RITCHIE'S

CATALOGUE

OF

PHYSICAL INSTRUMENTS.

ALLICIT ALENDO.

E. S. RITCHIE & SONS,

NO. 150 TREMONT STREET,

BOSTON.

1878.

RITCHIE'S

ILLUSTRATED CATALOGUE

OF

PHYSICAL INSTRUMENTS,

AND

SCHOOL APPARATUS.

OFFICE, 150 TREMONT STREET,
BOSTON.

FOUR MEDALS AWARDED

BY THE UNITED STATES CENTENNIAL COMMISSION, 1876.

PRESS OF BOSTON
T.R.MARVIN & SON.

PREFACE.

THE Instruments enumerated in this Catalogue are almost all of our own manufacture. We have added many instruments which have not appeared in former editions, although many of them we have made for years past.

The quality of our apparatus, both in the materials used and in workmanship, will be kept up to the high standard we have adhered to for over twenty-five years.

Our manufactory is the largest in the United States, and is furnished with every facility obtained by the best machinery; there is, however, a class of apparatus (made chiefly by hand-labor) which can be produced in Europe at lower prices than we can make them of equal quality, and we have received from the first makers of London, Paris, and other cities agencies for their productions, which we will import to the order of Colleges and Schools free of duty. We give for the articles of this description the approximate cost.

Our Instruments are *not* for sale by dealers in books and apparatus; we do not deem it advisable to add to our prices to enable us to give such dealers a large *discount*, which of course would be paid by the purchaser.

It is our aim to make, as far as possible, all the new instruments which modern research requires; and we are prepared to make other instruments not included in this catalogue. Prices of articles left blank will be given on application.

E. S. RITCHIE & SONS.

EDWARD S. RITCHIE.
THOMAS P. RITCHIE.
JOHN RITCHIE.
ANDREW M. RITCHIE.

ADVERTISEMENT.

TERMS, CASH.

Orders can be made by simply giving the numbers, with prices.

Drafts at sight to our order, on New York or Philadelphia, received at par. For small sums, post-office money-orders are convenient.

The expense of boxing, packing, and delivery to railroad, will be added to the bill; it usually amounts to two and a half per cent.

Great care will be used in packing; but unless we *insure*, our responsibility ends with the delivery in good order to the public carrier. The risk of injury by ordinary *freight* lines is far less than by Express.

We insure, when desired, and the amount exceeds $25, against damage by transportation and fire; the premium will depend on the distance, and the nature of the instruments; on an average invoice and risk it will be two per cent. Marine insurance will be effected, when desired, from underwriters.

Purchasers are requested to give particular directions by what route and lines to forward.

Our office is at No. 150 Tremont Street. Manufactory in Brookline, a short ride in steam-cars from Albany Railroad-Station, or in horse-cars from Tremont Street.

E. S. RITCHIE & SONS.

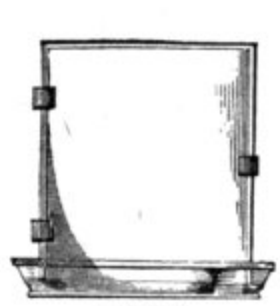
E. S. RITCHIE & SONS'

CATALOGUE.

LAWS OF MATTER AND MECHANICS.

Molecular Forces.

No. 1.



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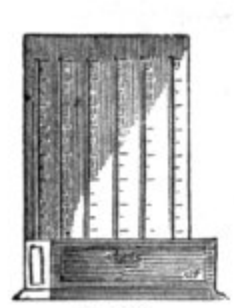
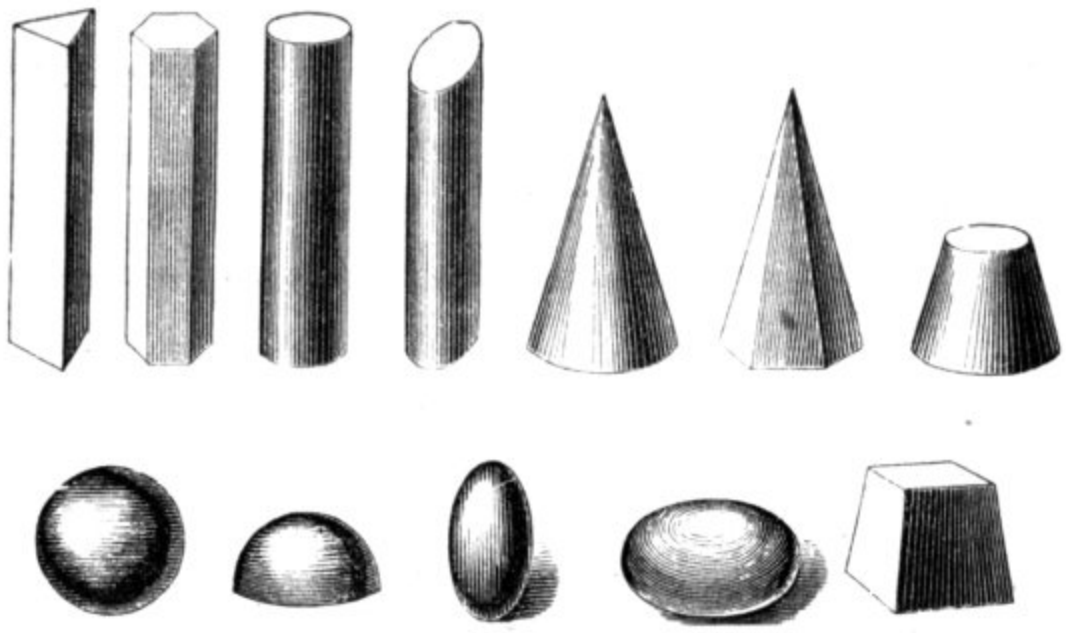


No. 8.

No. 2.

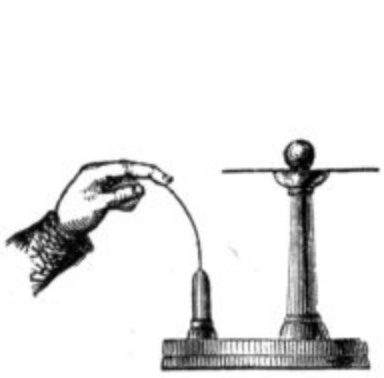
NUMBER		PRICE
1.	**Cohesion Plates**, of glass, three inches in diameter, ...	$0.75
2.	**Cohesion Hemispheres**, of lead, two inches diameter, . . .	.75
3.	**Adhesion Disc**, of glass, four inches diameter, with brass hook and silk cord, ...	.75
4.	**Capillary Plates**, of plate glass, four inches diameter, held together by mahogany clamps, showing the hyperbolic curve, ...	1.50
5.	**Capillary Plates**, of plate glass, with brass clamps and screws, and glass cistern, ...	3.00
6.	**Capillary Tubes**, a set of six glass tubes of different calibres in a box, ...	.75
7.	**Capillary Tubes**, six tubes sealed into a bar, to rest upon a tumbler,	1.25
8.	**Capillary Tubes**, a set of six of different calibres, mounted on a frame, with water-pan, ...	1.75
9.	**Endosmeter** or Osmose Apparatus, a glass bell over which to tie a membrane, with glass tube and rubber cork, ...	1.50
10.	**Endosmeter**, mahogany base and pillar, with adjustable screw clamps; graduated glass tube, with bell and jar, ...	6.00
11.	**Cohesion Figures**, a set of wire forms, with bars and supporting-rods, including the tetrahedron, cube, octahedron, prism, and cylinder, for immersion in solution of soap or Plateau's glycerine, .	3.50

Geometric Forms.



No. 12.

12. **Geometrical Solids**, set of twelve, including three and six-sided prisms, cylinders, cone, pyramid, frustums of cone and pyramid, sphere, hemisphere, oblate and prolate spheroids; neatly made in fine wood, in box, ... 2.00
13. **Models of Crystals**, of thin glass, of two to three inches diameter, with threads representing the axes, each, ... 1.25
14. **Models of Crystals**, in wood, to order, ...
15. **Models of Crystals**, thirteen pieces, giving the primary forms, according to Dana, in large size, ... 2.75
16. **Models of Crystals**, of solid glass, accurately ground and polished; thirteen pieces, ... 25.00



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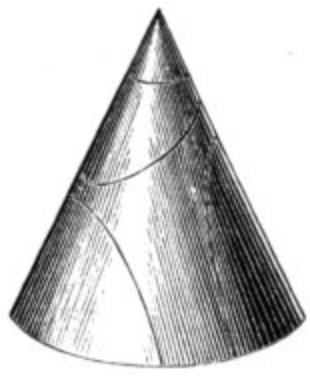

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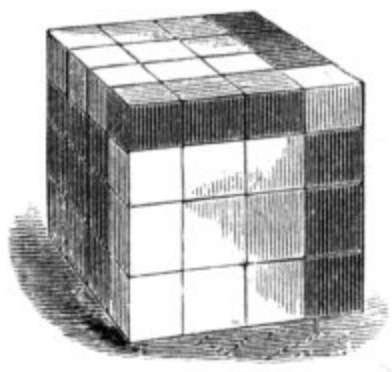
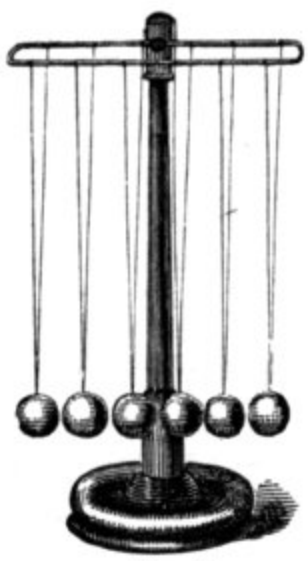


No. 17.

17. **Cube Root Solids**, set of eight pieces, illustrating the extraction of square and cube roots; of mahogany, in box, ... 1.25
18. **Dissected Cone**, illustrating conic sections, viz., the circle, ellipse, parabola, and hyperbola; of fine wood and of large size, . . . 3.50
19. **Dissected Cone**, smaller size, neatly made of maple wood, . . . 2.00

On Impact.



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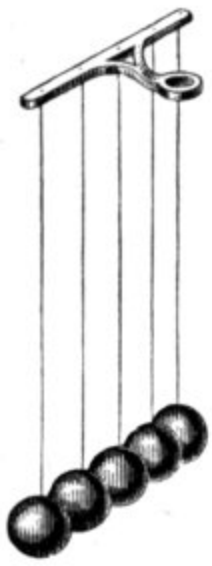

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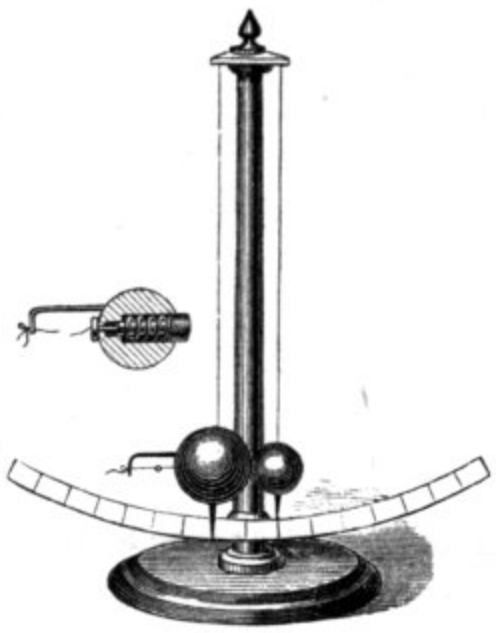
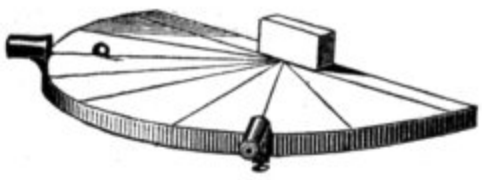


No. 26.

21. **Inertia Apparatus**, mahogany stand, with spring and ball, . . . 1.00
22. **Inertia Apparatus**, metal base and pillar, brass spring and ball, . .50
23. **Collision Balls**, a set of five celluloid balls, one and a half inches in diameter, suspended upon a metallic bar, which is fitted to attach to the pillar of the *Illustration of Pulleys*, ... 3.00
24. **Collision Balls**, mahogany frame with five 1½-inch celluloid balls, suspended by double silk cords, ... 4.50
25. **Collision Balls**, mahogany frame with five 1¼-inch ivory balls suspended by two silk cords; graduated arc, ... 10.00
26. **Illustration of Momentum**, two ball pendulums, one of which contains a spring hammer, the other is of half the weight; two additional balls, of one third and one fourth proportionate weight; the spring is to be held back by a thread, which in the experiment is burned, an equal force is expended on each of the balls, which are thrown distances proportionate to their mass, ... 12.00



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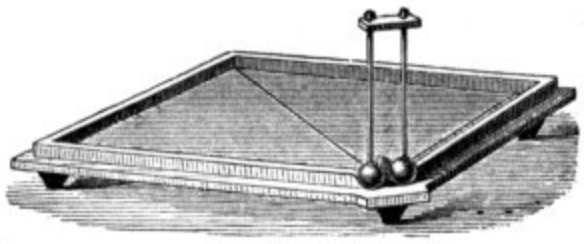
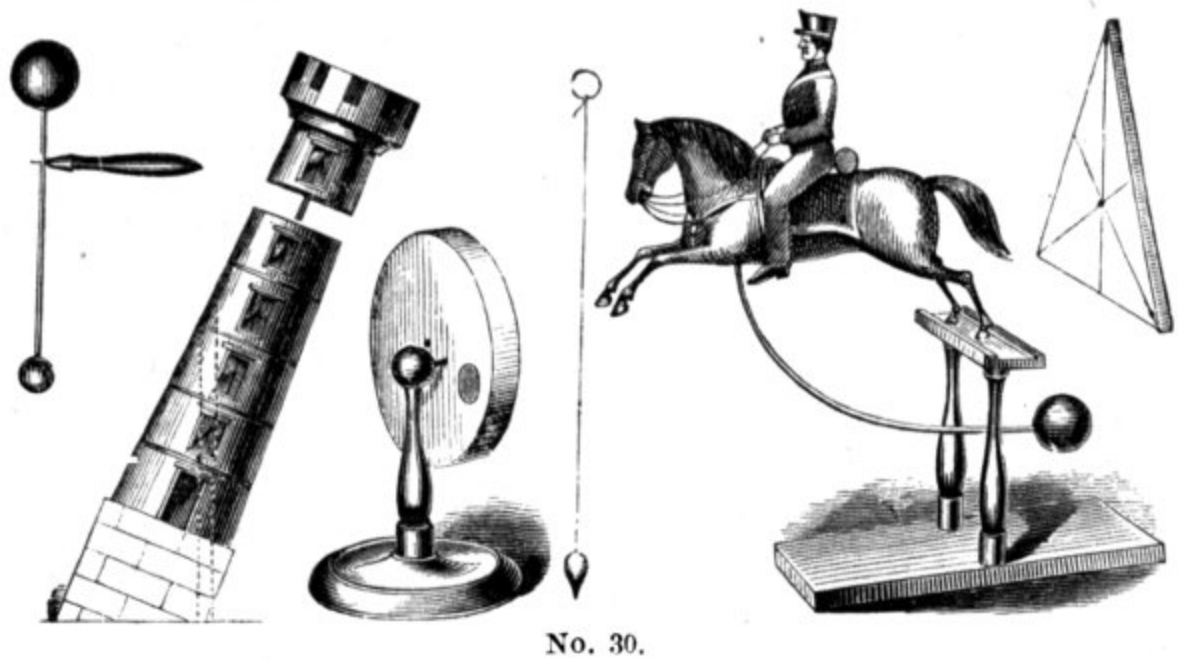


No. 28.

27. **Reflection of Motion** Apparatus, semicircular base with spring pistol, ivory ball, and receiving-cup; showing that the angle of reflection is equal to the angle of incidence, ... 15.00
28. **Resultant Motion Table**, mahogany table; two vertical rods are placed at one corner, upon which slide brass balls, which in falling impinge upon a ball, ... 10.00
29. **Marble Plate** and Ball, plate ten inches diameter, ivory ball, . . . 2.50

Centre of Gravity.



No. 30.

30. **Centre of Gravity**, a set of illustrations, including triangular block, with holes drilled at the angles, from which lines are drawn, representing the verticals through the several points, and the common centre of gravity; square block, with centres and lines; two balls of unequal mass, with centre in the connecting rod; loaded wheel, a disc of wood which has a mass of lead near one edge, with centres of magnitude and gravity, and stand; plumb line; leaning tower, with movable capital, — without the capital the centre falls within the base; with the capital, it falls beyond, — both centres are drilled; horse and rider, with balance-ball and stand; a handle and pin for balancing the pieces, ... 8.00

30*a*. **Centre of Gravity**, a set of illustrations including triangular block, loaded wheel, handle with pin, horse and rider with stand, . . 4.25

31. **Leaning Tower**, separately, (see No. 30,) 2.25

No. 32.

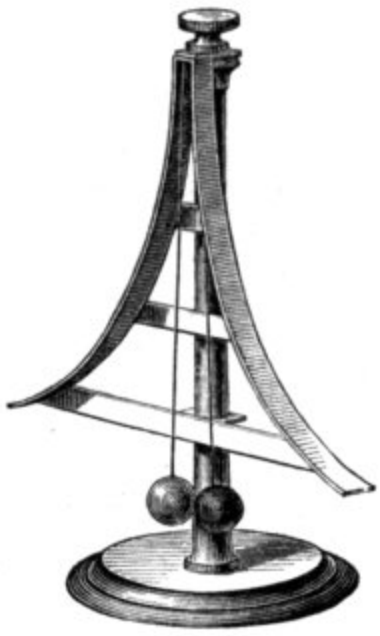
32. **Double Cone** and Inclined Plane; the cone rolls up the inclined plane, the bars of which diverge so that the axis of the cone actually descends, ... 1.25

33. **Horse and Rider**, balanced by ball with stand (see No. 30), . . 1.25

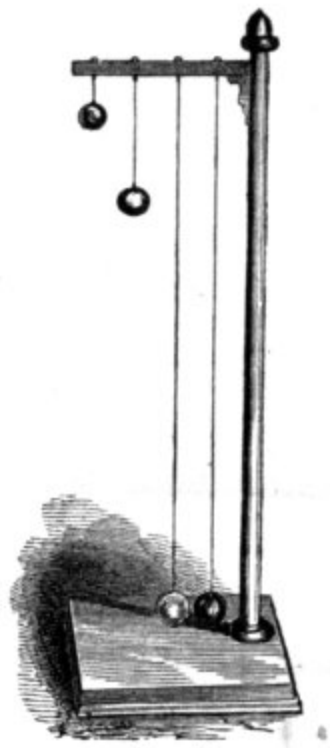
34. **Cone**, of cherry wood, four inches diameter, polished, illustrating stable, instable, and indifferent equilibrium, ...50

35. **Waltzers**, two little figures attached to a lens, which rotates upon an inclined wet plate of glass, ...75

Gravitation.



No. 47.



No. 40.

40. **Illustration of the Pendulum**, mahogany base and pillar, two pendulums of equal length, with balls of brass and boxwood, two other pendulums with brass balls of one fourth and one ninth of the proportional length, ... 6.50

41. **Illustration of the Pendulum**, four pendulums similar to No. 40, supported upon a bar fitted to attach to the pillar of No. 91, . . . 2.75

42. **Torsion Pendulum**, two brass balls attached to a bar, to the centre of which a brass wire is secured, and a clamp to attach to the pillar of No. 40 or No. 91, ... 2.50

43. **Clock Escapement**, mahogany base and pillar, pendulum, wheel with dead-beat escapement, dial and pointer, ... 12.00

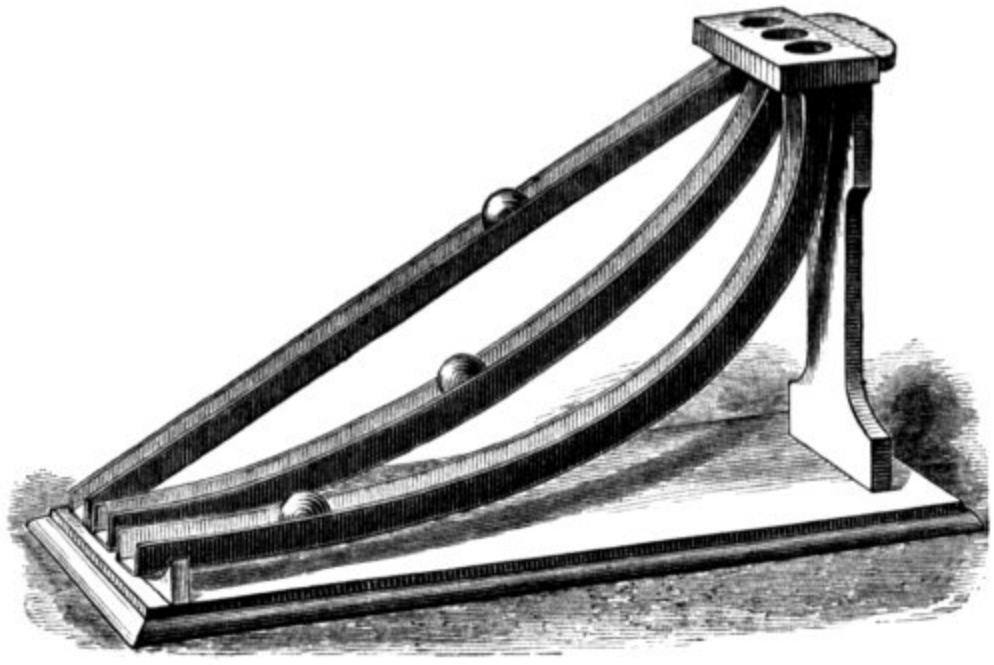
44. **Kater's Pendulum**, mahogany base and pillar, a bracket with agate planes for the support of the pendulum, which consists of a brass rod and ball, two knife-edged bars, and a weight adjustable with fine screw motion, ...

45. **Kater's Pendulum**, of more simple mechanism, ...

46. **Tate's Pendulums**. Upon two cross-formed frames, with two bars, each four feet long, are suspended two repelling bar-magnets, each held by four cords. When one is set in motion, it soon comes to rest by imparting force to the other, thus producing the alternate motion and rest of each pendulum, ...

47. **Cycloid Frame**, mahogany base and pillar, between which are suspended two balls by silk cords. At whatever distances the balls are released, they will meet on the central line, ... 5.00

48. **Cycloid Frame**, with curves and balls similar to No. 47, fitted to attach to the pillar of No. 91, ... 3.00



No. 50.

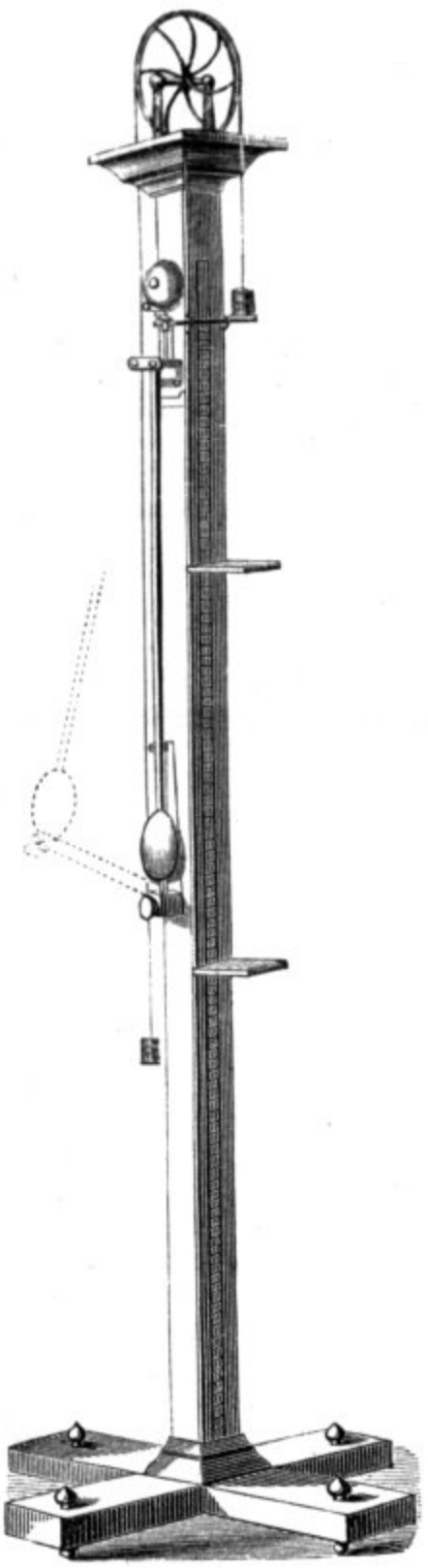
50. **Brachystochrone,** mahogany frame supporting three inclined ways, straight, circular, and cycloidal; over their upper ends is a holder for three balls, which are let fall at the same instant by withdrawing a slider; a movable box to receive the balls, which arrive by the cycloid the first, and by the arc, and straight line, together. A ball set free at any point on the cycloid will reach the bottom in the same interval of time, ... 18.00

51. **Atwood's Machine,** Ritchie's Automatic Action; turned mahogany pillar with base, levelling screws, graduated rod, and sliding platforms. The large pulley is supported upon steel pivots and delicately finished bearings; balanced weights of brass, and weights for impulse; seconds pendulum. At the instant of passing the perpendicular, a pin in the extension of the rod above the centre strikes a detent, releasing the drop-table without striking the bell; but at each *return* of the pendulum to the centre of oscillation, the bell is struck, marking the seconds of time during the experiment with the greatest precision, ... 87.00

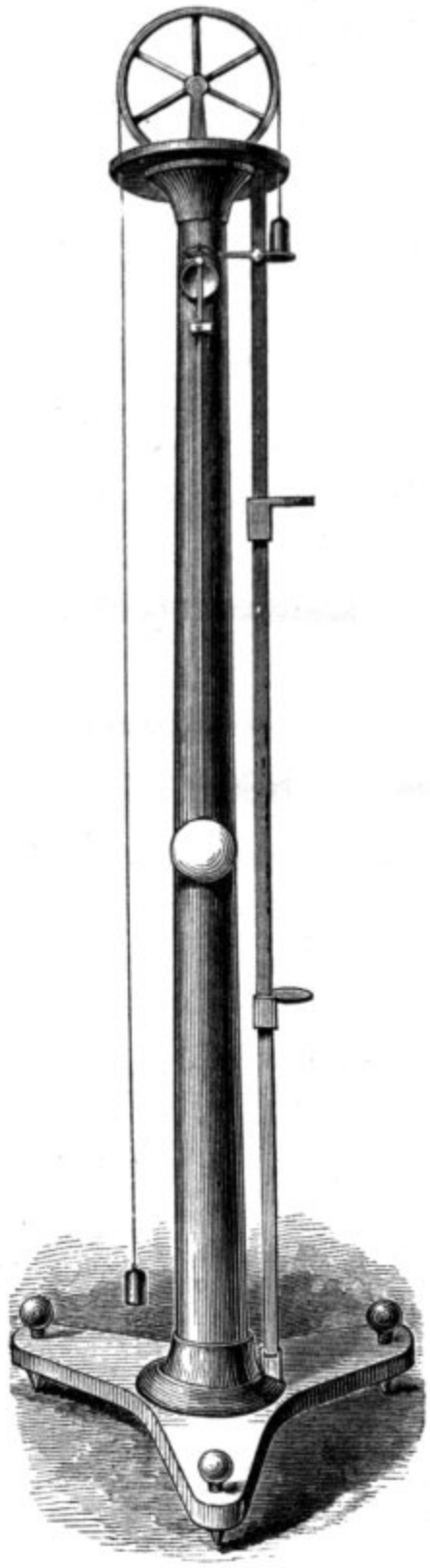
52. **Atwood's Machine,** Ritchie's Improved Automatic Action; heavy metal base with levelling screws, polished mahogany pillar, graduated rod, and sliding platforms of brass; large pulley on steel pivots delicately finished and balanced; seconds pendulum, with automatic drop-table which falls on the instant that the pendulum reaches the perpendicular without striking the bell, but marks the subsequent seconds with precision; balance and impulse weights of brass. The machine is finely finished, and every law can be illustrated as perfectly and easily as with the most elaborate machine, ... 55.00

53. **Atwood's Machine,** similar to No. 52, substituting a polished black-walnut pillar, ... 50.00

54. **Atwood's Machine,** similar to No. 52, without the pillar, fitted with brackets for attachment to a permanent pillar, or the wall of the room; an adjustable graduated rod for the sliding platforms. The fixtures are simply two small brass plates for the wall, by which



No. 51.



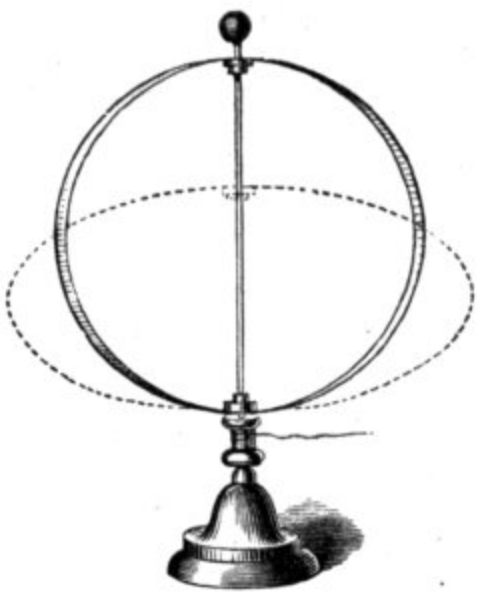
No. 52.

the movable brackets are sustained, and a small step for the rod. This arrangement is very convenient, and dispenses with the space required for the machine, ... 40.00

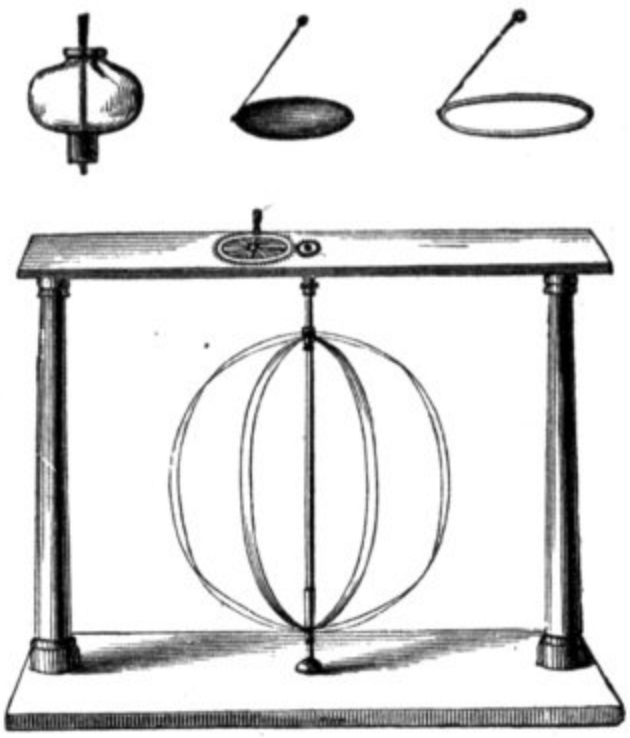
55. **Atwood's Machine**, similar to No. 51, fitted with electro-magnetic action, the circuit being made by a point upon the pendulum-rod passing through a drop of mercury; additional price, ... 12.00

56. **Friction Rollers** to either form of Atwood's Machine, with glass cover over the pulley; additional, ... 25.00

Centrifugal Force



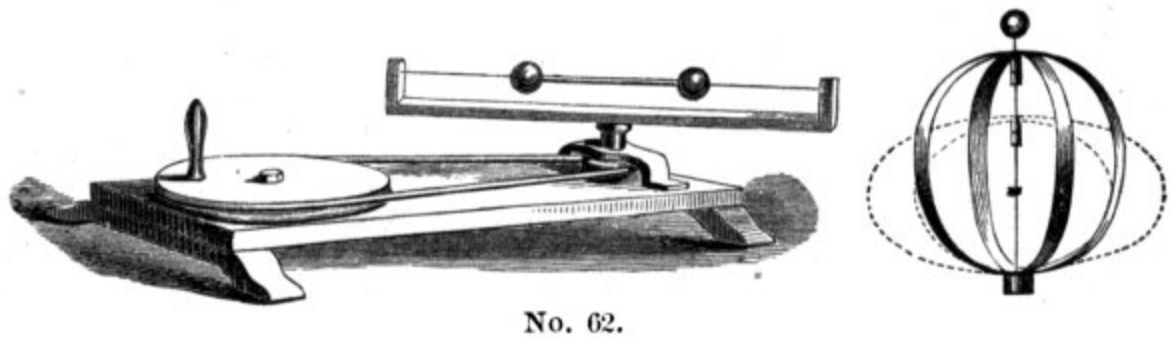
No. 60.



