings by a grey lead (120 mm).

Connect pin c3 of the fitting in X1 to a pin inserted in spindle L2 (210 mm grey). Finally, connect the contact breaker in L5 to the motor connection to which the green lead is connected (210 mm).



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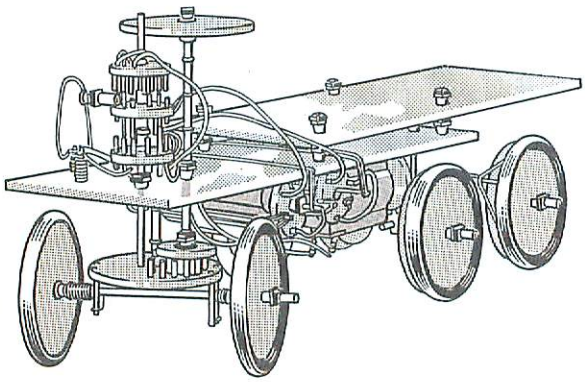
A6 - SIX-WHEEL TRUCK



The particular thing about this truck are the back wheels. Their special suspension permits all four to move up and down independently. They are also driven separately.
The electrical circuit is different to that of the previous vehicle. This oruck has two forward and one reverse speed with, in all cases, the whole battery of six cells supplying the current.
The switch consists of one rotor with three rotor contacts at the top and three underneath and two stator wheels. One contact spring always interconnects four contacts.
In the reverse and first forward positons the two 4.5 V batteries are connected in parallel and then the current to be supplied by each cell is cut by half, which makes for a long battery life. In the second forward position all the cells are connected in series. The voltage across the motor is then 9 V and the motor will run twice as fast.

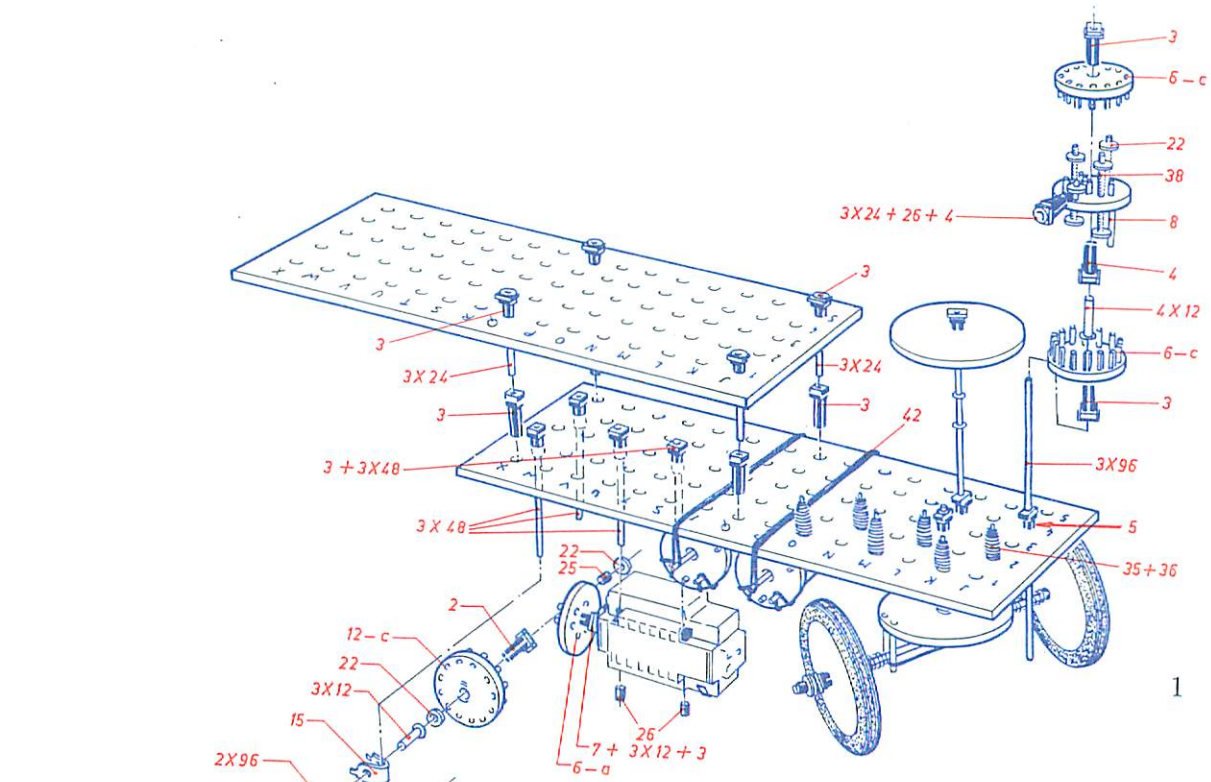
Order of assembly

1. Base plate.
2. Front axle assembly.
3. Back wheels with tandem set.
4. Driving wheel and spindle.
5. Motor.
6. Two battery holders.
7. Switch.
8. The electrical wiring.
9. Finishing off.

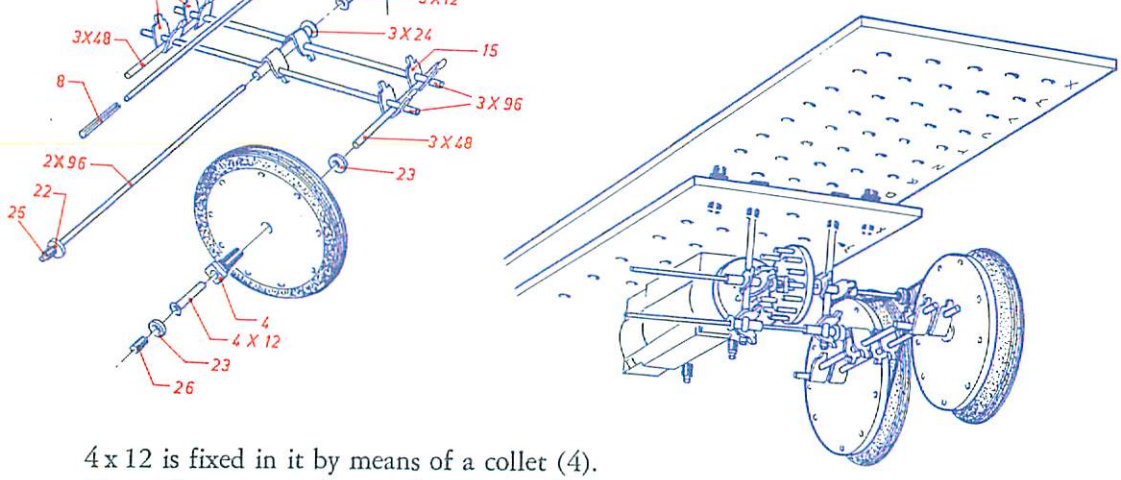
1. On the mounting plate fix spindles and clamping springs as indicated in the drawing. (The collets in Q1, Q5, X1 and X5, which support the second mounting plate, are kept till later). The 3 x 96 spindle comes at position 5 in J4. All the other spindles are 3 x 48. In L3 a collet with 4 x 12 bush is placed for the steering. The spindles in X2 and X4 each consist of two spindles 3 x 24 connected together by means of a pin.

2. The assembly of the front wheels and the steering follow the direction already given for model A5.

3. First make the two tandem sets which are each other's images. Take two spindles 3 x 96 on each put clamping springs at the centre and both ends. The lugs of the centre spring should point downwards, those of the spring at the ends should point upwards. Through the clamping springs at the ends, spindle 3 x 48 are pushed and through those at the centre 3 x 24 bushes. The bushes should extent about 1 mm from the clamping spring the spindles should extend from the clamping spring at the sides opposed to the flanges of the bushes. Of the second tandem set the flange of the bush and the spindles point in the opposite directions of the first.
On the spindles 3 x 48 a washer and a double wheel have to be pushed. The double wheel must have nine pins in circle F and a spindle



1



2

4 x 12 is fixed in it by means of a collet (4). The collet must point to the outside. The wheel is kept form shifting by a 3 mm washer and a piece of sleeving (26). On the lower ends of the spindles in X2 and X4 clamping springs have to be pushed, bushes 3 x 12 have to be pushed through these springs (flanges on the outside). In these bushes a 2 x 96 spindle is inserted and a tandem set is placed at each end of this spindle. They are

locked by means of 2 mm washers and pieces of sleeving (26). (See also fig. 2).

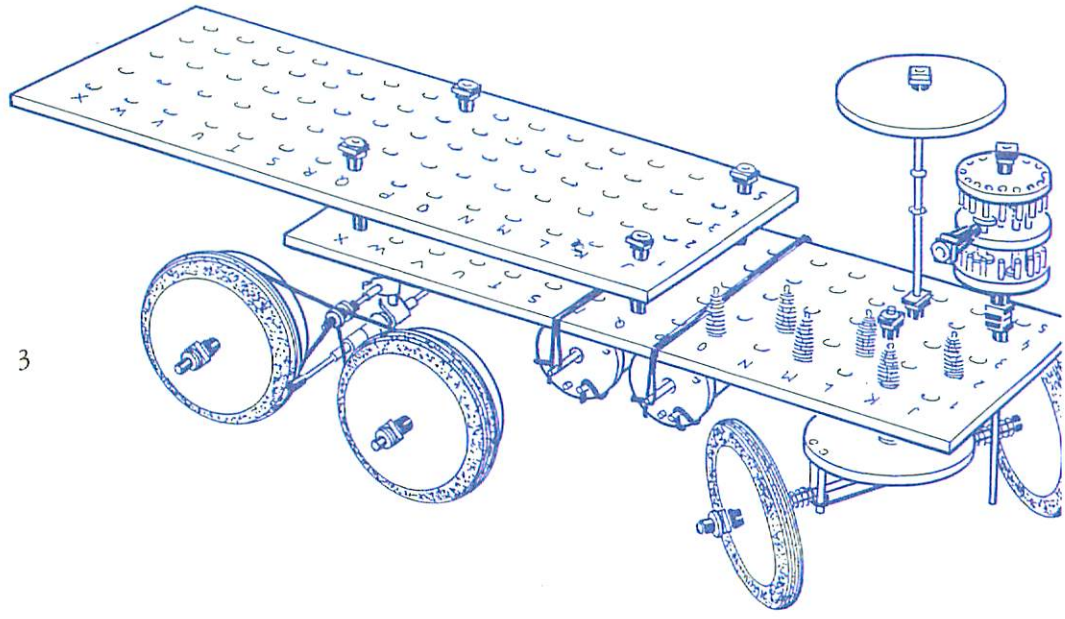
4. Mount the idler wheel. On the centre of the spindles in X2 and X4 bushes 3 x 12 are to be fixed by means of clamping springs (flanges pointing inwards). Before mounting the bush on the spindle X2, push a spindle 2 x 96 through the latter. On this spindle push a washer (22), the idler wheel, a collet, a piece of sleeving (25) and a second washer (22). This spindle also passes through the bush on the spindle in X4. Adjust the spindle in such a way that both ends extend the same distance and then fix the collet in the idler wheel. Over both ends of the spindle a pin (7) is pushed. On these pins pulleys are made by means of pieces of rubber hose and two 3 mm washers (see page 22, fig. D).

5. Fix a pin (7) on the motor spindle and over this a bush 3 x 12 with the flange pointing towards the motor. On this bush a small wheel with six pins in a is fixed by means of a collet (3). (slots pointing inwards).

Mount the motor and secure it by means c pieces of sleeving (26). Next adjust the pos tion of the spindle with the idler wheel th its pins properly engage those of the whe on the motor spindle (Fig. 1 and 2).

6. Connect 120 mm red flex to the positi terminals of both battery holders and bla flex (150 mm) to the negative termina Through the battery holders push a spind 2 x 96 and suspend them underneath t mounting plate by means of rubber ban

7. Both stator wheels consist of a small wh with pins in circle c (slots pointing outwar In the top stator wheel the following wi are inserted:
c1 grey 120 mm, c7 grey 120 mm, c9 120 mm, c10 grey 120 mm, c11 g 120 mm.
The wiring of the lowermost stator wh is as follows:
c3 red 60 mm, c4 black 60 mm, c5 black mm, c6 black 60 mm, c7 black 120 mm, red 60 mm, c10 red 120 mm, c11 red 60 m



3

The lowermost stator wheel is fixed on the spindle in J4 with a collet (3), next a bush 4 x 12 is pushed over this spindle. The switch rotor consists of a small wheel, with pins at the top side in the holes a1, a6, c1, c8 and c12 and protruding 4 mm underneath the wheel. Next mount the lever in the ordinary way. A 2 mm washer on the pin in c1 keeps the lever in position. In b3 a long pin is inserted which again protrudes 4 mm from the underside. Contact springs are pushed into the holes b2, b5 and b8, protruding equally at both sides. On to each end of these springs push a 2 mm washer.

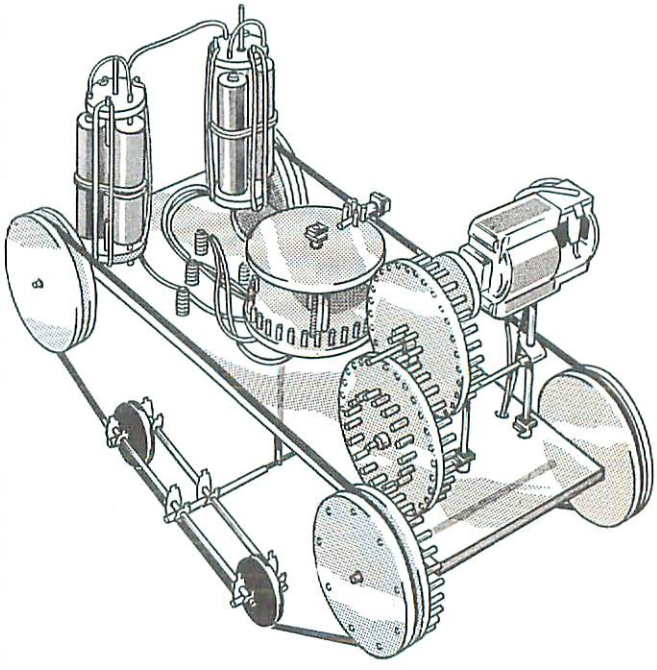
The rotor is fixed on a bush 4 x 12 by means of a collet (4) and then is placed on the spindle in J4. Next the uppermost switch stator is fitted on the same spindle, by means of a collet (3). It is important that the rotor can rotate freely between the two stators.

8. On the rearmost battery holder connect the positive lead to L2 and the negative lead to M1. Of the foremost battery holder the positive lead goes to J2 and the negative lead to K1. The red leads from c9 and c11 of the lower stator go to J2, and these from c3 and c10 to L2. The black leads from c4 and c6 go to K1 and those from c5 and c7 to M1. Connect the red lead from c9 of the top stator to L2, the grey leads from c10 and c11 with O1 and the green ones from c1 and c7 to N2. The motor should be connected to O1 and N2, with grey and green flex (210 mm each).

9. Mount rubber tyres on all wheels and fit rubber bands around the four back wheels and the pulleys on the driving spindle.

In the second mounting plate put bushes 4 x 24 in the holes J1, J5, Q1 and Q5. These are fixed by means of collets (4) in the holes Q1, Q5, X1 and X5 of the base plate. When the switch is moved to the forward position, the truck should move forward. If it goes in reserve, change over the motor leads.

A7 - CATERPILLAR TRUCK

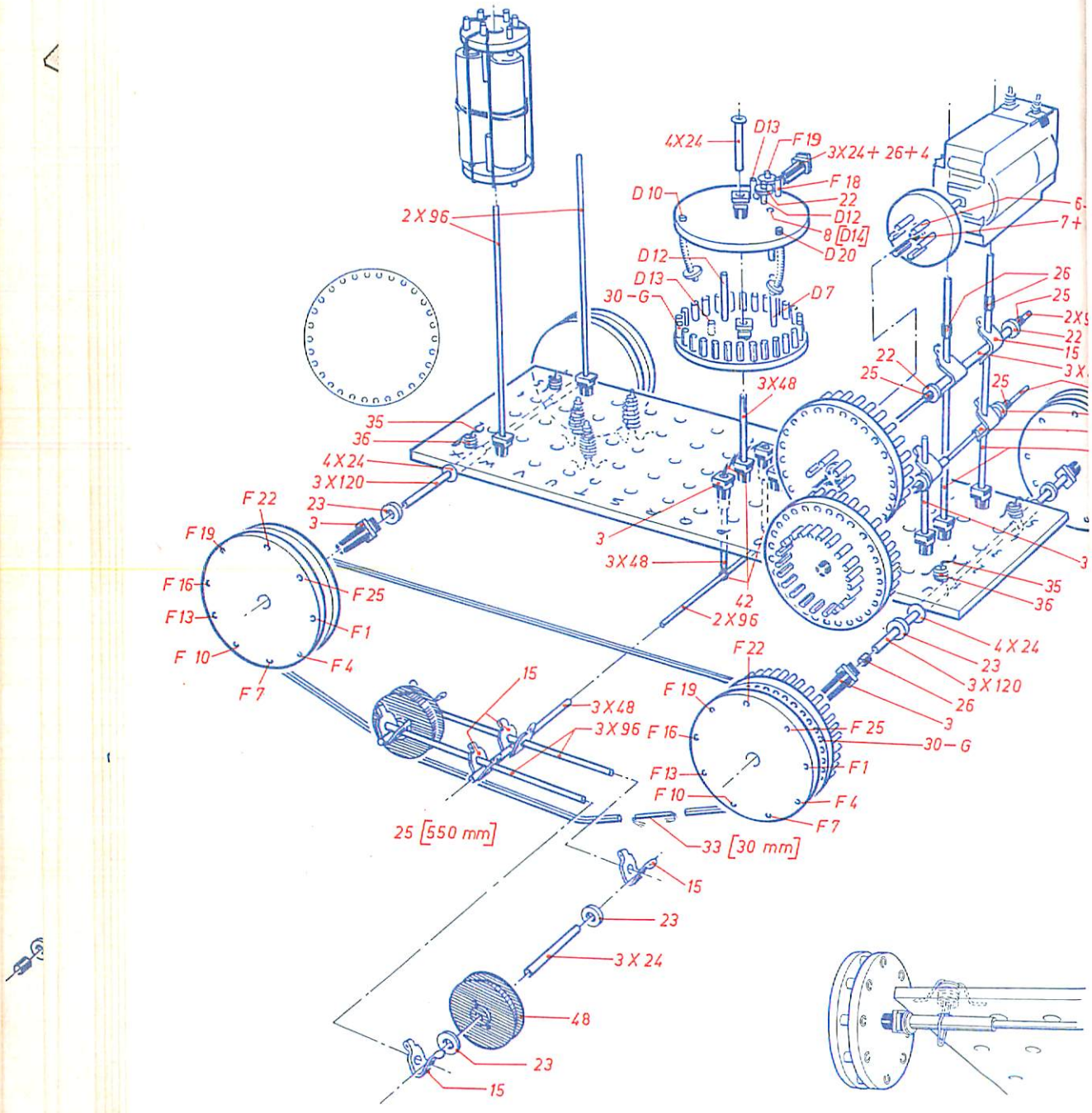


The caterpillar truck can be used to drive through almost any field. Its caterpillar tracks permit it to pass through the most difficult terrain. This model differs in almost every respect from those described previously. Only the motor drive is identical to that of model A6.

Order of assembly

1. The mounting plate.
2. The gear transmissions.
3. Placing of the motor.
4. The front wheels.
5. The rear wheels.
6. The sets of idler wheels.
7. The switch.
8. The battery holder.
9. The wiring.

*1.*Insert terminals in the holes N2, N4, T3, U2, U4 and V3 (see page 17, fig. A). Next push a large coil spring over a hairpin spring and insert the whole in J1. Through the opening of the coil spring pass a bush 4 x 24 (see fig. 2). Repeat this for J5, X1 a X5. The flanges of the bushes come again the outside of the mounting plate. Next pla spindles in the mouting plate as indicat below:



Spindle	*Collet*	*On position*	*Hole*
3 x 48	3	4	K2
3 x 120	3	10	K3
3 x 120	3	10	K5
3 x 48	3	1	Q2
3 x 48	3	4	Q3
3 x 48	3	1	Q4
2 x 96	2	8	W1
2 x 96	2	8	W5.

Then insert a bush 3 x 12 with collet (3) in P3.

2. Proceed by making the following gear wheels.

Large wheels with 30 pins (7) in circle G pointing upwards and 6 in circle A pointing downwards. Place this wheel on a spindle 2 x 96 (position 7). Large wheel with 30 pins at the top side in circle G and 18 pins underneath in circle D. Wheel on a spindle 2 x 96 (position 8). Push clamping springs on the spindles in K2, K3 and K5. Insert spindles 3 x 48 in the topmost clamping springs in K5 and K3. Through the other clamping spring in K5 and that in K2 a push 3 x 12 is pushed. On the spindles of the gear wheels push a short length of 2 mm sleeving and a 2 mm washer. Next bring the spindles in position. The gear wheels come above the side carrying the letters.

Adjust the position of the clamping springs until the gear wheels run smoothly and engage each other properly.

When the gear wheels are properly adjusted, a washer and piece of sleeving have to be pushed over each of the protruding spindle ends to lock the gear wheels in the right position.

3. Push a pin (7) on the motor spindle. Over this a bush 3 x 12 with the flange pointing towards the motor. Next a small wheel with 6 pins in circle A is fixed on this bush by means of a collet (3). On the spindles in K3 and K5 a piece of 3 mm sleeving is put. Next the motor is placed on these spindles and with the pieces of sleeving the position of the motor is so adjusted that the gear wheels engage properly.

4. Make two double wheels with pins in F1, F4, F7, F10, F13, F16, F19, F22 and F25. In one of the wheels moreover pins in circle G with the slots facing inwards. Through the bushes underneath J1 and J5 goes a spindle 3 x 120. On the spindle at J5 a 3 mm washer is placed, after which the double wheels without pin is mounted on the spindle with a collet (3). At the other side again comes a 3 mm washer and a length of 3 mm sleeving. Next the other double wheel is fixed on the spindle. The pins of this must engage the pins of the gear wheels which are already in position (Fig. 3).

5. Make another two double wheels and mount these in the same manner (as described sub 4) underneath X1 and X5.

6. On each of two spindles 3 x 96 three clamping springs are placed. Through the middle ones push a 3 x 48 spindle.

In-between the two clamping springs at the outside fix on a 3 x 24 spindle, a pulley (48) with at both sides a 3 mm washer. This we repeat once more. The pulleys must be able to run very smoothly. A rubber band is pulled from underneath through the spindle in Q2 by means of a piece of string.This band goes across the mounting plate and then through the spindle in Q4 down again.

Through both ends of the rubber band a spindle 2 x 96 is pushed. At both ends of this spindle a tandem set is mounted. Next we make the tracks. Take 55 cm of 2 mm sleeving and 3 cm flex. The insulation is stripped off over 5 mm from both ends after which the bare wire is bent back. By pushing this piece of flex in the ends of the sleeving, the tracks are closed.

Put the tracks around the front and back wheels and the tandem sets (see fig. 3).

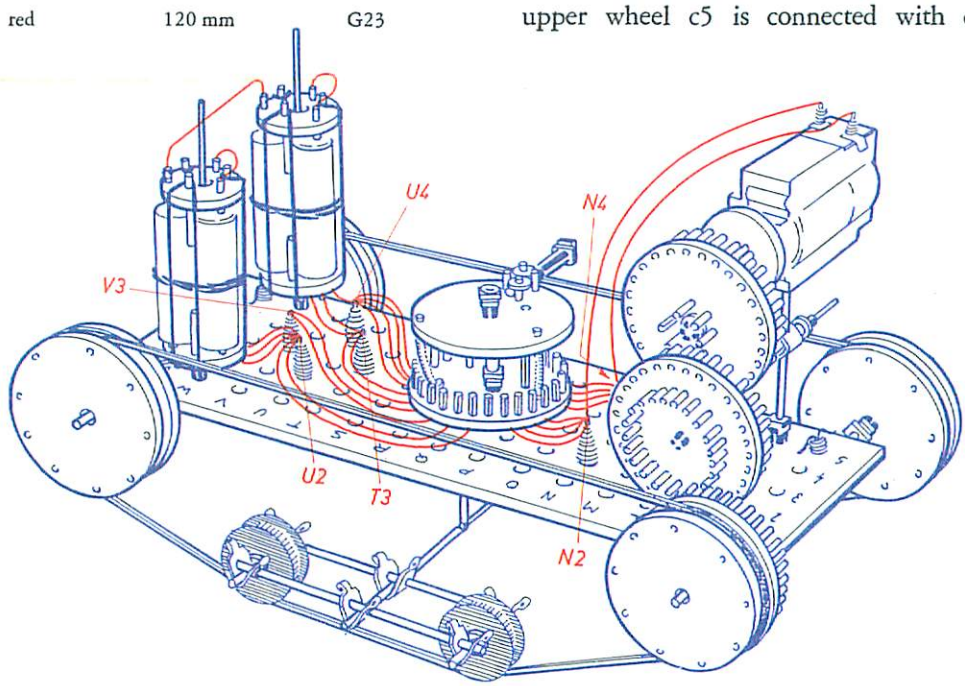
7. The stator of the switch consists of a large wheel with thirty pins pointing upwards in circle G (fig. 1 a). One downwards in D13 and two long pins upwards in D7 and D12. The wiring is fixed underneath the wheel, according to the following table.

Colour	*Length*	*Position*
red	60 mm	G5
green	120 mm	G6
green	120 mm	G9
black	120 mm	G10
green	120 mm	G11
black	120 mm	G12
black	120 mm	G13
grey	60 mm	G14
black	120 mm	G15
grey	60 mm	G16
grey	120 mm	G20
grey	60 mm	G21
red	120 mm	G22
red	120 mm	G23
green	60 mm	G24
grey	120 mm	G25
red	120 mm	G29
grey	120 mm	G30

Fix the stator on spindle Q3 of the mounting plate. Th pin in D13, which points downwards, comes in the bus in P3.

The switch rotor consists of a large whee with three contact springs, mounted fro underneath in G20, G20 and G30. On th ends of each spring a 2 mm washer is fixed On the top side of the wheel place pins i D12, D13, F18 and F19. The pins in D1 and F18 carry a 2 mm washer. Finally long pin (8) with a 2 mm washer at the end is placed from underneath in D14. Wit a collet (3) a bush 3 x 24 is mounted in th central hole. The switch lever is placed in between the pins at the top side of the wheel Then put everything into position (Fig. 3)

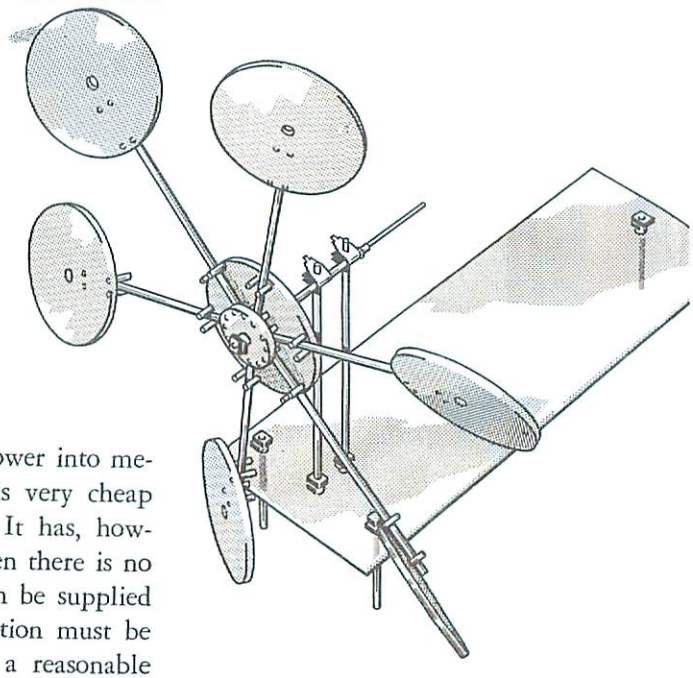
8. We procede by making two battery hol ders from small wheels (see page 18.) Firs the battery holder that goes in W1. In th upper wheel c5 is connected with c9 b



means of 60 mm green flex. In c1 120 mm green flex is inserted, which later on is connected to the other battery holder. In the lower wheel we connect c1 with the terminal in U2 (60 mm red), c5 with V3 (60 mm grey), and c9 with V3 (60 mm grey). The batteries are so inserted in the holder that of the upper wheel c1 and c5 press against the negative pole of a cell and c9 against the positive pole. The lower wheel must be so placed that c1 and c5 each contact the positive pole of a cell and c9 the negative pole. Next construct the battery holder in W5.

In the upper wheel c5 and c9 are interconnected (60 mm grey). In c1 comes the lead from c1 of the other battery holder. In the lower wheel c1 is connected with the terminal in U4 (60 mm black), c5 with T3 (60 mm grey) and c9 with T3 (60 mm grey) Insert the cells in such a way that c1 and c5 of the upper wheel are positive and c9 negative. In the lower wheel c1 and c5 are negative and c9 positive. The green leads of switch and battery go to N2. The grey leads to the terminal in N2. The black leads go to U4 and the red one is inserted in U2. Finally connect the motor bij means of green and grey glex of 210 mm length to N2 and N4.

B - DRIVE SYSTEMS
B1 - WINDMILLS

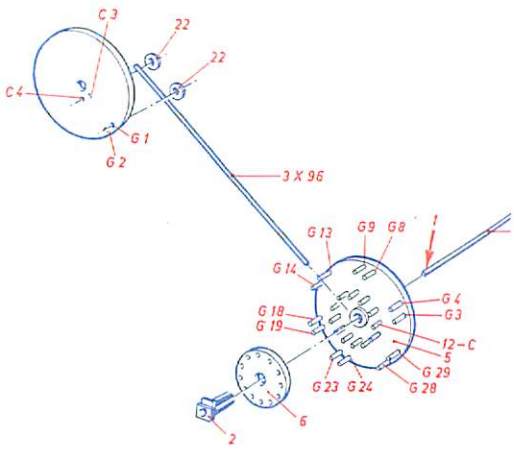


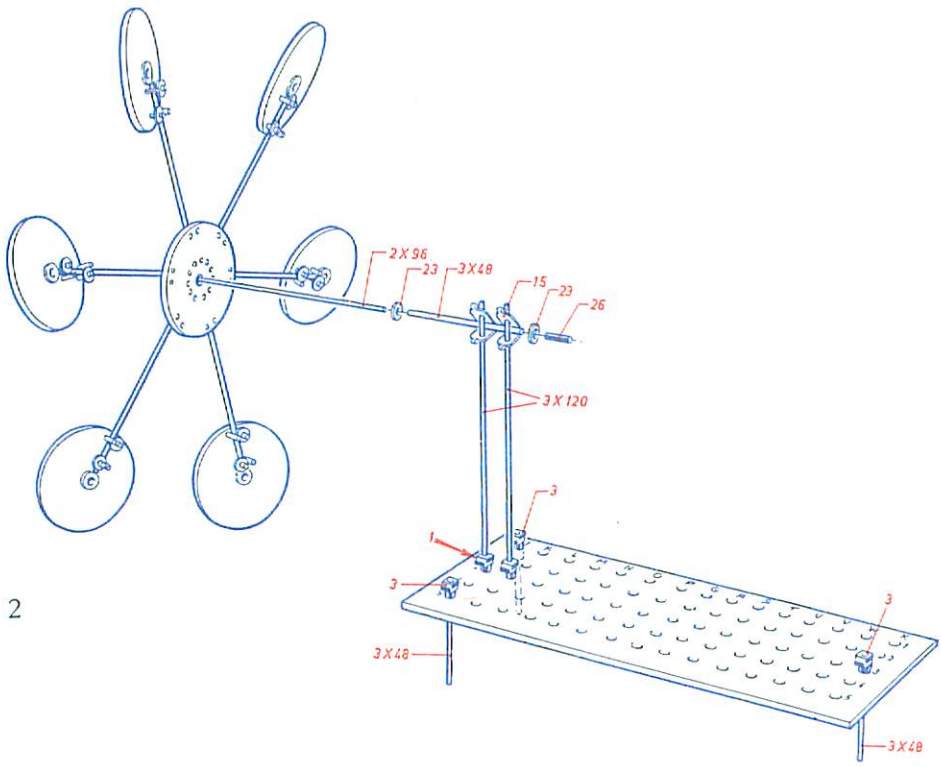
A windmill transforms wind-power into mechanical energy. This system is very cheap since the wind costs nothing. It has, however, the disadvantage that when there is no wind no mechanical energy can be supplied either. In addition, the installation must be very large if it is to provide a reasonable output of energy.

Order of construction

1. The baseplate.
2. The centre-piece.
3. The sails.

1. Put a 3 x 48 spindle in holes X3, J1 and J5. Next place upright spindles in J3 and K3. A 3 x 48 spindle is fitted into the top of these spindles with clamping springs as indicated.
Assemble a double wheel of a large wheel and a small wheel with pins in circles C and c respectively. The reverse sides must face each other. (Figs. C and D). The slots must alternately be turned towards and away from each other. The closed sides of the pins must be turned towards each other at the place where the sail spindle is later to be placed. Next put pins in the underside of the large wheel at G3, 4, 8, 9, 13, 14, 18, 19, 23, 28 and 29. These pins go in pairs a the slots must be turned away from e other. Finally using a collet (2) put a spin 2 x 96 into the small wheel.

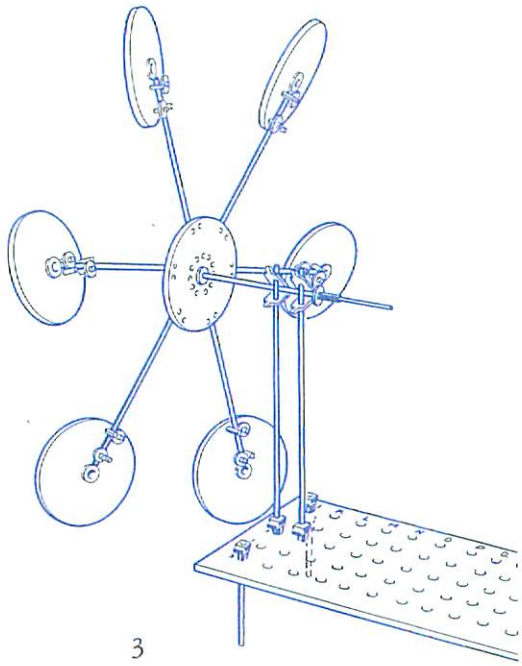




2

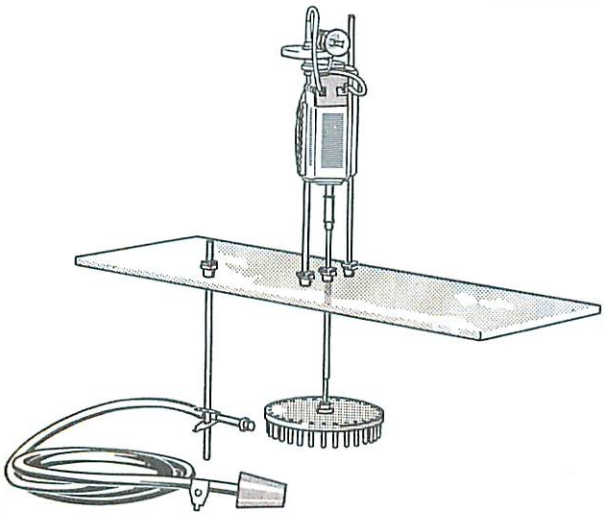
3. Take a large wheel and insert pins in holes C1, C2, G3 and G4, The pins go on the underside of the wheel and the slots are turned away from each other. A 2 mm washer goes over C1 and G4. A 3 x 96 spindle is inserted between the pins. Repeat this operation 6 times. Then put the sails on the centre-piece as indicated. The 2 x 96 spindle of the centre-piece is put into position. To ensure ease in spinning use two 2 mm washers and fix everything securely in place with a piece of 2 mm sleeving.

The sails must now be adjusted correctly. Tilt them all slightly to one side. Then place the complete model in the windstream of a fan and the windmill will turn. If the sails are slanted towards the other side, the windmill will spin in the opposite direction.



3

B2 - WATER TURBINE WITH DYNAMO

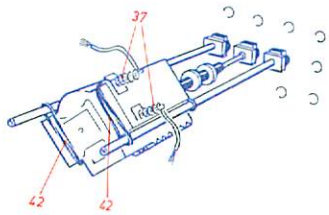


This model converts the energy produced by water pressure into a rotary movement which creates electric energy in the motor. This electric energy makes a bulb light up and, is thus transformed into light and heat energy. Characteristic of turbines is that the number of revolutions per minute is very high. That fact will be clearly demonstrated by this model.

