RATIONAL

RECREATIONS.

VOLUME THE THIRD.

CONTAINING

ELECTRICAL AND MAGNETICAL

EXPERIMENTS.

RATIONAL RECREATIONS,

In which the PRINCIPLES of

NUMBERS

AND

NATURAL PHILOSOPHY

Are clearly and copiously elucidated,

BY A SERIES OF

EASY, ENTERTAINING, INTERESTING

EXPERIMENTS.

Among which are

All those commonly performed with the CARDS.

By W. HOOPER, M. D.

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MDCCLXXIV.

DESCRIPTION of the PLATES.

PLATE I. p. 16.

THE electric machine. The two boards *a*, *a*, are equal and parallel: the uppermost has a groove, in which one of the pillars is moveable; the other, *d*, is fixed. The brass arm *c* supports the axis *d* that is fixed in the globe; *f* is the rubber, supported by an axis in the wooden circle *g*; *h* is a steel spring, regulated by a screw *i*; *k* is the prime conductor, consisting of a hollow vessel of polished copper, and receives its electricity by means of pointed wires *m*, and the arched brass rod *l*. The globe is turned by the wheel fixed in the moveable frame *e*. The chain *n* connects the rubber with the floor, when positive electricity is required.

PLATE II. p. 24.

The square figure *b* represents a plated coat of glass. *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, *k*, are several sorts of jars. On the stand, near *c*, are placed on a glaſs the cork-balls, that ſerve as an electrometer. From the end of the conductor, at *l*, hang the bells and knobs of braſs, for the magic dance; *s* is a metal rod for taking ſparks from the conductor.

PLATE III. p. 104.

Fig. 1, repreſents the row of tin-foil for exhibiting the luminous characters.

Fig. 2. The electrical battery, conſiſting of ſixty-four glaſs jars, which are connected by braſs rods, that run through wires in each of them, and the rods are connected by a chain laid over them.

PLATE IV. p. 90.

Fig. 1. The electrometer. A is a light rod that turns on the center of the ſemicircle B, and has at its extremity a cork-ball C; D is the pillar that ſupports the rod.

Fig. 2. The fulmineous conductor: *a* is an oblong pole, *b* a copper veſſel in form of a funnel, *c* a ſlender rod, terminated with a pointed wire; *d* is a wire that deſcends at a foot diſtance from the building, and is carried into the room where the experiments are to be performed.

Fig. 3. The electric branch and table: *a*, *b*, *c*, *d*, is the table, placed againſt the partition X.

The

The branch ABC is joined at A to the prime conductor in the other room; *e* and *f* are two links that come from two chains which communicate with the two ſides of a jar or battery, and are concealed in the table.

Fig. 4. The apparatus for conducting electricity from a kite: *a* is the ſtring of the kite, wound upon the reel *b*; *c* is a copper funnel, from which goes the metal rod *d*, that has a knob; *e* is the ſtaff that ſupports the funnel and reel; *f* is the chain by which the electricity is conducted to the ground.

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The method of making artificial magnets. Fig. 1, the poker rubbed by the tongs. Fig. 2, 3,

 and

and 4, the manner of giving the bars the vertical touch. Fig. 5, the method of giving them the horizontal touch. Fig. 6, the manner of disposing the bars in a case.

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Fig. 2. The magnetic dial. A is a circular border that turns quite free on the stand B; C a dial of pasteboard, that moves in the circular border; I a magnetic needle, which is the index to the dial; P a pin, that shows where the magnetic bar Fig. 3, is placed, under the dial.

Fig. 4. The dial for the magnetic cards, which is to be placed in the circular border of the last figure.

PLATE VIII. p. 148.

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PLATE

PLATE IX. p. 154.

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Fig. 4. The dial to be placed over the box, Fig. 2.

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Fig. 2. The inſide of the ewer, in the middle of which is an inverted tin cone: at H is a mirror.

Fig. 3. A paſteboard circle that is placed at QR in the laſt figure. This circle contains a touched needle, and is divided into four parts, in three of which are heads with different dreſſes.

Fig. 4. Four ſquare pieces of wood, each of which contains a magnet in a different poſition, and in three of them are the ſame figures as on the paſteboard.

Fig. 5. The magician's circles. The circle A has a hand that communicates with a movement in the box. The index of the circle B is a

touched needle : C the croſs piece by which the two circles are connected.

Fig. 6. The movement contained in the boxes under the two circles and the croſs piece between them.

PLATE XI. p. 168.

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Fig. 2, is a box, in which are placed the two caſes Fig. 3 and 4, that have each a magnet at O, and in each of which are placed two flowers; G E O is the ſection of theſe two caſes.

PLATE XII. p. 176.

Fig. 1. A B C D a box that contains ſix different pieces of metal, which have each a magnet in a different poſition.

Fig. 2. The circles that are placed at the end of a perſpective, and have the initials of the different metals.

Fig. 3. The box for the magnetic oracle. A, B, C, the three diviſions of the box: in A and C are eight ſmall rundlets marked with different numbers.

Fig. 4. The magnets to be fixed in eight ſmall tablets,

tablets, that are to be put in the part B of the laſt figure.

Fig. 5. A circle, with a touched needle for an index, which is to be placed on the part B of Fig. 3, over one of the tablets, in which a magnet is concealed,

Fig. 6. A B C D is the box for the magical cards, in the top of which is an opening of the ſize of a card. At the center of this box is a pivot, on which is placed a circle that has two cards painted on it, and a touched needle at its center. Between the two figures of the box is the magnetic wand.

PLATE XIII. p. 180.

Fig. 1. The magnetic planetarium. The central circle has an index A, that communicates with another circle underneath; and round it are wrote ſeven queſtions. Round the ſeven leſſer circles are wrote words that form anſwers to thoſe queſtions; and within theſe circles are drawn the characters of the five planets, with the earth and moon. On the center of each of theſe circles turns a magnetic needle, and the dotted lines in each of them ſhow the poſition of the magnets in ſeven other circles on the bottom of the box.

Fig. 2, ſhows the inſide of the box, and the two indexes at top; by the loweſt is turned the circle, fixed on a pivôt at the bottom of the box; and the other is placed againſt one of the months inſcribed round the circle. O and P are two of the needles to be placed on the ſmall circles.

PLATE

PLATE XIV. p. 192.

Fig 1 and 2. The magnetical table. ABCD, Fig. 1, the bottom of the table: at A, on the top of the table, is a circle, that ſurrounds a baſon, placed over P, where is the machinery, Fig. 3, which conſiſts of a wheel QR, a barrel X, a ſmall toothed wheel T, and the magnetic bar XY. MO is a magnetic bar moveable on a pulley, round which goes a ſtring, that is faſtened at one end to the ſpring N, and goes over another pulley at A. OP, at the part of the table next AB, is a magnetic bar, moveable on a pivot at P. The motion of this bar is regulated by the ſpring R. Round the pulley T goes a ſtring, that paſſes over another pulley at S. AB, near the part AR, is the magnetic roller, which is drawn backward and forward by a ſtring that paſſes over the pullies B and A, and is deſcribed in Pl. XVII. Fig. 5.

Fig. 2. AB, the top of the table, on which is placed the baſon: R, F, G, H, the legs, which are hollow, L, L, the croſs pieces, MN the ſtep: theſe are likewiſe all hollow, and communicate with the other ſide of the partition W.

Fig. 3 and 4, are two other circles to be placed round the baſon on the table.

PLATE XV. p. 189.

The ſcale to be placed againſt the back of the partition W. C is the pulley over which the ſtring

ſtring goes; D the weight; and E F the index. The diviſions of this ſcale correſpond to thoſe on the three circles in the laſt plate, Fig. 1, 4, and 5.

PLATE XVI. p. 204.

The apparatus for the ſagacious ſwan. Fig. 1. YX a hollow pedeſtal, on which is placed the baſon A, and round it are ſix vaſes; B is a hollow egg, placed on a ſtand C, that is alſo hollow; MAO is the magnet and wheel placed in the pedeſtal. The figures *a* ſhow the poſition of the vaſes.

Fig. 2. The machinery for moving the magnet, which is regulated by one of the etwees Y, and the cylinder F, Fig. 3, placed in the egg B and the ſtand C.

PLATE XVII. p. 220.

Fig. 1. The communicative bell. A B a copper box, E the inſide of the box, F the bell, D a magnet, that is placed on a pivot, and ſtrikes the bell.

Fig. 2. The magnetic balance, the ſcales of which are to be placed over the magnetic table at the part where is the magnet MO.

Fig. 3. The movement of the ſympathetic dials. ABCD the wheels and pinions, under which is the barrel A, F the fly, H the plate to which the

movement is fixed, LNM a catch of steel that is touched.

Fig. 4. QR is a case in which each of the dials is to be placed.

Fig. 5. The magnetic roller, in the twelve circles of which are placed magnets in different positions, marked with the letters of the alphabet.

PLATE XVIII. p. 232.

Fig. 1. The magician's box. AB is the base of the box, in the top of which is a hole E, about the size of a card: in this base is placed the circle OP, Fig. 3, that has five cards painted on it; contains a magnet QR, and is moveable on a pivot.

Fig. 2, is the body of the box, which consists of four inclined planes of glass; and in a hole at the top V, is fixed a convex lens. This box is placed on the magnetic table, by which either of the cards on the circle are brought under the hole.

Fig. 4. The mystical dial: this dial is divided into ten equal parts, and at its center is a touched needle, which is regulated by the magnetic table.

Fig. 5. The box for the intelligent fly. At the center of the box is a pivot, on which is placed a touched needle L, that has at one end of it an enamelled fly; over this needle is placed the pasteboard circle ABCD, on which ten letters are wrote.

PLATE

PLATE XIX. p. 238.

Fig. 1. The box with the eight tablets, on which are wrote the multifarious verſe, and in each of which is concealed a magnet, in a different direction.

Fig. 2. A board of the ſame ſize of the foregoing box, on which are drawn eight circles that have each the ſame words wrote round them as are on the tablets; and on the center of each of theſe circles is fixed a magnetic needle; this board is to be placed over the box.

Fig. 3. Four plates of glaſs, placed in an inclined poſition over the board, and in its top are two lenſes O, O.

PLATE XX. p. 246.

Fig. 1. The communicative mirror. A B is a hollow pedeſtal, in which is a hole at L, and over that is placed a ſtand, compoſed of four plates of glaſs C D, and on that is fixed a tube E, including another tube F. There is a hole through the tubes, next the top of the ſtand, and againſt it is placed an inclined mirror M, by which the eye at G ſees the paſteboard circle Fig. 2, fixed on a pivot at the bottom of the box.

Fig. 3. A box of the ſame ſize as the pedeſtal juſt deſcribed. In this box is placed one of the three tablets X, Y, Z, that have each a magnet in a different poſition, and over each of them is paſt-

ed a card of the ſame ſort with thoſe on the circle. When this box is placed in the pedeſtal, the needle in the circle conforms to the poſition of the magnet in the tablet.

Fig. 4. The box of dice by reflection. ABCD the box, whoſe top and ſides are of glaſs. I L two hollow cubes. At the end of the box are ſliders that draw up as in Fig. 5, and at M is a ſmall moveable piece that covers a hole. O P, and R Q, are two inclined mirrors placed in the box. The bottom of each of the cubes is divided into four equal parts, as in Fig. 8, and under each of them is placed a braſs ſtand, Fig. 6, diſpoſed as in Fig. 7, and on the ſtand is a pivot that holds two needles, one of braſs, the other of ſteel that is touched.

RATIONAL

RATIONAL RECREATIONS.

ELECTRICITY.

DEFINITIONS.

1. ELECTRICITY is that property in bodies which enables them, when excited by friction or heat, to attract other light bodies, and produce an effluvium that is sometimes luminous, attended with a snapping noise, and a faint phosphoreal smell.

2. Electricity is called the second of the three species of attraction, gravity being the first, and magnetism the third.

3. Those bodies that produce electricity by friction or heat, are called electrics, and are said to be electric *per se*.

4. Those bodies that receive and com-

municate electricity are called conductors, and those that repel it are called non-conductors.

5. All bodies that are made to contain more than their natural quantity of electricity are said to be electrified positively, and those from whom part of their natural quantity is taken away, are said to be electrified negatively. These two electricities being first produced, one of them from glass, and the other from amber or rosin, the former was called vitreous, and the latter resinous electricity.

6. When a quantity of electricity is communicated to any body, it is said to be charged.

7. The effect of the explosion of a charged body, that is, the discharge of its electricity on any other body, it is called the electric shock.

8. When any body is prevented from communicating with the earth, by the interposition of an electric body, it is said to be insulated.

9. The

9. The residuum of a charged body, as a jar or battery, is that part of the charge which remains in the body after the first discharge, and by which it will give a second shock, though less than the first.

APHORISMS.

1. All substances are distinguished into electrics *per se*, and non-electrics: the latter of which are conductors, and the former non-conductors.

2. All kinds of metals, semi-metals, water, charcoal, and other bodies of a similar nature, are conductors; and all other bodies, whether mineral, vegetable, or animal, are non-conductors: many of the latter, however, may be made to conduct electricity by being heated to a certain degree.

3. Positive electricity is produced by the friction of uninsulated glass tubes or globes; and negative electricity is produced, either from the rubber of those

bodies, or from the friction of inſulated glaſs bodies; or laſtly, from the rubbing of globes or ſticks of wax, ſulphur, and other bodies of a ſimilar nature.

4. It follows from the laſt aphoriſm that the electricity of the excited body and the rubber, are always oppoſite, that is, if that of the excited body be poſitive, that of the rubber will be negative; and the contrary. Thoſe two bodies, moreover, will act on each other with greater force than any other body.

5. In charging any body, as a coated phial, if one ſide communicate with the excited body, and the other with the rubber, the electricity of the two ſides of the charged body will be oppoſite.

6. There is a ſtrong attraction between the two electricities on the oppoſite ſides of a glaſs, ſo that when they are made to communicate by means of a conductor, they will be both diſcharged with a flaſh of light and a ſnapping noiſe.

7. The ſubſtance of glaſs is impervious

to

to electricity; but if the glaſs be thin, and the electricity on the oppoſite ſides be very ſtrong, that is, if the glaſs be overcharged, the oppoſite electricities will force a paſſage through the glaſs.

8. If an excited electric be in contact with an inſulated conductor, the former will communicate its power to the latter, which will then attract light bodies, and give a ſhock, in the ſame manner as the excited electric.

9. The flaſh of light from a body to which electricity has been communicated, is more denſe, and the ſound louder, than from one that is excited; for the conductor parts with all its electricity at once, but the excited body with only ſo much as is at, or near, the part that is touched.

10. If inſulated bodies have been attracted by, and have touched an excited body, they will, ſoon after, be repelled by that body, and will repel each other; nor will they return to the excited electric till after they

have touched ſome other body that communicates with the earth.

11. When an inſulated conductor is brought within the ſphere of action of an excited body, it requires the electricity oppoſite to that of the body, and the nearer it is brought the greater quantity it acquires, till the one receive a ſpark from the other, and then the electricity of both is diſcharged.

12. The electric exploſion always takes the ſhorteſt courſe through the beſt conductors.

13. If the exploſion between two bodies be interrupted by a non-conductor of a moderate denſity, the diſcharge will force a paſſage through it, in ſuch manner as to leave the appearance of a ſudden expanſion of the air about the center of the exploſion.

14. If an inſulated conductor be pointed, or if an uninſulated conductor that is pointed, be brought very near the earth, there will be no other appearance of electricity

tricity during the time of excitation, than a light, and a current of air, that may be perceived to come from thoſe points.

15. The electric attraction acts in vacuo.

16. Electricity and lightning are in all reſpects of a ſimilar nature. All the effects of lightning may be imitated by electricity, and all the experiments in electricity may be performed by lightning, brought down from the clouds by means of an inſulated pointed rod of metal.

ELECTRICAL APPARATUS.

A Defcription of all the machinery that has been ufed in electrical experiments, would fill a large volume. We fhall here confine ourfelves to fuch as are of general ufe, and neceffary, in particular, to the following recreations: fuch are the revolving globe and rubber, with its prime conductor, ufually called an electric machine; the electric battery; the fulmineous conductor; and the electrometer.

The conftruction of the electric machine is as follows *. Let *a a*, Plate I. be two

* A great number of different electrical machines have been contrived. This appears to be the invention of Dr. Prieftley, from whofe Hiftory of Electricity we have extracted the defcription of the following apparatus, and the fubfequent recreations, fome few articles excepted; for that valuable work contains every material difcovery or improvement that has been hitherto made in this fcience. A machine of a more fimple conftruction will be defcribed further on.

ftrong

ſtrong boards of mahogany, the lower about an inch on each ſide broader than the other: they are to be an equal length, parallel with each other, and about four inches aſunder. In the upper board is a groove, that goes almoſt its whole length. The pillars are of baked wood: that marked *b* is immoveable, being fixed to the upper and lower boards; the other ſlides in the groove juſt mentioned, that it may receive globes or cylinders of different dimenſions *, but is only neceſſary when they have axes. In each of the pillars there are holes at equal diſtances, by means of which the globes may be placed at a height adapted to their bulk. Theſe pil-

* It is not yet determined what ſort of glaſs is moſt proper for theſe globes and cylinders. The beſt flint is commonly uſed, but Dr. Prieſtley ſeems to think, that common bottle metal is the moſt eligible. Some operators line their globes or cylinders with wax, or ſome other electric ſubſtance; which in large globes may be of good uſe; but when they are ſmall, no material advantage can be expected from any lining.

lars

lars are to be high enough to admit two or more globes at the ſame time. If two globes be fixed on one axis, four of a moderate ſize may be uſed, and the wheel may have ſeveral grooves for that purpoſe. When a globe with one neck is uſed, as in the plate, a braſs arm *c*, with an open ſocket, is neceſſary to ſupport the axis beyond the pulley: this part is alſo contrived to put higher or lower, together with the braſs ſocket in which the axis turns. The axis *d*, is made to come quite through the pillar, that it may be turned by a handle, without the wheel, at the option of the operator. As the frame ſcrews to the table, it may be placed at different diſtances from the wheel, in proportion to the length of the ſtring, in different ſtates of the air. The wheel is fixed in a ſeparate frame *e*, by which means it may be placed in any ſituation, with reſpect to the pulley, and be turned to one ſide, ſo as to prevent the parts of the ſtring from cutting each other. The back part of this frame is supported by a separate foot *.

The rubber *f*, consists of a hollow piece of copper, stuffed with horse hair, and covered with a basil skin. It is supported by a socket, that receives the cylindrical axis of a round, flat piece of baked wood *g*, the opposite part of which is inserted into the socket of a bent steel spring *h* †. These parts are easily separated; so that the rubber, on the piece of wood by which it is insulated, may be

* Some electric machines are turned by a brass toothed wheel and pinion, inclosed in a box, which has a more elegant appearance; but these wheels are subject to accidents, which are not so easily repaired as those that happen to a string.

† If the rubber be very narrow, some parts of the globe will pass without a sufficient friction: to remedy this inconvenience the hand, when dry, may be held to the globe, just before the rubber, to supply the deficiency. There should be no sharp edges or angles about the rubber, for they would make its insulation, which is a matter of great consequence, ineffectual.

changed

changed at pleaſure. The poſition of the ſpring may be altered two ways: it may either be ſlipped along the groove, or moved in the contrary direction, ſo as to give it every deſireable poſition with regard to the globe or cylinder: and it is, beſides, furniſhed with a ſcrew *i*, which makes it preſs harder or lighter, as the experiment may require.

The prime conductor *k* *, is a hollow veſſel of poliſhed copper, in the form of a

* For common purpoſes a ſmall conductor is moſt convenient; but when a ſtrong ſpark is wanted, it is proper to have a large conductor ready, which may be placed in contact with the ſmaller. But whatever be the ſize of the conductor, that part which is moſt remote from the globe ſhould be round, and much larger than the reſt: for the effort of the electric matter to fly off, is always the greateſt at the greateſt diſtance from the globe; and from that part the longeſt and ſtrongeſt ſparks may be drawn.

The largeſt and moſt pungent ſparks are drawn from any conductor along an electric ſubſtance. Thus if the conductor be ſupported by pillars of

glaſs

pear, supported by a pillar on a firm basis of baked wood *; and it receives its

glaſs or baked wood, the longeſt ſparks will be taken cloſe to the pillar.

If part of the conductor be concave, a remarkable large, ſtrong, and undivided ſpark may be drawn from the concavity. Where the ſurface is convex, the ſpark is more apt to be weak and divided.

* Baked wood is found by experience to form a perfect inſulation, but it requires to be baked again at different times, eſpecially if it be kept in a damp ſituation. A hollow pillar of glaſs, lined with ſealing wax, will anſwer exceeding well, and does not require ſo much attention. The beſt method of lining a glaſs, is to diſſolve ſo much ſealing-wax, in ſpirit of wine, as will make it of a due conſiſtence. It may then be laid on the glaſs, by a bruſh, with very little trouble.

Dr. Prieſtley adviſes electricians to make all their ſtands and ſtools for inſulation, of baked wood; as it may be eaſily turned into any form; as it inſulates better than glaſs, and is not ſo brittle. But care muſt be taken that the wood be thoroughly baked, even till it be quite brown: it will not then be very apt to collect moiſture from the air: if it ſhould, a little warming and rubbing will be ſufficient to expel that moiſture. At moſt, it can only be neceſſary to boil it in linſeed oil, or give it a ſlight coating of varniſh after it comes out of the

6 oven.

electricity by means of a long arched wire, or rod of very soft brass *l*, easily bent into any shape, and raised higher or lower as the globe may require: it is terminated by an open ring, in which are hung some sharp-pointed wires or needles *m*, that play lightly on the globe when it is in motion.

The body of the conductor is furnished with holes and sockets, for the insertion of metallic rods, to convey the fire wherever it is wanted; and for many other purposes, incident to a course of electrical experiments. The conductor is by this mean steady, and yet may be easily put into any situation. It collects the fire perfectly well, and (what is of the greatest consequence, though but little regarded) retains it equally every where.

oven. When this preparation is used, it must be well heated once more, immediately after the boiling.

When

When positive electricity is wanted, a wire or chain, as is represented in the plate at *n*, connects the rubber with the table, or floor. When negative electricity is wanted, that wire is connected with another conductor, such as that represented at *r*, Pl. II. while the conductor in Pl. I. is connected, by another wire or chain, with the table. If the rubber be made tolerably free from points, the negative power will be as strong as the positive.

The principal advantages of this machine are, that glass vessels, or any other electric body, of any size or form, may be used, either with one or two necks. All the essential parts of the machine, as the globe, the frame, the wheel, the rubber, and the conductor, are quite separate, and the position of them to each other may be varied in every manner possible. The rubber has a complete insulation, by which mean the operator may command either the negative or positive power, and may change

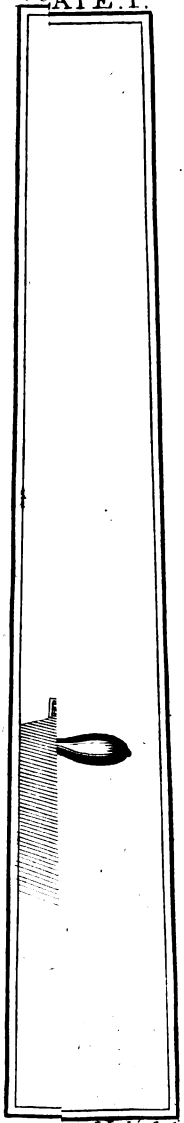
change them in an inſtant. This conductor is ſteady, and eaſily enlarged, by placing rods in the holes with which it is furniſhed, or by the conjunction of other conductors, in order to give larger ſparks, &c. It may be turned either with or without the wheel, ſo that the operator may ſit or ſtand to his work, at his option; and he may, with the utmoſt eaſe, manage both the machine and the other parts of the apparatus *.

When the air is dry, particularly when there is a froſt, and the wind is north or

* We are informed that Dr. Prieſtley, ſince the publication of his Hiſtory, has contrived a windmill, to be placed on the top of his houſe, by which his electrical machine is occaſionally turned. One or more globes excited by the force of a ſtrong wind, muſt doubtleſs produce a very great quantity of electricity; and from that gentleman's extenſive knowledge of this ſcience, and his unwearied application to the improvement of experimental philoſophy, the learned world has reaſon to hope for ſome further important diſcoveries in electricity.

east,

PLATE. I.



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east, there is ſcarce any electric machine but will work very well. If the air be damp, make a large fire in the room where the machine ſtands, and let the globe, and every thing about it, be made very dry: it will then work almoſt as well as in the beſt ſtate of the air.

To increaſe the quantity of electric fire from a globe, let the rubber be a little moiſtened, from time to time; or rather, moiſten the under ſide of a looſe piece of leather, that may occaſionally be put upon the rubber. But the moſt powerful exciter is a little amalgam, made by rubbing mercury and thin pieces of lead or tinfoil together, in the palm of the hand. If a rubber be at any time placed perpendicular to the horizon, it will be neceſſary to uſe a little tallow to make it ſtick. With this excellent reſource, almoſt all ſorts of weather become equally fit for electrical experiments.

A little time after fresh amalgam has been put upon the rubber, and often at other times, if there be any foulness upon the cushion, and sometimes when there is none, there will be found upon the globe, small black spots, of a hard rough substance, which grow continually larger, till a considerable quantity of that matter be accumulated upon the surface. This must be carefully picked off, or it will obstruct the excitation, and in a great measure defeat the intended operation.

When the amalgam has been used for some time, there will be formed upon the rubber, a thick incrustation of the same kind of black substance that is apt to adhere to the globe. This incrustation is a very great improvement of the rubber; for when once a considerable body of it is formed, and it is a little moistened or scraped, as much fire will be produced if fresh amalgam were used; so that it seems to supersede the further use of the amalgam.

As

As the electric matter is collected only at the rubber, it is neceſſary that it have a communication with the common maſs of the earth, by means of good conductors. If, therefore, the table on which the machine ſtands, or the floor of the room in which it is uſed, be very dry, little or no fire will be got, be the machine ever ſo good. In this caſe it will be neceſſary to connect the rubber, by means of chains or wires, with the floor, the ground, or even the next water, if the neighbouring ground be dry.

If the conductor be made perfectly well, and the air be dry, there will never be any loſs of fire from any part of it; for when the whole ſurface has received as high a charge as the machine can give, it will, in all places alike, perfectly reſiſt all efforts to throw any more upon it, and the circulation of the fluid by the rubber will be ſtopped, being balanced, as it were, by equal forces. Or if it loſe, in all places

 alike,

alike, the diffipation muft be invifible. This maxim almoft admits of ocular demonftration; for when the rubber is perfectly infulated, and the conductor has an opportunity of difcharging itfelf, the rubber will take fparks from a wire placed near it, very faft; but when the conductor has but little opportunity of difcharging itfelf, it will take fewer of thofe fparks.

The larger the conductor is, the ftronger fparks it will give: for the greater the electric furface, the greater quantity of the electric atmofphere it contains, and the more fenfible its effect will be, when it is all difcharged at once. The conductor, however, may be made fo large, that the neceffary diffipation of the electric matter from its furface into the air, will be equal to the fupply from the machine, which will conftitute the maximum of the power of that machine, and which will be different in different ftates of the air.

To

To form a juſt eſtimate of the electric power of different machines, take two wires, with knobs of any ſize, and fix one of them at the conductor of one of the machines, and the other wire about an inch or an inch and a half from it; and as the wheel turns, count the number of ſparks that paſs between them in any given time. Fix the ſame wires to the conductor of another machine (but if the ſame conductor were uſed the trial would be more exact) and the difference between the number of ſparks in the given time will determine the difference of ſtrength in the two machines*.

* For common purpoſes there are electric machines conſtructed without either globe, cylinder, or wheel, as thus: let two upright pieces of wood, of about two feet long, be joined at bottom by a croſs piece, and let there be a gripe to faſten them to a table, or any horizontal board. Againſt the inſide of each of the perpendicular pieces fix a leather cuſhion, and let there be a hole made thro' each piece and cuſhion, oppoſite to each other. Then take a plate of glaſs, about a foot ſquare, and poliſhed on both ſides, through the middle of

The electric machine being thus completely adjusted, the operator will next want metal rods to conduct, and coated glass jars or phials to retain and communicate the electric fire. Metallic rods, such as *s*, Plate II. used in taking sparks from the conductor, for various purposes, should have knobs, of different dimensions,

which let a workman make a hole, of the same size with those in the posts and cushions: if these holes be about nine inches from the top, you may work the machine either sitting or standing. Thro' all the holes let an axis be passed, that has a handle at one end. The cushions are to press hard against the glass.