No. 61.

60. **Whirling Ring**; an elastic brass ring, twelve inches in diameter, with spool and cord; supported on a heavy japanned iron base, and brass rod, ... 3.00

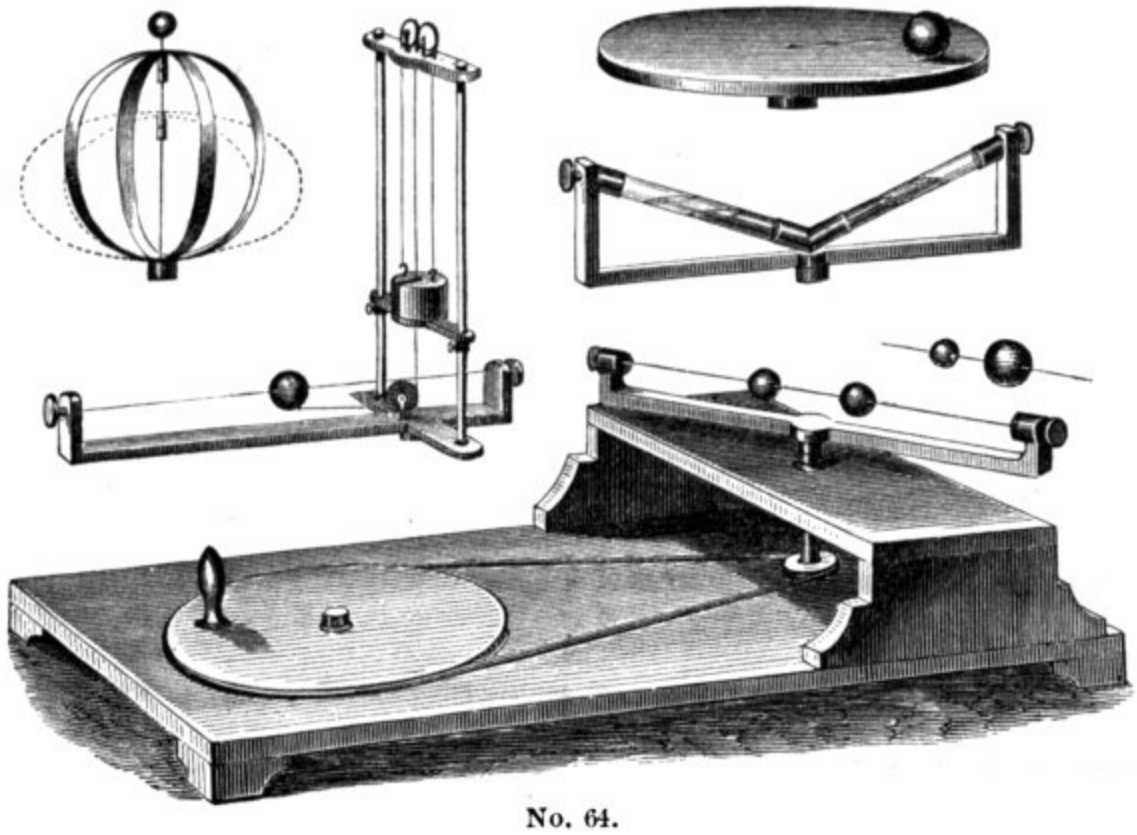
61. **Whirling Machine**, mahogany frame, steel spindle, with brass geared wheels; eight illustrations, consisting of a double elastic brass ring, globe, oblate and prolate spheroids, double cone, brass ring, ring of chain, and glass globe for liquids, ... 11.00



No. 62.

62. **Whirling Table**, mahogany base, iron driving-pulley, steel spindle supported in a brass frame with screw fittings, for revolving.
    1st. A brass frame with wire, upon which are placed—
        (*a*) Two brass balls connected by a tube;
        (*b*) Two of unequal mass, connected by a rubber cord.
    2d. A glass open globe for liquids.
    3d. A double elastic brass ring, twelve inches in diameter, ... 25.00

63. **Whirling Table**, base of iron, handsomely japanned, giving great steadiness and firmness, with geared wheels and attachments, same as in No. 62, ... 35.00



No. 64.

64. **Whirling Table**, polished mahogany table and frame, a steel spindle on brass bearings, with accurate screw fittings and japanned iron driving-pulley. A *governor* is attached in such manner that in a series of experiments the same velocity (or that of two or three times greater or less) can be obtained with certainty, and the laws of centrifugal force illustrated. To the spindle are attached the following illustrations: —

1st. A brass frame, upon which is stretched a wire, upon which are placed —

(*a*) Two equal brass balls connected by a tube;

(*b*) Two of unequal size connected by a rubber cord.

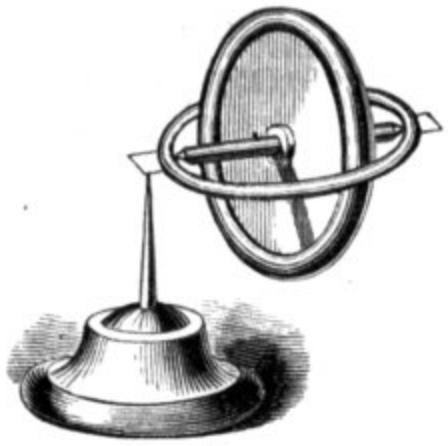
2d. A frame of brass, with inclined glass tubes, for liquids of different specific gravity.

3d. A double elastic brass ring, twelve inches in diameter, upon a spindle.

4th. A circular table, with a ball which is secured by a cord and swivel to its centre.

5th. Apparatus for determining centrifugal force. Upon a wire, stretched on a brass frame, is placed a heavy brass ball; a cord attached to it passes under and over pulleys to a weight, which is placed in the line of the centre of motion, guided by two brass pillars; the weight is in several sections, so that a greater or less amount may be applied. The ball may be placed at pleasure at different distances from the centre of motion, and the comparative force measured by the amount of weight raised, ... 75.00

NOTE. To the spindle of either of the *Whirling Tables* can be attached other apparatus requiring rapid revolution.



No. 69.

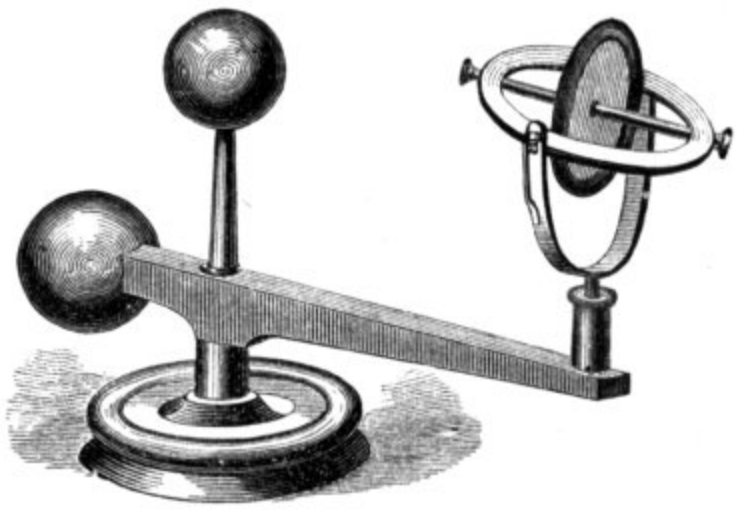
No. 68.

68. **Plateau's Apparatus**, a glass globe ten inches in diameter, with brass cap, shaft, and disc. Directions for easily operating it will be sent, ... 8.00

69. **Gyroscope**, brass wheel two and a half inches in diameter, mounted on pivot and stand, ... 3.00

70. **Gyroscope**, three-inch brass wheel, accurately balanced with gimbal for the centre, bar and sliding-weight, pivot and stand, ... 6.00

No. 71.



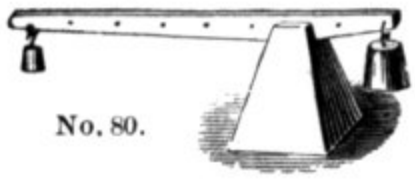
No. 72.

71. **Gyroscope**, brass wheel four inches in diameter, accurately balanced, mounted on a brass gimbal ring, with hook and weight, mahogany stand, ... 12.00

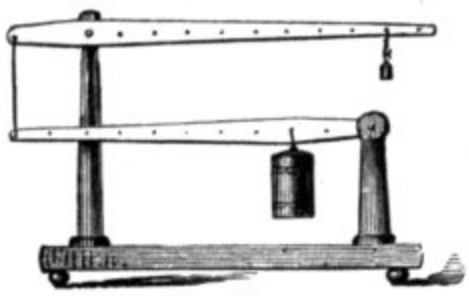
72. **Gyroscope**, with balance-frame, consists of No. 71 complete, with addition of a heavy base pedestal and steel spindle, on which revolves a stout bar, with a heavy iron ball balancing the gyroscope, a pillar and globe. The apparatus beautifully illustrates the parallelism of the earth's axis, and (with a small weight attached to the ring) the *Precession of the Equinoxes*, ... 18.00

73. **Gyroscope**, a heavy brass wheel eight inches in diameter, steel shaft and double gimbal rings, mounted upon a mahogany base and frame, with pillars; finely finished, ... 45.00

74. **Driving Pulley** and Frame; consists of a pulley twenty inches in diameter and frame for the support of the Gyroscope No. 72, with its gimbal ring so that its shaft rests upon the periphery of the pulley, by which a rapid motion can be given it, ... 20.00



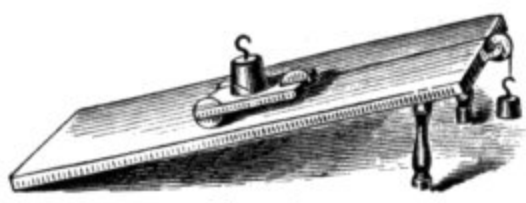
No. 80.



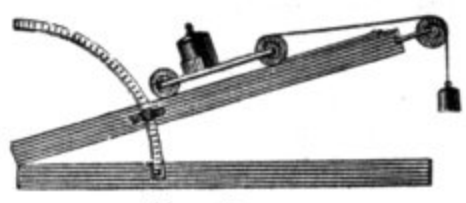
No. 81.

No. 82.

80. **Simple Lever**, with fulcrum of mahogany, ... 1.00
81. **Compound Levers**, mahogany base, pillars and levers, ... 3.75
82. **Lever, Balance** and **Steelyard**, brass pillar and mahogany beam, and hooks for weights, ... 6.50
83. **Lever, Balance** and **Steelyard**, brass beam eighteen inches long, mounted on metal stand and brass pillar, ... 7.00

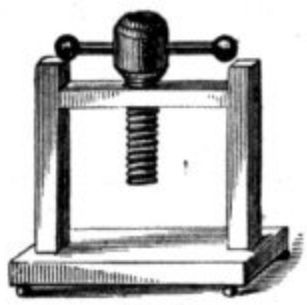


No. 84.



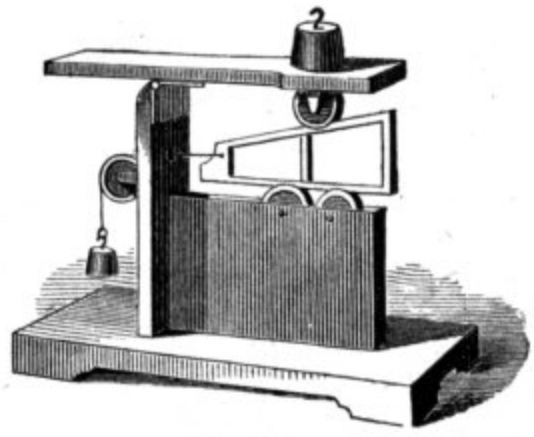
No. 85.

84. **Inclined Plane** and Car; mahogany plane, with fixed pillars; wheels and pulleys of brass, ... 3.00
85. **Inclined Plane** and Car; mahogany base and movable plane, with arc and binding screw, ... 6.00



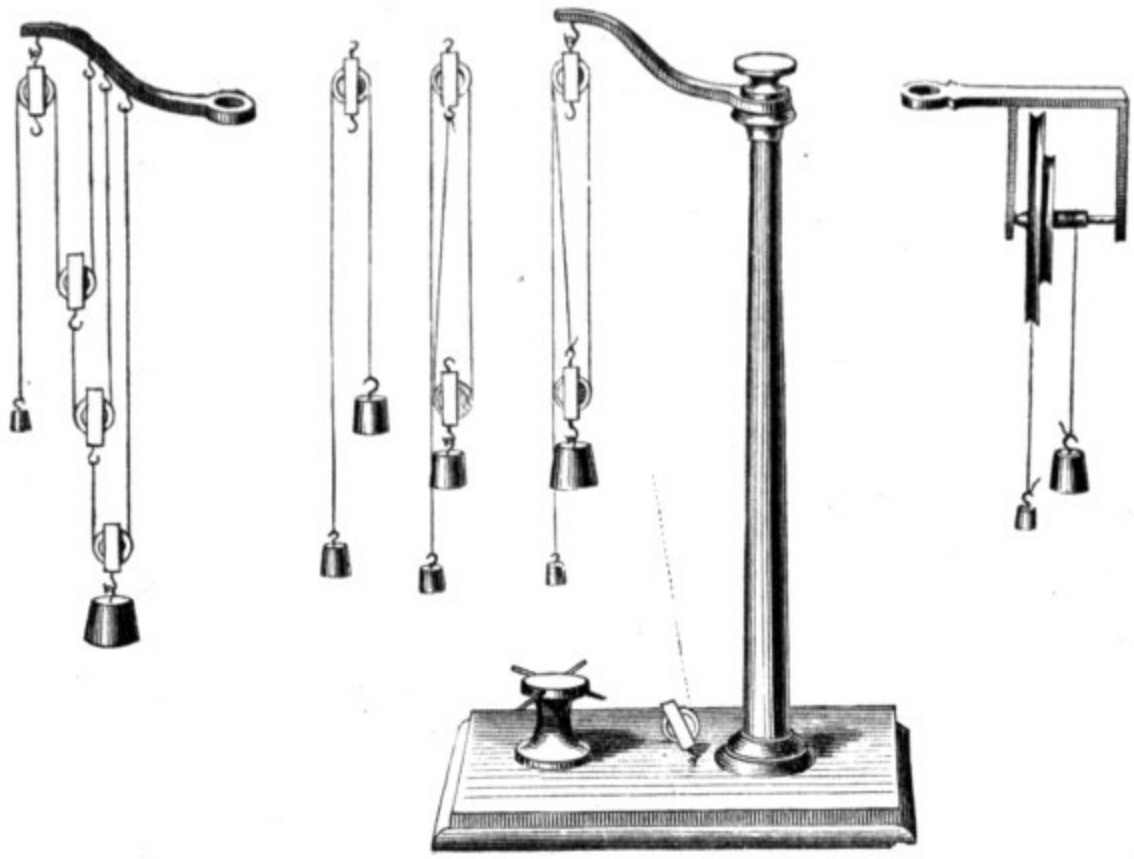
No. 86.

No 89.



No. 90.

86. **Screw**, mounted in mahogany frame, ... 3.00
87. **Screw**, mounted in strong iron frame, metal screw, carefully cut, three quarters of an inch in diameter, ... 4.00
88. **Hunter's Screw**; double screw of brass, in strong brass frame, . . 8.00



Nos. 91, 92.

89. **Wedge** of mahogany, in two sections, separable, ... 1.50

90. **Illustration of the Wedge**, mahogany frame, brass wedge with rollers; the upper bar and roller are balanced. *Cut on page* 11. . 15.00

91. **Illustration of Pulleys**, base of iron handsomely japanned, pillar of mahogany, with screw and brass nut to hold the supports for the systems. The pulleys are of brass, strung with silk cord, and balanced, and include:

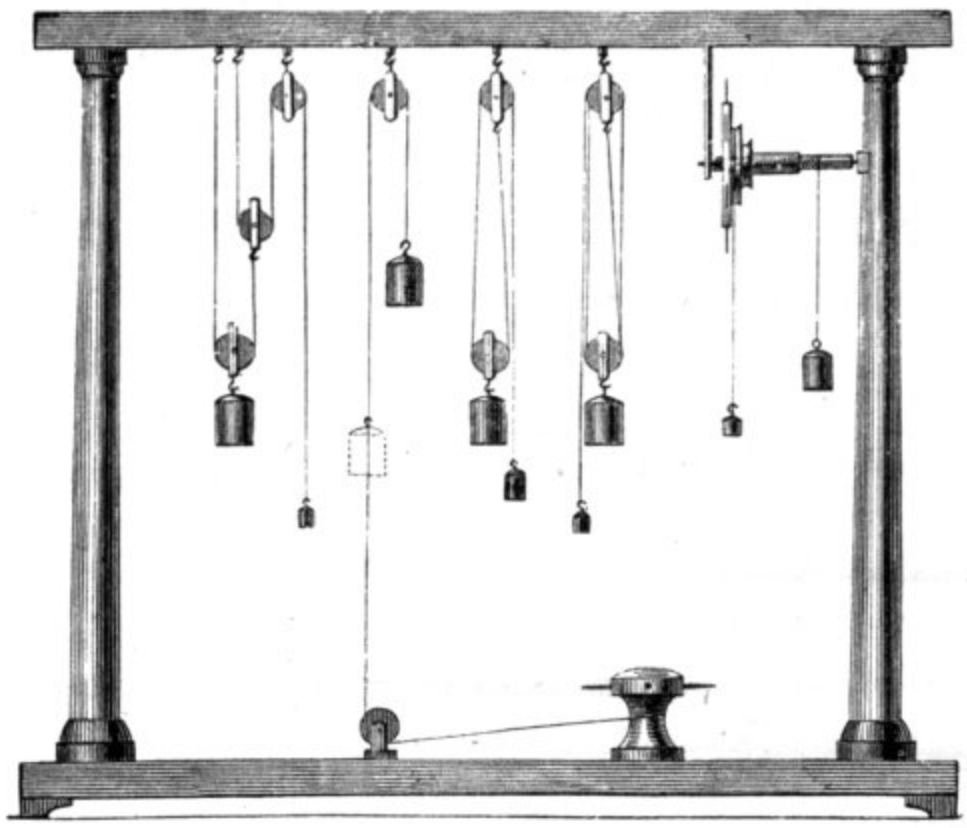
1st. *Fixed Pulley;* power and weight equal.
2d. *Fixed and Movable Pulleys*; power and weight as 1 to 2.
3d. *Double Fixed and Movable Pulleys*; power and weight as 1 to 4.
4th. *Wheel and Axle*, with four diameters, and cords.
5th. *Capstan and Levers.*

With the single pulleys the *System of Three Single Pulleys* can be made, for which hooks are placed on the bar, and cords are fitted and sent with the set, ... 16.00

92. **Illustration of Pulleys**, polished mahogany base and pillar, with supports for the *Systems of Pulleys* and *Wheel and Axle.* The pulleys are of large size, with improved straps; on the double ones the wheels are separated by partitions; all are balanced and strung with silk cords, and include:

1st. *Fixed Pulley*; power and weight equal.
2d. *Fixed and Movable Pulleys*; power and weight as 1 to 2.
3d. *Double Fixed and Movable Pulleys*; power and weight as 1 to 3.
4th. *System of Four Single Pulleys.*
5th. *Wheel and Axle*, with four diameters, and cords.
6th. *Capstan and Levers.* The apparatus is finely finished, . . . 35.00

NOTE. To avoid duplicates, no weights are included in any of the Sets of Pulleys, Gears, or Levers. *See Nos.* 96 *and* 97.



No. 93.

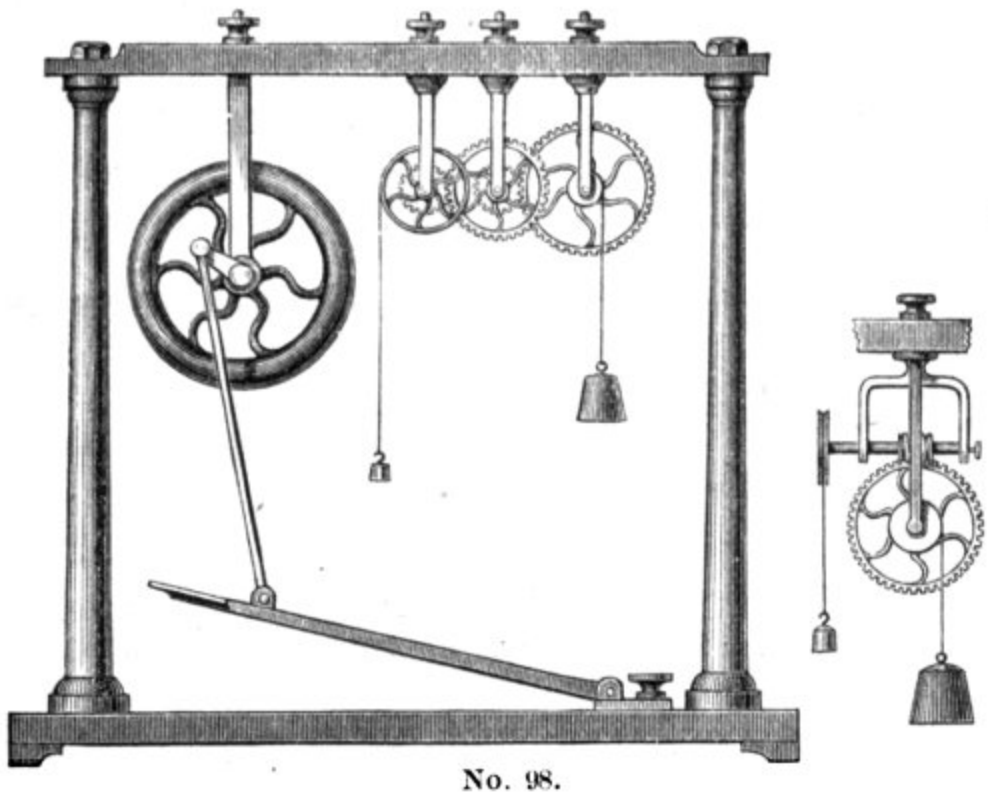
93. **Illustration of Pulleys**, polished mahogany frame, thirty-six inches long and thirty inches high; four systems of pulleys, of large size, with improved straps, and divisions between the sheaves; silk cords, and balanced; including:
1st. *Fixed Pulley*, and cord; power and weight equal.
2d. *Fixed and Movable Pulleys;* power and weight as 1 to 2.
3d. *Double Fixed and Movable Pulleys;* power and weight as 1 to 4.
4th. *System of Four Single Pulleys;* power and weight as 1 to 2, 4, or 8.
5th. *Wheel and Axle*, with four diameters, and cords.
6th. *Capstan and Levers*, ... 25.00

94. **White's Pulley**. The upper block has a pulley with three grooves, the diameters of which are relatively as 2, 4, and 6; the movable block pulley has three grooves, diameters as 1, 3, and 5. Finely finished, of brass, with silk cords, ... 6.25

95. **Differential Pulleys**; consists of a fixed block, and pulley with two grooves, the diameters relatively as 9 to 10; a movable pulley, with one sheave, and an endless chain of brass. The peculiarity of this arrangement is, that while the weight may be raised or lowered by the chain, it will remain wherever left, and cannot be *run down* by the weight, ... 6.25

96. **Set of Weights**, of brass, from one to thirty-two ounces, duplicates of one and four ounces, ... 5.00

97. **Set of Weights**, of iron, japanned, one to thirty-two ounces, duplicate of one and four ounces, ... 2.50



No. 98.

98. **Illustration of Gears and Belts,** consists of a mahogany base and pillars supporting a double metal bar, by which the frames of the systems of wheels are held, allowing them to be placed at all desired distances and positions.

Three metal frames with screw pivots, holding steel axles, upon which the geared wheels or pulleys are arranged as desired.

Six brass geared wheels, with 72, 48, 48, 36, 24, and 12 teeth, and three grooved pulleys of three, two, and two inches diameter, all of which have hubs with binding screws, and can be arranged in a great variety of combinations.

A frame, with geared wheel of seventy-two teeth, and pulley for weight, and an endless screw, which engages in the gear, with pulley for power.

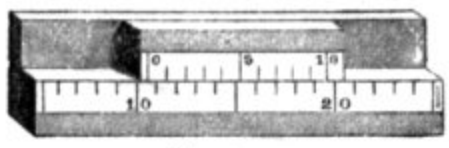
A heavy balance-wheel, grooved for belt, with crank and treadle, and a frame (not shown in cut), with pulley to be connected by open or cross-belt, with round belt.

All the frames have square shoulders to fit the space between the plates of the upper bar, and brass screw nuts, ... 40.00

99. **Parallelogram of Forces**; a light, graduated frame, with hinged joints, illustrating the composition and resolution of forces, with pulleys to attach to the frame of No. 93 or to the blackboard, . 3.50

100. **Riehle's Testing Machine,** for testing band-iron, wire, and other materials, by tensile, transverse, and crushing power, with the proper tools for the various strains. The power is derived from an ingenious ratchet, which can be worked either way. The beam is graduated from one pound up, and has a sliding poise, capacity 1000 lbs. The machine is admirably fitted for the lecture-room, and demonstrates practically to the student the strength of materials and also their behavior while under strain. Full description will be sent on application, ... 100.00

Measurement



No. 103.

103. **Model of Vernier**; graduated rod of half a meter in length, of fine wood, with sliding vernier, ... 3.00

104. **Model of Vernier**; arc of circle of one meter in diameter; graduated arc and vernier, ... 8.00

105. **Cathetometer**; heavy tripod base, brass pillar one meter long; sliding bar, with fine screw adjustment and telescope; for vertical measurements of objects with great accuracy, ...

No. 104.

The Trustees of the AMERICAN METRIC BUREAU have established with us a DEPOSITORY of their apparatus, which we furnish at their lowest prices. We will send on application their complete catalogue free.

106. **Metric Chart**, on roller, in colors, varnished; paper, 1.00; cloth, . 1.50

107. **Meter**, rod of wood, with metal tips, graduated, with inches on side, .20

108. **Meter**, fourfold with hinges, in boxwood, 40 cents; extra broad, arch joint, ...84

109. **School Meter**, four faces, showing meter, decimeter, centimeter, and millimeter, ...60

110. **Liter Block**. Dissected and graduated liter block, of polished mahogany, one decimeter cube, weight one kilogram, separable into one gram, ten grams, one hundred grams, or in liter, deciliter, centiliter, and milliliter blocks, graduated in millimeters; each piece adjusted to specific gravity of water, ... 2.00

111. **Liter Case**, stop-cock, glass face, graduated for specific gravity, in tin, 1.75; in polished copper, lacquered, ... 2.50

112. **Double Liter** to centiliter; of polished copper; eight pieces, . . 2.40

113. **Dekaliter** to deciliter; market form, of wood; seven pieces, . . 1.48

114. **Brass Weights**, kilogram to gram; 13 pieces, ... 4.33

115. **Fairbanks' Balance**, gram to two kilograms, ... 4.40

116. **Steel Tape** in nickel case, 150 centimeters; automatic spring, 1.50; with inches on one side, ... 1.75

117. **Balance**; base and painted iron column, brass beam, seven inches long, with pans and bows, ... 13.00
118. **Balance**; brass column, brass beam nine inches long, brass pans and chains; mounted on wooden box, with drawer, ... 18.00
119. **Set of Weights**, avoirdupois, in nests from one pound to half an ounce, in brass, ... 2.50
120. **Set of Weights**, in mahogany box lined with velvet, of brass, lacquered, one ounce to one quarter grain troy, ... 3.50
121. **Set of Weights**, similar to 120, four ounce to one quarter grain troy, ... 6.50
122. **Set of Weights**, with box, 20 grams to 1 centigram, ... 2.00
123. **Set of Weights**, velvet-lined box, 20 grams to 1 cg. (Becker's), . 3.10

Becker's Balances.

124. **Analytical Balance**, for a charge up to one hundred grams in each pan, in French polished glass case. Front sliding frame counterpoised, all bearings steel, sensible to one quarter milligram, with its full charge, with arrest for pans, ... 45.00
125. **Analytical Balance**, for a charge up to one hundred grams in each pan; in fine French polished glass case, front sliding frame counterpoised. All bearings agate planes, with new improved arrangements for arrest of pans and beam; sensible to one-twentieth milligram with its full charge. Provided with apparatus for specific gravity. Rider and weighing tubes. Beam divided in one-half parts of milligrams. Pans two and three-eighths inches diameter, ... 85.00

Troemner's Balances.

126. **Analytical Balance**, in French polished mahogany case, with counterpoised sliding doors; capacity two thousand grains, sensible to one-hundredth grain. Steel bearings, movable three-and-one-half-inch pans, ten-inch beam, ... 40.00
127. **Analytical Balance**, similar to No. 126, with attachments for rider and pan arrests. Beam graduated to one milligram, ... 50.00
128. **Analytical Balance**, in fine polished glass case. Beam divided in one-half milligrams, sensible to one-tenth milligram, capacity one hundred grams in each pan; beam ten inches; pans, two and three quarters inches. All bearings agate, ... 86.00

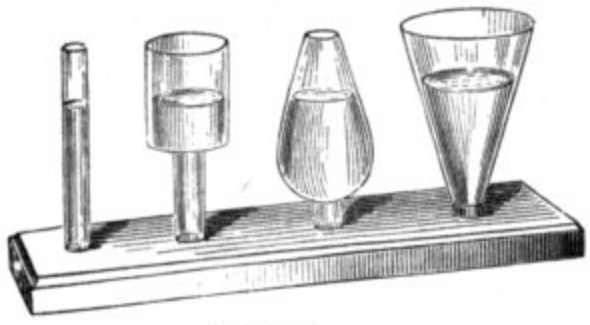
Weights of Precision.

In fine velvet-lined polished block with cover; the weights lacquered and adjusted with greatest care and precision. The smaller weights in platinum and aluminium.