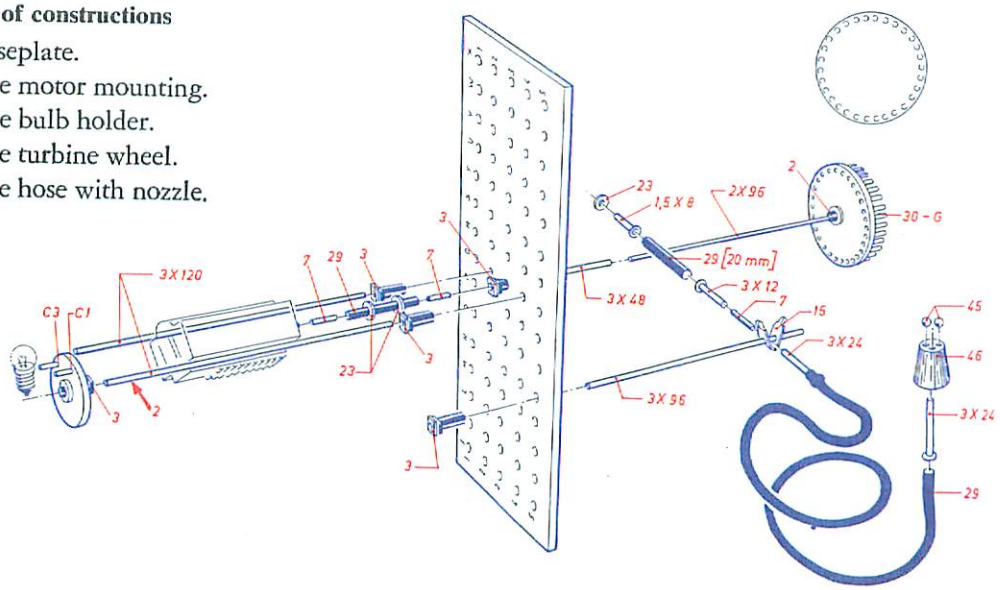
Order of constructions

1. Baseplate.
2. The motor mounting.
3. The bulb holder.
4. The turbine wheel.
5. The hose with nozzle.

1. In the baseplate 3 x 120 spindles go i
Q2 and Q4 (position 10), one 3 x 96 sp
dle into N5 (position 1) and one 3 x
spindle into Q3 (position 1).
2. First place a pin (7) on the motor spin
and secure a piece of hose (approx. 2 m
to it with a washer (3 mm). Another 3 m
ring goes over the hose by means of wh
a 3 x 96 spindle will later be secured. P
ce the motor slantwise (Fig. 2) between
spindles and Q2 and Q4 and fix it to th



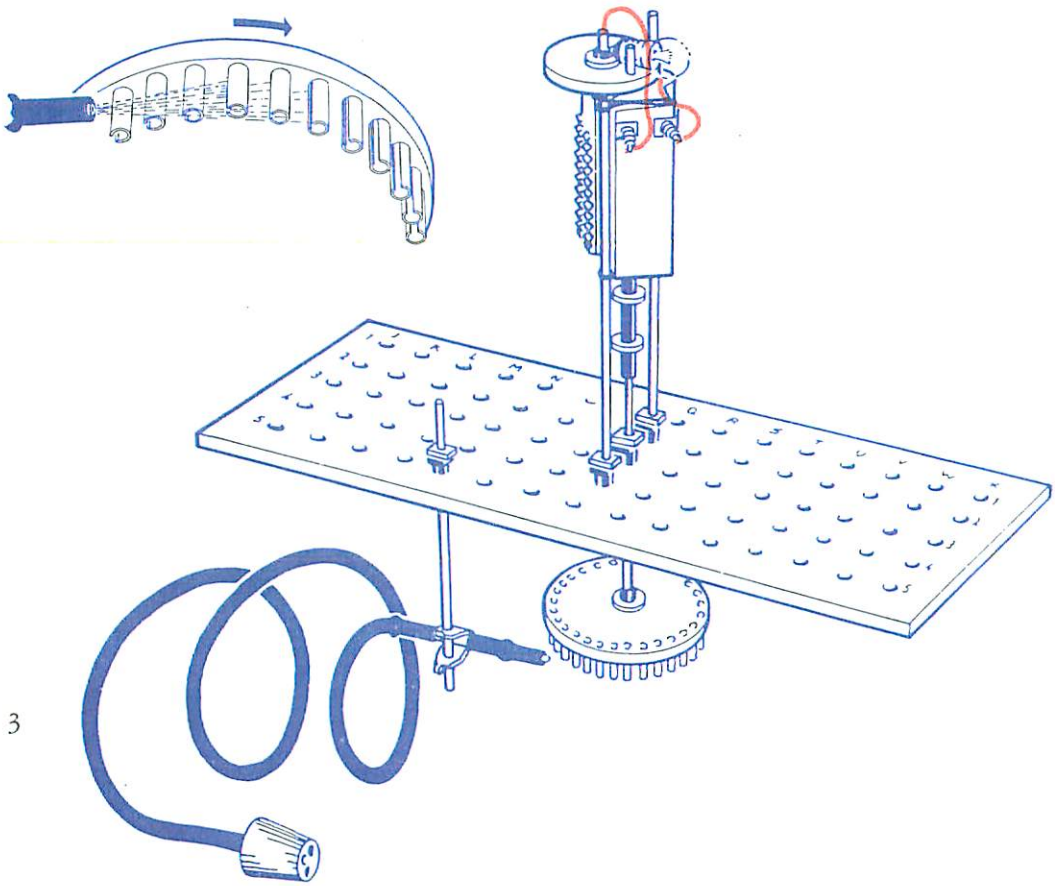
spindles by means of two elastic bands. T
motor pulley must be directly opposite hc
Q3.



2. Make a bulb holder (Page 17, fig. D) and connect the terminals of the bulb holder to those of the motor.

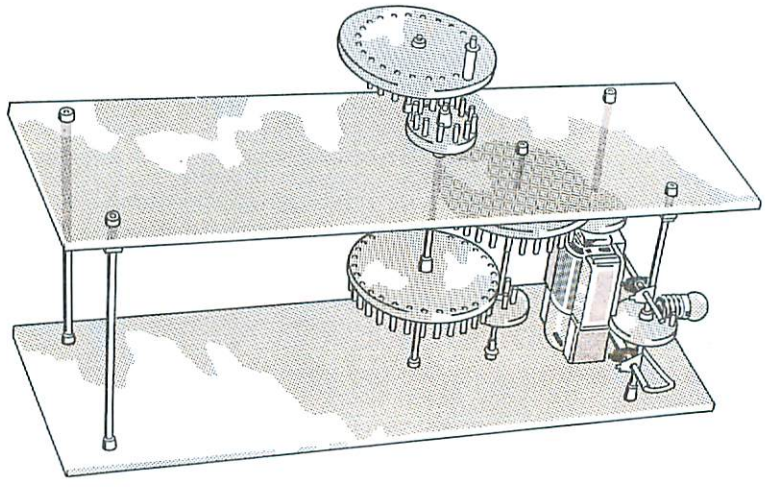
3. Place 30 pins according to the diagram. It is extremely important to position these correctly. Using the collet (2) place a 2 x 96 spindle in this wheel. Push this spindle through the 3 x 48 spindle in Q3. Next put a pin (7) on top of it. Push this complete structure into the hose of the motor pulley and then push the ring over it to secure everything in place.

4. Fix a 3 x 12 bush and a 3 x 24 bush together using a long pin. (Flanges facing outwards). Push the long hose over the flange of the 3 x 24 bush. A piece of hose 20 mm long goes over the other bush. A 1½ x 8 bush goes into the other side of this piece of hose and the flanged end is fixed into the hose. Finally push a 3 mm washer over this side to prevent the bush from being ejected from the hose. Secure the complete structure tot the spindle in N5 with a clamping spring. A 3 x 24 bush is pushed into the other end of the long hose with the flanged edge inside the hose. The other side is inserted in the thick end of the rubber stopper and then the remaining two apertures in the stopper are closed off with metal balls.
Adjust the whole apparatus so that the nozzle sprays into the hollow side of the pins. To make the model work stick the rubber stopper into the tap and turn it on.



3

B3 - THE HAND-DRIVEN DYNAMO

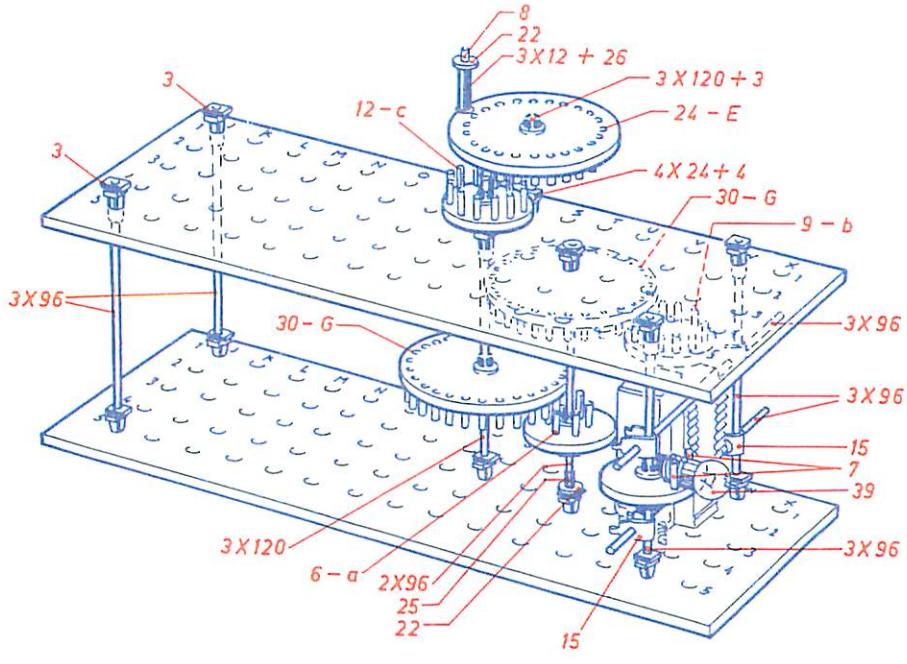


This model demonstrates that the motor can also function as a dynamo and can therefore really generate electric power. Take the bottom baseplate and place spindles in J1, J5, W1 and W5. Fix a bulb holder approximately in the centre of the spindle in W1. (see page 17, Fig. D).

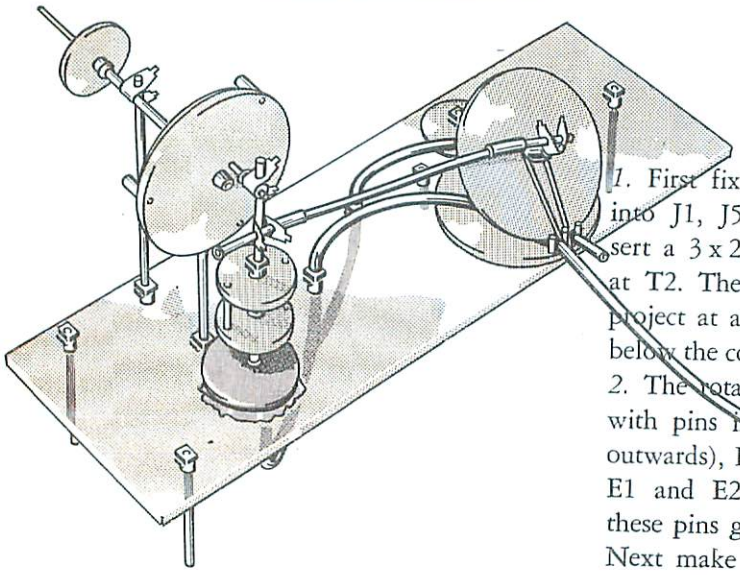
A clamping spring goes on both sides of this bulb holder and 3 x96 spindles are inserted through these. The motor is pushed over these spindles and a cogwheel with 9 pins is placed on it in the usual way. This cogwheel points towards the baseplate. A collet with a 3 x 12 bush goes in T3. Now on a 2 x 96 spindle put a large wheel with 30 pins in C at position 7, and a small wheel with 6 pins in A at position 3. Both wheels are turned with the pins facing each other. The pins are placed in the underside of both wheels. Fit this spindle into the bush in T3. The pins of the large wheel must rotate in the pins of the wheel on the motor. Now using clamping springs fix the two spindles which carry the motor securely on the spindle in W1. Now put a collet with a 4 x 12 bush in R3 of the baseplate. Push a 3 x 120 spindle through this. A small wheel is placed on the part of the spindle projecting on the underside, with 12 pins in the underside in c. On the topside first push a 3 mm washer and a piece of 3 mm sleeving over the spindle. Next put a large wheel on this spindle with 30 pins in the topside in G. These pins must engage in the cogs of the small wheel in the spindle in T3. Now put a collet with a 3 x 12 bush in R1. The rotary shaft goes in this. This rotary shaft consists of a 3 x 120 spindle on the end of which a large wheel is placed with 24 pins in E. Push a washer, then a piece of sleeving, then another washer over a long pin and insert it at A1. The cogs of this wheel must engage with the cogs of the small wheel on the spindle in R3. Now take the second baseplate and place a collet with a 3 x 12 bush in T3. A collet with a 4 x 12 bush goes in R3 and R1.

Push a piece of sleeving and then a washer over the spindles in T3, R3 and R1. Next put the second baseplate into position. Secure the spindles in W1, W5, J1 and J5 with a 3 mm cone. Now adjust the distance

between plates so that the cogwheels engage firmly. If the bottom baseplate is now held firmly and the wheel is turned the motor will rotate. Connect one of the motor contacts to one of the pins of the bulb holder and the other contact to one of the spindles on which the motor is mounted. If the whole apparatus has been properly assembled, the bulb will light up when the rotary shaft is turned. This dynamo can also feed two bulbs without difficulty. The power delivered is then approximately 1 watt. When operating this model it is advisable to hold the plate which is closest to the rotary shaft.



B4 - ADJUSTABLE COMPRESSED AIR MOTOR



The source of power employed here is compressed air. In engineering this is normally obtained by means of a compresoor. With our models the compressor consists of an inflated car tyre tube. To make a compressor motor work the intake hose and discharge hose must be closed in turn. The calve system is used which alternately closes the intake hose and the discharge hose. In later models we shall use other different types of valve.

Compressor motors are used in places where exhaust gases may prove dangerous, for example in coal mines. The alternate opening and closing of the air supply causes the diaphragm to move up and down (by alternately opening and shutting off the air supply the diaphragm is made to move up and down) and this up-and-down movement is taken over by the connecting rod which transmits the power to a crank which transforms the up-and-down movement into a rotary movement.

Order of construction

1. The baseplate.
2. The valve system.
3. The flywheel with crank pi
4. Diaphragm housing with connecting rod.
5. The hoses.

1. First fix the feet of the whole assemb into J1, J5 and X3. (3 x 48 spindles). I sert a 3 x 24 bush at S2 and a 4 x 12 bus at T2. The 3 x 24 spindles in O3 and Q project at an equal distance both above an below the collet.

2. The rotary disc consists of a large whe with pins in G16, G17, G18 (slots facin outwards), F1, F2, F3 (slots facing inwards E1 and E2 (slots facing each other). Al these pins go on the underside of the whee Next make the regulating wheel. This is small wheel with 9 pins in b on the unde side. A 3 x 48 spindle goes into this whee at position 1. The rocker wheel consists o a 3 x 48 spindle with a large wheel at posi tion 2 and a small wheel at position 3. Pu a 5 mm long piece of 7 mm sleeving (28) i T4 of the mounting plate.

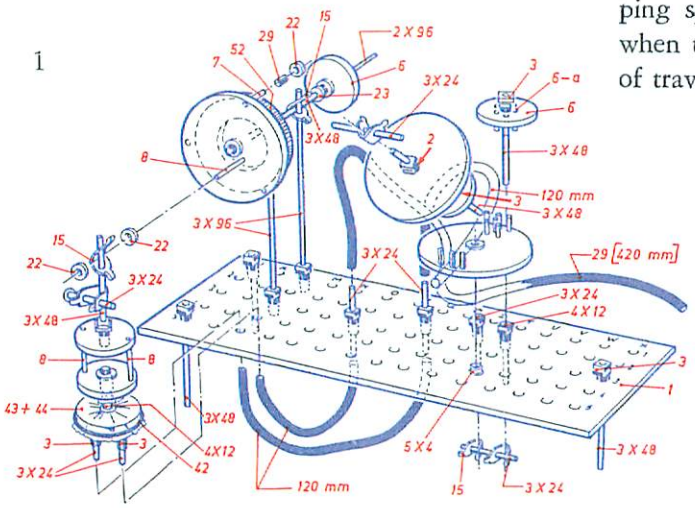
The rotary disc goes on top of this. Push 120 mm hose over the spindle in Q2. 420 mm hose goes on the spindle in O3 Lay these hoses between the pins G16, G1 and G18 of the rotary disc.

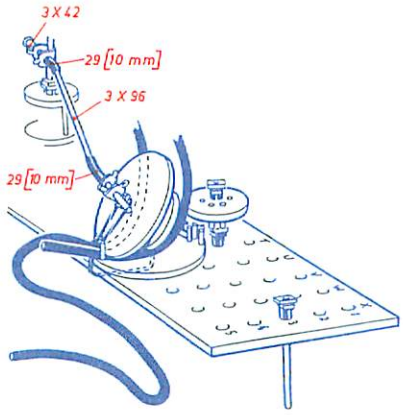
Put two elastic bands over the rocker arm so that the elastic bands come between both wheels. Next double the elastic and push i through the hole in the rotary disc, pull i tightly under the mounting plate and draw i upwards round the edge of the plate. Pu the ends round the collet in the large wheel One end of the elastic band lies under the top of the collet in the small wheel of the rocker arm, the other under the top of the collet in the large wheel of the rocker arm. The bottom end of the spindle of the rocker arm lies between pins E1, E2 and F2 of the

rotary disc. The rocker arm must be able to move easily to and fro over the two hoses. Now push the spindle of the regulating wheel through the bush in T2. On the underside, push two clamping springs with a 3 x 24 spindle through them over this spindle over the bush in S3. A clamping spring with a 3 x 24 spindle goes on the upper side of the spindle of the rocker arm.

3. A clamping spring goes at the top of the spindle in L1 and L3 and a 3 x 48 spindle is pushed through this. The spindle of the flywheel goes through this. The flywheel consists of a large wheel with pins in the upper side in G1, G11 and G21. Pieces of rubber hose (5 mm) go over these pins and after that place the supporting washer between then and push a 2 mm washer over the pins.
A long pin with two 2 mm washers over it goes in at A1 on the other side of the wheel. A clamping spring must fit between this. Put a 2 x 96 spindle in the flywheel. First push a 2 mm washer over this and put it in position. Another 2 mm washer then goes over this and finally a small wheel with a collet (2). The whole assembly must be able to rotate easily.

1





2

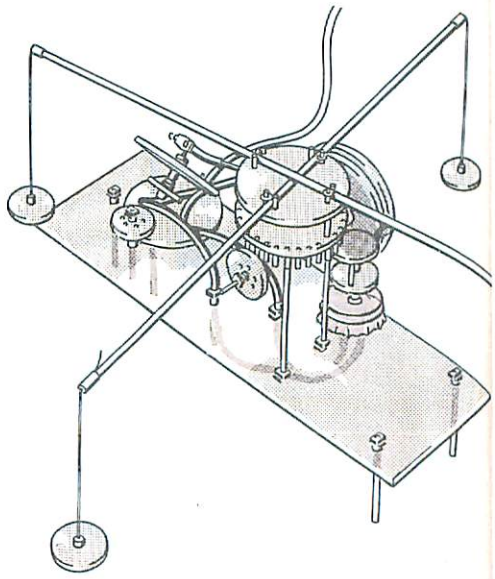
4. Build the diaphragm housing according to page 15. A 3 x 24 bush goes into the lower small wheel and a 3 x 48 spindle into the upper one. Place the membrane housing in L5 and M5. The 3 x 48 spindle is fixed between the washers on the pin in the flywheel by means of a clamping spring. Another clamping spring goes on this spindle with a 3 x 24 bush. By means of a piece of rubber hose (10 mm) a 3 x 96 spindle is fitted between this bush and the 3 x 24 spindle on the rocker arm (see Fig. 2).

5. Connect the bush in L5 to the spindle in O3 with a 90 cm hose. The bush in L4 is connected to the spindle in Q2 by a 120 cm hose. Adjust the position of the upper clamping spring on the connecting rod so that when the crank has reached its lowest point of travel the lowest bush presses on the bottom of the diaphragm.
The rocker arm is set to the correct position by means of the adjusting wheel and the rotary disc. The motor is made to work by pressing air into the long end hoses.

B5 - AIR DRIVEN MERRY-GO-ROUND

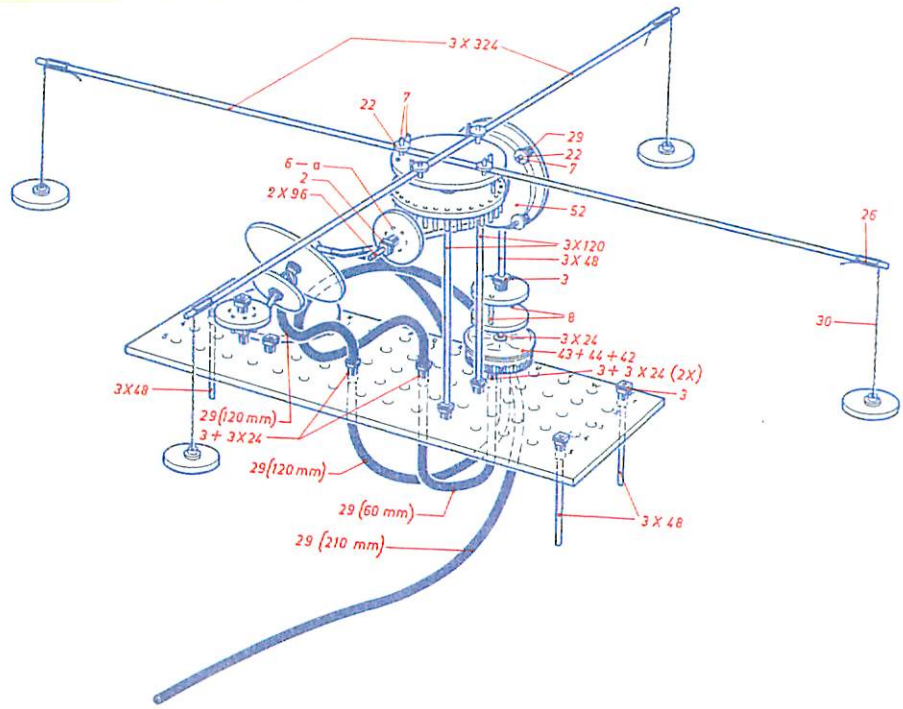
Order of construction

1. The air motor.
2. The merry-go-round.

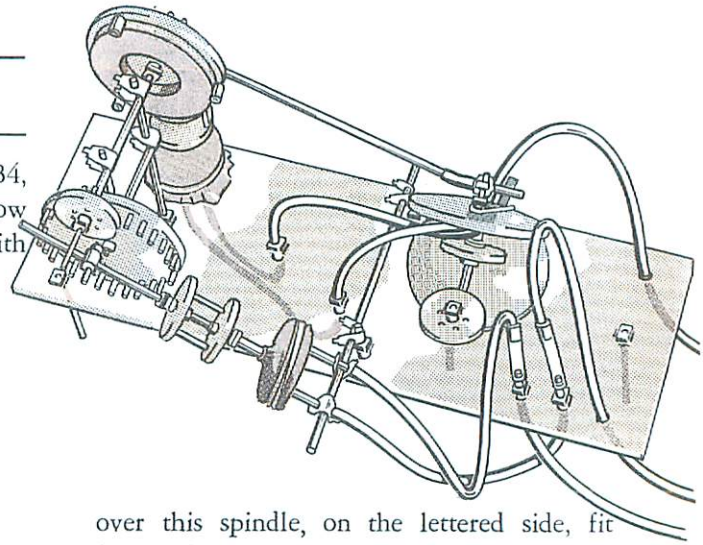


1. The air motor is once again completely identical to that of model A4. The position of the air motor is different. Place a small wheel on the end of the motor spindle with 6 pins in the underside.

2. In the top side of a large wheel put 30 pins in G and in the underside a long pin in F1, F10 and F19. On this place a second large wheel with the underside facing the other wheel. In the top side of this large wheel put pins in E1, E2, E7, E8, E13, E14, E20. A 2 mm washer goes over the pins in E1, E7, E13 and E19. Put a piece of 3 mm sleeving over the spindle in T5 and a 3 mm washer on top of this. A combination of the two wheels which have just been made goes on top of this. The cogs of this wheel mu engage in the cogs of the small wheel o the motor spindle. Now make the two r tating arms as illustrated and put this i position.



B6 - COMPRESSED AIR MOTOR WITH PUMP

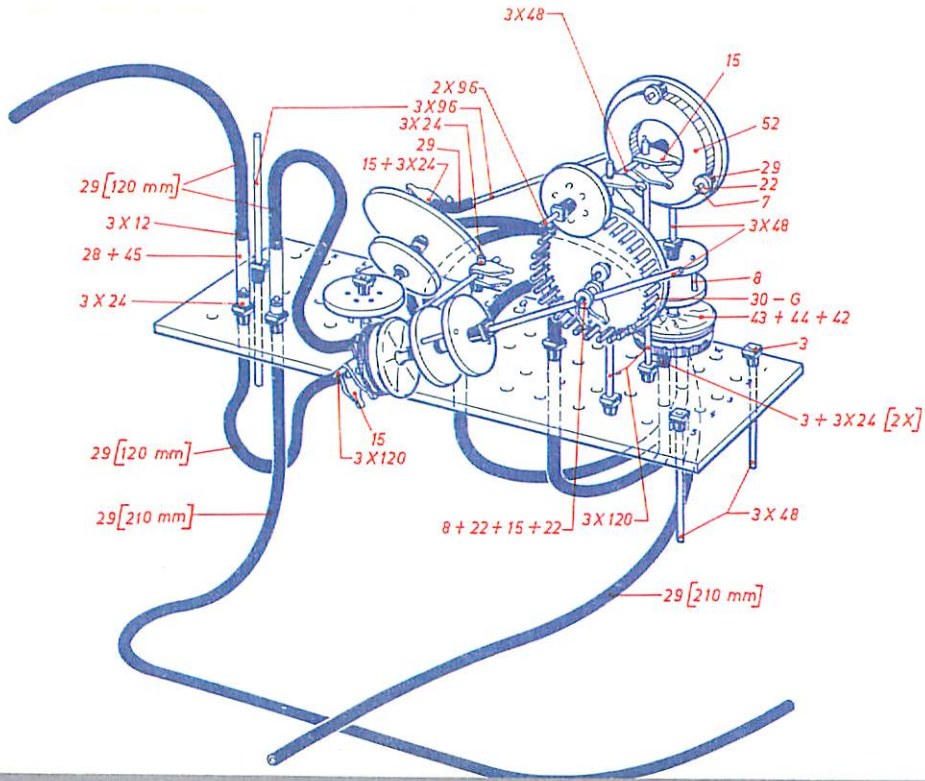


In this model the starting point is model B4, the normal compressed air motor, but now using a reduction gear we drive a pump with it.

Order of construction

1. The compressed air motor.
2. Cog wheels with eccentric.
3. The pump.
4. The valves.

1. The compressed air motor is the same as in model B4 but at a different position.
2. Put a small wheel with pins in a on the underside on the spindle with the flywheel. This spindle must now be detached with its clamping springs from the two upright spindles to permit a clamping spring to be pushed over each of these spindles. A 3 x 48 spindle goes between these clamping springs. Then over this spindle, on the lettered side, fit large wheel with 30 pins in G and a long pin with two 2 mm washers in A1. These pins go on the underside. Using a collet place a 4 x 12 mm bush in the centre hole. This wheel must revolve freely around the 3 x 48 mm spindle. The wheel is kept in position by a washer and a piece of sleeving. The top spindle of the compressed air motor can now be put back into position. The cogs



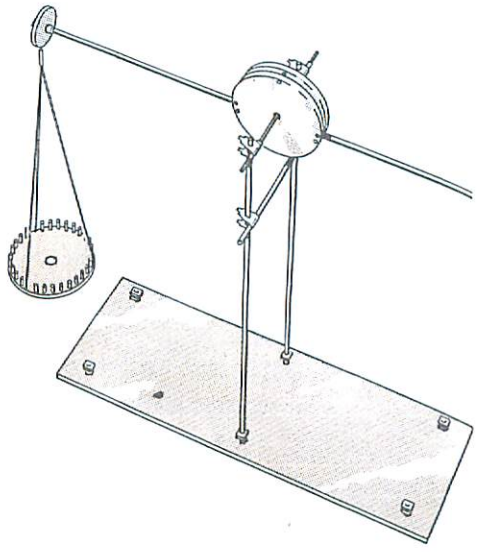
of the small wheel must run freely in those of the large wheel which has just been fitted. Fix a 3 x 48 spindle by means of a clamping spring between the two washers on the long pin in A1 of the large wheel.

3. Make a pump with connecting rod construction in the usual way. Fix the complete assembly on the 3 x 48 mm spindle which is fixed to the pin of the large wheel (see page 15). Leave out the friction assembly under N4 and O4. By means of collet 3 fix a 3 x 24 bush in P1 and P5 and using retaining clips (page 13 fig. D) fix a 3 x 96 spindle on top of this. Secure the two bushes projecting from underneath the pump to this spindle with clamping springs.

4. Make 2 valves in the usual way. (see page 16) and put them in K5 and L5. Next connect hoses to them as illustrated.

C1 - BALANCE

From ancient times this balance has be to determine the weight of merchan is still used nowadays in laborator measuring small weights.



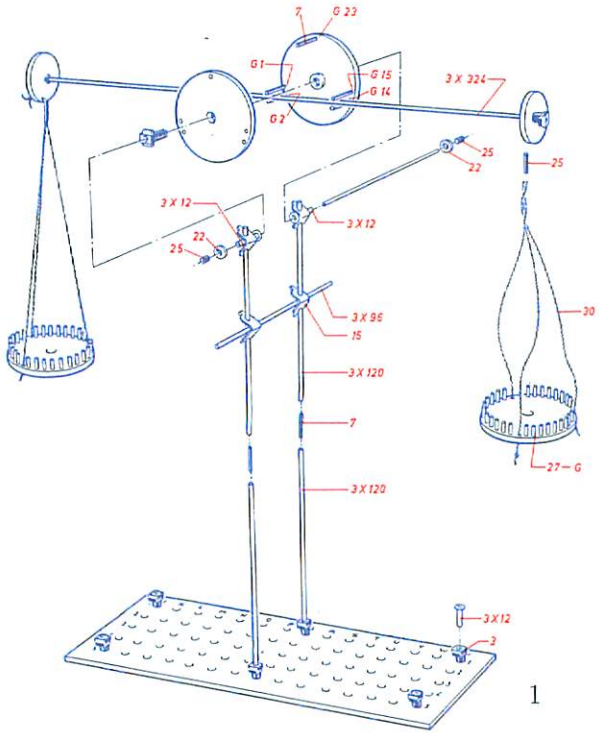
Order of construction

1. The baseplate.
2. The beam.
3. The pans.

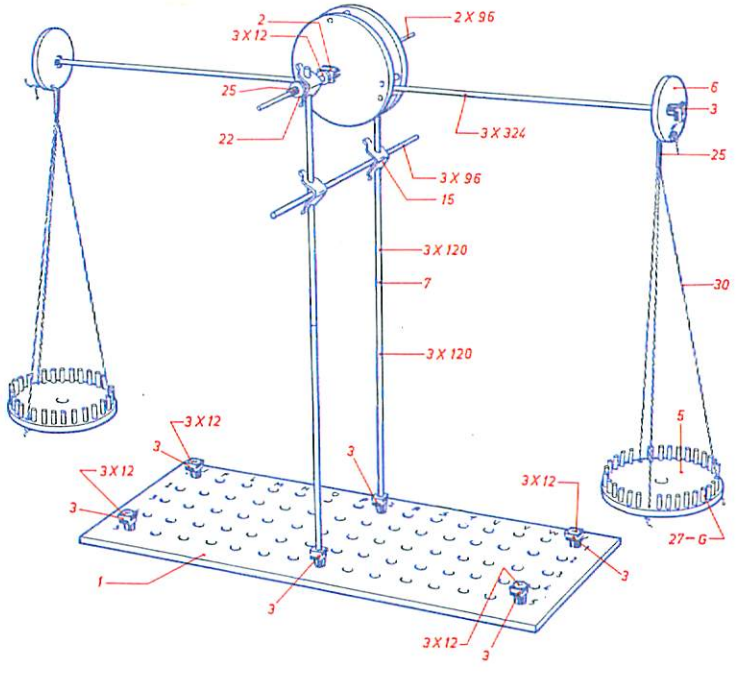
1. Place collets (3) with a 3 x 12 bush them on the corners of the baseplate. I two 3 x 120 spindles to each other by mea of a pin (7). Repeat this once more. Put th se spindles in Q1 and Q5 (position 1). A 3 96 spindle goes through the bottom clampir springs and a 3 x 12 bush through each the top nes.

2. Make a double wheel with pins in G G2, G14, G15 and G23. Insert a 3 x24 spin dle between the pins situated beside eac other. Put a small wheel on each end of thi spindle.

3. The pans consist of big wheels with pins in the outer circle except in holes G1, G11 and G21. Pieces of string, 25 cm long, go through these holes. Insert these pieces of string through a piece of 2 mm sleeving on the upper side, then through the bottom hole in the small wheel and after this tie a knot in it. Put the beam in place and then from one side push a 2 x 96 spindle first through the 3 x 12 bush, then through the beam, next through a collet (2) and finally through the other 3 x 12 bush. Secure the beam to this spindle with the collet (2). Finally on both sides of the 2 x 96 spindle we place a washer (22) and a small piece of sleeving (25).

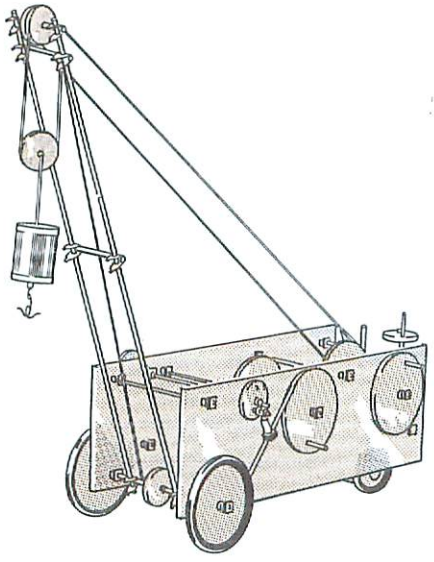


1



2

C2 - CRANE

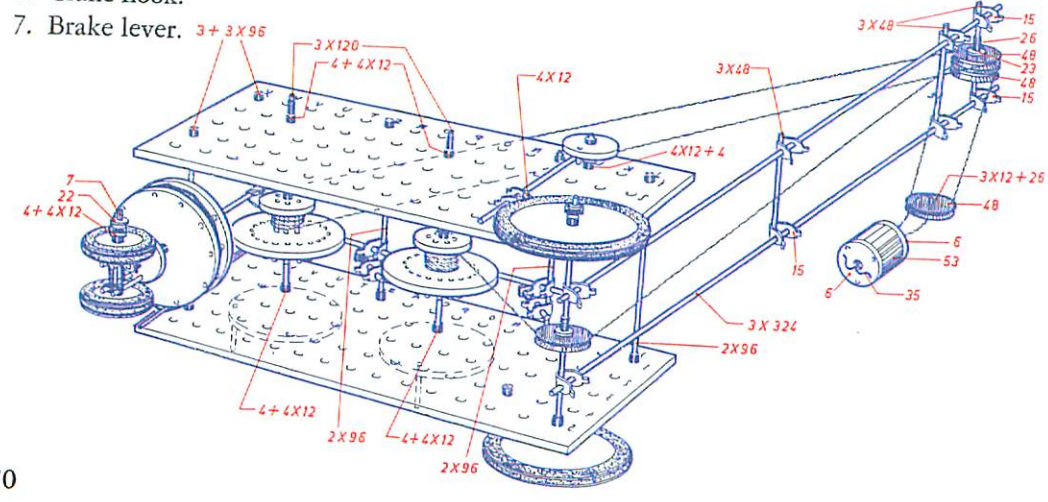


This model is the first of a series of lifting machines and this hand-operated crane serves to make the builder familiar with this kind of equipment.

Order of Assembly

1. The mounting plates.
2. The cable drums.
3. The pawl mechanism.
4. The jib.
5. Provisional assembly.
6. Crane hook.
7. Brake lever.
8. Turntable with wheels.
9. Steering wheel.
10. Front wheels.
11. Cables.

1. In the front plate mount: in J1, M1 a S1 2 x 96 spindles; in X1 and X4 3 x spindles all at position 1. Also 4 x 12 bus in J5, L1, L4, P2 and V3. In the back pl 4 x 12 bushes in J5, L1, L4, P2 and V2.
2. Each cable drum is made of a dou wheel composed of a large and a small wh (facing each other), six pins (8) in the c cles A and a. Also 18 pins (7) at the t in circles D. Fix each drum with two colle (3) in the centre of a 3 x 120 spindle.
3. Push a collet (3) on a 3 x 24 bush wi the collet head resting against the flange an hold the collet in position with a piece o sleeving. Push the free end of this bus through a clamping spring which, in turn is placed on the end of a 3 x 25 spindle Put another clamping spring on a 3 x 4 spindle and put this spring on the free end of the 3 x 24 spindle. Repeat this for the second one.



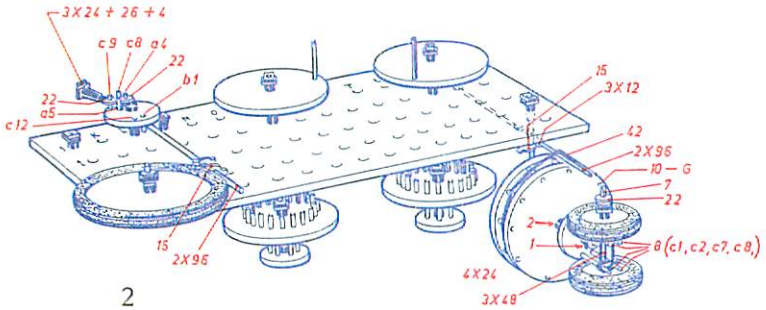
4. Make the jib from two 3 x 324 spindles and three 3 x 48 spindles. One 3 x 48 spindle joins the two long spindles at the centre and is attached to those by means of clamping springs. The second comes slightly below the end. On the third 3 x 48 spindle first two pulleys are pushed with at the left and the right a 3 mm washer and a piece of 3 mm sleeving. Then this spindle is fixed by means of clamping springs at the very end of the two 3 x 324 spindles. The jib is fixed with clamping spindles to the 3 x 120 spindle in J5.

5. Mount both cable drums as shown in the front plate and at the front side of this (fig. 2) fix with a 3 mm collet a large wheel with one pin (8) in circles G. Push a pawl mechanism over the spindles in M1 and S1. Retain the pawls with pieces of 2 mm sleeving. Take the spindle 3 x 120 in the bush in J5. At the centre of this spindle place a pulley whic his retained by a 3 mm washer and a piece of 3 mm sleeving at either side. Next fix the back plate with collets in J1, M1, S1, X1 and X4. Over the ends of the spindles of the cable drums which protrude from the rear through the collets in P2 and V2 90 pieces of 3 mm sleeving.