Next, provide a conductor, which may consist of a small iron rod, fastened by sealing-wax to an upright piece of wood, supported by a glass vessel of any sort; from the rod must go a wire, at the end of which are to be two large needles, that communicate with the two sides of the glass; and from each of the rubbers there must go a chain to the floor or table. When positive electricity is wanted, the needles are to communicate with the glass; and when negative electricity, with the cushions. With this machine and a little care and practice, you will be enabled to perform all the common operations in electricity.

in

in proportion to the curvature of the conductor. If the knob be too ſmall, it will not diſcharge the conductor at once, but by degrees, and with a leſs ſenſible effect; whereas the ſpark between broad ſurfaces is thick and ſtrong.

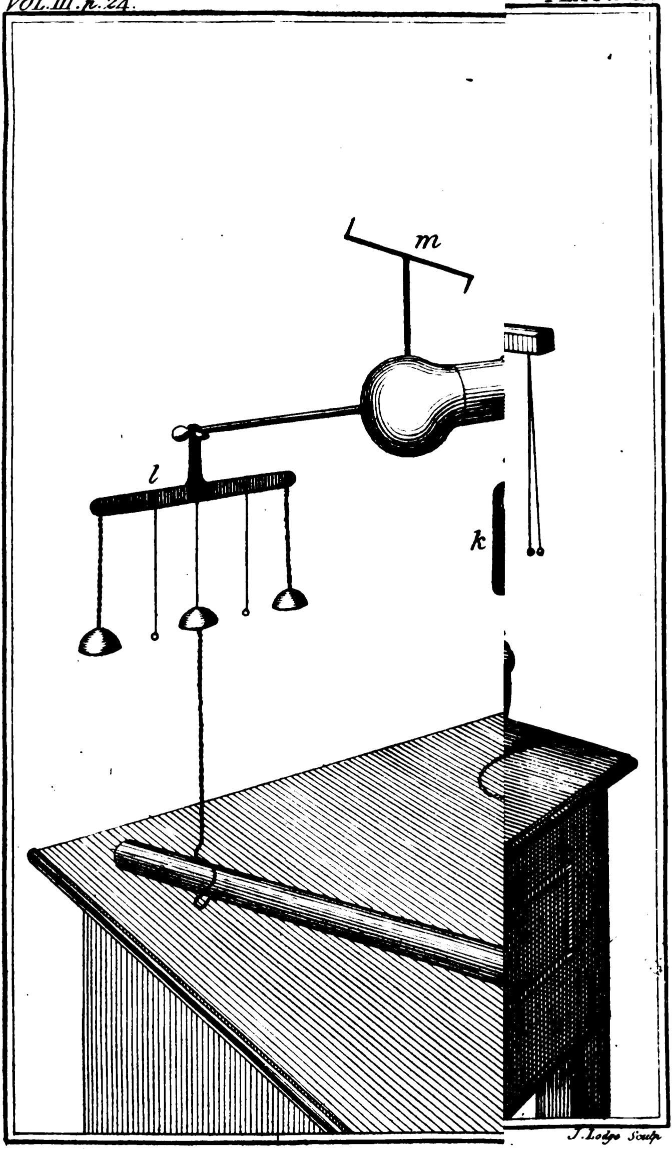
The moſt formidable part of the electric apparatus is the coated glaſs, uſed in the Leyden experiment * and the battery. The form of the glaſs is immaterial with reſpect to the ſhock; but for different experiments both plates and jars, of various ſhapes and ſizes, muſt be uſed. The moſt commodious form, for common uſe, is that of a jar, as wide as a perſon can conveniently graſp, and as tall as will ſtand without danger of falling: perhaps about three inches and a half diameter, and about eight inches high. The mouth

* By the Leyden experiment is here meant the ſhock that is given by two wires, communicating with the two ſides of a charged coated glaſs or phial.

ſhould be pretty open, that it may be the more conveniently coated on the inſide, as well as on the outſide, with tinfoil: but it will be generally moſt convenient to have the mouth narrower than the belly, for then it may more eaſily be kept clean and dry, and the cork, when one is wanted, will be eaſier to manage. A jar thus prepared, of a moderate ſize, is called the Leyden phial. But no electrician ſhould be without jars of various forms and ſizes. The figures of ſeveral of them are expreſſed in Plate II. at *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, and *k*. The form of a plated coat of glaſs is repreſented at *b*.

The practice of coating jars is far preferable to that of putting water, or braſs ſhavings, into them, which not only makes them heavy, but incapable of being inverted, which is requiſite in many experiments. Braſs duſt, or leaden ſhot, are, however, very convenient for ſmall phials, and ſerve very well where it is neceſſary to remove the

PLATE. II.



J. Lodge Sculp.

coating as ſoon as the jar as is charged, but in this caſe quickſilver will generally anſwer beſt. The tinfoil may be put on either with paſte, gum-water, or bees wax. To coat the inſide of veſſels that have narrow mouths, moiſten the inſide with gum-water, and then pour ſome braſs duſt upon it: enough will ſtick on to make an exceeding good coating, and will not eaſily come off, unleſs ſomething very hard rub againſt it.

Being thus provided with a machine to produce, and jars to receive the electric matter, it will be proper, in the next place, to conſtruct an electrometer, that you may know when your jars are ſufficiently charged *. There have been

* The moſt effectual method of charging a jar, is to connect the outſide, by means of wires, with the rubber, while the wire, proceeding from the inſide, is in contact with the conductor. In this manner the inſide of the jar will be ſupplied with the very ſame fire that left the outſide. In this caſe alſo the jar will receive as high a charge as it is capable

many different inventions for this purpose. That of Mr. Cauton is one of the most ſimple, and is uſeful on many occaſions. It conſiſts of two pieces of cork, or pith of elder, nicely turned in a lathe, to about the ſize of a ſmall pea, and ſuſpended on fine linen threads, repreſented at *c*, Plate II. on a glaſs, ſtanding on a ſtool. It is convenient to place them in a ſmall box for the pocket; the box ſhould be the full length of the ſtrings, that they may lie in it without being bent *. Theſe

pable of receiving, though the rubber be inſulated, and have no communication but with the outſide coating; ſo that in the caſe of charging, there can be no occaſion for the directions given above, when the table, the floor, or the ground are very dry. When a thin jar is diſcharged, it is adviſeable not to do it by placing the diſcharging rod oppoſite the thinneſt part, as it will endanger the burſting of the jar in that part.

* If a ſmooth cork ball be hung on a long ſtring of ſilk, and electrified poſitively, it will always be repelled by poſitive, and attracted by negative electricity: but the ſtrongeſt repulſion will be changed into attraction at a certain diſtance.

balls

balls not only ſhow when a jar has a ſufficient charge, but alſo diſcover a very ſmall degree of electricity, and mark its changes from poſitive to negative, and the contrary *.

* If two pith-balls, hung by linen threads, and diverging with poſitive electricity, be inſulated; though in connection with conductors of conſiderable length, the approach of a body electrified poſitively, will firſt make them ſeparate, and then (if the electricity of the balls be ſmall, and that of the approaching body great) it will, at a certain diſtance, make them approach, and at length come into contact with it. Sometimes the divergence, previous to the convergence, is very ſmall, and, without great attention, is apt to be overlooked.

If the balls have a free communication with the earth, for inſtance, if they be held in the hand of a perſon ſtanding on the ground, and (as in the former caſe) they be made to diverge with poſitive electricity, in conſequence of being held within the influence of a body electrified negatively, the approach of poſitive electricity will make them converge; and negative electricity, diverge: the electric matter of the approaching body, in the former caſe, repelling that of the balls, and thereby, as it were, unelectrifying them; whereas, in the

But the most sensible of all electrometers consists of two or three threads of silk, as they come from the worm, to which is fastened a piece of down, that is just sufficient to keep them perpendicular to the horizon. If insulation be necessary, fasten them to a piece of baked wood. When the ends of these threads have received a small degree of electricity, they will retain it a considerable time, and the slightest electric force will put them in motion *. But before any experiment be made, it will be proper to observe carefully, how long they will retain the degree of electricity that is intended to be given them, in any

the latter case, the negative electricity of an approaching body, draws it more powerfully into the threads, and makes them diverge more. This method of judging is, therefore, excellently adapted to ascertain the kind of electricity in the atmosphere, or of a charged jar or battery; the balls being held in the hand of a person standing on the earth or floor.

* These threads will discover a smaller degree of electricity than can be easily perceived by the balls.

situa-

ſituation, and a proportionable allowance is to be made in the courſe of the experiments.

The only inſtrument, however, that can with propriety be called an electrometer, that is, ſuch as meaſures the preciſe degree to which any body is electrified, was invented by Mr. Henly, and is deſcribed in the Philoſophical Tranſactions, in a letter from Dr. Prieſtley to Dr. Franklin, and is as follows: A (Plate IV. Fig. 1.) is a very light rod, that turns on the center of a ſemicircle B, ſo as always to keep pretty near its graduated limb: at the extremity of the rod is a cork ball C. D is the pillar that ſupports the rod, and may be either fixed to the prime conductor, or let into the braſs knob of a jar or battery, or be ſet on a ſtand to ſupport itſelf. The whole inſtrument may be made of wood or ivory, but is found moſt perfect when the pillar and rod, or index, are of box, made very ſmooth with emery paper: the ball of cork, and

and the ſemicircle ivory, as the diviſions on that are more legible than on wood.

The moment this inſtrument begins to be electrified, the rod is repelled by the pillar, and conſequently begins to move over the edge of the ſemicircle, and ſhows, to the greateſt preciſion, the degree to which the prime conductor is electrified; or how high any jar or battery is charged. As the materials of which this inſtrument are made are very imperfect conductors, it will very rarely diſſipate any of the electricity of the prime conductor, &c. with which it is connected: but if it be found, by a trial in the dark, that any part of it collects the electric matter, it muſt be placed before, the fire to dry off the damp, particularly from the index: it ſhould not, however, be much heated, for then it will not receive the electricity ready enough, and the motion of the index will not anſwer with ſufficient accuracy, to the degree of electricity in the body with which it is in contact: but this inconvenience may be easily remedied by moistening the pillar and the index; for the semicircle can never be too dry.

It is evident, from the construction of this instrument, that the force of different explosions may be ascertained by it, before the discharge, with the greatest accuracy. If a jar be charged with positive electricity, and you want to know the precise time, while you are attempting to charge it negatively, that it becomes discharged, watch the moment the index comes to the perpendicular station, which may be observed without the least danger of a mistake, and you will then find there is not the least spark left in the jar. If you continue the operation, the index will begin to advance again; and thereby show the exact quantity of the opposite electricity the jar has acquired.

The

The electrical battery is composed of a number of coated jars, enclosed in a case; as in Fig. 2. Plate III. Very large jars are not the most eligible; those that are smaller contain a greater coated surface in proportion to their bulk; and it is by that the force of a battery is produced. The largest jars that can be conveniently made are about 17 inches high, and they should not be more than 3 inches in diameter, and every where of an equal width.

The battery used and recommended by Dr. Priestley, consists of 64 glass jars*, each 10 inches high, and two inches and a half diameter, and coated to within one inch and a half of the top (see Plate III). The coated part of each is, therefore, half a square foot; so that the whole battery contains 32 square feet. The wire of each

* A less number, however, will be quite sufficient for common purposes: on the contrary, where a very great force is wanted, two or more batteries may be connected, and separate jars added to them.

jar

jar has a piece of very ſmall wire twiſted about the lower end of it, to touch the inſide coating in ſeveral places, and it is put through a pretty large piece of cork, within the jar, to prevent any part of it touching the ſide, which would tend to promote a ſpontaneous diſcharge *. Each wire is turned round, ſo as to make a hole at the upper end, and through theſe holes is put a pretty thick braſs rod with knobs; one rod ſerving for one row of the jars.

The communication between theſe rods is made by laying over all of them a chain, which is not drawn in the plate, leſt the figure ſhould appear confuſed. When you would uſe only a part of the battery, you lay the chain over as many rods as you want rows of jars. The bottom of

* Inſtead of this wire with a cork, the jars of ſome batteries have wires bent double, whoſe lower parts are ſprings, ſo that they touch the ſides of the jar next the bottom, without coming near the top.

the box in which these jars stand, is covered with tin-foil and brass dust; and a bent wire, touching the tin-foil, is put through the box, and appears on the outside, as in the figure. To this wire is fastened whatever is intended to communicate with the outside of the battery, as the piece of small wire in the figure; and the discharge is made by bringing the brass knob to any of the knobs of the battery. The glass of which this battery is made, is what the workmen call flint green, which Dr. Priestley thinks much better for this purpose than the best flint, as jars made of it are not so apt to discharge themselves; and it is moreover much cheaper.

In order to judge of the strength of a charge, (which in large batteries is a matter of considerable consequence) apply the electrometer to the wires, from time to time. A comparison of the degree of the divergence of the balls, compared with the actual explosion, will soon enable the oper-

operator to tell how high his battery is charged, and consequently what will be the force of the explosion.

You are not to conclude, because you can touch the wires of a large battery without any effect, that therefore, while your hand is upon them, you can safely touch the outside coating with the other hand; for sometimes when the wires have shown no signs of a charge, and even two days after the battery has been discharged, very violent shocks have been received. Therefore, soon after the first explosion, it is proper to discharge the residuum for fear of a disagreeable accident. When the box is very dry, there will sometimes remain even the residuum of a residuum, for several days.

The best construction of a fulmineous conductor, that is, a machine to draw down electricity or lightning from the clouds, is as follows. On the top of any building, (which will be more convenient if it ſtand on an eminence) erect a pole *a* (Plate IV. Fig. 2.) as tall as a man can well manage, having on its top a ſolid piece of glaſs, or baked wood, a foot long; over which fix a tin or copper veſſel *b*, in form of a funnel, to preſerve it conſtantly from the rain; above this let there riſe a long ſlender rod *c*, terminating in a pointed wire, and having a ſmall wire twiſted round its whole length, to conduct the electricity the better to the funnel. From the funnel let a wire *d*, deſcend along the building, at about a foot diſtance from it, and be conducted through an open ſaſh, into the room that is moſt convenient for performing the experiments. In this room let a proper conductor be inſulated, and connected with the wire that comes in at the window. This wire and conductor being completely inſulated, will be electrified whenever there is a conſiderable quantity of electricity in the air; and notice will be given when it is properly charged,

either

either by the pith balls hung to it, or by such a set of bells as will be hereafter described.

To make experiments with this apparatus in perfect safety, the electrified wire should be brought within a few inches of a conducting rod, which serves to guard the house, that the redundant electricity may pass off that way, without striking any person who may chance to stand near it. The conductor to guard the house should consist of one rod, between one-fourth and one-half of an inch thick, if it be of iron, but smaller, if it be of brass or copper, and terminating upward in a sharp point, about four or five feet above the highest part of the building; and below, it should, if possible, be continued to some well or running water; if not, it should be sunk several feet into the ground, at the distance of some yards from the building. It is of no consequence whether this conducting rod be fastened to the inside or outside of the house, or how many bendings there are in it.

Beside these principal parts of an electrical apparatus, the operator will frequently find it very convenient, when only small quantities of electricity are required, to be provided with tubes and cylinders of glass, and sticks of wax or sulphur.

Glass tubes should be made as long as a person can well draw through his hand at one stroke, that is, about three feet, or something more, and as wide as can be conveniently grasped. It is not necessary that the glass be thick; perhaps the thinner the better, if it will bear sufficient friction, which however need be but very gentle, when the tube is in good order. It is most convenient to have the tube closed at one end; for the electric matter is not only thereby best retained on its surface, but the air may be more easily drawn out, or condensed in it, by means of of a brafs cap fitted to the open end. A tube thus furnifhed is reprefented at *a*, Plate II. and is requifite for various experiments.

The beft rubber for a fmooth glafs tube is the rough fide of black oiled filk, efpecially when a little amalgam of mercury and any metal, is put upon it. A little bees wax drawn over the furface of a tube will alfo greatly increafe its power. In rubbing a tube, the hand fhould be kept two or three inches below the upper part of the rubber, otherwife the electricity will difcharge itfelf upon the hand, and nothing will remain upon the tube for the experiment. When the tube is in very good order, and ftrongly excited, it will throw off many pencils of rays at every ftroke, without the approach of any conductor, except what may float in the common atmofphere.

An electrician should also be furnished with rough glass tubes, that is, such as have their polish taken off; though a cylinder of baked wood will do nearly as well. The best rubber for a rough glass tube, or a cylinder of baked wood, as well as for a stick of wax or sulphur, is soft new flannel; or rather skins, such as hare or cat-skin, tanned with the hair on, being smoother, and having a more exquisite polish.

Such is the common construction of an electrical apparatus; but to make this part of our work correspond with the rest, by adding surprise to learning and ingenuity, it will be necessary to conceal the apparatus, by placing it in an adjoining room. For which purpose, let the table *a*, *b*, *c*, *d*, (Plate IV. Fig. 3.) be placed against the partition X, that separates the two rooms. Let the branch ABC be joined at A to the prime conductor in the other room: round the part A must be a piece of wood, baked and

and prepared as is described in the account of the apparatus; this piece must be made to take out, that it may be heated by the fire, in damp weather, before the exhibition begins; and must be nicely fitted to the wainscot, that it may not occasion suspicion of any communication. The knob at C must be larger than usual, that it may give the larger snap. The branch being thus joined to the prime conductor, will answer all the purposes of the conductor itself, and larger snaps will be taken from C, than from any part near the globe.

In each side of the top of the table, between *a e* and *b f*, must be concealed a glass tube that communicates with the other room, and in these tubes must be placed the two chains that come from the two sides of a jar or battery, only one link of which, however, is to be seen at *e* and *f*, which may appear as hooks fastened to the table: to these hooks two other chains

chains or wires are to be faſtened, when an exploſion is wanted.

Certain words or phraſes muſt be agreed on between the operator and his aſſiſtant, by which the latter may know when he is to charge the conductor, or connect the chains with the jar or battery. There ſhould likewiſe be a ſmall hole in the partition, by which he may guide himſelf with more certainty. Under the table may be a drawer, that may be pulled out occaſionally, to ſhow that there is nothing concealed.

To the foregoing apparatus it may be proper to add ſome account of the tourmalin, a ſubſtance that has been uſed in electric experiments but a few years paſt, but is ſuppoſed to be the lyncurium of the ancients, to which they attributed ſome electric properties. This ſtone is common in ſeveral parts of the Eaſt, and particu-

larly

larly in the island of Ceylon, from whose inhabitants it received its present name *.

The tourmalin is a fossil of a hard and very compact substance, of a deep red colour, and pellucid. Its principal properties are thus described by Mr. Canton, in the Gentleman's Magazine for September 1759.

1. When the tourmalin is not electrical, or attractive, heating it, without friction, will make it so; and the electricity of one side of it (distinguished by A) will be positive, and that of the other side (B) will be negative.

2. The tourmalin not being electrical, will become so by cooling; but with this difference, that the side A will be negative, and the side B positive.

3. If the tourmalin, in a non-electric state,

* Since the use of the tourmalin in electricity, it has been discovered that some other stones or gems, particularly the Brazil topaz, have similar properties.

ſtate, be heated, and ſuffered to cool again, without either of its ſides being touched, A will be poſitive, and B negative, the whole time of the increaſe and decreaſe of its heat.

4. Either ſide of the tourmalin will be poſitive by friction, and both may be made ſo at the ſame time.

Mr. Canton obſerved further, that it is not heat, but the circumſtance of changing its degree of heat, that gives electricity to this ſtone.

Dr. Prieſtley has ingeniouſly remarked, that a pleaſing deception might be made by encloſing a tourmalin, in a thin coat of ſealing-wax; for the coat will then ſeem to have acquired the properties of the tourmalin.

We have been more minute in the deſcription of this apparatus than may ſeem neceſſary to the performing the following recre-

recreations: but it is from the definitions and aphorifms, together with a defcription of the apparatus, that a knowledge of the feveral branches of fcience contained in this work, is to be acquired; the recreations being principally intended to exemplify what is there laid down. Befide, a perfon of ingenuity, in poffeffion of this electric apparatus, may invent a great number of fimilar recreations; which being the produce of his own mind, will, perhaps, be found more entertaining than any here defcribed; and at the fame time may, fome of them, tend to the further ecclairciffement of this very pleafing branch of experimental philofophy.

ELEC-

ELECTRICAL RECREATIONS.

We ſhall divide theſe Recreations into ſuch as are performed in the light, and ſuch as require a dark chamber; beginning with the former.

RECREATION I.

The animated feather.

ELECTRIFY a ſmooth glaſs tube with a rubber, and hold a ſmall feather (or piece of leaf gold) at a ſhort diſtance from it. The feather will immediately fly to the tube, and adhere to it for a ſhort time, and then fly off; and the tube can never be brought cloſe to the feather till it has touched the ſide of the room, or ſome other body that communicates with the ground. If, therefore, the operator take care to keep the tube conſtantly between the feather and the ſide of the room, he may drive it round to all parts without touching it; and, what is very remarkable, the ſame ſide of the feather will be conſtantly oppoſite the tube.

While the feather is flying before the ſmooth tube, it will be immediately attracted by an excited rough tube, or a ſtick of wax, and fly continually from one tube to the other, till the electricity of both is diſcharged *.

This was one of the firſt, and is one of the moſt common experiments in electricity; it is however very entertaining, and ſhows the nature of electric attraction and repulſion altogether as well as a more elaborate performance.

* This feather not badly repreſents one of that deſpicable ſort of women they call coquettes; who when an excited ſuitor appears, readily flies to him, but preſently quits him. If another ſuitor appear, ſhe in like manner flies to him, and in like manner leaves him; and then, unleſs a third party appear, is continually changing from one to the other; till at laſt, they both grow tired of her, and ſhe then remains as inſignificant and contemptible as a mere feather.

RECRE-

RECREATION II.

The self-raising pyramid.

PROVIDE a large circular bundle of threads, of different colours, and let the threads be also of different lengths, increasing from the circumference to the center, where they are to be longest. Suspend this bundle from the middle of the brass arch between the pillars (Plate IV. Fig. 3). Then inform the company that the threads will rise up, at their command, in form of a pyramid, and continue in that form as long as they direct, and then return to their first position.

Therefore, when they command the threads to rise, you give the signal to the operator behind the partition, who, by turning the wheel, electrifies the arch, when the threads will immediately rise up, in form of a pyramid, and continue ſo, as long as the operator continues turning the wheel, but when that ſtops they will immediately return to their former poſition.

RECREATION III.

The magical dance.

FROM the middle of the braſs arch ſuſpend three ſmall bells, in the ſame manner they are ſuſpended from the end of the conductor in Plate I. at *l*. The two outer bells hang by chains, and that in the middle by a ſilk ſtring, while a chain connects it with the floor. Two ſmall knobs of braſs, which ſerve as clappers, hang, by ſilk ſtrings, one between each two bells. Therefore when the two outer bells, communicating with the conductor, are electrified, they will attract the clappers, and be ſtruck by them. The clappers being thus loaded with electricity, will be repelled, and fly to discharge themſelves upon the middle bell; after which, they will be again attracted by the outer bells: and thus, by ſtriking the bells alternately, the ringing may be continued as long as the operator thinks proper *.

The muſic for your dance being thus provided, you are next to ſuſpend a plate of metal from the ſame part of the arch to which the bells are connected: at the diſtance of a few inches from the arch, and exactly under it, place a metal ſtand of the ſame ſize, in the ſame manner as at *v* and *n* in Plate II. On the ſtand place ſeveral figures of men, other animals, or what you pleaſe, cut in paper of leaf

* In the dark a continual flaſhing of light will be ſeen between the clappers and the bells, and when the electrification is very ſtrong, theſe flaſhes of light will be ſo large, that they will be tranſmitted by the clapper from one bell to the other, without its ever coming into actual contact with either of them; and conſequently the ringing will ceaſe.

gold,

gold, and pretty ſharply pointed at both extremities *.

When the plate that hangs from the arch is electrified, the figures will dance with amazing rapidity, and the bells at the ſame time ringing inceſſantly, will afford no ſmall entertainment to the ſpectators. This Recreation may be ſtopped and renewed at pleaſure, in the ſame manner as the laſt.

* If a piece of leaf gold be cut with a pretty large angle at one extremity, and a very acute angle at the other, it will want no ſtand, but will hang, by its larger angle, at a ſmall diſtance from the conductor, and by the continual waving motion of its lower extremities, will have the appearance of ſomething animated, biting or nibbling at the conductor. It is therefore called by Dr. Franklin the Golden Fiſh.

RECREATION IV.

The artificial ſpider.

CUT a piece of burnt cork, about the ſize of a pea, into the form of the body of a ſpider; make its legs of linen thread, and put a grain or two of lead into it, to give it more weight. Suſpend it by a fine line of ſilk between the electrified arch and an excited ſtick of wax, and it will, like a clapper between two bells, jump continually from one body to the other, moving its legs at the ſame time, as if animated; to the no ſmall ſurprize of thoſe who are unacquainted with the electric influence *.

* This is an American invention, and was firſt deſcribed by Dr. Franklin.

RECREATION V.

The marvellous fountain.

SUSPEND a veſſel of water from the middle of the braſs arch, and place in the veſſel a capillary ſyphon. The water will at firſt iſſue by drops only, from the lower leg of the ſyphon; but when the wheel is put in motion, there will be one continued ſtream of water, and if the electrification be ſtrong, a number of ſtreams will iſſue, in form of a cone, the top of which will be at the extremity of the tube. This experiment may be ſtopped and renewed, almoſt inſtantly, at the word of command.

This Recreation may be diverſified by having one of thoſe fountains that are made by condenſed air, as will be deſcribed under the article of Hydraulics: the fountain is to be inſulated, when it will pour forth one ſtream only, but on being electrified, that one ſtream will be divided into a thouſand, and diſperſed over a large ſpace of ground. You may here command either the ſingle, or the divided ſtream, at pleaſure, by only laying your finger on the arch or taking it off. The ſtreams from both theſe fountains will appear quite luminous in the dark.

RECREATION VI.

The magic picture.

HAVE a large print, ſuppoſe of the king, with a frame and glaſs *. Cut a pannel out of the print at about two inches from the frame all round: with thin paſte, or gum water, fix the border that is cut off, on the inſide of the glaſs, preſſing it ſmooth and cloſe, then fill up the vacancy, by covering the glaſs well with leaf gold, or thin tin-foil, ſo that it may lie cloſe. Cover likewiſe the inner

* This experiment was invented by Mr. Kinnerſley, the author of many other improvements in electricity.

edge

edge of the bottom part of the back of the frame with the ſame tin-foil, and make a communication between that and the tin-foil in the middle of the glaſs; then put in the board, and that ſide is finiſhed. Turn up the glaſs and cover the foreſide with tin-foil, exactly over that on the back-ſide, and when it is dry, paſte over it the pannel of the print that was cut out, obſerving to bring the correſponding parts of the border and the pannel together, ſo that the picture will appear as at firſt, only part of it behind the glaſs, and part before. Laſtly, hold the print horizontally by the top, and place a little moveable gilt crown on the king's head *.

Now if the tin-foil on both ſides of the glaſs be moderately electrified, and another perſon take hold of the bottom of the frame with one hand, ſo that his fingers

* If you have not the figure of a crown, a guinea or ſhilling will ſhew the experiment equally well.

touch the tin-foil, and with the other hand endeavour to take off the crown, he will receive a very ſmart blow, and fail in the attempt. The operator who holds the frame by the upper end, where there is no tin-foil, feels nothing of the ſhock, and can touch the face of the king without danger, which he pretends to be a teſt of his loyalty. When a ring of perſons take a ſhock among them, the experiment is called the conſpirators.

RECREATION VII.

The Tantalian cup.

PLACE a cup or pot, of any ſort of metal, on a ſtool of baked wood, or a cake of wax. Fill it to the brim with any ſort of liquor: let it communicate with the branch by a ſmall chain, and when it is moderately electrified, deſire a perſon to taſte the liquor, without touching the cup with his hands, and he will immediately receive a ſhock at his lips; which,

which, however, ſhould not be very ſtrong.

The motion of the wheel being ſtopped, you offer to taſte the liquor yourſelf, and deſire the reſt of the company to taſte it likewiſe, which they will do without any inconvenience. You then give the ſignal to the operator, and while you are amuſing the company with diſcourſe, the cup is again charged, and you deſire the ſame perſon a ſecond time to taſte the liquor, when, to the no ſmall diverſion of the company, he will receive a ſecond ſhock.

RECRE-

RECREATION VIII.

The circular chimes.