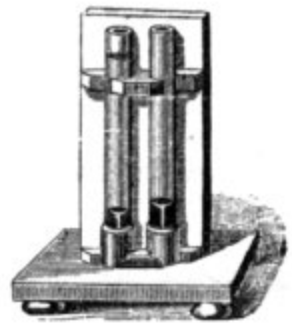
129. **Set of Weights**, velvet-lined box, 1 gm. to 1 mg. (Becker's), . . 3.00
130. **Set of Weights**, velvet-lined box, 50 gms. to 1 cg. " . . . 4.20
131. **Set of Weights**, velvet-lined box, 100 gms. to 1 cg. " . . . 5 20
132. **Set of Weights**, velvet-lined box, 100 gms. to 1 mg. " . . . 10.00
133. **Set of Weights**, in grains, of proportionate weight, at same prices.

HYDRODYNAMICS.

Equilibrium of Liquids.



No. 136.



No. 140.

136. **Equilibrium Tubes**: a set of four forms, connected by a tube within the mahogany base, ... 3.00

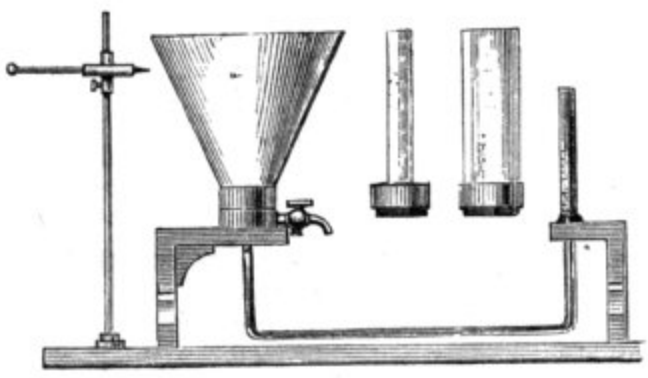
137. **Equilibrium Tubes**; a set of six forms, mahogany base, . . . 3.75

138. **Equilibrium Tubes**; a set of six forms, with brass caps and screw connections to a tube within the mahogany base, ... 4.50

139. **Equilibrium Tubes**; a set of six forms with brass caps, connected by screws to a brass tube, mounted on brass feet, ... 8.00

140. **Equilibrium Apparatus**, for liquids of different densities; mahogany frame, glass tubes with graduated scale, ... 7.50

141. **Equilibrium Apparatus**, mounted on metal support, ... 5.00



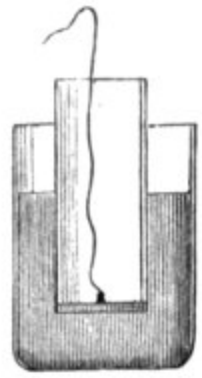
No. 142.

No. 143.

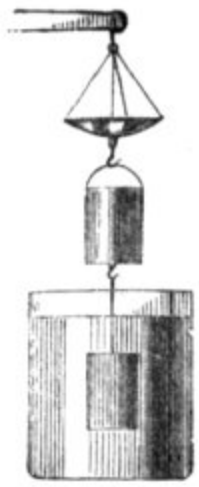
142. **Haldat's Apparatus**, mahogany frame, bent tube for mercury, brass base with stop-cock, glass funnel and tubes with brass caps, adjustable indicator for the water-level, ... 18.00

143. **Illustration of Buoyancy**; glass vase upon a brass stand, brass tube and stop-cock, glass tube and tumbler, and wooden ball. Partly fill the vase and mark the level by the slider on the tube, put in the ball and draw off the water down to the original level. The weight of the water will equal that of the ball, ... 7.50

No. 144.



No. 145.



No. 147.

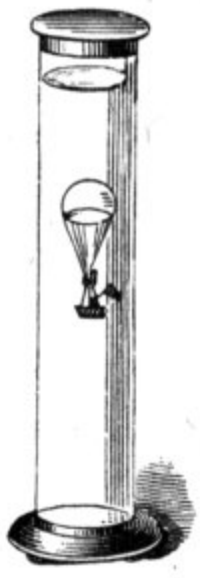
144. **Masson's Apparatus**; a glass jar with brass cap, to which are screwed the glass vessels of different forms; a cylinder extends below the cap, its lower edge is ground to fit a brass plate, which is attached by a cord to a balance; an indicator, mounted on a stand, with adjustable index for the water-level, ... 13.50

145. **Upward Pressure of Liquids**; a glass cylinder, and heavy brass plate ground to fit the cylinder, with hook and cord, ... 2.00

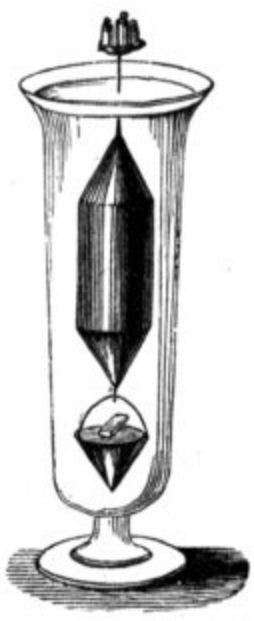
146. **Upward and Downward** Pressure of Liquids, similar to No. 145, with the cylinder contracted at one end to hold a light wooden globe, which is held down by pressure of the water above, . . 2.50

147. **Archimedes' Principle**; a brass cylindrical cup, with bail and hook; a solid cylinder of brass exactly fitting the cup, . . . 2.75

No. 150.



No. 148.



No. 155.

148. **Balloon and Car**, glass jar eighteen inches high, ... 3.00

149. **Cartesian Devil**, in glass jar, and rubber cover, ... 1.50

150. **Hydrometer**, for liquids lighter than water, ... 1.25

151. **Hydrometer**, for liquids heavier than water, ... 1.25

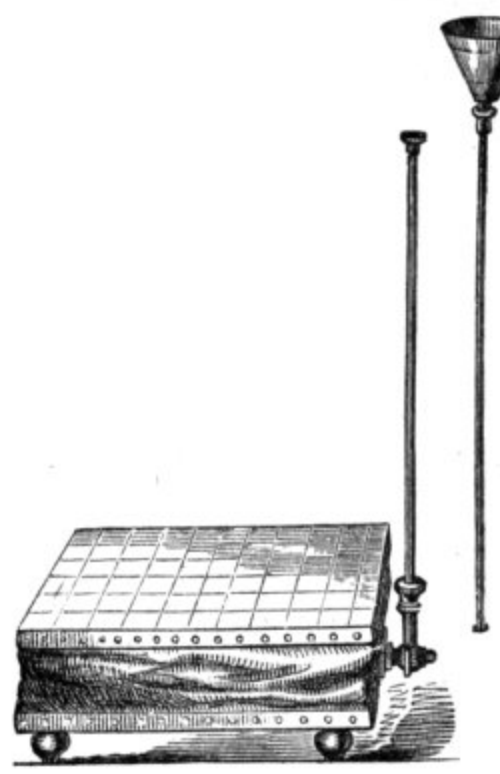
152. **Universal Hydrometer**, of large size, with the zero in the middle of the scale, adapted for all liquids, ... 2.25

153. **Hydrometer Jar**, with foot and lip, twelve inches high, ... 1.00
154. **Hydrometer Jar**, with foot and lip, fifteen inches high, ... 1.25
155. **Nicholson's Hydrometer** for Specific Gravity, of japanned iron, 2.50
156. **Nicholson's Hydrometer**, of brass, ... 4.50
157. **Specific Gravity Balance**, brass beam fourteen inches long, with steel knife-edges, brass elevating-stand, a pair of scale-pans for ordinary use in weighing; one of the pans has a hook for suspending a body in liquid; the balance is sensitive to a quarter of a grain. See No. 289, ... 12.50
158. **Diving-Bell**, of glass, with lead ring, hook and cord, ... 3.00
159. **Diving-Bell**, of glass, lead ring, with brass cap, hook and chain and rubber tube. *Cut on page* 21. . . . . 5.25

Liquids in Motion.

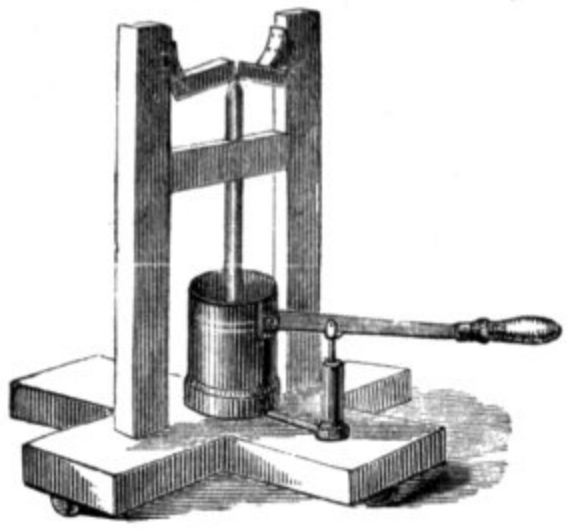
160. **Glass Siphon**, plain, ...50
161. **Glass Siphon**, with suction-tube, ... 1.00
162. **Brass Siphon**, plain, ...75
163. **Brass Siphon**, with suction-tube, ... 1.50
164. **Wurtemberg Siphon**, of glass, eighteen inches long, ...75
165. **Tantalus' Cup**, illustrates intermittent springs, ... 1.50

No. 166.



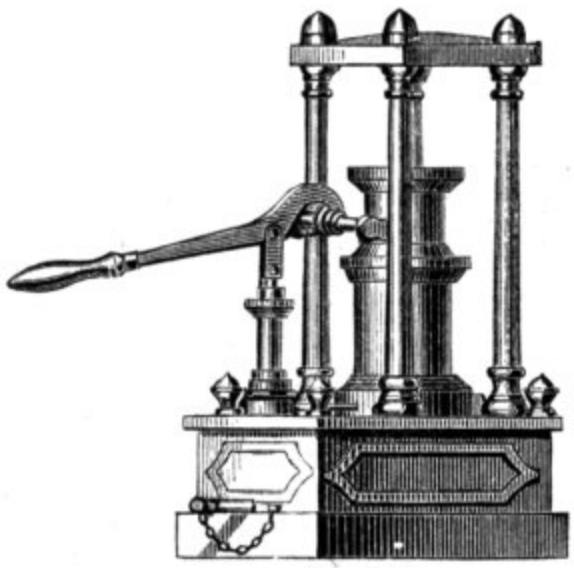
No. 167.

166. **Ritchie's Illustration** of the Hydraulic Press; mahogany base with a sliding platform supported by brass pillars, with a weight; upon the base is placed a bellows-formed rubber-bag, connected by a tube to a globular bag fitted with a cap and cork.
Fill the globe with water, and elevate it; the pressure of the column will force the water into the bellows, raising the weight; lower the globe, and the weight will force the water back into it, . . . 12.00
167. **Hydrostatic Bellows**, of mahogany, twelve inches square, with patent-leather sides, lined with vulcanized rubber, brass socket, two brass tubes with screw connections and funnel, ... 18.00



No. 168.

168. **Hydraulic Press**, strong frame of polished cherry-wood, brass cylinder four inches in diameter, force-pump of brass, three quarters of an inch in diameter, brass connecting-tube, stop-cock, and water-pan. The power of the press is shown by the breaking of bars, or can be estimated by a lever (with suitable fulcrum secured to a wall or pillar) and weight, ... 30.00



No. 169.

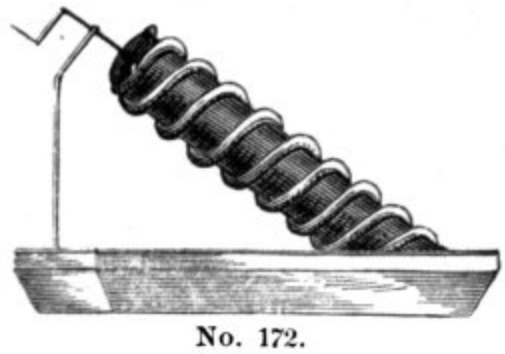
169. **Hydraulic Press**, improved form, handsomely mounted on a strong iron frame, with brass pillars, cylinder, force-pump, and stop-cock; a movable attachment, to show the power of the press by breaking bars of cast iron and wood. A water-cistern is contained in the iron base, ... 40.00

NOTE. The use of lard oil or sperm oil instead of water is preferable.

170. **Oersted's Apparatus** for the compression of liquids; a strong cylinder of glass, with brass caps and screw, for compression, glass bulb and tube, mounted on a scale and graduated. The instrument is very substantially made, ... 25.00

No. 159.

No. 165



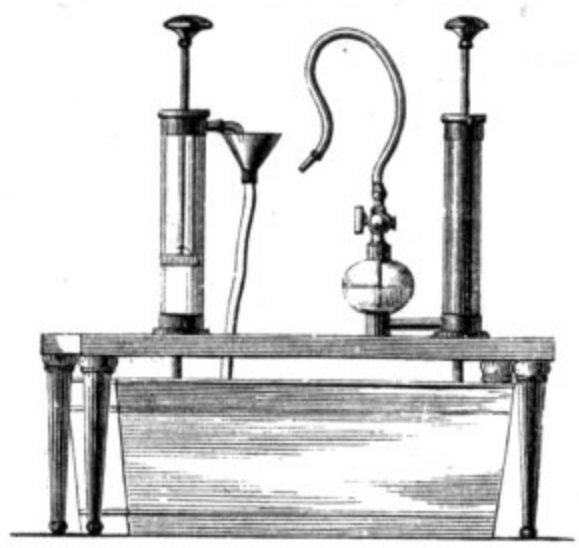
No. 172.

171. **Intermittent Fountain**; a glass vase supported on a glass tubular pillar, with side-jets and water-cisterns, ... 18.00

172. **Archimedes' Pump**, cistern, and cylinder twelve inches long, of japanned tin, with screw of block-tin, ... 6.00

173. **Fountain Siphon**, glass flask, brass cap, with tube and interior jet, long exit-tube, ... 3.00

No. 173.



No. 177.

No. 174.

174. **Lifting-Pump**; a strong glass cylinder, with brass mountings; the valves are placed so as to show their action clearly, ... 4.00

175. **Force-Pump**; glass cylinder and air-chamber, brass mountings, stop-cock, hose, and jet, ... 8.00

176. **Force-Pump**, similar to No. 175, with brass cylinder, ... 7.00

177. **Lifting and Force-Pumps**, Nos. 174 and 176; mounted on mahogany table, with japanned water-cistern, complete, ... 15.00

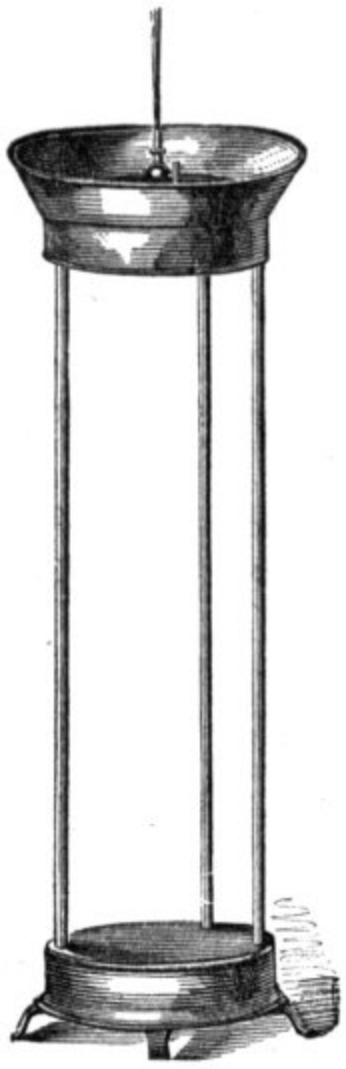
178. **Lifting and Force-Pumps**, with Nos. 174 and 175, mounted on a mahogany table with japanned water-cistern, complete, . . . 16.00

179. **Centrifugal Pump**, metallic tripod, frame, with cisterns below and above the revolving tubes, motion given by brass geared wheels, height of apparatus twenty inches, ... 16.50

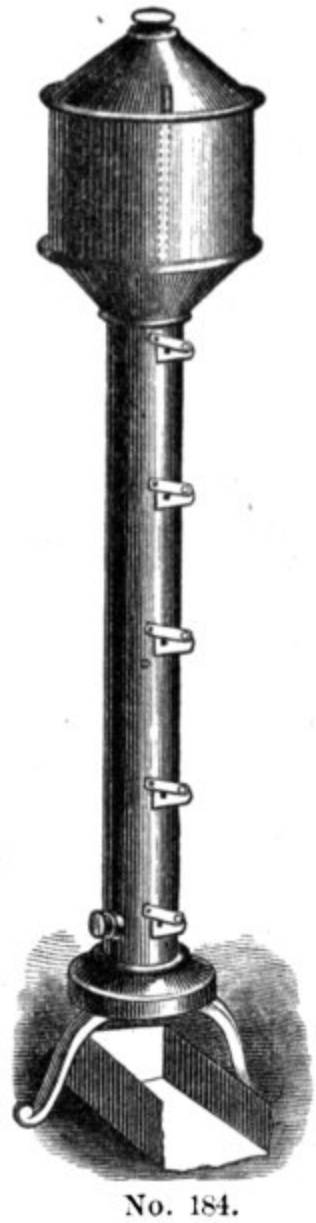
180. **Hydraulic Ram**; a reservoir, mounted upon three pillars, a spiral tube for the flow of water, and cistern; spring-valve and air-chamber, the tube from which ends in a jet above the reservoir, 18.00

181. **Hero's Fountain**; cisterns of tin, neatly japanned, tubes and jet of brass, height thirty inches, ... 7.50

No. 183.



No. 181.



No. 184.

182. **Hero's Fountain**, cisterns of copper, japanned, tubes and jet of brass, height thirty-six inches, ... 10.00

183. **Hero's Fountain**, glass globes, cistern, base tubes and caps of brass, 25.00

184. **Spouting Fluids Apparatus**, Ritchie's improved form; cylinder of brass upon a tripod-stand; large copper vase with screw cover, fitted as a *Mariotte's Vase*, by which the water-level is effectively constant, with gates arranged so that the flow may be through orifices with thin sides, or through cylindrical or conical tubes, for Savart's experiments. A rod connects the gates, so that all or any of them may be opened and closed at the same moment, a horizontal tube, with vertical jets, showing the friction of the tube on the water flowing through it; a long cistern to receive the flow. The apparatus is arranged for the beautiful experiment of the total reflection of light in a liquid vein. The apparatus is very perfect and complete, ... 65.00

185. **Water-Wheels**; two large model wheels, representing the *Breast*, *Overshot* and *Undershot* water-wheels, made of heavy tin, and neatly japanned, ... 9.00

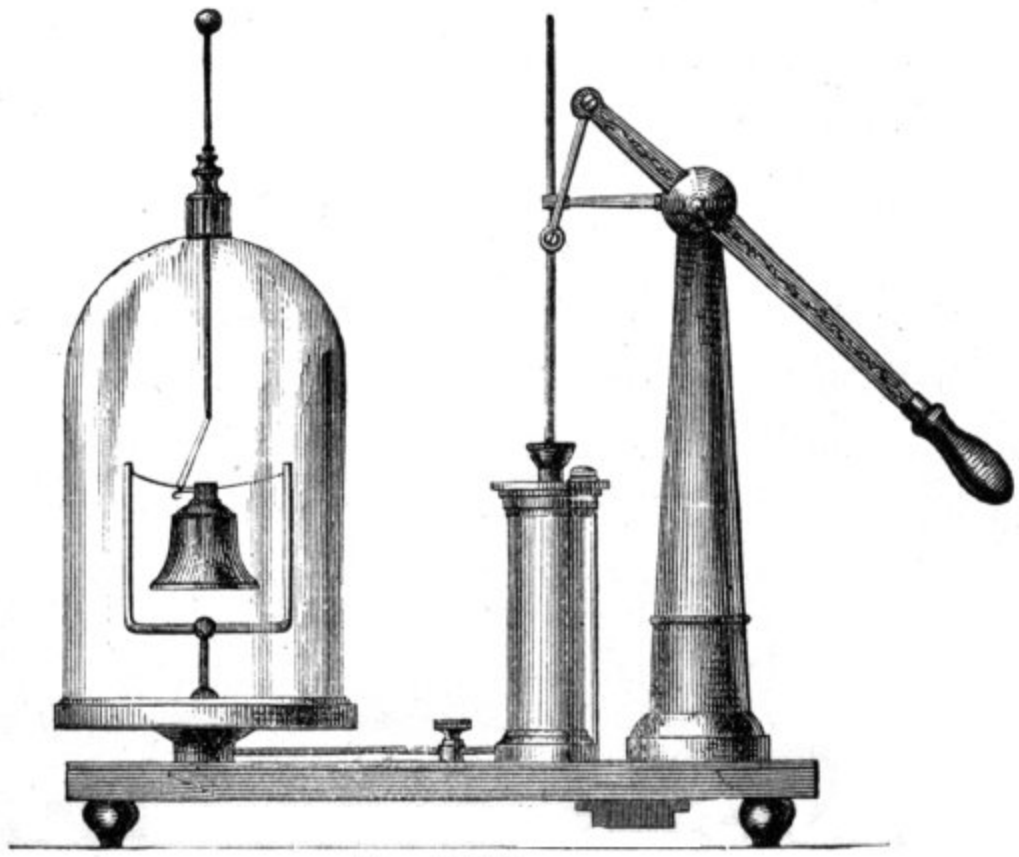
186. **Turbine Water-Wheel**, model of brass, mounted upon a mahogany support, with cisterns for water above and below, ... 25.00

187. **Barker's Mill**; mahogany base and pillar, with water-cistern, glass tubes, and revolving arms, ... 16.50

PNEUMATICS.

No. 200.

200. **Air-Pump**; mahogany base, cylinder of brass, seven inches long by one and a quarter inches in diameter; brass plate, eight inches in diameter. The pump may be worked in a vertical or inclined position, ... 15.00



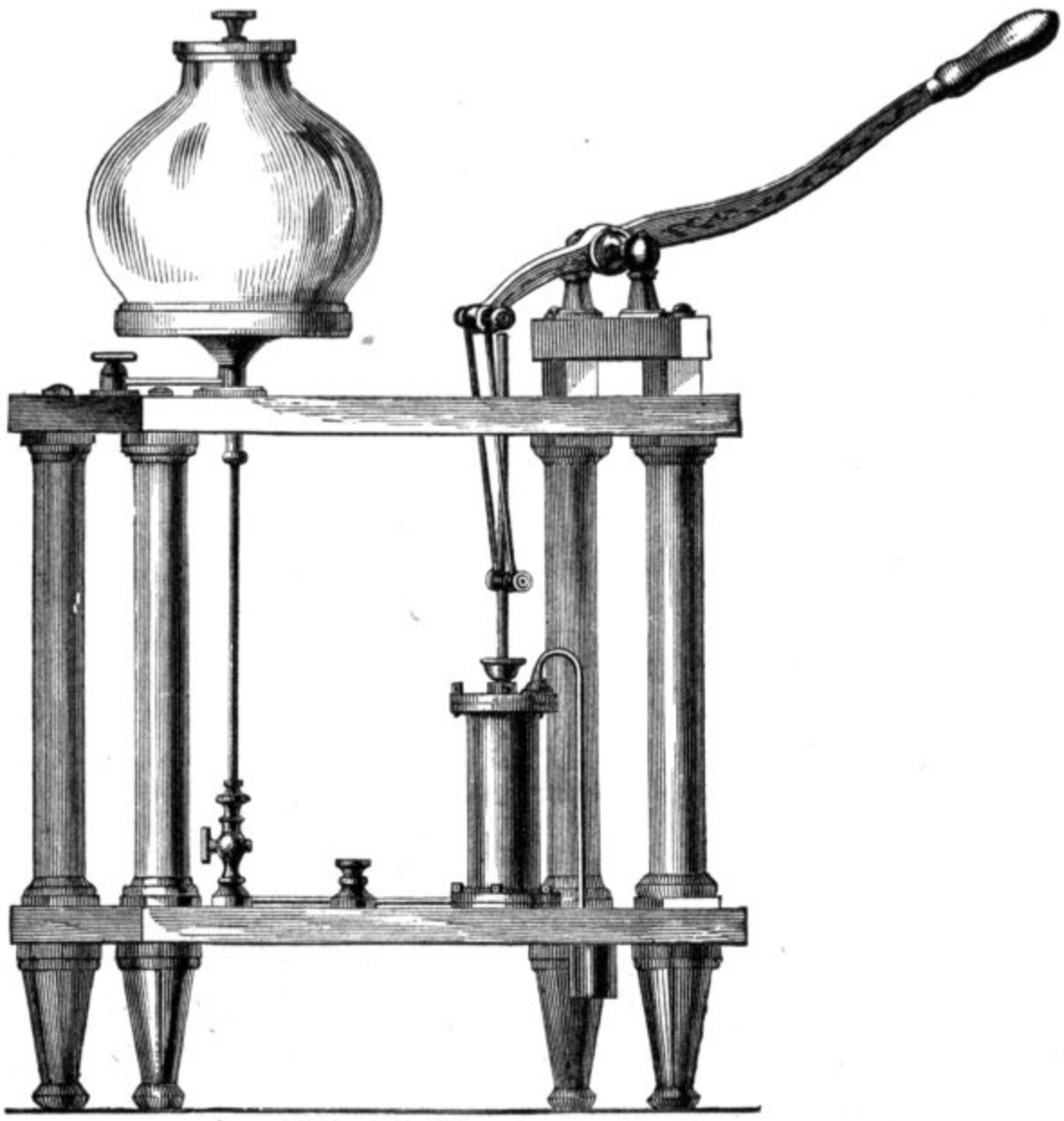
Nos. 201-204.

201. **Air-Pump**; polished mahogany base and pillar, brass cylinder, seven and a half inches long by two inches diameter; brass plate eight and a half inches diameter; the piston is packed in a manner to prevent leakage with slight friction, the valves are accessible. The cup around the piston should be partly filled with oil to prevent leakage and to lubricate the piston 35.00

202. **Air-Pump**, same as No. 201, substituting a polished black-walnut base and pillar, ... 33.00

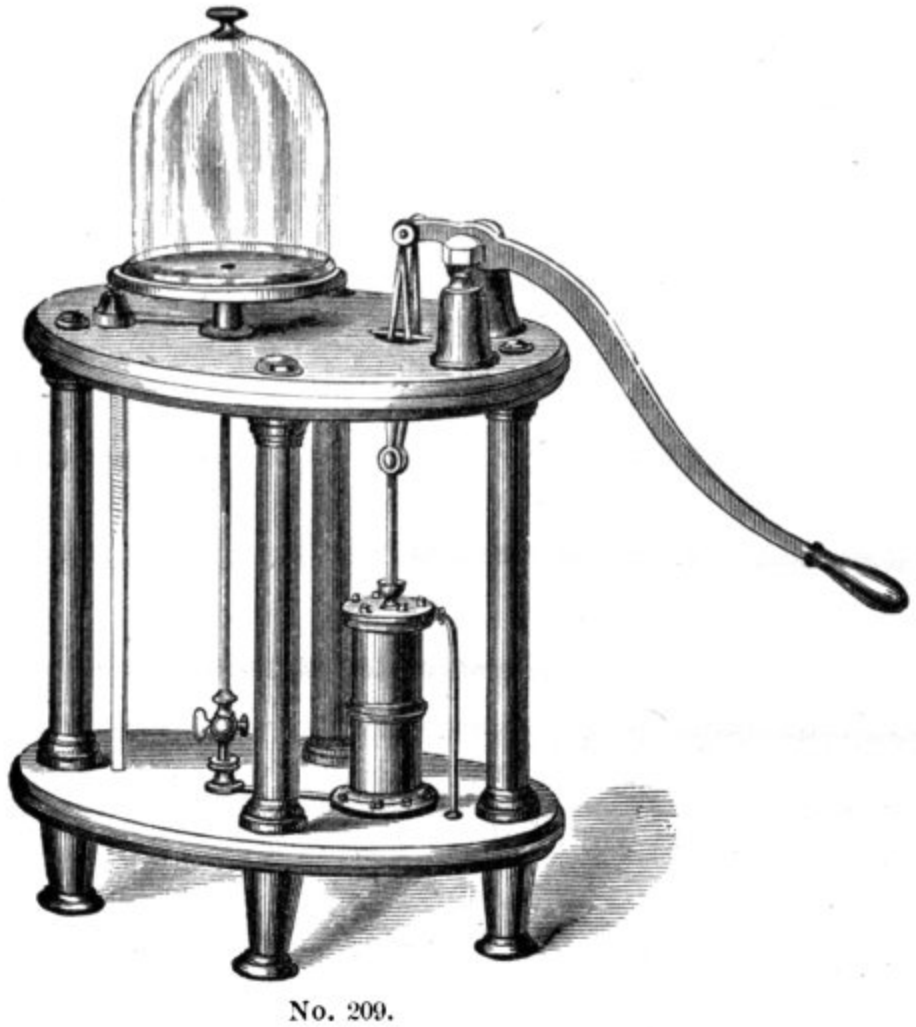
203. **Air-Pump**, brass cylinder, seven and a half by two inches, plate eight and a half inches, polished walnut pillar, mounted on an iron base, neatly japanned, securing great steadiness, and forming a very serviceable and handsome instrument, ... 32.00

204. **Air-Pump**, brass cylinder, eight inches long by two and a half inches diameter, brass plate twelve inches in diameter, polished mahogany base; finely finished, ... 48.00



Nos. 205—208.

205. **Air-Pump**, frame of solid mahogany, highly polished, thirty-one by nineteen inches, brass cylinder twelve inches long by four inches diameter, brass tubes and stop-cock, heavy brass plate twelve inches diameter; the plate is elevated forty-three inches from the floor, ... 135.00



No. 209.

206. **Air-Pump**, of same dimensions and materials as No. 205, with the substitution of solid black-walnut for the frame, ... 130.00

207. **Air-Pump**, frame of solid mahogany, highly polished, thirty-three by twenty inches, brass cylinder twelve inches long by four inches diameter, brass tubes and stop-cock, heavy brass plate fifteen inches diameter; the plate is elevated forty-five inches from the floor, ... 145.00

208. **Air-Pump**, similar to No. 207, with plate of fifteen inches diameter, with black-walnut frame, ... 140.00

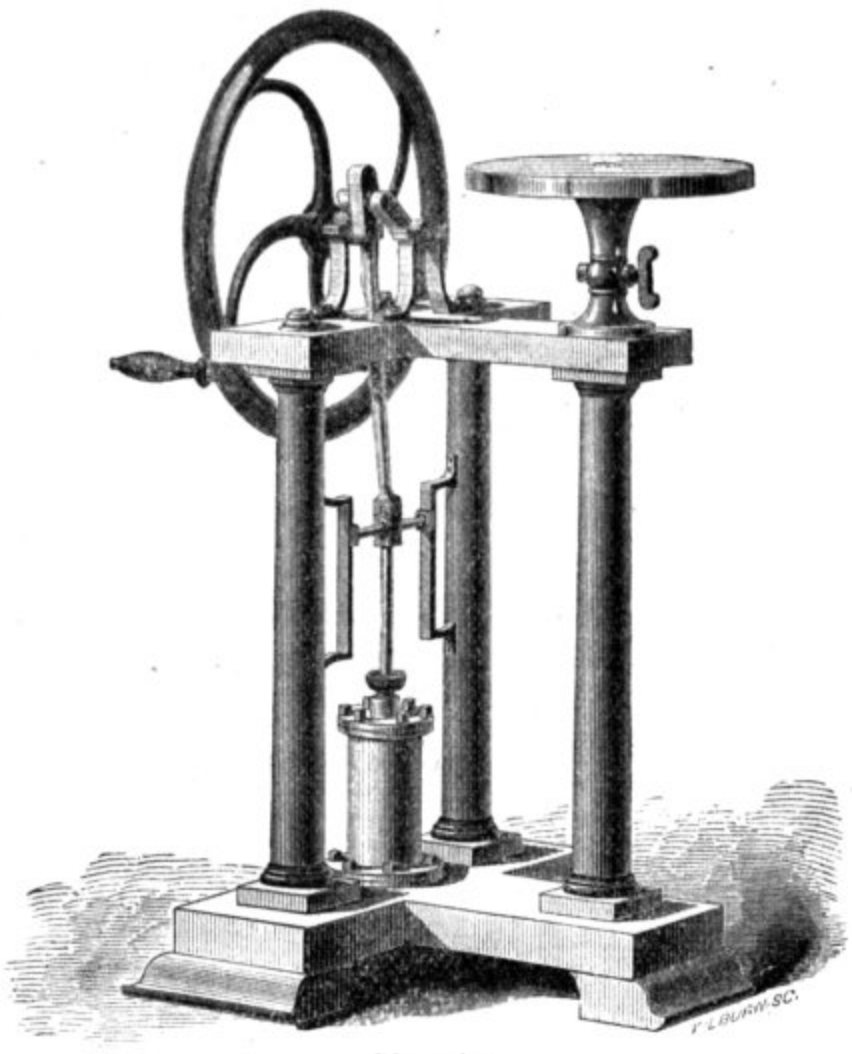
209. **Air-Pump**, frame of solid mahogany, of elliptical form, highly polished, brass cylinder twelve inches long by four inches in diameter, brass plate twelve inches diameter. The plate is elevated forty-two inches from the floor. Very substantially made and finely finished, ... 150.00

NOTE. Either of the above pumps, Nos. 204 to 209, will be made with *Ritchie's Patent Action*, at the additional price of twenty dollars.