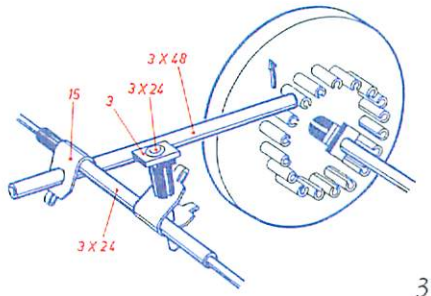
6. Push a pulley between two pieces of sleeving onto a 3 x 12 bush; pass a piece of string approximately 16 cm long through this bush and tie the two ends together. Pull the knot into the bush. Push pins (7) in holes c1, c5 and c9 of two small wheels protruding from underneath and press these wheels in the supporting pipe. Pass the loop of string through the spindle holes in the small wheels and then hook a hair-pin spring into the loop, after which the string is pulled taut.

7. The brake lever consists of a small wheel with pins from underneath in a4, a5, c8 and c9. In-between these push a 3 x 24 bush with collet 4 and a piece of 3 mm sleeving. Press 2 mm washers over the pins in a4 and c9. Run from above two pins in b1 and c12. Fix wheel on a 3 x 120 spindle (position 1). This spindle is pushed in L1 and behind the back plate a small wheel with pin in b1 is fitted (fig. 1). From the inside place a 3 x 24 bush through the bushes in L4 and at the outside and at the outside fix 3 x 96 spindles with clamping springs.

8. In a small wheel at the topside put long pins in c1, c2, c7 and c8 (slots facing each other). Fit 4 x 24 bush in spindle hole (position 1) with the flange against the head of the collet. Make a double wheel from two large wheels (backs facing each other) with ten pins in G. Fix this also on the 4 x 24 bush of the small wheel. On a 3 x 48 spindle push at both ends a 3 mm washer, a



2



3

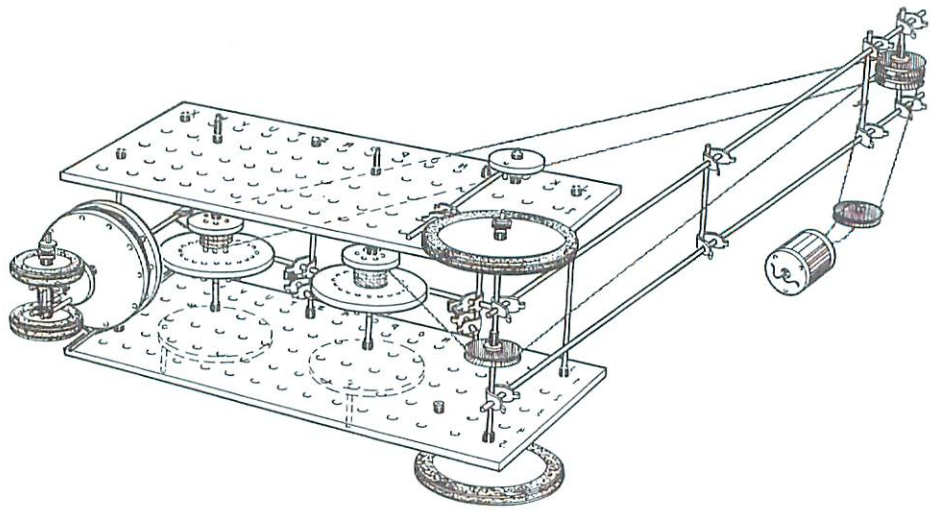
small wheel with collet and 4 x 12 bush and in the ends a pin with 2 mm washer. Put tyres on the wheels and then place the spindle in-between the long pins of the small wheel made previously. Place a rubber band along the long pins, to prevent the spindle from dropping out. At the centre of the spindles in X1 and X4 fix a 3 x 96 spindle with clamping springs to the centres of the spindles in X1 and X4. This spindle should protrude about the length of a collet underneath the bottom clamping spring. Push a 3 mm washer and the turntable on this spindle. To get the clamping springs across the spindles it will be necessary to release the spindles in X1 and X4 temporarily.

9. At the under side of a small wheel place a long pin (8) in c1 and fix the wheel to the end of a 2 x 96 spindle with the pin poin ting in the opposite direction as the spindle. Place 3 x 12 bushes on the spindles in X1 and X4 at the side of the front plate by means of clamping springs. Through the latter we insert the steering column. Pla rubber band around the wheel and around 2 x 96 spindle of the steering wheel.

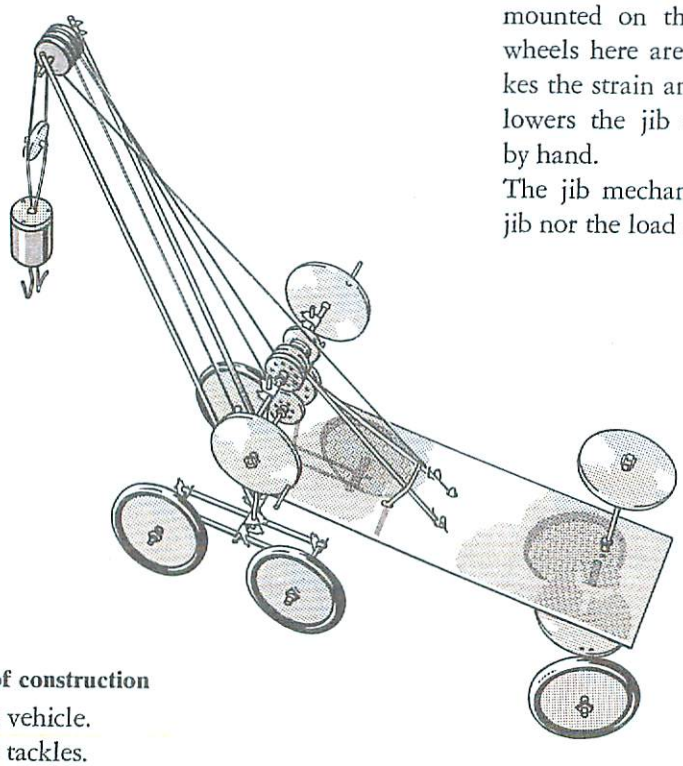
10. Two large wheels with tyres are fi with collets and 4 x 12 bushes on the spi le in J5. In the ends of this spindle in pins with 2 mm washers.

11. Tie one end of an approximately 1 long piece of string to the centre of t spindle X1. Pass it over all the spindles a place it around one of the two pulleys the top of the jib, then back over all t spindles to the cable drum in V2, to a p to which the other end is tied. The hoistin cable is also roughly 1 m. One end is tie at the top of the jib in the centre of the 3 48 spindle, without pulleys. Then pass th string over the pulley of the crane hook over the other pulley at the top of the jib along the jib downwards, around the pulley on J5 and finally to the drum in P2, to a pin of which the other end is tied.

4



C3 - SIX-WHEEL TRUCK WITH CRANE



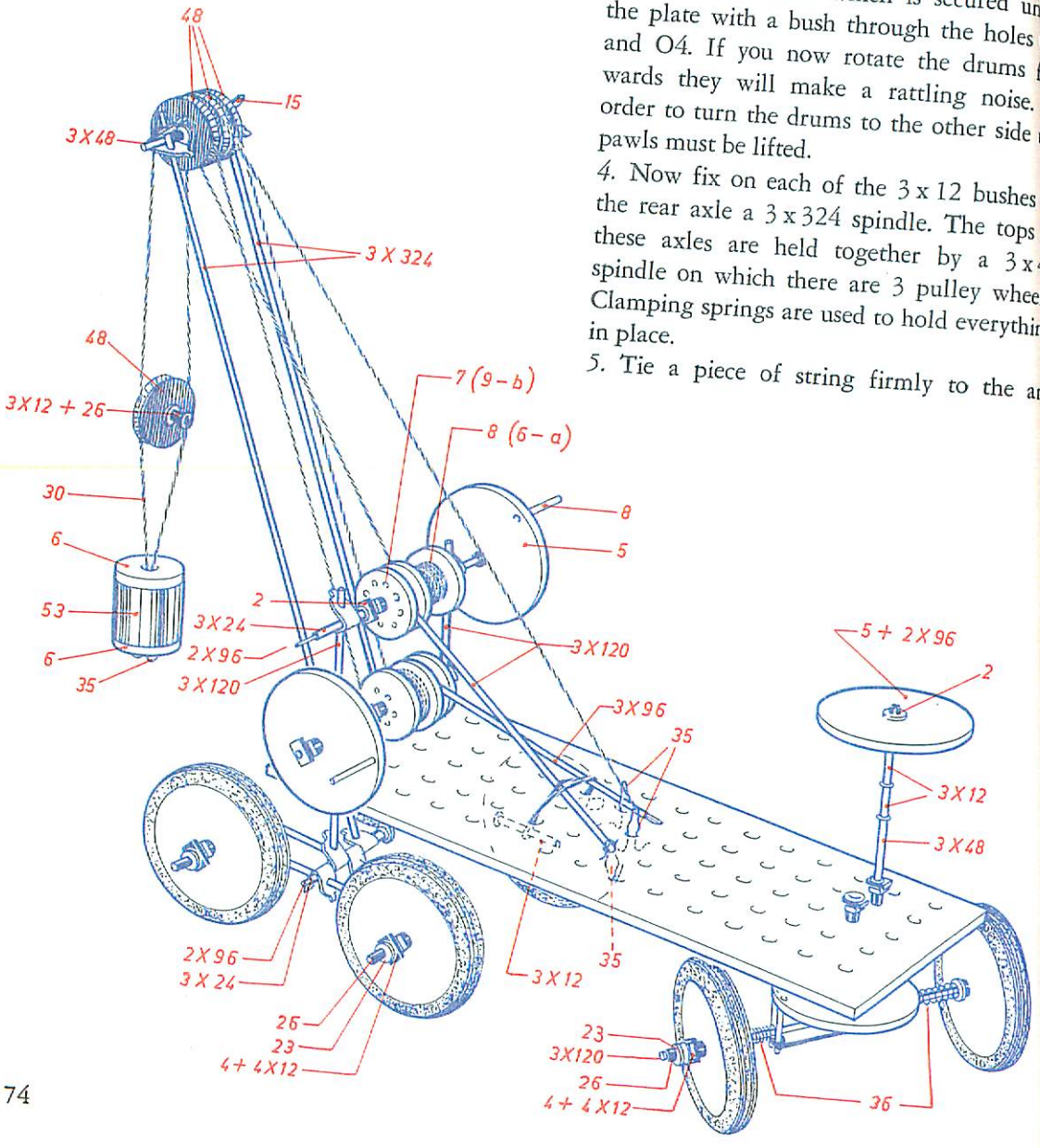
This model is derived from the six-wheel truck A6. The steering unit is again the same, but now it is placed further forward. The rear wheels in this model are likewise mounted on the tandem assembly but the wheels here are single. The tackle which takes the strain and the tackle which raises and lowers the jib are to be worked separately by hand.
The jib mechanism ensures that neither the jib nor the load can fall down.

Order of construction

1. The vehicle.
2. The tackles.
3. The ratchet mechanism.
4. The loading arm.
5. The cables.

1. Make a steering unit with forward axle and wheels as described in model A1, and place these in the holes W2 and W3 in the baseplate. Next make two tandem assemblies and fix two single wheels on this in the normal way. A 3 x 120 axle is clamped in the holes J1 and J5 at position 6. A tandem assembly is mounted underneath this. Fix it by means of a clamping spring on the 3 x 24 axle in the centre of the tandem assembly. A 2 x 96 axle is pushed through the 3 x 24 axles. Two 3 x 12 bushes go in the centre of this on which the arms of the jib will later be mounted. Push pieces of sleeving and 2 mm washers at the end of this axle.
2. Now take three small wheels and with two of them make a double wheel with nine pins in circle b. Next fit another small wheel to this which is attached to the double wheel in ring a by means of six long pins. The upper side of the two outer wheels must face outwards. Next fix this drum on a 2 x 96 spindle with a collet on both sides. A 3 x 24 bush is placed over both ends with the flange against the collet. Finally, by the side of the wheel with the long pins, we place another large wheel with a long pin in the upper side in circle G. Now by means

of clamping springs fix this whole assembly around the 3 x 24 bushes on the vertical spindles in J1 and J5. Now make another combination like this and fix it above the previous assembly so that they "mirror" each other. Align the whole assembly so that the spindles and drums can rotate easily. The bottom cog wheel must not rub against the plate.



3. From above press a hairpin spring the holes P2 and Q4 of the baseplate hairpin spring goes into hole Q3 to the b plate from underneath. Now take a 3 x spindle and push one end of this under spring in Q4. The other end goes over top double wheel which has the pins in ci b. Make a similar pawl on the lower dr with a 3 x 96 spindle. Over these spindl put an elastic band which is secured und the plate with a bush through the holes O and O4. If you now rotate the drums fo wards they will make a rattling noise. I order to turn the drums to the other side th pawls must be lifted.

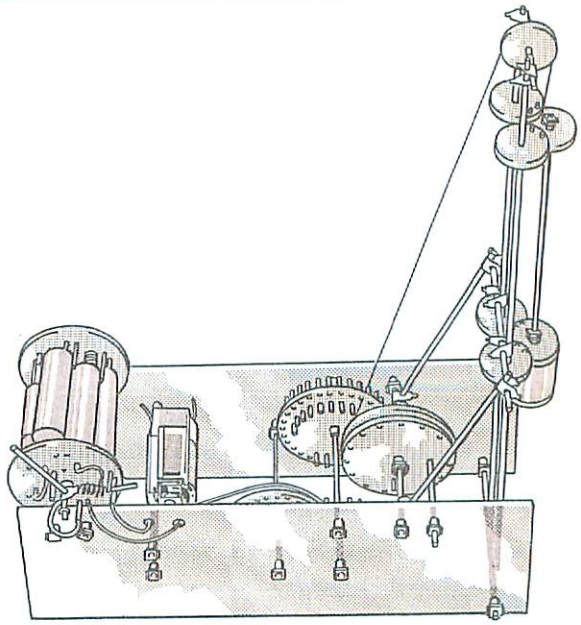
4. Now fix on each of the 3 x 12 bushes o the rear axle a 3 x 324 spindle. The tops o these axles are held together by a 3 x 48 spindle on which there are 3 pulley wheels. Clamping springs are used to hold everything in place.

5. Tie a piece of string firmly to the an-

chor spring in Q3. Lay this string over the central pulley wheel of the jib and tie the other end to the top drum. Make sure that this string is not too short. By turning the upper drum we can now raise and lower the jib. Now take a pulley wheel and push a 3 x 12 bush through it. The flange of the bush is now on one side of the pulley wheel. On the other side first put a 3 mm washer, then a piece of 3 mm sleeving. Now push a piece of string approximately 14 cm long through the bush. Tie this firmly and pull the knot into the bush. Next put a number of pins in two small wheels in circle c. Now press a wheel like this on each side of the supporting washer with the pins in the circle. Now push the loop of the string which was previously fixed through the pulley wheel through the holes of the whole assembly.

Finally draw another anchor through the loop and press the whole assembly firmly together. Now attach a piece of string to the centre of the rear axle. Stretch this string over the top side of one of the outer pulley wheels then through the combination you have just made, continue over the top of the other pulley wheel and finally attach the end to the bottom drum. Choose the length of the string so that the load can be pulled up and down at a reasonable distance. Remember that this jib is so rigged that one metre of string on the drum can let the load travel 50 cm up and down.

C4 - ELECTRIC PILE DRIVER



This machine is used to drive piles into the ground. It is provided with a heavy weight, in upright guides. The hoisting winch was first driven by steam, but later by diesel engines and electric motors. In actual practice the winch is operated by hand, because no winch would be able to withstand the impacts to which it would be subjected if driven automatically.

Order of assembly

1. The mounting plates.
2. The gear wheel.
3. The cable pulley.
4. The motor.
5. The battery holder.
6. The guide and weight.

1. In the back plate insert 3 x 96 spindles in M2, M3, U1 and X5 and 2 x 96 spindles in J1 and K1, all position 1. Also 3 x 12 bushes in Q3 and S1, a 4 x 12 bush in S3. In the front plate 3 x 12 bushes in J1, K1, Q3 and S1, a 4 x 12 bush in S3 and a 3 x

48 spindle in V1, extending about 12 m above the head of the collet. Push a piece of 3 mm sleeving over the other end of the spindle.

2. A large wheel with 30 pins in G at the top side and six pins underneath in A. Place this at position 6 of a 2 x 96 spindle. Push pieces of 2 mm sleeving and 2 mm washers across the ends of this spindle and fit it in Q3 of the back plate. Make another large wheel with 30 pins in G at thet op and a small wheel with six pins underneath in circle a. Put the large wheel at position 7 of 2 x 96 spindle and the small wheel at position 2. This spindle is inserted with the side carrying the small wheel in S3 of the back plate. Make another large wheel with 30 pins underneath in G. In the top side insert eight pins in E1 to E8 inclusive and another eight in E13 to E20 inclusive. Fit this at position 6 of a 2 x 96 spindle. Over the ends push pieces of 2 mm sleeving and then 2 mm washers. This spindle is inserted in S1 of the mounting plate.

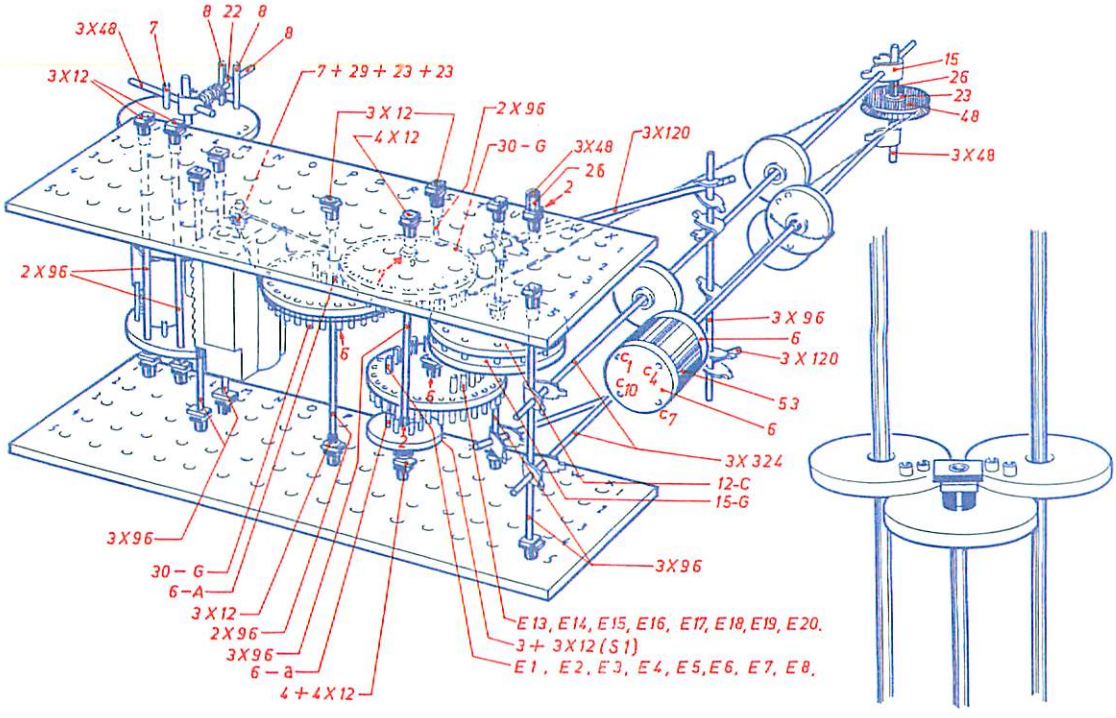
3. Make a large double wheel with 15 pins in G (rear sides facing). At one side insert twelve pins in C, at the other side one pin in D1. In the spindle hole of the latter wheel insert a 4 x 24 bush. Tie 60 cm string to the pin in G10 of the wheel which also carries a pin in D1. Push a piece of 3 mm sleeving and next a 3 mm washer on the spindle in U1. Then place the cable pulley with the twelve pins pointing downward and follow this up with a 3 mm washer and a short length of 3 mm sleeving.

4. Push on the motor pulley a pin, a piece of rubber hose, two 3 mm washers, as described on page 22, fig. D. Push a short length of 3 mm sleeving over the spindles in M2 and M3 and then push the motor onto those spindles with the pulley at top. Secure the motor with another two ces of 3 mm sleeving.

5. Make a battery holder for six R6 c as described on page 20. On this goes the off switch (see page 21).
Push the battery holder across the spind in J1 and K1 of the mounting plate and c nect the positive and negative leads to motor.
The front plate can now be mounted. It fixed with the spindles in M2, M3, U and X5. Adjust all the gear wheels order that they engage properly and the pi do not touch other wheels. Place the mod right-side up and continue as follows.

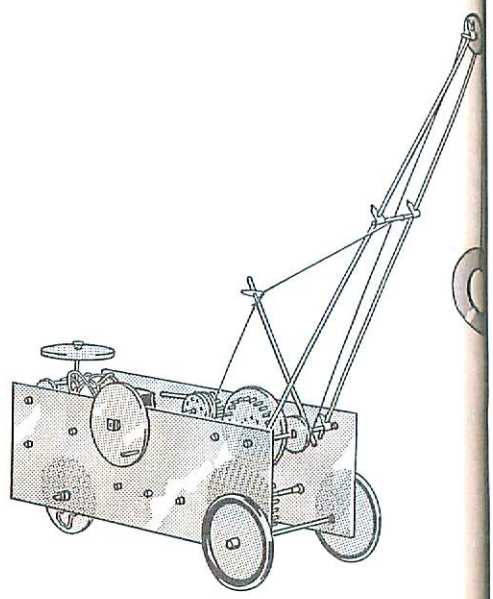
6. Fix two 3 x 324 spindles by means o clamping springs on the spindle in X5 wit a distance of 24 mm in-between. In a small wheel insert pins in c1, c3, c6., C7, c9 and c10, from underneath. Place this wheel up side down on two other small wheels, which are also placed upside down. The pins in c6 and c7 are pushed in two holes of circle c of one wheel and those of c9 and c10 in two holes of circle c of the other wheel. The central wheel is fixed to the supporting pipe. Underneath the supporting pipe comes another wheel with four pins in c1, c4, c7 and c10, all underneath the wheel. In the spindle hole of the wheel on top of the supporting pipe fix a spindle 3 x 120, extended by means of a pin with a 3 x 24 spindle. Make another combination of three small wheels with pins in c6, c7 c9 and c10. Fix this at the end of the spindle just made.
Next the entire assembly is pushed over the two 3 x 324 spindles, as shown in the drawing. At the top end those spindles are kept together by 3 x 48 spindle, with in the middle a pulley with two 3 mm washers and two pieces of 3 mm sleeving. Use two clam-

ping springs. Mount a 3 x 96 spindle crosswise, just below the lowest point taken up by the guide and fix two 3 x 120 supporting spindles at an angle to the spindle and fix them in turn to the spindle in U1. The supporting spindles must be so arranged that the 3 x 324 spindles are exactly vertical. Pass the cord already tied to the cable pulley through the hole in a4 in the centre wheel of the guide and tie it in hole c2 in this wheel. The cord passes over the top of the pulley; the length of it should be such that with the weight on the ground the pin in D1 in the cable pulley should just touch the spindle in V1. In this way it is ensured that the cord always remains taut when the weight falls.



C5 - ELECTRIC CRANE

This crane is in essence an extension of model C2. The position of the jib is still adjusted by hand, but hoisting is done by means of the electromotor.



Order of assembly

1. The mounting plates.
2. The gear wheels.
3. The hoisting drum.
4. The motor.
5. The cable drum with pawl mechanism for jig.
6. The switch.
7. The steering.
8. The battery holder.
9. The jib.

1. In the foremost mounting plate insert bushes 3 x 12 in P4, R4 and T4, bushes 4 x 12 in Q1 and V1. In the other mounting plate spindles 3 x 96 are inserted in the holes J1, J3, M1, M2, X1 and X5. Also insert 3 x 12 bushes in the holes P4, R4 and T4 and 4 x 12 bushes in V1 and V4.

2. From two large wheels make a double wheel with 15 pins in circle G. In one of the wheels also put six pins in circle A.
Mount the wheel without pins in circle A on a spindle 2 96 with a collet (2)., in such a way that the spindle protrudes 24 mm through the collet. Put a piece of 2 mm sleeving and a 2 mm washer over both ends of the spindle and then place it, pins pointing downward, in the back plate in the bush in P4. Next make three wheels, in each at the top 30 pins in circle G and underneath six pins in circle A. In one of these fix 2 x 96 spindle such that it extends 48 mm above the head of the collet and in the other wheel, so that it extends 60 mm. The third wheel is fixed on a spindle 3 x 96, which should extend 72 mm above the head of the colle Put sleeving and washers on all the spindl ends, and then mount them as shown in th bushes R4, T4 and V4 of the mounting pla shown at the rear. Put a rubber band aroun the double wheel.

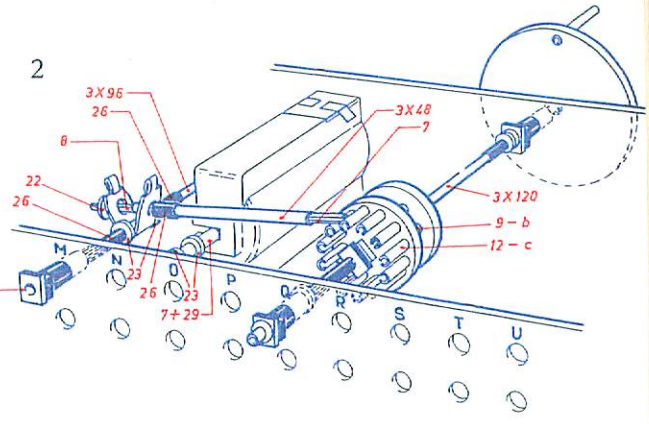
3. The cable pulley consists of a large and small wheel, which, with the rearsides fac ing are connected by means of nine long pin in the circles B and b. In a large wheel at the top 24 pins are inserted in circle E. This cable drum is fixed on a spindle 3 x 96 with collets in both wheels and so that the pins of the large wheel engage with the pins of the other large wheel next to it.
On both ends of this spindle push a piece of sleeving and a 3 mm washer, then insert this spindle in bush V1 of the rearmost mounting plate. The pins should now point downwards.

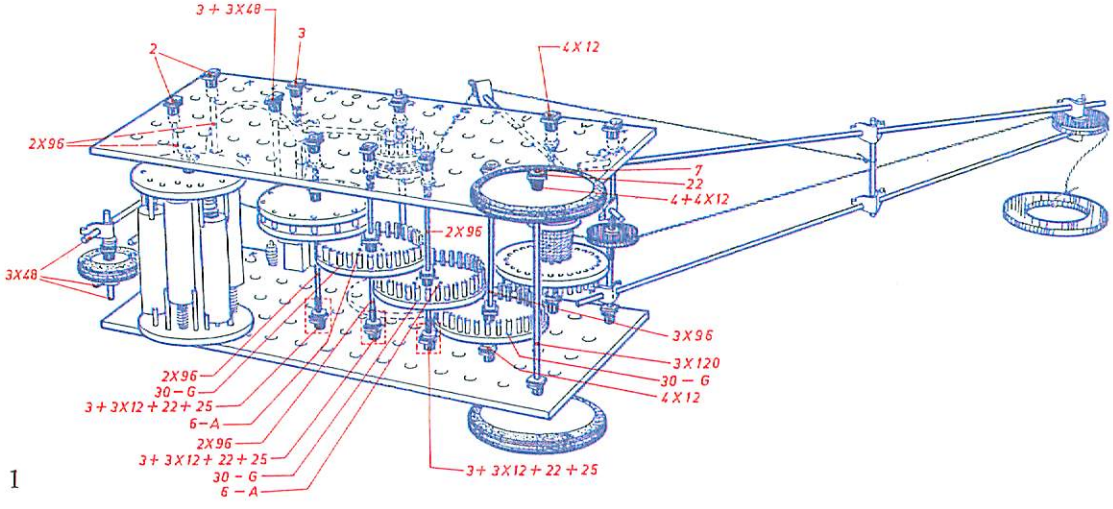
4. Fit a pin with a piece of rubber hose (29) and two 3 mm washers on the motor spindle (see page 22, fig. D). Pass the motor over

the spindles in M1 and M2 of the rearmost mounting plate with the pulley pointing upward. Lock the motor with two pieces of 3 mm sleeving.

5. The construction of the cable drum for the jib with the pawl mechanism is shown in fig. 2. The cable drum is made of two small wheels with the reverse sides facing, connected together with six pins in circle a. In one of tje wheels, place twelve pins in circle c. This wheel is fixed at position 3 of a 3 x 120 spindle, which is kept in place by means of 3 mm sleeving and 3 mm washers. For the pawl mechanism take 3 x 8 spindle with a short pin in one end and a long pin in the other. Push a 2 mm washer over the long pin. After mounting the spindle is held in the clamping spring by pushing a short length of 3 mm sleeving over the other side of the spindle.

2





1

6. For the stator of the switch take a small wheel with at the underside long pins in c1, c4, c7 and c10 and short pins in c2, c3, c8 and c9, all with the slots pointing outward. Fix this stator on the spindle in J1. The head of the collet rests against that in the mounting plate. All pins are provided with leads of 120 mm length as follows:

c1	red	c2	grey
c3	grey	c4	black
c7	black	c9	green
c9	green	c10	red.

In the underside of another small wheel insert four pins in a2, a3, c4 and c5. In-between those pins push the operating lever, made of a 3 x 24 bush with a length of 3 mm sleeving and a collet (4). Lock this lever with two washers over the pins in a3 and c4. At the topside of this wheel insert contact springs in c1 and c7, each fitted with a 2 mm washer and protruding about 5 mm underneath the wheel. In the centre clamp a bush 3 x 12. Next push on the long end of the spindle in J1 8 mm sleeving of 2 mm, a 2 mm washer and the totor, in such a way that the washers on the contact springs come in-between the pins with leads, but take care that the contact springs do not touch the wheel itself. Then insert terminals in K1 and L1 and put clamping springs on the centres of the spindles in J1 and J3. Now the front mou ting plate is fixed by means of collets in J1, J3, M1, M2, X1 and X5.

7. In a large wheel put pins from above in C1 and C7. On each pin push a spindle 3 x 48 and then mount the wheel on a 3 x 6 spindle such that the spindle extends about 30 mm above the head of the collet. The 3 x 48 spindle is next fixed with clamping springs on the three spindles extending from the wheel and as close as possible to the wheel. In a small wheel fit a 4 12 bush with a collet (4) and fit a tyre around the wheel. This is placed on a spindle with three 3 mm washers at both sides collet. By means of clamping spring spindle is fitted on the two spindles of the large wheel. The small wheel be able to run smoothly. Over the long of the 3 x 96 spindle a 3 mm washer is ed and then this spindle is inserted thr the clamping springs on the centres o spindles in J1 and J3. Finally, on the t large wheel is fixed with a 3 mm collet.

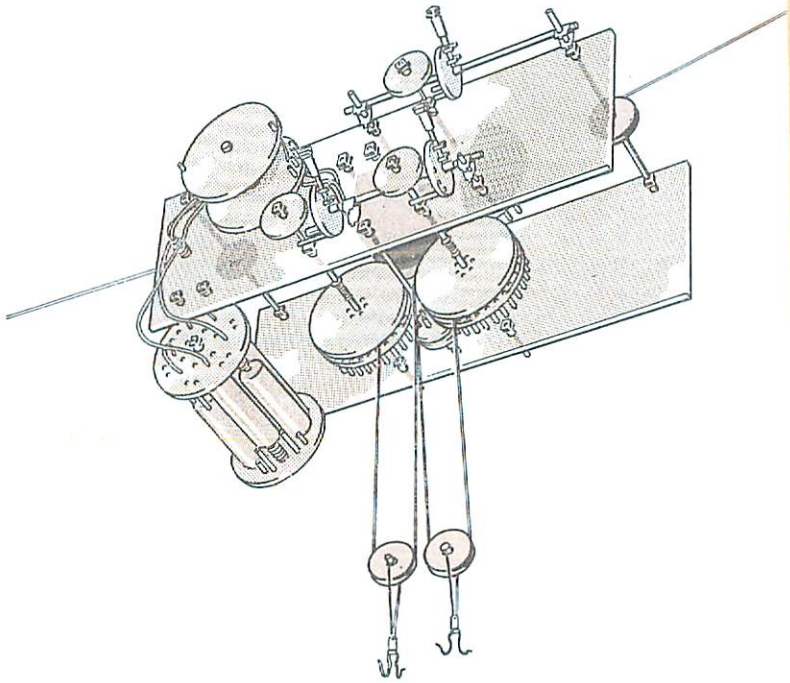
8. Make a battery holder for six R6 cell described on page 19. Use a 2 x 96 spin Connect the red leads of the switch to terminal in K1 and also the red (positi lead of the battery holder. The black le of the switch and of the battery holder connected to the terminal in L1. The t grey leads of the switch are connected one of the motor terminals, two green o to the other motor terminal.

9. The jib consists of two spindles 3 x 2 which are fixed with a clamping spring the spindle in X1. The other ends are ke together by a 3 x 4 spindle and two clam ing springs. This spindle carries at the cent a pulley (48) with two 3 m washers.
Slightly above the middle of the long spind le a spindle 3 x 48 is fixed with two clamp ing springs. On the spindle in X1 a spindl 3 x 120 is also fixed with a clamping spring This spindle carries a second clamping spring at the other end. A piece of string 60 cm long is tied around the cable drum for the operation of the jib. This string runs through the clamping spring just mentioned, to the 3 x 48 spindle half-way on the jib, to which it is fixed. The cable drum is then turned so far that the string is kept tight, the pawl on it prevents the jib from falling down. A piece of string about 1 m long is fixed to the cable drum at the front.

This passes over the lowermost pulley and finally over the pulley at the top. The free end is knotted around the supporting ring. Operation of the switch permits us to hoist or lower a load.

C6 - CABLE CAR

As the name implies this is a vehicle which moves along a cable suspended in the air. The car also contains two hoisting mechanisms, enabling it to transport highly varying loads. Since the whole swings on a cable, the condition of the ground is immaterial and it may even be used over water.



Order of assembly

1. The mounting plates.
2. Double wheels.
3. Cable drums.
4. The motor.
5. The switch.
6. Sub-assembly of various parts.
7. The switch levers.
8. The pulleys.

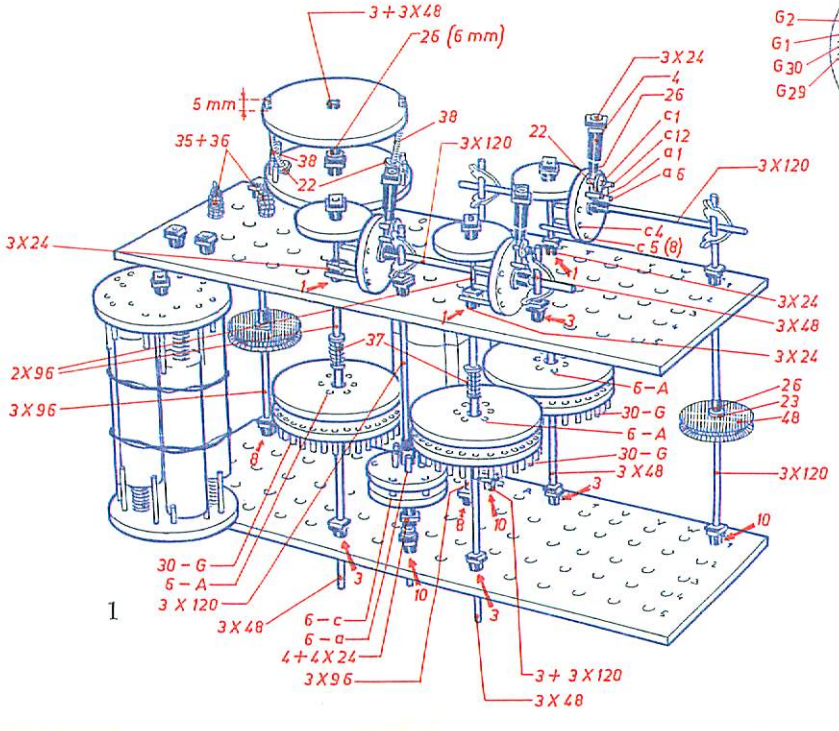
1. In the front plate insert a 3 x 48 spindle in U5 (position 3) and a 3 x 24 spindle in O5, S1 and S5, position 1. Terminals in J3 and K2. In the back plate 3 x 120 spindles in Q1, Q5, position 10, 3 x 96 spindles in J1, P2 and Q2 (position 8), 3 x 48 spindles in O5, S1 and S5, position 3.

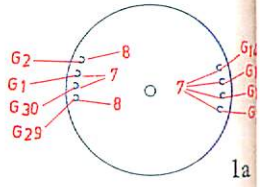
2. In a small wheel insert at the topside six pins in circle and underneath six pins in the odd-numbered holes in c. A second small wheel is fixed with its reverse side on these latter pins.
This wheel carries a 4 x 24 bush (position 1) and a collet.
Make a second double wheel exactly like this one.

3. Put 30 pins in a large wheel at the top in circle g and six pins underneath in A. On these pins fix a second large wheel, backs facing. Fix this wheel in position en of a 2 x 96 spindle with the collet in the wheel carrying the 30 pins. Make another two of these cable drums.

4. Provide the motor spindle with a pin and a piece of hose with two 3 mm washers (see page 22, fig. D).

5. The rotor of the switch consists of a large wheel with contact springs in G1 and G16, protruding roughly 5 mm below the wheel. Fit 2 mm washers on the ends of the contact springs above the wheel. Fit this wheel onto a 3 x 48 spindle and push approximately 6 mm of sleeving onto the spindle against the collet.
The stator consists of a large wheel with pins in the top side at G1, G14, G15, G16, G17 and G30 (slots outwards) (fig. 1a). Insert long pins at the top in G2 and G29, also with the slots outwards. These pins are wired as follows (leads emerging from underside of wheel).