LET a ſmall upright ſhaft of wood paſs, at right angles, through a thin round board, of about twelve inches diameter, and let the ſhaft turn on a ſharp point of iron fixed in the lower end; while a ſtrong wire in the upper end, paſſing through a ſmall hole in a thin braſs plate, keeps the ſhaft truly vertical. About 30 radii, of equal length, made of ſaſh glaſs, cut in narrow ſlips, are to iſſue horizontally from the circumference of the board; the ends moſt diſtant from the center being about four inches aſunder, and on the end of every one of them is fixed a braſs thimble. If a wire fixed to either of the links at F or H, while the other end of that chain communicates with the wire of a bottle electrified in the common way, be brought near the circumference of the the wheel, it will attract the neareſt thimble,

ble, and ſo put the wheel in motion. That thimble, in paſſing by, receives a ſpark, and being thereby electrified, is repelled, and ſo driven forward, while a ſecond thimble, being attracted, approaches the wire, receives a ſpark, and is driven after the firſt, and ſo on, till the wheel has gone once round; when the thimbles before electrified approaching the wire, inſtead of being attracted as they were at firſt, they are repelled, and the motion preſently ceaſes.

But if a wire communicating with the other chain, that is connected with another bottle charged through the coating, be brought near the ſame wheel, it will attract the thimble repelled by the firſt, and thereby double the force that carries the wheel round; and not only taking out the fire that had been communicated by the thimbles to the firſt wire, but even robbing them of their natural quantity; inſtead of being repelled when they come again toward

toward the first wire, they are more strongly attracted; so that the wheel mends its pace, till it goes with great rapidity, twelve or fifteen rounds in a minute, and with such strength, that the weight of four or five pounds, when laid on it, does not visibly retard its motion*.

* This part of the machine is sometimes called an electrical jack: for if a large fowl be spitted on the upper shaft, it will be carried round with a motion fit for roasting; and it appears from one of Dr. Franklin's letters, that it has been actually applied to this purpose. "In the year 1748, the hot weather coming on, when electrical experiments were not so agreeable, we put an end to them for that season, says the Doctor, somewhat humourously, in a party of pleasure on the banks of the Skuylkil. First, spirits were fired by a spark sent from side to side through the river, without any other conductor than the water. A turkey was killed for our dinner by an electrical shock, and roasted by the electrical jack, before a fire kindled by the electrical bottle; and the healths of all the famous electricians in England, Holland, France, and Germany, were drank in electrified bumpers, under a discharge of guns from the electrical battery." Franklin's Letters, p. 35.

Now

Now if a radius of baked wood, of about eight inches, be fixed in the upper ſhaft, and a number of ſmall bells, correſponding to the notes of a tune, be placed on pillars, and fixed in two ſemicircular ſtands, at a proper diſtance from the thimbles, when the wheel turns round the radius will ſtrike againſt the bells, and conſequently play the tune; and as the celerity of the wheels is continually altering, ſo will be the time, or duration of the notes. It is to be obſerved, that the two ſemicircles in which the bells are fixed, muſt not be brought within reach of the radius till the wheel has acquired a conſiderable velocity, for otherwiſe they will at leaſt check, if not totally ſtop, its motion. If the ſtroke of the wooden radius do not give a tone ſufficiently acute, a piece of ſolid glaſs may be fixed to the end of it.

If a greater variety of tones is required there may be two ſets of bells, one for the

treble

treble and the other for the base. The bells may likewise be made to take out of the stand, so as to perform different tunes by being placed in different positions.

RECREATION IX.

The self-moving wheel.

THIS wheel, though constructed on the same principles with the foregoing, appears still more surprising. It is formed of a thin round plate of window-glass, 17 inches diameter, well gilt on both sides, all but two inches next the edge. Two small hemispheres of wood are then fixed with cement to the middle of the upper and under sides, centrally opposite, and in each of them a thick strong wire, eight or ten inches long, which together make the axis of the wheel. It turns horizontally, on a point at the lower end of its axis, which rests on a bit of brass, cemented within a glass salt-cellar. The upper end of its axis passes through

7 a hole

a hole in a thin brass plate, cemented to a long and strong piece of glass, which keeps it six or eight inches distant from any non-electric, and has a small ball of wax or metal on the top, to keep in the fire.

In a circle on the table which supports the wheel, are fixed twelve small pillars of glass, at about eleven inches distance, with a thimble on the top of each. On the edge of the wheel is a small leaden bullet, communicating by a wire with the gilding of the upper surface of the wheel; and about six inches from it is another bullet, communicating, in like manner, with the under surface. When the wheel is to be charged by the upper surface, a communication must be made from the under surface to the table.

When it is well charged it begins to move. The bullet nearest to a pillar moves towards the thimble on that pillar, and passing

paſſing by, electrifies it, and then puſhes itſelf from it. The ſucceeding bullet, which communicates with the other ſurface of the glaſs, more ſtrongly attracts that thimble, on account of its being electrified before by the other bullet, and thus the wheel increaſes its motion, till it is regulated by the reſiſtance of the air. It will go half an hour, and make, one minute with another, 20 turns in a minuet, which is 600 turns in the whole. The bullet of the upper ſurface gives in each turn 12 ſparks to the thimbles, which makes 7200 ſparks; and the bullet of the under ſurface receives as many from the thimbles, thoſe bullets moving in the ſame time 2500 feet. The thimbles are well fixed, and in ſo exact a circle, that the bullets may paſs within a very ſmall diſtance of them.

If inſtead of two bullets, you put eight, four communicating with the upper ſurface,

face, and four with the under surface, placed alternately, (which eight, at about six inches distance, complete the circumference) the force and celerity will be greatly increased; the wheel making 50 turns in a minute; but then it will not continue so long in motion.

RECREATION X.

The magician's chace.

ON the top of a finely pointed wire, rising perpendicularly from the conductor, let another wire, sharpened at each end, be made to move freely, as on a center. If it be well balanced, and the points be bent horizontally, in opposite directions, it will, when electrified, turn very swiftly round, by the re-action of the air against the current which flows from off the points. These points may be nearly concealed, and the figures of men and horses, with hounds and a hare or fox, may be placed upon the wires, ſo as to turn round with them, when they will look as if the one purſued the other *. If the number of wires proceeding from the ſame center be increaſed, and a ſtill greater variety of figures be put upon them, the chace muſt be more diverſified and entertaining. If the wire which ſupports the figures have another wire finely pointed, riſing from its center, a ſecond ſet of wires, furniſhed with another ſort of figures, may be made to revolve above the former, and either in the ſame or the contrary direction, as the operator ſhall think fit.

If ſuch a wire, pointed at each end, and the ends bent in oppoſite directions, be furniſhed, like a dipping needle, with a ſmall axis fixed in its middle, at right an-

* This is alſo an invention of Mr. Kinnerſly, and is called by him, when the figures of horſes only are uſed, the electrical horſe-race.

gles

gles with the bending of the points, and the same be placed between two insulated wire strings, near and parallel to each other, so that it may turn on its axis freely upon and between them, it will, when electrified, have a progressive as well as circular motion, from one end of the wires that support it to the other; and this even up a considerable ascent.

RECREATION XI.

The planetarium.

FROM the branch suspend six concentric hoops of metal, at different distances from each other; and under them, on a stand, place a metal plate, at the distance of about half an inch. Then place upon the plate, within each hoop, and near to it, a round glass bubble, blown very light; these bubbles and the distances between the hoops should correspond to the different diameters of the planets, and those

thoſe of their orbits; but as that cannot be on account of the vaſt diſproportion between them, it muſt ſuffice here to make a difference that bears ſome relation to them.

Now the hoops being electrified, the bubbles placed upon the plate, near the hoops, will be immediately attracted by them; in conſequence of which, that part of a bubble which touches a hoop will acquire ſome electric virtue, and be repelled: the electricity not being diffuſed over the whole ſurface of the glaſs, another part of the ſurface will be attracted, while the former goes to diſcharge its electricity upon the plate. This will produce a revolution of the bubble quite round the hoop, as long as the electrification is continued, and will be either way, juſt as the bubble happens to ſet out, or is driven by the operator. A ball hung over the center of all the hoops will ſerve to re-

preſent

present the ſun in the center of its ſyſtem. If the room be darkened the ſeveral glaſs balls will appear beautifully illuminated. This experiment affords a remarkable inſtance of electric attraction and repulſion.

RECREATION XII.

The incendiaries.

LET a perſon ſtand upon a ſtool made of baked wood, or upon a cake of wax, and hold a chain communicating with the branch. Upon turning the wheel he will ſoon become electrified; his whole body, in reality, making a part of the prime conductor, and will exhibit the ſame appearances; emitting ſparks whereever he is touched by any perſon ſtanding on the floor. If the prime conductor be very large, the ſparks may be rather painful than agreeable; but if it be ſmall, the electrification moderate, and none of the company touch the eyes, or the more tender parts of the face, the experiment is diverting enough to all parties.

Many of the preceding experiments may alſo be performed to advantage by a perſon ſtanding upon the ſtool as above, and holding in his hand what was directed to be faſtened to the prime conductor. If he hold a large plumy feather in his hand, it is very pleaſing to obſerve how it becomes turgid, its fibres extending themſelves in all directions from the rib; and how it ſhrinks, like the ſenſitive plants, when any unelectrified body touches it; when the point of a needle is preſented to it, or to the prime conductor with which he is connected.

If a diſh, containing ſpirits of wine made warm, be brought to the electrified perſon, and he be directed to put his finger,

finger, or a rod of iron into it, the ſpirit will be immediately in a blaze; and if there be a wick or thread in the ſpirit, that communicates with a train of gunpowder, he may be made to blow up a magazine, or ſet a city on fire with a piece of cold iron; and at the ſame time know nothing of what he is about.

A recreation of this ſort may be performed by ſeveral perſons, that all ſtand upon inſulated ſtools, and many diverting circumſtances may be added to thoſe here mentioned. Care ſhould be taken that the floor on which the ſtools ſtand be free from duſt, but it is moſt eligible to have a large ſmooth board for that purpoſe.

RECREATION XIII.

The inconceivable ſhock.

PUT into a perſon's hand a wire that is fixed on to the hook that comes from the chain which communicates with one ſide of the battery, and in his other hand put a wire with a hook at the end of it, which you direct him to fix on to the hook that comes from the other chain, which when he attempts he will inſtantly receive a ſhock through his body, without being able to gueſs from whence it proceeds. The ſhock will be in proportion to the number of jars that are charged; but it is remarkable, that a ſmall ſhock gives a much more pungent ſenſation in paſſing through the body, than one that is large *.

* The ſhock may be made to paſs through any particular part of the body, without much affecting the reſt, if that part, and no other, be brought into the circuit through which the fire muſt paſs from one ſide of the jar or battery to the other.

This

This recreation may be diverſified, and rendered ſtill more entertaining, by concealing the chain that communicates with that which comes from the outſide of the battery, under a carpet, and placing the wire that communicates with the chain which comes from the inſide, in ſuch manner that a perſon ſhall put his hand upon it without ſuſpicion, at the ſame time that his feet are upon the other wire. Many other methods of giving a ſhock by ſurprize may be eaſily contrived; but great care ſhould be taken that theſe ſhocks be not too ſtrong, and that they be not given to all perſons indiſcriminately.

When a ſingle perſon receives a ſhock, the company is diverted at his ſole expence; but all contribute their ſhare to the entertainment, and all partake of it alike, when the whole company forms a circle, by joining their hands, and when the operator directs the perſon who is at one extremity of the circle, to hold the chain

chain which communicates with the coating, while he who is at the other extremity of the circle touches the other chain or wire. All the perſons who form this circuit being ſtruck at the ſame time, and with the ſame degree of force, it is often very pleaſant to ſee them all ſtart at the ſame moment, to hear them compare their ſenſations, and obſerve the very different accounts they give *.

This experiment may be agreeably varied, if the operator, inſtead of making the company join hands, direct them to tread on each other's toes, or lay their hands on each other's heads. If in the latter caſe the whole company ſhould be ſtruck to the ground, as it once happened

* M. Monnier of Paris is ſaid to have communicated this ſhock through a line of men, and other conductors, of 900 toiſes, that is, more than an Engliſh mile; and Abbé Nollet performed the ſame experiment upon 200 perſons, ranged in two parallel ranks.

ed when Dr. Franklin gave the ſhock to ſix very ſtout men, the inconvenience a-riſing from it will be very little: the company that was ſtruck in this manner neither heard nor felt the ſtroke, and immediately got up again, without knowing what had happened. This ſtroke was given with two large jars, each of the meaſure of about ſix gallons, but not fully charged.

RECREATION XIV.

Magical exploſions.

WE have ſhown in a preceding recreation how gunpowder may be fired by the intervention of ſpirits, but there is another method, more ſimple and expeditious, which we ſhall here deſcribe. Make up gunpowder in the form of a ſmall cartridge, in each end of which put a blunt wire, ſo that the ends within the cartridge may be about half an inch diſtant from

from each other, then joining the chain that comes from one side of the battery to one of the wires at the end of the cartridge, bring the chain that comes from the other side of the battery, to the wire at the other end, when the shock will instantly pass through the powder, and set it on fire.

By a similar method fine brass or iron wire may be melted; for the explosion will pass from one chain to the other, through the wire, which will be first red hot, and then melt into round drops *. A battery of 35 jars has entirely destroyed fine brass wire, of the 33oth part of an inch in diameter, so that no particle of it could be found after the explosion. At the moment of the stroke, a great number of

* The power of a battery to melt wire is different at different distances. Dr. Priestley found that he could melt nine inches of small iron wire at the distance of 15 yards, but at 20 yards distance he could only make six inches red hot.

sparks,

ſparks, like thoſe from a flint and ſteel, flew upward and laterally from the place where the wire was laid, and loſt their light, in the day, at the diſtance of about two or three inches *.

A ſtroke from a common jar will eaſily ſtrike a hole through a thick cover of a book, or many folds of paper, leaving a remarkable bur or prominence on both ſides, as if the fire had darted both ways from the center.

* The late Mr. Cauton, by whoſe ingenuity and induſtry this branch of philoſophy received very great improvement, clearly proved, that pure gold and ſilver might be calcined by the electric exploſion, and be converted into numberleſs globules of glaſs, ſome of which were tranſparent, and others tinged with a great variety of colours.

RECREATION XV.

The priſmatic colours *.

TO the ends of each of the chains that come from the battery, fix an iron wire, and between thoſe wires place a plate of tin, of about three inches ſquare, and poliſhed on one ſide †, in a perpendicular direction. The wire next the poliſhed ſide ſhould be finely pointed, and brought very near the ſurface of the plate.

By repeating the exploſions of the battery, there will firſt appear a duſky red,

* This diſcovery was made by Dr. Prieſtley, and ſerves to confirm the Newtonian doctrine of the difference of colours in bodies ariſing from the different denſities of the fine plates that compoſe their ſurfaces.

† The poliſh is not neceſſary, but the colours appear more beautiful than on a rough ſurface. This experiment may be made equally well with the other metals, as gold, ſilver, copper, braſs, iron, or lead.

about

about the edge of the central ſpot; preſently after, generally after four or five ſtrokes, there appears a circular ſpace, viſible only in an oblique poſition to the light, and looking like a ſhade on the plate: this expands very little during the whole courſe of the exploſions. After a few more diſcharges, the ſecond circular ſpace is marked, by another ſhade beyond the firſt, of one-eighth or one-tenth of an inch in width, which never changes its appearance after any number of exploſions. All the colours make their firſt appearance about the edge of the circular ſpot; more exploſions make them expand toward the extremity of the ſpace firſt marked out; while others ſucceed in their place, till after 30 or 40 exploſions, three diſtinct rings appear, each conſiſting of all the colours in the priſm or rainbow.

It makes no difference whether the electricity iſſue from the pointed wire upon the plate, or from the plate upon the pointed wire, the surface opposite the point being marked exactly the same in both cases. The points themselves, from which the fire issues, or at which it enters, are coloured for about half an inch to a considerable degree, and the colours are repeated, as on the plate.

The innermost, that is, the last formed colours, on the plate, are always the most vivid, and those rings are also closer to each other than the rest. These colours may be brushed with a feather or the finger, without injury, but they are easily peeled off by the nail, or any thing that is sharp.

RECREATION XVI.

The artificial earthquake.

IN the middle of a large baſon of water place a round wet board: this board repreſents the earth, and the water the ſea. On the board erect an edifice, compoſed of ſeveral ſeparate pieces, which may repreſent a church, a caſtle, a palace, or if you pleaſe all of them.

Then placing a wire that communicates with the two chains of the battery, ſo that it may paſs over the board and the ſurface of the water, upon making the exploſion the water will become agitated, as in an earthquake, and the board moving up and down, will overturn the ſtructures it ſupports; at the ſame time that the cauſe of this commotion is totally concealed.

This experiment likewise was invented by Dr. Prieſtley, and, when well executed, cannot fail to give great ſurprize as well as entertainment.

RECREATION XVII.

The electrical kite *.

TAKE a large thin ſilk handkerchief, and extend it, by faſtening the four corners to two ſlight ſtrips of cedar. The handkerchief thus prepared and accommodated with a tail, loop, and ſtring, will riſe in the air as a common paper kite. To the top of the upright ſtick of the croſs is to be fixed a pretty ſharp-pointed wire, riſing a foot or more above the wood. To the end of the twine next the hand is to be tied a ſilk ribband, and where the twine and ſilk join, a key or tin tube may be faſtened.

* This is an invention of Dr. Franklin.

This

This kite is to be raiſed when a thunder guſt appears to be coming on, and as ſoon as the thunder clouds come over the kite, the pointed wire will draw the electricity from them, and the kite, with all the twine, will be electrified, the loſe filaments of the twine will ſtand out every way, and be attracted by the finger. When the rain has wetted the kite and twine, ſo that it cannot conduct the electric fire freely, it will ſtream out plentifully from the key, on the approach of a man's knuckle. At this key a phial may be charged, and from the electric fire thus obtained, ſpirits may be kindled, and all the other experiments performed.

The greateſt quantity of electricity that was ever brought from the clouds by an apparatus, was by M. de Romas, of Nerac, in the ſouth of France. This gentleman was the firſt who made uſe of a wire interwoven in the hempen cord of an electric kite, which was ſeven feet and a half high,

 and

and three feet wide, so that it contained 18 square feet of surface. This cord was found to conduct the electricity of the clouds more powerfully than a hempen cord, even though it was wetted; and being terminated by a cord of dry silk, it enabled the observer (by a proper management of his apparatus) to make whatever experiments he thought proper, without danger.

By the help of this kite, on the 7th of June, 1753, about one in the afternoon, when it was raised 550 feet from the ground, and had taken 780 feet of string, making an angle of near 45 degrees with the horizon, he drew sparks from his conductor three inches long, and a quarter of an inch thick, the snapping of which was heard 200 paces. While he was taking these sparks, he felt, as it were, a sort of cobweb on his face, though he was more than three feet from the string of the

* That is, being the half way between the horizon and the point directly over the spectator's head.

kite:

kite: after which he did not think it ſafe to ſtand ſo near, and called aloud to all the company to retire, as he did himſelf about two feet.

Thinking himſelf now ſecure enough, and not being incommoded by any body very near him, he took notice of what paſſed among the clouds that were immediately over the kite. There was no appearance of lightning there, or any where elſe, nor ſcarce the leaſt noiſe of thunder, and no rain at all. There was a pretty ſtrong wind at weſt, which raiſed the kite at leaſt 100 feet higher than in any other experiment. Caſting his eyes afterwards on the tin tube faſtened to the ſtring of the kite, and about three feet from the ground, he ſaw three ſtraws, one of which was about a foot long, a ſecond four or five inches, and the third three or four inches, all ſtanding erect, and performing a circular dance, like puppets, under the tin tube, without touching each other.

This little ſpectacle, with which ſeveral of the company were much delighted, laſted about a quarter of an hour; after which ſome drops of rain falling, he again perceived the ſenſation of the cobweb on his face, and at the ſame time heard a continual ruſtling noiſe, like that of a ſmall forge bellows. This was a further warning of the increaſe of electricity, and from the firſt inſtant Mr. De Romas perceived the dancing ſtraws, he thought it not adviſeable to take any more ſparks, even with all his precautions; and he again intreated the company to retire to a ſtill greater diſtance.

Immediately after this came on the laſt act of the entertainment, which M. De Romas acknowledges made him tremble. The longeſt ſtraw was attracted by the tin tube, upon which there followed three exploſions, the ſound of which greatly reſembled that of thunder. Some of the company compared it to the exploſion of rockets,

rockets, and others to the violent crashing of large earthen jars against a pavement. It is certain that it was heard into the heart of the city, notwithstanding the various noises there.

The fire that was seen at the instant of explosion had the shape of a spindle, eight inches long, and five lines in diameter. But the most astonishing and diverting circumstance was produced by the straw, which had occasioned the explosion, following the string of the kite. Some of the company saw it at 45 or 50 fathoms distance, attracted and repelled alternately, with this remarkable circumstance, that every time it was attracted by the string, flashes of fire were seen, and cracks were heard, though not so loud as at the time of the former explosion.

It is remarkable, that from the time of the explosion, to the end of the experiment, no lightning at all was seen, and scarce any thunder heard. A ſmell of ſulphur was perceived, much like that of the luminous electric effluvia iſſuing from the end of an electrified bar of metal. Round the ſtring appeared a luminous cylinder of light, three or four inches in diameter; and as this was in the day time, M. de Romas did not queſtion but that if it had been in the night, the electric atmoſphere would have appeared to be four or five feet in diameter. An end was put to theſe remarkable experiments, by the wind's ſhifting to the eaſt, and rain, mixed with hail, coming on in great plenty *.

* The quantity of electric matter brought by this kite from the clouds at another time is really aſtoniſhing. Auguſt 26, 1756, the ſtreams of fire iſſuing from it were obſerved to be an inch thick, and ten feet long. Theſe amazing flaſhes of lightning, whoſe report was equal to that of a piſtol, and whoſe effect, had any of them ſtruck on buildings, or animal bodies, would perhaps have been equally deſtructive with any mentioned in hiſtory, were ſafely conducted by the cord of the kite, to a non-electric body placed near it.

As

As the foregoing account might deter ſome perſons from attempting this very entertaining experiment, eſpecially when there is the appearance of an approaching thunder-ſtorm, we ſhall here add an apparatus, invented by Dr. Prieſtley, and with which he thinks there can be no great danger in any thunder-ſtorm.

Let the ſtring A, of a kite (Plate IV. Fig. 4.) be wound upon a reel B, going through a ſlit in a flat board, faſtened at the top of it; by which more or leſs of the ſtring may be let out at pleaſure. Let the reel be fixed to the top of a tin or copper funnel C, and from the funnel let a metal rod D, with a large knob, be projected, to ſerve as a conductor. This funnel and reel muſt be ſupported by a ſtaff E, the upper end of which, at leaſt, muſt be well baked, and the lower end may be made ſharp, to thruſt into the ground, when the kite is well raiſed.

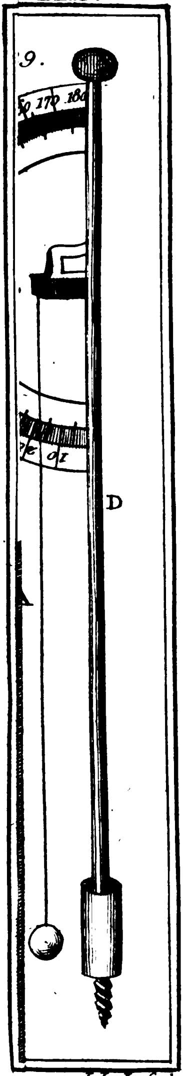
The

The ſafety of this apparatus depends on the chain F, faſtened to the ſtaff by a hook a little below the funnel, and dragging on the ground: for the redundant lightning will ſtrike from the funnel to the chain, and ſo be conducted as far as is deſired, without touching the perſon who holds the ſtaff.

Sparks may be taken from the conductor of this apparatus, with all ſafety, by means of a ſmall rod of baked wood A, Fig. 4. furniſhed with a ſmall funnel B, a braſs rod C, and a chain connected with it; for the lightning which ſtrikes the rod, will paſs by the funnel and the chain, without touching the perſon who holds the rod.

RECRE-

PLATE IV.



J. Lodge Sculp.

RECREATIONS IN THE DARK CHAMBER.

To exhibit a great number of pleaſing and ſurpriſing recreations in the dark, as well as in the light, is the peculiar property of electricity: for though there are many beautiful experiments performed in the camera obſcura, it is ſtill by the aid of the ſun's rays, or thoſe of a candle or lamp: whereas the electric apparatus contains within itſelf thoſe particles of fire by which theſe recreations are performed.

RECREATION XVIII.

The miraculous luminaries.

TO perform this recreation it is neceſſary to be provided with a quantity of the following phoſphorus. Calcine common oyſter-ſhells, by burning them in the fire for about half an hour; then beat them into powder, of the cleareſt

of

of which take three parts, and of flowers of ſulphur one part, and put the mixture into a crucible about one inch and a half deep. Let it burn in a ſtrong open fire, for a full hour; when cool turn it out, and break it into ſeveral pieces, and taking thoſe pieces into a dark place, ſcrape off the brighteſt parts for uſe, which, when good, will be a white powder.

Then take a circular board of three or four feet diameter, on the center of which draw the figure of the half moon, of three or four inches diameter, and round it, at different diſtances, draw a number of ſtars, of different magnitudes. On each of theſe figures fix the phoſphorus juſt mentioned, to the thickneſs of about a quarter of an inch. The board being thus prepared, you muſt have ready a number of charged jars, or phials, and by diſcharging one of them, at the diſtance of about an inch, over each figure, it will become illuminated. The light of the creſcent will be ſo ſtrong

at

at firſt, that you may diſtinguiſh by it the figures on the dial of a watch. Round the board let there be placed a rim or hoop, and over that, at a ſufficient diſtance from the figures, draw a curtain.

The board thus prepared is to be brought into the darkened room, and placed, by hooks, againſt the ceiling. The curtain is then to be drawn back, and the moon and ſtars will appear as emerging from behind a cloud, and will continue to ſhine for half an hour; the light, however, growing continually more faint.

Previous to the performing the following recreation, it will be neceſſary to have a globe and cuſhion placed on the middle of the table, which muſt communicate, by a ſtring that goes through the partition, with the wheel in the other room.

RECREATION XIX.

The globular fires.

LET the room, and all the parts of the apparatus, be made very dry, and let the globe be ſtrongly excited, ſo that the electricity may be very vigorous; the fire will then be ſeen to dart from the cuſhion toward the wire of the conductor. Sometimes theſe lucid rays (which are in part viſible in day-light) will make the circuit of half the globe, and reach the wires; and they will frequently come in a conſiderable number, at the ſame time, from different parts of the cuſhion, and reach within an inch or two of the wires. The noiſe attending this beautiful phenomenon exactly reſembles the crackling of bay leaves in the fire. Theſe lucid arches have frequently radiant points, often four or five in different parts of the ſame arch. Theſe radiant points are intenſely bright, and

and appear very beautiful. It is peculiarly pleafing to obferve the circles of fire rife from thofe parts of the cufhion, where the amalgam or moifture has been put, or which have been lately fcraped. Single points on the rubber will then appear intenfely bright, and for a long time together will feem to pour out continual torrents of flame. If one part of the rubber be preffed clofer than another, the circles will iffue from that part more frequently than from any other.

When the conductor is taken quite away, circles of fire will appear on both fides the rubber, which will fometimes meet, and completely encircle the globe. If in that ftate a finger be brought within half an inch of the globe, it is fure to be ftruck very fmartly; and there will often be a complete arch of fire from it to the rubber, though it be almoft quite round the globe.

If

If all the air be exhaufted from the globe, the electricity will be found to act wholly within it, where it will appear in the form of a cloud or flame of reddifh or purple-coloured light, filling the whole interior fpace of the globe *.

RECREATION XX.

The luminous fhower.

ON the plate at *n*, Plate II. put a number of feeds of any kind; or grains of fand, or a quantity of brafs duft. The conductor being ftrongly electrified, thofe light particles will be attracted and repelled by the plate *o*, fufpended from the conductor, with amazing rapidity, fo as to exhibit a perfect luminous fhower.

* When this recreation is finifhed the globe and rubber muft be taken away, that they may not incommode the apparatus of the following experiments.

Another

Another method of reprefenting luminous rain, is by a fpunge that has been immerfed in water. When this fpunge is firft hung to the conductor, the water will drop from it very flowly; but when it is electrified, the drops will fall very faft, and will appear like globules of fire, illuminating the bafon into which they fall.

RECREATION XXI.

The illuminated vacuum.

TAKE a tall receiver that is very dry, and through the top of it fix, with cement, a wire, not very acutely pointed. Then exhauft the receiver, and prefent the knob of the wire to the conductor, and every fpark will pafs through the vacuum, in a broad ftream of light, vifible through the whole length of the receiver, how tall foever it be. This ftream often divides itfelf into a variety of beautiful rivulets, which are continually changing their courſe, uniting and dividing again in a moſt pleaſing manner. If a jar be diſcharged through this vacuum, it gives the appearance of a very denſe body of fire, darting directly through the center of the vacuum, without ever touching the ſides: whereas, when a ſingle ſpark paſſes through, it generally goes more or leſs to the ſide, and a finger put to the outſide of the glaſs, will draw it wherever a perſon pleaſe. If the veſſel be graſped by both hands, every ſpark is felt, like the pulſation of a large artery, and all the fire makes towards the hands. This pulſation is felt at ſome diſtance from the receiver, and a light is ſeen between the hands and the glaſs.