210. **Siphon Gauge**, attached to either of the Air-Pumps Nos. 201–204. This gauge is capable of giving accurate measurements, . . . 4.00

211. **Siphon Gauge**, attached to either of the Air-Pumps Nos. 205–209, with stop-cock and a screw-plug to use in its place, ... 7.00

212. **Manometer** or Barometer Gauge attached to Nos. 205–209, with a screw-plug to use in its place. This form of a gauge is not recommended, ... 5.00



No. 213.

DESCRIPTION OF RITCHIE'S PATENT AIR-PUMP.

The cylinder is made in the usual form.

Fig. A is a section showing the valves, &c., much exaggerated for distinctness.

The lower valve is conical, held in place by a triangular stem fitting the tube; it is raised by the *valve-rod* passing up through a stuffing-box in the piston; an enlarged section (Fig. B) shows the manner in which the attachment is made, which allows a motion of the rod sidewise, so that any slight change of form of the packing of the piston, or stuffing of the rod, cannot prevent the valve from shutting properly. The cone of the valve is ground to a perfect fit to its seat; but the valve is also furnished with a disc of oiled silk, which projects just beyond its outer edge, and touches the flat surface of the valve-seat; the valve-rod extends up, and is secured in a hole drilled in the upper plate, of depth to allow motion vertically to open the valve.

The piston is of thick brass, made in two parts; the upper piece has a conical bearing, ground to fit a cone on the piston-rod, which forms the piston-valve; a series of channels give free passage for the air; the lower plate covers the end of the rod, allowing motion to open the valve.

In the thickness of the upper plate of the cylinder is inserted a steel lever, one end of which covers the valve-rod; the other end, when the lower valve is closed, is *flush* with the plate; but when the valve is raised, it projects into the cylinder. A third valve is placed outside the cylinder, made of oiled silk.

In action, the first motion upward of the piston-rod closes the piston valve; the first motion of the piston opens the lower valve; as the piston ascends, the

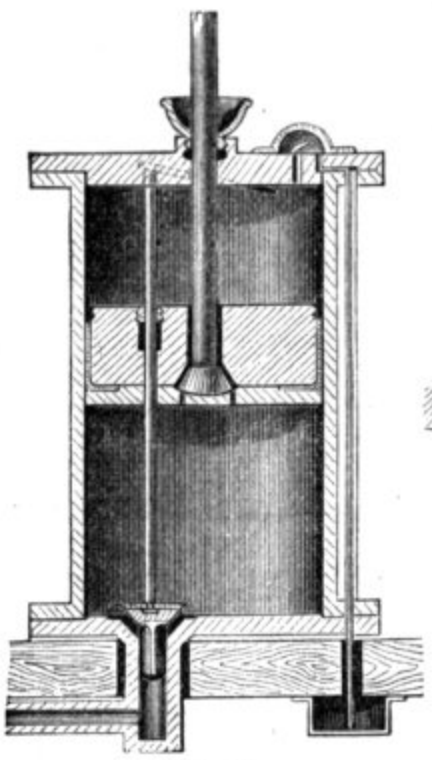


Fig. A.

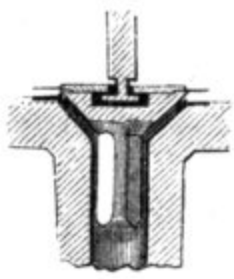
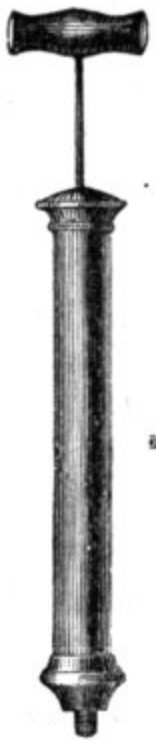
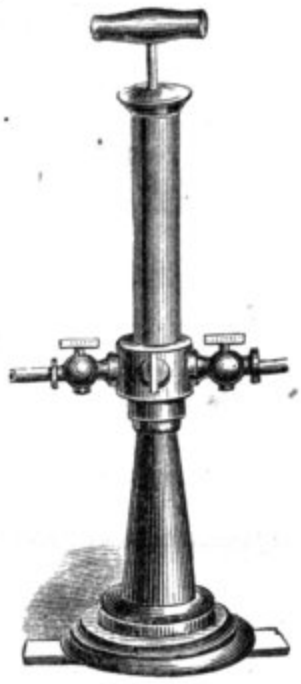


Fig. B.



No. 215.



No. 217.

air above it is forced out through the upper valve; and air from the receiver flows unobstructedly into the cylinder. The piston strikes the end of the lever, and, at the instant of arriving at the top, closes the lower valve. The first downward motion of the piston-rod opens the piston-valve, the air in the interstices above the piston, which is then of normal pressure, distributes itself throughout the cylinder, but *none* can pass the lower valve back into the receiver. During the descent of the piston there is a free passage for the air through it.

The working parts are very substantial, not likely to be deranged, and are readily accessible. Almost a *Torricellian* vacuum is obtained; a *true* mercury gauge can be brought to within one fiftieth of an inch. The *Aurora Tube*, with the electric discharge, is *filled* with brilliantly stratified light.

The rapidity of action, the ease of working, and the very high degree of rarefaction obtained by this pump, and the comparatively small space it occupies, render it a very valuable instrument. It has been in use and highly approved in many of the principal colleges in the country.

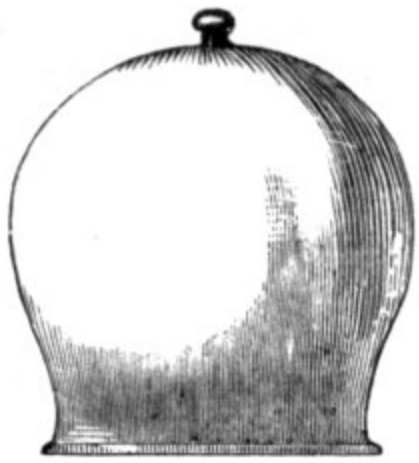
213. **Ritchie's Rotary Air-Pump**, with Patent Action, solid mahogany frame, polished; all the metallic work is brass except the balance-wheel; the plate is fifteen inches in diameter, with a guard-chamber inclosed in its pedestal; it is elevated forty-three inches above the floor. Very substantially made and finely finished, . 250.00

215. **Condenser**, brass cylinder eight inches long by one and a quarter inches in diameter, ... 6.50

216. **Condenser**, with reversible piston and valves (converting it into an exhausting-pump), brass cylinder eight by one and a quarter inches, ... 7.50

217. **Transferrer**, cylinder eight by one and a quarter inches, with brass stop-cocks for admitting and discharging gas, mahogany base and pillar, with flanges for the feet, ... 14.00

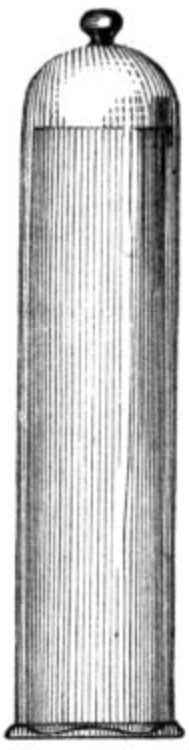
218. **Transferrer**, similar to No. 217, with screw-sockets for hose, mounted on iron base neatly japanned, ... 12.00

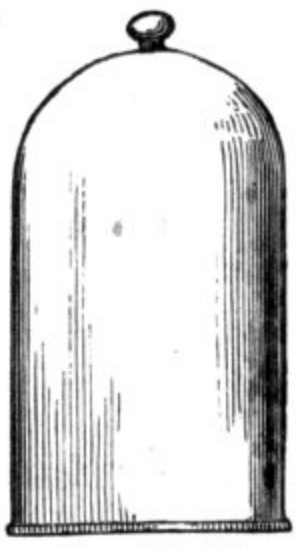


Nos. 220—222.

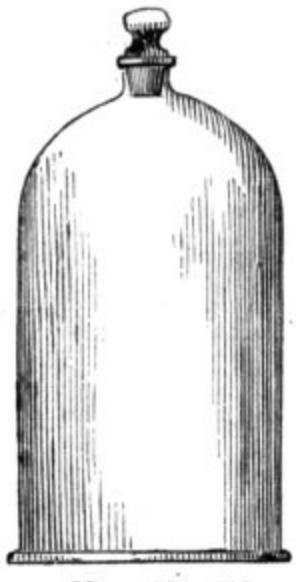
Nos. 223—225.

220. **Swelled Receiver**, two gallons, with ground flange, ... 2.50
221. **Swelled Receiver**, four gallons, ... 3.25
222. **Swelled Receiver**, six gallons, ... 5.00
223. **Open Receiver**, with ground flanges, to be closed with No. 256 or plate of No. 292, two gallons, ... 2.50
224. **Open Receiver**, four gallons, with ground flange, ... 3.25
225. **Open Receiver**, six gallons, " " " 5.00





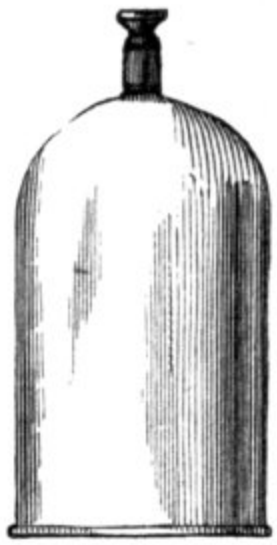
Nos. 226—231.



Nos. 232, 233.

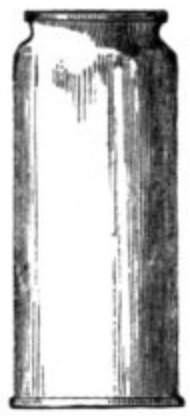
Nos. 234—237.

226. **Plain Receiver**, one pint, with ground flange, ...50
227. **Plain Receiver**, one quart, " " " 75
228. **Plain Receiver**, two quarts, " " " 1.00
229. **Plain Receiver**, one gallon, with " " 1.50
230. **Plain Receiver**, two gallons, " " " 2.25
231. **Plain Receiver**, four gallons, ... 4.00
232. **Tubulated Receiver**, two quarts, with glass stopper, ... 1.25
233. **Tubulated Receiver**, one gallon, " " " 1.50
234. **Tall Receiver**, 18 inches high, 4 inches diameter, ... 2.25
235. **Tall Receiver**, 22 inches high, 4½ inches diameter, ... 3.00
236. **Glass Jar**, for No. 234, ... 1.50
237. **Glass Jar**, for No. 235, ... 2.00



Nos. 240—245.

No. 253.

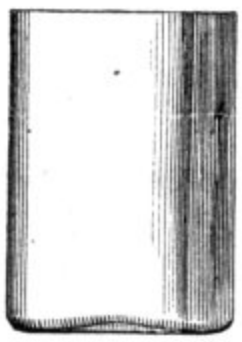


Nos. 250—252.

240. **Capped Receiver**, with brass screw-cap, to receive the *Sliding Rod*, &c., or closed with the *Screw-Plug*, one quart, ... 1.50
241. **Capped Receiver**, two quarts, ... 1.75
242. **Capped Receiver**, one gallon, ... 2.25
243. **Capped Receiver**, six quarts, ... 3.00
244. **Capped Receiver**, two gallons, ... 3.50
245. **Capped Receiver**, three gallons, ... 4.50

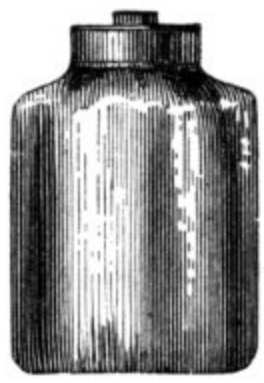
NOTE. The *Capped Receiver* is the most convenient and generally useful form.

250. **Cylindrical Receiver**; open top, with both flanges ground, to be closed by the brass plate of the *Upward-Pressure Apparatus*, No. 292, or by No. 256; two quarts, ... 1.00
251. **Cylindrical Receiver**, one gallon, ... 1.50
252. **Cylindrical Receiver**, two gallons, ... 2.25
253. **Hand Glass** or Bladder Glass, both flanges ground, ... 1.00



No. 254.

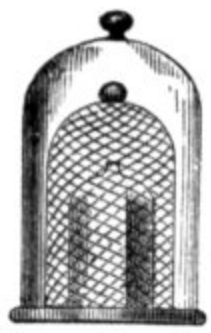
No. 257.



No. 258.

254. **Glass Jar**, for one-gallon *Receiver*, ...75
255. **Glass Jar**, for two-gallon *Receiver*, ... 1.00
256. **Brass Plate**, four inches diameter with ground surface, for closing the *Open Receivers* with screw for *Sliding Rod*, &c., ... 1.75
257. **Condensing Chamber**, of heavy copper, six inches in diameter; with dome and side sockets, stop-cock, and interior tube, . . . 7.25
258. **Condensing Chamber**, of glass, brass cap with opening two inches in diameter, screw-cap and wrench; capable of resisting three pressures of atmosphere; capacity, two quarts, ... 15.00

No. 260.



Nos. 261—263.

No. 264.

No. 266.

260. **Resistance Fan**, to be placed edgewise, or crosswise, on the axle; with handle, ... 1.00

261. **Bursting Squares**, for expansion or pressure; per dozen, . . . 2.25

262. **Wire Guard**, for *Bursting Squares*, ...75

263. **Brass Cap and Valve**, for *Bursting Squares*, ...50

264. **Expansion Apparatus**, bolt-head and jar, with quart receiver, . 1.50

265. **Expansion Apparatus**, bolt-head and jar, without receiver, . . .75

266. **Bladder Cup**, with stop-cock and stand, ... 3.00

No. 267.

No. 271.

No. 272.

No. 274.

267. **Magdeburg Hemispheres**, of brass, three and one half inches diameter, of extra thickness, and highly finished; with stand, . 6.50

268. **Magdeburg Hemispheres**, of brass, similar to No. 267, five inches diameter, ... 10.00

269. **Magdeburg Hemispheres**, of iron, handsomely japanned, four inches in diameter, brass stop-cock; with stand, ... 5.50

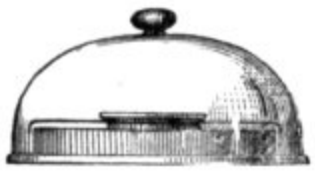
270. **Magdeburg Hemispheres**, similar to No. 269, five inches in diameter, ... 6.50

271. **Pump in Vacuo**; consists of an Adapter, or tube with socket and screw, to use with Nos. 174, 251, 254, and the brass plate of No. 292, ... 1.50

272. **Siphon in Vacuo**; capped receiver, funnel, stop-cock and tube, glass cylindrical jar, vase and siphon, ... 5.50

273. **Water Hammer**, a strong glass tube, with brass cap, stop-cock and stand (for exhaustion), ... 4.00

274. **Water Hammer**, glass tube and bulb, fifteen inches long, . . . 1.50



No. 275—276.

No. 277.

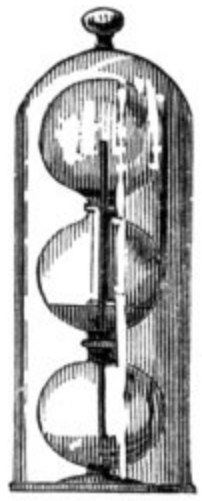
No. 278.

No. 279.

275. **Freezing Apparatus**, receiver six inches in diameter, pan for acid, water-cup and supporting-frame, ... 2.50
276. **Freezing Apparatus**, receiver eight inches in diameter, pan for acid, water-cup and supporting-frame, ... 3.00
277. **Bacchus Illustration**, glass jars, with brass caps and tube, . . 2.25
278. **Mercury Tunnel and Cup**, used with the *Hand-Glass*, ... 1.75
279. **Brass Plate** and **Wood Cylinder**, showing the porosity of wood fitted to use with the *Hand-Glass* or *Cylindrical Receiver*, . . 1.50

No. 280.

No. 273.

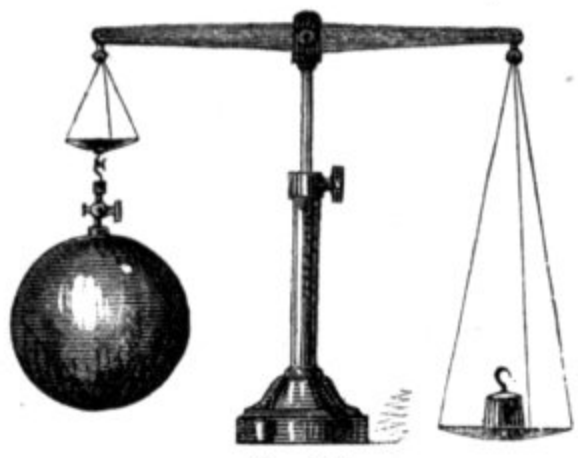


No. 282.

No. 283.

280. **Fountain in Vacuo**, improved heavy glass bell, twenty inches high; with brass stop-cock, and jet and stand, ... 5.00
281. **Fountain in Vacuo**, same as No. 280, thirty inches, ... 6.50
282. **Treble Globe**, or Liquid Transferrer, twelve inches high, with brass cap and tube; used under a receiver, ... 3.50
283. **Bolt-Head**, thirty inches long, with cap, stop-cock, and tube, to use with a *Capped Receiver and Jar*, ... 3.50
284. **Bolt-Head**, thirty inches long, with brass plate, fitted to use with an *Open Receiver*, ... 2.50

No. 287.



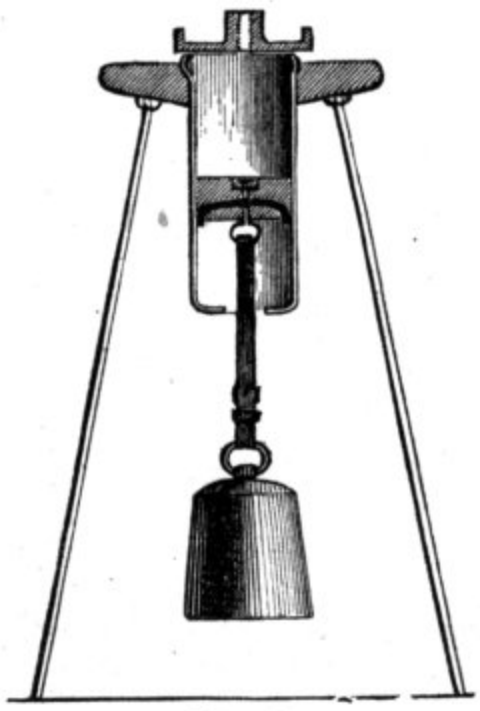
No. 289.

287. **Weight and Buoyancy of Air**, four-inch brass globe, with stop-cock and hook; a very sensitive steel balance, with brass support and mahogany stand; a box of centigram weights, and counterpoise weight, and scale-pans, ... 9.00

288. **Weight and Buoyancy of Air**, similar to No. 287, with glass globe, ... 8.00

289. **Balance and Globe** for weighing air; brass beam fourteen inches long, with steel knife-edges, brass stand, pans fitted for *specific gravity*, six-inch polished brass globe, with stop-cock and hook, 16.75

290. **Globe**, of polished brass, six inches diameter, with stop-cock and hook, ... 6.50



No. 292.

No. 293.

291. **Upward Pressure Apparatus**, tripod stand thirty inches high, glass cylinder nine inches in length by three inches diameter, with strap for weight, ... 7.50

292. **Upward Pressure** Apparatus, tripod stand with brass legs, cylinder nine by three inches, brass plate and strap for weight, . . 10.00

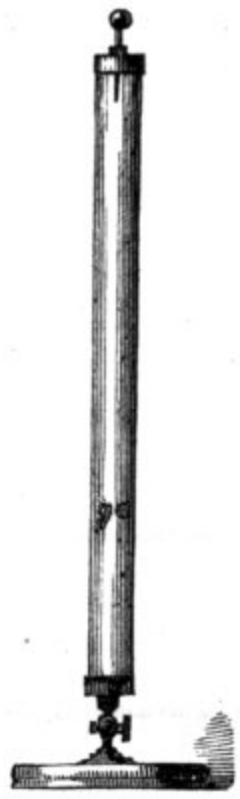
293. **Upward Pressure** Apparatus, glass bell with brass cap and India rubber bag, tripod stand and strap for weight, ... 10.00

294. **Iron Weight** for *Upward Pressure Apparatus*, forty pounds, . . . 5.00


No. 296.


No. 298.


No. 299.


No. 300.

296. **Cryophorus in Vacuo.** The tube is fastened into a ground brass plate, to rest upon an *Open Receiver*, ... 4.50

297. **Barometer Tube,** a thick glass closed tube and mercury dish, . . 1.25

297*a*. **Barometer Tube** and brass plate, fitted to use with the *Hand Glass* and *Cup* of No. 278, ... 2.50

298. **Barometer Apparatus,** bell-glass thirty inches high, screw cap and mercury cistern, ... 5.00

299. **Barometer Apparatus,** bell-glass, with brass cap and sliding-rod, graduated tube with hook, and mercury-cistern. The tube should be lowered into the mercury after the exhaustion is completed, before admitting the air, ... 6.50

300. **Guinea and Feather Tube**; glass tube with brass caps, stop-cock and stand; thirty inches high. The tube is fitted with points for an *Aurora Tube* for electrical discharge, ... 6.75

301. **Guinea and Feather Tube,** similar to No. 300, four feet high, . 8.00

302. **Bell for Vacuum,** with clock-work movement; the whole is suspended by cords to a frame, ...

303. **Bell for Vacuum,** with stand. The bell is suspended on silk cord; it is to be screwed into pump-plate (see Fig. No. 201), . . . 2.50

304. **Wood Cylinder, and Weight** for sinking when the air is removed from the pores, ...25

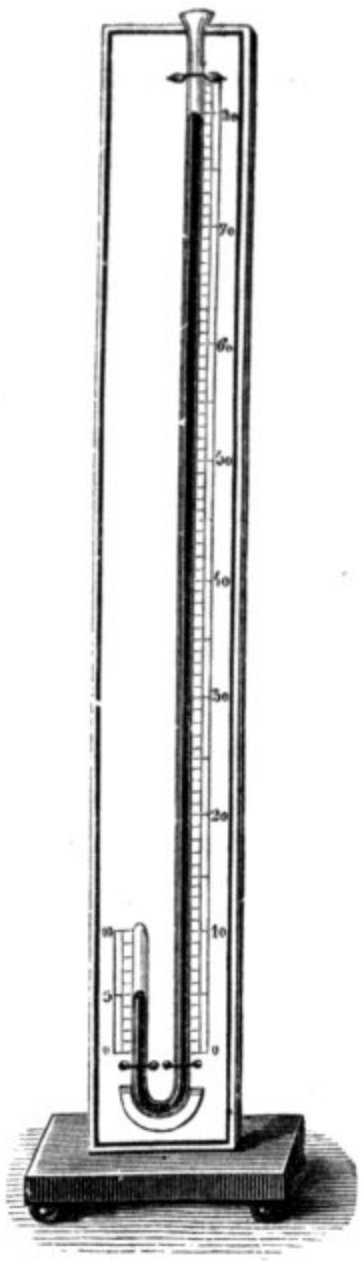
305. **Hydrostatic Balloon**; small Rubber bag, to use in the *Tall Receiver* and *Jar*, ... 1.00

306. **Sheet Rubber Bag,** six inches diameter, to use under an exhausted receiver; with cap, 2.00; with stop-cock and loop, ... 3.50

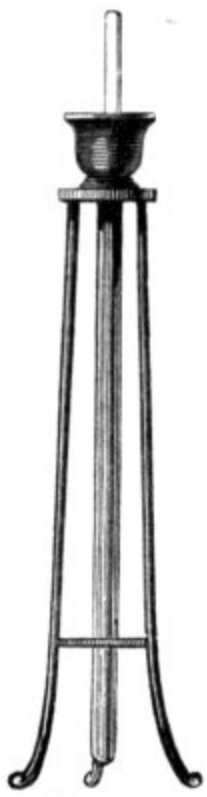
307. **Sheet Rubber,** pure and elastic, per square foot, 40 and 60

308. **Square Vials,** for use with condensed air in No. 258, per dozen, . 2.25

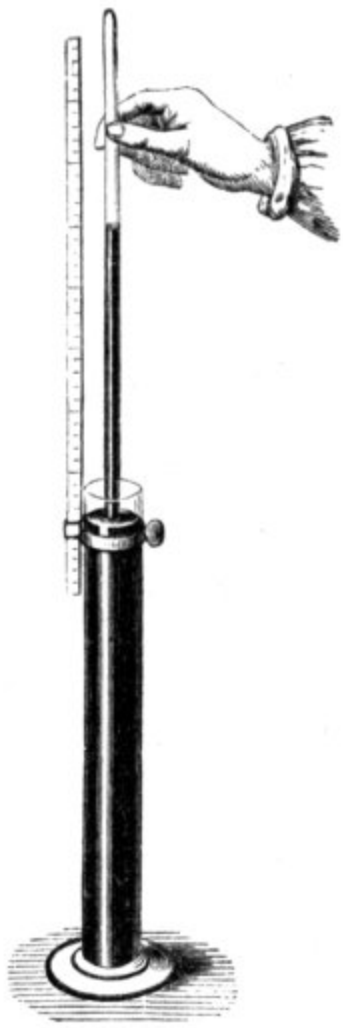
309. **Apparatus** for exploding gunpowder in vacuum, ... 6.00



No. 316.



No. 321.



No. 320.

316. **Mariotte's Law** Apparatus, an upright support of mahogany, forty-six inches high, neatly finished, to which is attached a bent glass tube, the shorter branch with a closed end, and the longer one furnished with a funnel; a graduated scale is attached to each of the tubes, ... 9.00

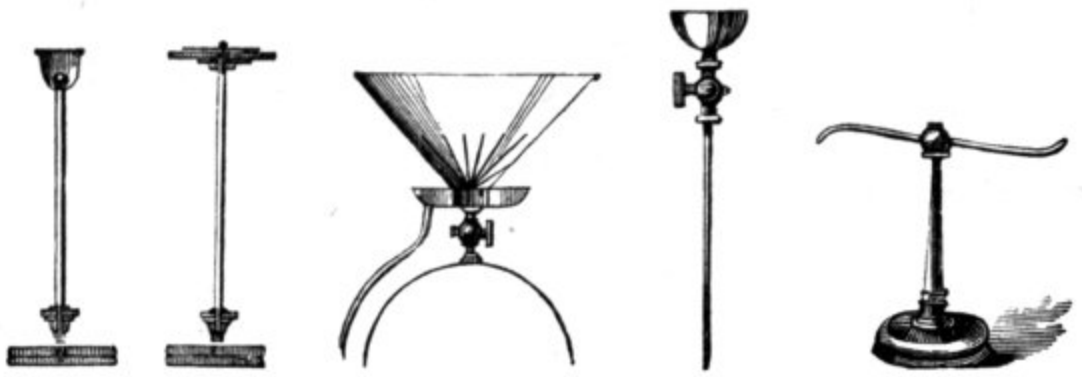
317. **Mariotte's Law** Apparatus, similar to No. 316, with an adjustable scale to the long tube, ... 10.50

318. **Mariotte's Law** Apparatus, support similar to No. 316; the tubes have brass caps which screw into a brass connecting tube, stop-cock, and cistern to receive mercury; an additional tube of thirty-three inches is attached by screw couplings, ... 15.00

319. **Mariotte's Law** Apparatus, similar to No. 318, with all the metal parts made of iron, ... 20.00

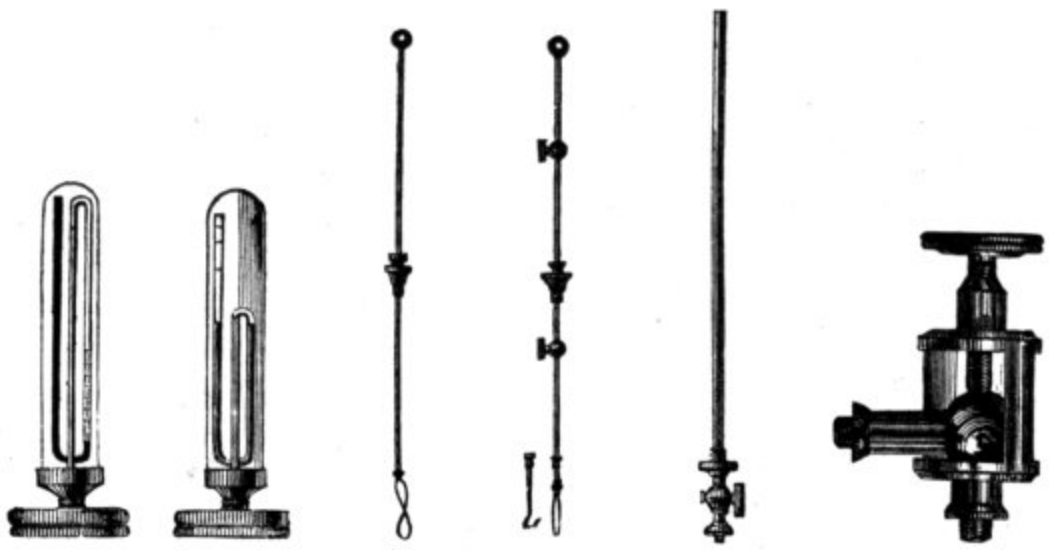
320. **Mariotte's Law** Apparatus, a tall mercury cistern of iron, on a pedestal neatly japanned, with closed graduated tube, ... 6.00

321. **Mariotte's Law** Apparatus, for pressures of less than one atmosphere; a tall mercury cistern of iron, supported upon an iron tripod frame, with closed graduated tube, ... 8.00



No. 322. No. 323. No. 324. No. 325. No. 326.