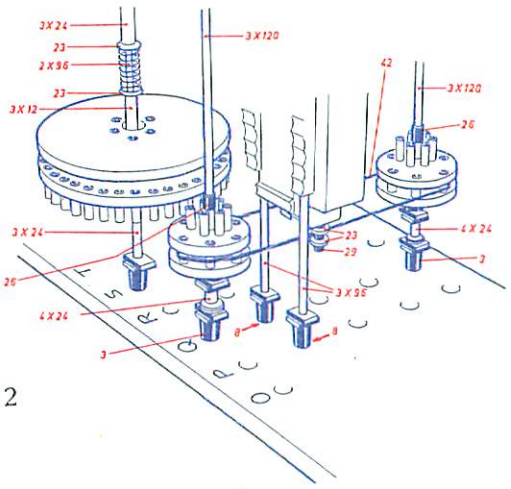


G29 black	60 mm	G14 red	120 mm
G30 green	120 mm	G15 grey	120 mm
G1 grey	120 mm	G16 green	120 mm
G2 black	60 mm	G17 red	120 mm

Fix a 4 x 24 bush in the spindle hole (position 1). Mount the stator of the switch in M2 of the front plate by using a 4 mm collet. The letter G of this wheel must be next to the terminal in K2. Push the rotor with its spindle in bush M2 and secure it by means of a 3 mm washer and a piece of 3 mm sleeving.

6. Make a battery holder for six R6 cells (see page 19).

On the centre of the spindle in J1 of the backplate push successively a piece of 3 mm sleeving, a washer (23), a pulley, another washer (23) and finally a piece of 3 mm sleeving. Repeat the same for the spindle in X1. Place a rubber band around collets in Q1, Q2 and Q5; this is the function as driving belt. Push a washer (23) over the spindle in Q1, lower one of the double wheels onto it and fit another 3 mm washer and a piece of 3 mm sleeving. Repeat this for spindle Q5. Push a piece of 3 mm sleeving onto the spindle in Q2 up to roughly 20 mm above the collet. Lower the motor over



2

the spindles in P2 and Q2 with the pulley end downwards and the connections at the O-end. Pass the rubber band around the two double wheels and at the end Q along the motor pulley. Move the piece of sleeving on the spindle Q2 until the rubber band runs properly over the motor pulley. Push another piece of 3 mm sleeving onto the spindle to keep the motor in position. Insert a cable drum with pins downwards in O5 and push a 3 x 12 bush, a 2 mm washer, a coiled spring and another 2 mm washer onto the spindle of the cable drum. Fit cable drums in a similar manner to S1 and S5. Insert two 2 x 96 spindles through the battery holder and place these in J5 and K5 (without collets). Carefully position the front plate and fix the 2 x 96 spindles with collets. The red positive lead of the battery holder goed to J3 and the black negative lead to K2. The two red leads of the stator of the switch go to J3 and the two black leads to K2. The two green leads of the stator go to one of the motor terminals, and the two grey leads to the other.

7. The three switch levers consists of small wheels with pins underneath in a1, a6, c1 and c12. Push an approximately 16 mm long piece of 3 mm sleeving over a 3 x 24 bush and slide a 4 mm collet onto the bush, with the head of the collet resting against the flange.

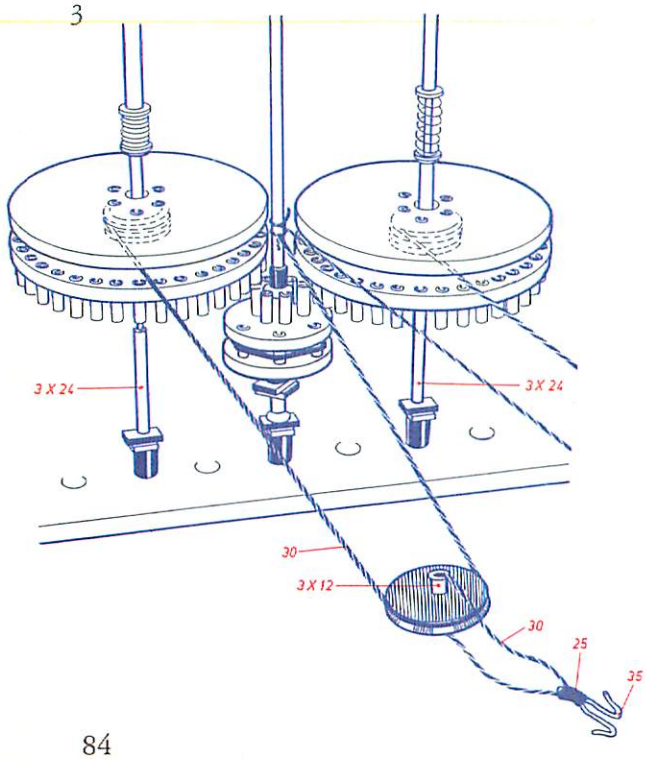
Insert the bush between the fitted pins and push 2 washers around the pins a1 and c12. Insert two pins at the top side of the small wheel in c3 and c4, and a long pin in c5. Fix a 4 x 12 bush in the spindle hole. Repeat this twice. Fit pieces of 3 mm sleeving onto one of the switch levers and position it at place 5 on a 3 x 120 spindle. Push a clamping spring onto the spindle Q1 and another one to spindle X1. Block the latter temporarily with a 4 m washer and pass

the spindle with switch lever through the clamping spings in X1 and Q5, with the point of the springs facing the end with figure 5 of the plate. The long pin of the lever should pass at the S2 side along the spindle in S1. Fix a small wheel in place 1 on the 2 x 96 spindle in S1. Remove the 4 mm washer from the clamping spring on the spindle in X1. Fit the other switch levers in a similar manner in places 2 and 7 of a 3 x 96 spindle. These are kept in place with short pieces of 3 mm sleeving. This spindle is fixed with clamping springs on the spindles Q5 and U5. On the spindles in O5 and S5 place small wheels with 2 mm collets. If everything is correct, the switch levers must be able to push up the small wheels in S1, O5 and S5. Now on a 3 x 12 bush push first a piece of 3 mm sleeving, next a 3 mm washer, a pulley, another 3 mm washer and a piece of 3 m sleeving. Pass an approximately 10 cm long piece of string through the bush and tie the ends together. Pull the knot into the bush. Over the end of the loop push a piece of 3 mm sleeving, hook a hairpin spring in the loop in the string and push the sleeving partly back onto the spring. Repeat this for the second one. Tie one end of an approximately 2 long piece of string to one pin on the cable drum in O5. Pass the end through the string on a pulley and tie this to the spindle Q5. Repeat this for the string on drum S5. The other end first passes through a pulley and is then tied to the spindle in Q5.

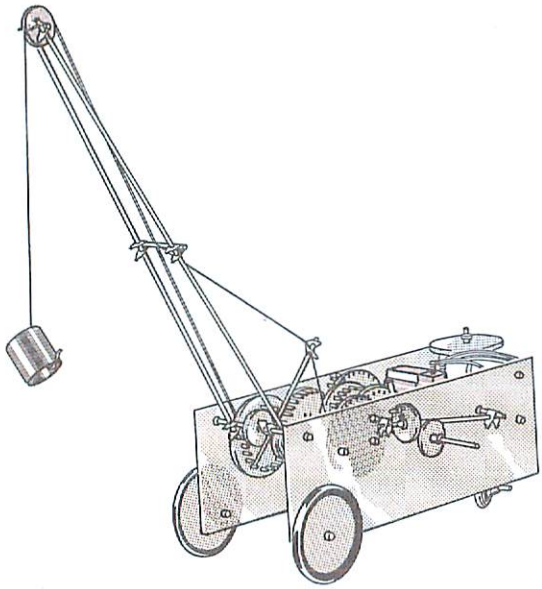
Find two strong supporting points at roughly the same level (50 to 100 cm above the ground). Tie one end of a sufficiently long piece of string to one of these points and thread it through the car as follows: Starting from the left, pass it on the lettered side of the plate along pulley J1, wind one complete turn around this pulley and pass to drum S1. Pass it again along the lettered side, give it one complete turn and then to pulley X1, where the procedure is the same. The string can now be tied to the second supporting point. Ask someone else to hold the model while you are tightening the string, to prevent it from falling.

Set the three switch levers vertically upwards so that all gear wheels are disengaged. Switch on the motor; the direction in which it runs depends upon the switch setting. With the levers the three cable drums can now be operated independently.

3



C7 - LARGE ELECTRIC CRANE



This model is, in fact, an extension of model C5. The hoisting motion and the position of the jib is each controlled electrically. Thus the motor drives two transmissions to the respective cable drums, which each can be engaged separately.

Order of assembly

1. The mounting plates.
2. The main shaft.
3. The coupling shaft.
4. The stengthening shaft.
5. Drum shaft for jib with free-running gear wheel.
6. Cable drum shaft.
7. The switch.
8. The steering mechanism.
9. The motor suspension.
10. Battery holder for 9 V.
11. The jib.
12. Front coupling operating spindle.
13. Rear coupling operating spindle.
14. Aligment of the gear wheels.

1. Place a mounting plate in front of you with the topside up. This will be the back mounting plate. Insert into L1 and N1 a hairpin spring with large coil spring at the top. Furthermore a 4 x 12 bush with collet (4) in P2, T2 and X1, a 3 x 24 bush in T1.
The flange of the latter comes against the head of the collet. Insert a bush 3 x 24 in X5, such that it extends at the rear of the mounting plate. Over this goes a large wheel with tyre with a collet 4 and a 4 x 12 bush. At the end of the 3 x 24 bush a pin with a 2 mm washer is to be inserted. In the front mou nting plate we place a 3 x 12 bush in J3, 4 x 12 bush in T2 and X1 and in P2 a 4 x 12 bush with a 4 mm collet which is not pushed tight. In X5 at the topside a large wheel, just as in X5 of the back mounting plate.

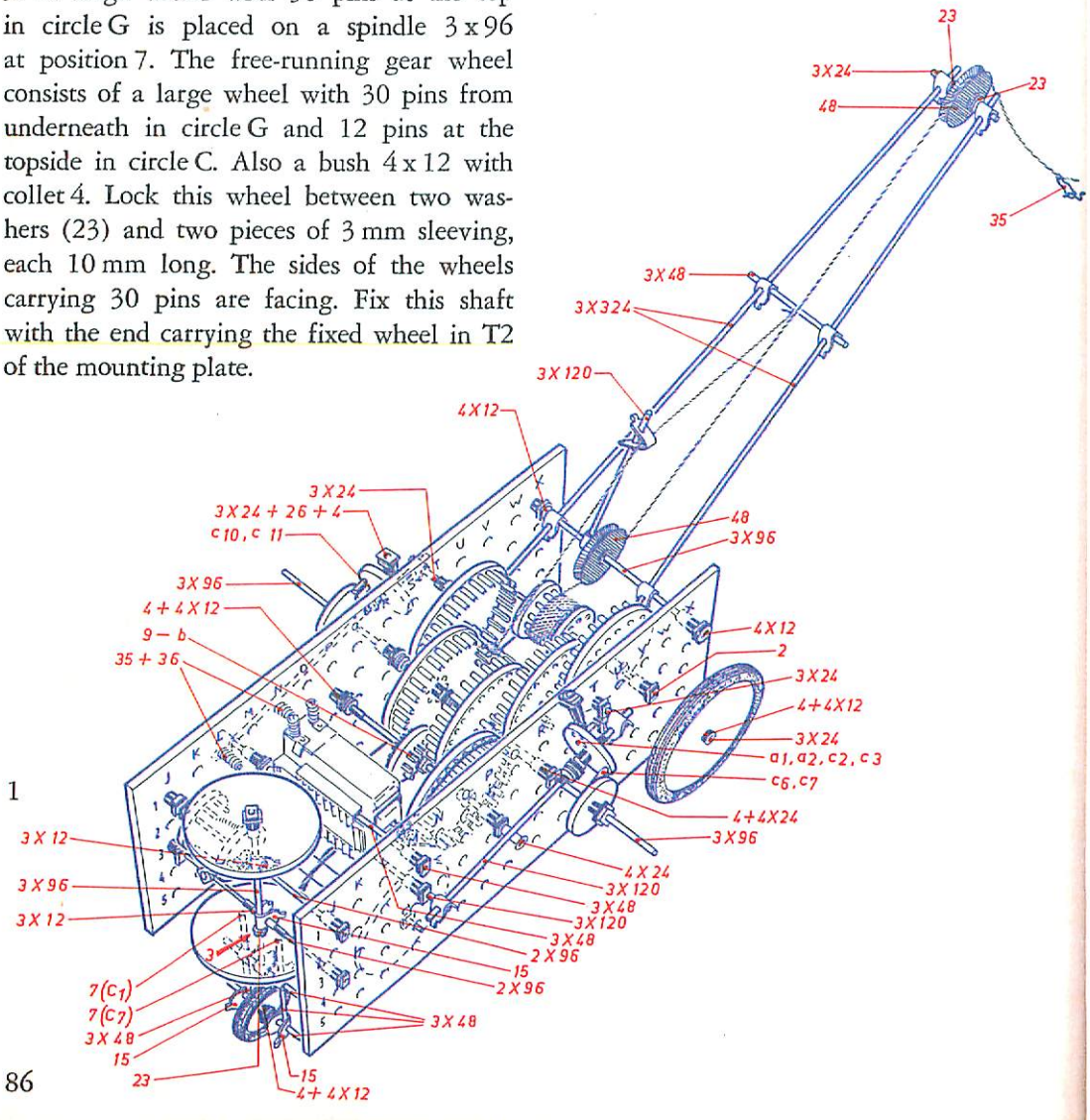
2. In a small wheel place nine pins in circle b, slots facings outward and at both sides protruding by an equal amount. Fix this on a 3 x 96 spindle, position 5. Next put 30 pins in circle G at the topside of a large wheel and mount this at position 2 on the 3 x 96 spindle. Put a rubber band around the 30 pins. This will serve as the drive belt. At the side of the small wheel push a piece of 3 mm sleeving 8 mm long on the spindle and also a 3 mm washer. Then place this shaft in P2 of the back mounting plate.

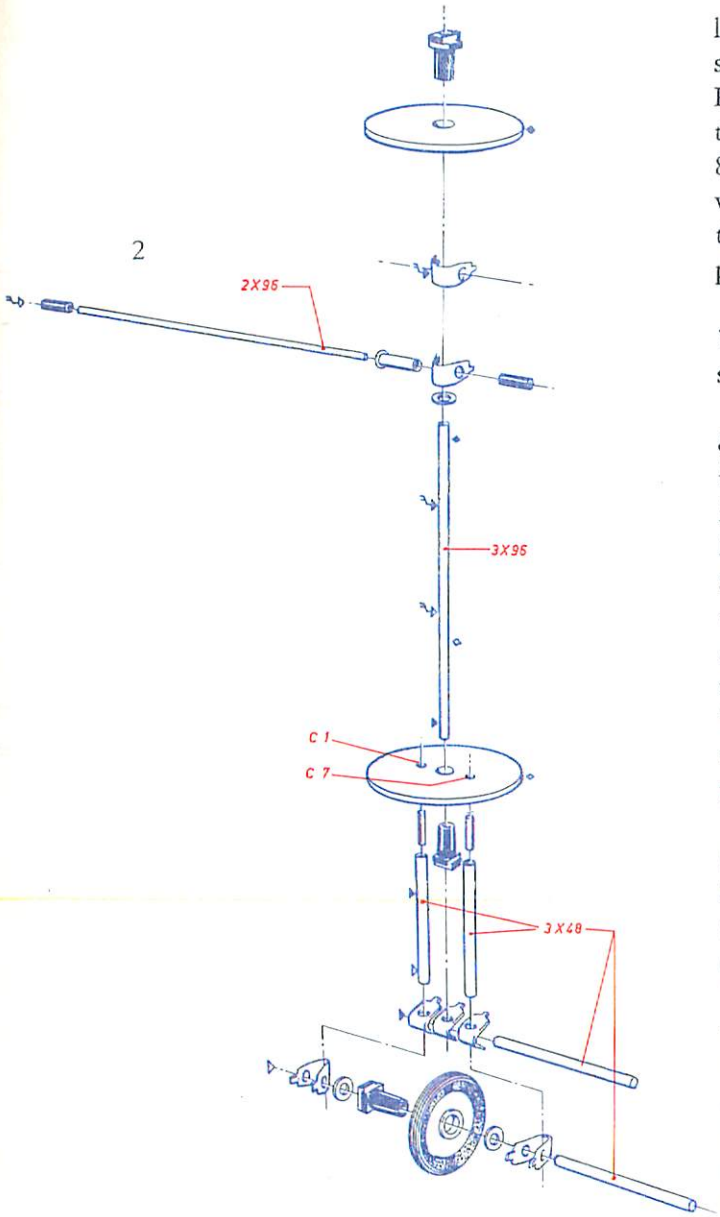
3. In a large wheel insert 27 pins at the topside in circle F and six from underneath in circle A, and fix this at position 1 of a 3 x 96 spindle.
On the other end of the spindle push successively a small coil spring, a washer (23), a 4 x 4 bush with flange pointing towards the gear wheel and a piece of sleeving (23), which is removed again at the final assembly. Make another one of these.

4. At the middle of a 2 x 96 spindle push a piece of 2 mm sleeving so that the distance between the pins of the two wheels becomes 4 mm. On both ends of the strengthening shaft we push one of the coupling shafts described in section 3. The topsides of the wheels are facing one another. The 4 x 24 bush of one of the coupling shafts is fixed at position 2 in hole R2 of the mounting plate. The two gear wheels should then be at the two sides of the small gear wheel on the main shaft.

5. A large wheel with 30 pins at the top in circle G is placed on a spindle 3 x 96 at position 7. The free-running gear wheel consists of a large wheel with 30 pins from underneath in circle G and 12 pins at the topside in circle C. Also a bush 4 x 12 with collet 4. Lock this wheel between two washers (23) and two pieces of 3 mm sleeving, each 10 mm long. The sides of the wheels carrying 30 pins are facing. Fix this shaft with the end carrying the fixed wheel in T2 of the mounting plate.

6. The cable drum shaft carries two small wheels, one of which has nine pins at the top in circle and the other also nine pins in circle b, but this time at the underside. The first small wheel is fixed on a 3 x 48 spindle at position 2 and after this a 3 x 12 bush is pushed on each pin. Fix the second wheel with the pins falling likewise in the bushes. Before clamping down the second collet press the two small wheels closely together. See that the pins protrude by 1 mm from the wheel at the end where the collet is to be fitted. The bushes are now



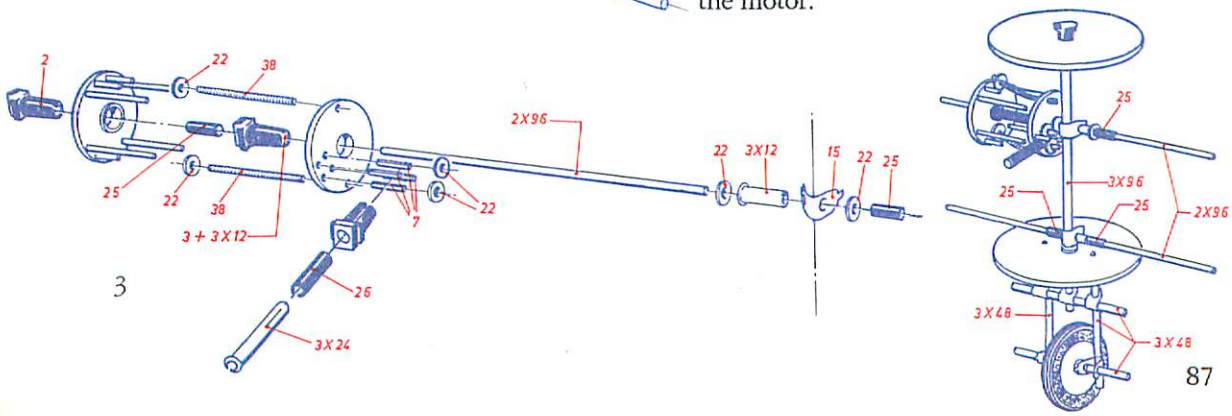


locked at both ends. At the other end in position 1 fit a large wheel with 24 pins in E. Pass a 2 x 96 spindle through the hole. At the drum end fit a 2 mm washer and a 8 mm long piece of sleeving. Fix this spindle with a 2 mm collet in V2. The double wheel then will be closest to the back mounting plate.

7. The construction and mounting of the switch is the same as in model C5.

8. The steering mechanism is identical to that of model C5 only a large wheel is used instead of a small one. It is mounted as follows: Push a 3 mm washer over a 3 x 96 spindle, followed by a clamping spring in which a 3 x 12 bush.
Above this, at a distance of 3 cm comes a second clamping spring with a 3 x 12 bush. The two bushes are pushed on spindles 2 x 96 in J1 and J3. Lock the bushes with pieces of 2 mm sleeving.

9. Fit a pulley on the motor spindle (page 22, fig. D). Pass a 3 x 120 spindle through the holes furthest removed from the electrical terminal and fix a spindle in M2 of the back mounting plate with the pulley facing upwards. Lock the motor with two 8 mm long pieces of 3 mm sleeving. Fit the front mounting plate. This plate is fixed in the holes J1, M2, R2 and V2. This 3 x 48 spindle in M1 should pass through the free hole of the motor.



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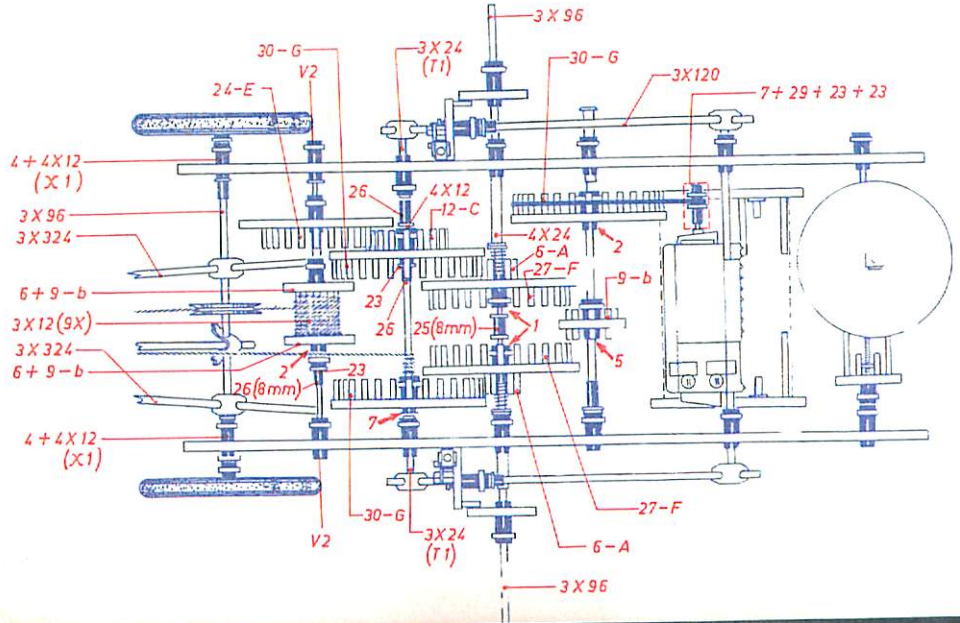
10. Make a battery holder for six R6 cells, as described on page 19. Fix it in the holes M4, of the front and back mounting plate. The red (positive) flex goes to the terminal N1 of the mounting plate, the black one to L1. The black leads from the switch likewise go to L1 and the red ones to N1. The grey leads on the switch go to one terminal on the motor and the green leads to the other.

11. The jib consists of two 3 x 324 spindles each with three clamping springs with cross connections fitted. This is again identical to model C5.

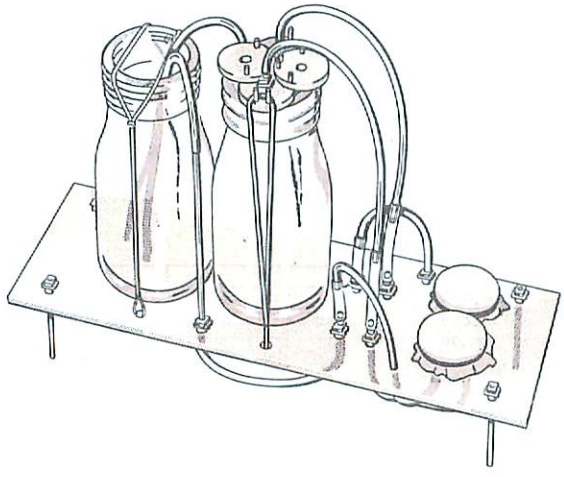
12. On a 3 x 20 spindle fit at postition 7 between two pieces of 3 mm sleeving and 3 mm washers a small wheel with four pins underneath in a1, a2, c2 and c3 and two pins at the top in c6 and c7. The hub of the wheel is formed by a 4 x 12 bush with a collet. Push a clamping spring to both ends of the spindle. The lever is fixed in the usual way. Mount the operating spindle as shown in the illustrations.

13. The rear coupling operating spindle is identical to the one described in section 12, but with the two pins inserted in c10 and c11 at the top, instead of c6 and c7. The piece of string that serves as the jib cable is fixed to the drum in T2 and the hoisting cable to the drum in V2.

14. Fig. 2 gives a top view of the assembled crane. This shows clearly how the wheels have to be aligned. The two levers have to be in the highest position, in which the two cable drums are disengaged. Adjust the gear wheels exactly according to the drawing. By operating the levers the hoisting cable and the jib can be engaged either separately or simultaneously.



D - PUMPS
D1 - TWIN DIAPHRAGM PUMP



Pumps are used to carry liquids from one place to another. Many types of pump are used for this purpose. Each of these has its own applications. The type of liquid, the temperature, etc. determine which type of pump must be used. The diaphragm pump which we are making here is used, amoungst other things, as a petrol pump in cars. The diaphragm pump operates on the same principle as the suction pump, i.e. a space is alternately expanded and reduced in volume. Inlet and outlet valves ensure that the liquid can only flow in one direction.

Order of construction

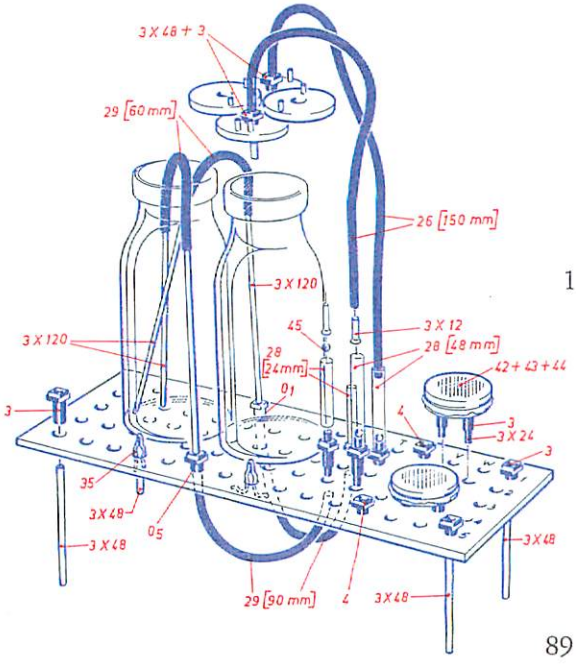
1. Baseplate.
2. The diaphragm housing.
3. The valve system.
4. Other hoses.
5. Fixing piece.

1. Put 3 x 48 mm spindles on the corners of the mounting plate. A 3 x 120 spindle goes in at O1 and O5 and it must project form the collet by approximately 1 cm on the underside.

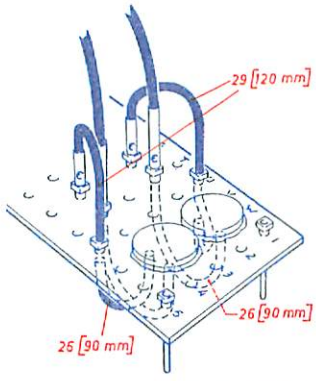
2. Make two diaphragm housings with 3 x 24 bushes (see page 15). Put one diaphragm housing in V2 and W2 and the other in V4 and W4.

3. The suction valves go in S2 and S4 and the discharge valves in T2 and T4. Make a suction valve with 24 mm plastic tube, two 3 x 12 bushes and one metal ball. See also page 16. 120 mm hose goes on the top of the suction valve and 90 goes on the underside. Make the discharge valves with 48 m plastic tubing and then continue as for the suction valves. 90 mm of sleeving (26) is fixed underneath this and 150 mm of this sleeving to the upper side.

4. Fig. 2 illustrates how the pipes of the valve system are fitted. Where the hose goes through the mounting plate at U1 and U5 a cone (4) is first of all pushed onto the hose and this whole assembly is pushed loosely into the plate. Connect the undersides of the valves in S2 and S4 with the spindles in O1 and O5 respectively. For this purpose use rubber hose. On the top sides of these spind-



1

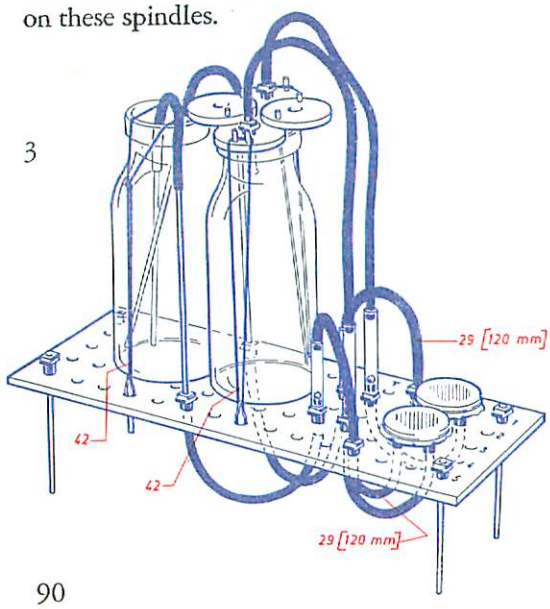


2

les push pieces of 60 mm rubber hose, and 3 x 120 spindles are again pushed onto this. Use $^1/_8$th litre ($^1/_4$ pint) milk bottles as supply tanks. These milk bottles are fixed in position on the plate in holes M1, M5 and Q1 and Q5 by means of elastic bands and anchor springs.

Only one elastic band is stuck into the anchor springs in Q1 and Q5. These are later hooked around the fixing piece.

5. Fix four small wheels to each other by means of pins in the holes C1, C3, C4 and C6 of each wheel. The underside of every wheel must face downwards. In the two bottom wheels pins are placed vertically in C9 and C10: 3 x 48 spindles are likewise fixed into these wheels (position 2). Put the hoses on these spindles.



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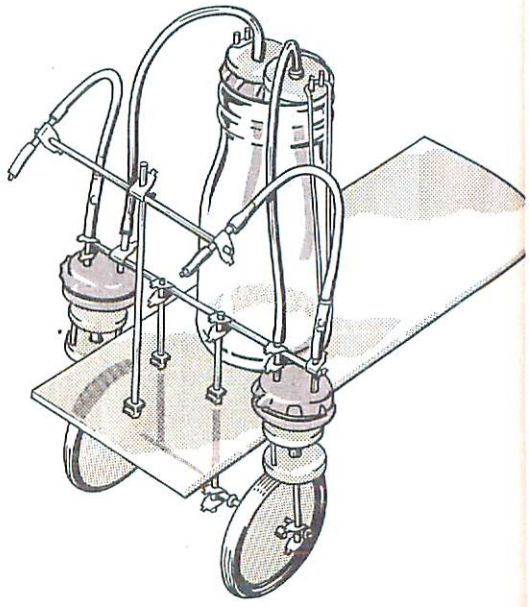
D2 - PUMP TRAILER



This is a trailer without front wheels, the front resting on the back of he tractor. When this trailer is pulled along jets of water will be sprayed alternately on the left and the right from the nozzles.

Order of assembly

1. The mounting plate with wheels.
2. Diaphragm housing with drive rod.
3. The hoses and valves.

1. 3 x 96 spindle (position 4) in L2 and L4 of the mounting plate. Underneath fix 3 x 12 brushes to the spindles by means of clamping springs and pass a 2 x 96 spindle through those bushes.

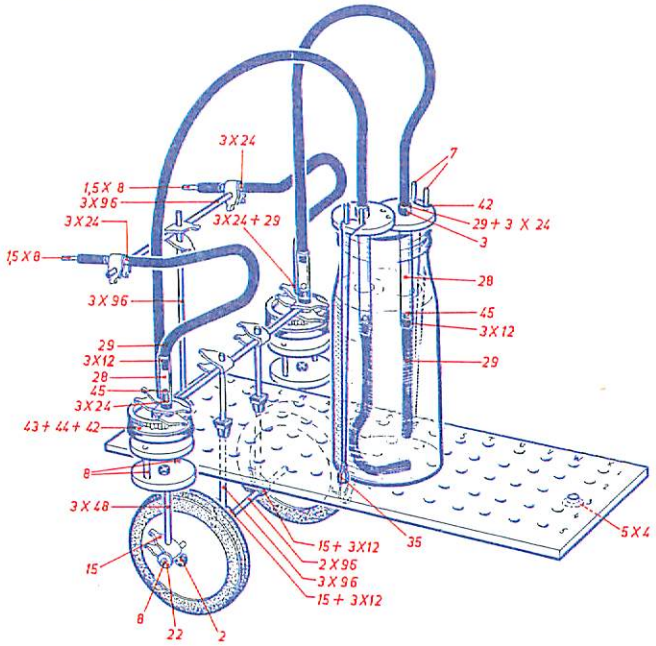
This is centralized by means of 2 mm washers and pieces of 2 mm sleeving. On two wheels fix at the topside a long pin in circle A, each pin at the end carrying a 2 mm washer. Fix these wheels on the 2 x 6 spindle with the heads of the collets facing. On

the ends of the 3 x 96 spindles protruding above the mounting plate, place a clamping spring carrying a spindle 3 x 120. In J3 of the mounting plat pleace a spindle 3 x 120 with at the top end a clamping spring through which a 3 x 6 spindle passes.
At the end of this spindle place clamping springs with bushes 3 x 24. The flanges should point upward. Push pieces of rubber hose (29) across the flanges and into these pieces of hose bushes 1.5 x 8 with the flanges inside the hose.

2. The diaphragm housings are made as described on page 15. They are mounted upside down, in such a way that the bushes are situated on either side of the 3 x 120 spindle. The crank shaft is a 3 x 8 spindle fixed with a clamping spring on a pin in the wheel. The proper adjustment of wheel and diaphragm housing and of the length of the crank shaft requires patience, because otherwise the small wheels may run against the types or the mounting plate.

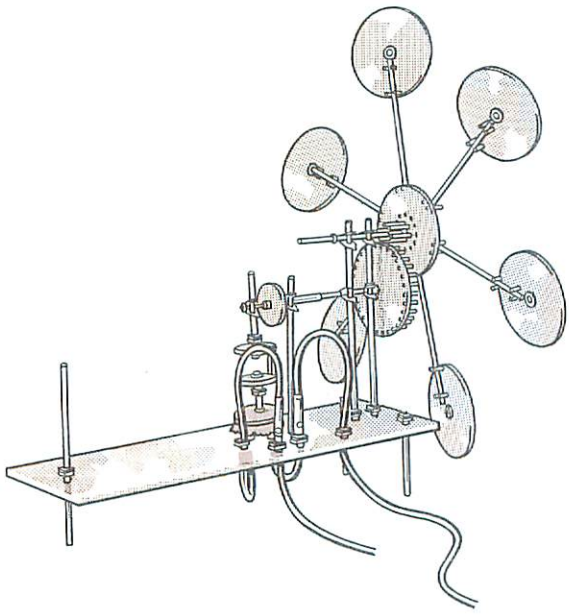
3. The pressure valves are on the diaphragm housing (see also page 16). On the top of both pressure valves a piece of hose 60 mm long goes to the bushes fixed on the spindle that is clamped to J3. Through the other bushes of the diaphragm housing fit pieces of hose 120 mm long. Join two small wheels together, by means of two pins in circle c. The top sides of the wheels should point in the same direction. Insert in each wheel two more small pins in circle c and from underneath, near the edge of the assembly. In the spindle holes fix 3 x 24 mm bushes with the flanges at the topside of the wheel and protruding from the collet at by the same amount. On the flanges mount valves as usual and underneath those valves fix pieces of hose 60 mm long. Put these in a bottle of about the illustrated size and fix the bottle with rubber rings and hairpin springs in hose Q1 and Q5. The hoses which are fixed to the diaphragm housing are now placed on the bushes in the two small wheels.

4



D3 - WINDMILL WITH PUMP

In this model our starting point is model B1, the normal windmill, now, however, by means of a transmission mechanism a pump is set in motion by this windmill.