All this while the pointed wire is ſuppoſed to be electrified poſitively; if it be electrified negatively, the appearance is remarkably different. Inſtead of ſtreams of fire, nothing is ſeen but one uniform luminous appearance, like a white cloud, or the

the milky way in a clear ſtar-light night. It ſeldom reaches the whole length of the veſſel, but generally appears only at the end of the wire, like a lucid ball.

If in the neck of a tall receiver a ſmall phial be inſerted, ſo that the external ſurface of the glaſs may be expoſed to the vacuum, it will produce a very beautiful appearance. The phial muſt be coated on the inſide, and while it is charging, at every ſpark taken from the conductor into the inſide, a flaſh of light is ſeen to dart, at the ſame time, from every part of the external ſurface of the phial, ſo as to quite fill the receiver. Upon making the diſcharge, the light is ſeen to return in a much cloſer body, the whole coming out at once.

RECREATION XXII.

The luminous cylinder *.

PROVIDE a glaſs cylinder three feet long and three inches diameter : near the bottom of it fix a braſs plate, and have another braſs plate ſo contrived that you may let it down the cylinder, and bring it as near the firſt plate as you deſire. Let this cylinder be exhauſted and inſulated, and when the upper part is electrified, the electric matter will paſs from one plate to the other, when they are at the greateſt diſtance from each other the cylinder will admit. The braſs plate at the bottom of the cylinder will moreover be as ſtrongly electrified, as if it was connected by a wire with the prime conductor.

The electric matter in its paſſage thro' this vacuum is ſaid to produce a delightful

* This is an invention of Dr. Watſon.

ſpec-

ſpectacle ; not making, as in the open air, ſmall bruſhes or pencils of rays, an inch or two in length, but coruſcations of the whole length of the tube, and of a bright ſilver hue. Theſe do not immediately diverge, as in the open air, but frequently form a baſe that is apparently flat, dividing themſelves into leſs and leſs ramifications, and very much reſemble the moſt lively coruſcations of the aurora borealis.

RECREATION XXIII.

The magical conſtellations.

AS the moon and ſtars in the zenith will become dull during the time of performing the preceding recreations, it will be proper to draw the curtain gently before them, that it may ſeem as if a cloud came ſlowly over them ; and then the operator may, by his magical power, light up other conſtellations. In order to which, he muſt provide a large board, on which let him mark the ſtars that are in two or more conſtellations, which are contiguous and viſible in the northern hemiſphere, as Taurus, Gemini, &c.

To repreſent theſe ſtars, let there be a hole on each ſide of the ſpot that is marked for a ſtar, at about a quarter of an inch diſtant from each other, and let the extremities of two wires, neatly rounded, come through theſe holes, and be brought near together, exactly over the mark. Theſe wires ſhould be of different ſizes, that they may the better repreſent the different magnitudes of the ſtars.

The other ends of the wires muſt be ſo diſpoſed, that they may all receive a ſpark from the conductor at the ſame time, and the ſtars will then be all luminous at the ſame inſtant. Theſe ſtars are not evaneſcent, like thoſe made by the phoſphorus, but will continue with equal

equal ſplendor as long as the motion of the wheel is continued. After the ſame manner any cypher, or the outlines of a drawing may be exhibited.

RECREATION XXIV.

The luminous characters *.

PROVIDE a board about four inches wide, as A B, (Plate III. Fig. 1.) and of what length you pleaſe. On this board place ten or twelve rows of tin-foil, at about half an inch diſtance from each other, and that all communicate together. From theſe lines are to be cut out the characters you intend to repreſent; obſerving that the ends of the tin-foil where it is cut, ſhould not be ſtrait, but pointed as in the figure.

At the beginning of the tin-foil there muſt be a braſs knob C, which being brought

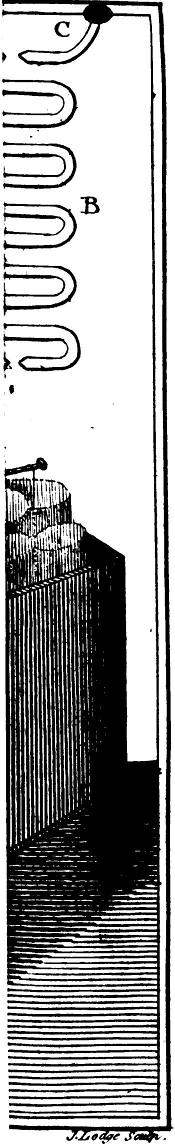
* This is an invention of Mr. Henly, the author of the graduated electrometer deſcribed in the apparatus.

to the conductor, receives the electricity and conveys it to the tin-foil, over which it would run imperceptibly, were there no breaks in the lines, but being there interrupted, it jumps from one point to the other, making at the ſame time a lucid ſpot, by which the characters are formed, and will continue as long as the wheel is in motion. If at the ſame time the knob is applied to the conductor, the operator place his finger againſt the other end of the uppermoſt line of the tin-foil, and draw it ſlowly down, over the ends of the other lines, it will ſeem as if the characters were formed by the motion of his hand.

This experiment may be made by the diſcharge of a jar or phial, but it will then be of a ſhort continuance. By this method alſo the conſtellations, or the outlines of a drawing, &c. may be repreſented.

RE-

PLATE III.



J. Lodge Sculp.

RECREATION XXV.

Prismatic illuminations *.

TAKE a glaſs veſſel about a foot long and eight inches diameter, open at both ends; and let one of its ends be cloſed by a braſs ferule, which is to conſtitute one of the centers on which it is to turn: the other end muſt be cloſed with a metal plate. In the center of the plate let there be a ſquare ſtem, which is to be applied to the arbor of a lathe, by which the globe is to be turned round. On one ſide of this laſt plate muſt be fixed a cork, by means of which the glaſs is ſcrewed upon the air-pump.

Upon rarefying the air within the glaſs about 500 times, and afterwards turning

* This experiment was firſt made by Mr. Smeaton, the inventor of the new air-pump.

the glaſs in the lathe, and rubbing it at the ſame time with the hand, a conſiderable quantity of lambent flame, variegated with all the colours of the rainbow, will appear within the glaſs, under the hand. This light is perpetually changing colour under the hand, but in every other reſpect is pretty ſteady.

When a little air is let into the glaſs, the light appears more vivid, and in greater quantity, but is not ſo ſteady, for it will frequently break out into a kind of coruſcation, like lightning, and fly all over the interior part of the glaſs. When a little more air is let in, the flaſhing is continual, and ſtreams of bluiſh light ſeem to iſſue from under the hand, within the glaſs, in a thouſand forms, with great rapidity, and appear like a caſcade of fire. Sometimes it is ſeen to ſhoot out into the form of trees, moſs, &c.

When

When more air is let in, the quantity of light is diminiſhed, and the ſtreams that compoſe the flaſhes narrower. The glaſs now requires greater velocity and harder friction. Theſe circumſtances will increaſe as ſtill more air is let in, ſo that by the time the glaſs is one-third full of air, the coruſcations quite vaniſh, and a much ſmaller quantity of light appears, partly within and partly without the glaſs. When all the air is let in, the light appears wholly without the glaſs, and much leſs in quantity than when the glaſs is only in part exhauſted.

RECRE-

RECREATION XXVI.

The aurora borealis *.

MAKE a Torricellian vacuum in a glafs tube, about three feet long, and feal it hermetically †: it will then be always ready for ufe. Let one end of this tube be held in the hand, and the other applied to the conductor, and immediately the whole tube will be illuminated, from end to end; and when taken from the conductor will continue luminous, without interruption, for a confiderable time, very often above a quarter of

* This is one of the inventions of that great benefactor to this fcience, Mr. Canton.

† The Torricellian vacuum is made by filling a tube with pure mercury, and then inverting it, in the fame manner as in making a barometer; for as the mercury runs out, all the fpace above will be a true vacuum. A glafs is hermetically fealed by holding the end of it in the flame of a candle till it is ready to melt, and then twifting it together with a pair of pincers.

an

an hour. If after this, it be drawn thro' the hand either way, the light will be uncommonly intenſe, and, without the leaſt interruption, from one hand to the other, even to its whole length. After this operation, which diſcharges it in a great meaſure, it will ſtill flaſh at intervals, though it be held only at one extremity, and quite ſtill; but if it be graſped by the other hand at the ſame time, in a different place, ſtrong flaſhes of light will hardly ever fail to dart from one end to the other; and this will continue 24 hours, and perhaps much longer; without freſh excitation. Small and long glaſs tubes exhauſted of air, and bent in many irregular crooks and angles, will, when properly electrified, beautifully repreſent flaſhes of lightning.

RECREATION XXVII.

The circulating lamps.

AFTER keeping the company thus long in the dark, it will be proper to illuminate the room before you diſmiſs them. In order to which, introduce the circulating wheel, mentioned in the 9th Recreation. To the upper axis of which let there be fixed a number of radii, made of baked wood, at the end of each of which muſt hang a ſmall globular lamp, filled with ſpirits; and let that of each lamp be tinged with a different colour. The wheel, having previouſly acquired its greateſt velocity, is to be placed on the table, and a chain, depending from the branch, is to dip into each lamp as it paſſes by; ſo that all of them will become illuminated in a very ſhort time, Theſe lamps will not only enlighten the room, but by their variegated colours, and continual revolution, afford a very pleaſing phenomenon.

MAG-

MAGNETISM.

MAGNETISM.

DEFINITIONS.

1. MAGNETISM is the ſcience that explains the ſeveral properties of the attractive and repellent powers in the magnet or loadſtone.

2. The magnet is a rich, heavy, iron ore, of a hard ſubſtance, a duſky grey colour, with ſome mixture of a reddiſh brown, and ſparkling when broke.

3. The magnetic virtue is called the third ſpecies of attraction; gravity being the firſt, and electricity the ſecond.

4. The two ends of a magnet, when it is properly formed, are called its poles; and when it is placed on a pivot, in juſt equilibrium, one end will turn toward the north, and is called its north pole, and the other end the ſouth pole *.

* The poles of a magnet are found by holding a very fine ſhort needle over it; for where the

5. When the two poles of a magnet are ſurrounded with plates of ſteel, it is ſaid to be armed.

6. If the end of a ſmall iron bar be rubbed againſt one of the poles of a magnet, it is ſaid to be touched, and is then called an artificial magnet.

7. If ſuch a magnet be ſupported on a pivot, it is called a magnetic needle; one end of it turning toward the north, and the other toward the ſouth.

8. The difference between the poſition of the needle, and the exact points of north and ſouth, is called its declination.

9. That end of the needle which is touched will incline toward the earth, and that is called its inclination or dipping.

poles are the needle will ſtand upright, but nowhere elſe. The exterior parts are then to be filed or ground off, and the two extremities which contain the poles, to be made quite ſmooth.

APHO-

APHORISMS.

1. The magnetic attraction is produced by effluvia emitted by the magnet, and passing from one pole to the other *.

2. One pole of a magnet will attract iron, and the other repel it, but no other body †.

* The direction of the magnetic effluvia is shown by the following experiment. Let AB, CD, (Plate V. Fig. 1.) be the poles of a magnet. Round every side lightly strew steel filings, on a sheet of white paper; the particles of the filings will be so effected by the effluvia of the stone, as to show the course they take every way. In the middle of each pole, between A B and C D, they appear to proceed in lines nearly straight; toward the ends they are more and more curved, till at last the lines from both sides, coinciding with each other, form numberless curves round the stone, which are nearly of a circular figure, as in the plate. This experiment seems to show that the magnetic effluvia, issuing from one pole, circulates to the other.

† The property of the magnet to attract iron has been known many ages: but those of its polar direction, and of its communicating that property to iron, was not discovered till the 14th century.

3. The magnet attracts iron as well in vacuo, as in the air.

4. The magnetic attraction will be continued through several pieces of iron placed contiguous to each other.

5. The magnetic effluvia pervades all bodies.

6. The magnetic attraction extends to a considerable distance *.

7. The north pole of one magnet will attract the south pole of another: and the similar poles will repel each other †.

* The learned Muschenbroek made a number of experiments, with great care and assiduity, to determine the extent and progress of the magnetic attraction, but was never able to discover any regular proportion between the force and distance; but merely that the force increased as the iron approached the magnet. Nor does there seem to be any prospect of establishing the proportion of attraction to the distance, till a method is found, if it can be found, of separating the attracting from the repelling parts. A needle has been known to be attracted by an iron bar at the distance of eight or ten feet.

† If a magnet be gently cut through the middle of its axis, each piece becomes a complete magnet; for

8. The end of a needle touched by the north pole of a magnet will turn ſouth, and that touched by the ſouth pole will turn north.

9. The declination of the magnetic needle is different in different parts of the earth, and in the ſame part at different times *.

10. The inclination of the needle is not

for the parts that were contiguous become poles, aad even oppoſite poles. So that the end of each piece may become a north or ſouth pole according as the ſection is made neareſt to the north or ſouth pole of the large magnet. Upon cutting a magnet longitudinally, there will be four poles, in the ſame poſition as before the cutting. Sometimes a ſtrong ſtroke with a hammer wlll bring all the magnetic power from one end of a needle to the other; ſometimes make it more ſtrong where it was before, and at other times totally deſtroy it.

* The declination of the needle at London, in the year 1580, was 11 degrees, 15 minutes eaſt. In the year 1657, there was no declination, that is, the needle ſtood exactly north and ſouth. At preſent, the declination is more than 20 degrees weſtward.

always the ſame in different places, nor in the ſame place at different times *.

11. The ſtrength of natural magnets differs in thoſe of different magnitudes, but not in proportion to their magnitudes †.

* The inclination of the needle when it was firſt obſerved, in the year 1576, was found to be 71 degrees 50 minutes: at preſent it is between 74 and 75 degrees.

To prevent the dipping of the needle in the common compaſs, the end that is not touched is made ſomething heavier, by which it is kept in equilibrium. Under the equator the needle has no inclination, being equally attracted by the two poles of the earth.

† The ſmalleſt magnets have generally the greateſt power, in proportion to their bulk. A large magnet will ſeldom take up more than three or four times its own weight; whereas a ſmall one will frequently take up more than ten times its weight. A magnet that weighs ſcarce three grains, and that a gentleman wears in his ring, will take up 746 grains, or 250 times its own weight. A magnetic bar made by Mr. Canton, according to the method we ſhall hereafter deſcribe, and that weighed 10 ounces 12 pennyweights, took up ſomething more than 79 ounces; and a flat ſemi-

circular

12. The ſtrength of a natural magnet is conſiderably increaſed by its being armed *.

circular ſteel magnet that weighed an ounce and 13 pennyweights, lifted an iron wedge of 90 ounces.

* There are various ways of arming magnets; the moſt eligible ſeems to be that of placing two pieces of ſteel againſt the two poles, ſo that they may come down below the bottom of the ſtone, and binding them on with one or more pieces of braſs; the two ends of the ſteel pieces then become the poles of the magnet. To determine the quantity of ſteel to be applied, try the magnet with ſeveral ſteel bars, and the greateſt weight it takes up, with a bar on, is to be the weight of its armour.

Though an armed magnet have a great degree of force, it may be eaſily counteracted. If an oblong piece of iron be ſuſpended by one of its poles, and the pole of a different denomination of a weaker and unarmed magnet be placed under the iron, it will quit the firſt magnet, and adhere to the other. In like manner when a needle hangs by its point to a magnet, if a common bar of iron be applied to the head of the needle, it will directly quit the magnet and adhere to the bar; but if it hang by its head to the magnet, neither the iron, nor a weak magnet, will diſengage it. Tho' the

13. Iron acquires a magnetic power by being continually rubbed in the ſame direction *.

14. Iron bars become magnetic by ſtanding a long time nearly upright †.

the pole of an armed magnet have great power, yet if an iron bar of great length be placed under it, the magnet will not appear to have any force whatever.

If a magnet, by lying a long time unuſed, have loſt part of its power, it may ſometimes be recovered. An armed magnet that weighed 14 ounces and a half, and would take up 16 times its own weight, by laying by ſome years loſt one-fourth part of its power. But as much weight being applied to it, as it would then take up, and being ſuffered to hang to it ſome weeks, it would then take up an additional quantity; and the quantity being continually increaſed, at different periods, for the ſpace of two years, it would then take up more than 20 pounds; whereas, before its virtue was impaired, it would not take up 15.

* From hence files, augurs, and ſuch like tools, have always ſome magnetic power.

† Therefore pokers, tongs, and other irons, that always ſtand with the ſame end downward, are conſtantly magnetic. Some bars acquire ſeveral

15. The magnetic virtue may be communicated by electricity *.

16. A ſtrong blow at the end of a ſhort iron bar will give it a magnetic power †.

17. Fire totally deſtroys the power of magnets, as well natural as artificial.

veral magnetic poles, alternately north and ſouth.

* When the electric ſhock is very ſtrong it will give a polarity to needles; and ſometimes it will reverſe their poles.

† If ſuch a bar, or a pair of pincers, be ſtruck hard, or thrown forcibly aganiſt a ſtone floor, they will manifeſtly attract a ſmall needle that floats upon the ſurface of the water in a glaſs.

METHOD

METHOD OF MAKING ARTIFICIAL MAGNETS*.

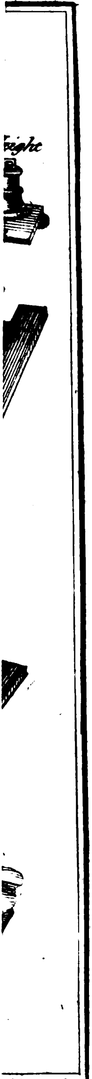
PROCURE a dozen bars; ſix of ſoft ſteel, each three inches long, one quarter of an inch broad, and one-twentieth of an inch thick, with two pieces of iron, each half the length of one of the bars, but of the ſame breadth and thickneſs; and ſix of hard ſteel, each five inches and a half long, half an inch broad, and three-twentieths of an inch thick, with two pieces of iron of one half the length, but the ſame breadth and thickneſs as one of the hard bars; and let all the bars be marked with a line quite round them at one end.

Then take an iron poker and tongs (Plate VI. Fig. 1.) the larger they are and

* There are various methods of making theſe magnets: this method is taken from the 47th volume of the Philoſophical Tranſactions, and was invented by the late Mr. Canton; to whom the learned world is indebted for many uſeful diſcoveries and improvements in magnetiſm, as well as electricity.

4 the

E VI.



Lodge Sculp

the longer they have been ufed, the better; and fixing the poker upright between the knees, hold to it, near the top, one of the foft bars, having its marked end downward, by a piece of fewing filk, which muft be pulled tight with the left hand, that the bar may not flide: then grafping the tongs with the right hand, a little below the middle, and holding them nearly in a vertical pofition, let the bar be ftroked, by the lower end, from the bottom to the top, about ten times on each fide, which will give it a magnetic power fufficient to lift a fmall key at the marked end; which end, if the bar was fufpended on a point, would turn toward the north, and is therefore called the north pole, and the unmarked end is, for the fame reafon, called the fouth pole of the bar.

Four of the foft bars being impregnated after this manner, lay the other two (Fig. 2.) parallel to each other, at the diftance of about a quarter of an inch, between

between the two pieces of iron belonging to them, a north and a ſouth pole againſt each piece of iron: then take two of the four bars already made magnetical, and place them together, ſo as to make a double bar in thickneſs, the north pole of one even with the ſouth pole of the other; and the remaining two being put to theſe in ſuch a manner as to have two north and two ſouth poles together, ſeparate the north from the ſouth poles at one end, by a large pin, and place them perpendicularly with that end downward, on the middle of one of the parallel bars, the two north poles towards its ſouth, and the two ſouth poles towards its north end; ſlide them backward and forward, three or four times, the whole length of the bar; and removing them from the middle of this, place them on the middle of the other bar, as before directed, and go over that in the ſame manner: then turn both the bars the other ſide upwards, and repeat the former operation: this being done, take the

the two from between the pieces of iron, and placing the outermoſt of the touching bars in their room, let the other two be the outermoſt of the four to touch theſe with: and this proceſs being repeated till each pair of bars have been touched three or four times over, which will give them a conſiderable magnetic power, put the half dozen together after the manner of the four, Fig. 3. and touch with them two pair of the hard bars, placed between their irons, at the diſtance of about half an inch from each other: then lay the ſoft bars aſide, and with the four hard ones let the other two be impregnated, Fig. 4. holding the touching bars apart, at the lower end, near two-tenths of an inch, to which diſtance let them be ſeparated, after they are ſet on the parallel bar, and brought together again before they are taken off.

This being obſerved, proceed according to the method deſcribed above, till each pair

pair has been touched two or three times over. But as this vertical way of touching a bar, will not give it quite ſo much of the magnetic virtue as it will receive, let each pair be now touched once or twice over, in their parallel poſition between the irons, Fig. 5, with two of the bars held horizontally, or nearly ſo; by drawing at the ſame time the north of one from the middle over the ſouth end, and the ſouth of the other from the middle over the north end of a parallel bar; then bringing them to the middle again, without touching the parallel bar, give three or four of theſe horizontal ſtrokes to each ſide. The horizontal touch, after the vertical, will make the bars as ſtrong as they can poſſibly be made: as appears by their not receiving any additional ſtrength, when the vertical touch is given by a greater number, and the horizontal, by bars of a ſuperior magnetic power. This whole proceſs may be gone through in about half an hour; and each of of the larger bars, if well hardened, may be made to lift 28 troy ounces; and sometimes more. And when these bars are thus impregnated, they will give to an hard bar of the same size, its full virtue in less than two minutes; and therefore will answer all the purposes of magnetism in navigation and experimental philosophy, much better than the loadstone, which is well known not to have sufficient power to impregnate hard bars. The half dozen being put into a case, Fig. 6. in such manner, as that two poles of the same denomination may not be together, and their irons with them as one bar, they will retain the virtue they have received. But if their power should, by making experiments, be ever so far impaired, it may be restored without any foreign assistance in a few minutes. And if, out of curiosity, a much larger set of bars should be required, these will communicate to them a sufficient power to proceed

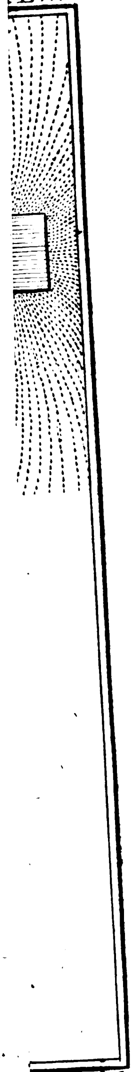
proceed with, and they may in a ſhort time, by the ſame method, be brought to their full ſtrength.

THE MAGNETIC PERSPECTIVE GLASS.

PROVIDE an ivory tube, about two inches and a half long, and of the form expreſſed in Plate V. Fig. 2. The ſides of this tube muſt be thin enough to admit a conſiderable quantity of light. It is to open at one end with a ſcrew: at that end there muſt be placed an eye-glaſs A, of about two inches focus, and at the other end, any glaſs you pleaſe.

Have a ſmall magnetic needle, Fig. 4. like that placed on a compaſs. It muſt be ſtrongly touched, and ſo placed at the bottom of the tube that it may turn freely round. It is to be fixed on the center of a ſmall ivory circle C, of the thickneſs of a counter, which is placed on the object-glaſs D, and painted black on the ſide

TE V.



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next it. This circle must be kept fast by a circular rim of pasteboard, that the needle may not rise off its pivot, after the same manner as is in the compass. This tube will thus become a compass, sufficiently transparent to show the motions of the needle. The eye-glass serves more clearly to distinguish the direction of the needle; and the glass at the other end, merely to give the tube the appearance of a common perspective.

It will appear by aphorism 8, that the needle in this tube, when placed over, and at a small distance from, a magnet, or any machine in which it is contained, will necessarily place itself in a position directed by that magnet, and consequently show where the north and south pole of it is placed. The north end of the needle constantly pointing to the south end of the magnet.

This effect will take place, though the magnet be inclosed in a case of wood, or

 even

even metal, as the magnetic effluvia penetrates all bodies. You muſt obſerve, however, that the attracting magnet muſt not be very far diſtant from the needle, eſpecially if it be ſmall, as in that caſe its influence extends but to a ſhort diſtance.

This tube may be differently conſtructed by placing the needle in a perpendicular direction, on a ſmall axis of iron, on which it muſt turn quite freely, between two ſmall plates of braſs placed on each ſide the tube: the two ends of the needle ſhould be in exact equilibrium. The north and ſouth ends of this needle will, in like manner, be attracted by the ſouth and north ends of the magnetic bar. The former conſtruction, however, appears preferable, as it is more eaſily excited, and the ſituation of the needle much more eaſily diſtinguiſhed.

THE MAGNETIC WAND.

PROCURE a round ſtick of ebony, or other wood, of about eight or ten inches long, and about half an inch thick. Let there be a hole bored through the length of it, of about two or three-tenths of an inch in diameter (ſee Plate V. Fig. 5.) Provide a ſmall ſteel rod, and let it be very ſtrongly impregnated by a good magnet. Place this rod in the hollow of the wand, and cloſe it at each extremity, by two ſmall ends of ivory A and B, that ſcrew on, and are differently formed, that you may the more eaſily remember the poles of the magnetic bar.

When you preſent the north pole of this wand to the ſouth pole of a magnetic needle, ſuſpended freely on a pivot, or to a light body, ſwimming on the ſurface of water, or any other fluid, and in which you have placed a magnetic bar, that body will then approach the wand, and prefent that fide which contains the fouth end of the bar. On the contrary, if you prefent the north or fouth end of the wand to the north or fouth end of the needle, or of the bar, they will recede from it.

Obferve, that after the needle or the floating bar has retired from the wand, it will prefent the other pole to it; therefore as foon as the needle retires, you muft withdraw the wand, or keep it conftantly prefented to the pole of the fame name. This wand is of ufe but in very few experiments. To give it more force it may be armed with iron, after the manner explained in the aphorifms.

RECRE-

RECREATION XXVIII.

The communicative crown.

TAKE a crown piece, and bore a hole in the ſide of it; in which place a piece of wire, or a large needle well poliſhed, and ſtrongly touched with a magnet. Then cloſe the hole with a ſmall piece of pewter, that it may not be perceived. Now the needle in the magnetic perſpective before deſcribed, when it is brought near to this piece of money, will fix itſelf in a direction correſpondent to the wire or needle in that piece.

Deſire any perſon to lend you a crown piece, which you dextrouſly change for one that you have prepared as above. Then give the latter piece to another perſon, and leave him at liberty either to put it privately in a ſnuff-box, or not; he is then to place the box on a table, and you are to tell him, by means of your glaſs, if the crown is or is not in the box. Then bringing your perſpective cloſe to the box, you will know, by the motion of the needle, whether it be there or not; for as the needle in the perſpective will always keep to the north of itſelf, if you don't perceive it has any motion, you conclude the crown is not in the box. It may happen, however, that the wire in the crown may be placed to the north, in which caſe you will be deceived. Therefore to be ſure of ſucceſs, when you find the needle in the perſpective remain ſtationary, you may make ſome pretence to deſire the perſon to move the box into another poſition, by which you will certainly know if the crown piece be there or not.

You muſt remember that the needle in the perſpective muſt here be very ſenſible, as the wire in the crown cannot poſſibly have any great attractive force.

RECRE-

RECREATION XXIX.

The magnetic table.

UNDER the top of a common table place a magnet that turns on a pivot, and fix a board under it, that nothing may appear. There may alſo be a drawer under the table, which you pull out to ſhow that there is nothing concealed. At one end of the table there muſt be a pin that communicates with the magnet, and by which it may be placed in different poſitions: this pin muſt be ſo placed as not to be viſible by the ſpectators. Strew ſome ſteel filings, or very ſmall nails, over that part of the table where the magnet is. Then aſk any one to lend you a knife, or a key, which will then attract part of the nails or filings, in the ſame manner as the iron attracts the needle, in the note to the twelfth aphoriſm. Then placing your hand, in a careleſs manner, on the pin at the end of the table, you alter the position of the magnet; and giving the key to any person you desire him to make the experiment, which he will then not be able to perform. You then give the key to another person, at the same time placing the magnet, by means of the pin, in the first position, when that person will immediately perform the experiment.

RECREATION XXX.

The mysterious watch.

YOU desire any person to lend you his watch, and ask him if he thinks it will or will not go, when it is laid on the table. If he say it will, you place it over the end of the magnet, and it will presently stop*. You then mark with chalk, or a pencil, the precise point where you placed the

* To perform this experiment you must use a strong magnetic bar, and the balance of the watch must not be of brass, but steel.

the watch, and moving the poſition of the magnet, as in the laſt Recreation, you give the watch to another perſon, and deſire him to make the experiment, in which he not ſucceeding, you give it to a third perſon, at the ſame time replacing the magnet, and he will immediately perform the experiment.