322. **Pipe Paradox**, with ball, fitted to the *Condensing Chamber*, . . 1.50
323. **Plate Paradox**, with mica disc, fitted to *Condensing Chamber*, . 1.50
324. **Jet and Ball** Apparatus, for supporting a ball on a jet of water, consists of a funnel with wire guards, ball, water-pan and tube, stop-cock with interior and exterior jets, fitted to the *Condensing Chamber*, ... 5.50
325. **Tunnel, Stop-Cock, and Jet**, for introducing liquids into an exhausted receiver, ... 3.00
326. **Revolving Jet** and stand, ... 2.50
327. **Double Revolving Jets**, which turn in opposite directions, . . 3.50



No. 328. No. 329. No. 330. No. 331. No. 332. No. 333.

328. **Vacuum Gauge**, siphon form, in glass case, with stand, ... 4.00
329. **Pressure Gauge**, siphon form, in glass case and stand, ... 4.00
330. **Sliding-Rod**, with ball-handle and packing-screws, ... 2.25
331. **Sliding-Rod**, with ball-handle, packing-screw, and hook and pincers, ... 3.25
332. **Air-Gun Barrel**, fitted to the *Condensing-Chamber*, and balls, . . 1.00
333. **Gallows Connecter** and Tip; exterior screws, ... 1.75
334. **Gallows Connecter** and Tip, interior screws, ... 1.75
335. **Long Connecter**, small exterior screws, ...50
336. **Flexible Rubber Hose**, four feet long, with brass screw-couplings to connect the *Air-Pump* to apparatus for exhaustion, ... 3.00

337. **Leather Collars**, for stop-cocks; assorted, per hundred, ...50
338. **Oil**, prepared to use with Instruments, 25 cents, and 75
339. **Stop-Cock**, large screw, ... 1.50
340. **Stop-Cock**, small screw, one and one half inch, ... 1.50
341. **Iron Stop-Cocks**, to use with mercury, ... 3.00
342. **Coupler**, large interior screws, ...50
343. **Coupler**, large exterior, small interior screws, ...50
344. **Coupler**, large and small interior screws, ...50
345. **Coupler**, large exterior screws, ...50
346. **Guard-Plug**, for pump-plate, ...50
347. **Screw Plug**, for closing brass caps, &c., ...50

HEAT.

Sources of Heat.

No. 363.

No. 365.

No. 369.

No. 374.

360. **Alcohol Lamp**, of copper, with five wicks, ... 1.50
361. **Spirit Lamp**, of glass, with ground cap and large wick, ...75
362. **Berzelius' Lamp**, of brass, with rack-motion, on a stand, and iron chimney, ... 4.50
363. **Bunsen's Burner**, single tube, on stand, ... 1.00
364. **Bunsen's Burner**, single tube, on stand, with adjustable inlet, . . 1.25
365. **Bunsen's Burner**, with three tubes, on stand, ... 2.50
366. **Bunsen's Burner**, with three tubes and cap, to produce a circular flame of great heating power, ... 3.50
367. **Tripod**, for Bunsen's burner, to rest on the top of the tube, to support an evaporating-dish, &c., ...25
368. **Star Support** and chimney, to rest on a Bunsen's burner, ...50
369. **Bunsen's Blast-Jet**, of French form, on stand, with a universal joint and stop-cock, ... 6.50
370. **Oxy-Hydrogen Jet**, for deflagration, with lime-holder and stop-cocks, mounted on stand, ... 13.50
371. **Oxy-Hydrogen Jet**, similar to No. 370, with gallows-screw connections, without stop-cocks, ... 13.00
372. **Aphlogistic Lamp**, with platinum coil, ... 1.50
373. **Tyndal's Apparatus**, for boiling water by heat of friction, cylinder of copper, with an interior closed tube to reduce the volume of water, insulated by vulcanite; fitted to attach to the *Whirling Table*, No. 63, ... 5.00
374. **Fire Syringe**, brass cylinder and piston, and box of tinder, . . . 2.00
375. **Blowpipe**, of brass, ...25
376. **Blowpipe**, of brass, with bulb, ...50

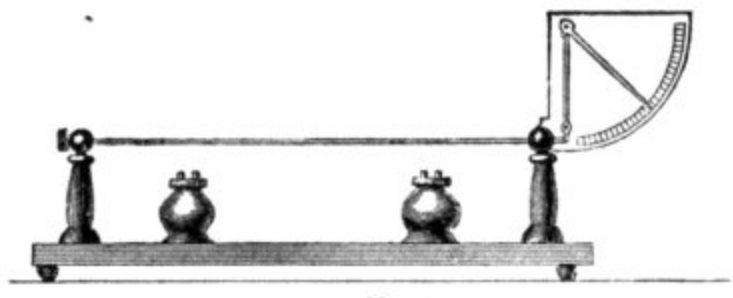
Expansion by Heat.

No. 377.

377. **Ring and Ball**, with handles; brass ball one and a quarter inches diameter, ... 1.75

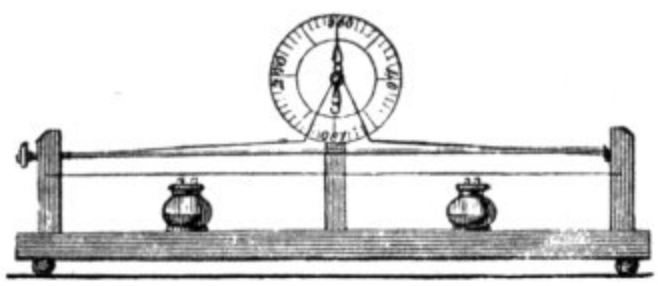
378. **Ring and Ball**; brass ball one and a quarter inches in diameter, mounted on mahogany base, to use with a *Spirit-Lamp*, . . . 3.00

379. **Bar and Gauge**, with handles; bar three inches long, ... 1.75



No. 380.

380. **Pyrometer**, mahogany base; graduated quadrant, with compound levers and index, brass and iron rods for expansion, and two spirit lamps, ... 5.00



No. 381.

381. **Pyrometer**, mahogany frame, brass and iron rods, two spirit lamps. The expansion is indicated by an index revolving on a dial, . . 5.00

381*a*. **Pyrometer**, mahogany frame, brass and iron rods, and spirit lamp; the expansion of the rod gives motion to a mirror; a beam of light is to be thrown upon the mirror and reflected upon the wall, 7.50

382. **Compound Bar**, of brass and iron; to show the unequal expansion of metals, ... 1.00

383. **Maximum Density** of Water Apparatus; consists of a glass jar, with a copper reservoir for mixture of ice and salt, with two thermometers, which enter through the side of the jar, . . . 8.00

No. 383.

No. 387.

384. **Maximum Density** of Water. A glass jar and reservoir, similar to No. 383, with two thermometers attached to a scale; the bulb of one is near the surface, while the bulb of the other extends down to near the bottom of the jar, ... 6.50

385. **Joule's Apparatus**, to show the *contraction* of India rubber by heat. A stand and pillar, with short iron tube enclosing the rubber tube, with spiral spring and index, ... 15.00

386. **Compensated Pendulum**, known as the gridiron pendulum. Five rods of brass and iron, with mahogany base and pillar, . . . 12.00

387. **Rogers' Apparatus** for the combustion of air in hydrogen. A glass cylinder on stand, with inlet and outlet pipes for hydrogen, and pipe and jet for air, sliding rod and platinum coil; the jet of air can be lighted and burned in its *atmosphere* of hydrogen, . . 6.00

Thermometers.

388. **Air Thermometer**, glass bulb and tube, ...50

389. **Alcohol Thermometer**, scale to —150° Fahrenheit, ... 2.00

390. **Thermometers**; japanned tin case, eight inches long, .75; ten inches, 1.00; twelve inches, ... 1.25

391. **Thermometers**; brass case, superior quality, Fahrenheit's scale; eight inches long, 1.00; ten inches, 1.25; twelve inches, . . . 1.40

392. **Thermometers**; brass case, Centigrade scale; eight inches long, 1.00; ten inches, 1.25; twelve inches, ... 1.40

393. **Comparative Thermometers**, with the three scales — Centigrade, Fahrenheit, and Reaumur, twelve inches long, ... 2.50

394. **Thermometer**; brass scale, with hinge, graduated to 500°, . . . 4.50

395. **Thermometer**, graduated on the tube; Fahrenheit, ... 3.50

396. **Thermometer**, graduated on the tube; Centigrade, ... 3.50

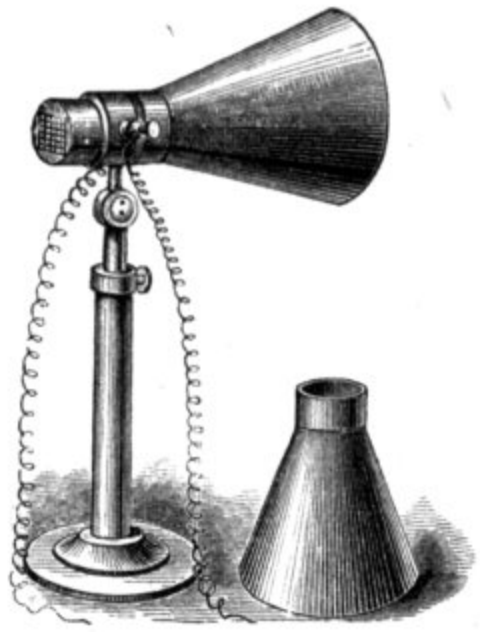
397. **Thermometer**, enclosed in a glass tube, for liquids, ten inches, . . 1.25

398. **Leslie's** Differential Thermometer, on stand, with scale, ... 4.00

399. **Leslie's** Differential Thermometer, mahogany stand, with scales on both arms. See Fig. 424. . . . . 4.75

400. **Matthiessen's Thermoscope** or Differential Thermometer, arranged for the immersion of the bulbs in liquids, on a mahogany stand, with scale. This instrument indicates the difference of temperature between the bulbs, but does not measure the amount. 10.00

NOTE. For Self-Registering Thermometers, &c., see *Meteorology*.



No. 405.

405. **Thermo-Multiplier**, Melloni's. Twenty pairs of antimony and bismuth bars, mounted in a brass case on an elevating stand, with conical reflectors (*see Electricity*, No. 1082), ... 25.00

406. **Thermo-Multiplier**, similar to No. 405, with forty-nine pairs, . 40.00

407. **Melloni's Grand Thermo-Electric Apparatus**, for the study of the diathermal properties of bodies, their emissive and absorbent power, polarization and reflection of heat, and also the apparatus designed by Tyndall. Upon a mahogany base is supported a strong brass graduated bar, to which are attached six or more brass saddles secured by screw clamps, with tubular standards, to which are connected elevating-rods bearing screens, tables for supporting bodies to be tested, and instruments.

As the Thermo-Multiplier, galvanometer, sources of heat, mirrors, prisms, lenses, &c., are included in this catalogue, and as some of them may already be in the collection of the purchaser, and are required for other purposes, we shall not take the space for their enumeration, but will, on application, give price for the whole or any of the appliances.

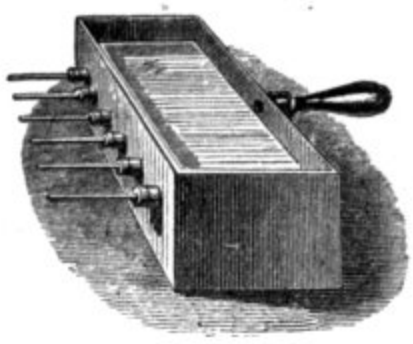
Conduction of Heat.

408. **Wire Gauze**; piece four inches square, with handle, to use with spirit-lamp or Bunsen's burner, ...50

409. **Davy's Safety-Lamp**, — miner's lamp, — 4.00

410. **Conductometer**, brass plate, with stem and wooden handle, with rods of copper, iron, tin, slate, and glass, with cups for phosphorus; to be used over a spirit-lamp, ... 2.00

411. **Conductometer**; brass ring and plate upon a tripod, bearing rods of copper, iron, tin, lead, slate and glass, with cups for phosphorus, ... 3.00



No. 412.

412. **Conductometer** of Ingenhaus, copper vessel for hot water, with handle and projecting rods of different materials, for coating with wax, ... 5.00

413. **Conductometer** of Ingenhaus, similar to No. 412, of tin, ... 3.50

414. **Conductometer** for Liquids, a glass vase, with an air-thermometer extending downward, ... 1.25

415. **Conductometer** for Liquids, a glass vase with an air-thermometer on a stand. A copper pan, for heated oil to dip into the liquid, rests by a frame upon the edge of the vase, ... 5.00

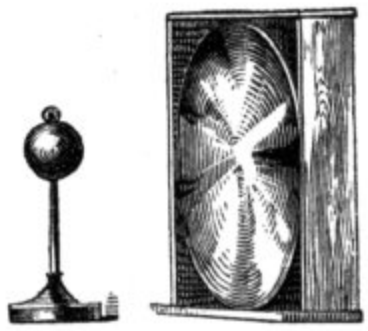
416. **T-Bar**, of copper and iron, with bismuth plates, for conductivity, . 2.50

417. **Convection of Liquids**, a tall, thin, cylindrical glass, with hemispheric bottom, supported on a stand; the motions are shown by paper raspings, ... 4.50

418. **Principles of Ventilation**, glass jar with tubular neck divided by a sliding plate, and stand for candle. When the plate is inserted, the candle burns brightly, in consequence of the circulation down and up the tube, ... 2.50

Radiation, Reflection, and Absorption.

No. 422.



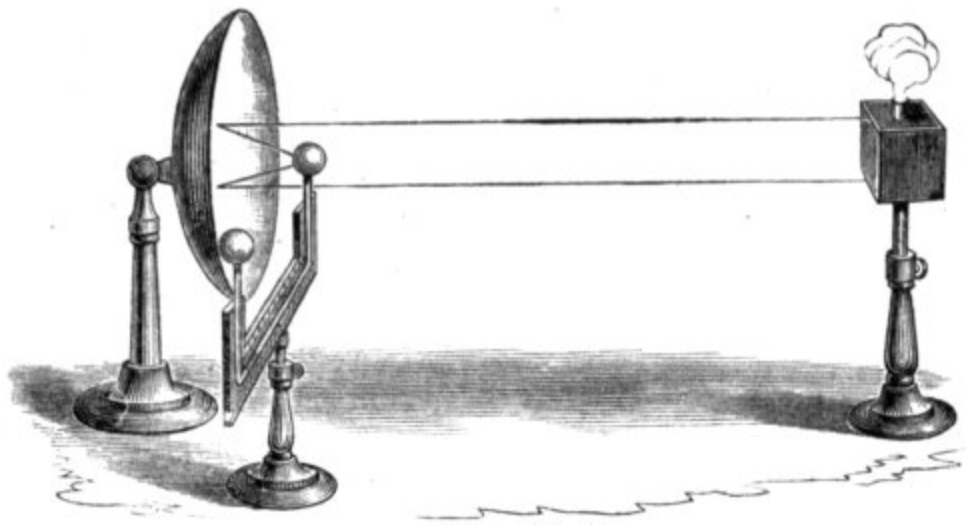
No. 420.

420. **Parabolic Reflectors**; a pair of highly-polished nickel-plated reflectors, ten inches in diameter, mounted in a case divided in manner to form a stand for each, with an iron ball, and holder for phosphorus or matches, each on a stand, ... 8.00

421. **Parabolic Reflectors**, similar to No. 420, twelve inches diameter, 10.00

422. **Parabolic Reflectors**; a pair of highly-polished nickel-plated reflectors, ten inches in diameter, mounted each on a metal base, with ball, and holder for phosphorus, ... 12.00

423. **Parabolic Reflectors**, similar to No. 422, twelve inches diameter, 16.00



Nos. 424—428.

424. **Parabolic Reflectors**, a pair of highly-polished nickel-plated reflectors, twelve inches in diameter, mounted on brass pillars on heavy stands, with elevating and adjusting motions, with iron ball and phosphorus cup, and adjustable holders for each, . . 25.00

425. **Single Reflector**, of either of the above forms, at one half the price of the pair, including the phosphorus cup and its holder.

426. **Leslie's Radiating Cubes**, a pair, three inches on a side, painted in different colors. One of the cubes has an air-thermometer tube, ... 2.25

427. **Leslie's Cube**, three inches on a side, having four faces of different metals, polished, ... 2.00

428. **Elevating Stand** for Leslie's cube, ... 1.50

429. **Radiator**, a flat vessel of tin, twenty-four inches square; one side is blackened; mounted on a stand. To be filled with boiling water. A spirit-lamp should be placed beneath, to keep the temperature constant. To be used with the *Thermo-Multiplier*, . 7.00

430. **Apparatus** to illustrate the relation of radiation and absorption of bodies; consists of a differential thermometer, of which the two bulbs are replaced by two copper cylindrical reservoirs; their interior faces are white and black; a larger intermediate cylinder for hot water is supported on a pillar adjustable with scale, and has its faces, black opposite the white, and white opposite the black. The whole is supported on frame and heavy base, with graduated scale to the tube, ...

431. **Cell for Iodine**. For solution of iodine in bisulphide of carbon; this solution has the property of cutting off totally all heat from a *luminous source*, while it permits *obscure* heat to pass freely, . 3.00

432. **Specific Heat**. Two balls of copper and tin, of equal weight, supported by fine chains, ... 1.25

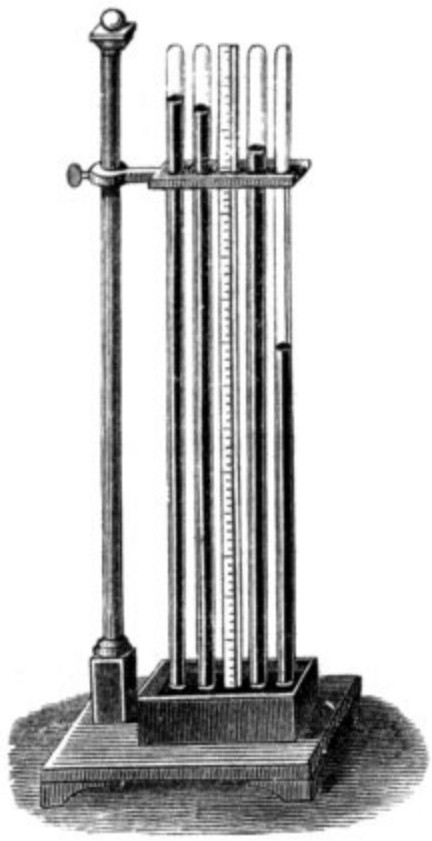
433. **Specific Heat**. Base and frame supporting five balls, of copper, iron, tin, zinc, and lead, of half-pound weight, with glass tumblers, ... 10.00

434. **Specific Heat**, Tyndall's Apparatus; a stand of metal to hold a plate of wax; and five balls of copper, tin, lead, iron, and zinc, and a pan for moulding the wax, ... 2.50

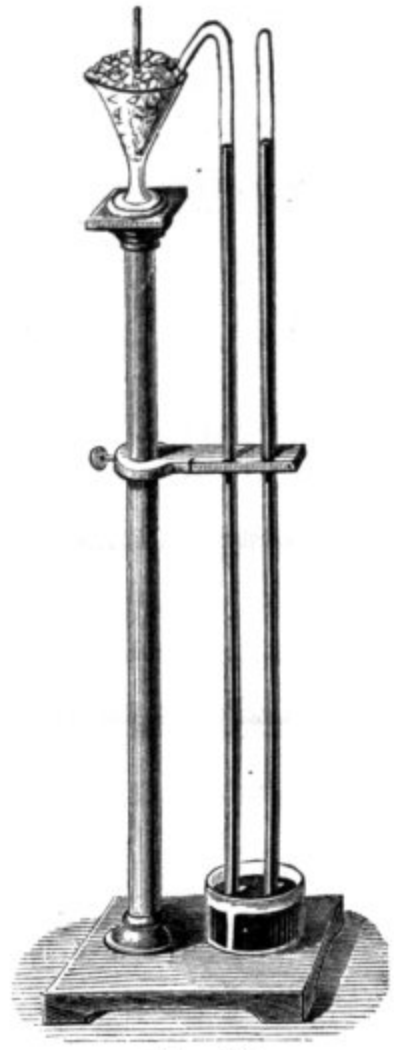
435. **Boxwood Mould**, for the regelation of ice by pressure, . . . 2.50

436. **Capsule** for showing the spheroidal state of water; made of polished copper, ... 2.00

Tension of Vapor.



No. 439.



No. 440.

437. **Elastic Force of Vapor**; a U tube, with the long arm open and shorter arm closed. Partly fill with mercury, with a few drops of ether in the closed arm, ... 1.25

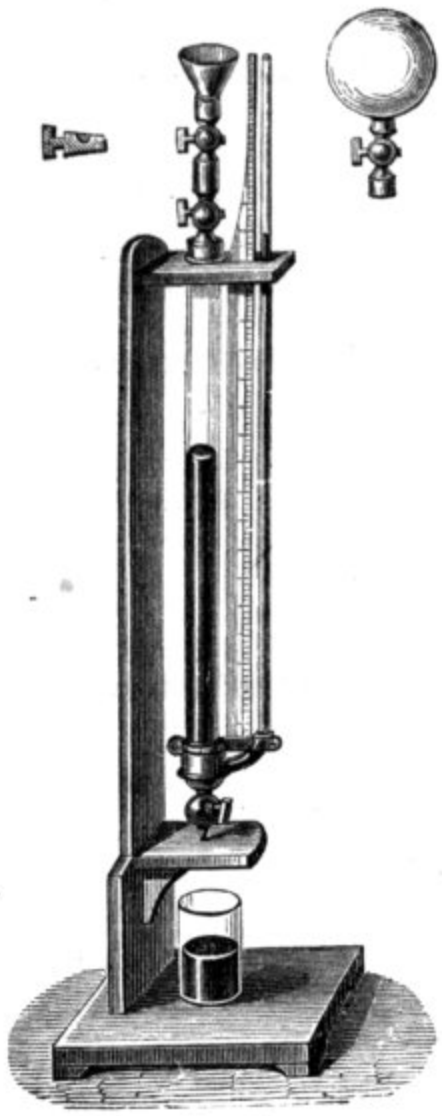
438. **Elastic Force of Vapor**, tube No. 437, with a glass vase for water-bath, ... 1.75

439. **Apparatus** to illustrate the instantaneous evaporation of volatile liquids in a vacuum, and also the saturation and maximum tension of vapor. Mahogany frame, cistern of iron for mercury, four graduated glass tubes, ... 13.50

440. **Gay Lussac's Apparatus**, to show the tension of aqueous vapor below the freezing point; mahogany frame, mercury cistern, bent and straight tubes, and vase, ... 10.00

441. **Dalton's Apparatus**, for measuring the tension of aqueous vapor between 0° and 100° centigrade; cylindrical iron reservoir for mercury, a glass cylinder thirty-six inches long, two closed barometer tubes, thermometer with long tube and scale, a charcoal furnace. The furnace bearing the cylinders and tubes rests on a base which has a pillar and adjustable support for the cylinder, and also an adjustable support for the thermometer on the central line, and a graduated scale. A diaphragm in the cylinder retains the tubes in position.

442. **Apparatus** for non-saturated vapor. See *Pneumatics*, No. 320.



No. 444.

No. 445.

444. **Gay Lussac's Apparatus**, to illustrate the *Laws of Dalton* for mixtures of gases and vapors; mahogany frame with glass tubes, funnel, and globe, with iron mountings and stop-cocks, and graduated scale, ... 30.00

445. **Marcet's Steam Globe**, five and one half inches diameter; upper hemisphere of brass, the lower of iron, for holding mercury; a thermometer in brass case, stop-cock and safety-valve, tube, and graduated scale, ... 30.00

No. 446.

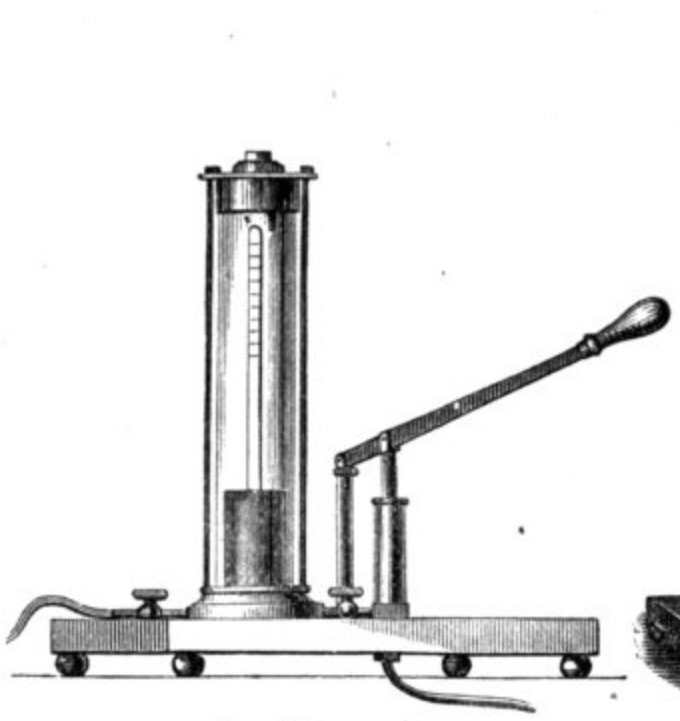
No. 447.

446. **Franklin's Palm Glass**, ...75

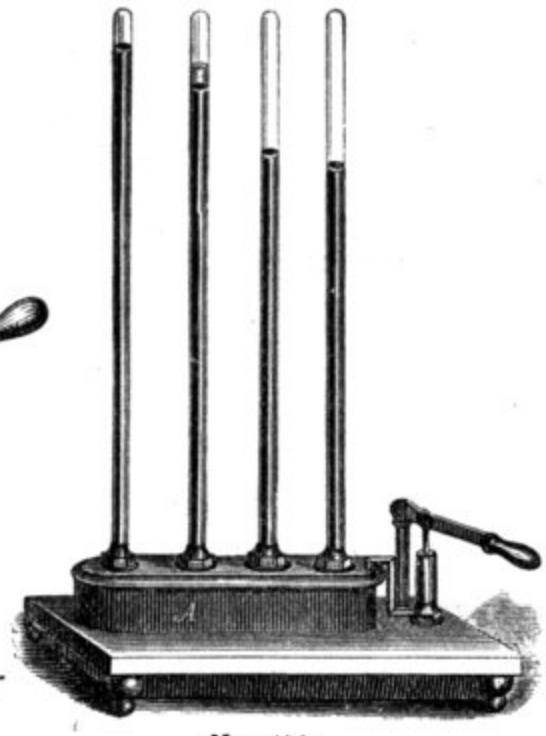
447. **Franklin's Palm Glass**, mounted on mahogany stand, ... 2.50

448. **Pulse Glass**, a *Palm Glass* with a cylindrical bulb at one end, . . .75

448*a*. **Cryophorus**, ... 1.25



No. 449.



No. 450.

449. **Apparatus** for Liquefying Gas; a strong glass cylinder capable of bearing a pressure of twelve atmospheres, with brass base and cap, secured by iron rods; an opening in the cap admits an iron cistern for mercury, in which is inverted a tube filled with the gas for liquefying; a pump by which water is forced into the cylinder, forcing the mercury up into the tube, compressing and liquefying the gas; mahogany base, pan for water, . . . 40.00

450. **Cooke's Apparatus** for showing the identity of gases and vapors; a strong iron cistern for mercury, into which are screwed four glass tubes, three to contain gases which liquefy at different pressures, the fourth, air for a manometer, graduated to atmospheres, force-pump, with stop-cocks and tubes; mounted on mahogany base. The phenomena of the liquefying of gas are strikingly exhibited by this instrument. The pressure exerted by the pump causes the mercury to rise gradually and equally in each tube, until one of the gases begins to liquefy; it then remains constant (as shown by the manometer) until all the gas has disappeared; the mercury then rises in the remaining tubes, until a second gas commences to liquefy; and so on, ... 50.00

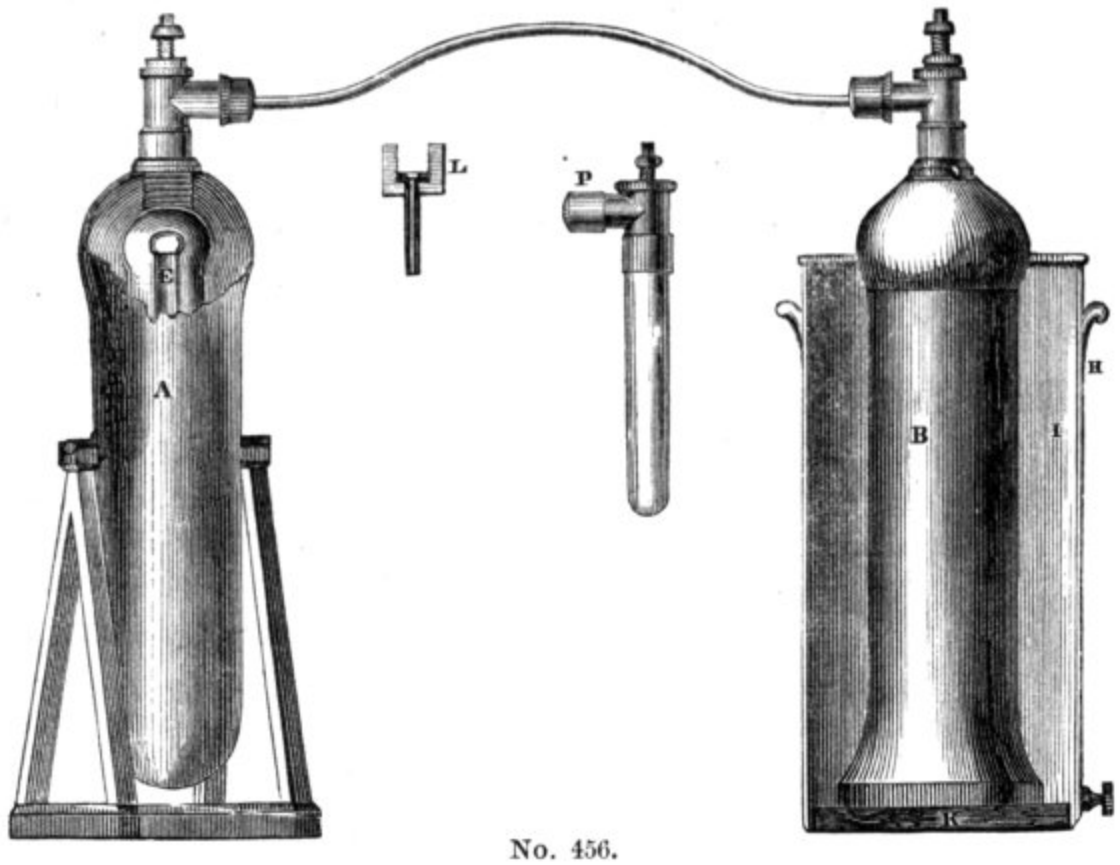
No. 451.

No. 452.