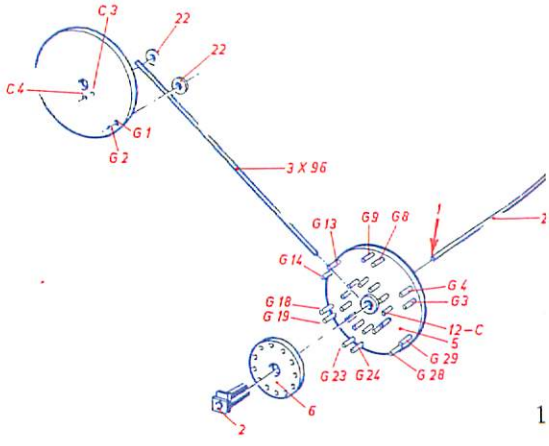


Order of construction

1. Windmill.
2. The transmission mechanism.
3. The pump.
4. The hoses.

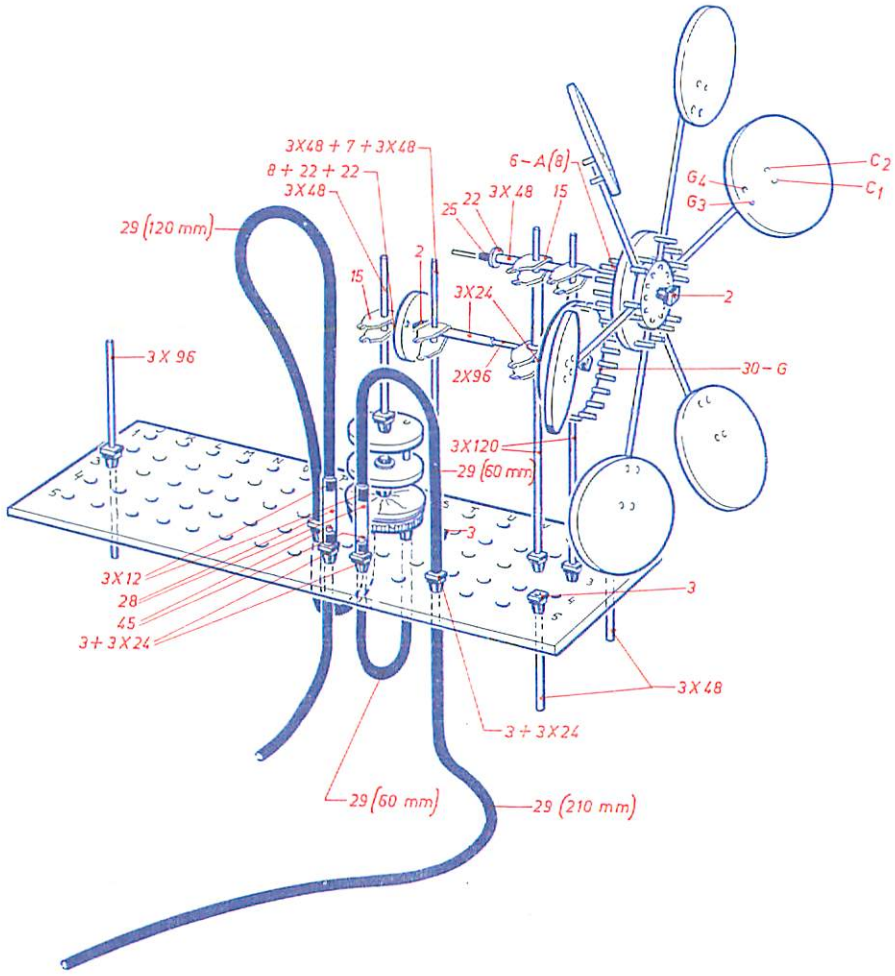
1. The only difference between this windmill and model B1 is that six long pins are pushed into circle A on the rear of the large wheel on the mill spindle.
Before this spindle is put in position, however, two clamping springs must first be pushed over the spindles in W3 and X3.

2. Now put 30 pins in a large wheel in circle G of the upper side. Fix this wheel in position 1 with a 2 x 96 spindle. Now in T3 put a spindle made up of two 3 x 48 spindles with a pin. A clamping spring with a 3 x 24 bush goes on this spindle at the same height as the two bottom clamping springs on the spindles in W3 and X3. A 3 x 24 spindle goes through these latter clamping springs. Now push the 2 x 96 spindle of the large connecting wheel from the side of the plate marked X through this spindle and through the 3 x 24 bush on the spindle in T3. To do this it will be necessary to remove the centre-piece with the sails from its place.
When the intermediate spindle has been fitted this can be replaced. The long pins in the centre-piece must now cause the connecting wheel to rotate. On the end of the intermediate spindle above the holes S place a small wheel with a long pin underneath in circle a. Push two 2 mm washers over this pin, the width of a clamping spring apart from each other.



3. Next make a pump housing with connecting rod (page 15). The connecting rod is a 3 x 48 spindle. Fix the connecting rod with a clamping spring to the long pin in the crank wheel. The pump housing is fixed into the holes R3 and S3 by means of collets 3.

4. Make two valve housings (page 16). Fix these into the mounting plate at R5 and S5 with 3 x 24 bushes. In Q4 and U5 place a 3 x 24 spindle with a collet so that equal lengths of the spindle project from either side of the collet. Using 60 mm hose connect the spindle in Q4 with the bush in R3 on the underside. The valve in S5 is connected with the bush of the pump housing in S3. 60 mm hose is also used for this purpose. A 120 mm piece of hose goes on the underside of the valve in R5. The top of the valve in R5 is connected to the bush in Q4 by means of a 120 mm piece of hose. The top of the valve is S5 is connected to the spindle in U5 by 60 cm of hose. A 210 mm piece of hose goes underneath this spindle.



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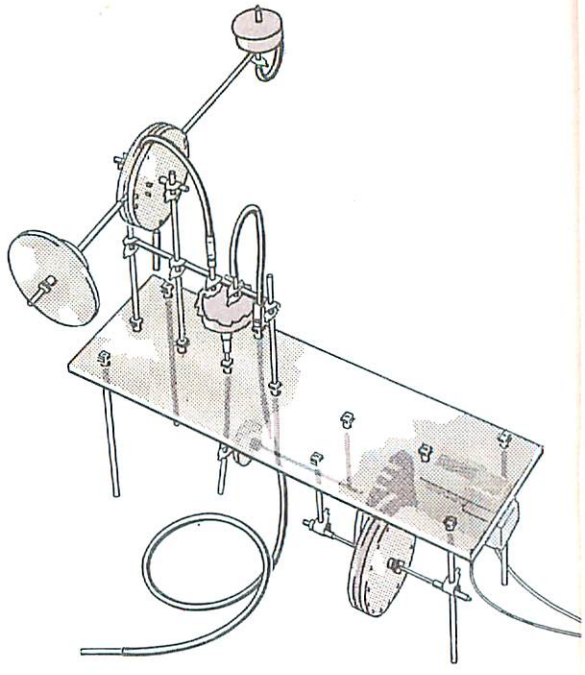
D4 - ELECTRICAL DOSAGE PUMP



The system employed in this pump is one which is frequently used in industry. Whenever a great quantity of small items such as washers or bolts have to be counted, one of the items is weighed, the weight is multiplied by the numer of items and in this way the weight of the whole quantity is obtained. It would be nearly impossible to count a thousand tiny washers by hand for example. This method is also used for liquids as in this model. It obviously saves a great deal of time and labour. In this model the weight can be adjusted by sliding the pulley wheels which act as counterweights along a spindle.

Order of constuction

1. The baseplate.
2. The motor.
3. The transmission.
4. The pump.
5. The balance.

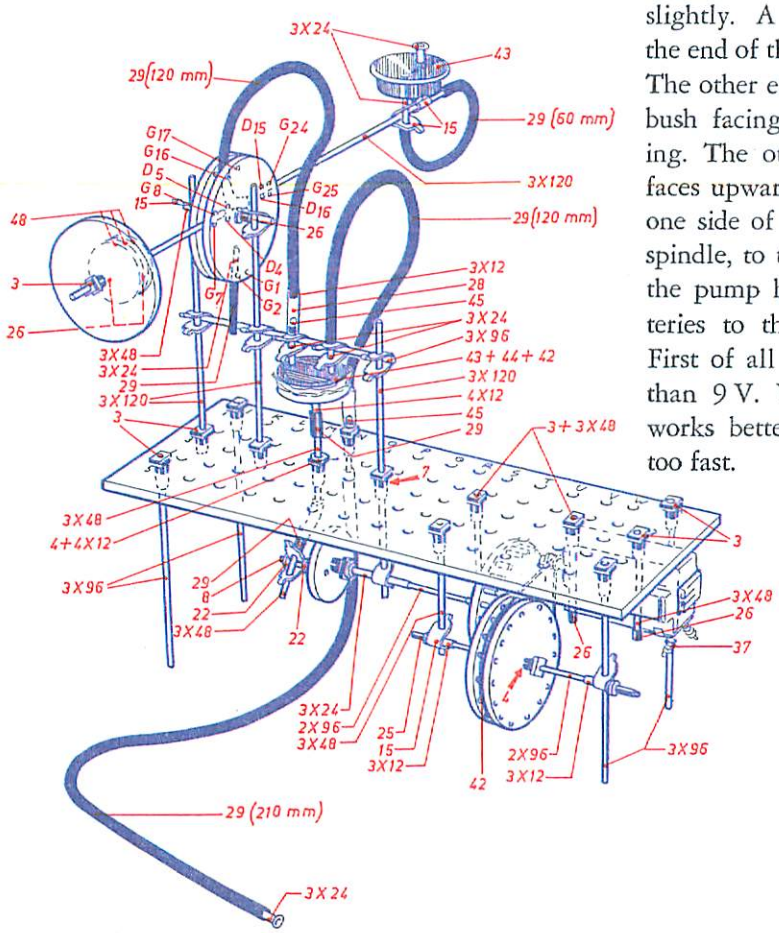
1. Put all spindles in the baseplate at the places indicated. Begin with the spindles at the four corners. A collet 4 with 4 x 12 bush goes in hole N3. This bush performs the same function as the guide shoes which are used in large suction machines. Two clamping springs go on the spindles in J3 and L3. A clamping spring goes on the top and the bottom of the spindle in P3. Clamping springs also go on the spindles in S3, S5 and X5, all three of which are situated at the same distance from the baseplate as the clamping spring on the spindle in P3. A 3 x 12 bush goes through the clamping springs on the spindles in S3, S5 and X5; a 3 x 24 bush goes through those in P3.

2. Fit a pulley to the motor spindle (page 22, Fig. D) and put the motor on the spindles in V3 and X3, then fix a small piece of 3 mm sleeving on these spindles.

3. Now make a double wheel with two large wheels with their reverse sides turned inwards to face each other. For this purpose put fifteen pins in circle G. In one of the two wheels put 6 pins in circle a. Now place an elastic band round the double wheel and mount the whole assembly in bushes on the spindles in S5 and X5. The pins in circle A of one of the wheels must point in the same direction as the spindle of the motor. Put 2 mm washers and pieces of 2 m sleeving on the ends to fix the spindle in position. Next put the elastic band round the motor pulley. If necessary push the wheel so that the motor pulley and the double wheel are exactly level. This prevents the elastic band from running off the double wheel. Now put 30 pins in the underside of a large wheel in circle G. Put a 2 x 96 spindle through the bushes on the spindles in P3 and S3 and on this spindle mount this wheel under the holes T. The pins o

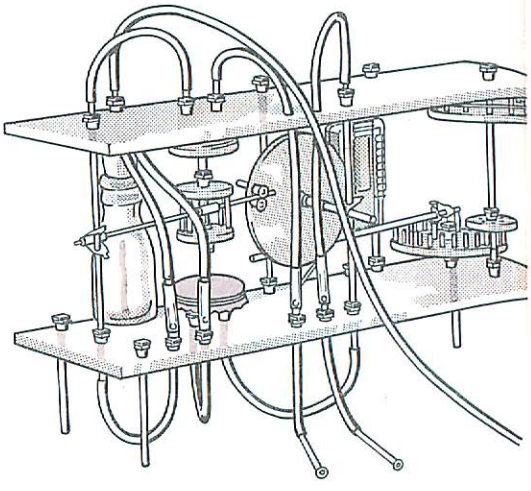
this wheel must engage in the pins on the double wheel. On the other side of the spindle last mentioned (2 x 96) place a small wheel with a long pin and two 2 m washers on the underside in circle. This small wheel is the crank.

4. Make a pump housing in the normal way (see page 15). Then push a 3 x 96 spindle through the bottom clamping springs on the spindles in J3 and L3 and through the clamping springs on the spindle P3. Using clamping springs fix the pump housing upside down on this spindle. Push a piece of rubber hose over the bush on the diaphragm and then put a 3 x 48 spindle in this hose from underneath through the bush in N3. Push this spindle through until it engages in the bush on the diaphragm. A piece of hose is likewise pushed over the bottom end of this spindle. Another 3 x 48 spindle goes into this and it is secured to the large pin of the crank wheel with a clamping spring. A pump valve is now mounted in N1 with a 210 mm piece of hose on the bottom side and a 120 mm piece of hose on the top (see page 16). The other side of this last piece of hose is fixed to a bush of the pump housing. A pump valve is mounted on the other bush of the pump housing and a 120 mm piece of hose from the balance will later be fixed to the top of this.



5. Now fit the balance together. On the 3 x 96 spindle first put a piece of 3 mm sleeving, then the three pulley wheels, next another piece of 3 mm sleeving and finally the large wheel. In order to fit the 120 mm piece of hose on the 3 x 120 spindle it will be necessary to slacken the double wheels slightly. A 60 m piece of hose goes on the end of this spindle.
The other end of this hose is pushed over the bush facing downwards in the pump housing. The other bush of the pump housing faces upwards. Finally fix the 120 mm hose, one side of which is attached to the 3 x 120 spindle, to the valve situated on the bush of the pump housing. Finally connect the batteries to the motor using cylinder springs First of all test it by using a voltage lower than 9 V. You will see that the assembly works better then. At 9 V the pumping is too fast.

D5 - DOUBLE-ACTING WATER PUMP



This pump contains two diaphragm chambers which alternate, i.e. if one sucks, the other pushes and vice versa. Compared with the single-acting pump, the interruptions in the water flow become smaller and the yield is twice as great. To make the water flow even more regularly and to combine the yield of the two chambers into one outgoing pipe, a bottle sealed with a perforated rubber stop (46) is used. This gadget is known as the air-vessel. An ordinary glass bottle of a volume of 10 to 20 cc is suitable. It should not be higher than about 55 mm.

Order of assembly

1. The two mounting plates.
2. The intermediary spindle.
3. The drive wheel.
4. The rockers.
5. The motor.
6. Two pumping chambers with coupling piece.
7. Provisional assembly.
8. The connecting hoses.

1. In the top mounting plate fix 4 x 12 bush in K2. In the base plate insert 3 x 48 spindles from underneath in J1, J5, X1 and X5 and also a 4 x 12 bush in K2, at the topside 3 x 96 spindles in M5, N5 and Q5 and 3 x 120 spindles in Q1 and X3. These latter should protrude about 12 mm underneath the collet. Lay the base plate down in the position shown on the drawing and then continue as follows:

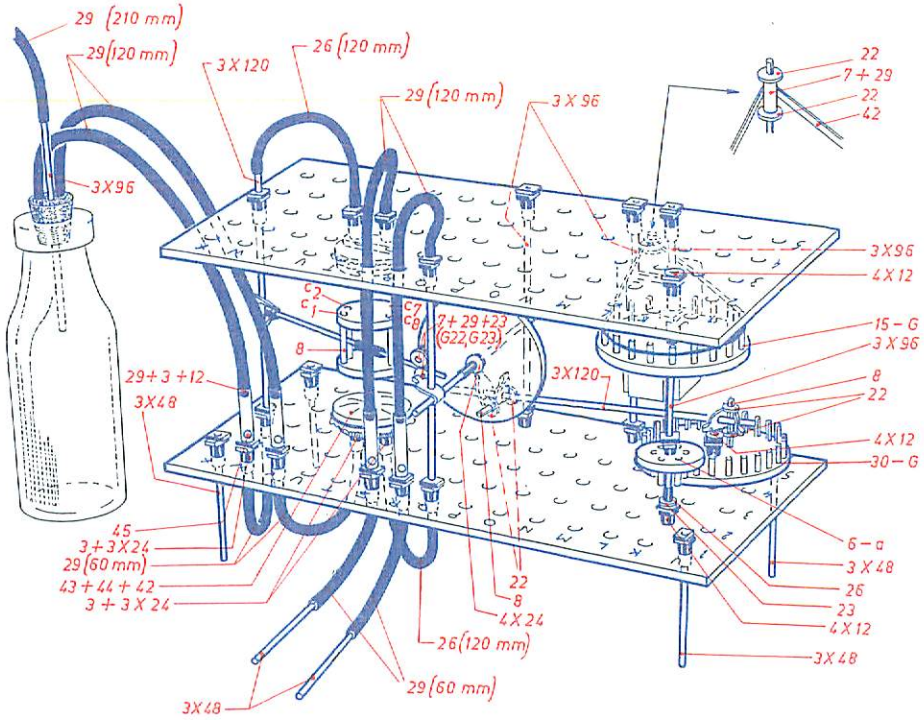
2. In a large wheel insert 15 pins from above in circle G and fix this at position 2 of a 3 x 96 spindle. From underneath insert six pins in circle a of a small wheel. Place this wheel at position 6 of the 3 x 96 spindle. At the side of the small wheel push a piece of 3 mm sleeving and a 3 mm washer on t spindle and then insert this end in the bu in K2. Put a rubber band around the pi of the large wheel.

3. In another large wheel at the top ins 30 pins in circle G, a 4 x 12 bush in spindle hole and a long pin (8) with t 2 mm washers in B1. The distance betw the two washers should be about 7 n (width of a clamping spring). In the 4 x bush insert a 3 x 24 bush and mount combination by means of a 3 mm collet hole K4. See that the wheel runs smoot Underneath in a large wheel put pins G22 and G23. On each pin put 5 mm of ber hose and a 2 mm washer. At the tc de in G1 insert a long pin with two wasl the same way as done for the driving wl In the spindle hole place a 4 x 24 bush which the end without flange extends al the head of the collet. Fix this whee a 3 x 96 spindle with at the topside a 3 washer and a piece of 3 mm sleeving, underneath a 3 mm washer. This w should be situated above the lower sic

the third row of holes of the base plate. The spindle of the rocker passes about halfway between the two mounting plates. Now connect the pin on the driving wheel with that on the rocker by means of clamping springs and a 3 x 120 spindle.

5. Put a pulley on the motor spindle (see page 22, fig. D). On the spindle in N5 first push a piece of 3 mm sleeving and next the motor with the pulley pointing upwards, and then another piece of 3 mm sleeving. The pulley must be at the same height as the idler wheel on the intermediary shaft.

6. Make two diaphragm chambers as described on page 15, fig. B, C, D and E. In the diaphragm house place two 3 x 24 bushes and on the diaphragm a bush 4 x 24. The coupling piece consists of two small wheels with the reverse sides facing and linked by long pins (8) in c1, c2, c7 and c8. Fix the bushes on the diaphragm housings with a 4 mm collet in the spindle holes of the coupling piece, allowing a distance of 3 to 4 mm between the bushes. This gap should be equally far removed from both wheels.



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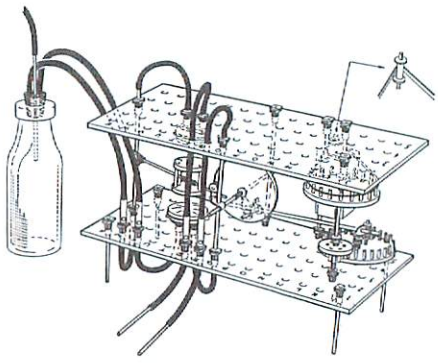
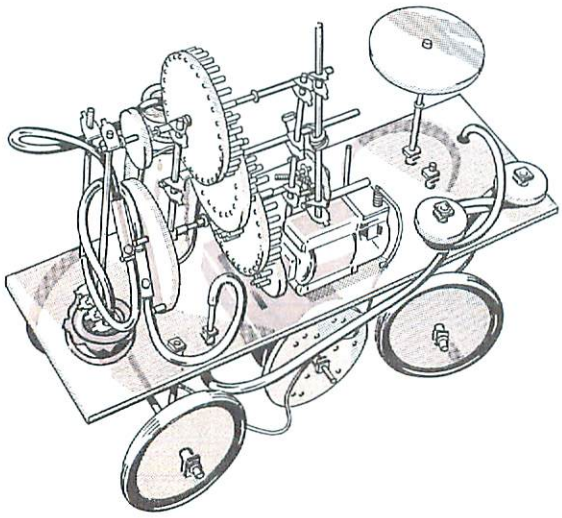
7. Fix one of the pump chambers in the mounting plate in the holes T3 and U3 and place a clamping spring at the centre of the spindle in X3. Continue by fixing the top plate. The top plate is fixed with collets in M5, N5, Q1, Q5 and X3. The upper diaphragm housing is fixed to the top plate with collets in T3 and U3.

8. Take two pieces of 3 mm sleeving each 120 mm long, two pieces of rubber hose 10 mm long, four pieces of hose 60 mm long and four pieces of 120 mm length. For the outlet pipe use 210 mm of hose.
First make four valves (see page 16) with underneath a 3 x 24 bush and at the top 3 x 12 bushes. Fix these in the holes R1, S1, V1 and W1. Next fix all pieces of hose and sleeving as shown in the drawing. Please note that for the sake of clarity the bottle has been made too large here; see to it that you use a bottle in which the cork fits exactly. The two ends of hose have been fixed to the cork by means of a 3 x 24 spi
The rubber band which is around the wheel, should also be put around the p of the motor. Take a 2 x 96 spindle push over it two 10 mm pieces of r hose, one at the centre and one at one c ends.
Insert this spindle between the pins o coupling piece, grouped in pairs, in su way that the piece of hose at the cent the spindle comes in-between the two b and the end of the spindle without ho between the two paired pins on the rc The other end, carrying a short piece of comes in the clamping spring on the s le in X3. Now it is time to connect the tor to the battery. Don't use 9 V to with, but first try it on 6 V and you see that the motor will take up suffi speed to operate the pump properly. two pieces of hose connected to a 3 spindle, are the inlet and should be p in a dish of water.



D6 - TRUCK WITH REVERSIBLE PUMP



Trucks on which a pump is mounted are often used for jobs, which have to be carried out in different places. They are often found for example in building concerns and public services. The pump on this truck can operate in two directions. The tank on the truck (a bottle) can thus be filled or emptied by the pump. The valves of this pump are mounted on a rotary disc by means of which the working of the pump can be reversed. As long as the rotary disc with the valves is not in one of the two working positions the motor is disconnected. In the working position the motor drives the pump by means of a reduction gear. The special feature of this pump is that the diaphragm housing moves whilst the centre of the diaphragm remains stationary. In this respect it differs from the previous pumps.

Order of construction

1. The baseplate.
2. The rear wheels.
3. The front wheels with steering assembly.
4. The motor.
5. The reduction gear.
6. The diaphragm housing with connecting rod.
7. The rotary disc with valves.
8. The switch disc with stop lever.
9. The battery holder.
10. The finishing touches.

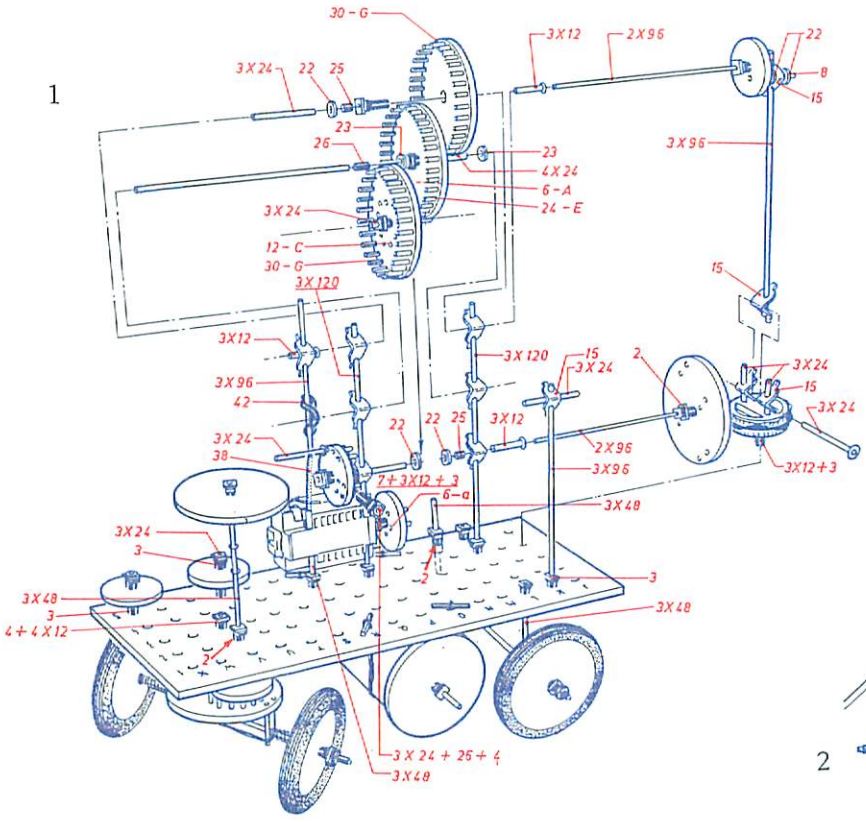
1. Fit into the baseplate bush 4 x 12 in V3.
3 x 48 spindles in L1, L5 and R4.
3 x 48 spindles in M5 and V2 at position 3.
3 x 120 spindles in L4, P4.
3 x 96 spindles in K1, and at the top of this spindle place a 3 x 24 spindle which must project from the clamping spring at an equal distance on either side. See Fig. 1 for the correct placing of these spindles.

2. The rear wheels are fitted in the normal way as described in model A1.

3. The front wheels with steering assembly are likewise identical to those of model A1.

4. On the motor spindle place a small wheel with 6 pins in A. Do this using a pin and 3 x 12 bush. Push the motor onto the 2 spindles in P4 and R4. Screw a contact spring into the spindle in R4.

5. Make a cogwheel with 30 pins on the topside in G, and 12 pins underneath in C. A 3 x 24 spindle goes in the central hole and projects approximately 3 mm above the cone.
The second cogwheel is a large wheel with 24 pins on the upper side in E and 6 underneath in A. A 4 x 24 bush goes in the central hole and projects on the underside.
The third cogwheel is a large wheel with 30 pins on the upper side in G. Using a clamping spring fix a 3 x 12 bush on the spindle in L4, and a 3 x 24 spindle on the spindle in P4 with another clamping spring.
A 2 x 96 spindle is pushed through the bush



at L4 on the underside under the holes marked J. This spindle next goes through a piece of 2 mm sleeving and a 2 mm washer. Then push the first cogwheel onto it, next another 2 mm washer and finally this spindle goes through the spindle in T4.

The 30 pins of this cogwheel must engage in the pins of the wheel on the motor. This can be adjusted by regulating the height of the two clamping springs. Next put another clamping spring on L4 and P4. The second cogwheel goes through this. The cogs must engage in the cogs on the rear side of the first cogwheel. Finally a clamping spring is fitted to the two top spindles and on one side of it plave a 3 x 12 bush and on the other a 3 x 24 spindle. Between this again comes the third cogwheel with a 2 mm collet a piece of 2 mm sleeving and a 2 mm washer. Figure 3 shows the completed assembly. Place the crank wheel on the spindle of the top cogwheel. This is a small wheel with one long pin on the underside in a. Fir place two 2 mm washers on this pin. Th connecting rod will later be secured to th with a clamping spring.

6. Two 3 x 24 mm bushes go into the di phragm housing. Fix a 4 x 12 mm bush the diaphragm using the metal ball. Fit th bush into a 4 mm collet with the head agair the diaphragm and put the complete asser bly into J4 of the baseplate. Put clampi springs on the two bushes which proje upwards and a 3 x 24 mm bush betwe them. Fix a 3 x 96 spindle to the spinc in the centre using the clamping spring. T other end of this spindle is secured to t crank wheel with a clamping spring.

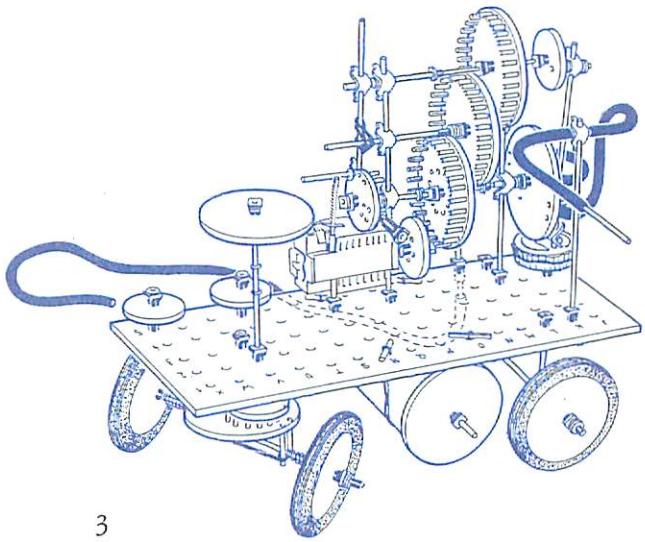
7. On the underside of a large wheel pla pins in A2, A5, C3, C9, E11, F14, F G30. Put the wheel on the spindle of t bottom cogwheel. Now make two valves

described on page 16. Two 3 x 12 bushes go on each valve. On one side of each valve place a piece of 90 mm hose and on the other a piece of 120 mm hose. Now clip the valves between the pins on the rotary disc so that the pieces of 120 mm hose lie closest to the rim of the wheel. The 120 mm hose of the top valve goes on the spindle in N5, the other hose on this valve goes on the bush of the diaphragm housing. The 90 mm hose of the bottom valve goes on the other bush of the diaphragm housing. The 120 mm hose of the bottom valve is pushed over the 3 x 24 spindle which is fixed above the spindle in K1. On the other side of this spindle place a piece of 60 mm hose into which a 3 x 48 spindle is pushed. Hang this spindle in the bottle. A 420 mm piece of hose goes on the underside of M5.

8. In the underside of the small wheel put pins in c1, c2, c3, c4, c6, c7, c10 and a6. A long pin goes in c5 and must project the same distance as the short pins on the underside. It therefore projects 10 mm on the upper side. Similarly on the underside place a pin in c11 with a 2 mm washer, and in a5 a pin with two 2 mm washer. A 3 x 24 bush goes on the long pin on the top side. On the underside fit a switch lever consisting of a 3 x 24 bush with a piece of 3 mm sleeving and 4 mm collet on it. These are secured between pins a5, a6, c10 and c11. Using a 2 mm collet we place the small wheel on the spindle of the bottom cogwheel. (Fig. 1). Fit a 3 x 12 m bush with a clamping spring to a 2 x 96 mm spindle (approximately position 3). Another loose clamping spring goes over the end of the spindle. Push the bush over the spindle of the top cogwheel. Finally fix the lever to the spindle of the central cogwheel by means of an elastic band. The bottom clamping spring must now fall between the pins of the switch plate.

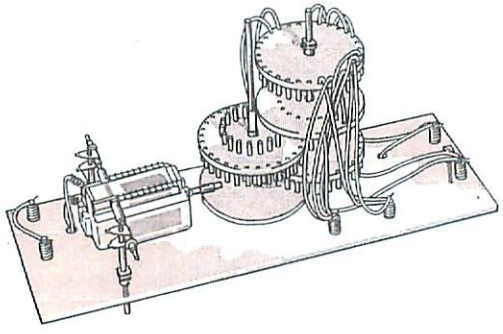
9. Suspend the battery holder with elastic bands and pins under the baseplate. Connect 120 mm red flex to the + pole and 120 mm black flex to the —pole. The +flex is connected with a pin to the underside of the spindle in A4, the —flex is connected to the motor. The other motor lead is connected to the contact spring at the top of the spindle in R4.

10. Before the completed model is set in motion all cogwheels must first be in perfect alignment (Fig. 3). The position of the switch plate and the turntable must be accurately fixed.
Place a small wheel on a 3 x 24 bush and then fit another collet onto this bush and place the whole assembly in X5 of the baseplate. A similar combination goes in U5. The 420 mm hose is laid between this. When the switch plate is in the lowest or topmost position it makes contact with the contact spring in R4 and the motor works. If the model does not function properly the position of the rotary disc in relation to the switch plate must be altered.



3

E - CLOCKS
E1 - SOS TRANSMITTER



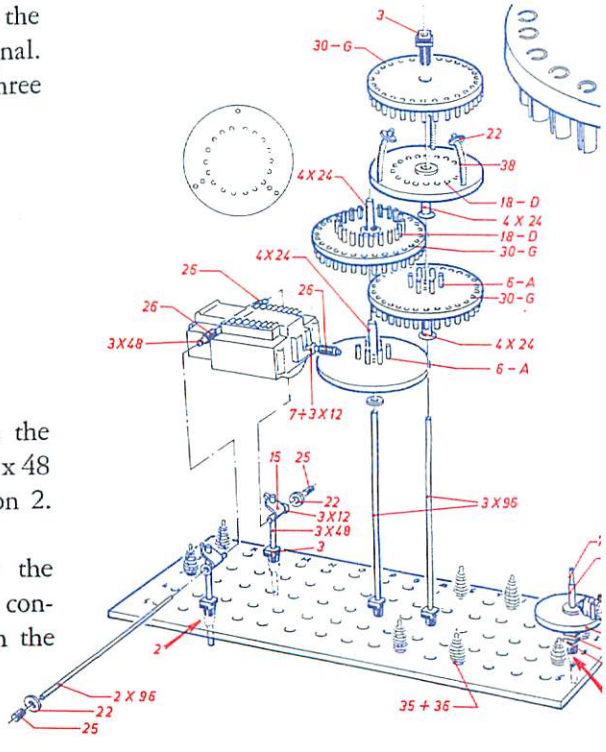
This transmitter automatically sends out a fixed morse signal. This is basically what often happens in the case of beacons for air and sea nagivation. A signal like this can be transmitted as a radio signal or a light signal. The equipment consists of a switch section and a transmitting section. Here we shall confine ourselves to describing the switch section which gives an SOS signal. This is represented by three dots, three dashes and another three dots.

Order of construction

1. The baseplate
2. Cogwheels
3. The motor
4. The wiring.

1. Place the various contact springs in the mounting plate at X2, X4 etc. The 3 x 48 spindles go in X3, L1 and L5 at position 2.

2. First place a 3 mm washer over the spindle in Q3. Then place a cogwheel consisting of a large wheel with 6 pins on the underside in A. Put the wheel on the 4 x 24 bush (position 1). Next make a cogwheel with 30 pins on the upper side in G and six pins on the underside in A. The wheel goes on a 4 x 24 bush (position 2). Push this wheel over the spindle in S3. Next make a cogwheel with 30 pins on the upper side in G and 18 pins on the underside in E. Put the wheel on a 4 x 24 bush (position 1). Push this cogwheel over spindle Q3. Put the switch rotor consisting of a large wheel with 18 pins on the upper side in D and contact springs in the underside in G6, G14 and G28. A 2 mm washer goes over the contact springs. Connect these springs in G6 and G28 with a small piece of flex. Put the wheel on a 4 x 24 bush (position 2).
Push the whole assembly over spindle S3



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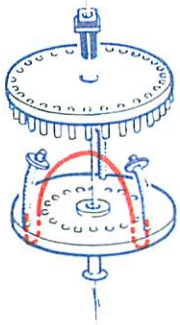
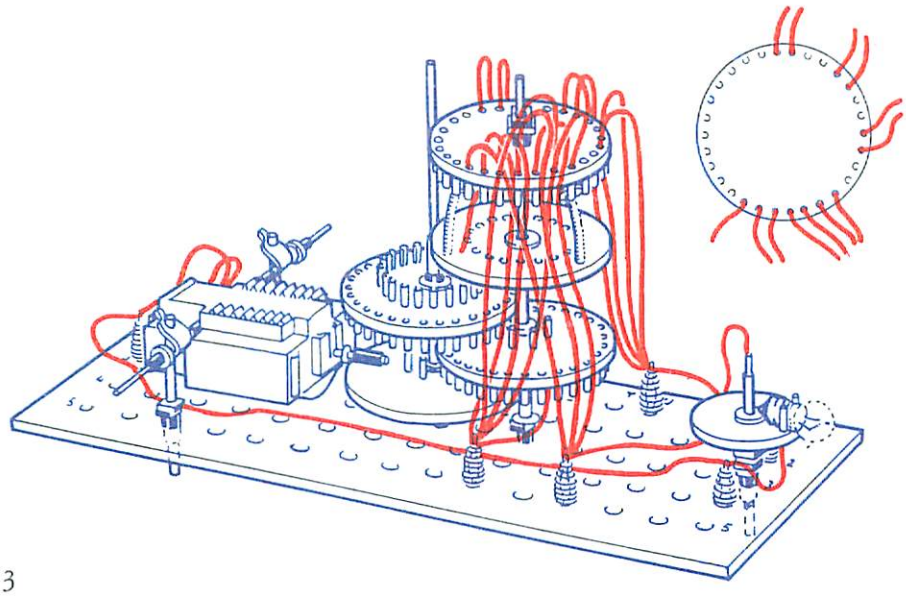


Finally adjust the wheels, if necessary, by moving the spindles so that the teeth interlock firmly and thee wheels turn freely with each other.

3. Push a pin onto the motor spindle with a 3 x 12 bush over it. (flange turned towards the motor). Push a piece of 3 mm sleeving over this bush. Insert a 3 x 48 spindle through the motor with a pieces of 3 mm sleeving on both sides. Put the entire assembly in position as indicated.

4. First make the switch stator consisting of a large wheel with 30 pins on the underside in G. (slots facing outwards). On the upper side of the wheel push a piece of 120 mm flex into holes G1 (red), G4 (grey), G5 (grey), G6 (green), G7 green), G8 (grey), G9 (grey), G22 (black), G23 (black), G26 (red), G27 (red) and G30 (red).
Place the stator on spindle S3 with the wiring upwards. The hole G14 goes beside the spindle in Q3. The contact springs of the rotor run along the inner side of the stator pins. Now see Fig. 2. Connect the grey wires kith S5, the green wires with U5, the black wires with S1 and the red wires with U1.
Connect U5 with X2 (120 mm green flex). Connect S1 with X4 (120 mm black flex), and S5 with X4 (120 mm grey).
Connect U1 with X2 (60 mm red flex). Next connect J3 and X4. J3 is similarly connected to the top terminal of the motor. The bottom terminal goes to J1. Finally make a lamp holder (see page 17, Fig. D). Put this in the 3 x 48 spindle in X3. A pin goes into this spindle. Connect this pin with X2. Connect the other contact of the lamp holder with U1. Fit a battery at J1 and J3.