RECREATION XXXI.

The bouquets.

IN a box of light wood, that ſhuts with hinges, and is about nine or ten inches long, five or ſix wide, and one inch thick, as ABCD (Pl. VII. Fig. 1.) fix a ſmall vaſe, that has a hole in one ſide, through which is to paſs the end of a bouquet of artificial flowers; of which you are to have two, as F and G. The two principal ſtalks of theſe bouquets are to be made of ſteel, that has been ſtrongly touched; and you are to obſerve that the north pole of one of theſe bouquets is to be placed

placed in the vaſe, and the other is to be at the top of the flower. Both theſe wires, as well as well as all the others that compoſe the flowers, are to be covered with ſilk.

You preſent one of theſe bouquets to any perſon, and give him the choice either of placing it privately in the vaſe or not. Then, ſhutting the box, he is to give it you. When applying the magnetic perſpective to it, you diſcover, by the motion of the needle, whether it be there or not; for if it be not there, the needle will not fix itſelf to either end of the box.

You then preſent both the flowers, and give him the choice of placing either of them, in like manner, in the box; and by applying the perſpective as before, you diſcover, by the fixing of the needle, which of the bouquets is there placed. You may yet farther diverſify this Recreation by having three flowers, of which one

one muſt not be impregnated; and give the perſon the choice of placing either of them in the box: but in this caſe he muſt put in one of them.

You muſt obſerve that the needle in the perſpective, in making this experiment, muſt be very ſenſible: it will be proper to try its force on the ſtalk of the bouquet before the flowers are placed on it.

RECREATION XXXII.

The magnetic dial.

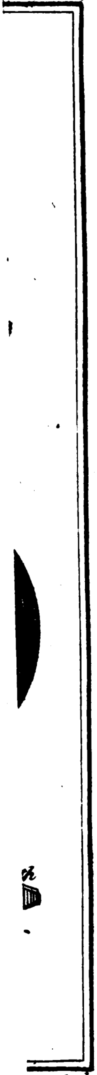
PROVIDE a circle of wood or ivory, of about five or ſix inches diameter, as Pl. VII. Fig. 2. which muſt turn quite free on the ſtand B, in the circular border A: on the circle muſt be placed the dial of paſteboard C, whoſe circumference is to be divided into twelve equal parts, in which muſt be inſcribed the numbers from one to twelve, as on a common dial. There muſt be a ſmall groove

groove in the circular frame D, to receive the paſteboard circle: and obſerve that the dial muſt be made to turn ſo free, that it may go round, without moving the circular border in which it is placed.

Between the paſteboard circle and the bottom of the frame, place a ſmall artificial magnet E, Fig. 3. that has a hole in its middle, or a ſmall protuberance. On the outſide of the frame place a ſmall pin P, which ſerves to ſhow where the magnetic needle I, that is placed on a pivot at the center of the dial, is to ſtop, This needle muſt turn quite free on its pivot, and its two ſides ſhould be in exact equilibrium.

Then provide a ſmall bag, that has five or ſix diviſions, like a lady's work bag, but ſmaller. In one of theſe diviſions put ſmall ſquare pieces of paſteboard, on which are wrote the numbers from one to twelve; and if you pleaſe you may put ſeveral of each number. In each of the other

ATE VII.



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other divisions you must put twelve or more like pieces, observing that all the pieces in each division must be marked with the same number.

Now the needle being placed upon its pivot, and turned quickly about, it will necessarily stop at that point where the north end of the magnetic bar is placed: and which you previously know by the situation of the small pin in the circular border.

You therefore present to any person that division of the bag which contains the several pieces on which is wrote the number opposite to the north end of the bar, and tell him to draw any one of them he pleases. Then placing the needle on the pivot, you turn it quickly about, and it will necessarily stop, as we have already said, at that particular number.

Another Recreation may be made with the same dial, by desiring two persons to draw

draw, each of them, one number out of two different divisions of the bag, and if their numbers, when added together, exceed twelve, the needle or index will ſtop at the number they exceed it: but if they do not amount to twelve, the index will ſtop at the ſum of thoſe two numbers. In order to perform this Recreation you muſt place the pin againſt the number five, if the two numbers to be drawn from the bag be ten and ſeven: or againſt nine, if they be ſeven and two.

If this Recreation be made immediately after the former, as it eaſily may, by dextrouſly moving the pin, it will appear ſtill the more extraordinary.

RECRE-

RECREATION XXXIII.

The magnetical cards.

ON the pasteboard circle mentioned in the preceding Recreation, instead of the twelve numbers, inscribe the four suits of the cards, and the eight cards of each suit that are used at piquet, in the following order:

Divisions.

1. Ace
2. King
3. Knave
4. A heart
5. Queen
6. A diamond
7. An eight
8. A spade
9. A ten
10. A seven
11. A club
12 A nine,

as is expressed in Plate VII. Fig. 4. You must have two similar needles, which however muſt be diſtinguiſhable by ſome private mark. Theſe needles muſt have their oppoſite points touched. Of the eight cards of piquet inſcribed on the circle there are only four that are of uſe here, which are thoſe that are oppoſite the four pips: the others however are uſed in the ſecond part of this Recreation.

When you place that needle or index on the pivot whoſe pointed end is touched, it will ſtop at one of the four pips againſt which you have placed the pin in the frame: then taking that needle off, and placing the other, it will ſtop at the oppoſite point.

Therefore deſire a perſon to draw a card from a piquet pack, offering that card againſt which you have placed the pin of the dial, which you may eaſily do by having a long card, as is explained in the firſt volume. Tell the perſon who draws the

the card to keep it close, that it may not be seen. Then give him one of the two needles, and desire him to place it on the pivot and turn it about, when he will see it stop at the colour of the card he has chose: then taking that needle off, change it dextrously for the other, and give that to another person, telling him to place and turn it in like manner, and it will stop at the name of the card the first person chose.

If the first person should not draw the card you intend, you cannot directly perform this Recreation: therefore to prevent any suspicion that you have failed in your design, cut the cards yourself at the large card, and let him put the card he drew under that card, then give them to one or more persons to cut, and when you perceive the long card is at bottom, you tell the person that the card he drew is at the top of the pack: and after this little diverſion you may begin the Recreation again.

The foregoing Recreation may be diverſified by having a pack of piquet cards in which there are two longer than the reſt, and that anſwer to two that are oppoſite each other on the circle, and were not uſed in the other Recreation. Then let two perſons draw each of them one of thoſe two cards.

Preſent the needle that will point to the ſecond perſon's card to the firſt perſon: after which take it off, and changing it privately, preſent to the ſecond perſon the needle that will point to the firſt perſon's card. You will obſerve that this Recreation does not ſhow the particular ſuite in which the two cards were drawn.

RECRE-

RECREATION XXXIV.

The dextrous painter.

PROVIDE two ſmall boxes as M and N, (Pl. VIII. Fig. 1.) four inches wide, and four inches and a half long. Let the box M be half an inch deep, and N two-thirds of an inch. They muſt both open with hinges and ſhut with a claſp. Have four ſmall pieces of light wood, as OPQR in the ſame plate, of the ſame ſize with the inſide of the box M, and about one third of an inch thick. In each of theſe let there be a groove, as AB, EF, CD, GH, theſe grooves muſt be in the middle, and parallel to two of the ſides. In each of theſe grooves place a ſtrong artificial magnet, as V. The poles of theſe magnets muſt be properly diſpoſed with regard to the figures that are to be painted on the boards; as is expreſſed in the plate. Cover the bars with paper to prevent their being ſeen; but take care in paſting it on not to wet the bars, as they will thereby ruſt, which will conſiderably impair their virtue. When you have painted ſuch ſubjects as you chooſe, you may cover them with a very thin clear glaſs.

At the center of the box N, place a pivot T, on which a ſmall circle of paſteboard OPQR, Fig. 2. is to turn quite free; under which is to be a touched needle S. Divide this circle into four parts, which are to be diſpoſed with regard to the poles of the needle, as is expreſſed in the figure. In theſe four diviſions you are to paint the ſame ſubjects as are on the four boards, but reduced to a ſmaller compaſs. Cover the inſide of the top of this box with a paper M, (ſee Fig. 1.) in which muſt be an opening D, at about half an inch from the center of the box, that you may perceive, ſucceſſively, the four ſmall pictures on the paſteboard circle juſt mentioned. This opening is to ſerve as the cloth on which the little painter

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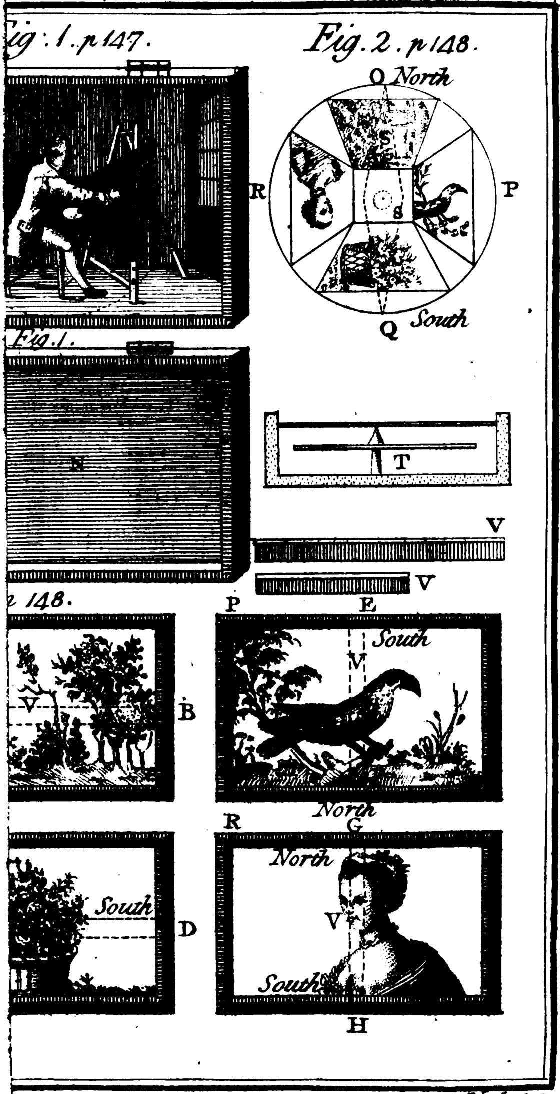
PLATE VIII.



J. Lodge Sculp.

painter is ſuppoſed to draw one of the pictures. You may cover the top of the box, if you pleaſe, with a thin glaſs.

Then give the firſt box to any perſon, and tell him to place any one of the four pictures in it privately, and when he has cloſed it, to give it you. You then place the other box over it, when the moveable circle, with the needle, will turn till it comes in the ſame poſition with the bar in the firſt box. It will then appear that the little dexterous painter has already copied the picture that is incloſed in the firſt box.

RECREATION XXXV.

The cylindric oracle.

PROVIDE a hollow cylinder of about ſix inches high, and three wide, as AB, Pl. IX. Fig. 1. Its cover CD, muſt be made to fix on any way. On one ſide of this box or cylinder let there be a groove, nearly of the ſame length with that ſide; in which place a ſmall ſteel bar as H, that is ſtrongly impregnated; with the north pole next the bottom of the cylinder. On the upper ſide of the cover deſcribe a circle, and divide it into ten equal parts, in which are to be wrote the numbers from one to ten, as is expreſſed in the figure. Place a pivot at the center of this circle, and have ready a magnetic needle. You are then to provide a bag, in which there are ſeveral diviſions, like that deſcribed in the 32d Recreation. In each of theſe diviſions put a number of papers,

on

on which the ſame, or ſimilar queſtions, are wrote.

In the cylinder put ſeveral different anſwers to each queſtion, and ſeal them up in the manner of ſmall letters. On each of theſe letters or anſwers is to be wrote one of the numbers on the dial or circle at the top of the box. You are ſuppoſed to know the number of the anſwers to each queſtion.

You then offer one of the diviſions of the bag, obſerving which diviſion it is, to any perſon, and deſire him to draw one of the papers. Next put the top on the cylinder, with that number which is wrote on the anſwer directly over the bar. Then placing the needle on the pivot you turn it briſkly about, and it will naturally ſtop at the number over the bar. You then deſire the perſon who drew the queſtion to obſerve the number at which the needle ſtands, and to ſearch in the box for a paper with the ſame number, which he will find to contain the anſwer.

You may repeat the experiment by offering another diviſion of the bag to the ſame or another perſon: and placing the number that correſponds to the anſwer over the magnetic bar, proceed as before.

It is eaſy to conceive of ſeveral anſwers to the ſame queſtion. For example, ſuppoſe the queſtion to be. Is it proper to marry?

Anſwer 1. While you are young not yet, when you are old not at all.

2. Marry in haſte, and repent at leiſure.

3. Yes, if you can get a good fortune, for ſomething has ſome ſavour, but nothing has no flavour.

4. No, if you are apt to be out of humour with yourſelf; for then you will have two perſons to quarrel with.

5. Yes,

5. Yes, if you are ſure to get a good huſband (wife); for that is the greateſt bleſſing of life. But take care you are ſure.

6. No, if the perſon you would marry is an angel; unleſs you will be content to live with a devil.

RECREATION XXXVI.

The myſtical dial.

IN a box A B C D, (Plate IX. Fig. 2.) of about four inches ſquare, and that ſhuts with a hinge, let there be an opening O, of three inches and a half ſquare, and half an inch deep.

Provide four ſquare pieces of wood E, F, G, H, Fig. 3. of the ſame ſize with the opening in the box. On theſe pieces deſcribe the cirles I L M N, which divide into four equal parts by the diagonals I M and L N and then ſubdivide the parts NM and IL into four other equal parts: in each ſquare piece

piece make a groove, as P, Q, R, S, and in each groove place a magnetic bar: then cover the ſquares with paper, and write on them the words two, ſix, eight, and twelve, as is expreſſed in the figure.

On another ſquare piece, Fig. 4. of the ſame ſize with the ſurface of the box, deſcribe a circle, and divide it into four equal parts by the diagonals M P and N O: then ſubdivide each of thoſe four parts into four other equal parts; forming in the whole ſixteen equal diviſions, in which you are to write the numbers expreſſed in that figure. You will obſerve that on the ſide M N, are wrote the numbers that are in the other four ſquares; on the oppoſite ſide O P, the double of thoſe numbers; on the ſide N P, the half of thoſe numbers; and on the oppoſite ſide M O, the triple of the firſt numbers. Fix a pivot at the center of this circle, and on it place a magnetic needle.

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You then give the four ſquare pieces to a perſon, and deſire him to put any one of them in the box, then to ſhut it, and place it himſelf on the table. He is next to chooſe whether the index of the dial ſhall point to the number of the ſquare he has placed in the box, its half, its double, or triple; and you then place the dial over the box in the proper poſition. For the north pole of all the bars in the four ſquare pieces being on the ſame ſide, the index will neceſſarily ſtop at that ſide; and conſequently, as the dial is placed, will point to the whole, the half, the double, or triple of each number.

RECREATION XXXVII.

The enchanted ewer.

FIX a common ewer as A, Plate X. Fig. 1. of about twelve inches high, upon a ſquare ſtand BC, in one ſide of which there muſt be a drawer D, of about four inches ſquare and half an inch deep. In the ewer place a hollow tin cone, inverted, as AB, Fig. 2. of about four inches and a half diameter at top, and two inches at bottom; and at the bottom of the ewer there muſt likewiſe be a hole of two inches diameter.

Upon the ſtand, at about an inch diſtance from the bottom of the ewer, place a ſmall convex mirror H, Fig. 2. of ſuch convexity that a perſon's viſage, when viewed in it, at about fifteen inches diſtance, may not appear above two inches and a half long.

Upon the ſtand likewiſe, at the point I, Fig. 2. place a pivot of half an inch high, on which muſt be fixed a touched needle R Q, incloſed in a circle of very thin paſteboard O S, Fig. 3. of five inches diameter. Divide this paſteboard into four parts, in each of which draw a ſmall circle: and in three of theſe circles paint a head as *x*, *y*, *z*, the dreſs of each of which is to be different, one, for example, having a turban, another a hat, and the other a woman's cap. Let that part which contains the face in each picture be cut out: and let the fourth circle be entirely cut out; as it is expreſſed in the figure. You muſt obſerve that the poles of the needle are to be diſpoſed in the ſame manner as in the plate.

You are next to provide four ſmall frames of wood or paſteboard, *w*, *x*, *y*, *z*, Fig. 4. each of the ſame ſize with the inſide of the drawer. On theſe frames muſt be painted the ſame figures as on the circular

cular pafteboard, with this difference, that there muft be no part of them cut out. Behind each of thefe pictures place a magnetic bar, in the fame direction as is expreffed in the plate; and cover them over with paper, that they may not be vifible.

Matters being thus prepared, you firft place in the drawer the frame *w*, on which there is nothing painted. You then pour a fmall quantity of water into the ewer, and defire the company to look into it, afking them if they fee their own figures as they are. Then you take out the frame *w*, and give the three others to any one, defiring him to choofe in which of thofe dreffes he would appear. Then put the frame with the drefs he has chofe in the drawer, and a moment after, the perfon looking into the ewer will fee his own face furrounded with the drefs of that picture.

This recreation, well performed, is highly agreeable. As the pafteboard cir-

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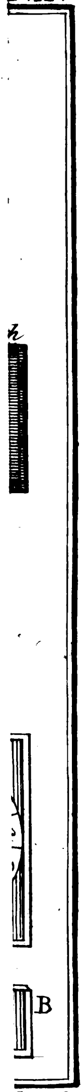
L. X.



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cle can contain only three heads, you may have ſeveral ſuch circles, but you muſt then have ſeveral other frames: and the ewer muſt be made to take off from the ſtand.

RECREATION XXXVIII.

The magician's circles.

LET there be two boxes A and B, Pl. X. Fig. 5. of about ſix inches ſquare, and connected by the piece C, of one inch and a half wide. The depth of the boxes muſt be one inch, and that of the piece half an inch. In theſe boxes and the piece place the movement AB, Fig. 6. compoſed of two horizontal wheels D and E, that have the ſame number of teeth, and two pinions F and G. The axis of the wheel D muſt paſs through the top of the box; and on it muſt be placed a hand, by which it may be turned about; but that of E muſt end beneath the cover of the box; a magnetic bar being placed on it, and above the box, on a ſmall pivot, muſt be placed a touched needle. This move-

movement ſhould be ſo contrived as not to make any noiſe by its motion.

Draw a magic ſquare in the following manner, conſiſting of twenty-five leſſer ſquares, numbered; and each line of which, whether read horizontally or perpendicularly, contains five words that give an anſwer to a queſtion propoſed. Let the five queſtions be as follows:

	1.	2.	3.	4.	5.
1.	Are	you	pleaſed	with	matrimony?
2.	What	does	all	times	pleaſe?
3.	Should	we	wiſh	for	inheritance?
4.	Do	you	deſire	more	riches?
5.	What	pleaſure	is	moſt	deſireable?

Then draw the ſquare thus.

Magic Square.

1. I love	2. quite	3. well	4. my	5. huſband
6. quite	7. pleaſes	8. what	9. wealth	10. brings
11. well	12. what	13. man	14. craves	15. delight
16. my	17 wealth	18. craves	19. much	20. encreaſing
21. huſband	22. brings	23. delights	24. encreaſing	25. ever

On

On each ſide of the boxes place a ſquare paſteboard of the ſame dimenſion, and on that of A draw a circle, and divide it into thirty equal parts On that of B, draw likewiſe a circle, and divide it into fifteen equal parts. In the diviſions of the circle A, write the words contained in the firſt five columns of the following table, which compoſe the foregoing queſtions in the order they are there numbered. That is, the word *are* in the firſt diviſion, the word *be* in the ſecond diviſion, the word *you* in the third, the word *what* in the fourth diviſion, &c. On the fifteen diviſions of the circle B, write the words in the order they ſtand in the laſt column of this table. In the firſt circle the words muſt be wrote from right to left, and in the other from left to right.

Order of placing the words of the queſtions and anſwers on the two circles.

No.	1 queſtion	2 queſtion	3 queſtion	4 queſtion	5 queſtion	No.	Anſwers
1	1 are or 2 be	- -	- -	- -	- -	1	I love
2	3 you	4 what	- -	- -	- -	2	quite
3	5 content	- -	6 ſhould	- -	- -	3	well
4	7 with	- -	- -	8 do	- -	4	my
5	9 matrimony	- -	- -	- -	10 what	5	huſband
6	- -	10 does or 12 can	- -	- -	- -	6	pleaſes
7	- -	13 all	14 we	- -	- -	7	what
8	- -	15 times	- -	16 you		8	wealth
9	- -	17 pleaſe	- -	- -	18 pleaſure	9	brings
10	- -	- -	19 wiſh or 20 pray	- -	- - - -	10	man
11	- -	- -	21 for	22 deſire		11	craves
12	- -	- -	23 inheritance	- -	24 is	12	delights
13	- -	- -	- -	25 more or 26 greater	- -	13	much
14	- -	- -	- -	27 riches	28 moſt	14	encreaſing
15	- -	- -	- -	- -	29 deſireable or 30 eſtimable	15	ever

The words being thus tranſcribed on the dials, the hands of both of them are to be placed to the correſponding diviſions; for example, when the index of the dial A, is placed to the word *are*, that of the dial B, muſt direct to the diviſion which contains *I love*; and ſo of the reſt. You muſt then write on five cards the five foregoing queſtions, that is, one of them on each card.

Matters being thus prepared, you preſent the five cards to any perſon, and deſire him to chooſe one of them, and then let him direct the index of the firſt dial ſucceſſively to each of the five words which compoſe that queſtion: while another perſon, placed by the dial to which the touched needle is placed, writes down the words it ſucceſſively points to, and they will be found to form the anſwer. The moſt remarkable circumſtance in this recreation is, that the fifteen words on the dial B, give proper anſwers to the five queſtions on the other dial, which contain thirty words; and that every anſwer conſiſts of the ſame number of words with the queſtion.

Theſe dials, by means of pullies, may communicate when placed on the oppoſite ſides of a room: and this experiment may be diverſified, by having ſeveral dials to place over the movement, with various words or figures: the foregoing ſerving only as a ſpecimen of the manner of performing recreations of this ſort.

RECREATION XXXIX.

The box and dice.

MAKE a hollow pedeſtal as CA, (Pl. XI. Fig. 1.) twelve inches long, nine wide, and one deep. The cover of this pedeſtal muſt be made to ſlide on and off, and not be above two-tenths of an inch thick. Toward the part A of the cover deſcribe the circle B, which is to be divided

divided into twenty equal parts; and on these parts mark the different points that can be thrown by two dice *. At the center place a pivot, on which a magnetic needle is to turn.

On the bottom of the inside of this pedestal, and directly under the circle at top, describe another circle M, which must be divided and marked in the same manner. At the center fix a magnetic bar by a screw, so that it may be easily placed in any position; but not move of itself.

You must have two needles, the point of one being north and the other south: they should be in appearance quite similar; but there must be, however, some mark by which you can distinguish them.

* The number of different points that can be thrown by two dice is twenty-one, of which there are only twenty here, as the divisions are obliged to be diametrically opposite each other: that number however is quite sufficient for the present purpose.

On the pedeſtal place a vaſe D E, of tin or paſteboard, about twelve inches high. In the ſide of the vaſe there muſt be two parts that open, one at F G, and the other at G H. Theſe openings ſhould not be deeper than the depth of one die, nor wider than two; and they muſt be made to ſhut quite cloſe, that the places where they open may not appear. The cover of the vaſe D, muſt take off. There muſt be a communication between the top and the diviſion G H, and in that diviſion are to to be placed two dice of any number. In the part I K muſt be placed the ſlider S T, which is exactly of the ſame length, and open next S, where muſt be placed two dice that contain the points at which one of the needles is to ſtop: and in the diviſion F G, two other dice that are to contain the points at which the other needle is to ſtop. The bar within the pedeſtal is ſuppoſed to be previouſly fixed to the points that anſwer to the dice.

Matters being thus prepared, you open the part G H, and taking out thoſe dice, you throw them in at the top, and ſhow that they will fall into the ſame place again. You take them out a ſecond time and give them to any perſon, telling him to throw them in at top. In the mean time you incline the vaſe toward your left hand, when the ſlider at I K will come to G H, and thereby prevent the dice that are thrown in at top from falling into that diviſion, by ſtopping up the paſſage. You then preſent him with the proper needle, which he places on the pivot and turns briſkly about, and when it ſtops you tell him that that the dice in the vaſe will have the ſame points with that diviſion at which it has ſtopped. Which on your opening the upper diviſion he will find to be true. You then take thoſe dice out, and give them to another perſon: and taking the needle off the pivot dextrouſly, change it for the other. You deſire that perſon to throw the dice in at top, and give him the proper needle: and when it ſtops, you open the diviſion F G, and taking out thoſe dice, he will find them alſo anſwer to the points on the diviſion of the circle where the needle ſtopped.

RECREATION XL.

The box of flowers.

PROVIDE a box of light wood, eight inches long, five wide, and one inch and a half deep, (Pl. XI. Fig. 2.) provide alſo two caſes F 3 and F 4, five inches long, four wide, and an inch and a half thick. Theſe muſt be made hollow on each ſide in the manner as is expreſſed in the profile E. In each of them there muſt be a groove, that contains a bar O, ſtrongly impregnated; the poles of theſe bars are to be diſpoſed in the manner expreſſed in the figure: toward the part G, there muſt be a ſlider that holds a glaſs, and the ſides of the caſes muſt be cloſed.

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In each of the four hollow parts in these two cases, and under the glasses, place four small natural flowers, of different sorts, and let them be in opposite directions, that is, the top of one flower to be level with the bottom of that on the other side.

In whatever position these cases are placed in the box, the poles of the bars next the hinges, will have a determinate direction. If the north pole of the bar attract the needle in the magnetic perspective at the point X, it is the rose that is there placed. If the south attract the needle, it is the jonquil. It will be the same when those two poles attract the needle at Z.

If the south pole attract the needle at the point Y, it is the carnation that is there placed. If the north pole attract it there, it is the hyacinth: and it will be the same when those two poles attract the needle at &c. You must remember that the

the north pole of the bar attracts the ſouth of the needle, and the ſouth the north. You therefore give the two caſes, containing the flowers, to any one, and let him place them, in what poſition he pleaſe, in the box: and then, by the aid of the magnetic perſpective. you tell him immediately where each flower is placed.

RECREATION XLI.

The box of metals.

PROVIDE a wooden box about thirteen inches long and ſeven wide, as A B C D, (Pl. XII. Fig. 1.) The cover of this box ſhould be as thin as poſſible.

Have ſix ſmall boxes or tablets, about an inch deep; all of the ſame ſize and form, as E F G H I K, that they may indiſcriminately go into ſimilar holes made in the bottom of the large box.

In each of theſe tablets is to be placed a ſmall magnetic bar, and their poles are to be be disposed as is expressed in the figure. Cover each of these tablets with a thin plate of one of the six following metals; viz. gold, silver, copper, iron, pewter, and lead. You must also have a magnetic perspective, at the end of which is to be two circles, one divided into six equal parts, and the other into four, as in Fig. 2. from the center of which there must be drawn an index N, whose point is to be placed to the north.

Therefore, when you are on the side C D of the box, and hold your perspective over any one of the tablets that are placed on the holes E, F, G, so that the index drawn on the circle is perpendicular to the side A B, the needle in the perspective will have its south pole directed to the letter that denotes the metal contained in that tablet. When you hold the perspective over one of the boxes placed in the holes H, I, K, so that the index drawn on the circle is perpendicular to the side C D, CD, the ſouth pole of the needle will in like manner expreſs the name of the metal incloſed.

If the under-ſide of any one of the tablets be turned upward, the needle will be ſlower in its motion, on account of the greater diſtance of the bar. The gold and ſilver will ſtill have the ſame direction, but the four other metals will be expreſſed by the letters on the interior circle.

If any one of the metals be taken away, the needle will not then take any of the above directions, but naturally point to the north; and its motion will be much ſlower.

You therefore give the box to any one, and leave him at liberty to diſpoſe all the tablets in what manner, and with which ſide upward he pleaſe, and even to take any one of them away. Then by the aid of your perſpective you tell him immediately the name of the metal on each tablet, and of that he has taken away.

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This box of metals * will, on comparison, be found far to exceed that which has been publicly exhibited: for that being composed of six tablets, of which two only differ in form, admits but of six different dispositions, whereas in this the tablets may be placed 720 different ways. In the other you must also know the particular side of the box, which in this is not at all necessary, Nay, you may here distinguish each metal, though the box be completely covered with paper; for the effect of the needle will be always the same. The recreations with this box are therefore much more extraordinary, and its construction at the same time more simple.