451. **Eolipile**; brass ball, with handle and jet, ... 2.00

452. **Wollaston's Illustration** of the low-pressure steam-engine; copper globe boiler, brass cylinder, piston and rod, handle, and safety-valve, ... 4.00

453. **Steam Balls**, or candle bombs, for exploding by candles; dozen, . .50

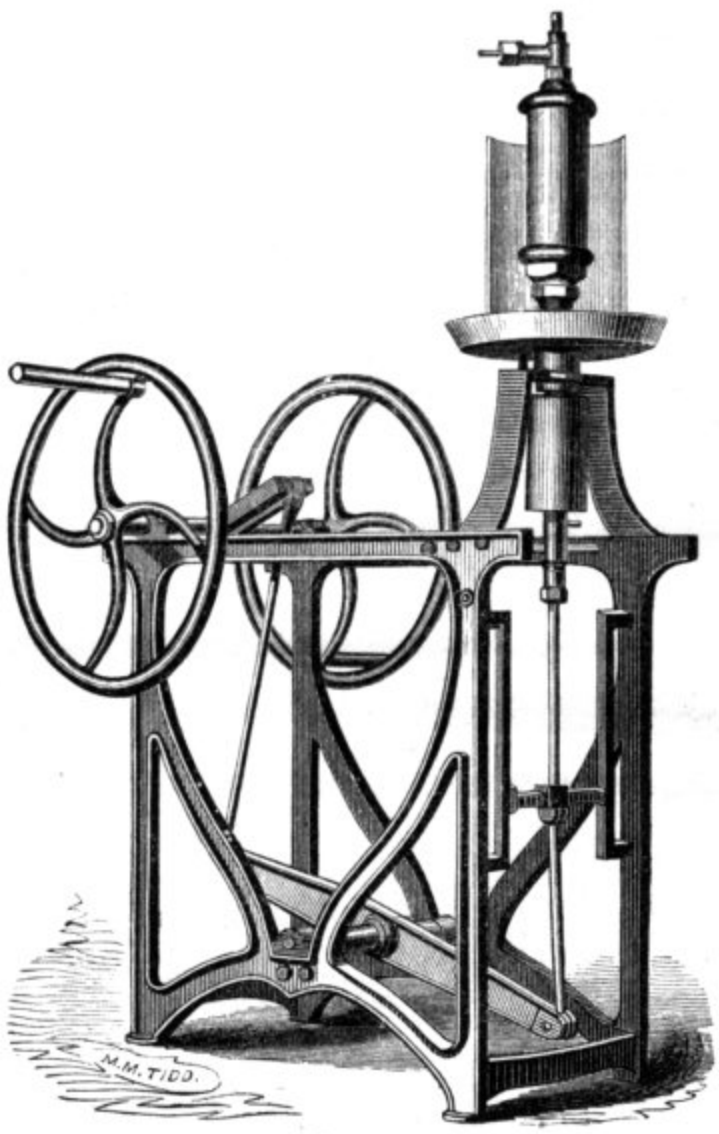


No. 456.

454. **Hero's Engine**; mahogany base, with two pillars, between which rotates a brass sphere, with two tubulures with jets in opposite directions, through which the steam escapes, to be used with a spirit-lamp or Bunsen's burner, ... 7.50

455. **Hero's Engine**, a brass globe with revolving jet, ... 4.25

456. **Thilorier's Apparatus** for Liquefying and Solidifying Carbonic Acid Gas; the generator, A, is made of iron, and is supported by centre trunnions upon an iron frame, so that in use it can be readily inverted; into the top is screwed a heavy brass cap, which is furnished with steel vent-screw, and screw for attaching a connecting tube; within the generator is placed a copper tube, E, to receive the sulphuric acid; the receiver, B, is also of iron, with a broad base, with cap and its connecting-screws; a cistern, H, of copper, to enclose the receiver with ice and salt; a long copper tube with connections; wrenches for the brass caps, connecting-screws and vent-screws, mallet, cylindrical brush; a connecter, L, is fitted to screw to the receiver, to which is attached a strong cloth bag to receive the solid carbonic acid; also a strong glass tube, P, with cap and vent-screw, to exhibit it in the liquid form. In the construction of this instrument every care will be used to render it perfectly safe; the iron used is that prepared by the United States Ordnance Department for guns, and both the generator and receiver are strongly banded with *wrought iron*, ... 175.00



No. 458.

458. **Ritchie's Improved Natterer's Apparatus** for Liquefying Gases. This beautiful instrument is designed to compress gases by means of a force-pump. The receiver is of bronze, and capable of resisting a pressure of 200 atmospheres; the pump is of steel, with steel piston, and is connected to the driving-crank by an inverted working-beam; by this means the receiver is brought to a convenient height; the receiver is surrounded by a copper vessel for ice and salt, and the pump is also enclosed in a cylinder through which ice-water flows; the frame is of iron; the driving-shaft has balance-wheels and cranks; a receiver of glass surrounded by a glass cylinder for chloride of calcium, for liquid nitrous oxide, and one for solidified carbonic acid. Every part of this instrument is most carefully constructed, . . . 300.00

459. **Illustration of the Geyser**; a tripod of iron which supports a pan of two and a half feet diameter, in the middle of which is screwed a brass tube of six feet in length; at the lower end, and two feet above it, are iron buckets to contain charcoal for heating the tube, or arranged with rings for Bunsen's burners for gas, ...

METEOROLOGY.

461. **Maximum Thermometer,** Rutherford's; Fahrenheit's scale, with support; twelve inches long, accurately graduated, ... 5.00

462. **Maximum Thermometer,** similar to No. 461, with Centigrade scale, ... 5.00

463. **Minimum Thermometer,** Rutherford's, with Fahrenheit's scale; twelve inches long, ... 4.50

464. **Minimum Thermometer,** Rutherford's, Fahrenheit's scale; twelve inches long; with support, ... 5.00

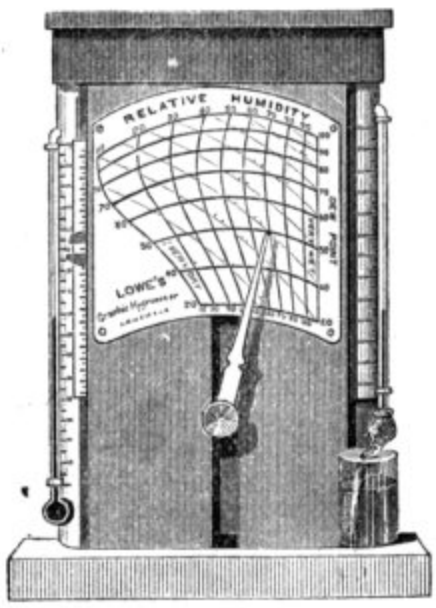
465. **Minimum Thermometer,** similar to No. 464, Centigrade, . . . 5.50

466. **Standard Thermometer**; eighteen inches long, on brass scale, graduated with very great accuracy; either scale, ... 5.00

467. **Barometer,** on mahogany frame, with thermometer, ... 9.50

468. **Standard Barometer**; bronzed metal cylindrical case, cistern of glass, showing the ivory point with adjustment for the zero level, large mercury tube; the scale with vernier reads to one five-hundredth of an inch; thermometer attached. This form is now generally used by the Government Departments, ... 35.00

469. **Aneroid Barometer,** in brass mounting, 4½ inches; in case, . . 10.00



No. 471.

470. **Mason's Hygrometer**; wet and dry bulb thermometers, with scales and cistern, ... 6.50

471. **Hygrodeik,** Lowe's improved form; consists of two thermometers, wet and dry bulb, with scales. By very simple adjustments of a sliding-bar and knob, two pointers are brought upon a scale to coincide with the thermometers. The index gives at a glance the relative humidity of the atmosphere, the dew-point, and the tension of vapor, with a close approximation to accuracy, . . 15.00

472. **Rain-Gauge**; copper cylinder, with funnel twelve inches in diameter; glass tube with graduated scale, ...

UNDULATIONS.

In addition to the apparatus of our own manufacture, for which are appended prices in column, are added articles for which we cannot compete in prices with Kœnig, the celebrated maker of acoustic instruments of Paris; and for such we give approximately the cost at which we can import them to order from Mr. Kœnig: for such articles the prices are placed inside the price-column, with letter K prefixed. We have made arrangements with Mr. Kœnig by which we can furnish his instruments at his prices, adding only the actual expenses of importation. See *Preface.*

476. **Cord of Elastic Brass Wire**, wound in a helix half an inch in diameter, for illustrating progressive wave motions, ... 2.50

477. **Cord of White Silk**, braided soft and pliable, ... 2.00

478. **Elliptical Vase**; for showing the interference of waves in an ellipse, and that waves propagated from one of the foci converge to the other; eight inches in diameter, for mercury, ... 2.50

479. **Circular Vase**, with an assortment of bodies of different forms for the production of a wave; to prove that the wave becomes in all cases circular in its propagation, ... 2.50

480. **Melde's Apparatus**, consists of a heavy stand and pillar, upon which is placed a *Diapason* or tuning-fork, twelve inches long, in manner to admit its being turned on its axis; a rod of three feet in length extends from the pillar, furnished with a sliding arm and tightening-key, to produce the desired tension in a cord attached to one arm of the diapason, and which is put into vibration by it. It gives successively the subdivisions of the harmonics, if the half, the third, &c., of its length is in unison with the vibrations of the diapason when placed so that it causes the cord to vibrate transversely; but if the diapason causes it to vibrate longitudinally, the cord must be tuned to an octave lower, to give the same subdivisions: an intermediate position of the diapason produces in the cord the co-existence of two vibratory movements in the proportion of 1 to 2. When the accord of the fork and the cord is perfect, it vibrates in a plane; otherwise it executes elliptical movements, ... 18.00

481. **Melde's Apparatus**; a diapason three feet high, mounted on a heavy base, with a stand to attach to a cord of twelve feet in length, for showing the simple vibrations, ... 12.00

482. **Melde's Grand Apparatus**, for the vibratory movements, both simple and composite, in cords; it consists of five diapasons mounted on two supports in a manner to exhibit the co-existence of the fundamental sound with the harmonics, or of two harmonics, and also a multitude of vibratory forms, . . K. 45.00

483. **Apparatus** to represent the molecular movement of an aerial wave produced by a simple shock, ... K. 7.75

484. **Apparatus** to represent the molecular movement of aerial waves, produced by a continuous sound, ... K. 7.75

485. **Apparatus** to represent the molecular movement of aerial waves confined in tubes, ... K. 10.00

486. **Apparatus** to represent the molecular movement of waves of ether, ... K. 15.75

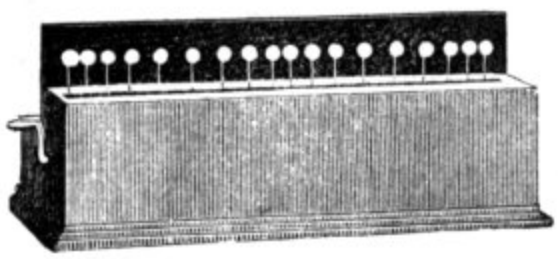
487. **Wheatstone's Wave Apparatus**; it shows the theoretical curves resultant from two systems of simple waves in the same plane; of two systems of waves perpendicular to each other; of a system of plane waves with another circular or elliptical, and finally, of two systems of waves, circular or elliptical, K. 115.00

488. **Wheatstone's Wave Apparatus**, similar to No. 487, but it does not show the curves resultant from the two systems of circular or elliptical waves, ... K. 58.00

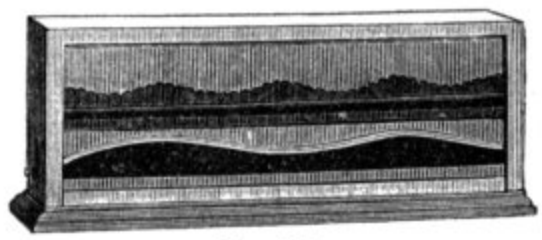
489. **Wheatstone's Wave Apparatus**, which shows only the theoretic curves resultant from two systems of waves in the same plane, or the figure resultant from two sounds combined, . K. 20.50

490. **Apparatus**, showing the theoretical curves resulting from two systems of waves, equal and perpendicular to each other (circular and elliptical polarization), ... K. 10.25

491. **Wheatstone's Apparatus** for the combination of two rectangular vibratory movements, ... K. 34.50



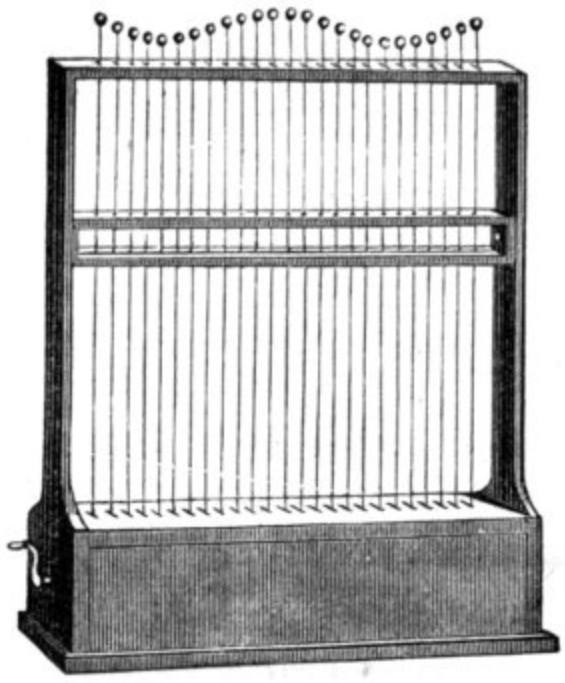
No. 492.



No. 493.

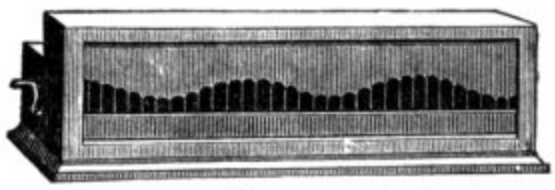
492. **Snell's Illustration of Sound-Waves**, or waves of condensation and rarefaction. In this species of waves the particles simply oscillate back and forth in the line of the wave. Thirty white balls are arranged to form two and a half waves; each ball oscillates one and a half inches. A black screen is placed behind the balls; the frame, of mahogany, is thirty inches in length. The instrument illustrates longitudinal vibrations in a most striking and beautiful manner, ... 35.00

493. **Dr. Young's Interference of Waves**, as improved by Prof. Snell. Fifty ebony keys arranged in a series, and kept in place by a bar in front, constitute the upper system of waves; the lower system is simply a dark board, which can be elevated by a lever at the back of the frame; when this is raised, all the ebony keys rest on its edge, so that their tops give the resultant form of both systems combined. There are four boards with different systems, illustrating musical intervals, and discord, or ocean and surface waves; mahogany frame, ... 35.00



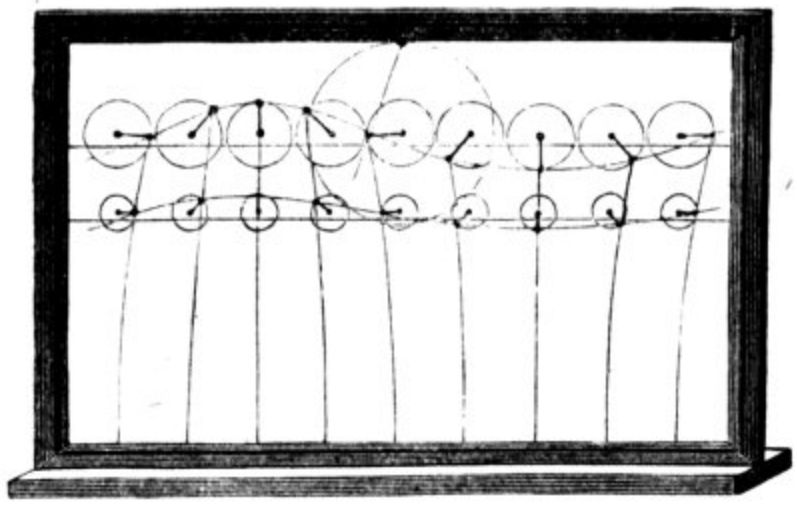
No. 494.

494. **Snell's Improved Powell's Wave Instrument,** for showing the undulations of light in plane, elliptical, and circular polarization. The frame is of mahogany, twenty-four inches long by thirty-six inches in height; twenty-four white balls are supported upon slender steel rods, to which motion is communicated by an equal number of eccentrics placed upon a shaft within the frame; the balls are arranged in two entire waves. By raising or depressing the sliding frame, which is sustained by springs, the balls may be made to move either in straight lines, ellipses, or circles, 65.00



No. 495.

495. **Snell's Illustration of Water Waves**; thirty keys, forming two and a half waves, rise and fall by eccentrics placed on a shaft within the frame, showing the form and motion of the undulations of water. As the keys perform their perpendicular oscillations in regular succession, they produce a steady onward movement of the waves, and thus the fact, of which the pupil finds it difficult to conceive, that the water itself only rises and falls, while the waves move horizontally, is made visible and rendered intelligible, ... 25.00



No. 496.

DESCRIPTION OF LYMAN'S WAVE APPARATUS.

This instrument exhibits not only the surface contour, but also the motions taking place in the whole mass of a liquid.

In front of a plane surface are two series of revolving cranks, the length of the lower ones being half that of the upper. Two elastic wires connect the crank-pins of each series; upright wires also connect each pair of cranks, and pass down through a plate into the base. The cranks all revolve synchronously; they thus keep their relative position, and come to any particular position successively, each in its turn.

The circles represent the orbits of as many liquid particles. The transverse wires represent continuous lines of particles, which at rest would be horizontal, and thus coincide with the lines drawn on the background, the upper being the surface-line, the lower a line of particles one ninth of a wave's length below. The upright wires represent lines of particles which at rest would be vertical. Every point in these moving lines describes its own distinct orbit. The spaces between the wires show the varying distortions of sections of water originally rectangular.

The circumference of the larger circle equals a wave's length; its radius, the height of a revolving pendulum keeping time with the wave. If this circle be rolled under an horizontal line, a point half the wave's height distant from its centre will trace the wave profile; the rolling circle for all profiles down to still water is the same. The sharper curvature of the crests than of the troughs, and its cause, are both made obvious. The wire pendulum represents the resultant of the weight and centrifugal force of a particle, and is normal to the wave-surface.

Since the motions are the same essentially as in nature, the various geometrical and dynamical points of the theory of waves are strikingly exhibited. A full description, with statement of the facts and principles illustrated, will be sent with each instrument. It can also be had on application.

This instrument has been *patented*, and the exclusive right to its manufacture assigned to E. S. Ritchie & Sons. A special medal was awarded by the judges of the Centennial Exhibition for this apparatus.

496. **Lyman's Wave Apparatus**, frame of mahogany, twenty-six inches long, with nine pairs of cranks, ... 37.50

ACOUSTICS.

Production of Sound.

501. **Eight Pieces of Wood**, sounding the gamut, ... 1.50
502. **Four Pieces of Wood**, giving the perfect chord, ... 1.00
503. **Whistling Tube**, of Caigniard de Latour, ... 1.25
504. **Steam Whistle**, model of locomotive whistle, ... 5.50
505. **Mouthpiece** of the cornet, ... 1.00
506. **Mouthpiece** of the trumpet, ... 1.00
507. **Mouthpiece** of the clarionet, ... 1.25
508. **Moulinet Siren**, of Caigniard de Latour; a revolving fan in a cylindrical tube, ... 5.00
509. **Moulinet**, with prismatic tube, ... 5.00
510. **Trevelyan's Apparatus**; a brass rocker with rod and ball and block of lead. Heat the rocker and lay it upon the block; set it in motion, and it will vibrate so rapidly as to produce a musical tone, ... 3.00
511. **Musical Jet**, and tube eighteen inches long, to be attached to the *Hydrogen Generator*, ... 1.25
512. **Rose Jet**; for hydrogen or carburetted hydrogen, to use with a large tube, producing a powerful organ-pipe tone, ... 3.75
513. **Wertheim's Apparatus**, for the production of sound by electricity. A bar of iron is sustained at its middle point on a heavy base and pedestal. To be used with the helix of the *Lifting Coil* and a *Battery*, ... 9.50
514. **Savart's Tube**, for the production of sound by a jet of water. A large glass tube fitted for suspension, with brass cap and variable jets. As water flows from the tubes, different harmonic tones of great purity are produced, each gradually swelling and dying away. The flow should be received two feet below, upon a board placed in a tub, and inclined so as to prevent any disturbing sound, ... 12.00
515. **Violoncello Bow**, for vibrating plates, &c., ... 2.00
516. **Contra-Bass Bow**, for vibrating plates, &c., ... 2.50
517. **Bell in Vacuum** (see *Pneumatics*, No. 303), ...
518. **Electric Interrupter**, in which the spring is replaced by a diapason, ut_2, ... K. 27.50
519. **Electric Interrupter**, with two supports and three diapasons, ut_{-1}, ut_1, ut_2, arranged in manner that either can be used for the interrupter, ... K. 47.50

NOTE. See reference to Kœnig's Apparatus, page 49.

Intensity, Reinforcement, and Reflection.

Nos. 520, 521.

520. **Savart's Bell and Resonator**, for the reinforcement and direction of sound. A heavy bell, nine inches in diameter, mounted upon a heavy stand and pillar, for vibrating with a bow; a tube of polished hard wood, five inches in diameter, tuned to the same note as the bell, mounted also on a stand and pillar, . . 15.00

521. **Savart's Bell and Resonator**; polished bell nine inches in diameter, mounted on a heavy pedestal and mahogany pillar; a resonant tube of bronze, closed by a movable piston, to admit of tuning to accord with the bell (and to show that if not in accord its effect is lost); the tube is mounted in similar manner to the bell, ... 20.00

522. **Resonant Tube**, open at both ends, with a sliding draw-tube for tuning to note of the bell of No. 521; fitted to the pedestal, . . 5.00

523. **Glass Tube**, for resonance (Tyndall), to use with the *Diapason*, . 2.00

524. **Pair of Parabolic Reflectors** (see *Heat*, No. 424), ... 25.00

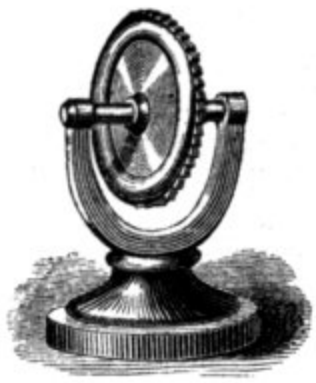
525. **Lens**. A brass ring eighteen inches in diameter, mounted on a mahogany base, with two membranes of thin vulcanized rubber, and stop-cock for admission of carbonic acid gas, ... 15.00

526. **Stethoscope**; two discs of sheet-rubber attached to the edge of a metal hemisphere, with stop-cock for inflation between the discs, rubber tube, and ivory tube to place in the ear, ... 7.50

527. **Speaking-Trumpet**, ... 3.50

Number of Vibrations.

528. **Siren of Caigniard de Latour**; an apparatus for determining the number of vibrations per second for any note of music; consists of a wheel on a vertical shaft, which revolves over the head of a cylinder, both pierced with diagonal holes. A continuous current of air causes a rapid revolution and opens and closes the holes, producing a vibration in the air, and a musical tone, which rises as the rapidity increases. The instrument is furnished with dials and hands, by which the number of vibrations are determined. The instrument is of brass and finely finished, ... 27.50



No. 530.

530. **Savart's Wheel**; a heavy brass ratchet-wheel, supported on an iron frame and pedestal, to be revolved by a cord wound around the axis. By holding a card against the teeth, when in rapid motion, a shrill tone will be produced, gradually falling in pitch as the speed is lessened, ... 6.00

531. **Double Siren** of Helmholtz, consists of two cylindrical wind-chests, with revolving wheels upon the same shaft. Several circles of holes, with stops to each, are made in each wheel, by which two or more notes can be sounded together, ... K. 120.00

532. **Grand Siren** of Seebeck; an elaborate and very perfect instrument. See Ganot's and other treatises on Physics, ... K. 230.00

Musical Intervals.

No. 533.

533. **Diapason** or tuning-fork, of polished steel, mounted upon a resonant case and tuned to C_3 (ut_3) = 512 simple, or 256 double, vibrations per second; the case is tuned to the same note. The vibration may be produced by a bow, ... 7.00

534. **Diapason** and resonant case, similar to No. 533, except that the diapason is made of bell-metal; polished, ... 6.50

535. **Diapason**, (ut_3) = 512 vibrations; of steel, with handle, ... 6.50

536. **Diapason**, official, of steel, on resonant case, sounding la_3 = 870 vibrations, ... 7.00

537. **Grand Diapason**, of steel, $ut_2 = 256$ simple vibrations; mounted on resonant case tuned to same note, ... 20.00

538. **Grand Diapason**, similar to No. 537, of bell metal, ... 18.00

539. **Four Diapasons**, of steel, sounding the perfect chord, C_3, E_3, G_3, C_4, on separate resonant cases, ... 26.00

540. **Four Diapasons**, similar to No. 539, with bell-metal forks, . . . 25.00

541. **Eight Diapasons**, of steel, giving the diatonic scale, C_3 to C_4; mounted on separate resonant cases, ... 55.00

541*a*. **Eight Diapasons**, similar to No. 541, with bell-metal forks, . . 52.00

542. **Resonant Case**, C_3, with cup for mercury and glass tumbler, to use with No. 535, for transmission of vibrations through a liquid, . 2.75

543. **Five Diapasons** for vocal sounds, to be held before the lips while the cavity of the mouth remains in the position for sounding the same vowels in a low tone; with resonators, ... 30.00

544. **Four Diapasons**, mi_4, sol_4, 7th harmonic of ut_2, and ut_5, mounted on resonant cases, ... 25.00

Analysis and Synthesis of Sound.

545. **Resonators** of Helmholtz, series of ten harmonics of C_2; namely, C_2, C_3, G_3, C_4, E_4, G_4, B_4, C_5, D_5, E^5, ... K. 25.50

546. **Helmholtz's Apparatus** for the artificial composition of different timbres, composed of diapasons fixed vertically between the poles of electro-magnets, traversed by an intermittent current produced by a diapason interrupter of 128 double vibrations, ... K. 185.00

Nodes, Loops, and Beats.

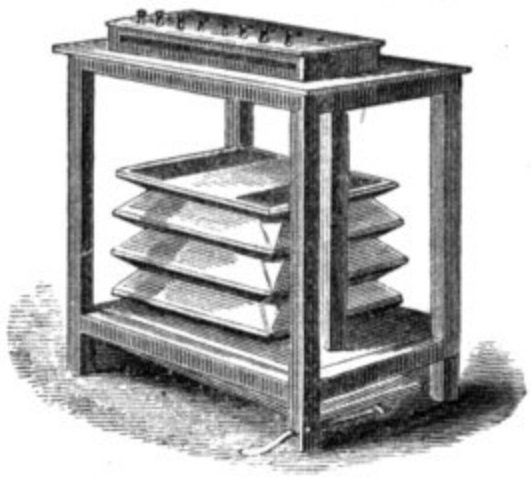
No. 547.

547. **Nodes** of a Bell. A large glass bell for vibrating with a bow; a heavy metal stand and frame for supporting eight balls of cork so that they may touch the outside edge of the bell. Those that touch the bell at the nodes remain unmoved, while those at the loops or ventres are violently repelled, ... 8.50

548. **Nodes** of a Bell. A bell similar to No. 547, with a stand supporting a single ball, to be placed at the nodes or loops, ... 5.50

549. **Two Diapasons**, ut_4, mounted on resonant cases, and accorded to give precisely four beats per second, ... 17.00

Vibrations of Air.



No. 566.

565. **Wind-Chest** (see cut, No. 641), of mahogany; two holes for pipes, with sliding stops and rubber hose for the breath, or to attach to bellows, ... 9.50

566. **Organ Bellows**, twenty-eight inches in length by fourteen in width, with improved bellows, insuring equal pressure; wind-chest, and holes for eight pipes, ... 50.00

567. **Grand Soufflerie** of Kœnig, 90 centimetres in length by 40 in width; constructed on the system of Cavallié Coll, which gives a perfectly equal flow, and can sustain a very high pressure; with regulator, wind-chest, and organ-keys; fitted to receive all species of tubes, ... 120.00

568. **Organ Pipe**; embouchure of brass three inches in diameter, with two movable glass tubes sixteen and thirty inches long. In these tubes a membrane can be introduced to show the nodes, . 8.00

569. **Organ Pipe**, with one side of glass; a membrane to introduce which resounds in all the length except at the node, ... 4.50

570. **Long Pipe**, of which one side is very thin; sand sprinkled over this surface is thrown off by the vibrating column of air, showing the position of the nodes and loops, ... 3.50

571. **Pipe with Slider**, which closes the tube at the node without changing the note, ... 3.00

572. **Pipe with Valve** placed at the loop, which can be open or closed without change of tone, ... 3.00

573. **Pipe**, with a slider at the loop, having holes of different diameters, sounding different notes, ... 3.50

574. **Pipe**, with sliding piston, sounding two octaves, the tones and semitones marked on the piston, ... 4.50

575. **Three Pipes**, of same dimensions, with lumiere of different widths, the narrowest giving the lowest tone, ... 5.50

576. **Pipe**, with four plates, each one pierced with a hole, serving for mouthpieces of different widths, ... 4.00

577. **Pipe**, of the same size as another of the set, lined with cloth, . . . 2.50

578. **Pipe**; embouchure, with three tubes of brass, wood, and paper, of same length and interior diameter, ... 6.00

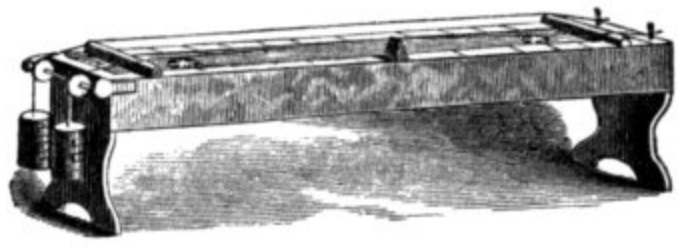
579. **Three Pipes**, of same size, of wood of different thickness, . . . 6.00

581. **Two Prismatic Pipes,** of same dimensions; one enlarges from the mouth, the other decreases, ... 5.00
582. **Three Pipes,** rectangular, one a cube, giving the same note, . . 7.00
583. **Four Pipes**; open, giving the perfect chord, ut_3 to ut_4, ... 7.00
584. **Eight Pipes**; open, giving the gamut from ut_3 to ut_4, ... 13.00
585. **Four Pipes**; open, of metal, giving the perfect chord, ... 3.00
586. **Four Pipes**; closed, of metal, giving the perfect chord, ... 3.00
587. **Eight Pipes,** of metal, giving the gamut ut_1 to ut_2, ... 5.50
588. **Thirteen Pipes,** of metal. One octave, including semitones, from C_1 to C_2, ... 8.50
589. **Reed Pipe.** The vibrating reed is placed in a glass chamber with a sliding rest, varying the vibrating length of the reed, and changing the note, conical metal pipe, ... 4.00
590. **Four Organ Reed Pipes,** giving the perfect chord, ... 9.00
591. **Vox-Humana Pipe.** A reed pipe of peculiar form, ... 2.50
592 **Model Organ Pipes.** A set of six pipes of the same note, ut_1, illustrating the *Open-Diapason*, *Flute-Harmonica*, *Viola de Gamba*, *Trumpet*, *Oboe*, and *Vox-Humana* Organ *Stops*, . . 12.00

Vibrations of Strings.

No. 593.