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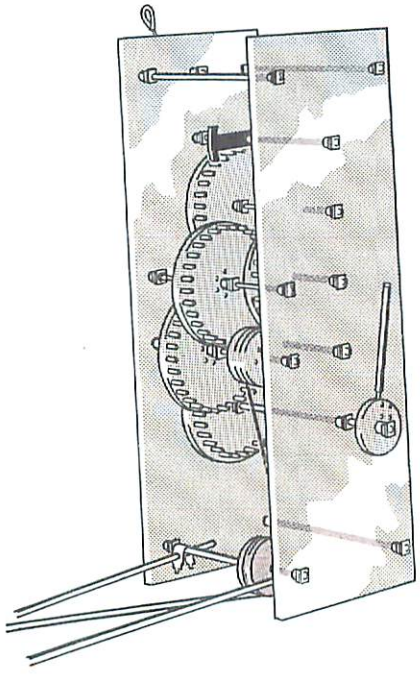
E2 - TABLE CLOCK



This is the simplest of the clock which we describe. It has only one hand like all clocks made before 1700, possibly thanks to the times being less hurried then. For clarity's sake the pendulum has been drawn longer than in reality. This clock is activated by means of a weight, but can nevertheless be placed on a table, a mantlepiece or chest. Remember that the making of clocks is very exacting work and that the gear wheels have to be aligned most carefully, while also the adjustment of the escapement will take some time.

Order of assembly

1. The mounting plate.
2. The escapement.
3. The gear wheels.
4. The pendulum.
5. The hand.
6. The pendulum fork.

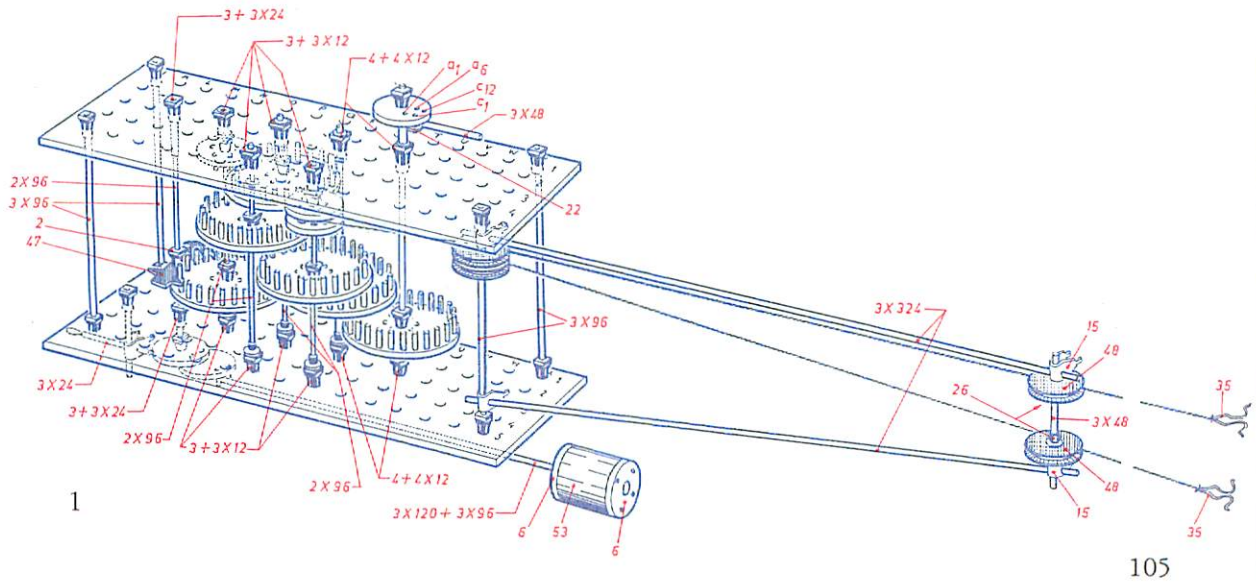
1. In the front plate place a 3 x 24 spindle in L3 (position 1), a 4 x 12 bush in R3 and T3, a 3 x 12 bush in N3, P3, P5 and R5. In the backplate a 3 x 24 spindle in L3, position 2, a 4 x 12 bush in R3 and T3, a 3 x 12 bush in N3, P3, P5 and R5. Furthermore 3 x 96 spindles in J1, J5, X1 and X5. These should fully extend above the plate. Put the back plate down and continue by mounting the parts on it.

2. Put the escapement (47) on a 2 x 9 spindle (position 4). At both ends push piece of 2 mm sleeving and a 2 mm washe and then place the spindle in L3, such tha the part of the spindle underneath the coll extends about 12 mm behind the bush.

3. In a large wheel at the top place 30 pi in circle G and place this wheel on a 2 x spindle (position 6). On the same spindle position 2 fix a small wheel with six p inderneath in circle a. Push 2 mm wash on both ends of this spindle and insert with the large wheel down in N3. Next the top side of a large wheel once m 30 pins in circle G and six pins underne in corcle A. Put it at position 4 of a 2 x spindle. At both ends place a piece of 2 sleeving and next a 2 mm washer. This put with the long end of the spindle in bush in P3. In another large wheel pla the topside 27 pins in circle F and m the wheel at position 9 of a 3 x 120 spi At the wheel end of the spindle push a washer and this side to be inserted in the mounting plate. On the other end of 3 mm sleeving and a 3 mm washer. put 30 pins at the topside of a large in circle G and at the reverse side nin in circle B. Fix this wheel at position 3 x 96 spindle and fit both ends spindle with a piece of 3 mm sleevir a 3 mm washer. Fix this spindle with

pins pointing upwards in R3.
Place a 2 x 96 spindle with a gear wheel with 30 pins at the topside in circle G and six pins underneath in circle A on position 5. At position 2 comes a cable drum, which is a double wheel made of two small wheels with the reverse sides facing, with nine pins in circle b, each pin with a short length of rubber hose. At the side of the gear wheel push a piece of 2 mm sleeving and a 2 mm washer over the spindle. The other side only carries a 2 mm washer.
The end with the sleeving is inserted in R5. Finally in a large wheel we insert 30 pins at the topside in circle G and six pins underneath in circle A. This wheel is fixed on a 2 x 96 spindle at position 4. At both ends of the spindle push a piece of sleeving and a washer and then place the spindle in P5 with the 30 pins pointing upward. Next on the spindle in X5 push a push a piece of 3 mm sleeving, a 3 mm washer, two pulleys and another 3 mm washer. We are now ready to fix the front plate with collets on the spindles passing through J1, J5, X1 and X5. Check whether all the gear wheels engage properly. If not, shift the pieces of sleeving on the various spindles. Join two small wheels with the undersides facing to an 8-shaped object by means of pins in c7 and c8. In one of the wheels insert two more pins from above in c1 and c2 with the slots so facing one another that a 3 x 120 spindle can pass through it without two much play. The other wheel is fixed to the spindle carrying the escapement with a 2 mm collet. The pins in the other wheel are now pointing away from the backplate. In J3 insert a 3 x 48 spindle protruding from underneath the plate.

4. Nex we start with making the pendulum. Join a 3 x 96 and a 3 x 120 spindle with a pin. Take 6 cm string and put a few knots in one end, such that these knots stick in the end of the 3 x 120 spindle.
The other end of the string we push through a 3 x 24 spindle and fold it back along the outside of the spindle and push a piece of sleeving over it, so that the string is kept in place. Put a clamping spring over the 3 x 24 spindle. The pendulum weight is made of two small wheels with each three pins underneath in c1, c5 and c9, inserted in the supporting pipe. Clamp this weight in the middle of the long spindle of the pendulum



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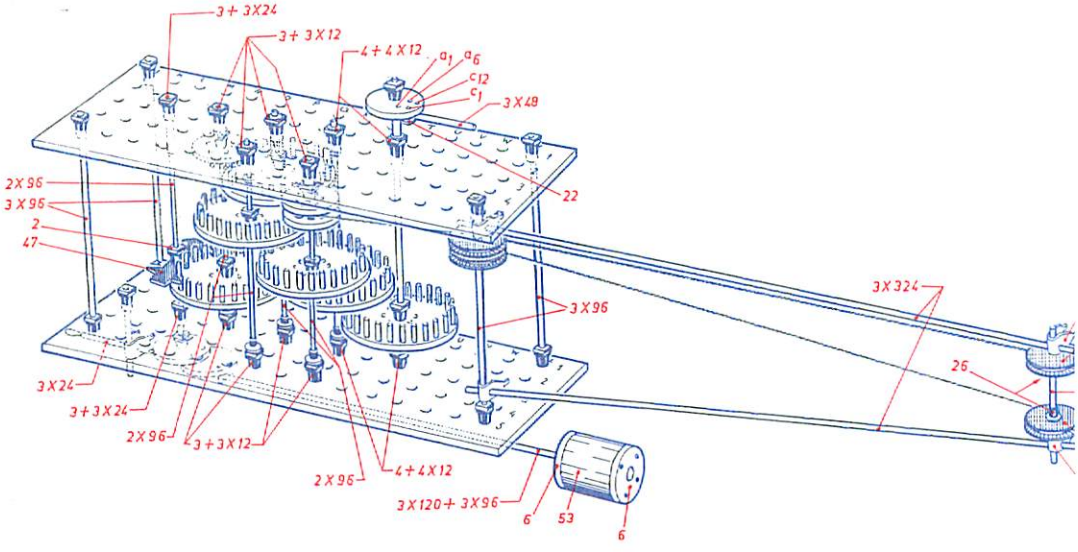
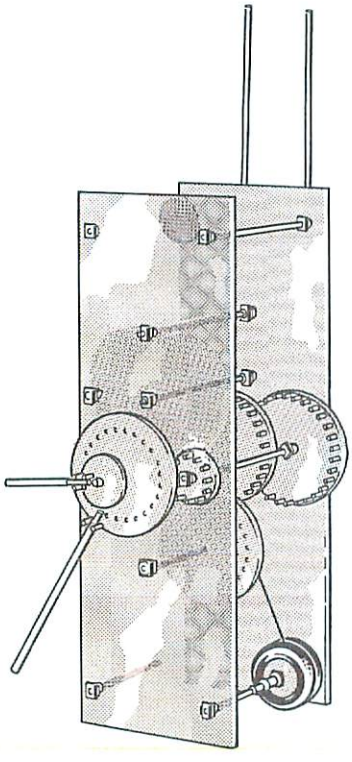
by means of a collet. The clamping spring we push on the 3 x 48 spindle in J3.
Next fix two 3 x 324 spindles on the ends of the spindle in X5 with clamping springs against the inside of the mounting plates. The two pulleys are placed as close as possible to the front plate. See that they can turn freely.
The ends of the 3 x 324 spindles are linked by a 3 x 48 spindle, carrying two pulleys with pieces of 3 mm sleeving and 3 mm washers in-between and 3 mm washers at the outside. The latter touch the clamping springs. Here also the pulleys must be able to run smoothly.
Tie a hairspring to both ends of a piece of string roughly 2 metres long which shoul be fitted as follows: Seen from the front right turn over the cable drum. Next bot ends go each over a pulley on the spindle i X5 and finally over a pulley at the end th earm. A bottle filled with some sand, bring the total weight up to about 25 grams, is attached to one of the hairp springs and the supporting spring functio as a counterweight.
The weights have to be so attached that t bottle tries to move the cable drum in t same direction as the hands of a clock. Wh the clock is placed on a chimney piece cupboard, the arm must be so placed t the weight hangs free.



E3 - SPRING-WOUND CLOCK



The power to operate this clock is provided not by weights, but by a motor with a spring. The great advantage of this is that the motor takes up much less space than a weight, which, also, needs room to drop. The drawback is, however, that the tension of an ordinary spring becomes less as it is restored to its ordinary length.
As a constant driving force is a basic essential for clocks, all winding-clocks are fitted with a flat spiral spring. As is not provided in the kit, we use a piece of rubber hose or a number of rubber bands, tied together for this purpose.

Order of assembly

1. The mounting plates.
2. The escapement.
3. The gear wheels.
4. The small hand.
5. The large hand.
6. The pendulum fork.
7. The pendulum.
8. The spring.

1. In the front plate mount 4 x 12 bushes in N3, Q3 and Q5, a 3 x 24 spindle in U3, position 1, and a 3 x 12 bush in Q1, S1 and S3.
In the backplate on which we continu to work, place 4 x 24 bush in Q3, position 2, 4 x 12 bush in N3, J2 and Q5, 3 x 96 spindles in J1, J5, X1 and X5 (position 8), 3 x 48 spindle in V3, position 1, 3 x 12 bush in Q1, S1, S3 and U3.

2. Place the escapement on a 2 x 96 spindle (position 2). On both ends of this spindle a piece of 2 mm sleeving and a 2 mm washer. After this, insert the spindle with the short end in U3 of the back plate. The lug on the escapement should come roughly above the hole U4.
On the spindle in J1 push a 3 mm washer, a pulley, 3 mm washer, pulley, a 3 mm washer and a piece of 3 mm sleeving.
Repeat this for the spindle in X1. Make the winding drum from two small wheels, the rearsides facing, on a 4 x 24 bush. Put a tyre on each wheel and push the spindle of the drum in J5. Secure it by a 3 mm washer, a coil spring, a 3 mm washer and a piece of 3 mm sleeving.

3. In a large wheel insert 30 pins at the topside in circle G and mount it on a 3 x 120 spindle, position 8. Place 3 mm sleeving and 3 mm washers at either end of this

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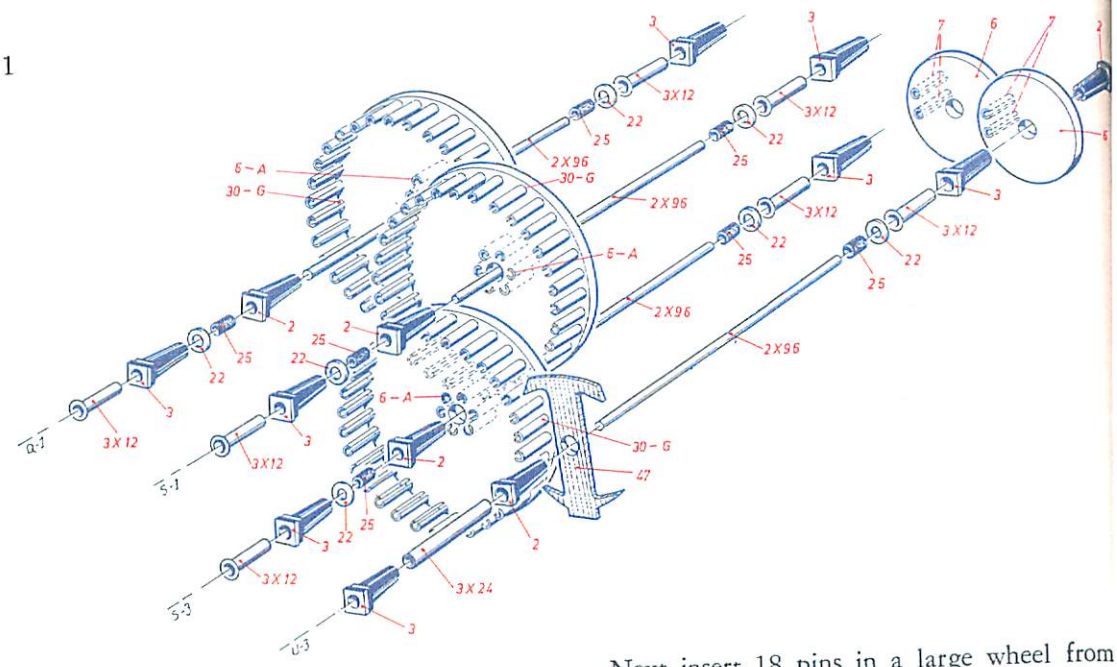


spindle. Place this spindle with the pins in the wheel pointing upward in Q5 and push another coil spring on the free end. In another large wheel insert 30 pins at the top in circle G and five pins underneath in circle A (thus one hole is without pin). Mount this at position 9 of a 3 x 120 spindle. Fit this spindle with 3 mm sleeving and 3 mm washers at both ends and insert it with the pins pointing upward in Q3 of the backplate. The five pins of this wheel should engage the pins of th ewheel previously mounted. The cable drum is made of two small wheels with backs facing each other and pins in a, a long pin in a6, protruding about 10 mm above one wheel.

Insert three pins (7) in b6, b8 and c11 at the topside of the wheel, from which a long pin protrudes. Fit a clamping spring and lock with a 2 mm washer at the end of the long pin in a6 (page 33, fig. I). Fix a 3 x 96 spindle with a collet in the wheel other than that which a clamping spring is fixed to (position 2).

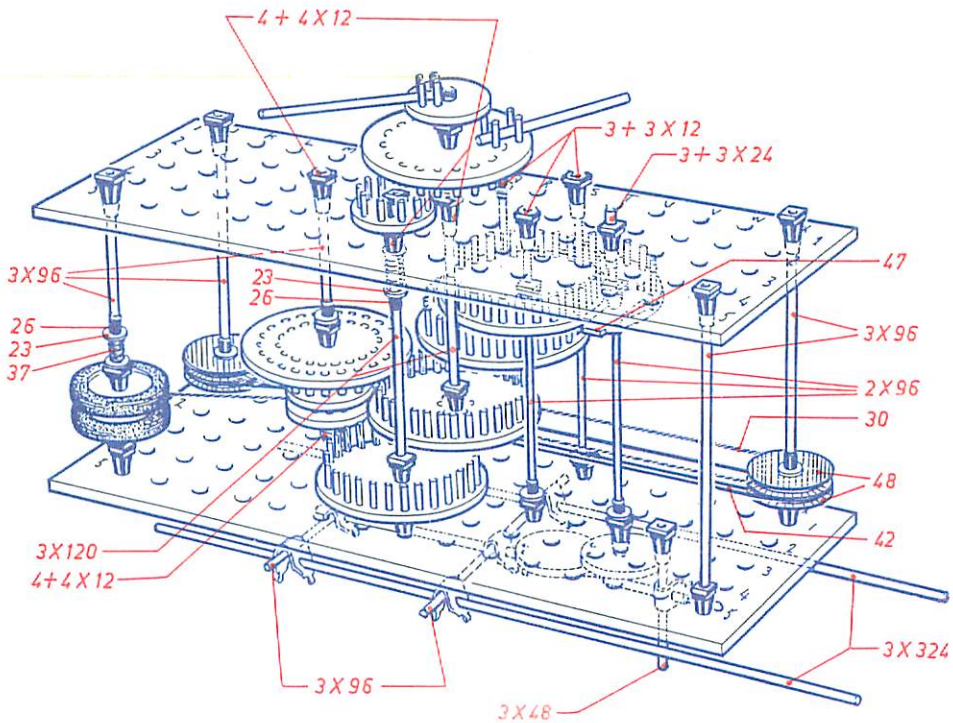
Next insert 18 pins in a large wheel from underneath in circle D and 24 pins also underneath in circle E. In the spindle hole insert a 4 x 12 bush and then push this whee on the spindle of the cable drum. The pin in this wheel should point towards the cabl drum. The ratchet wheel is kept in place b means of a 3 mm washer and 3 mm sleevin Furthermore at both ends of the spindl place a piece of 3 mm sleeving and a 3 m washer. The assembly with the cable dru down is inserted in N3. The ratchet whe meshes with the wheel previously mounte Make another gear wheel from a large whe with 30 pins at the topside in circle G a six pins underneath in circle A. Mount t wheel on a 2 x 96 spindle in position 5. Bo ends of this spindle carry a piece of 2 m sleeving and a 2 mm washer. Insert t wheel with the 30 pins pointing upward Q1. The wheel should mesh with the wh in Q3. Make another wheel like the previ one, fix this on a 2 x 96 spindle at posit 4 and put pieces of 2 mm sleeving and 2 m washers on it as usual. Place this with 30 pins pointing upward in S1. Mesh

with the wheel just mounted. Make another gear wheel like this, fix this at position 3 of a 2 x 96 spindle. Put sleeving and washers on this and insert it in S3, such that the wheel meshes with the one mounted in S1. The escapement must mesh with the pins at the topside of the last mounted wheel. Next fix the front plate wit collets on the spindles in J1, J5, X1 and X5. On the end of the spindle passing through Q5, place a small wheel with 12 pins in c, topside.

4. For the small hand insert 24 pins underneath in a large wheel, circle E and 4 pins at the top in D2, D3, G3 and G4. Pass a 3 x 48 spindle between those four pins with the spindle hole remaining clear and insert a 4 x 24 bush in this hole (position 1).
Push the small hand on the spindle in Q3, such that the pins underneath the wheel mesh with the pins of the wheel en Q5.

5. In a small wheel insert four pins from underneath in a1, a6, c1 and c12. Pass a 3 x 96 spindle between those four pins with the spindle hole remaining clear. Then place the large hand on the spindle in Q3.

6. The pendulum fork is described in model E2 sub 4 and is fixed to the spindle protruding from U3.



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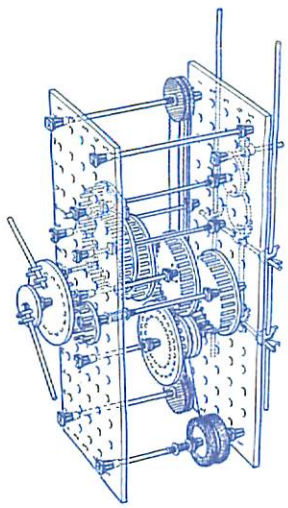
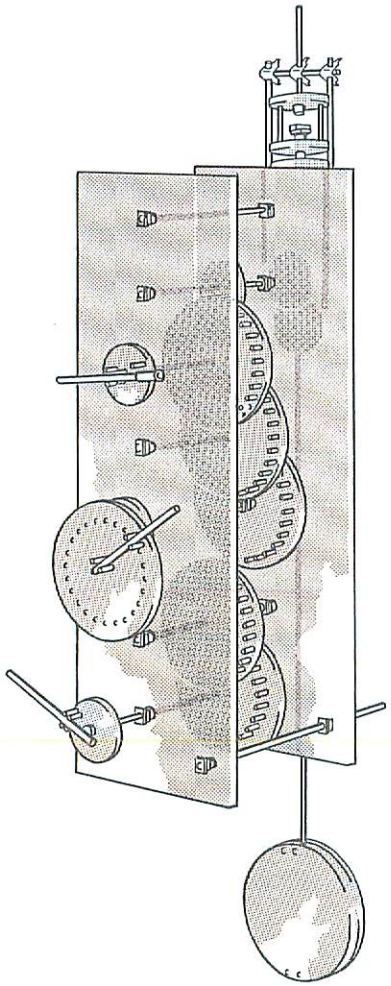
7. With the aid of a piece of string pull a rubber band through a 3 x 120 spindle with the rubber halfway in and halfway out of the spindle. Pull this end through a 3 x 24 spindle, thus connecting the spindles by means of the rubber band, leaving a space of about 2 mm between them. With the 3 x 24 spindle held in the hand, allow the 3 x 120 spindle to swing; observe the direction in which this pendulum tends to slow down most quickly and bear this in mind when fitting the next components, otherwise the pendulum may well develop a wobble when completed. Place one clamping spring in the centre of the 3 x 120 spindle and another one at the end without rubber band. Pass 3 x 96 spindles through these clamping springs and fit each end of those with other clamping springs, through which we pass spindles 3 x 324 (blocking them momentarily with a 4 mm washer). In V3 of the back plate insert a 3 x 48 spindle protruding from behind. Fix, by means of a clamping spring a 3 x 24 spindle to it. The 3 x 120 spindle comes in-between the two pins of the pendulum fork.

8. Tie seven rubber bands together (the next one looped in the previous), tie one end of an approximately 80 cm long piece of string to the last rubber band and tie the other end to one of the holes in the cable drum, which is mounted in the spindle in J5. Turn the string 2.5 times around the cable drum (counter-clockwise). Place the rubber bands onto the four pulleys the following manner. Over front pulley J1, front pulley X1, back pulley J1 and over the back pulley on X1. The end is fixed with a collet which, with a 3 x 12 bush is pushed into hole J2 of the back plate. When now we wind the clock by turning the winding drum and giving a small push to the pendulum, the clock must start to tick. If not, then probably the escapement or one of the gear wheels is out of alignment. If the clock does not keep time properly, the 3 x 324 spindles should be re-adjusted. The clock should tick at a rate of 125 per minute. If it is too fast drop the 3 x 324 spindles sligthly and vice versa. If the pendulum wobbles, re-read what we said about it sub 7.



E4 - WALL CLOCK WITH SECOND HAND



This clock has a fairly simple mechanism, which will not cause many difficulties, but the pendulum is of an entirely different construction to that of the previous models. This clock ticks at a rate of 1 per second, which would require a very long pendulum. By using a pendulum with a counterweight it is possible, however, to reduce the length of the pendulum.

Order of assembly

1. The mounting plate.
2. The escapement.
3. The driving drum with minute hand.
4. The second hand.
5. The hour hand.
6. The pendulum mechanism.

1. In the front plate insert 3 x 12 bushes in P3, R3, T3 and V3, 4 x 12 bushes in K3, M3 and O3. Then continue with the back-plate, in which 3 x 120 spindles are placed in J1, J5 and X3, which should protrude 24 mm underneath the collets. Furthermore, 3 x 12 bushes in P3, R3, T3 and V3 and 4 x 12 bushes in K3 and M3.

2. Put the escapement on a 2 x 96 spindle, position 4. Push sleeving and washers on the ends of spindle and insert the spindle in V3 of the back plate, according to fig. 1.

3. In a large wheel fix 24 pins at the top-side in circle A. Fix this on a 3 x 120 spindle such that the latter extends by 24 mm underneath the collet. Put 3 mm sleeving an a 3 mm washer at both ends of the spindle and place this in bush K3 of the backplate. In a large wheel place 30 pins at the top-side in circle G and 12 pins in C under-neath. Fix this wheel at position 4 on a 3 x 96 spindle at the underside, put a piece of 3 mm sleeving and a 3 mm washer at the underside of the spindle. At the topside of the spindle a piece of 3 mm sleeving, a 3 mm washer, a coil spring an another washer. Insert this spindle in M3. The pins under-neath the wheel should mesh with those of the wheel mounted previously. In another large wheel place 44 pins at the top in circle E and fit it on a 2 x 96 spindle, position 7. On the long end of the shaft push a piece of 2 mm sleeving and a 2 mm washer. Next insert the spindle with the short end in P3

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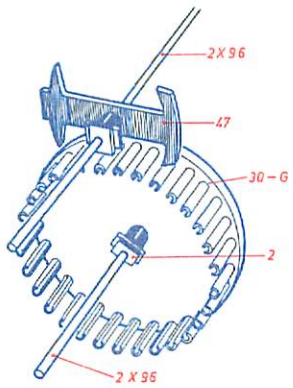

of the back plate. Make another wheel with 30 pins at the topside in G and nine pins in B underneath, which is placed at position 6 of a 2 x 96 spindle. Push 2 mm sleeving and a 2 mm washer on both ends and insert this spindle in R3 of the backplate. The nine teeth should mesh with the 24 teeth of the wheel in P3. Continue with a wheel with 30 pins at the topside in G and six underneath in A. Fit this at position 5 of a 2 x 96 spindle and put sleeving and washers at the ends of the spindle. This spindle is inserted in T3.

4. Out of two small wheels, with the backs facing, make a double wheel with five long pins (8) and one short pin (7) in circle a. The five long pins should protrude by 10 mm at one side. On the parts of the pins in-between the wheels rubber hose should be placed. Fix the wheel èn a 3 x 48 spindle position 4. Spindle pointing in the direction opposite to that the pins. From underneath place this spindle in the bush in 03 of the front plate. At the topside place a 3 mm washer and a piece of 3 mm sleeving. Now carefully fit the front plate and fix it wit collets on the spindles in J1, J5 and X Push the sleeving on the spindle in M3 fo ward over a small distance, so that the co spring comes under tension. On the free en of the spindle in P3, place a small whe with underneath six pins in circle a. Next i a large wheel put 24 pins at the topside i circle E and at the other side pins in G1, G C12 and C1. Place this wheel on the end the spindle in 03, in such a way that th pins engage those of the wheel mounted c the spindle in P3. In-between the four pi at the bottomside place the minute han which we make from three pieces of sti wire turned together.

5. At the underside of a small wheel inse pins in c1, c2, b5 und b6 and fit this whe on the end of the spindle in T3. Betwe the four pins put the second-hand.

6. In the underside of a small wheel p pins in c12, c1, a6 and a1. Fix this on t end of the spindle in K3. Put the hour-ha between the pins.

7. On that part of the escapement spin which extends from behind the backpl put a pendulum fork (see description of t previous two models). Make a diaphrag housing with in the housing two 3 x bushes and connect to the diaphragm a 4 24 bush (see page 15). Mount a coupli on the top of the 4 x 24 bush. Above t comes a 3 x 96 spindle to which a 3 x spindle has been connected with a clampi spring. Mount this assembly on the end the spindle in X3 (see fig. 2). Fix to 3 x 48 spindle two spindles 3 x 96, link at the underside by another 3 x 48 spin At the centre of the latter we fix a 3 x 3 spindle. At the lower end of this fix pendulum weight, which is made from

large wheels with the topsides facing, and pins in G1, G2, G16 and G17. On the 3 x 96 spindle at the top of the coupling we fix a 3 x 324 spindle by means of a pin. A small wheel is fixed to the spindle by means of a collet. This wheel serves to adjust the speed of the pendulum. By pushing it higher up, the pendulum is made to move slower. Finally, take a piece of string of about 1 metre long. Turn this string in the direction of the hands of the clock once around the cable drum and tie a hairspring pin to each end. To the right-hand end (seen from the front) attach a small bottle, if necessary filled with some sand and to the other end the supporting ring as counterweight.

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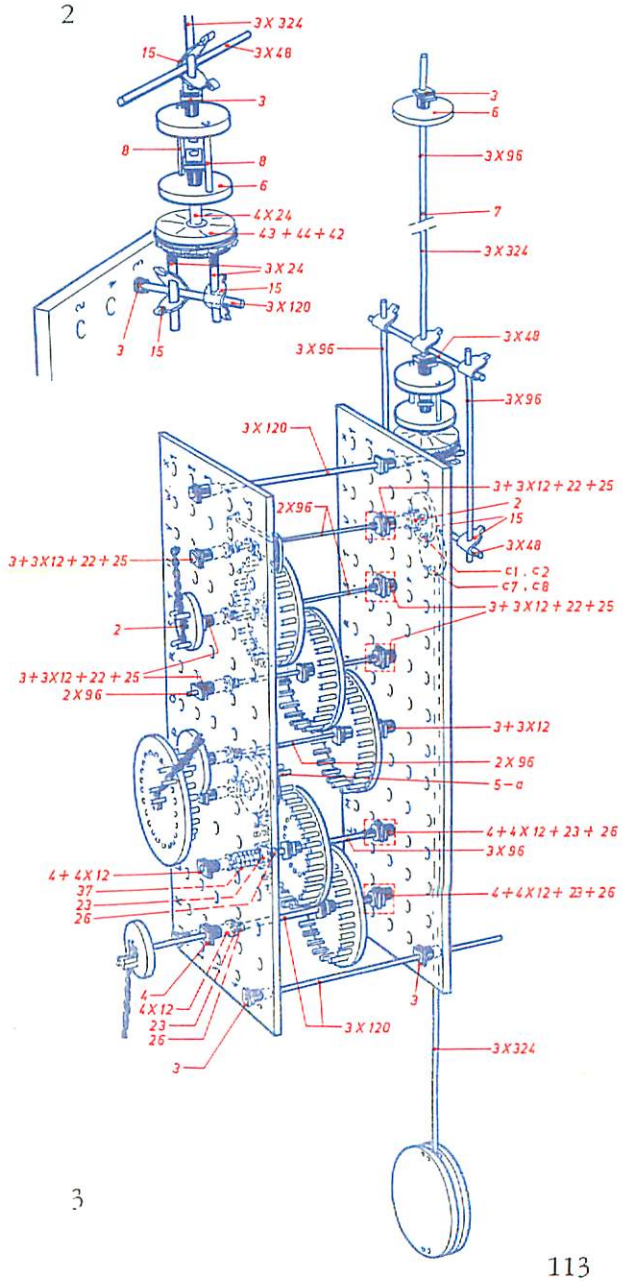

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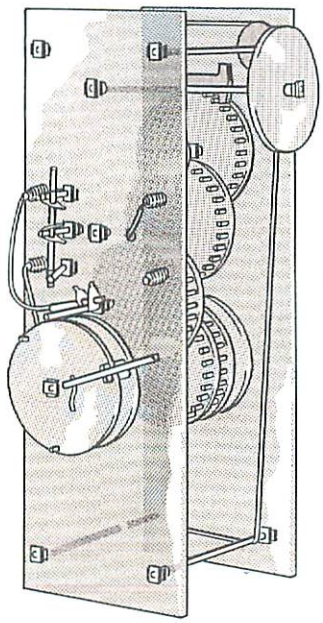
E5 - SWITCHING CLOCK



The switching clock has contacts which, after a certain time, can put electrical equipment into or out of operation. The contacts are mounted at the front of the clock. So they may *never,* repeat *never* be used in connection with equipment working from the mains. They can, however, be used in connecion with models made by means of the Electronic Engineer building kits, which are absolutely safe.

Order of assembly

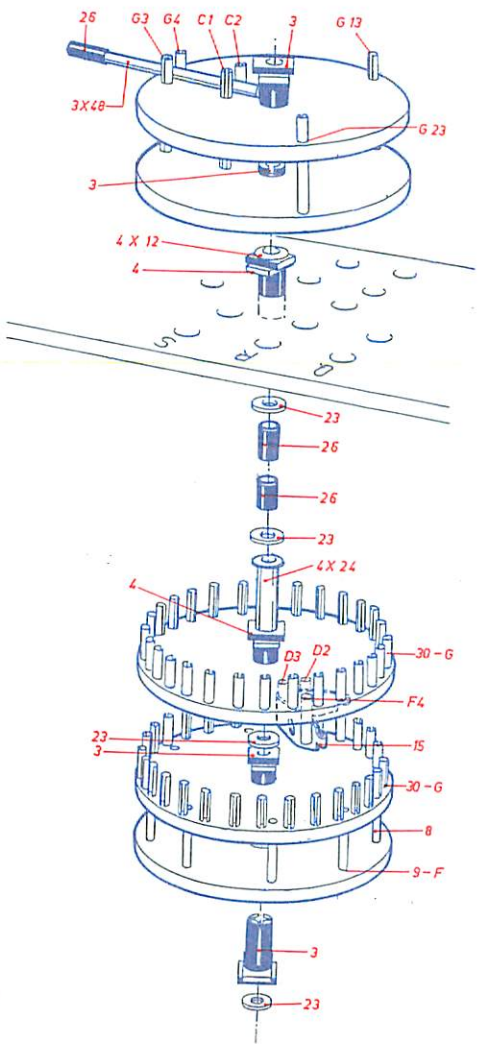
1. The mounting plates.
2. The driving mechanism.
3. The gear wheel transmission.
4. The escapement.
5. The winding mechanism, switch lever and switch.
6. The spring.

1. In the front plate insert in K3 a 3 x 48 spindle, extending by about 3 mm above the head of the collet, bushes 3 x 12 in M3 and 03, a bush 4 x 12 in S3, a spindle 3 x 24 with collet at position 2 in N4, a spindle 3 x 48 with collet as position 2 in O4. Furthermore, hairpin and coil springs with the latter at the topside in N1, M5, P1 and Q5. In Q3 a 3 x 48 spindle, extending by 5 mm underneath the collet. In P4 a 3 x 24 spindle with a pin in one end. The other end is fixed in P4 with a 3 mm collet. Next in the backplate 3 x 96 spindles with collets at position 8 in J1, J5, X 1and X5. Put a 3 x 12 bush in M3, O3 and Q3 and a 4 x 12 bush in S3.

2. Of two large wheels with the rearsides facing make a double wheel with nine long pins, equally divided over circle F. These pins should protrude by 5 mm out of one of the wheels. In the other wheel insert 30 pins in circle G, with the slots pointing outwards. With collets in both wheels the double wheel is fixed on a 3 x 120 spindle. The collets of the wheel from which the long pins extend should be at position 2. Over this end of the spindle push a 3 mm washer and then fix this in S3 of the backplate. On another large wheel put 30 pins with slots pointing towards the spindle hole, in circle G (topside). Furthermore pins in D2, D3, D4, which extend from underneath. Place a clamping spring across these three pins, such that the hooked part of the spring goes around the pin in D3 and the two ends push against the sides of the other pins.
Place this wheel on a 4 x 24 bush, such that between the flange and the head of the collet a space of 12 mm remains. Then mount this with the 30 pins pointing upwards over the 3 x 120 spindle in S3 of the backplate. The clamping spring should then be between the pins of this wheel and as such forms a pawl mechanism. The 4 x 24

bush is kept in its place by pushing a 3 mm washer and a piece of 3 mm sleeving over the 3 x 120 spindle. Next push another piece of 3 mm sleeving and a 3 mm washer onto this spindle.

3. In a large wheel insert 30 pins at the topside in circle G and six pins underneath in circle A. Fit this at position 3 of a 2 x 96 spindle, over which at both ends pieces of 2 mm sleeving and 2 mm washers are pushed. Place this spindle in Q3 of the backplate in such a way that the six pins of circle A mesh with the 30 pins of the wheel in S3. On a 2 x 96 spindle at position 6 we fix a large wheel with 30 pins in circle G at the topside and in-between positions 2 and 3 a small wheel with six pins at the underside in circle a. The pins of the two wheels should be pointing towards each other. Over both ends of the spindle push a piece of 2 mm sleeving and a 2 mm washer and fix the spindle with the side carrying the large wheel in O3 o fthe mounting plate. If everything is right, the pins of the small wheel will mesh with those of the wheel in Q3. Make a similar combination but with the large wheel at position 7 and the small one at position 5. At the side of the large wheel push a 2 mm washer over the spindle, at the other end a piece of 2 mm sleeving and a 2 mm washer. Insert this spindle with the end nearest to the large wheel in M3 of the mounting plate. The pins of the small wheel should again mesh with those of the large wheel fitted in O3. Over the spindle in J1 and J5 we push 3 mm washer, a pulley, another 3 mm washer and finally a piece of 3 mm sleeving. In K3 a 2 x 96 spindle is inserted with the collet a position 8.