* It was invented by the Duke de Pequigny, and by him communicated to M. Guyot.

RECRE-

RECREATION XLII.

The magnetic oracle.

IN a box a foot long, three inches and three quarters wide, and one inch deep, make three equal divifions, A, B, C, (Plate XII. Fig. 3.) Have eight fmall boxes or tablets of the fame fize with the divifion B of the box, into which they fhould go only one-fourth of an inch deep. In two of thefe tablets make a groove from the oppofite angles, going from right to left, in which place the bars A, B, Fig. 4. and in two others a groove that goes in like manner from left to right, in which put the bars C, D. In two others a groove that divides them vertically into two equal parts, and place in them the bars E, F: and in the two laft a groove that divides them horizontally, in which place the bars G, H. The poles of each of thefe bars are to be placed in the manner expreffed in the figure.

Upcn

Upon a board five inches ſquare deſcribe the circle N O, (Fig. 5.) which is to be divided into eight equal parts, in each of which write one of the numbers 1, 2, 3, 4, 5, 6, 7, 8, as in the figure, and let this board be placed on the part B of the box A B C.

Provide 32 ſmall rundlets of wood or ivory, of three quarters of an inch long, and pierced with a hole of about one quarter of an inch diameter, Fig. 3. and mark theſe barrels with the numbers 1, 2, 3, 4, 5, 6, 7, 8.

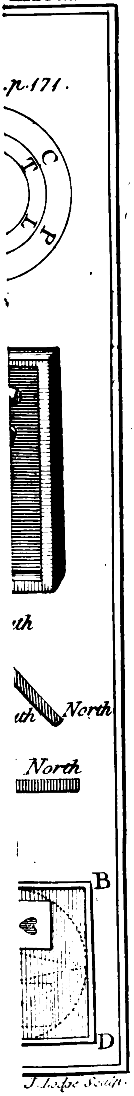
Then cover the tablets with paper to conceal the magnetic bars; and on each of them write ſome queſtion, in ſuch manner that the laſt word may direct to the north pole of the bar.

On ſmall ſlips of paper write four different anſwers to each queſtion, then roll them up and put them into the little rund-

rundlets. You must observe that the same number is to be wrote on four of the rundlets, and one of the four answers put into each of them; according to the direction of the needle of the dial. The little barrels being thus prepared, are to be placed on the two sides A and C of the box, Fig. 3.

You then give the eight tablets to any one, and leave him at liberty to place which of them he please on the box; which being done he is to turn the rundlet round, and when it stops he is to choose one of those rundlets that are marked with the number where it stops, in which he will necessarily find the proper answer. To diversify this Recreation, the favourable answers may be placed on one side of the box, and the unfavourable on the other, so that you may tell him to choose either the one or the other.

LATE XII.



RECREATION XLIII.

The incomprehensible card.

INSERT in the middle of a card, and parallel to its two longest sides, part of a watch spring, as thin as possible, and strongly impregnated: let it be so concealed as not to afford the least suspicion. This card should be a little longer than the others of the pack in which it is placed.

Offer any one to draw a card out of the pack, and present the long card dextrously to his hand. You then give him all the cards, and leave him at liberty to replace that card in the pack or not. He is then to lay the pack on the table, and by applying your magnetic perspective, you will discover whether the card be there or not.

If the perſon ſhould not draw that card, you muſt be ready with ſome other recreation, to prevent ſuſpicion of having failed in your deſign.

RECREATION XLIV.

The two magical cards.

PROVIDE a box ABCD (Plate XII. Fig. 6.) four inches ſquare and three quarters of an inch deep. Cover its top with a paſteboard, in which there is an opening at A. At the center of this box let there be a pivot that ſupports a circle of paſteboard E F, on which is painted two cards: and at its center is to be a magnetic needle; as is expreſſed in the figure.

Now if you lay the magnetic wand, deſcribed at the beginning of this volume, ſo that the north pole of the bar it contains be next the middle of one of the ſides of the box, the magnetic needle, with the paſte-

pasteboard circle, will turn so that its south pole will be next the wand. But if the south end of the wand be next the box, the north end of the needle will present itself, and consequently one or the other of the cards will be visible. You must therefore have a pack of cards in which one of the same sort with those painted on the circle is a small matter longer, and the other, wider than the rest.

Being thus prepared, you desire two persons to draw each one card, taking care to present those two cards, so artfully that they can scarce draw any other. Then holding the wand carelessly in your hand, you ask one of the parties whether his own or the other person's card shall appear first. You then touch the box with your magic wand, and lay it on the table, as if the more easily to open the box. After giving the needle a short time to settle, you open the box and shew the card desired.

To ſhow the other card, you place the box on the table with the other ſide next the wand.

You may ſhuffle the cards before you offer them, as you will always diſtinguiſh by the touch where the two cards are. If the parties ſhould not draw thoſe two cards, you muſt be ready with ſome other amuſement, that it may not be perceived you have failed.

RECREATION XLV.

The magnetic planetarium.

CONSTRUCT a round box I L M N, of eight or nine inches diameter, and half an inch deep, (Plate XIII. Fig. 1.) On its bottom fix a circle of paſteboard, on which draw the central circle A, and the ſeven circumjacent circles B, C, D, E, F, G, H. Divide the central circle into ſeven equal parts by the lines A B, A C, A D, A E, A F, A G, and A H, which muſt

muſt paſs through the centers of the other circles and divide each of them into two equal parts. Then divide the circumference of each of thoſe circles into 14 equal parts, as in the figure.

You are likewiſe to have another paſteboard of the ſame figure, and divided in the ſame manner, which muſt turn freely in the box, by means of an axis placed on a pivot, one end of which is to be fixed in the center of the circle A. See Fig. 2.

On each of the ſeven ſmaller circles at the bottom of the box, place a magnetic bar, two inches long, in the ſame direction with the diameters of thoſe circles, and their poles in the ſituations expreſſed in the figure.

There muſt be an index O, like that of the hour-hand of a dial, which is to be fixed on the axis of the central circle, and by which the paſteboard circle in the box

N 3 may

may be turned about. There muſt be alſo a needle P, that will turn freely on the axis, without moving the circular paſteboard.

In each of the ſeven diviſions of the central circle write a different queſtion, and in another circle, divided into 12 parts, you may write the names of the 12 months. In each of the ſeven circles write two anſwers to each queſtion, obſerving that there muſt be but ſeven words in each anſwer; in the following manner.

In the firſt diviſion of the circle G, which is oppoſite the firſt queſtion, write the firſt word of the firſt anſwer. In the ſecond diviſion of the next circle write the ſecond word; and ſo on to the laſt word, which will be in the ſeventh diviſion of the ſeventh circle.

In the eighth diviſion of the firſt circle write the firſt word of the ſecond anſwer: in

PLATE XIII.

Fig. 1. p. 180.

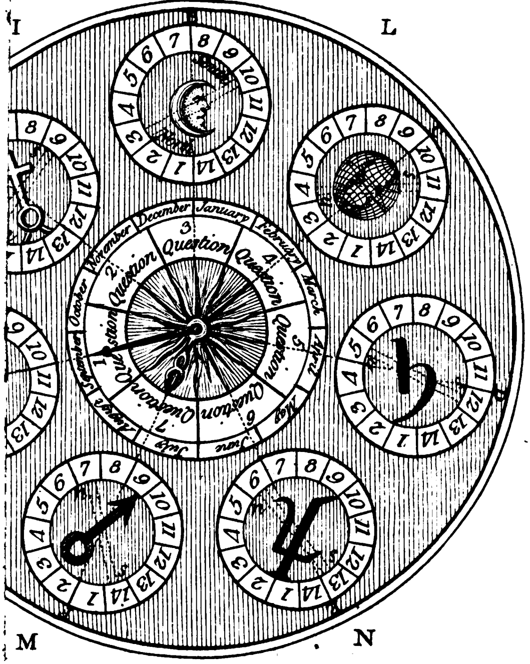
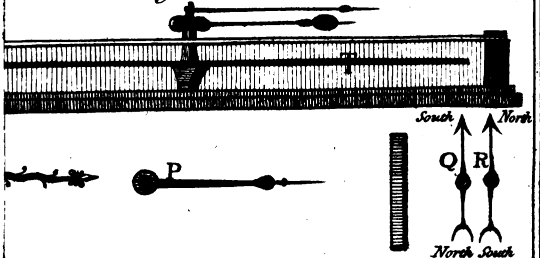


Fig. 2. p. 181.



J. Lodge Sculp.

in the ninth divifion of the fecond circle write the fecond word of the fame anfwer; and fo on to the fourteenth divifion of the feventh circle, which muft contain the laft word of that anfwer.

The fame muft be done for all the feven queftions, and to each of them muft be affigned two anfwers, the words of which are to be difperfed through the feven circles.

At the center of each of thefe circles place a pivot, and have two magnetic needles, the pointed end of one of which muft be north, and the other fouth.

Now, the index of the central circle being directed to any one of the queftions, if you place one of the two magnetic needles on each of the feven leffer circles, they will fix themfelves according to the direction of the bars on the correfpondent circles, at the bottom of the box, and consequently point to the seven words that compose the answer. If you place one of the other needles on each circle, it will point to the words that are diametrically opposite to those of the first answer, the north pole being in the place of the south pole of the other.

You therefore present this planetarium to any person, and desire him to choose one of the questions there wrote; and you then set the index of the central circle to that question, and putting one of the needles on each of the seven circles, you turn it about, and when they all settle they will point to the seven words that compose the answer. The two answers may be one favourable and the other unfavourable: and the different needles will serve to diversify the answers when you repeat the experiment.

There

There may alſo be a moveable needle to place againſt the names of the months; and when the party has fixed upon a queſtion, you place that needle againſt the month in which he was born, which will give the buſineſs an air of more myſtery.

At the center of the large circle may be the figure of the ſun, and on each of the ſeven ſmaller circles one of the characters of the five planets, together with the earth and moon. This Recreation, well executed, is one of the moſt entertaining that magnetiſm has produced.

CON-

CONSTRUCTION OF THE MAGNETICAL AND MECHANICAL TABLE.

LET the table ABCD (Plate XIV. Fig. 1, and 2.) be conſtructed by an able workman, as near as poſſible after the following plan and dimenſions.

Firſt, this table muſt be five feet long, by two feet and a half wide. Its top muſt be only half an inch thick, except at the edge, which is to be one inch and a half thick, and go out beyond the feet of the table about an inch. This precaution is quite neceſſary, that the magnetic apparatus concealed beneath the ſurface of the table may be the nearer to the pieces placed on it; and that there may be no room to imagine that there are any parts concealed.

Secondly, the four feet E, F, G, H, Fig. 2. as well as the two croſs-pieces L, L, muſt be hollow, being formed of four

four pieces of wood half an inch thick, and two inches wide, and consequently the ſpace between them a ſquare inch.

In the third place, there muſt be a ſecond ſurface to the table, placed under the other, and at one inch and a half diſtance from it. Fourthly, at one end of the table-frame, and parallel with the croſs-pieces L, L, there muſt be a ſtep MN, which joins to the frame; the joints of this ſtep are likewiſe to be hollow, and communicate with the two hind feet of the table. This table muſt be made with great care, that there may be no room to ſuſpect there are any cavities in the legs or top: and if any of the joinings ſhould appear, they muſt be painted to prevent all ſuſpicion. The table being thus prepared may be covered with a green cloth, on which are to be placed the different pieces hereafter deſcribed, by which the ſubſequent recreations are to be performed.

On

On the ſide of the lower plane of the table next AB, at eight inches diſtance from the point O, and at the point P, fix the piece QR, Fig. 3. compoſed of a pulley S, of ſix inches diameter, and one-third of an inch thick, on which is fixed a braſs rod; to one end of which muſt be faſtened two magnetic bars, eight inches long, and bound together by four braſs rings; or a ſingle bar, ſtrongly impregnated; or elſe an impregnated horſe-ſhoe, placed as XYZ.

Beneath this pulley, and at its center, fix the braſs barrel X, of one inch and a half diameter, and half an inch thick, in which fix the ſpring of a clock. At the end of the axis of the pulley, and beyond the braſs barrel, let there be a ſquare hole, that is to come out, under the table, and cloſe to it, and by which is to be faſtened a ſmall wheel with a catch, that the ſpring in the barrel may be contracted or extended at pleaſure. Round the pulley let there

go

TABLE.

V C D F E

Letters
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
W
X
Y

Cards	
Ace	Hearts
King	
Queen	
Knave	
Ten	
Nine	
Eight	
Seven	
Ace	Spades
King	
Queen	
Knave	
Ten	
Nine	
Eight	
Seven	
Ace	Diamonds
King	
Queen	
Knave	
Ten	
Nine	
Eight	
Seven	
Ace	Clubs
King	
Queen	
Knave	
Ten	
Nine	
Eight	
Seven	

Numbers
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
¼
½
¾

Z

go a ſmall ſtring, ſuch as is not much apt to dilate or contract *. It ſhould firſt paſs over a ſmall pulley near the opening into the foot H, and then over another at the bottom of the ſame foot †, and oppoſite to the communication with the ſtep, that it may go out behind the partition W.

Againſt the other ſide of the partition there is to be placed a table (Plate XV.) of two feet and a half long, and placed at a convenient height for the perſon who is to draw the ſtring that communicates with the magnetic apparatus, clearly to diſtinguiſh the numbers, letters, and words, there wrote.

The table is thus formed. Firſt, meaſure the exact diſtance that the cord paſſes over while the pulley makes a com-

* It may be braided like a lace, as that is not much ſubject to contract.

† Theſe pullies ſhould be fixed on their axes, that they may not make any noiſe in turning.

plete

plete revolution, and mark that diſtance on the table, as from V to Z.

Have three circles of wood, covered with paper, as A, B, and C, Fig. 1, 4, and 5. Divide that of A into 24 equal parts, and in each of thoſe parts write one of the 24 letters of the alphabet. Divide the firſt column of the table into the ſame number of equal parts, and in each of them write the ſame letters and in the ſame order.

Then divide the circle B into 32 equal parts, in each of which write the name of one of the cards of piquet. Divide the ſecond column of the table in the ſame number of equal parts, and in them write the ſame names in the ſame order.

Laſtly, divide the circle C, into 18 equal parts, in each of which write one of the numbers from 1 to 15, and the three fractions $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$. Then divide the third column of the table into the ſame number of of equal parts, and in them write the ſame numbers likewiſe *.

The pulley C muſt be placed above the table, and over it muſt run the ſtring, at the end of which is to hang the weight D, ſufficiently heavy to keep it diſtended, but not to put the pulley on the table in motion. To this ſtring muſt alſo be annexed the wire or index E, which muſt be moveable, that it may be adapted to the unavoidable contraction or dilation of the ſtring, occaſioned by the moiſture or dryneſs of the air: as otherwiſe it would not conſtantly anſwer to the diviſions on the board.

Provide a copper baſon, quite thin, about a foot in diameter, and one inch and a half deep. It ſhould have two handles, that

* You may have other circles, on which may be wrote the 21 chances on the dice; a number of anſwers to certain queſtions, and a great variety of other matters; as every one's fancy will ſuggeſt.

you

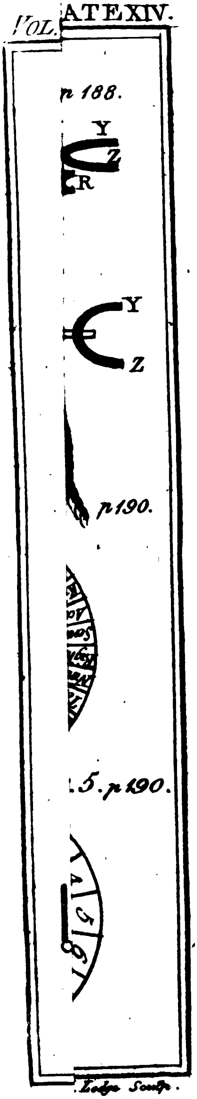
you may take it readily off the table without ſpilling the water. This baſon is to go into each of the circles deſcribed above. Each of thoſe circles alſo muſt have a private mark, by which you may place it on the table in its proper poſition.

Then, of very light wood or cork, make a ſmall figure, in the ſhape of a ſiren or mermaid, in which is to be placed a magnetic bar, in a proper direction with regard to the magnetic horſe-ſhoe. This figure is to float upon the ſurface of the water in the baſon *.

In the laſt place, part of the ſtep at the bottom of the frame muſt be moveable, in the manner of a lever, and communicate with the other ſide of the partition, ſo as to be viſible to the perſon behind it, but not to any one in the room where the machine ſtands.

* Inſtead of a ſiren you may form a ſmall fiſh of very thin copper, and hollow; or a ſmall boat, or any other figure you pleaſe.

Now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Now, matters being thus prepared, when you place the bafon on the table in one of the circles, fo that its center is over the axis that turns the magnetic piece concealed in the table, if the perfon behind the partition draw the index in the ftring up to any one of the numbers, letters, or words on Pl. XV. the magnetic piece on the table will place itfelf againft the fame number, letter, or word. Therefore, if you place the firen on the furface of the water, it will, by means of the magnetic wire concealed in it, direct itfelf to that part where the large bar or horfe-fhoe is moved. If the perfon behind the partition draw the wire up and down, before he fix it, the firen will in like manner make various motions, as if undetermined where to fix.

RECREATION XLVI.

To make the ſiren of the magnetic table point to all the letters of a given word.

YOU muſt have three cards, on which are wrote the names of three perſons or cities, or any other words you pleaſe. One of theſe cards muſt be of the common ſize, another a little longer, and the third a little wider. Theſe cards you give to any perſon and deſire him to chooſe which of them he thinks proper, and to keep it to himſelf. He is then to return you the two remaining cards, and you will diſcover immediately, by the touch, which card he has choſe. You are previouſly to agree with the perſon behind the partition on the three different expreſſions, which denote the card that is choſen. For example, you are to ſay either, *The ſiren ſhall name the word*; or *ſhe ſhall point to the letters that compoſe the word*; or *ſhe will*

will find out the word. Then your confederate, after giving the ſiren ſome indeterminate motions, will direct her ſucceſſively to the ſeveral letters that compoſe the word wrote on the card.

Note, the confederate muſt be of a ready apprehenſion; and to aſſiſt his memory, adjoining to the forementioned table, he ſhould have a paper, on which are wrote the ſeveral ſigns you are to give him.

The ſiren is to point out the time expreſſed by any given watch.

You deſire any perſon to lend you his watch, and laying it on the table, you tell him that the ſiren ſhall ſhow the preciſe time at which it then is. You then mount the ſtep, as if to place the watch more properly; and at the ſame time preſs down the moveable piece as many times as are equal to the hours. The perſon behind the par-

O 2 tition

tition obſerving carefully that number, makes the ſiren point to it. You then make a ſimilar ſignal for the quarters and minutes, and your confederate, in like manner as before, makes the ſiren point reſpectively to them.

To make the ſiren point to three numbers that have been choſen by three different perſons.

You muſt have a ſmall bag, like that deſcribed in the 32d Recreation of this volume, in which there are four diviſions. In the firſt of them you muſt put the numbers from 1 to 15; and in each of the three others ſeveral tickets that have the ſame number, but not higher than 15. You draw out a handful of tickets from the firſt diviſion, and ſhow that they conſiſt of different numbers. Then put them again in that diviſion, and offer one of the other diviſions to the three perſons, from which they are each to draw a ſingle

number.

number. Your confederate being previously informed what thoſe three numbers are, and in what order they are to be drawn, will immediately direct the ſiren to them.

After the parties have drawn the three numbers, you may aſk whether the ſiren ſhall point to their numbers ſeparately, or to the amount of the whole. Suppoſe, for example, the three numbers be 5, 7, and 11. The ſiren is then made to point firſt to 2, and then to 3, which form 23, the amount of thoſe numbers.

You may likewiſe let the ſame perſon draw two or three numbers, and the ſiren ſhall ſhow him either thoſe numbers ſeparately, their amount, or their product when multiplied together.

A person having drawn a card from the pack, the siren points to the name of that card on the circle.

The person having drawn, from a piquet pack, the card that you have previously agreed on with your confederate, by your presenting that card in the manner already described, he immediately directs the siren to that card. It will be proper to agree on a second card with your confederate, that you may repeat the experiment if it should be desired.

A question being proposed by any person, the siren gives the answer; tho' the person who exhibits the recreation does not know the question.

On five cards write five such different questions as may be all answered by the same word: as for example.

1. What can be in all parts of the earth at the same time?

2. What

2. What does the ivy round the oak?

3. What muſt a man have to carry him croſs the ocean?

4. What is it the hunter does with his horn?

5. What makes a great noiſe but no ſhow?

6. What brings trees, towers and ſteeples to the ground?

All theſe queſtions are to be anſwered by the word *wind.* You therefore ſhow that the cards contain different queſtions, and then give them to any perſon, telling him to chooſe one of them privately, and, keeping it to himſelf, to put the reſt in his pocket; which being done, your confederate directs the ſiren to the letters that compoſe that word. If you would repeat the experiment, you muſt have another ſet of cards which have a different anſwer, that it may not appear that the ſame word anſwers all the cards. This recreation is easily performed, and occasions no small degree of surprise.

The principal part of these recreations with the siren were invented by M. Guyot, and were therefore never exhibited in public before the appearance of his book.

RECREATION XLVII.

The sagacious swan.

PROVIDE a box X Y, (Pl. XVI. Fig. 1.) eighteen inches long, nine wide, and two deep, the top of which is to slide on and off, at the end Y. Toward the end X, describe a circle of six inches diameter, round which are to be fixed six small vases of wood or ivory, of one inch and a half high; and to each of them there must be a cover.

At the end Y place an egg B, of ivory or other matter, of about three inches and

a half

a half high, with a cover that ſhuts by a hing, and faſtens with a ſpring. It muſt be fixed on the ſtand C, through which, as well as the bottom of the egg, and the part of the box directly underneath, there muſt paſs a hole of one-third of an inch in diameter. In this cavity place an ivory cylinder F, that can move freely, and riſes or falls by means of the ſpring R. You muſt have a thin copper baſon A, of ſix inches diameter, which is to be placed on the center of the circle at X, and conſequently in the middle of the ſix vaſes.

Let a proper workman conſtruct the movement expreſſed by Fig. 2. which is compoſed of a quadrant G, that has 16 teeth, and is moveable about an axis in the ſtand H, that has an elbow, by which it is ſcrewed to the bottom of the box at L. To the quadrant there muſt be joined the ſtrait piece K. The horizontal wheel M, has 24 teeth, and is ſupported by the piece S, which is ſcrewed to the end of the box

box next Y. On the axis of this wheel place a braſs rod O P, five inches long, and at the part O place a large bar or horſe-ſhoe, of a ſemicircular form, and about two inches and a half diameter, ſtrongly impregnated. The ſteel rod V, takes at one end the teeth of the quadrant G, by the pinion F, and at the other end the wheel M, by the perpendicular wheel N, of 30 teeth; the two ends of this rod are ſupported by the two ſtands that hold the other pieces. Under the piece K, that joins to the quadrant, muſt be placed the ſpring R, by which it is raiſed, and puſhes up the cylinder that goes through the ſtand C into the egg.

You muſt alſo have ſix ſmall etwees or caſes as Y, Fig. 3. They muſt be of the ſame circumference with the cylinder in the ſtand, and round at their extremities: their length muſt be different, that when they are placed in the egg, and the lower end

enters

enters the hole in which is the cylinder, they may thruſt it down more or leſs, when the top of the egg, againſt which they preſs, is faſtened down; and thereby lower the bar that is fixed to the end of the quadrant, and conſequently, by means of the pinion F, and wheels N, M, turn the horſeſhoe that is placed upon the axis of the laſt wheel *.

In each of theſe etwees place a different queſtion, wrote on a ſlip of paper and rolled up, and in each of the vaſes put the anſwer to one of the queſtions; as you will know, by trials, where the magnetic bar or horſeſhoe will ſtop.

Laſtly, provide a ſmall figure of a ſwan, or what other you pleaſe, made of cork or enamel, in which you muſt fix a touched needle, of the largeſt ſize of thoſe commonly uſed in ſewing.

* Theſe exact length of theſe etwees can be determined by trials only; which trials, however, may be made with round pieces of wood.

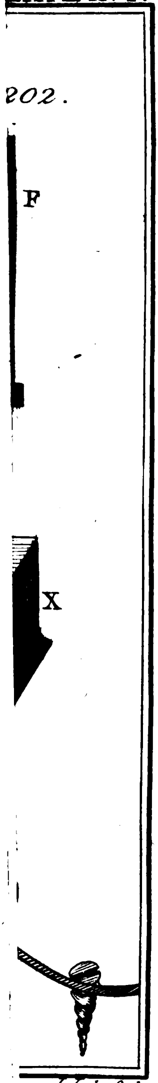
Being thus prepared, you offer a perſon the ſix etwees, and deſire him to chooſe any one of them himſelf, and conceal the others, or give them to different perſons. He is then to open his etwee, read the queſtion it contains to himſelf, and return the etwee to you, after replacing the queſtion. You then put the etwee in the egg, and placing the ſwan upon the water in the baſon, you tell the company ſhe will preſently diſcover in which of the vaſes the anſwer is contained. The ſame experiment may be repeated with all the etwees.

This apparatus is more commodious than that of the ſiren, as it may be eaſily moved from one place to another, and as there is here no occaſion for a confederate. But at the ſame time it will not admit of ſo great a variety of experiments.

CON-

LATE XVI.

202.



J. Lodge Sculp.

CONSTRUCTION OF THE COMMUNICATIVE BELL.

LET there be made a box of copper in the form of part of a hollow covered cylinder, as A B (Pl. XVII. Fig. 1.) This box muft be placed upon the circle of wood C, that has at its center a pivot, on which is to be placed a touched needle D, three inches long, and thicker than the common needles; at each end it muft have a very fmall brafs knob, and near to one end of it there muft be placed a fmall bell, like that of a repeating watch; the bottom of this box muft be clofed with a gauze, that the needle may not be vifible.

On the infide of the magnetic table, Pl. XIV. place a double bar M O, of about five inches long, ftrongly impregnated, and fixed on an axis, under which is placed a double pulley of an inch diameter. To one part of this pulley fix a fmall cord, the other end being faftened to the fpring N. From

From the other part of the pulley muſt go a cord that paſſes over another pulley at A, and from thence, through the leg H, and behind the partition W; in the ſame manner as in the experiment of the ſiren.

The motion of this cord being conſtantly the ſame, and of very little extent, a lever may be fixed behind the partition, by which the magnetic bar may be readily moved from B to C.

This preparation being made, when you place the copper box or cylinder on the table, in ſuch manner that the pivot which holds the needle is directly over that which holds the magnetic bar in the table *, if the lever behind the partition be thruſt down, the bar will be moved from B to C, and will cauſe the ſame motion in the needle, and conſequently make it ſtrike againſt the bell in the cylinder.

* There muſt be a mark on the cylinder, by which you will be directed in placing it on the table.

RECRE-

RECREATION XLVIII.

To tell, by the communicative bell, the card that a perſon has drawn from the pack.

YOU are firſt to obſerve, that the ſounding of the bell ſignifies *yes*, and its ſilence *no*.

Open the pack before the perſon, and dextrouſly preſent that card to him which you have agreed on with your confederate. When the perſon has drawn that card you interrogate the bell, after the following manner. Suppoſe the card drawn to be the knave of ſpades.

Queſtions.	Anſwers.
Do you know the perſon that has drawn the card?	Yes.
Is it a gentleman?	No.
Is it a lady?	Yes.
Do you know her?	Yes.
Is ſhe handſome?	Yes.

Are

Questions.	Answers.
Are you ſure you know the card?	Yes.
Is it a diamond—a heart—a club?	No.
Are you ſure you are not miſtaken?	Yes.
Is it then a ſpade?	Yes.
Is it the king—ten—nine of ſpades?	No.
Is it the knave?	Yes.

This manner of anſwering queſtions may be applied to various intentions; as to naming the hour, or the number of perſons in company, &c. The foregoing Recreation is ſufficiently common; the following is ſomething more extraordinary.

To tell, by the bell, at what number, from the top, any card of a pack is; that a perſon ſhall name.

To perform this Recreation you muſt be provided with a piquet pack of cards, in which the ſeveral ſuites are placed in the

the following order, diamonds, ſpades, hearts, and clubs: and the cards of every ſuite in their natural rank, as ace, king, queen, knave, ten, &c.

You ſhuffle them, according to the manner preſcribed in p. 79. of the firſt volume, and they will then be in the following order.