593. **Ritchie's Improved Sonometer.** The case is made of mahogany, forty inches in length, with a wide sounding-board of spruce, fitted for two wires; two scales divided to the diatonic scale, with letters and syllables for the intervals of the tones and semi-tones, the *ratio* of the length of cord, and the number of vibrations; a scale of sixty equal parts, with the numbers required for the divisions into two, three or four, and also marked for eight divisions; a balanced lever of brass, graduated, and two weights, 1 to 4; two tension-keys and wrench; movable bridges for one or both the wires; a box with set of wires. The wires may be fastened to stationary pins, or attached to the lever, the position of which is such that the actual tension upon the wire is much more easily and accurately determined than by the use of pulleys and weights. This arrangement of the sonometer facilitates the study and illustration of the laws of the vibration of strings; namely, the Law of the *Lengths*, the Law of the *Tensions*, the Law of the *Diameters*, and the Law of the *Densities;* and also on the production of *Overtones* and *Harmonics*, and the showing of sympathetic vibrations and interferences or beats, ... 21.50
593*a*. **Sonometer,** similar to No. 593, black-walnut case, balanced lever of japanned iron, with wires, wrench, and weights, ... 16.50
594. **Sonometer** of same dimensions, with all the scales, sounding-board, &c., neatly made of black-walnut, with weights and wires, . . 13.50



No. 596.

596. **Sonometer**, of mahogany, on frame, one metre in length, with sounding-board of spruce, scales for the intervals of the diatonic scale, for the ratio of length of cord and number of vibrations, for divisions of the vibrating cord into equal parts for over-tones and harmonics; two sets of weights, made in sections, for measuring the tension; wrench and fixed pins for straining the wire, and pulleys to use with the weights; two movable bridges, and set of wires, ... 27.50

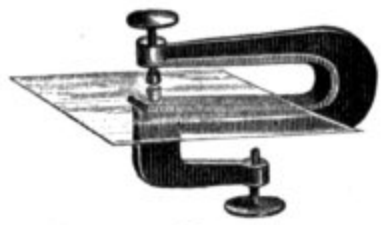
Vibrations of Rods and Bars.

600. **Four Bars of Steel**, for transverse vibration; of which two are of the same length and thickness, but different in width; the third is of same length, but twice the thickness; the fourth of same width and thickness as the first, but of half the length, . . . 7.50
601. **Four Bars of Brass**, of the same dimensions as in No. 600, . . 3.25
602. **Six Rods**, of the same dimensions, five of which are of wood of different densities, and one of brass, for the comparison of sonority, 4.00
603. **Two Rods of Steel**, of the same diameter, one a metre and the other half a metre in length, ... 4.00
604. **Two Rods of Brass**, of the same dimensions as in No. 602, . . 4.00
605. **Tube of Brass** one metre long, of same diameter as in No. 602, . 2.50
606. **Four Rods of Fir**, of same diameter, but of lengths to give *the perfect chord*, ... 2.00
607. **Apparatus** for Longitudinal Vibrations; consists of a mahogany base, with a brass screw-clamp for holding the rod, an ivory ball on a stand and frame, and a brass rod one metre in length. Place the ball in contact with the rod; the vibration will repel it forcibly, ... 12.00
608. **Apparatus** for Longitudinal Vibrations; consists of a brass rod one metre in length, a pair of clamps fitted to the *Screw Press*, and a stand with a ball to place before the rod, ... 3.75
609. **Wheatstone's Kaleidophone**; a silver bead upon a steel wire, secured to an iron pedestal, illustrating the superposition of vibrations, ... 2.50
610. **Kaleidophones**; pedestal with six steel rectangular rods and silver beads; producing the figures of the combination of two rectangular vibratory movements of intervals 1:1, 1:2, 2:3, 3:4, 3:5, 4:5. The light reflected from the beads describes very beautiful curves, ... 18.00
611. **Kaleidophone**; similar to No. 610, with plane reflectors, for projection, ... 20.00

Vibration of Plates.

No. 615.

No. 625.



No. 616.

615. **Simple Support** for vibrating plates; base and pillar, with screw and circular nut, ... 2.00

616. **Screw Press**, of Iron, for confining plates for vibration, with table clamp-screw, ... 5.50

617. **Screw Press**, similar to No. 616, with a heavy base, to stand upon the table, ... 4.75

Plates of Brass, for vibration. These plates are prepared with great care, to secure uniformity of vibration. To excite, hold the plate by the middle or other point, in the *Screw Press;* draw the bow across the edge, and from a sand-box held high above scatter equally over the plate a small quantity of fine black writing-sand, which will at once collect into fine lines, showing the *nodes*, and forming beautiful figures and curves; these tones are most readily obtained by touching the plate at one or two points on its edge with the finger while exciting it at different distances by the bow.

619. **Circular Brass Plate**, ten inches, $2.75; twelve inches, . . . 3.75

620. **Square Brass Plate**, ten inches, $2.75; twelve inches, ... 3.75

621. **Brass Plates**, triangular and polygonal; each, ... 4.50

622. **Circular Glass Plate**, twelve inches in diameter, ... 3.00

623. **Square Glass Plate**, twelve inches on a side, ... 2.75

624. **Six Plates of Spruce**, square and rectangular, of different proportions, ... 5.00

625. **Hopkins' Tube**; cedar tube, with two branches, mounted on a heavy stand and pillar, with adjusting screw, to be used over a vibrating plate, for interference of waves of sound, ... 8.00

626. **Hopkins' Tube**, of metal, cylindrical, with sliding draw-tube for tuning to the note of the plate; mounted upon a heavy base and pillar, with a sliding arm and ring, permitting the tube to be turned round as desired. This form is preferable, ... 8.00

627. **Hopkins' Tube.** Similar to No. 626, with a brass pillar to attach to the *Screw Press*, or to be held in the hand, ... 5.00

Vibration of Membranes.

No. 630.

630. **Circular Membrane.** Thin rubber membrane upon a frame, with screws to change the tension, ... 3.50

631. **Circular Membrane**, of paper, on frame, thirteen inches diameter, 2.00

632. **Square Membrane**, of paper, thirteen inches square, ... 2.00

633. **Triangular Membrane**, of paper, on frame, ... 2.00

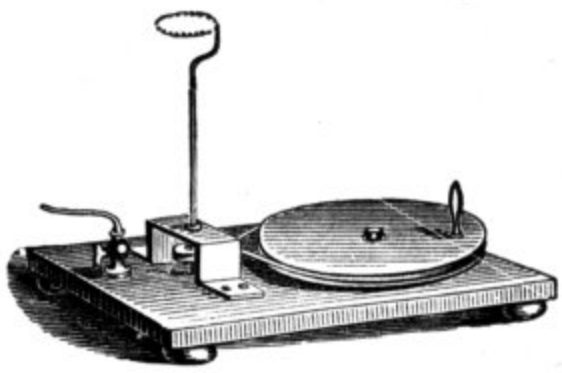
Communication of Vibrations.

634. **Diapasons**, on resonant case, duplicate of No. 533. Sound one with a bow for a short time; the other, placed at a distance, will vibrate by influence, ... 8.50

635. **Plate of Brass**, duplicate of No. 619, with handle. Vibrate one by the bow, sand sprinkled on each will form the same figure, . 5.00

636. **Plate of Brass**, duplicate of No. 620, with handle, ... 5.00

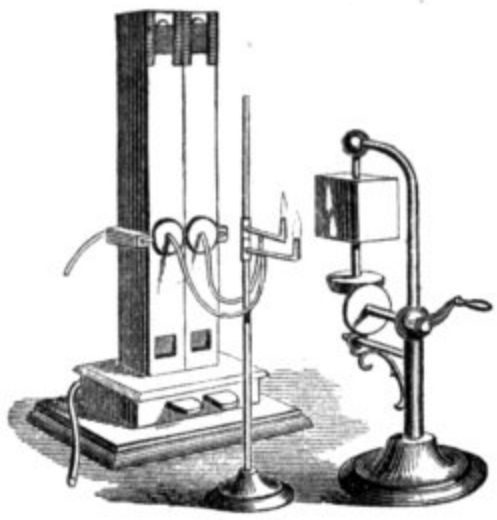
637. **Sensitive Jet**, mounted on stand, to attach by a rubber tube to a gas-burner or to a rubber bag, ... 2.50



No. 638.

638. **Rogers' Apparatus,** to show the intermittence of sonorous flames. A vertical gas-jet, bent so that its point will describe a small circle within a glass tube; with stop-cock, and tubes, mahogany base and pulleys, ... 10.00

Optical Method of Observation.



No. 641.

640. **Kœnig's Manometric Pipe**, to render visible the compressions and dilatations of the air. An open pipe with three openings at the nodes of the fundamental note and its octave, are closed each by a thin membrane, and covered by a capsule to which is attached a tube and gas-jet, a rubber tube for gas to flow into the capsules. When the fundamental note is sounded, all the jets are thrown into vibration; when the octave is sounded, the middle jet remains tranquil, ... 12.00

641. **Kœnig's Apparatus** for comparison of the vibrations of two pipes by the method of manometric flames. It consists of a small wind-chest furnished with sliding stops, and a rubber hose for the breath, or to connect to bellows. Five pipes, each with sliding valves for tuning into unison or chord, or for producing *beats* sounding C_3, C_3, E_3, G_3, C_4, and each furnished with a membrane and capsule; two adjustable jets are placed on a stand, connected by rubber tubes to the capsules; a revolving cube of mirrors is mounted upon a separate base for reflecting light from the jets. The images of the flame, as elongated or shortened by the differing pressure during each vibration, are detached and rendered perfectly distinct in a most beautiful manner, ... 60.00

642. **Lissajou's Apparatus**; Ritchie's improved construction. Two large diapasons, with mirrors for the projection of sonorous vibrations by the reflection of a beam of light; each diapason is supported on an adjustable frame and base, and is made capable of showing the figures resulting from vibrations, 1 : 1, 1 : 2, 2 : 3, 3 : 4, and 4 : 5, and all other combinations between the limits of one to one and one to two, with great amplitude. Finely finished, 40.00

NOTE. We do not consider it to be desirable to copy into our catalogue a list of elaborate and costly apparatus, which can only be obtained of Kœnig, but confine our list as stated in our *Preface*. We will, on application, send Kœnig's catalogue, with an estimate of cost for such instruments.

OPTICS.

Luminous Sources.

650. **Porte Lumiere**, a mirror of silvered glass, mounted in a brass frame, to attach to a window, to reflect the solar light into a room, with motions by geared wheels in revolution, and by a screw in elevation; the movements are made within the room for adjustments by hand, ... 25.00

651. **Porte Lumiere**, with two mirrors, one of silvered glass and the other of polished black glass, for polarized light. Accurately made and finished, ... 40.00

652. **Heliostat**, of new construction, with clock movement, made of brass, bronzed, with mirrors of silvered glass, capable of throwing a beam of light two inches in diameter. The instrument is of small compass, and can be placed on a bracket outside the shutter, and will throw the light with perfect steadiness during the entire day, ...

653. **Heliostat**, similar in construction, of larger size, reflecting a beam four inches in diameter, ...

654. **Brass Ring**, with collar, attached to either form of the *Porte Lumière*, or for the shutter, for holding lenses or diaphragms, . . 5.00

655. **Attachment** to No. 654, with condensing lens four inches in diameter, holder for sliders, and achromatic magnifier with a rack motion, similar to the *Magic Lantern*, ...

656. Diaphragm, with circular holes of different diameters, fitted to No. 654, ... 6.50

657. **Diaphragm**, with sliding plate for rectilinear opening, ... 6.50

658. **Diaphragm**, with long opening, one half of which is closed by pieces of blue or red glass, to show that the prism decomposes the white, but simply displaces the colored ray, ... 6.50

659. **Oxy-Hydrogen Lamp**; consists of a double concentric jet for directing a stream of oxygen gas, within one of hydrogen, upon a cylinder of lime, rendering it incandescent, with adjustable lime-holder, mounted on a stand with stop-cocks, fitted to use in a *Lantern* or upon the table. For the accompanying apparatus, see *Chemistry*, ... 18.50

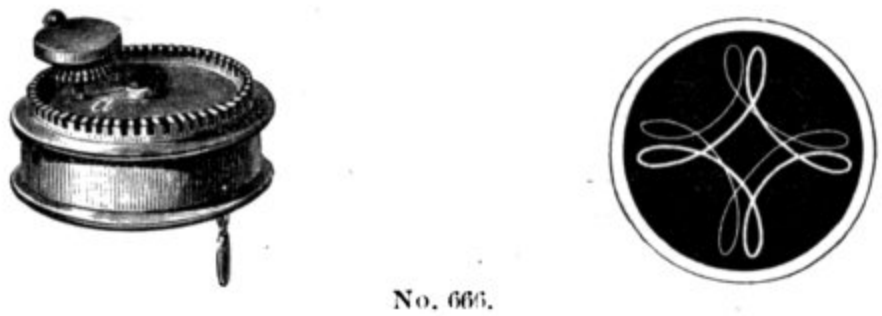
660. **Morton's Monochromatic Light**. Apparatus for showing sodium and other colored flames, ... 10.00

661. **Electric Regulator**, Browning's, ... B. 15.00

662. **Electric Regulator**, Duboscq's. See *Electricity*, . . D. 62.00

NOTE. In this catalogue of Optical Instruments we enumerate some desirable articles which cannot be made at prices to compete with those of Duboscq of Paris, and Browning of London; for these we give the approximate cost, with the letter B or D prefixed, at which we can import to the order of the purchaser. We have made arrangements with Mr. Browning and Mr. Duboscq by which we can supply their instruments at their prices, adding only the actual expenses of importation. See *Preface*.

Measurement of Intensity.



No. 666.

666. **Wheatstone's Photometer**; a brass cylindrical case inclosing a system of wheels giving motion to a disc upon which is placed one or more polished beads. It is founded on the endurance of the impression of light on the retina. With a single bead with two lights, a double system of curves is produced, of comparative intensity. There are also four discs with beads, which can be arranged in different forms, which produce in sunlight a great variety of most beautiful elliptical curves, ... 12.50

667. **Bunsen's Photometer**; consists of a large square tube of tin, neatly japanned, two openings at the middle, with doors, between which is a diaphragm of paper, upon which is a circle covered by a solution of spermaceti in naphtha. When the lights are equal, this circle is invisible, ... 4.50

Reflection of Light.

668. **Plane Mirror**, in frame, with handle; six inches diameter, . . . 1.50

669. **Plane Mirror**, six inches diameter, on an elevating stand, and adjustable to any angle, ... 2.25

670. **Spherical Convex Mirror**, of glass, accurately ground, and polished and silvered; six inches in diameter; mounted on a frame to suspend, or with a handle, ... 2.50

671. **Spherical Concave Mirror**, of glass, accurately ground, and polished and silvered. Mounted on a frame to suspend, or with a handle. Six inches in diameter, ... 2.75

672. **Pair of Mirrors**, similar to Nos. 670 and 671, mounted in one frame, ... 4.75

673. **Cylindrical Mirror**, ground and polished glass, silvered, in frame; six inches in diameter, ... 2.50

674. **Multiplying Mirror**, in frame, six inches diameter, ... 2.50

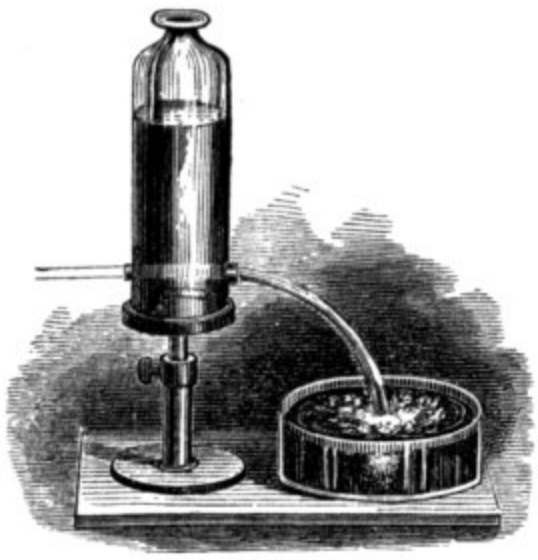
675. **Claude Lorraine Mirror**, convex, in morocco case, ... 6.00

676. **Parabolic Reflectors** (see *Heat*, No. 424), ... 25.00

677. **Kaleidoscope**, of simple form; in paper case, ... 1.25

678. **Kaleidoscope**; a tube mounted on walnut stand, with revolving object-case in brass, ... 2.50

679. **Pair of Plain Mirrors**, in frames hinged together, with hook adjusted to different angles to produce multiplied reflections, . 4.50



No. 685.

No. 689.

685. **Apparatus** for showing the reflection of light in a liquid vein. A glass jar with brass cylindrical extension bearing a tube and jet, opposite to which is placed a lens. A ray of solar or artificial light is transmitted through the water, and into the vein as it issues from the jar, and by interior reflection follows the curvature, and forms a brilliantly luminous jet, ... 8.50

686. **Seven Mirrors**, mounted each on a gimbal, attached to a grooved bar, which is supported by hinged joints to a base and pillar; to reunite the prismatic colors, and recompose white light, . . .

687. **Seven Mirrors**, each mounted in a ring, adjustable in all directions, upon separate brass stands, ...

688. **Three Mirrors**, on brass stands, adjustable to all directions, for recomposing white light, ... 15.00

689. **Cylindrical Mirror**, for showing the caustic curves by reflection, in successive orders. A ring of nickel, highly polished, mounted with movable joint on a base and pillar; placed in sunlight, the caustics will be thrown on the white plane with great distinctness, ... 7.50

690. **Cylindrical Mirror**, with six distorted tableaux, ... 10.00

691. **Conical Mirror**, with six distorted tableaux, ... 9.50

692. **Incidence and Reflection Apparatus**; consists of a semicircular plane fixed vertically on a mahogany base; at its centre is hinged a small plane mirror, with an index, extending to a graduated scale near the edge of the plane; a small mirror is placed so as to receive rays of light and reflect them horizontally upon the central mirror; a plate of ground glass is held by a slider upon the edge of the plane, to receive the reflected ray; the index indicating half the number of degrees to the receiving-plate, ... 18.50

693. **Wollaston's Goniometer**, for measurement of angles of crystals, with accurate graduation; finely finished in brass, . D. 38.00

Refraction of Light.

No. 704.

No. 714.

700. **Prism**, of crown glass, finely polished; three inches in length, . . .50
701. **Prism**, four inches in length, ...75
702. **Prism**, six inches in length, ... 1.25
703. **Prism**, eight inches, ... 2.00
704. **Mounted Prism**; a prism suspended by points in frame, with movable joint and stand, so that it may be adjusted to a beam of light from an opening in the shutter; six inches in length, . 3.00
705. **Mounted Prism**, eight inches in length, ... 3.75
706. **Prisms** of crown and flint glass, mounted, to show the principle of achromatism, ... 7.00
707. **Achromatic Prisms**, of crown and flint glass, mounted on a brass elevating stand, adjustable at any angle, ...
708. **Hollow Prism**, for liquid. A glass vessel with two planes of plate glass, ... 4.00
709. **Prism** for bisulphide of carbon; of brass, with plate-glass faces of size to receive a pencil of rays of three inches in diameter, for projection, ... 6.00
710. **Two Prisms**, similar to No. 709, mounted in a mahogany box, . . 13.00
711. **Three Prisms**, similar to No. 709, mounted in a mahogany box, . 20.00
712. **Rectangular Prism**, of large size and very fine, for total reflection, mounted on a brass elevating stand, adjustable, ... 10.00
713. **Fine Prism**, of sixty degrees angles, mounted on a brass elevating stand, adjustable to all positions, ...
714. **Prismatic Lens**, or multiplying-glass, in tube, ...50
715. **Pair of Lenses**; plano-convex and plano-concave, two inches in diameter; of same focal length, neutralizing each other. Finely finished, the edges neatly ground, ... 2.00
716. **Pair of Lenses**, neutralizing; two and a half inches, ... 2.50
717. **Pair of Lenses**, double convex and concave, neutralizing; finely finished, ground edges, two inches diameter, ... 2.50
718. **Pair of Lenses**, double convex and concave, two and a half inches, 3.00
719. **Pair of Lenses**, meniscus, convex and concave, neutralizing; ground edges; two inches diameter, ... 2.50
720. **Pair of Lenses**, meniscus; two and a half inches, ... 3.00
721. **Six Lenses**, Set of, as above; two inches in diameter, ... 7.00
722. **Six Lenses**, Set of, two and a half inches diameter, ... 8.50
723. **Demonstration Lenses**, Set of six; one and three quarters inches diameter, ... 2.50

725. **Support for Lenses**; base and elevating pillar of white maple; ring to hold one or two lenses, giving motions in all directions; neatly polished, ... 2.50

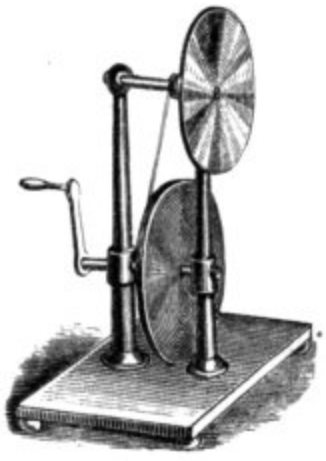
726. **Lense** of crown glass, for condensing light; four inches in diameter, and short focus; very fine, ... 4.50

727. **Frame**, for No. 726, for one or two lenses, fitted to No. 725, . . . 1.25

728. **Achromatic Lenses**, two inches in diameter, ... 10.00

729. **Achromatic Lenses**, two and a half inches diameter, ... 20.00

Recomposition of Light.



No. 733.

No. 735.

730. **Newton's Disc**, for recomposing white light by reflection. A stout cardboard disc, with seven spectrum colors; a central tube, and a small drum for winding a cord to give a rapid revolution; with handle and pin, ... 3.00

731. **Color Disc**, with three colors, red, yellow, and blue, for recomposing white light; mounted same as No. 730, ... 3.00

732. **Color Disc**, with three colors, for recomposition, red, green, and blue; mounted similar to No. 730, ... 3.00

733. **Revolving Disc Apparatus**; mahogany base, scroll metal frame, and pulley with screw-nut for confining the discs, ... 6.00

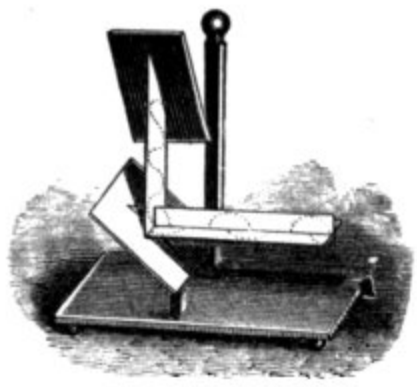
734. **Set of Discs**; twenty-four circles of cardboard and paper, of variety of brilliant colors, including each of the discs for recomposing white light. One set are cut in such a manner that they may be arranged so that any combination of the prismatic colors may be made in the circle; also forms to produce the graded, or the gradual, blending of one color into another, producing very interesting and beautiful effects. In box, ... 2.50

735. **Snell's Apparatus**, for exhibiting the accidental colors in vision. A white screen, with three openings, each of 60°, behind which revolves a disc with the colors of red, blue, and yellow, alternating with white. In use, fix the eye intently upon a bead in the centre for a length of time, then let the disc be turned so as to present a perfectly white surface; the *complementary* colors of each of the departments will be vividly *seen*, ... 8.50

736. **Soleil's Saccharimeter**, furnished with four tubes, three of which are of brass and the fourth of glass. This instrument gives the quantity of sugar contained in a solution to an accuracy of about one per cent., ... D. 72.00

Polarization and Interference.

No. 741.



No. 742.

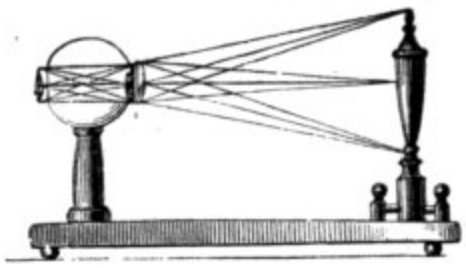
No. 745.

741. **Model** of a ray of light, showing two planes of vibration, ... 2.50
742. **Model** of the reflecting Polariscope, with mirrors, and incident and polarized ray, ... 9.50
743. **Model** of the Tourmaline Polariscope, with rays, ... 8.50
744. **Model** of a crystal of Iceland spar, large size, made of glass, showing the incident ray, the separation and polarization within the crystal, and the ordinary and extraordinary issuing rays, . . . 7.50
745. **Plates** for Newton's rings; mounted in brass frame with screws. The plates are four inches in diameter, and are ground and polished with great care, ... 6.50
746. **Plates** for Newton's rings; mounted; with one disc of black glass, for projecting the images on the screen, ... 10.00
747. **Tourmaline Polariscope**; mounted in pincers, for interposing a crystal, ... 5.00 to 10.00
748. **Nichols' Prisms**, from . . . . . 3.00 to 10.00
749. **Foucault's Prisms**, from . . . . . 3.00 to 12.00
750. **Senarmont's Prisms**; polarizers, ... 4.00 to 8.00
751. **Norremberg's Reflecting Polariscope**, ... D. 28.50
752. **Double Image Prism**, of Iceland spar, ... 3.00 to 7.00
753. **Mirror of Black Glass**, for polarizer, ... 1.50 to 4.00
754. **Selenite Objects**, mounted in sliders. The films of selenite represent geometrical figures, flowers, fruits, &c. Seen by ordinary light they are transparent, but in polarized light the figures are seen in brilliant complementary colors, ... 2.00 to 4.00
755. **Plates of Crystals**, cut perpendicularly and obliquely to their axes; Iceland spar, arragonite, beryl, &c., ... 2.00 to 5.00
756. **Unannealed Glass**, of six forms; each, ... 1.50
757. **Press**, for showing the rings in glass plates, ... 3.50
758. **Camera Obscura**; mahogany box, well finished, ... 7.50
759. **Camera Lucida Prisms**, ... 4.00 to 6.00
760. **Camera Lucida**, mounted upon an adjusting stand, . . 7.00 to 9.00
761. **Plates of Mica**, of different colors; each, ... 1.50
762. **Plate of Mica**; uneven in thickness, giving varied tints, ... 1.50

On Vision.

No. 766.

No. 769.



No. 767.

766. **Model of the Eye**, showing the coats severally separable, the vitreous humor and crystalline lens, retina, iris, cornea and optic nerve; three and a half inches in diameter; with mahogany stand, ... 5.50

767. **Illustration of the Eye**, showing the path of the rays through the crystalline lens, the formation and inversion of the image in the eye, and the cause of long, short and perfect sight. Glass globe mounted on mahogany frame, ... 6.00

768. **Illustration** of the cause of long and short sight; brass cylinder and draw-tube, with ground glass for the retina, and three lenses of different focal length, ... 10.00

769. **Artificial Eye**; brass globe of four inches diameter with lens, concentric draw-tubes with ground glass for the retina. A convex and a concave lens are mounted on a frame, and revolve in front of the cornea. This instrument illustrates the use of spectacles for long and short sight, ... 15.00

770. **Illustration of the Persistency of Vision**; consists of a stout circular cardboard with central cap, fitted to revolve on a pin and handle. On the face of the card a spiral line is drawn from the centre to circumference. A similar cardboard with circular lines about equally distant as the spiral. By fixing the eye upon the revolving card for a short time, and then looking at the other, the circular lines appear to *dilate* or *contract*, in the opposite direction to the revolving card, ... 3.50

771. **Zoetrope**, or wheel of life, ... 3.00

772. **Thaumatrope**, ... 3.50

775. **Magnifying Lenses**; two plano-convex lenses in brass cylinder and ivory handle; diameter twelve millimetres, .75; eighteen millimetres, 1.00; twenty-five millimetres, ... 1.25

776. **Magnifying Lenses**, in horn mounting, ...35 to .75

777. **Magnifying Glasses**; three lenses in horn mounting, . . .75 to 1.50

778. **Magnifying Lens**; brass mounting, on tripod, ... 1.50

779. **Reading Lens**; silver-plated ring, ebony handle, fifty millimetres diameter, ... 1.00

780. **Reading Lens**, similar to No. 779, seventy millimetres diameter, . 1.33

781. **Reading Lens**, similar to No. 779, ten centimetres diameter, . . 3.00

Microscopes.

782. **Coddington Lenses**; silver mounting, ... 2.00 to 3.00
783. **Tolles' Achromatic Triplet**; silver case, ½ inch focus, ... 12.00
784. **French Microscope**; brass mounting, draw-tube, illuminating mirror, with one power; in mahogany box, ... 2.50
785. **French Microscope**; brass-mounted illuminating mirror and condensing lens, three powers; mahogany box, ... 5.00
786. **French Microscope**; mirror and condensing lens, with three achromatic powers; in mahogany box, ... 5.75
787. **Microscope**; brass mounting, hinge joint, on iron tripod base, table with object holder, rack-motion, condenser and mirror, achromatic triplet, set of objects, ... 15.50

No. 788.

788. **Tolles' Student's Microscope**, designed under the advice of distinguished microscopists, is of pattern and size most approved by experts. The curved arm is supported on a trunnion of new form, which admits of motion from horizontal to vertical, with a stop-movement, stage with spring clips, revolving diaphragm, concave mirror, with movement to give oblique light, or placed on separate stand; coarse and fine adjustments; one-inch eye-piece, two objectives of one inch, and one-fourth inch power, giving about eighty and three hundred and fifty diameters. The stand is very carefully made; height fifteen inches, and weight six pounds. Black-walnut case, ... 50.00
789. **Additions to Student's Microscope**: extra eye-pieces, two-inch, one and one-half inch, and three-quarter inch, 4.00 each; Camera Lucida, 5.00; sub-stage for accessory apparatus, 5.00; sliding stage, giving vertical and horizontal motions by the hand, and adapted to Maltwood's finder, 15.00; draw-tube, 4.00; rack and pinion, 12.00; plane mirror, 3.00.

793. **Tolles' Student's Microscope,** with one-inch and one-fourth-inch objectives, one ocular, rack and pinion, lever-pin, adjustment for focus, sub-stage for illuminating apparatus, revolving diaphragm, plane and concave mirrors, side-stand for illuminating objects; black-walnut case, ... 90.00

Browning's Microscopes will be imported to order at his prices. J. Browning's priced catalogue will be sent by mail to order on application. Price, 50 cents.

794. **Microscopic Preparations,** on standard size, 76×26 m. m. slides. Anatomical and Pathological; Botanical by Dr. Hunt and others; Diatomaceæ; Rock-sections by Julian and Dickinson. Prices, from 25c. to $2 00 each.

795. **French Objects;** one dozen slides, insects and parts; in mahogany box, ... 1.62

Stereoscopes.

Nos. 797, 798.