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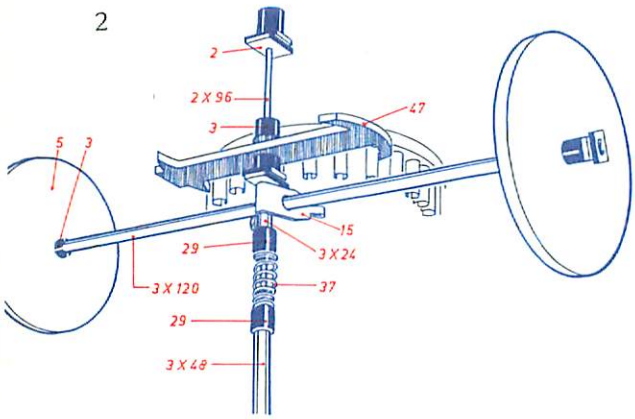
4. On a 3 x 24 spindle the escapement is fixed at position 2. Against the collet a 3 x 120 spindle is fixed with a clamping spring. This spindle should at both ends extend by equal amounts from the clamping spring. On the short free end of the little spindle push a short length of 3 mm sleeving, over which are pushed a few windings of a coil spring. On both ends of the 3 x 120 spindle a large wheel is fitted with a 3 mm collet. This assembly in its entirety we push over the 2 x 96 spindle in K3 with the escapement pointing downard.

2

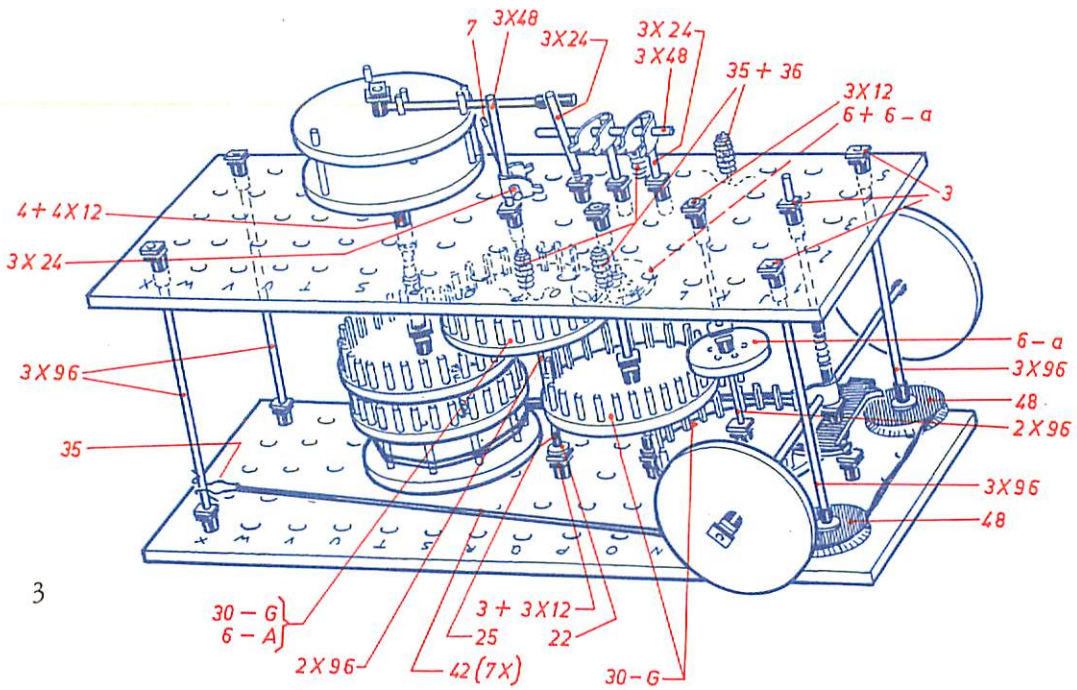


Before fixing the mounting plate, we have to fix a few other components which later on are difficult to get into position.
In the spindle which passes through P4 of the front plate a piece of black flex 60 mm long is pushed in the end carrying the pin. This flex we pull through hole P2 and connect the free end with the terminal in P1. A pin is to be pushed in that part of the spindle that goes through N4, that is in the collet, and in this we also push one end of a 60 mm long pieces of black flex. The other end is led trough hole N2 to the terminal in N1. Push a short length of 3 mm sleeving on the long end of the 3 x 48 spindle in K3. Later on we push a few windings of the coil spring of the balance across this.
Fix the front mounting plate with collets in J1, J5, X1 and X5. The pieces of sleeving which are on the various spindles, are now so adjusted that all spindles are in the correct position and stay there.

5. Of two large wheels with the undersides facing we make a double wheel with long pins in G3, G4, G13, G24, C1 and C2. The pins should extend about 5 mm above the wheel. In-between the pins in G3, G4, C1 and C2 a 3 x 48 spindle is inserted with at the free end a piece of 3 mm sleeving about 1 cm long. From underneath a piece of red flex 120 mm long is pushed through the double wheel, which at the underside is pushed in the pin in C2. Over the spindle end that extends from the bush in S3 a 3 mm washer is pushed and next a collet with the head against this washer. Next the double wheel, which is clamped on the collet, and finally, on the same spindle we fix a collet in the top wheel. The other end of the red flex is connected to the terminal in O5. Seen from the front the lever should now be on the left-hand side of the spindle in Q3.
On this spindle we mount a 3 x 24 spindle with a pin in one end fixed with a clamping spring. The pin must point to the left and in it we fix 60 mm long red flex. The other end of this flex is connected to the terminal N5. Next a contact spring is screwed into the spindle in P4 and over this another 3 x 24 spindle. With two clamping springs a 3 x 24 spindle is fixed to the spindles in N4 and O4.

6. Tie six rubber bands together and fix the last one to the pin at the far right of the winding drum (seen from the front). Put this rubber band half a turn around this wheel, then over the pulley in J5, next over the pulley in J1 and finally the end is fixed with a hairpin spring to the spindle in X1. When everything is right, the clock, after the lever has been moved over half a turn against the hands of a clock, must turn for about twenty minutes before is switches. If, for instance, we wish a lamp to burn for some time, one of the terminals of the lamp is directly connected to one of the battery terminals. The other battery terminal is connected to P1, the second terminal of the lamp to N1. When now we wind the clock

the lamp will burn until the clock needs rewinding. Then the contact is automatically interrupted. If, on the other hand, we only want to light the lamp after a certain time, the terminalsin M5 and O5 are used. Otherwise the connections are exactly the same.



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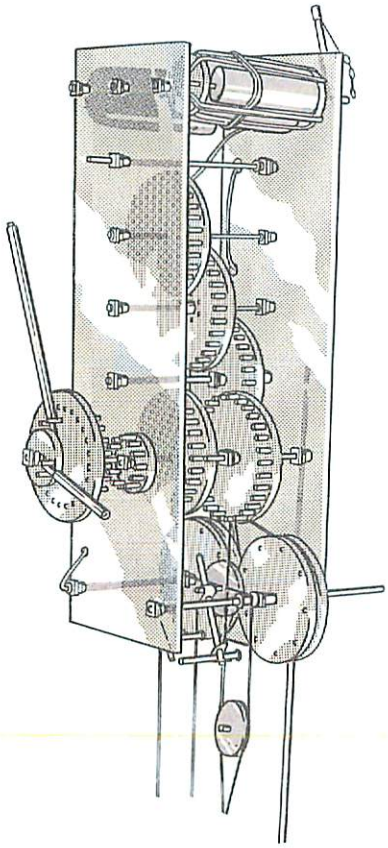
E6 - SELF-WINDING CLOCK



Clocks which hang on the wall and are driven by a weight suspended below it, have been in existence for several hundred years. In this model, when the weight reaches its lowest position, it is raised automatically, so that the clock won't stop.

Order of assembly

1. The mounting plates.
2. The drive spindle with drive wheel and small gear wheel.
3. The gear transmission.
4. The weight raising wheels.
5. The escapement.
6. The motor.
7. Provisional assembly.
8. The hands.
9. The battery holders.
10. Switch levers.
11. The wiring.
12. The pendulum.

1. In the front plate fix a 3 x 24 spindle in L3 (position 2) and a 3 x 48 spindle in U5 (position 1), 4 x 12 bushes in R3, T1, T3 and X5, 3 x 12 bushes in N3 and P3, and 3 x 48 spindles which are only temporarily used during assembly in K1, K5, W1 and W5 (position 4), and 3 x 120 spindles in J3, V5 and X1 (position 1).
In the back plate fix a 4 x 24 bush in X3 (position 2, flange against back of plate), 4 x 12 bushes in R3, T1, T3 and X5, 3 x 12 bushes in L3, N3 and P3. Now lay the front plate in front of you with the topside down and continue as follows:

2. In the topside of a large wheel insert 30 pins in G and underneath six pins in a. Fix the wheel on a 2 x 96 spindle at position 3 and put pieces of 2 mm sleeving and 2 mm washers at both spindle ends. Insert this with the 30 pins pointing towards the mounting plate in N3. Make another wheel like the previous one, but fix it at position 4 of a 2 x 96 spindle.
After putting sleeving and washers on it, insert it with the 30 pins again pointing towards the mounting plate in P3. The pins on the three wheels so far mounted should mesh properly.

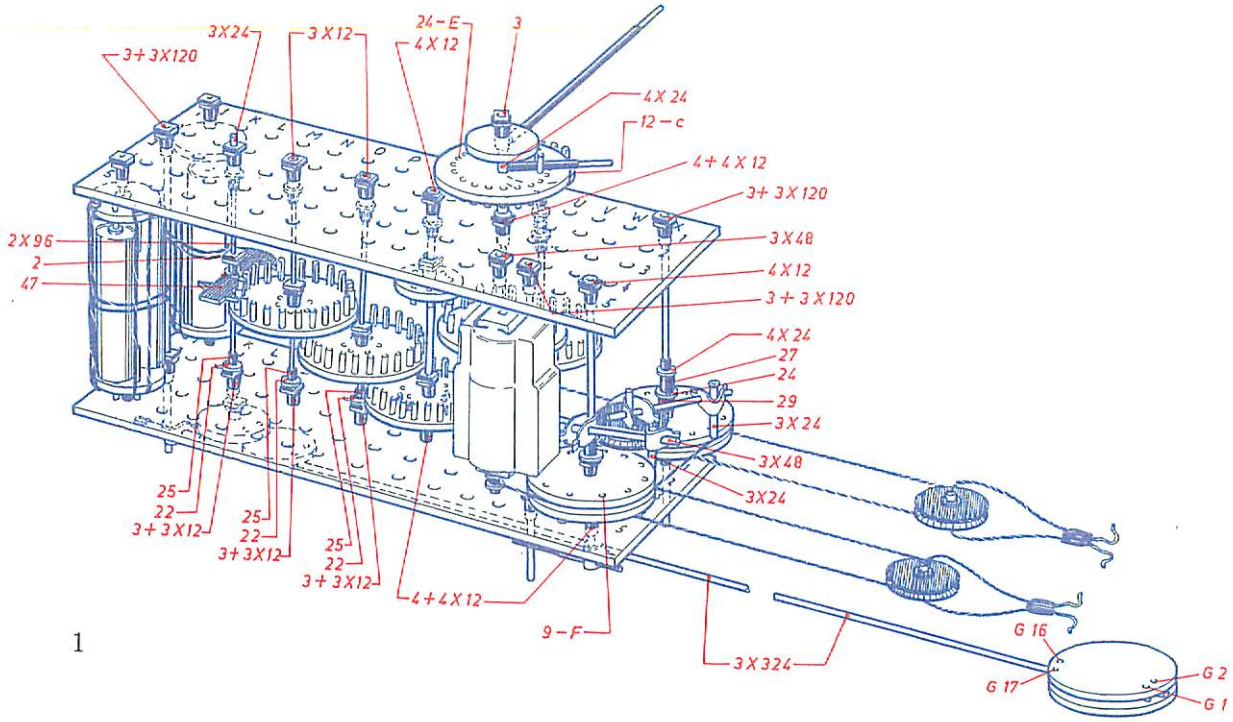
3. In a large wheel insert 30 pins at the topside in G and nine pins with pieces of rubber hose (29) underneath in B. On these nine pins fix a small wheel (rearsides facing). Fix a 3 x 96 spindle with a collet at position 5 in the large wheel. At position 2 a small wheel with nine pins underneath in b. At the side of the small wheel push a 3 mm washer over the spindle and insert this side of the spindle in R3 of the front plate. At the other end of the spindle push a piece of 3 mm sleeving and a 3 mm washer.

Continue by putting 27 pins at the topside in F and 5 (five) underneath in A of a large wheel. Mount this at position 6 of a 3 x 120 spindle. Push pieces of 3 mm sleeving and 3 mm washers on both ends and insert it in T3 with the 30 pins pointing downward. To this purpose it will be necessary to lift the spindle in R3 slightly. The 30 pins should mesh with the nine pins of the small wheel on the drive spindle.

In a large wheel insert 30 pins at the top in G and fix it on a 3 x 96 spindle at position 5. At the spindle end at the rearside of the wheel put a piece of 3 mm sleeving and a 3 mm washer. At the other end a 6 mm piece of 3 mm sleeving, a 3 mm washer, a coil spring and another 3 mm washer. Insert this end in T1. The 30 pins should mesh with the si xpins of the wheel fixed previously.

4. For the weight raising wheels make two double wheels with nine pins in F1, F4, F7, F10 etc. The distance between the two wheels should be 2 mm and thus at one side the pins will protrude by 2 mm from the double wheel.

On a 4 x 24 bush push 8 mm of 4 mm sleeving, a 4 mm washer and a piece of rubber hose (29), also 4 mm long. Finally, a bush with the flange against the rubber hose. On this place a double wheel with the collet in



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the wheel from which no pins protrude. Repeat the same for the other weight raising wheel. Put a rubber band around the spindles in V5 and X1, over the spindle in X1 push a piece of 3 mm sleeving and a 3 mm washer and then push a weight raising wheel on this spindle.

5. Fix the escapement at position 2 of a 2 x 96 spindle. Over both ends of the spindle push a piece of 2 mm sleeving and a 2 mm washer and fix the spindle in L3. The lug on the escapement should come roughly above the hole L2.

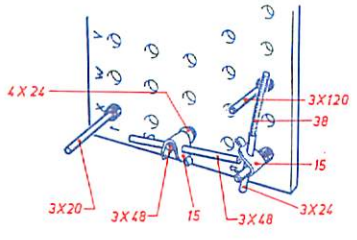
6. Push a pin (7) on the motor spindle and on this a piece of rubber hose and two 3 mm washers. See page 22. The motor is now placed on the spindles in U5 and V5 with the pulley pointing upward. The terminals will be at the T-side. Keep the motor in position by a piece of sleeving on the spindle in V5.

7. In the bush in X5 insert a 3 x 96 spindle with a piece of 3 mm sleeving. Put round this the rubber band which is already around the spindles in X1 and V5. On this spindle place the second weight-raising wheel. Now the backplate can also be fxed by means of collets in J3, V5 and X1. The spindles in K1, K5, W1 and W5 of the front plate can now be removed. Adjust all the gear wheels in such a way that they engage one another properly. The piece of sleeving on the front part of the spindle in T1 must be so adjusted that the coil spring comes under tension. Put a rubber band around the motor pulley and two weight-raising wheels.

8. On the part of the spindle in T1 that protrudes from the mounting plate, place a small wheel with twelve pins at the topside in c.
Small hand: In a large wheel insert 24 pins at the topside in E and two pins underneath in D5 and D6. Fix the wheel at position 2 of a 4 x 24 bush and push a 3 x 48 spindle in-between the pins in D5 and D6. Push this wheel over the spindle at the front in T3. At the very end of this spindle we mount a small wheel with collet 3. This wheel should have pins in c1 and c2 at the top, in-between which a 3 x 96 spindle is inserted (large hand).

9. Make two battery holders, each for three R6 cells, as described on page 18. Place these on 2 x 96 spindles which later on are inserted with a single collet in J1 and J5 of the front plate. Connect the negative terminal of one battery holder with the positive terminal of the other. To the remaining positive terminal connect 210 mm of red flex and to the free negative terminal 210 mm of black flex.

10. Fix a 3 x 48 spindle with a clamping spring on the spindle in X5, in front of the



weight-raising wheel. On the end of this spindle extending beyond the rear plate, fix a 3 x 24 spindle with a contact spring screwed into it. When turning the spindle in X5, the contact spring must touch the spindle in V5. On this 3 x 48 spindle also fix a 3 x 24 bush with a clamping spring. The clamping spring with which the 3 x 48 spindle is fixed to the spindle in X5, and locks the weight-raising wheel in position. Push a 3 x 48 spindle through the bush in X3. At the front and rear parts fix 3 x 48 spindles with clamping springs and a pulley These spindles should point in opposite directions.

On the foremost 3 x 48 spindle fix a 3 x 24 bush with a clamping spring. Fig. 2 shows how the various parts of the switch should be adjusted.

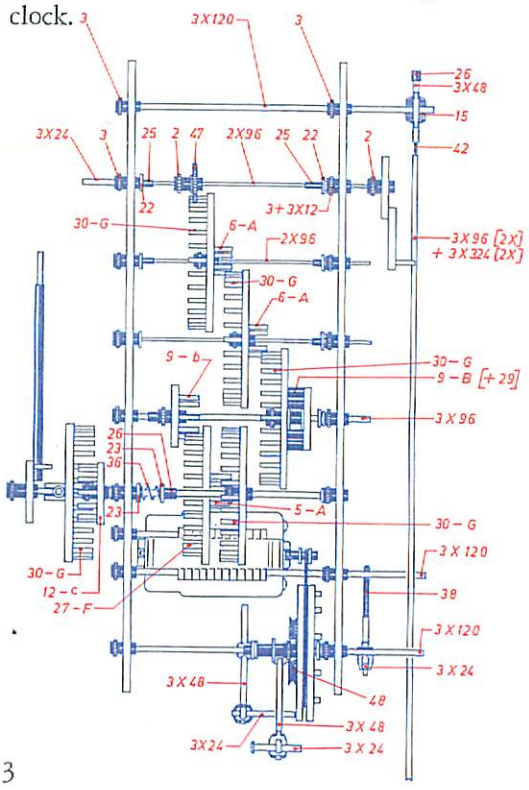
11. The positive terminal of the battery holder combination is connected to the front end of the spindle in V5. The negative lead goes to the motor. The spindle in X5 is connected to the other motor terminal. When now we press the contact spring on X5 against the spindle in V5, the motor should run and the pulley, and with it the two weight-lifting wheels, should turn with the hands of the clock when seen from the front. Should this not be the case, then reverse the motor connections.

12. Make a pendulum fork as in the previous models. Fix this on the spindle in L3 behind the backplate. Now take two 3 x 324 spindles and two 3 x 96 spindles and join these with pins. At the end push a double wheel made out of two large wheels with pins in G1, G2, G16 and G17, the wheels with the topsides facing. With a 3 x 48 spindle make a hinge as in model E2. Fix the 3 x 48 spindle on the one in J3. Hang the clock on the wall with a piece of string tied to the spindle in J3. J3 should be about 20 cm below the fixing point. To conclude take a piece of string about one metre long and two pulleys with hairpin springs (compare model C6).

At the end of the string we temporarily fix some heavy object. The other end first goes over a pulley, then, turning right, over the pins covered with rubber hose of the driving wheel, next across the second pulley, then over the rubber on the bushes of the two weight-raising wheels and finally connect the ends of the string together. On the left-hand pulley hang a bottle or another object weighing about 250 grams. To the right-hand pulley we hang a supporting ring.

The clock has to make 75 ticks each minute. The exact speed can be adjusted by moving the double wheel of the pendulum up or down. Should the pendulum move irregularly, then try and adjust this by turning the 3 x 48 spindle to which the pendulum is suspended.

The position of the escapement is very important for the correct functioning of the clock.



3

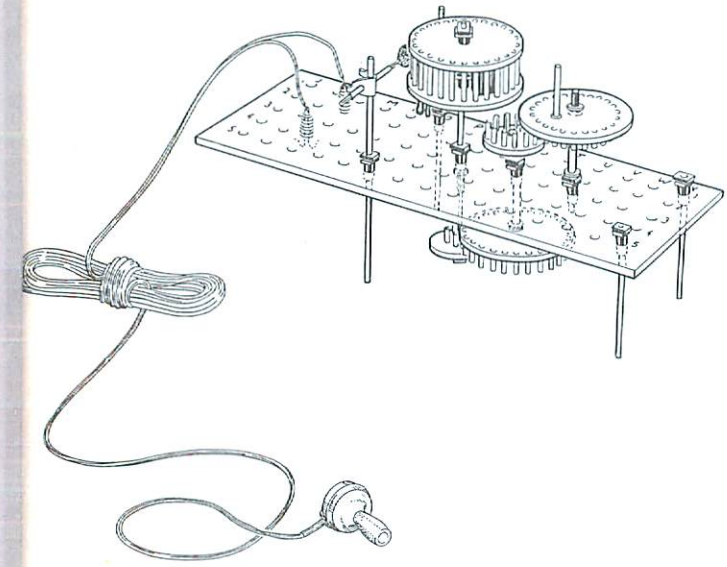
ELECTRONIC-MECHANICAL MODELS

If you are lucky enough to have an EE-kit as well as an ME-kit, you will be able to make even more interesting models. As in full-scale engineering, the combination of the mechanical, electrical and electronic principles opens up a vast range of possibilities.
A small section of this range will be discussed here.
The models described are made of components contained in both the ME- and the EE-kits. On dismantling these models, make certain that the components are returned to their appropriate kits, thereby avoiding making more work for yourself when making further models.
As a number of design details keep recurring, it is useful to describe these first. In many circuits the battery has to be tapped to supply 1.5 V negative with respect to the positive pole.

For the 9 V battery holder described on page 19 this means that the connection D3-D18 is replaced by two leads which come together on a terminal in the circuit. This tapping is taken from the wheel with the three interconnections and is thus situated between the first and the second cells, counted from the positive terminal or between the fifth and the sixth cell, counting from the negative terminal.
Because the battery now has three connections, we must use a double switch and for this the small sliding switch from the EE-kit will do admirably. It is fixed to two 3 mm bushes or spindles by means of two short pins and two 2 mm washers and the bushes or spindles are spaced 30 mm apart on the assembly plate. The leads are best fixed to the tags before the switch is placed in position. For the wiring we use the assembly wire from the EE-kit, except for the leads to be connected to pins for which it is obviously better to use the leads provided in the ME-kit. The potentiometer from the EE-kit can be clamped with the associated washer and nut on two 3 mm spindles inserted 15 mm apart in the mounting plate.
The reasons for not providing assembly sheets of the kind included in the EE-kit in order to show how to wire the circuits in the combined models are two-fold.
Firstly, we assume that anybody tackling such models will have gained sufficient experience not to need them and secondly, assembly sheets would be rather difficult to compile, since the mechanical construction and the electronic wiring are mixed up together.

Moreover, electronic circuits are not necessarily designed for one model only and may very well be suitable for several models, for which the wiring may have to be arranged quite differently. The real object of giving descriptions of models is that it may encourage you to use your talents and work out your own design. With this in view, we have given a few circuits at the end of this section, which are not associated with any particular model. It is up to you to find some uses for them.

MAGNETIC SIREN WITH EARPHONE



The operation of this model is based on the induction principle, i.e. that a voltage is induced in a coil when the magnetic field through this coil varies in strength. Here, part of the field of a permanent magnet passes through a choke from the EE-kit. Pins inserted in a revolving wheel pass between the magnet and the coil.

When a pin arrives between the magnet and the coil, the part of the field passing through the coil will be less, because the field will be attracted by the steel pin. While the shutter wheel rotates the field through the coil varies continuously.

The voltage induced in the coil is at most 0.1 V. As this is insufficient to trigger a loudspeaker, we use an earphone.

The base plate contains: hairpins from below in L2 and L4 with coil spring on then 3 x 96 spindles in O1 and O5, with the collet in place 5, 3 x 48 spindles up. in Q3 and U3, 4 x 24 bush up in S3, 3 x 48 spindles down X1 and X5.

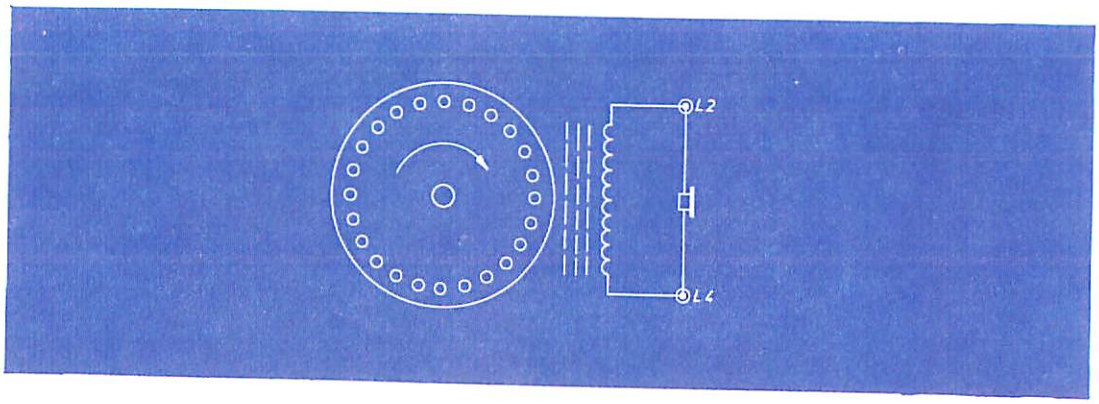
The shutter contains 30 long pins in circle G and a 2 x 96 spindle, with at the other end a small wheel with six pins.

The intermediate shaft consists of a 3 x 48 spindle containing a small wheel with 12 pins and a large wheel with 30 pins.

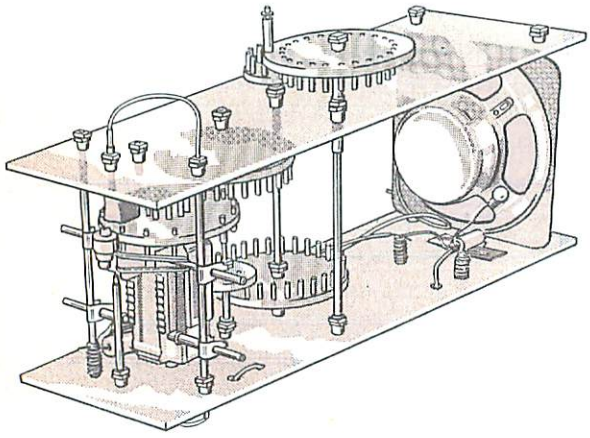
The driving wheel contains 24 pins and moves with a 4 x 24 bush on the fixed spindle in U3.

Immediately below the pins of the shutter a large wheel is fixed. The collet is in place 2 on the spindle in Q3. This wheel carries the magnet which is fixed to it, with its narrow side facing outwards, and with two rubber bands passed double through the holes D2, D3, E2 and E3.

The coil and the magnet should be as close as possible to the pins in the shutter wheel.



MODEL F 2 — MAGNETIC SIREN WITH DYNAMO, AMPLIFIER AND LOUDSPEAKER



The electronic part of this model is very simple. One AC 126 transistor serves as an amplifier and is followed by a loudspeaker. The transistor is driven by a choke which produces the sound.

The fields of the magnets pass through the core of the choke and are varied in strength by the passing pins, inducing voltages in the choke which produce an audible tone. The pitch depends on the speed at which the wheel rotates. This wheel is fixed on the spindle of an electric motor which operates here as a dynamo. The electrical energy delivered by the dynamo is supplied to the amplifier.

The siren is made on a frame consisting of two plates fixed together by four 3 x 96 spindles in J1, J5, W1 and W5. This frame should be very strong, because it is subject to fairly high forces when being used.

The front plate (the plate at the crank end) contains two 4 x 12 bushes in R1 and R3, a 3 x 12 bush in T3 and two 3 x 24 spindles down in W3 and X3.

The back plate contains two 4 x 12 bushes in R1 and R3, a 3 x 12 bush in T3 a 3 x 48 spindle up in X3 and four spring terminals in M1, M3, U5 and X4.

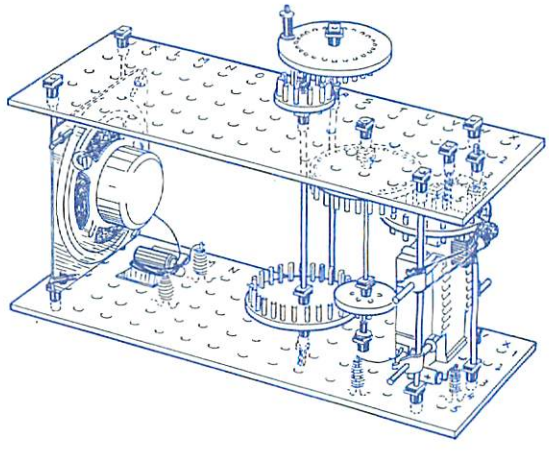
A pin is placed at both ends of the spindle in W1 and on the two spindles in X3.

The motor is supported on two 3 x 96 spindles fixed with clamping springs to the frame spindles in W1 and W5. It is prevented from shifting by two 4 x 12 bushes on the back cross spindle. The motor should be placed as far as possible to the back.

In the bearings in R1 is a 3 x 120 spindle with at the front end a 4 x 12 distance bush and a wheel with 24 pins from below in circle E and a long pin on the top-side in F1. The long pin is provided with a 3 x 12 bush with a piece of sleeving pushed over it and a 2 mm washer.

In the bearings in R3 is a 3 x 120 spindle with a large wheel with 30 pins from the top-side in circle G and at the front a small wheel with 12 pins from the top-side in circle c.

In the bearings in T3 is a 2 x 96 spindle with



a small wheel with six pins from below in circle a and a large wheel with 30 pins from below in circle G.

The shutter wheel on the dynamo spindle contains nine pins on the top-side in circle B and fifteen pins in circle G, the last ones protruding 4 mm at the bottom from the wheel which is fixed to the dynamo spindle by means of a pin and a 3 x 12 bush.

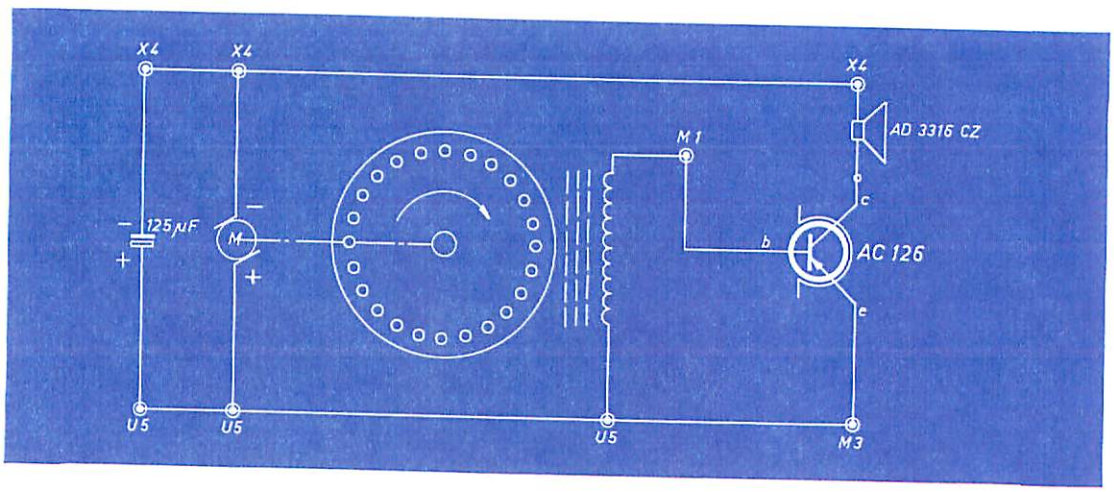
One magnet is placed with a rubber band on the dynamo cover. The second magnet must be placed the other way round, with the north pole facing the south pole of the first one. It is clamped between the spindles in W3 and X3, for which purpose the first one is provided with a piece of rubber hose and the second one with a 3 mm collet. To ensure that the magnet is fixed firmly a flat piece of rubber hose is inserted between this collet and the magnet.

The ends of the two spindles in X3 each contain a pin in which the wires of the choke are inserted (folded double, if necessary). These are bent so as to be as near as possible to the shutter wheel. The transistor (with heatsink) is fixed with a rubber band in the holes K2 and L2 of the back plate.

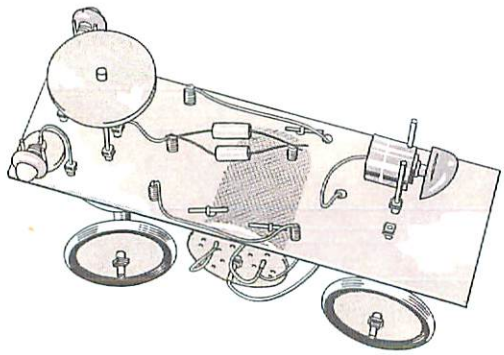
Since the dynamo in this model is to feed the transistor, we must know where the positive and the negative terminals are. As noted on page 21 the polarity applies to one direction of rotation only and this must therefore not be changed while the model is operating.

The polarity is determined by connecting a lamp and diode in series to the dynamo and rotating this. If the lamp lights, the negative pole of the dynamo will be at the end of the diode marked with a dash. If not, the situation will be the reverse. Do not allow the lamp to burn for longer than a few seconds, because the diode is overloaded during this test.

When operating the model, hold it by the front plate and start it up gradually.



MODEL F 3 — STEERABLE CAR WITH ELECTRONIC FLASHING INDICATORS



The electronic circuit switches a lamp on and off periodically at a rate which is adjustable with a potentiometer.

The steering mechanism includes a switch by means of which the left hand light is connected into circuit when the steering wheel is turned to the left; similarly the right hand light is connected when the wheel is turned to the right.

The car is constructed in the same way as model A1 (page 40).

The potentiometer is mounted on a 3 x 48 spindle up in L3 and a 3 x 96 spindle in L4 protruding 48 mm above the fixing collet which is also used to fix the back axle. The electronic switch is mounted on terminals in N2, N4, O1, O3, P2, P4, S2, T1, T3, T5 (see circuit and wiring diagram).

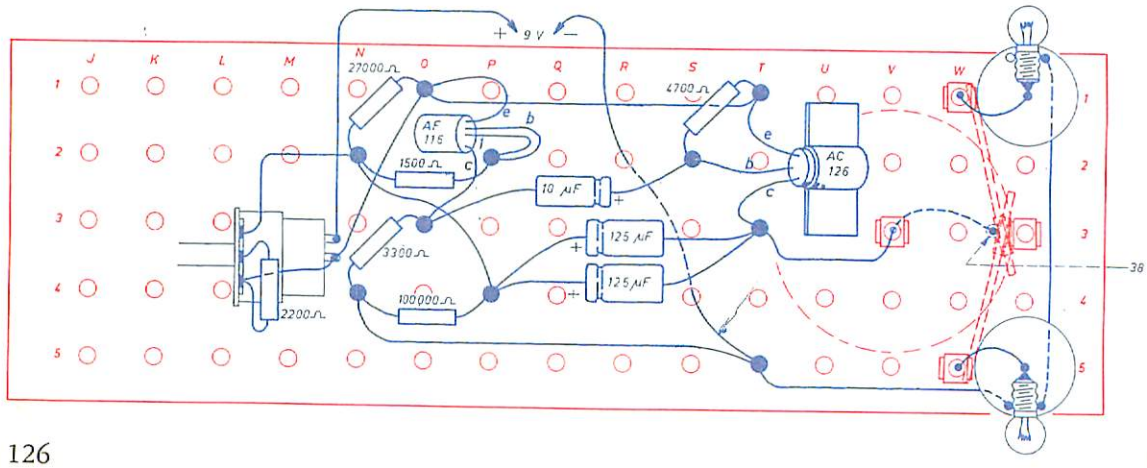
The lamp holders are fixed with 3 x 24 spindles in X1 and X5.

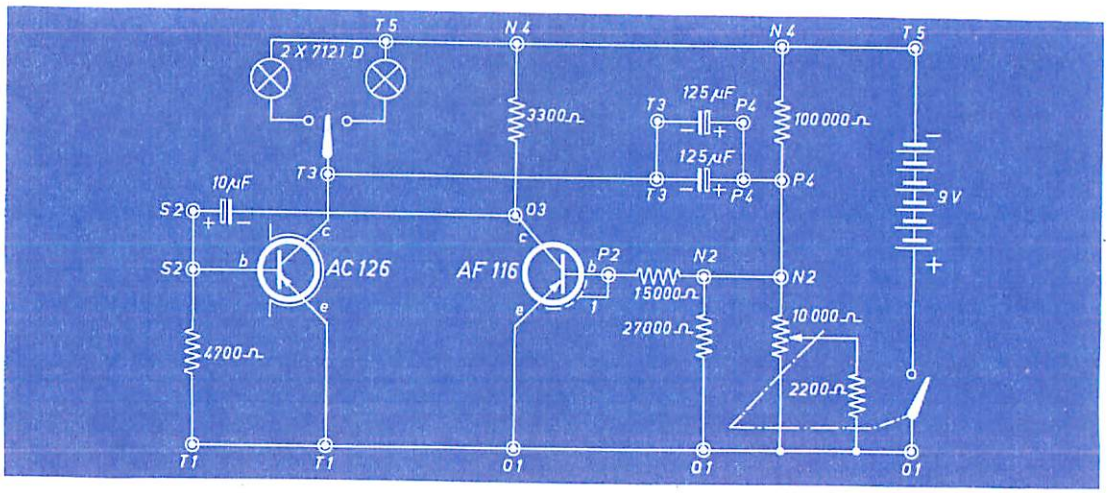
The flasher switch comprises two 3 x 48 spindles and one contact spring. The spindles are fixed with clamping springs to 3 x 24 spindles down in W1 and W5. The contact spring is inserted in hole G23 of the turntable and connected with a lead which passes upwards through the rotary spindle to the terminal in T3.

The lamps are connected by means of pins and 60 mm leads to the spindles in W1 and W5.