1	Knave	clubs	17	Eight diamonds	
2	Ten		18	King	ſpades
3	Eight	hearts	19	Queen	
4	Seven		20	Knave	
5	King		21	Eight	
6	Queen		22	Seven	
7	Ten	ſpades	23	Ace	hearts
8	Nine		24	Knave	
9	Seven diamonds		25	Ten	
10	Ace ſpades		26	Nine	
11	Queen	diamonds	27	Ace	clubs
12	Knave		28	King	
13	Ace		29	Queen	
14	King		30	Nine	
15	Ten		31	Eight	
16	Nine		32	Seven	

A copy of this arrangement your confederate muſt have. Therefore when the perſon has named the card he chooſes, he who is behind the partition hearing what card it is, either by the other's naming it, or your repeating it, by looking on his ſcheme will ſee the number at which it is placed, and immediately ſtrike that number on the bell.

This Recreation is the more extraordinary, as it may be repeated a ſecond or third time, by your ſhuffling the cards in a determinate order; nothing more being neceſſary than for the confederate to have a ſcheme of the ſituation of the cards after each ſhuffle.

RECRE-

RECREATION XLIX.

The magnetic balance.

YOU muſt have a ſmall balance, ſuch as is commonly uſed for weighing money, as A B (Plate XVII. Fig. 2.) It ſhould be very exact, and the ſcales muſt be iron or ſteel, very thin, and gilt or laquered. This balance muſt be ſupported by a ſtand fixed to the top of the magnetic table. The bottom of the ſcales ſhould not be above half an inch diſtant from the table.

You muſt obſerve, that they are to be placed over that part of the table where is the magnetic bar that is uſed for the ſiren and bell: ſo that the centers of the two ſcales are to be over the points O and M. Theſe ſcales muſt be ſtrongly touched, that they may be the more eaſily attracted by the magnetic bar.

This preparation being made, you aſk a perſon to lend you two pieces of money, ſuppoſe two guineas, and you place them in the ſcales, which will remain in equilibrium, if the pieces be of equal weight. You then propoſe to the perſon to augment the weight of either of them at pleaſure, and when he has determined, your confederate behind the partition, by means of the lever, moves the bar toward one of the ſcales, and it immediately deſcends. You then, if required, make the ſame experiment with the other ſcale.

To give your confederate notice which ſcale is to be moved, nothing more is neceſſary than to ſay, is it *this*, or is it *that* ſcale; you having previouſly agreed with him which ſcale the words *this* or *that* ſhall ſignify.

RECRE-

RECREATION L.

The sympathetic dials.

LET there be two dials constructed of the same form and size. The movements of each consisting of a barrel A, and the four wheels A, B, C, D, with their pinions, and the fly F. The same as in the striking part of a clock or dial. (See Pl. XVII. Fig. 3.)

The movements of each of them must be enclosed between two plates of brass G and H, Fig. 4. of about two inches and a half diameter, and distant from each other about two-thirds of an inch. Let the axis of the wheel C pass through the center of the upper plate G, which is to be covered with a dial plate, that serves for ornament only. On the same axis place a needle or index, as in a common dial.

Under the plate H, Fig. 3. and on the axis of the barrel, continued out beyond the plate, fix a wheel with a catch, by which the movement of each of the dials may be wound up.

To one of theſe dials let there be a catch or trigger on the outſide, by which it may be ſtopped or put in motion with a touch of the finger. To the other dial fix the catch L N M, whoſe axis is at N; the end L takes the fly of the movement, and conſequently when the other end is thruſt back the wheels are at liberty to move. This catch is to be placed on the braſs wheel H, near the part I. It is to be of ſteel, well poliſhed and touched, with its ſouth pole at M. Great care muſt be taken to make this part move extremely free, that it may be eaſily attracted by the bar in the magnetic table, on which it is to be placed. Each of theſe dials is to be encloſed in a caſe of thin copper or braſs Q R.

On the inside of the magnetic table, Plate XIV. place the piece O P, composed of four steel bars strongly impregnated: they should be seven or eight inches long, half an inch wide, and one inch thick: they must be bound close together by four brass rings, of which that next P should be larger than the rest, and standing out beyond the bars, should have a hole thro' it, by which it is to be fixed on a pivot at P. These bars are to be drawn toward N, where they are to be stopped by the spring R. There must also be a string, which, passing over the pullies S and T, goes down the leg of the table; the bottom of which is to be a lever or treddle, under the step, by means of which the piece O P may be moved by your foot.

You therefore place the second dial on the table, directly over that part where the extremity of the bars O P is; when you put your foot upon the lever at the bottom of the table. Therefore if you then place your foot on that lever, the bars attracting the end M, of the catch, will set the fly at liberty, and the wheels being put in motion, the index on the front of the dial will move with considerable velocity; but when you take your foot off the lever, the catch will again take the fly, and stop the movement.

Therefore having placed the second dial as above directed, you give the other dial, that had the end of the catch on the outside, to any person, and tell him, that when he shall stop it, or put it in motion, the dial on the table will, by sympathy, do the same, and by mounting the step you make it perform accordingly. You may also tell him that the dial on the table shall either stop or go, at his command: but this perhaps may destroy the notion of the dials acting by sympathy.

You

You may contrive to have ſtops or levers at different parts of the room, by carrying the cord under the floor: or in an adjacent room, to be moved by a confederate.

CONSTRUCTION OF THE MAGNETIC ROLLER.

PROVIDE a board two feet and a half long, three inches and a half wide, and half an inch thick, (ſee Plate XVII. Fig. 5.) and divide it into ten equal parts, in each of which deſcribe a circle, and divide its circumference likewiſe into ten equal parts. In each of the circles make a groove, and in each groove place a magnetic bar, whoſe poles are to be diſpoſed as in the figure. Under each end of the board place a roller, on which it is to move in the magnetic table, Plate XIV.

To the end A of the roller (ſee Pl. XIV.) faſten a cord, which is to paſs over a pulley at B, and go down the leg of the table:

to

to the end of this cord is to be faſtened a weight, incloſed in a bag, which is to paſs freely up and down the hole at B. To the other end B, of the roller, there muſt likewiſe be faſtened a cord, which, paſſing over a pulley at A, going down the leg of the table, and through the ſtep at the bottom, comes out behind the partition W.

Againſt the other ſide of the partition place the table in page 220; and at the top of it fix a pulley, over which muſt paſs a ſtring, with a weight at the end, and to the ſtring muſt be faſtened an index; as in the experiment of the ſiren.

The table is formed in the following manner. You are firſt to determine by trials, the ſpace that the index faſtened to the ſtring paſſes over, while each of the ten diviſions of the roller comes to the point S, in the magnetic table; and mark them down on the plan. Then divide it into five columns. In the ten diviſions of the first column write the numbers 10, 9, 8, 7, 6, 5, 4, 3, 2, 1. In the ten divisions of the second column write the vowels A, E, I, O, U, and the five consonants D, G, L, N, R. In the divisions of the third column write the figures 1, 2, 3, 4, 5, 6, 7, 8, 9, 0. In the fourth column, in every other division, write the name of one of the five following cards, ace of spades, eight of spades, seven of spades, nine of hearts, seven of hearts. In the fifth column write, after the same manner, the names of five states, as England, Portugal, Spain, Prussia, Austria. You may place what other letters you please in the second column, but they should be such as by their combinations will produce several words. The words in the fourth and fifth columns may likewise be changed for such as will answer to any other questions you choose.

TABLE

TABLE.

Divisions	Letters	Figures	Cards	States
10	A	1	ace spades	
9	E	2		England
8	I	3	8 spades	
7	O	4		Portugal
6	U	5	7 spades	
5	D	6		Spain
4	G	7	9 hearts	
3	L	8		Prussia
2	N	9	7 hearts	
1	R	0		Austria

Now it follows from what has been said, that when the person behind the partition fixes the index in the cord against any one of these divisions, the part of the roller which corresponds to that division will be brought opposite to the point S, in the magnetic table, and consequently the touched needles in the pieces hereafter described, will place themselves in the same direction with the bar in that part of the roller.

THE

XVII.

7.

RECREATION LI.

The magician's box.

FIRST conſtruct the baſe AB, (Plate XVIII. Fig. 1.) of ſix inches long, four wide, and one deep. Let it be hollow, and covered with a piece Q, that ſlides in in a groove. In the middle of the top piece make a hole, either ſquare or round, of about half an inch wide.

On this baſis place four planes of glaſs F, Fig. 2. joined together in the form of a truncated pyramid, and lined with gauze, or thin paper. At its bottom IL, it ſhould be two inches and a half ſquare, but at top only one inch and a half. At the opening place a convex glaſs V, of five inches focus, that is, equal to the height of the machine. Let it be fixed to the baſe AB.

On the inſide of the baſe, and at two inches diſtance from one of its ſhorteſt ſides, fix a pivot, on which is to be placed the

the circle of pasteboard O P, Fig. 3. of four inches diameter, in which must be fixed the touched needle Q R. The pasteboard circle must be divided into ten equal parts, as in the figure; which parts are to correspond to the divisions in the foregoing table. In the five divisions 1, 3, 5, 7, 9, are to be drawn the cards there expressed.

On a second circle of pasteboard, that has the same divisions, write in those marked 2, 4, 6, 8, 10, the five names of different states mentioned in the foregoing table.

As each circle must be previously placed on the base, and changed for every different recreation, it will be proper to have two boxes, as it would be impolitic to change the circles before the spectators. It would be still much better if the box could be placed in a chest or cabinet, that was fixed against a partition, behind which

which a confederate is placed; for then, after performing one recreation, the box might be placed in the cabinet, and the confederate, by a private opening in the partition, might take out the circle, and insert another.

It will be easy to conceive, from what has been already said, that when the machine is placed on the magnetic table, at the part S, so that the pivot on which the circle turns is exactly over the point S, the bar in the part of the roller then there, will put the needle in a similar direction, and consequently by looking into the machine, the spectator will see the card, letter, or word, that is opposite the index in the table of columns.

A perſon is to name the ſtate in which is the city whoſe name is on the cards that have been dealt to another.

On thirty cards write the names of the five following cities; London, Liſbon, Madrid, Berlin, Vienna. Then ſhuffle and deal them after the manner explained in page 79. of the firſt volume.

Then tell the ſecond perſon to look into the box, and read the name of the ſtate in which is the city whoſe name is on the cards in the firſt perſon's hand. The ſame is to be done for the four other parties.

To perform this Recreation, nothing more is neceſſary than to have a circle with the names of the five ſtates; and that the confederate be inſtructed in the order that each name is to be brought forward to the eye of the ſpectator.

In

In recreations of this kind it will be proper to have a hole in the partition, by which the confederate will know when to move the circle, and keep it ſteady till he who performs the experiment has covered the eye-glaſs of the box.

RECREATION LII.

The myſtical dial.

PROVIDE a board four inches ſquare, and let it be ſupported at the four corners by feet about one quarter of an inch high, as A B (Plate XVIII. Fig. 4.) On this board draw two concentric circles, and divide them into ten equal parts, in nine of which write one of the numbers from 1 to 9, and in the tenth an o. Theſe numbers muſt be placed in the ſame manner as in the figure, and the line A B muſt divide the diviſions marked 1 and 6, into two equal parts. At the center of this dial place a needle of a convenient ſize.

It is evident from the conſtruction of this dial, that when the perſon behind the partition places the index of his table againſt any number in the third column, the needle of this dial, when it is placed over the roller in the magnetic table, will point to the ſame number.

To ſhow, by the foregoing dial, the numbers that two perſons have choſe, their ſum, or their product.

You muſt here have the ſmall bag deſcribed in p. 140: in the firſt diviſion of which put the numbers from 1 to 10, and in three other diviſions any numbers you pleaſe, ſuppoſe 3, 7, and 8; that is, all the tickets in each of thoſe three diviſions muſt have the ſame number. You then offer two different diviſions of the bag to two perſons, and they each draw one number, ſuppoſe 5 and 7, you having previouſly agreed with your confederate what the numbers are to be.

You

You then aſk them whether the index ſhall point to their numbers ſucceſſively, their amount, or their product when multiplied together.

If the numbers are to appear ſingly, the confederate firſt directs the index of his table to the number 5, which you are to allow him a ſufficient time to do. You then place the index on the dial, and turning it about it will ſtop at that number. You take off the index while your confederate moves the ſlider, and placing it on again it will then ſtop at 7.

If the amount of the two numbers be required, the confederate directs his index firſt to 1 and then to 2, which make 12. If the product be required, he directs the needle, in like manner, firſt to 3 and then to 5, which make 35.

You muſt obſerve to take the needle off the pivot immediately after it ſtops, before the roller begins to move again: and as the needle will place itself directly in the position of the bar underneath, you must turn it about as soon as you have placed it on the pivot. Attention should be had to this observation in all the experiments with the magnetic needle.

RECREATION LIII.

The magical game of all-fours.

TO perform this Recreation you must have a pasteboard circle, on which there are twelve divisions, on six of which cards are to be painted, and to which six divisions of the roller must be adapted. A pack of cards are to be previously ranged and shuffled, after the manner described in the first volume, p. 78. and when they are dealt, the hands are to be as follows.

Eldest

Eldeſt		Youngeſt	
King Ten	ſpades	Ace Queen Nine	ſpades
Ace clubs			
Ace diamonds			
King Knave	hearts	Ace Queen Eight	hearts

Turn-up card, knave of ſpades.

The eldeſt takes up his cards. Thoſe dealt for the youngeſt lie on the table. Now the natural way of playing the above cards would be as follows: firſt, the eldeſt hand would lead one of his aces, which the youngeſt would win with his nine of trumps; and then play his ace and queen of hearts, the latter of which the eldeſt would win with his king: he would next lead his other ace, to which the youngeſt would play his eight of hearts. The eldeſt muſt then lead from his king and ten of trumps, both which the youngeſt muſt take with his ace and queen, and conſequently have higheſt, loweſt, and game,

 which,

which, with the knave turned up, will make him all-fours.

Therefore when the eldeſt plays, you ſay aloud to another perſon, the gentleman plays the ace of clubs, for example, look in the box and ſee what card I muſt play; when your confederate will directly bring the nine of trumps on the circle to view. When it is your turn to play, you have no occaſion to ſay any thing, but only deſire the perſon to look in the box and ſee what card is played, your confederate having directions what to do. Thus you go on till the eldeſt has played all his cards. But you muſt obſerve, each time the circle is to be moved to prevent the perſon from immediately looking into the box, by ſome amuſing diſcourſe; or it might be better to ſtand by the box yourſelf, in order to cover and uncover it each time the perſon is to look in, that the circle may have time to ſettle.

RECRE-

RECREATION LIV.

The intelligent fly.

AT the center of a box about fix inches fquare and one inch deep (Pl. XVIII. Fig. 5.) place a pivot. Have a touched needle L, three inches and a half long, and at the end of it that is touched fix a fly made of enamel: the other end of the needle muft be fomething heavier, to keep it in equilibrium. This needle is to be placed on the pivot.

On a piece of fquare pafteboard that will juft go into the box, draw a circle, ABCD, three inches and a half diameter; and another at a fmall diftance, concentric with the former. The part within the laft circle muft be cut out. This pafteboard circle is to be placed about half an inch from the bottom of the box, and divided into ten equal parts, in which are to be wrote the letters A, E, I, O, U, D, G, L, N, R, as in the figure.

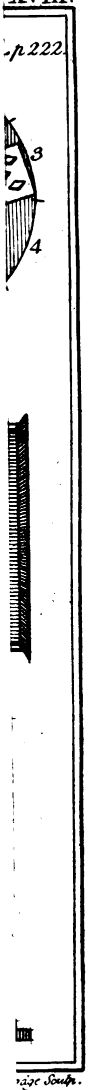
Place a glaſs about half an inch above the circle, and cover it with a circle of paper C, large enough to hide the needle, and leave only the fly viſible; on this paper you may paint ſome allegoric figures, that its uſe may not be ſuſpected. You muſt next write on 24 cards the following queſtions. Theſe cards are to be packed and ſhuffled, according to the method explained in the firſt volume, p. 78. that they may be in the order the queſtions are here placed.

QUESTIONS.

1. Which is the land of liberty? 2. Which is the firſt city in the world? 3. Whom do many men deſpiſe, though they have not half his merit? 4. Who is the pooreſt man in the world? 5. Who is the meaneſt of all mankind? 6. For what do all young women long? 7. Who, by ſtation, is the moſt

XVIII.

p 222.



Soulp.

most miserable of all beings. 8. By what does a man discover his weakness? 9. What would every married woman do if she could? 10. In what does a man show his pride and folly? 11. What makes a woman cry more than the loss of her husband? 12. How does a man talk who has nothing to say? 13. What most resembles a fine lady? 14. What frequently reminds us of a great loss, without giving disgust? 15. What makes a young woman in love with an old man? 16. What does the poet want to cover his empty skull? 17. What should a man never take from the woman he loves? 18. What must that man be who would gain the esteem of all? 19. Who is he that seeks a man's company when his money and friends are all gone? 20. What gains the good will of the physician, the lawyer, and the harlot? 21. What do good men revere and knaves abuse? 22. What does a man depend on when he trusts to his friends for support?

23. What can he be ſure of, who leaves his affairs to other? 24. What makes as great a difference almoſt, if not altogether, between this man and that, as between that and a brute?

After you have ranged the cards in the manner before mentioned, you place them on the table, and aſk any perſon which of them, in the order they then ſtand, ſhall contain the queſtion to which the fly ſhall give him the anſwer. If he ſay, for example, the 20th, your confederate, who has the following copy of the anſwers, will make the needle, at the end of which the fly is, ſucceſſively point to the letters that compoſe that word: then counting the cards over till you come to the 20th, you will find that word anſwer the queſtion.

ANSWERS.

1. England. 2. London. 3. A dog. 4. A niggard. 5. A liar. 6. A ring.

7. A

7. A nun. 8. Anger. 9. Rule. 10. A duel. 11. An onion. 12. Loud, 13. An angel. 14. A dial. 15. Gold. 16. A laurel. 17. A denial. 18. Generous. 19. A dunn. 20. A guinea, 21. Religion. 22. A reed. 23. Ruin. 24. Learning.

Many other recreations may be performed by this intelligent fly by numbers, cards, &c. similar to thoſe we have already explained on other occaſions, and which, to avoid the appearance of repetition, we ſhall not here deſcribe.

RECRE-

RECREATION LV.

The multifarious verse.

THE eight words that compose this Latin verse,

Tot sunt tibi dotes quot cœli sidera virgo *,

being privately placed in any one of the different combinations, of which they are susceptible, and which are 40,320 in number, to tell the order in which they are placed.

Provide a box that shuts with hinges, and is eight inches long, three wide, and half an inch deep (Plate XIX. Fig. 1.) Have eight pieces of wood about one-third of an inch thick, two inches long, and one and a half wide, which will therefore, when placed close together, exactly fill

* Thy virtues, virgin, are as numerous as the stars of heaven.

the

the box. In each of these pieces or tablets place a magnetic bar, with their poles as is expressed in the figure. The bars being covered over, write on each of the tablets, in the order they then stand, one of the words of the foregoing Latin verse.

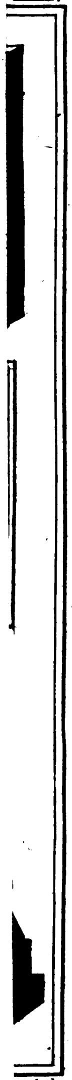
On a very thin board of the same dimension with the box, Fig. 2, draw the eight circles, A, B, C, D, E, F, G, H, whose centers should be exactly over those of the eight tablets in the box, when the board is placed upon it. Divide each of those circles into eight parts, as in the figure, and in each of those divisions write one of the words of the Latin verse, and in the precise order expressed in the plate, so that when the board is placed over the box, the eight touched needles placed at the center of the circles may be regulated by the poles of the bars in the box, and consequently the word that the needle points to in the circle be the same with that inscribed on the tablet. Cover the board with a glass

glaſs to prevent the needles from riſing off their pivots, as is done in the ſea-compaſs.

Over the board place four plates of glaſs, I, L, M, N, Fig. 3, which will give the machine the figure of a truncated pyramid, of eight inches high. Cover it with a glaſs, or rather a board in which are placed two lenſes of eight inches focus, and diſtant from each other about half an inch. Line the four plates of glaſs that compoſe the ſides with very thin paper, that will admit the light, and at the ſame time prevent the company from ſeeing the circles on the board.

Theſe preparations being made, you give the box to any one, and tell him to place the tablets on which the words are wrote, privately, in what poſition he thinks proper, then to cloſe the box, and if he pleaſe, to wrap it up in paper, ſeal it, and give it you. Then placing the board with the pyramid upon it, you immediately tell him

XIX.



...o Sculp.

him the order in which the tablets are placed, by reading the words to which the needles on the circles point.

This Recreation, which appears to have been invented by M. Guyot, is of the ſame nature with that of the box of numbers, that has been frequently exhibited, but much more entertaining. For here there is not only a vaſt number of combinations to be formed, but the words at the ſame time conſtantly preſerve one meaning. If the firſt inventors of this ſort of recreation had made uſe of words in this manner, inſtead of numbers, the inveſtigation would have been attended with much more difficulty.

RECRE-

RECREATION LVI.

The communicative mirror.

LET there be made a box AB, (Plate XX. Fig. 1.) the top of which draws off at the end A. Let it be on the inside nine inches long, six wide, and two-thirds of an inch deep. At the bottom of this box, and at three inches distance from the end A, fix a pivot, on which is to be placed the circle of pasteboard M, Fig. 2. that contains a touched needle. Divide this circle into four equal parts, in three of which paint three cards, in the position expressed in the figure.

In the top of the box make a hole an inch and half in diameter, over which place the pedestal CD, composed of four plates of glass, covered on the inside with very thin paper.

On the top of the pedeſtal place the tube E F, about ſix inches long and one and a half in diameter. In this tube, at M, is to be fixed an inclined mirror, by which the part of the paſteboard circle under the hole at L, may be ſeen by the eye at G. At the end F of the tube place an eye-glaſs, whoſe focus is equal to the diſtance G M; and at the end E, any glaſs you pleaſe. At the end B of the box, place the mirror T V, which ſerves to make the ſpectator think it is in that he ſees the card on the paſteboard.

In the box ABCD, Fig. 3. that ſhuts with hinges, and is of the ſame dimenſion with the inſide of the other box, are to be placed ſucceſſively the three tablets X, Y, Z, in one determinate poſition. In each of theſe tablets muſt be fixed a magnetic bar, in the manner expreſſed in the figure, and on each of them is to be paſted one of the ſame cards with thoſe on the paſteboard circle. One of these tablets, as, for example, that marked Z, being placed in the box, in the manner expressed in the third figure, the needle on the circle will place itself in a corresponding position, and the similar card on the circle will come under the pedestal. You therefore present the box, Fig. 3. and the three tablets, to a person, desiring him to place any one of them he thinks proper, in the box, privately; then to conceal the others, and after he has closed the box, to return it you. Then, placing the first box with the pedestal, tube, and mirror over the other, you direct him to look in the seeming perspective-glass, when he will see the figure of the card he placed in the box, and it will appear to him to be in the mirror CV.

You may have a fourth tablet, that contains a bar, but on which there is nothing painted. This tablet you may place first

in

in the box, and let the party ſee that when there is no card in the box he cannot ſee any in the perſpective.

RECREATION LVII.

The box of dice by reflection.

LET there a ſmall box of wood, ABCD, (Plate XX. Fig. 4.) ten inches long, two wide, and one and a half high. At the two ends of this box fix the two hollow cubes I, L, one inch and a half ſquare, in which are to be placed two dice exactly of the ſame dimenſion.

The ends AC and BD of the box are to have ſliders that draw up, in the manner expreſſed by Fig. 5. There muſt be likewiſe at each end a ſmall pannel M, that may be raiſed or depreſſed one-tenth of an inch, by which a ſmall hole at N may be covered or uncovered; and through this hole you are to ſee into the box.

The top and two longeſt ſides of the box are to be of glaſs, lined with a thin paper. Within the box are to be placed two mirrors O P and Q R, at an angle of forty-five degrees, by which, when you look through the holes at the two ends of the box, you will eaſily ſee the bottoms of the two cubes I, L, that are placed on it.

Divide the bottoms of the cubes juſt mentioned into four equal parts, by diagonals drawn from the oppoſite angles, as in Fig. 8. and again divide that ſide next the middle of the box into ſix equal parts, which are to correſpond to the ſix points that are on a die.

Under each of the cubes place a ſmall braſs ſtand A B, Fig. 6. which is to be difdispofed as in Fig. 7. On the ftand there muft be a pivot, directly under the center of the cube, and it muft hold two needles, one of brafs and the other of fteel, and touched. Thefe needles are to be placed at right angles to each other, as in the figure.

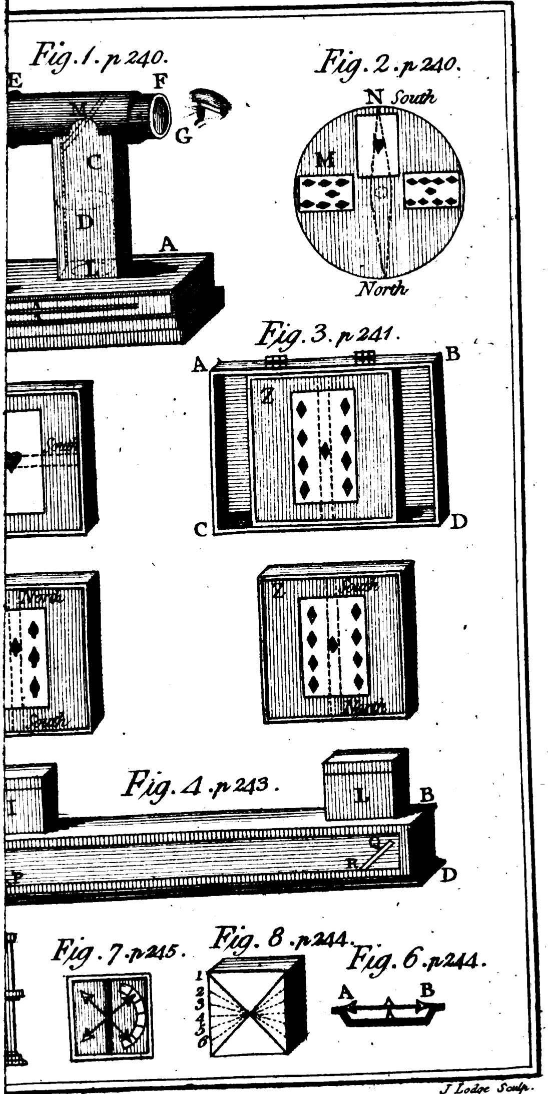
Divide each face of the die into four equal parts, by diagonals from the oppofite angles, and then divide each fide into fix equal parts, and in each fide of the die, oppofite to one of thofe parts, each different from the other, place a magnetic bar one inch and a quarter long, two-tenths of an inch wide, and one-tenth thick. All the divifions on thefe dice muft be very exact: cover them with double papers, and write on each fide of them the points it is to exprefs, when its oppofite fide is next the touched needle: they are then to be placed in the two hollow cubes, which are to be covered.

 This

This machine being conſtructed with care, according to the foregoing directions, you preſent the two dice to any perſon, and deſire him to place them privately in the two cubes, in what poſition he pleaſe, and put on their covers. Then looking through the two holes, you immediately tell him, by the direction of the needles to the under ſides of the cubes, the exact number of points they compoſe.

THE

PLATE XX.



J Lodge Sculp.

THE

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RECREATION I. p. 46

The animated feather.

A feather being brought near an excited tube is first attracted by it and then repelled, and the tube cannot be brought close

close to the feather, till it has touched ſome other body.

RECREATION II. p. 48

The ſelf-raiſing pyramid.

A large bundle of threads being ſuſpended from the electric branch, (Plate IV. Fig. 3.) will riſe up in form of a pyramid, and continue ſo as long as the wheel is turned, but when that ceaſes the threads will reſume their firſt poſition.

RECREATION III. p. 49

The magical dance.

Three bells are ſuſpended from the electric branch, and between them hang two braſs knobs. The bells being electrified will attract the clappers, and be ſtruck by them, and the ringing will continue as long as the machine is in motion. This is the muſic for the dance. A plate is then ſuſpended from the branch,

branch, and on a metal ſtand, placed under it, are put the figures of men, which being attracted by the plate will be in continual motion. This Recreation may be ſuſpended or renewed at pleaſure.

RECREATION IV. p. 52

The artificial ſpider.

The body of this ſpider is of cork, and its legs of linen thread. When it is held, by a fine line of ſilk, between the electric branch and an excited ſtick of wax, it will appear to be animated, continually jumping from one to the other.

RECREATION V. p. 53

The marvellous fountain.

A veſſel of water, in which a ſyphon is placed, being ſuſpended from the branch, as ſoon as it is electrified the water will begin to flow, and when the electrification is strong several streams will issue, in form of a cone. This experiment may be diversified by using a fountain made with condensed air.

RECREATON VI. p. 54

The magic picture.