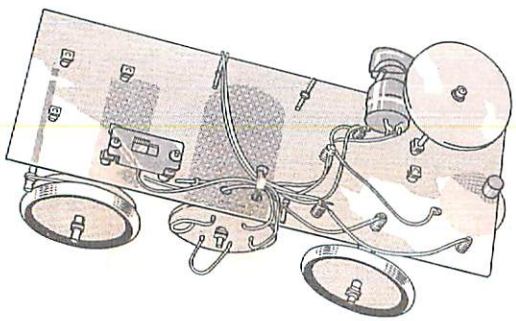
The 3 x 48 spindles are provided at their ends with a piece of sleeving which rests against a 3 x 24 bush down in X3.

The following leads are used: 7 x 60, 2 x 90, 2 x 120, 1 x 210 mm.



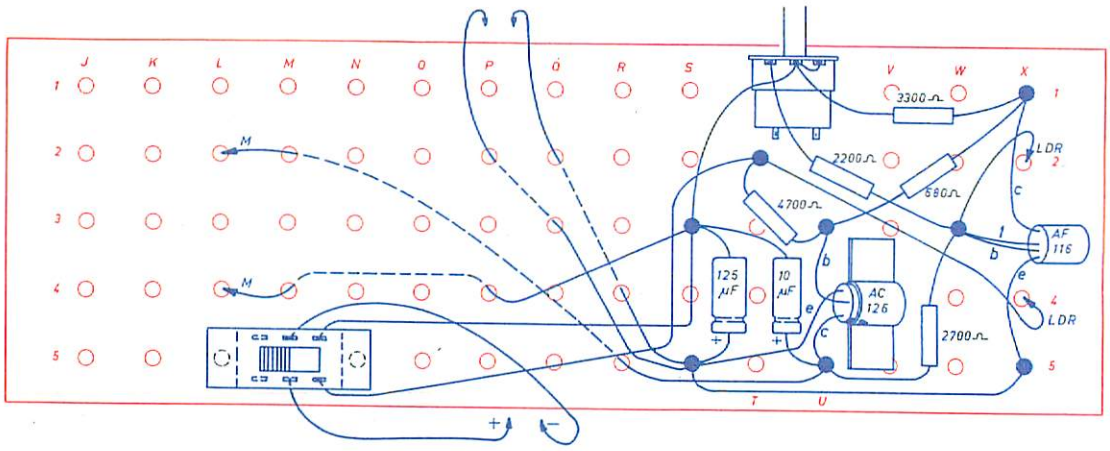


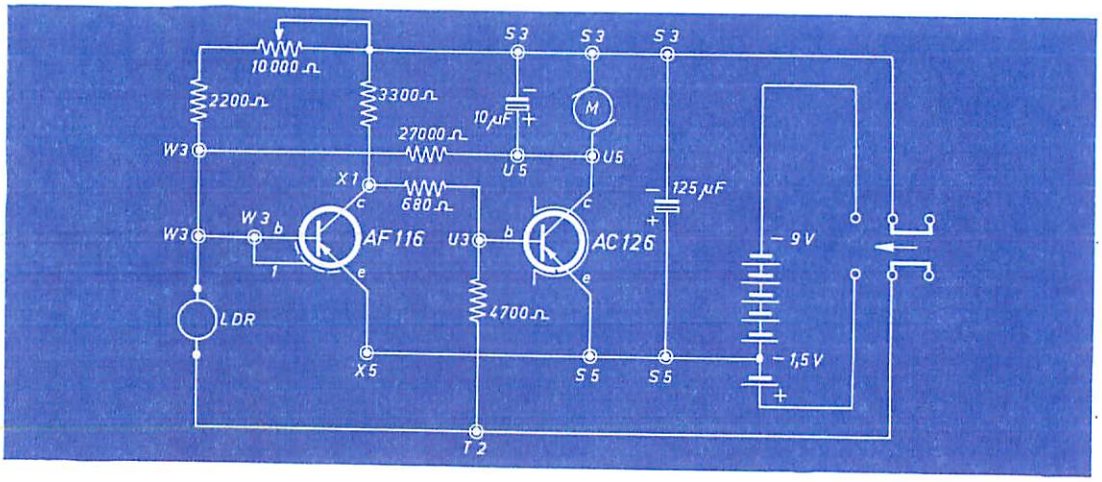
MODEL F 4 — ELECTRIC CAR WHICH STOPS WHEN MOVING ON TO A DARK FLOOR AREA



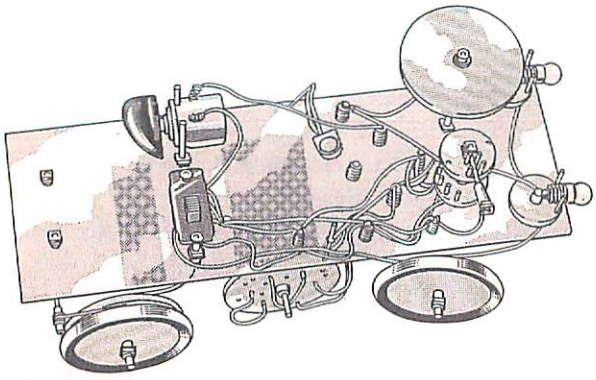
This mechanical-electronic model, the electronic part of which can be made from components in the EE 20 is a very entertaining piece of equipment. At the front under the mounting plate is a screened light-sensitive cell which absorbs only the light reflected by the surface on which the car travels. If the reflected light is sufficiently strong, a current will pass through the motor via the AC 126 transistor and the car will move. If the surface becomes darker, the current to the motor is interrupted. The level at which this happens can be adjusted with the potentiometer. The drive and steering mechanism is made in the same way as for the electric car A4. The 9 V battery holder must be tapped at a point where 1.5 V negative is obtained with respect to the positive terminal. To this end the connection between D3 and D18 is replaced by two 120 mm long leads which come together on a terminal in the hole T4 of the mounting plate.

The light-sensitive cell from the EE-kit is mounted in a diaphragm housing and covered with a piece of cardboard with a hole the size of the cell cut in it. The cell and the cardboard are held by means of a small rubber band. The diaphragm housing is mounted in hole X3 with a 3 x 24 bush. The potentiometer is fixed to two 3 x 48 spindles up in the holes T1 and U1.
The on-off switch (sliding switch from the EE-kit) is mounted on two 3 x 24 bushes up in L5 and N5.
The connections to the battery holder consist of 120 mm long leads.





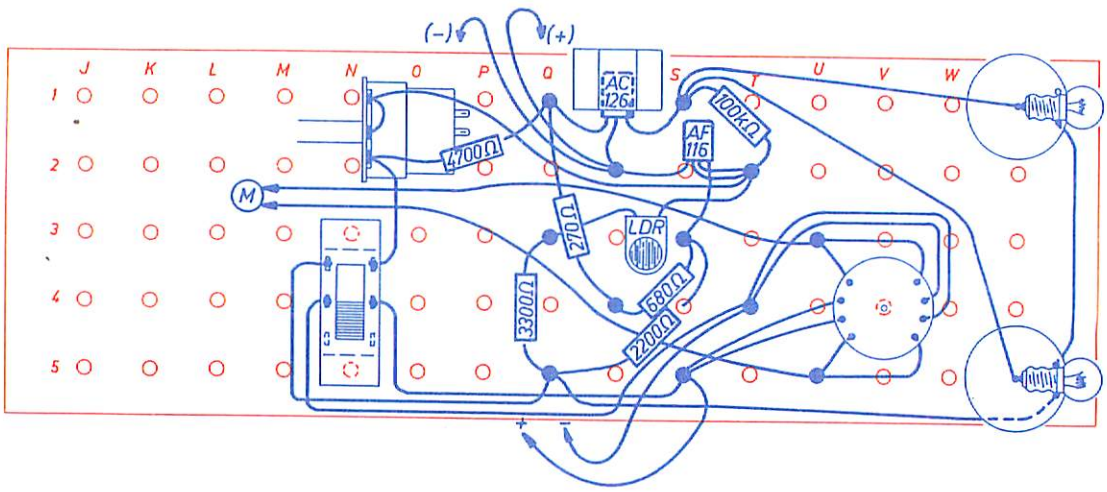
MODEL F 5 — ELECTRIC CAR WITH AUTOMATICALLY LIGHTING HEADLAMPS



The electronic circuit is again mounted on the electric car A4. The light-sensitive cell which is fixed on top of the mounting plate absorbs the light in the surroundings. When this drops below a certain level, as adjustable with the potentiometer, the headlamps come on.

If the light becomes stronger again, they will be switched off. The circuit is very similar to that used in the last model; some modifications had to be made, however, to suit it to the special function it has to perform.

The control switch for the driving motor has been left in its original place; the on-off switch and the potentiometer are therefore



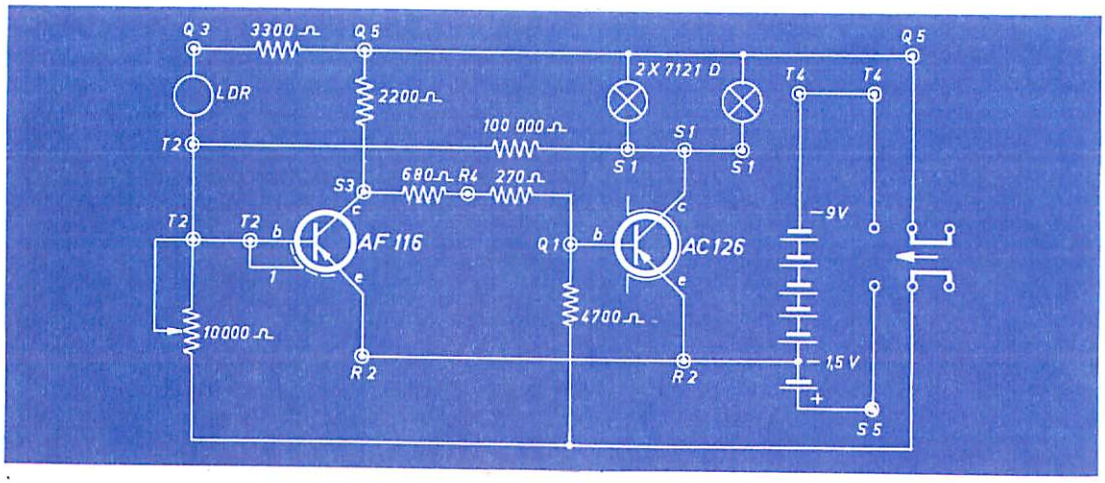
mounted differently than in the previous model.

The switch is fixed on two 3 x 24 bushes up in N3 and N5.

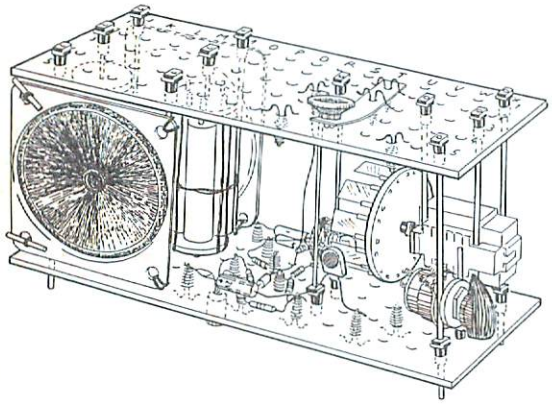
The potentiometer is clamped on two 3 x 48 spindles up in N1 and N2.

The lamp holders are fixed with 3 x 24 spindles up in X1 and X5.

It may happen that the lights flicker when the car passes from a dusky into a darker area. This is caused by light of the head-lamps being absorbed by the cell, either direct or reflected by an object in the vicinity. This may be overcome by screening the lamps and light-sensitive cell with respect to each other by means of cardboard.



MODEL F 6 - LIGHT ACTUATED SIREN WITH TWO LOUDSPEAKERS



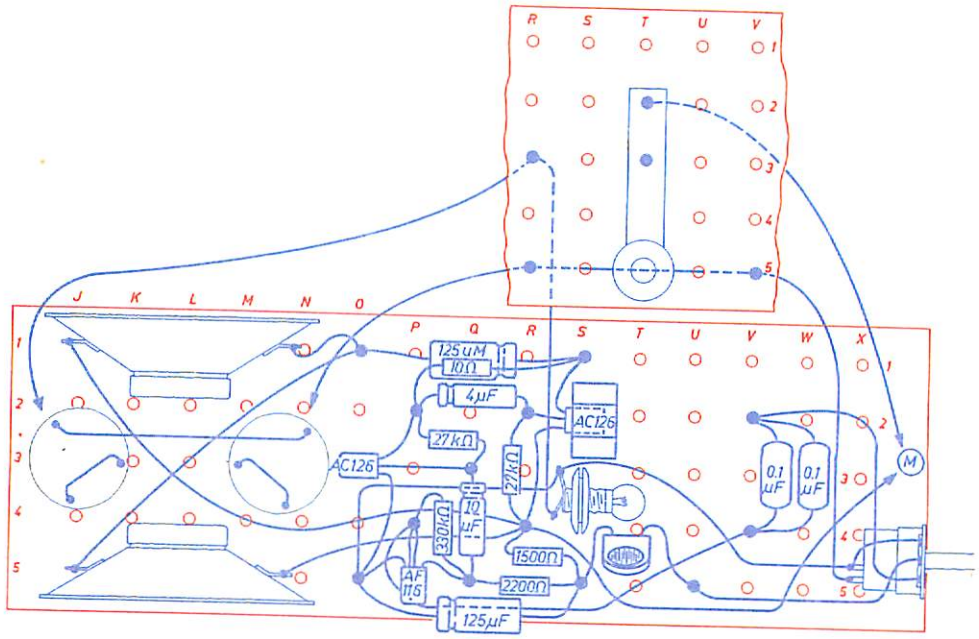
The light of a lamp falls on a light-sensitive cell, causing its resistance to vary. Between the lamp and the cell we pass a number of pieces of cardboard fixed to a wheel on the spindle of the electric motor. The resistance of the cell will now rise and drop so quickly that sound is produced. This is amplified and transmitted through loudspeakers.
The pitch of the sound is determined by the speed at which the motor revolves. The amplifier circuit is similar to that numbered A3 of the EE-20 kit, with some minor modifications.

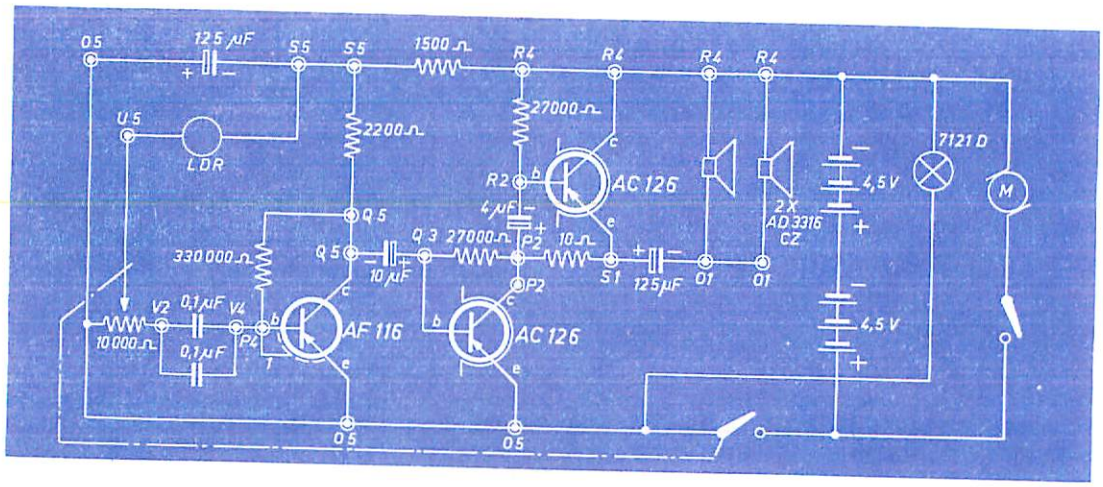
The siren is mounted between two mounting plates spaced apart so as to enable 96 mm long spindles to be just fitted between them. This model should be built in the following order:

1. Fix all the terminals in the bottom mounting plate.
2. Fix the four 3 x 120 spindles in the corners.
3. Mount the amplifier as far as possible.
4. Place all the other spindles in the bottom mounting plate.
5. Mount and connect the potentiometer, motor with wheel, lamp, battery holders, speakers.
6. Prepare the top mounting plate.
7. Fix this on the model.

The 120 mm spindles in the holes J1, J5, X1 and X5 also serve as legs on which the model stands.
3 x 96 spindles in the holes N1, N5, V3 and X3.
2 x 96 spindles in the holes J3, N3, S3 and S4.
One 3 x 48 spindle up in hole X4 in the bottom plate.
The amplifier is mounted on the bottom plate; terminals are inserted from below in the holes O1, O5, P2, P4, Q3, Q5, R2, R4, S1, S5, U5, V2 and V4.
The loudspeakers are fixed to the spindles in J1, N1 and J5, N5, the battery holders (2 x 4.5 V) to the spindles in J3 and N3, the lamp with a rubber grommet between the spindles in S3 and S4, the motor to spindles in V3 and X3 and the potentiometer with a washer and nut to the spindles in X4 and X5.

The push-button by means of which the motor is switched on is fitted on the top mounting plate and is fixed with terminals in T2 and T3 from the top, whereas the bare lead serving as a fixed contact is inserted with terminals in R5 and V5 from the top.
The cardboard screens for interrupting the light are held in place by short or long pins which are placed in pairs, with the slots facing each other, in circle G of a large wheel.
The holes used are G3 and G5, G6 and G8, G9 and G11, etc.

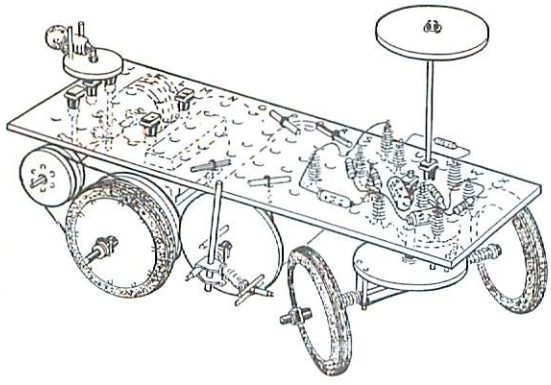




MODEL F 7 — ELECTRONIC STOPPING CAR WITH STOPLIGHT

The many possibilities offered by electronics are once again demonstrated in this model. A car proceeds for a while, then stops with the stoplight burning. After a little while it proceeds again. All this occurs fully automatically.

This model is based on the electric car A4. It is different in that the control switch near the steering wheel is not fitted and the drive is slightly modified. The back wheels which are placed one hole further forward are not driven by two rubber pulleys on the half-shaft as in the original model, but by two

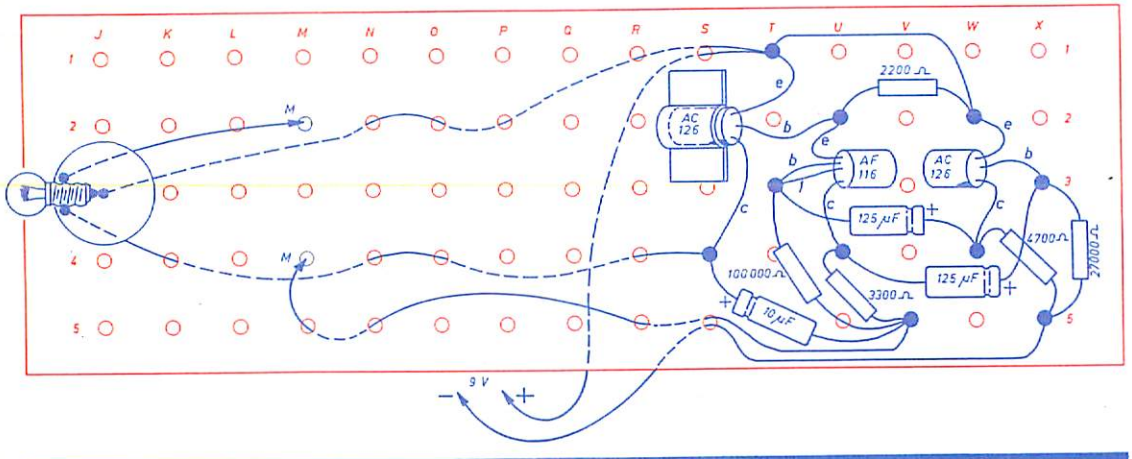


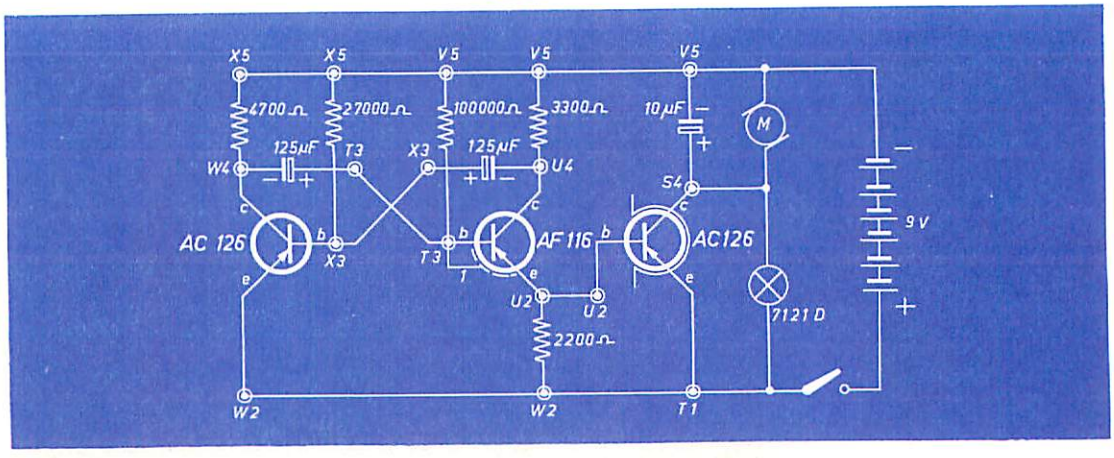
pulleys with six pins in circle a.
This speeds up the car and makes the stopping action more spectacular; to ensure that the car comes to a full stop, the motor has had to be loaded slightly more heavily. If we lift the car up, the wheels will consequently be seen to turn slowly.

The battery holder is provided with an on-off switch of the kind described on page 21. The electronic circuit is mounted on terminals inserted from below in X3, X5, W2, W4, V5, U2, U4, T1, T3 and S4 of the mounting plate.

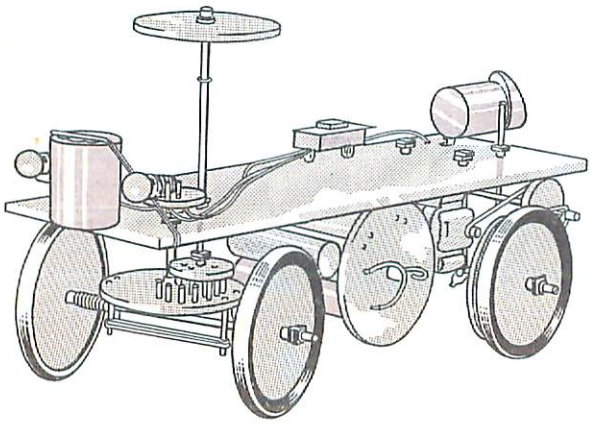
The lampholder is placed with a 3 x 24 spindle in J3, the motor and back axle are fixed on to 3 x 48 spindles inserted down in M2 and M4.

The following leads are used for the wiring: 3 x 120, 1 x 120, 1 x 90 and 6 x 60 mm; the six 60 mm long leads include those used for the interconnections in the battery holder.





MODEL F 8 — ELECTRIC CAR WHICH REDUCES SPEED IN THE DARK AND LIGHTS HEADLAMPS AUTOMATICALLY



This is yet another variation on the electric car A4.

The car goes along normally until it comes to a place where the light is less strong, say, under a piece of furniture. It reduces speed and the headlamps will light up automatically. When the light gets stronger, the car will gather speed and the headlamps go out. The light level at which this change takes place may be varied with the potentiometer. The running mechanism should be put together with special care to ensure that it works lightly.

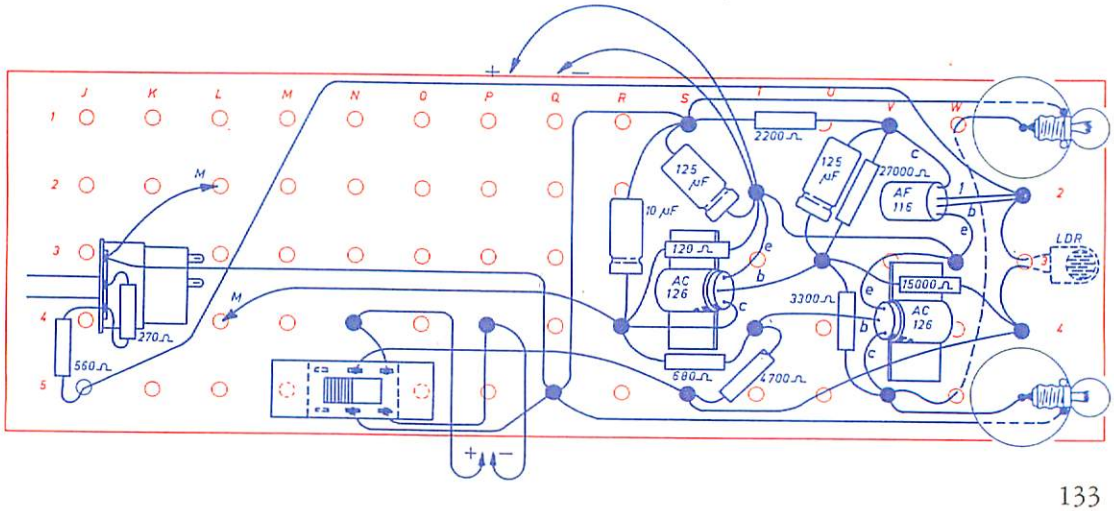
The potentiometer is fixed to a 3 x 24 spindle up in J3 and a 3 x 48 spindle up in J4. The on-off switch is mounted on two 3 x 24 bushes inserted up in M5 and O5. The ordinary control switch is eliminated.

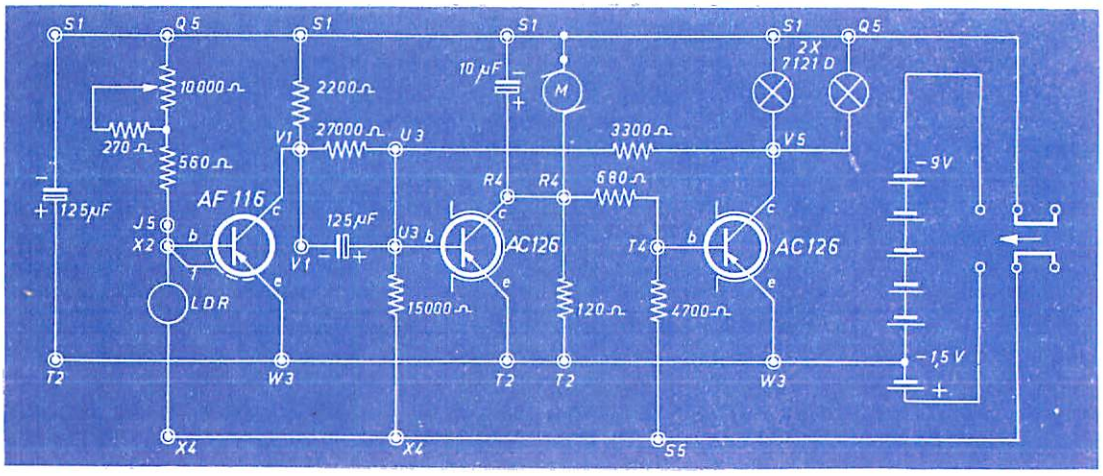
The battery holder is provided with the usual tap.

The lampholders are fixed to two 3 x 24 spindles inserted up in X1 and X5.

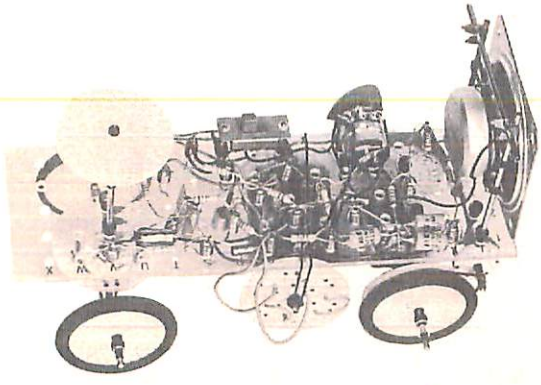
The light-sensitive cell is fixed under the mounting plate with the sensitive end upwards. The leads pass via the hole X3 to the terminals in X2 and X4.

Above the cell the supporting pipe (No. 53) is held in place by means of a rubber band. This prevents the light from the headlamps falling on to the cell, as this would result in the cell no longer being able to "sense the dark" and would render the whole mechanism inoperative.





MODEL F 9 — WHISTLE-CONTROLLED ELECTRIC CAR



This model is the most spectacular model of this series.

A moving car can be stopped by blowing a whistle. After 5 to 7 seconds it continues its moving and can be "ordered" to stop again any time.

The electronic circuit necessary to achieve this can be made entirely of components from the EE 20 kit.

The model consists again of the standard electric car without the control switch near the steering wheel. The on-off switch is mounted on the holes P5 and R5 and the potentiometer on 3 x 48 spindles inserted up in M5 and N5.

Two 3 x 96 spindles inserted up in the holes J1 and J5 support the loudspeaker which is fixed with four rubber bands and serves as a microphone. The top ends of the spindles are joined by means of a third 3 x 96 spindle to make the construction as a whole more rigid.

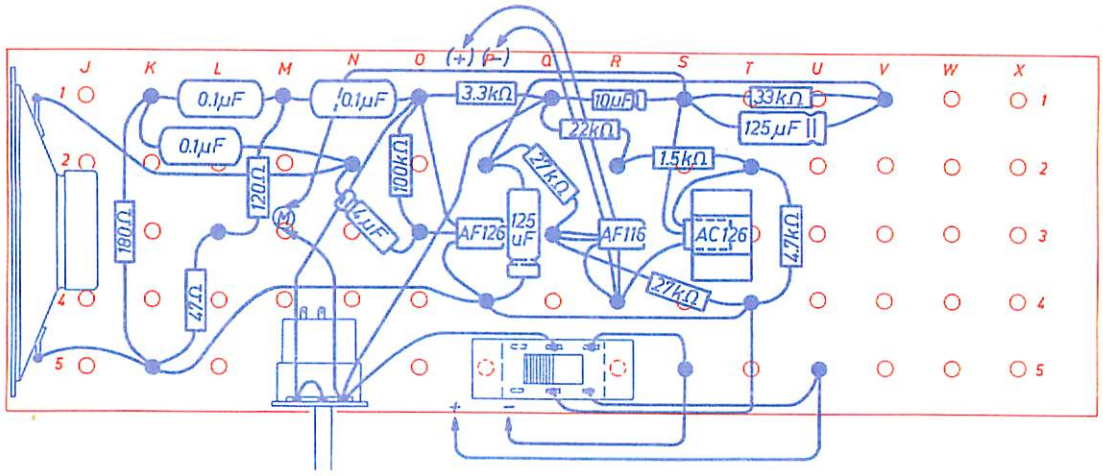
The battery contains the usual tap by means of two leads on pins D3 and D18, connected to terminal R4.

The circuit is designed so as to be sensitive to a sound of a certain pitch and less sensitive to other sounds, with a view to obviating the possibility of the circuit being triggered by ambient noise.

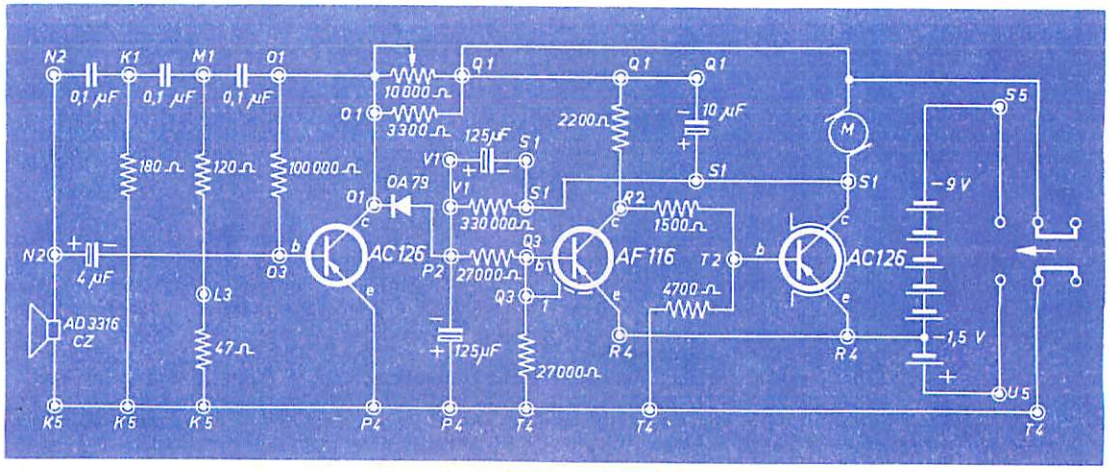
The circuit is most sensitive to sound of a pitch of approx. 2500 cycles per second, which is roughly equivalent to the fourth E flat on the piano.

This is the sound produced by the usual type of cheap whistle.

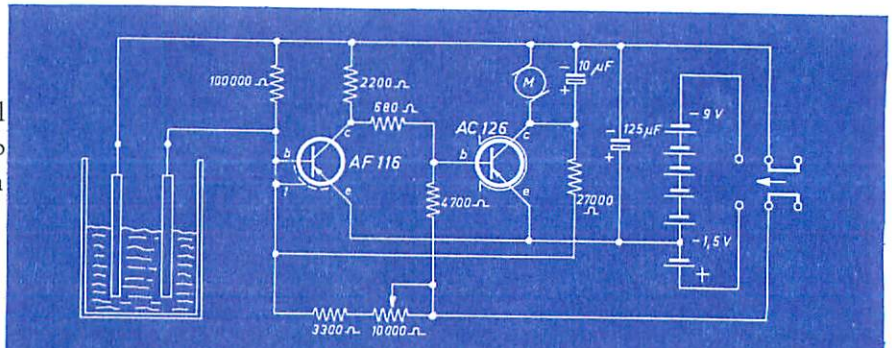
The potentiometer is used to adjust the circuit to the maximum possible sensitivity. If this is too great, the circuit will oscillate;



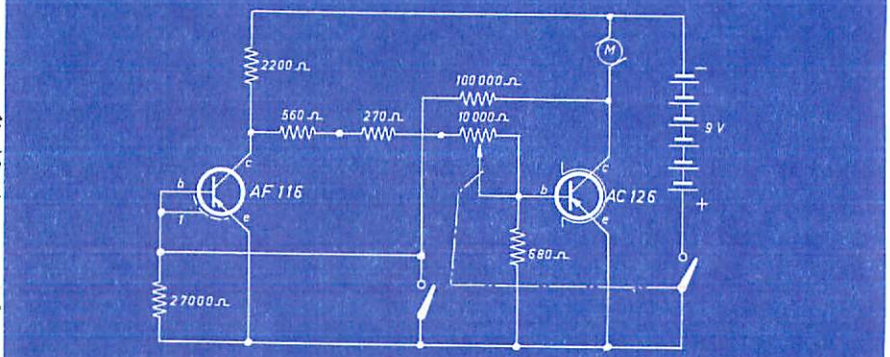
this is characterised by a soft whistling tone from the loudspeaker and by the fact that the model stops permanently. In this case the potentiometer should be turned slowly clockwise until this tone is just no longer heard. After a few seconds the car will start to move; at this point the circuit will be tuned at maximum sensitivity. By turning the potentiometer further clockwise, the sensitivity will become less which means that we shall have to whistle harder and come ever closer to the car to stop it.



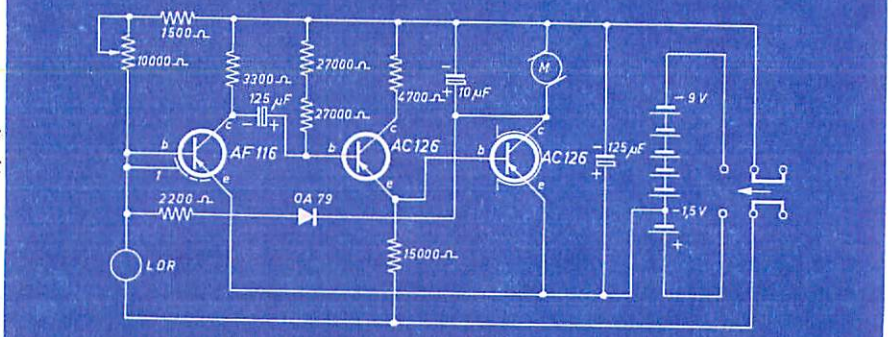
Level control for pump installation



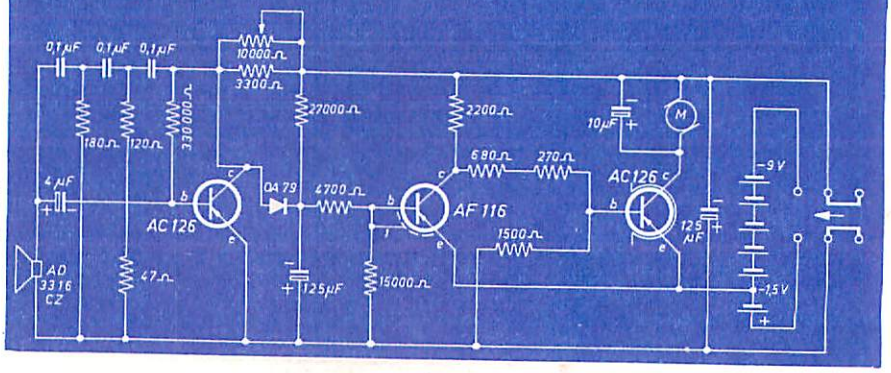
Adjustable maximum-setting switch



Light-sensitive cut-out



Whistle-controlled motor



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