This picture or print must have a frame and glass. The border of the print is cut off, all round: the upper and under part of the middle of the glass is covered with tin-foil, that communicates by the bottom of the frame: over this tin-foil the print is pasted. When the picture is a portrait a crown is placed on its head, which a stranger attempting to take off, at the same time he holds the frame by the bottom, receives a smart shock, and fails in the attempt.

RECREATION VII. p. 56

The Tantalian cup.

A metal cup is placed on a ſtool of baked wood, and a chain from the branch is fixed to the cup. A perſon endeavouring to taſte the liquor in the cup, receives a ſhock. The machine being ſtopped, another perſon drinks out of the cup with eaſe: the machine being again put in motion, the firſt perſon again attempts to taſte the liquor, and receives a ſecond ſhock.

RECREATION VIII. p. 58

The circular chimes.

A round board is fixed to a perpendicular axis, and ſeveral glaſs radii iſſue from the board, and to the end of each of them is fixed a braſs thimble. Two wires that are joined to the hooks of the electric table, (Pl. IV.) and which are dif-

differently electrified, put the wheel in motion, by being properly applied to the thimbles, and the motion increases till it goes fifteen rounds in a minute. Two semicircular stands, that hold several bells, being then brought near the wheel, they are alternately and incessantly struck by a radius fixed to the upper part of the axis. This wheel is sometimes used as a jack for roasting meat p. 60 (note)

RECREATION IX. p. 62

The self-moving wheel.

This wheel is constructed on the same principle as the foregoing. A circular plate of glass, gilt on both sides, is fixed to a perpendicular axis: on the edge of this wheel are fixed two bullets, one communicating with the upper surface, and the other with the under surface; twelve small pillars of glass, with a thimble on the top of each of them,

them, are fixed in a circular ſtand, round the wheel. When this wheel is well charged, the bullets on its edge being differently electrified, attract and repel the thimbles alternately, and thereby give the wheel a motion that increaſes continually, till it goes more than 20 turns in a minute, and the motion will continue half an hour. The celerity of this wheel may be increaſſed by an additional number of bullets.

RECREATION X. p. 65

The magician's chace.

A wire is placed perpendicular to the branch, and on the top of it turn ſeveral horizontal wires, the points of which are bent in oppoſite directions, and on them are fixed the figures of men, horſes, hounds, &c. When theſe wires are electrified they will turn ſwiftly round, and the figures will ſeem to purſue each other. This Recreation may be improved by another ſet of wires, placed

placed over the former; or by giving the figures a progressive, as well as a circular motion p. 67

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The planetarium.

Six concentric hoops of metal are suspended from the branch; under and near to them is placed a metal plate, on which are put glass bubbles, between the hoops; these bubbles correspond to the planets, the hoops to their orbits, and a ball hung over the center of the hoops represents the sun. When the hoops are electrified the balls will move round them, and the motion will continue as long as the operator thinks fit.

RECREATION XII. p. 69

The incendiaries.

A person standing on a cake of wax holds a chain that is connected with the branch, and putting his finger into a dish

dish containing spirit of wine, it will be immediately in a blaze; and if a wick that communicates with the spirit be laid to a train of gunpowder, it may blow up a magazine, or set fire to a city. This experiment may be diversified by making the electricity pass through several persons that touch each other.

RECREATION XIII. p. 72

The inconceivable shock.

A person holding a chain that is joined to one of the hooks of the electric table, attempts to fix a wire on the other hook, when he instantly receives a shock through the body, without knowing from whence it proceeds. This Recreation may be diversified by concealing the chain under a carpet on which a person treads, and by laying a wire that communicates with the other hook, in such manner that he may accidencidentally take hold of it. Methods of communicating the ſhock to a great number of perſons at the ſame time p. 73

RECREATION XIV. p. 75

Magical exploſions.

Gunpowder is made up in the form of a ſmall cartridge, in each end of which is put a blunt wire; the ends of theſe wires within the cartridge are about half an inch diſtant. Two chains, that communicate with the two hooks in the electric table, being joined to the external ends of the wires, the electric fire will paſs through the cartridge, with an inſtant exploſion. By a ſimilar method braſs or iron wire may be melted.

RECREATION XV. p 78

Priſmatic colours.

A tin plate is placed between two wires that communicate with the two hooks of the electric table, and after many explosions three distinct rings appear, each of which contains all the colours of the prism or rainbow. This experiment corroborates the Newtonian doctrine of colours p. 78 (note)

RECREATION XVI. p. 81

The artificial earthquake.

An edifice, composed of several loose pieces, is placed on a board in the middle of a large bason of water. A wire that communicates with the hooks in the table, being laid over the board and the surface of the water, they become greatly agitated by the explosion, and the edifice is laid in ruins.

RECREATION XVII. p 82

The electrical kite.

This kite consists of a large thin silk handkerchief, whose corners are fastened to the

the ends of two ſlips of cedar, and to the top of the upright piece is fixed a pointed wire, about a foot long: the other parts are the ſame as in a common kite. To the end of the twine next the hand a ſilk ribband is tied, and where the twine and ribband join a key is hung. This kite is raiſed when thunder is approaching. The electricity is conducted from the wire of the kite to the twine, and from that to the key, by which a phial may be charged and all the common experiments in electricity performed. Account of ſome very extraordinary phenomena that were produced by an electric kite in the ſouth of France p. 83

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RECREATION XVIII. p. 91

The miraculous luminaries.

Method of making the phoſphorus proper for this Recreation. The figure of the moon and ſtars being drawn on a board, a quantity of the phoſphorus is fixed over them, and a number of phials are diſcharged on the phoſphorus, by which the figures are ſtrongly illuminated. The board is then placed againſt the cieling, and the luminaries appear as ſhining in the zenith.

RECREATION XIX. p. 94

The globular fires.

Theſe fires are produced by the globe and cuſhion only, without the conductor. The globe being ſtrongly excited parts of circles of fire will appear on both ſides the rubber, and ſometimes completely ſurround the globe. If a finger be brought near the globe, when it is in that ſtate, there will frequently be a complete arch of fire from the finger to the rubber, though it be almoſt on the oppoſite ſide of the globe. If the air be exhauſted from the globe, the electricity will all appear on the inſide p. 96

RECREATION XX. p. 96

The luminous ſhower.

On a metal plate ſet under the branch is put a quantity of braſs duſt, and over it another plate is ſuſpended from the branch, and when it is ſtrongly excited the duſt will be attracted and repelled with great rapidity, and exhibit the appearance of a luminous ſhower. A ſimilar phenomenon by a ſponge filled with water p. 97

RECREATION XXI. p. 97

The illuminated vacuum.

A wire is cemented in the top of a large exhausted receiver, and the upper end of the wire is brought to the conductor, when one or more streams of light, that reach the whole length of the receiver, appear in a beautiful manner. The appearance of this light remarkably different, according as the vessel is electrified positively or negatively p. 98

RECREATION XXII. p. 100

The luminous cylinder.

A brass plate is fixed at the bottom of an exhausted receiver, and another plate is contrived to let down, near the former. The electricity passes from one to the other of these plates, the whole length of the vessel, and appears as a corruscation of a bright silver hue.

RECRE-

RECREATION XXIII. p. 101

The magical conſtellations.

On a board are marked a number of ſpots, at different diſtances, ſo as to correſpond with the ſtars in two or more contiguous conſtellations. On the ſides of each ſpot are made two holes, in which wires are placed, that nearly meet over the ſpot. The other ends of the wires communicate with the branch, and when that is electrified all the ſtars appear luminous, and ſhine with unfading luſtre as long as the machine is in motion.

RECREATION XXIV. p. 103

The luminous characters.

Several rows of tin-foil, that all commumunicate, are placed on a board, at equal diſtances (Plate III. Fig. 1.) From these rows the characters are cut out. One end of the tin-foil being brought to the conductor the electric fire would pass over the whole imperceptibly, but being stopped by the breaks in the lines it jumps from one to the other, and all the characters become luminous, and remain so as long as the operator thinks fit.

RECREATION XXV. p. 105

Prismatic illuminations.

An exhausted cylinder is fixed to a lath, and is rubbed by the hand as it turns, when a body of light, variegated with all the colours of a prism, appears in the glass, and these colours are continually changing. When a little air is let into the cylinder the colours are more vivid: when more air is admitted there are continual corruscations, with the appearance of a cascade of fire, trees, moss, &c.

RECRE-

RECREATION XXVI. p. 108

The aurora borealis.

A Torricellian vacuum is made in a glaſs tube, one end of which is applied to the conductor, and the other end held in the hand; the whole tube then appears to be filled with light, which continues for a conſiderable time: after this light diſappears, if the tube be drawn through the hand, a very intenſe light is ſeen, and reaches, without interruption, from one hand to the other.

RECREATION XXVII. p. 110

The circulating lamps.

To the upper axis of the ſelf-movingwheel are fixed ſeveral radii, and from the end of each of them hangs a lamp, filled with ſpirit, and that of each lamp

is tinged with a different colour. The wheel having acquired a confiderable velocity is placed under the branch, from which hangs a chain, that as the wheel turns round dips into the fpirit of each lamp and fets it on fire. Thefe lamps being all of different colours, and revolving in a quick fucceffion, produce a pleafing effect.

MAGNETISM.

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RECREATION XXVIII. p. 133

The communicative crown.

A large ſewing-needle, that is ſtrongly touched, is concealed in a crown piece. You deſire a perſon to lend you a piece of the ſame ſort, which you change for the other, and giving that to the perſon, you diſcover whether it be encloſed in a ſnuff-box, or not, by holding the magnetic perſpective over the box.

RECREATION XXIX. p. 135

The magnetic table.

A magnet is concealed under a table, and is moveable by a pin, at one end of it. Small nails are laid on that part of the table where the magnet then is, and they are attracted by a key you hold over them. You change the poſition of the magnet, by the pin, and give the key to any one, when it will

not attract the nails. You change the position of the magnet a ſecond time, and giving the key to another perſon, it will immediately attract the nails.

RECREATION XXX. p. 136

The myſterious watch.

You aſk any one to lend you his watch, and placing it over that part of the table mentioned in the laſt Recreation, where the magnet is, it will preſently ſtop. You change the poſition of the magnet, and deſire the perſon to lay his watch in the ſame place, when it will not ſtop. You move the magnet a ſecond time, and giving the watch to another perſon, it will ſtop as before.

RECREATION XXXI p. 137.

The bouquets.

A ſmall box of thin wood (Pl VII. Fig. 1.) is contrived to contain two artificial flowers;

flowers; the principal ſtalk of each of them is ſtrongly touched, but in different directions. By holding the magnetic perſpective over the box you diſcover which of the flowers is concealed in it.

RECREATION XXXII. p. 139

The magnetic dial.

A magnetic needle is concealed in a hollow circle, (Plate VII. Fig. 2.) and oppoſite its north end a pin is fixed in the border of the circle; over the needle is placed a dial, that moves freely in the hollow circle, and on which are numbers, &c. A perſon draws a ticket from a bag, in which there are ſeveral diviſions, and then turning the hand of the dial about it ſtops at the number he has drawn; you having previouſly ſet the north end of the magnet, by the pin in the circle, to that number on the dial.

RECRE-

RECREATION XXXIII. p. 143

The magnetical cards.

This Recreation is similar to the laſt, but here inſtead of the numbers of the hours, one of each of the four ſuits of the cards are drawn, and the eight names of the cards of piquet are wrote (Plate VII. Fig. 4.) You offer a piquet pack to a perſon that he may draw a card, taking care that he draws the long card, as is explained in the firſt volume. He then turns the needle round, and it ſtops at the card he drew; you having previouſly placed the magnet againſt that card. This Recreation may be diverſified by having two needles, and letting two perſons draw each a different long card.

RECREATION XXXIV. p. 147

The dexterous painter.

There are two ſmall boxes and four ſmall boards, (Plate VIII. Fig. 1.) on which different ſubjects are painted, and in each of which a magnet is concealed. There is likewiſe a ſmall circle of paſteboard, Fig. 2, on which are drawn the ſame ſubjects as on the boards: this circle turns on a pivot, and contains a magnet. A perſon places any one of the four boards in one of the boxes privately, and you place the other box, with the paſteboard circle, over it; when the magnet in the board will turn the circle, till that part of it which is under an opening made in the top of the box, preſent the ſame picture as that on the board, and which is ſuppoſed to be drawn by a little painter concealed in the box.

RECRE-

RECREATION XXXV. p. 150

The cylindrical oracle.

In the ſide of a hollow cylinder (Plate IX. Fig. 1.) is concealed a magnetic bar; on its cover is a circle, with numbers, and at the center of that circle is a pivot, on which a magnetic needle turns. A perſon draws a queſtion out of one of the diviſions of a bag, and and turning the needle at the top of the cylinder it ſtops at the number with which the anſwer contained in the cylinder is marked; you having placed that number over the magnetic bar when you put the cover on the cylinder. Example of the different anſwers that may be given to the ſame queſtion, p. 152.

RECRE-

RECREATION XXXVI. p. 153

The myſtical dial.

There is a ſmall box, (Plate IX. Fig. 2.) and four boards, Fig. 3; in each of theſe boards a magnet is placed, in a different poſition, and on it a different number is wrote. A perſon is to place one of the boards in the box, and to chooſe whether the needle of the dial, Fig. 4, when placed over the box, ſhall point to the whole, the half, the double, or triple of the number on the board; and you then place the dial on the box in a determinate poſition.

RECREATION XXXVII. p. 156

The enchanted ewer.

A hollow cone is placed in a ewer, (Plate X. Fig. 1.) at the bottom of which is a

hole: under that hole a convex mirror, and between the hole and the mirror is a pasteboard circle, Fig. 3, that turns on a pivot. The ewer is placed on a ſtand, Fig. 1, in which is a drawer. The paſteboard circle is divided into four parts, in three of which are painted the ſame figures as on three of the boards, Fig. 5, and the fourth is left blank: this paſteboard circle contains a magnetic needle, and the four boards have each a concealed magnet; therefore when one of them is put in the drawer under the ewer, the circle will correſpond to the poſition of that magnet, and a perſon looking into the top of the ewer will ſee his own face ſurrounded with the head dreſs of the figure in the drawer.

RECRE-

RECREATION XXXVIII. p. 159

The magician's circles.

There are two hollow ſquares that are connected by a croſs piece which is alſo hollow (Plate X. Fig. 5.) On each of the ſquares is a dial, with a moveable hand, and within the ſquares and croſs piece is a movement, ſo contrived that when the hand of one of the dials is moved, that of the other ſhall place itſelf in a determinate poſition. On theſe dials are to be wrote certain words, taken from tables conſtructed for the purpoſe, and when the hand of one dial is placed to a certain number of words in ſucceſſion, that of the other directs itſelf to words which compoſe the anſwer. Method of varying this Recreation, p. 164.

RECREATION XXXIX. p. 164.

The box and dice.

At one end of a long hollow caſe or pedeſtal (Plate XI. Fig. 1.) is drawn a circle, divided into twenty equal parts, in which are marked the points that can be thrown by two dice. At the center of this circle is placed a magnetic needle, which is directed by a bar underneath it. At the other end of this pedeſtal is a vaſe that has different diviſions, in which dice are placed, that ſeem to be thoſe thrown in at the top of the vaſe. When the needle is turned round it will ſtop at thoſe points in the circle that anſwer to thoſe on the dice in the vaſe: the bar underneath the circle having been previouſly ſet to thoſe points.

RE-

RECREATION XL. p. 168

The box of flowers.

There are two cases, (Plate XI. Fig. 3 and 4) in each of which two flowers are placed, and in each of them is concealed a magnetic bar, fixed in a certain direction; these cases are put in a box of very thin wood, Fig. 2. and when the magnetic perspective is held over them, it is readily discovered, by the direction of the needle, what flower is in that part of the box.

RECREATION XLI. p. 170

The box of metals.

At the bottom of a box, whose cover is as thin as possible, (Plate XII. Fig. 1.) are six holes, exactly similar, and in these holes are placed tablets, that each of them contain a magnet, in a different position,

poſition, and that is covered with a thin plate of different metal. There is a magnetic perſpective, Fig. 2, that has two circles marked with the letters of the different metals, and from its center is drawn an index. If this perſpective be held over any one of the tablets, in ſuch manner that its index is perpendicular to the ſide of the box, the needle in the perſpective will point to the letter of the metal over which it then is. This box of metals far preferable to thoſe formerly exhibited, p. 173.

RECREATION XLII. p. 174

The magnetic oracle.

There are eight tablets that each contain a magnet, in a different poſition; there is alſo a dial marked with the digits from 1 to 8, (Plate XII. Fig. 5.) and thirty-two ſmall rundlets that have the ſame numbers. On the tablets queſ-

tions

tions are wrote, and four of the rundlets contain different anſwers to each queſtion. A perſon puts the dial over any one of the tablets, and turning the hand round it ſtops at the number which is marked on the rundlets that contain the anſwer.

RECREATON XLIII. p. 177

The incomprehenſible card.

A very thin ſteel magnet is concealed in a card. You preſent a pack to a perſon that he may draw one, and offer the card with the magnet: he is then at liberty to conceal the card, or replace it, privately, in the pack, and you tell, by your perſpective, whether it be there or not.

RECREATION XLIV. p. 178

The two magical cards.

At the bottom of a ſmall box (Plate XII. Fig. 6.) a pivot is placed, on which

turns a pasteboard circle that contains a touched needle, and on which two cards are painted; and in the top of the box is a hole, by which those cards are visible. You are to have a pack of cards that has a long and a wide card, which are the same as those in the box: these two cards are to be drawn by two persons, and by applying your magnetic wand to the box, either of the cards becomes visible, at pleasure.

RECREATION XLV. p. 189

The magnetic planetarium.

A round moveable pasteboard is placed at the bottom of a box, (Pl. XIII. Fig. 1.) at its center a circle is drawn, and seven other circles round that; and cross each of these a magnet is fixed. Over this pasteboard another is placed, on which are drawn eight corresponding circles; in that at the center seven questions are wrote, and in the others are words that answer

those

those queſtions, and on each of theſe circles turns a magnetic needle. The lower circle is moved by a hand fixed to its axis, which comes through the upper circle; and when the lower paſte-board is moved, the attraction of its magnets moves all the needles on the upper board. A perſon therefore ſetting the hand to any one of the queſtions in the central circle, the needles on the other circles immediately point to the words that compoſe the anſwer.

CONSTRUCTION OF THE MAGNETICAL AND MECHANICAL TABLE. p. 186.

Under the top of this table, (Plate XIV. Fig. 1.) and about one inch and a half from it, is another ſurface, on which is placed the magnetic apparatus, by which the ſubſequent recreations are performed. The legs of this table, Fig. 2, are hollow, and through them, and the ſtep that joins to them,

goes

goes a cord, that comes out behind the partition, and paſſing over a pulley, Plate XV, has a weight joined to the end of it, and to it is likewiſe fixed an index. On the upper ſurface of this table are placed, in ſucceſceſſion, three circles, (Plate XIV. Fig. 1, 4, and 5.) on whoſe circumference are different numbers of diviſions, that correſpond to the diviſions in the ſeveral columns of the table, Plate XV. One of theſe circles is placed on that part of the table which is over the magnetic bar; on the circle is placed a ſhallow baſon with water, in which floats the figure of a ſiren, that contains a touched needle: therefore, when the perſon behind the partition places the index on the cord againſt any one diviſion of the table, he will, by moving the magnetic bar under the circle, make the ſiren point to a letter or number in a correſponding diviſion of that circle.

RE-

RECREATION XLVI. p. 194

To make the ſiren of the magnetic table point to all the letters of a given word.

On three cards that are each of a different ſize, are wrote the names of three perſons or cities. Theſe three cards being given to any perſon, he keeps one of them and returns you the other two, which you lay aſide without looking at them, and the ſiren immediately points to the letters that compoſe the word on the card the perſon has taken. For you diſtinguiſh by the touch which of the three cards is choſe, and by certain words, previouſly agreed on, make it known to the confederate.

The ſiren is to point out the time expreſſed by any given watch, p. 195

A part of the ſtep on which the operator ſtands goes through the partition,

and is moveable, like a lever. The watch is laid on the table, and the operator presses down the step with his foot as many times as are equal to the number of hours; which the confederate behind the partition observing, makes the siren point to that number. A similar signal is then made for the quarters and minutes.

To make the siren point to three numbers that have been chosen by three different persons, p. 196.

These three numbers are drawn from a bag, in which there are several divisions; and the confederate knowing what those numbers are, makes the siren point to them.

A queſtion being propoſed, the ſiren gives the anſwer; though the perſon who exhibits the recreation does not know the queſtion, p. 198.

On five cards are wrote five different queſtions, but which may be all anſwered by one word. A perſon chooſes any one of theſe cards, and lays the reſt aſide: the confederate knowing the word that will anſwer it, makes the ſiren point to the ſeveral letters which compoſe that word.

RECREATION XLVII. p. 200

The ſagacious ſwan.

On the top of an oblong box (Plate XVI. Fig. 1.) is placed a ſhallow baſon, in which floats the figure of a ſwan, that contains a touched needle. Round this baſon are placed ſix ſmall vaſes, and in each of them is put an anſwer to a queſtion.

tion. At the other end of the box is an ivory egg, on a hollow ſtand. There are ſix etwees, Fig. 3, of different lengths, and that each contain a queſtion. A perſon having choſe one of the etwees, takes out the queſtion, and puts the etwee into the egg, and by ſhutting down the top of the egg preſſes the etwee down the hollow ſtand, and againſt a movement in the box, Fig. 2, by which mean a magnetic bar is brought under a particular part of the baſon, according to the length of the etwee, and the ſwan is thereby directed to the vaſe that contains an anſwer to the queſtion.

THE COMMUNICATIVE BELL. p. 205

In a hollow circular box (Plate XVII. Fig. 1.) there is fixed a ſmall bell, and at the center of the box is a pivot, on which is placed a touched needle, that has at each end a ſmall braſs knob. The bottom of this box is covered with gauze.

gauze. This box is placed on the magnetic table, over that part where there is a large magnetic bar, by moving of which the touched needle on the pivot is made to ſtrike the bell.

RECREATION XLVIII. p. 207

To tell, by the communicative bell, the card that a perſon has drawn from the pack.

The ſounding of the bell ſignifies *yes*, and its ſilence *no*.—You are to preſent the pack in ſuch manner that the perſon will naturally draw the card you offer, and which is known to your confederate. You then aſk ſeveral queſtions of the bell, which your confederate reſolves, either by making it ſound or remain ſilent.

To tell by the bell at what number from the top any card of a pack is placed, that a perſon ſhall name, p. 208.

The cards of piquet being previouſly packed, they are to be ſhuffled in the manner

manner directed in the firſt volume, and they will then be in a determinate order; of which the confederate having a copy, and hearing the name of the card the perſon has choſe, makes the bell ſtrike the number at which it is from the top.

RECREATION XLIX. p. 211

The magnetic balance.

A pair of ſteel ſcales, that are gilt and very true, (Plate XVII. Fig. 2.) are ſuſpended over the magnetic table, near the part under which the bar is placed. Two pieces of money that are preciſely of the ſame weight being put in theſe ſcales either of them is made to preponderate at pleaſure. The confederate, at a ſignal given, bringing the bar under one or other of the ſcales.

RECRE-

RECREATION L. p. 214

The sympathetic dials.

One of these dials has a catch on the outside, by which it is stopped at pleasure: the other has a steel catch within the case, that takes the fly of the movement. A large bar in the magnetic table, when brought under this dial, attracts the catch and puts the wheels in motion, but when the bar is moved from it, the motion ceases immediately. You therefore give the dial with the stop to a person, and tell him that when he stops that dial, or puts it in motion, the other on the table will, by sympathy, stop or move also; and by mounting the step you make it act accordingly.

CONSTRUCTION OF THE MAGNETIC ROLLER. p. 217.

This roller consists of a long and narrow piece of wood, (Pl. XVII. Fig. 5.) on which there are twelve circles, and in each of them a magnet, placed in dif-

ferent directions from the others. This roller is placed at the bottom of the magnetic table, and moves upon two cylinders, being drawn by a ſtring that goes down a leg of the table, through the partition, and over a pulley placed on the other ſide of it: to this ſtring a weight and an index are faſtened. Under the pulley is placed a table, p. 220, that has five columns, which contain numbers, letters, the names of cards, countries, &c. and in each of theſe columns are ten diviſions that correſpond to the ten circles on the roller: ſo that when the index on the ſtring is ſet by the confederate, againſt any one of thoſe diviſions, the circle on the roller that anſwers to it is brought to a certain part of the magnetic table, that the bar it contains may act on the needle of ſome machine to be placed over it.

RE-

RECREATION LI. p. 221

The magician's box.

In a ſmall hollow box (Pl. XVIII. Fig. 1.) is placed, on a pivot, a paſteboard circle, Fig. 3, which has ten equal diviſions, in five of which cards, &c. are painted, and in the middle of it is a magnetic needle. In the top of the box is a hole, nearly of the ſame ſize with one of the diviſions on the circle. Over this box is placed a glaſs cover, Fig. 2, and when it is put on the magnetic table, over the roller, any part of the circle may be made viſible by bringing the proper circle of the roller under it. A ſimilar experiment with a circle that has the names of five cities wrote on it, inſtead of the cards, p. 224.

RECREATION LII. p. 225

The myſtical dial.

This dial has ten diviſions, in which are wrote the nine digits and a cypher, and it has a magnetie needle for an index, which points to any one of the ten divisions on the circle, according to the position of the magnet in the part of the roller over which it is placed. Method of showing by this dial the numbers that two persons have chose, their sum, or their product, p. 226.

RECREATION LIII. p. 228

The magical game of all-fours.

There must be a circle with twelve divisions, on six of which cards are painted, and to which six of the divisions of the roller correspond. A pack of cards are previously disposed, according to the manner explained in the first volume; so that after the cards are dealt they can be played only one way. The other person plays his cards, yours remain on the table, and every time you are to play you direct another person to look in at the top of the box, (Pl. XVIII. Fig. 2.) and see what card is played, your confederate having brought the proper card in view, by moving the roller.

RECREATION LIV. p. 231

The intelligent fly.

The ſpace between two concentric circles contained in a box (Pl. XVIII. Fig. 5.) is divided into ten equal parts, in each of which a letter is wrote; and at the center of the circle, is placed a pivot, that holds a magnetic needle, at the end of which is the figure of a fly: all the needle, except that part to which the fly is fixed, is concealed by a paper placed over it. There are laid on a table a parcel of cards, properly packed, and on each of them a queſtion is wrote. You aſk a perſon at what number the card ſhall be to which the fly ſhall give him an anſwer. When he has determined, you place the box over the roller, and your confederate knowing the queſtion on the card, makes the fly point to the letters that compoſe the anſwer.

RECRE-

RECREATION LV. p. 236

The multifarious verſe.

On eight tablets that are of the ſame ſize, and that exactly fill a box, (Plate XIX. Fig. 1.) are wrote the eight words of a Latin verſe, and in each of them is placed a magnet, in a different poſition. Over this box is placed a board, Fig. 2, that has eight circles, whoſe centers are directly over thoſe of the tablets: round each of theſe circles are wrote the eight words of the Latin verſe, and on each of them is placed a needle. Over the board and box is placed a glaſs frame, Fig. 3. If a perſon put the tablets in any poſition privately, then cover the box over with paper, and place it under the board, the needle on each circle will point to the word on the tablet under it; ſo that by looking into the top of the box you will always know in what order the tablets are placed.

RECRE-

RECREATION LVI. p. 240

The communicative mirror.

In a box (Plate XX. Fig. 1.) is placed a pivot, on which is fixed a pasteboard circle, Fig. 2, that has a touched needle, and on which are painted three cards. Over this pasteboard is a hole, in the top of the box, and over that is placed a hollow glass pedestal, on which is fixed a tube, containing an inclined mirror. There are three tablets that have each a card, similar to those on the circle, and a magnetic bar. One of these being placed in the box, Fig. 3, and that put in the other box, Fig. 1, under the circle, it will place itself in a corresponding position; so that a person looking into the tube will see the same card as that on the tablet concealed in the box, and he will seem to see it in the mirror placed opposite the tube.

RE-

RECREATION LVII. p. 243

The box of dice by reflection.

At each end of a long box (Pl. XX. Fig. 4.) is a ſmall hole, and over the ends are placed two hollow cubes; under each of theſe cubes is an inclined mirror, and a ſmall touched needle on a pivot. The top and two longeſt ſides of this box are of glaſs, lined with a thin paper. There are two dice, that have concealed in each of their ſides a ſmall magnet: ſo that when theſe dice are placed in the cubes, in any poſition, you will ſee, by looking in at the hole at each end of the box, the poſition of the needle under each cube, and conſequently diſcover which ſide of each die is next the top of the box.

THE END OF THE THIRD VOLUME.