796. **Stereoscope,** Wheatstone's reflecting, ... 7.00

797. **Stereoscope,** Brewster's refracting, of Holmes' form; very neatly mounted with rosewood eye-shade, sliding picture-holder, and handle; superior lenses, ... 2.00

798. **Stereoscope,** similar to No. 797, mounted on stand, ... 3.00

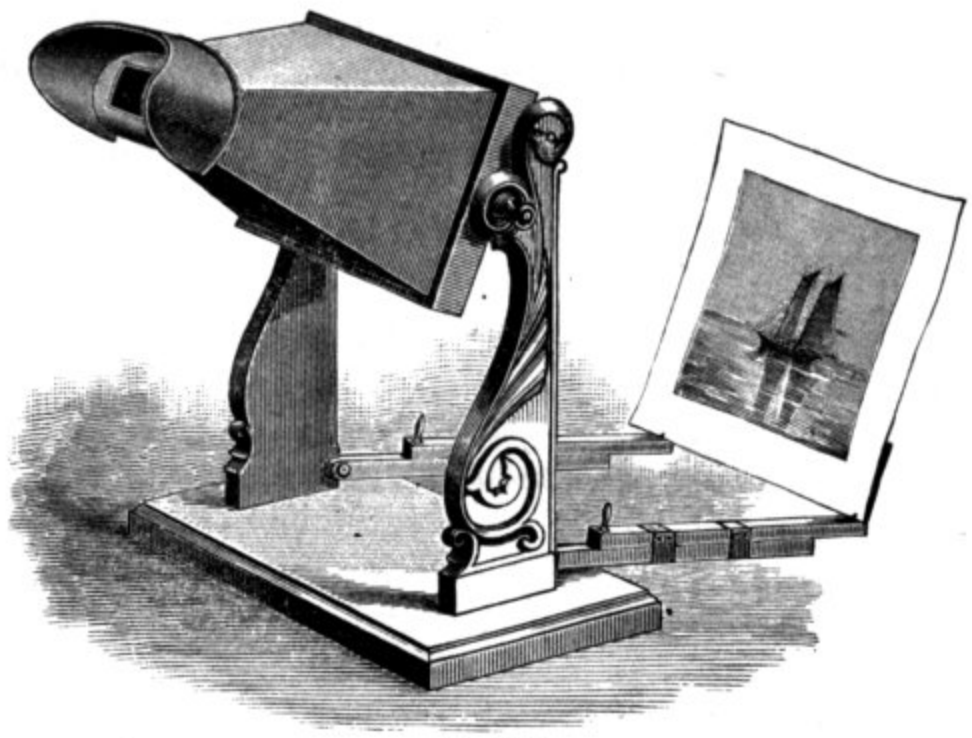
Photographic Pictures, of fine quality; views from landscapes, buildings, cathedrals, transparent views of interiors of palaces; including, —

Wilson's Scotch and English Views,	Rogers' Groups of Statuary,
Lamy's Switzerland and Italy,	Ball's Statues,
Egypt and the East,	Vatican and Louvre Statues,
European Cities,	Yosemite Valley,
Portraits of Celebrities,	Pacific Railway,
Rhine and Tyrol,	Canada and Niagara,
American Cities,	Snow and Frost,
Boston and Vicinity,	Public Buildings.

799. **American Pictures,** each, ...20 to .25

800. **Foreign Pictures,** each, ...30 to .40

Megascopes.

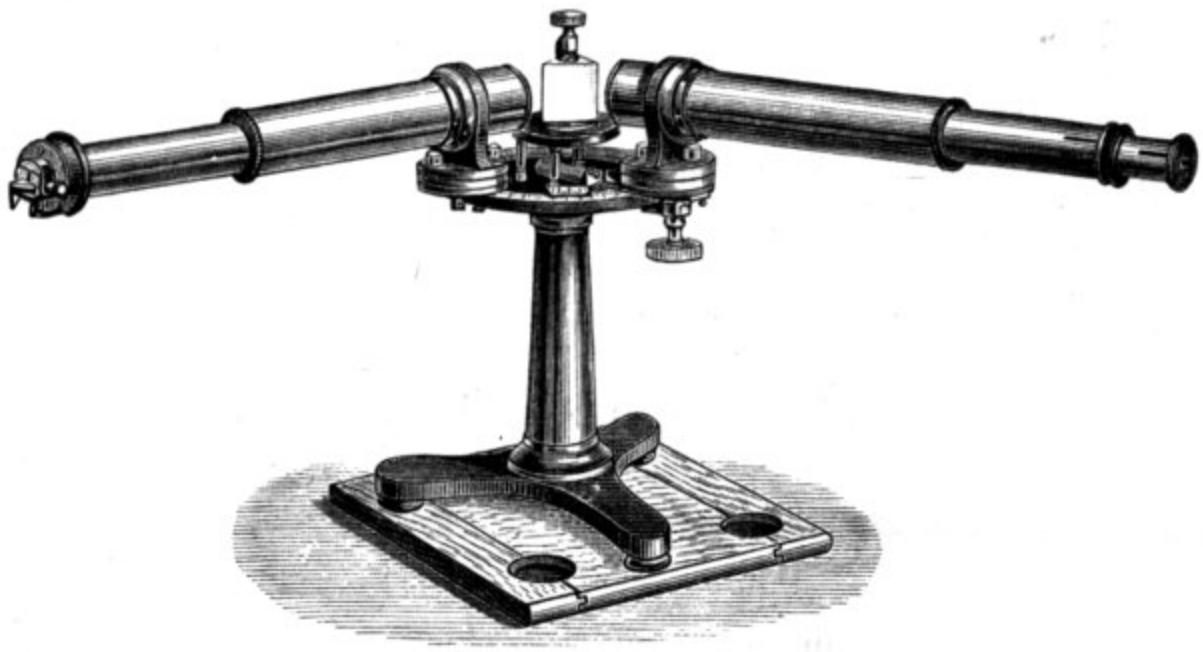


No. 805.

805. **Ritchie's Patent Megascope**, an instrument for viewing photographs and engravings; consists of a pyramidal tube bearing a lens eight and a half by five inches at its larger end, and at the smaller, a shade for the eyes; a sliding frame for holding pictures and adjusting the focus. Within the tube, near the eyes, is a second lens, for use of persons of long sight. The tube is mounted on a base with pillars, and is adjustable at any angle. When not in use, the picture-holder can be folded, and tube put in vertical position. The advantage of the tube is in cutting off all extraneous light, to the entire relief of the eyes, and adding greatly to the perspective effect of the picture. It can be used for hours without fatigue. Pictures of twelve by ten inches, inside the margin, are distinctly seen without disturbance from spherical aberration. Neatly mounted in black polished walnut, ... 30.00

806. **Ritchie's Megascope**, very handsomely mounted in polished French walnut; ornamented, ... 35.00

Spectrum Analysis.



No. 808.

BROWNING'S SPECTROSCOPES.

We have made arrangements with Mr. John Browning of London for the sale of his unrivalled spectroscopes. We will import to order the following, or any other of Mr. Browning's instruments, free of duty, for colleges or schools, at his lowest prices, adding only the actual shipping charges and expenses. We give the approximate cost.

We will send, on application, a list of higher-priced spectroscopes, and directions for use, also Browning's full list of instruments, including a colored chart of spectra. Price 50 cents.

807. **Direct-Vision Spectroscope,** with five prisms, fitted in mahogany case. This is a most powerful and portable direct-vision instrument, easily separating the D lines in the solar spectrum, . . B. 34.00

808. **Student's Spectroscope,** in stained cabinet. This instrument has a prism of extremely dense glass of superior workmanship. The circle is divided, and reads with a vernier; thus dispensing with the inconvenience of an illuminated scale. This arrangement possesses the very great advantage of giving angular measures in place of a perfectly arbitrary scale. The slit is also furnished with a reflecting prism, by means of which two spectra can be shown in the field of view at the same time, . B. 38.00

809. **Model Spectroscope** with two prisms; mahogany cabinet, . B. 78.00

810. **Sorby-Browning Micro-Spectroscope,** with rack motion, . B. 31.50

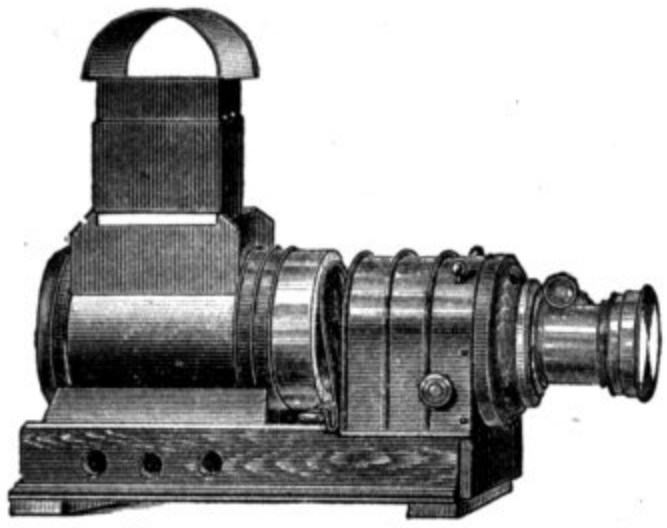
811. **Spectroscope Lamp**; elevating stand, with Bunsen's burner and adjusting clip for holding platinum wires, ... 4.25

812. **Becquerel's Apparatus,** for obtaining the spectrum of a substance in solution; elevating stand with binding-screws, ... 5.50

813. **Browning's Improved Spark Condenser,** with holders for metals; mahogany box, ... 24.00

814. **Geissler's Tubes** for the spectra of various gases. See page 90.

Magic Lanterns.



No. 815.

Marcy's Patent Sciopticon has decided advantages over other forms of the magic lantern, in the great brilliancy of the light obtained by his arrangement of the lamp; and by the improvements he has introduced into its construction, it has become so perfect an instrument as to place it above all others that we have seen. The condensing lenses used are of superior quality, and the magnifying lenses are achromatic, and give very perfect definition. The arrangement of the flame-chamber is such that all the heat generated is conducted off, preventing any inconvenience. The light is remarkably white, and is very equally distributed upon the screen. Mr. Marcy's adaptation of the oxy-hydrogen light is very convenient and effective, as is also the arrangement for the microscope and polariscope attachments.

815. **Marcy's Sciopticon,** cylindrical form; extension chimney, lamp for kerosene oil, inclosed flame-chamber; condensers, four-inch aperture; achromatic objectives with rack-motion, opaque curtain and tinters, ... 45.00

816. **Sciopticon Case,** for holding the instrument and for standing it upon when in use, ... 3.00

817. **Pair of Sciopticons,** with dissolving fittings, ... 100.00

818. **Oxy-hydrogen Jet,** complete, ... 14.00

819. **Microscope Attachment,** with achromatic objectives; according to the number and perfection of the objectives, from 60.00

820. **Polariscope Attachment,** 60.00

NOTE. — For the necessary accompanying apparatus for the oxy-hydrogen light, see *Chemistry*.

Lantern Slides.

We are prepared to furnish slides from the best makers at their lowest prices. We do not copy their catalogues into our pages, but will send a full list on application.

The pictures are beautifully colored photographs, of uniform size, in frames seven by four inches; pictures three inches in diameter. The prices are subject to such discounts as are made by the makers.

821. **Spectrum Analysis.** Set of twenty very interesting and valuable Illustrations, presenting to the student not only a vivid representation of the special object, but also illustrating the science of *Spectrum Analysis.* The slides are: 1. Decomposition of Light by prism (Solar Spectrum); 2. Comparative intensity of heating, luminous, and chemically active rays — in spectrum; 3. Fraunhofer's map of solar spectrum; 4. The Spectroscope; 5. Spectra of the Sun, Beta Cygni, and hydrogen; 6. Spectra of potassium, rubidium, sodium, and lithium; 7. Spectra of carbon, comet II. (1868), spark and nebulæ; 8. Spectra of Aldebaran and Alpha Orionis; 9. Kirchoff's map (from 194 to 220) and Rutherford's photograph of the same; 10. Spectra of chlorophyll, chloride of uranium, magenta, and blood; 11. Gassiot's Spectroscope — made by Browning; 12. Huggin's map of metallic lines, from 320 to 2790; 13. Huggin's map of metallic lines, from 2790 to 5250; 14. Huggin's Star Spectroscope; 15. Map of solar spectrum, from 38 to 163; 16. Map of solar spectrum, from 162 to 287; 17. Map of solar spectrum, from 283 to 406; 18. Coincidence of spectra of iron with 65 of the Fraunhofer lines; 19. Spectra of the sun, chromosphere, prominences, and corona; 20. The atmospheric lines; each, . . . 2.50

822. **Astronomical** Illustrations; set of twenty slides, each, ... 1.50

823. **Astronomy**, on long slides; set of 41 pictures, ... 25.00

824. **Geology**; twenty slides; each, ... 1.50

825. **Natural Phenomena**; twenty slides; each, ... 1.75

826. **Natural History** in all branches; each, ... 1.50

827. **Sacred History**; Doré's Illustrations,&c.; Foreign and American Views, and miscellaneous pictures in great variety, from 1.50 to 2.50

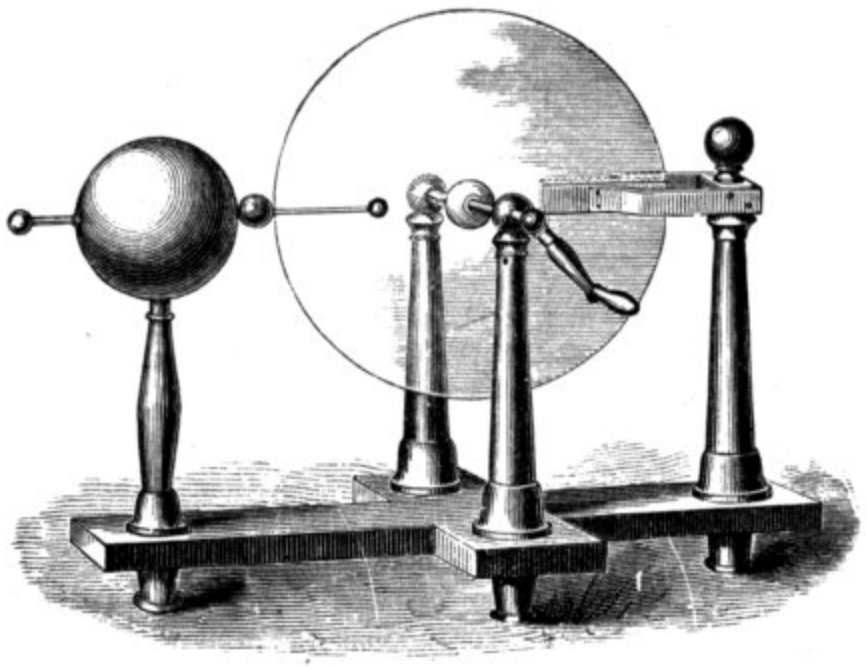
828. **Chromotropes** and moving slides, ... 2.50 to 5.50

829. **Plain Slides**; pictures three inches square, in narrow bindings; including views, statuary, buildings, &c.; each, from 75 cents to 1.00

830. **Microscopical Objects**, enlarged from nature.

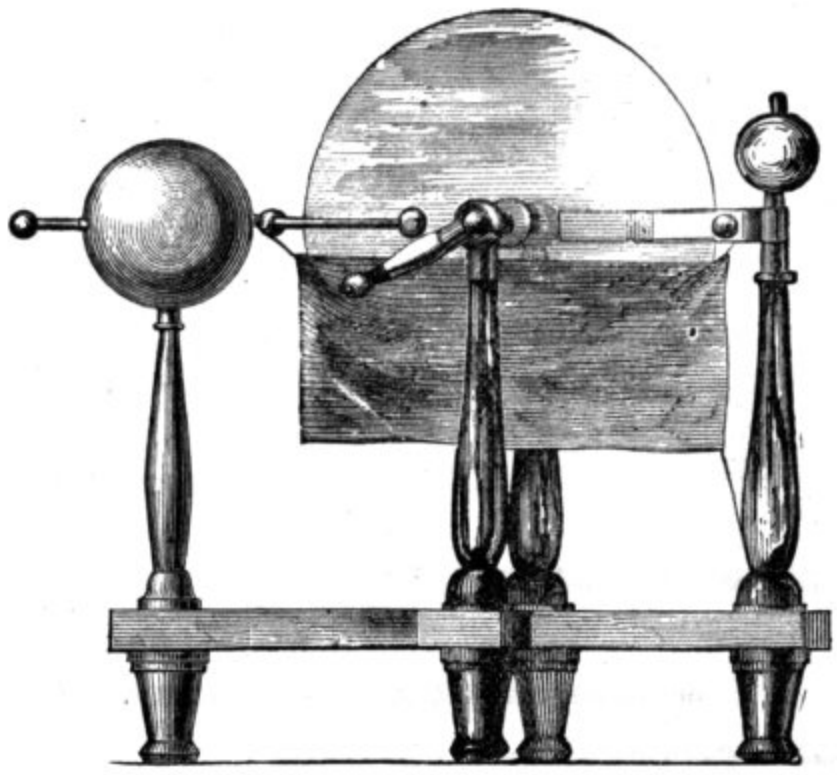
Any of the pictures of the sets may be selected.

ELECTRICITY.



No. 836.

831. **Friction Cylinder**, of glass, ...50
832. **Friction Cylinder**, of sealing-wax, ... 1.25
833. **Friction Cylinder**, of vulcanite, ...75
834. **Electrophorus**, twelve inches diameter, of vulcanite; mounted upon base of brass, with metal plate and insulated handle, . . 8.00
834*a*. **Electrophorus**, a plate of thick vulcanite, twelve inches in diameter, with metal plate and glass handle, ... 4.00
835. **Electrophorus**, similar to No. 834; fourteen inches diameter, . . 10.00
836. **Frictional Machine**; plate sixteen inches in diameter, prime conductor, neatly japanned; mounted on swelled glass pillar with brass base, mahogany negative pillar, brass springs and rubber plates, silk bag, brass chain, polished mahogany base, ... 21.00
837. **Frictional Machine**, similar to No. 836, substituting Rogers' condenser for the conductor, and black-walnut for mahogany, . . 18.00
838. **Frictional Machine**, plate sixteen inches in diameter; prime conductor of brass, glass negative pillar with brass ball four inches diameter, brass springs with screw tension and rubbers, silk bag, brass chain; mounted on polished mahogany base and pillars for the shaft, ... 25.00
839. **Frictional Machine**, similar to No. 838, substituting the Rogers' condenser and black-walnut base, ... 22.00
840. **Frictional Machine**, plate twenty inches; similar to No. 838; prime conductor seven inches diameter, mahogany base, . . 33.00
841. **Frictional Machine**, plate twenty inches; similar to No. 838, substituting the Rogers' condenser and black-walnut base, . . 30.00

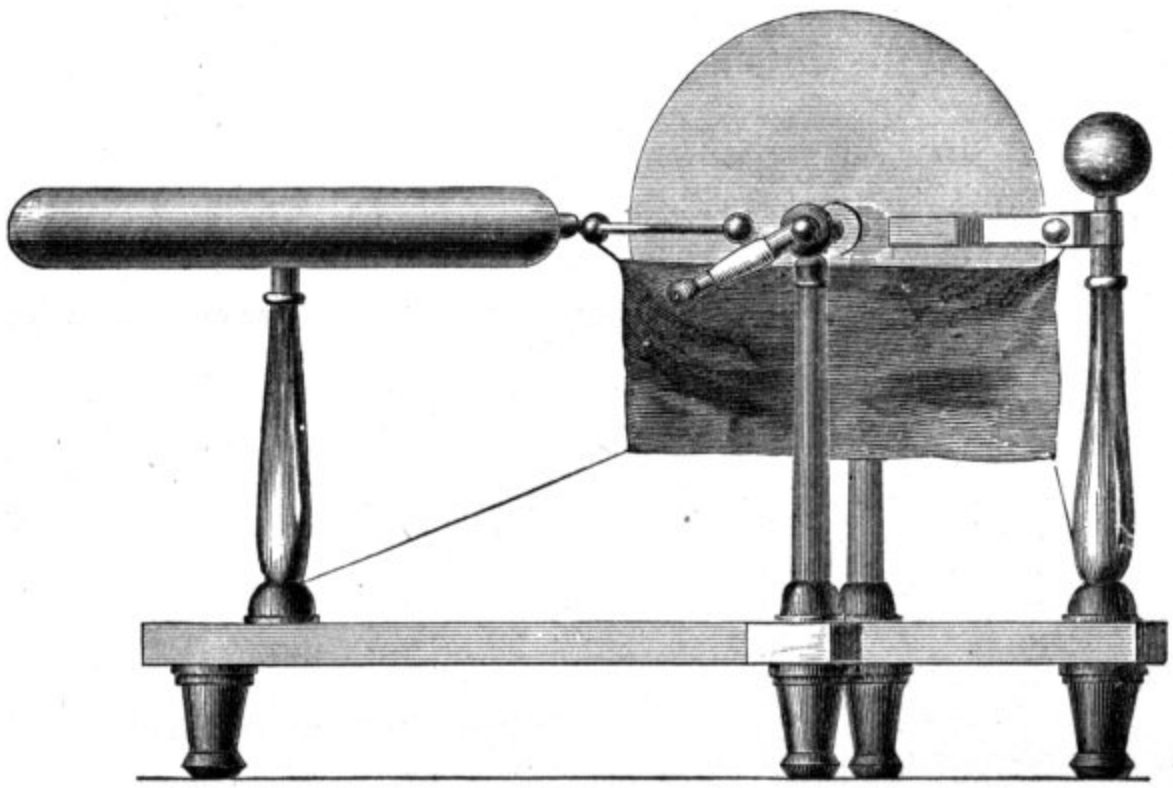


NO. 838—842.

842. **Frictional Machine**, plate twenty-four inches diameter, similar in form to No. 838; mahogany base, ... 45.00

843. **Frictional Machine**, plate twenty-four inches; similar to No. 838, substituting Rogers' condenser, and black-walnut base, . . . 42.00

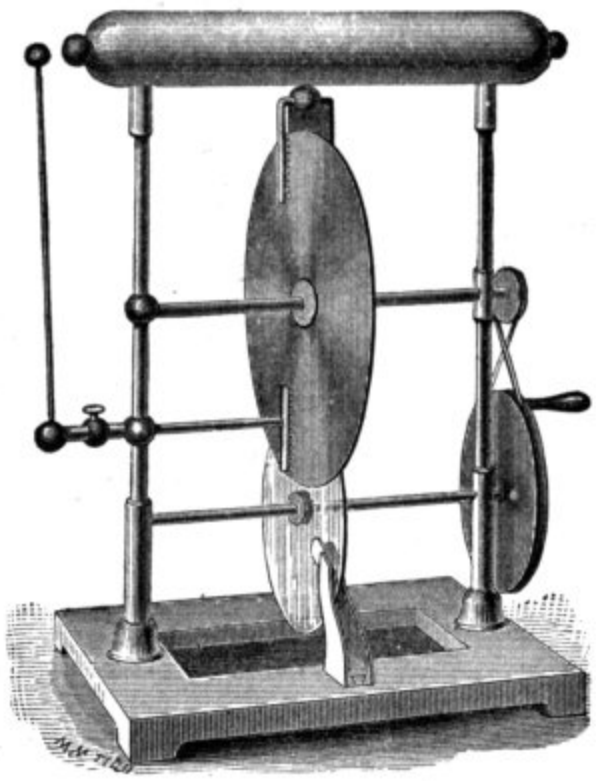
844. **Frictional Machine**, plate thirty inches in diameter, similar to No. 838, ...



No. 845.

845. **Frictional Machine**, plate thirty inches in diameter; brass prime conductor mounted on a swelled glass pillar with brass pedestal; negative conductor upon a similar pillar; double and separable sets of points; brass spring with tension screw and rubber plates; polished mahogany base and pillars for the shaft. The shaft is elevated forty-four inches from the floor, ...

Frictional Machines will be made to order, of larger dimensions, with one or two plates.



Nos. 846—848.

Carrè's Dielectric Machine; consists of two plates of vulcanite, which revolve in opposite directions and overlap each other. The lower plate is excited by a pair of rubbers; a prime conductor is supported by insulating pillars; to this are attached a comb and a sector plate of vulcanite; to one of the pillars an opposite comb is fixed, bearing a discharging-rod and ball; a pulley with crank is attached to the shaft of the lower plate, and a small pulley to the upper, with a cross-belt. The power of the machine is greater than the frictional, but is much inferior to the Holtz. Moisture in the atmosphere affects it about equally with the frictional, and less than the Holtz Machine.

846. **Dielectric Machine**; vulcanite plates eight and thirteen inches diameter; mahogany base, ... 50.00

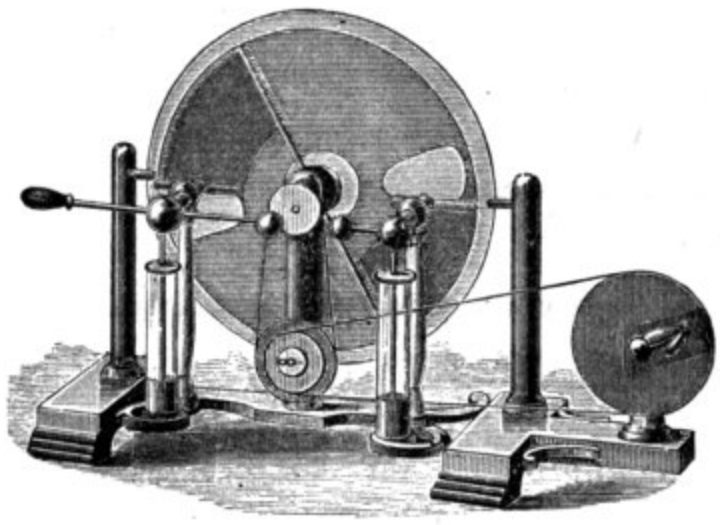
847. **Dielectric Machine**; plates of thirteen and eighteen inches diameter; mahogany base, ... 60.00

848. **Dielectric Machine**; plates of sixteen and twenty inches in diameter, ... 75.00

Brass chain and amalgam are sent with each machine.

850. **Bertsch Machine**; mahogany base, insulating glass pillars holding a cylindrical brass conductor; pillars for support of a vulcanite revolving plate; two bars with combs, one connected with the conductor, the other by a chain to the earth; pulley and crank, and multiplying pulleys; vulcanite plate twenty inches in diameter, ... 65.00

The machine can only be used in a favorable state of atmosphere, and is inferior in power to the dielectric machine.



RITCHIE'S HOLTZ MACHINE.

The base is of cast iron, of handsome form and neatly japanned; a mahogany pillar in the middle of the base supports the shaft of the revolving plate, and also holds the cross-comb. The *window-plate* is held in position by two small mahogany pillars; two conductors holding combs, are sustained on glass pillars; a driving-pulley with crank is supported on a pillar upon the base, movable to give the desired tension to the belt; a multiplying pulley is placed below the shaft. Two Leyden jars connect with the conductors; a sliding discharger regulates the striking-distance of the spark. All the metal-work except the base is of brass.

The power of the machine is very great, the length of the spark being nearly the radius of revolving plate.

The excitement is made by gently striking the paper sector of the window-plate with a cat's skin, or by holding against it a piece of vulcanite which has been previously rubbed on a cat's skin.

851. **Ritchie's Holtz Machine**; revolving plate sixteen inches in diameter, with chain and piece of vulcanite, ... 40.00

852. **Ritchie's Holtz Machine**; revolving plate twenty inches in diameter; chain and vulcanite piece, ... 50.00

853. **Ritchie's Holtz Machine**; revolving plate twenty-four inches in diameter, with chain and vulcanite piece, ... 60.00

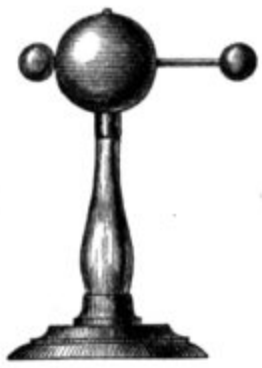
854. **Ritchie's Holtz Machine**, with two revolving plates twenty inches in diameter, ...

855. **Ritchie's Holtz Machine**, with two plates twenty-four inches in diameter, ...

856. **Cat's Skin**, for exciting the Holtz machine, electrophorus, &c., . . .75

Distribution and Induction.

No. 860.



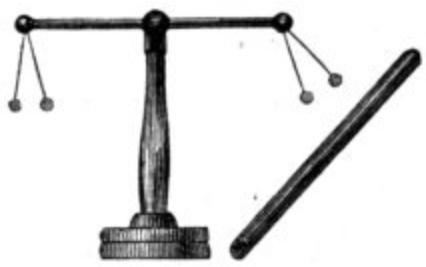
No. 863.

860. **Insulated Conductor**, of large surface, to use with the Holtz and other machines, made of tin neatly japanned, and mounted on a glass pillar and base; conductor twenty inches long by five and a half inches in diameter, ... 8.00

861. **Insulated Conductor**, similar to No. 860; twenty-four inches long by seven inches in diameter, ... 9.00

862. **Insulated Conductor**, of brass, fifteen by four inches; mounted on a swelled glass pillar, mahogany base, ... 10.00

863. **Insulated Conductor**; a brass ball four inches in diameter, on a glass pillar and base, with arm and ball upon which can be suspended the *Electric Bells, Image Plates*, &c., ... 8.00



No. 864.

No. 865.

864. **Insulated Bar**, with electrometers, for induction, ... 4.00

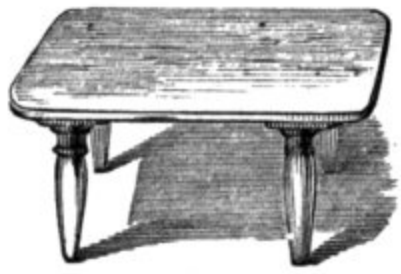
865. **Ellipsoidal Conductor**; showing the unequal distribution of electricity; of brass, supported on glass pillar and base, ... 15.00

866. **Faraday's Muslin Bag**, sustained upon an insulated ring of wire, with silk strings, ... 4.00

867. **Hollow Sphere**; to show that electricity resides on the exterior surface. A brass globe five inches in diameter, on insulating pillar and mahogany base; an opening in the top admits the test-needle; a rod of glass or gum lac, with disc of gold foil, . . . 8.00

868. **Biot's Globe**; brass globe four inches diameter, mounted on mahogany base and insulating pillar; a pair of thin hemispheres, with insulating handles inclose the globe, ... 9.00

869. **Biot's Globe**, similar to No. 868, five and a half inches in diameter, 11.00



No. 873.

872. **Insulating Stool**, of mahogany, braced, with fixed swelled glass legs, ... 4.50

873. **Insulating Stool**; mahogany, braced; large swelled glass legs, with brass screw-caps, ... 6.00

874. **Apparatus** for Illustrating the Tension of Electricity; four brass insulated globes of diameters one to four inches, adjustable at different distances; on mahogany base, ... 15.00

875. **Apparatus** Illustrating the Relation between Surface and Intensity. A mahogany base with two insulating glass pillars, between which is a cylinder of brass; a sheet of thick tin foil is wound upon the cylinder, which can be extended or rolled up at pleasure after being excited. A pith-ball electrometer is attached to a pillar, ... 12.00

876. **Sliding Directing-Rod**; three feet in length, with hinged joint, to attach to the Electrical Machine, ... 2.50

Electrometers.

No. 877.

No. 878.

No. 879.

No. 880.

877. **Pith-Ball Electrometer** and stand, ...75

878. **Quadrant Electrometer** and stand, ... 1.75 and 2.75

879. **Gold-leaf Electrometer**, with stem and ball, ... 3.75

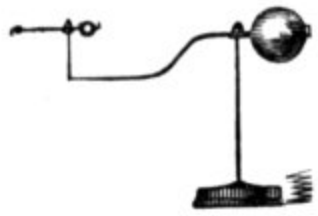
880. **Gold-leaf Electrometer**; glass cylinder on brass stand, brass cover and plate; a movable condensing plate with insulated handle, ... 8.00

881. **Coulomb's Tortion Electrometer**, for accurately measuring small quantities of electricity; glass cylinder ten inches diameter, with graduation, on mahogany levelling-base; tube with graduated cap and adjustments; needle, with gold plate; ball on stem for excitation. Finely finished, ... 25.00

Attraction, Repulsion, and Discharge.

No. 885.

No. 886.



No. 887.

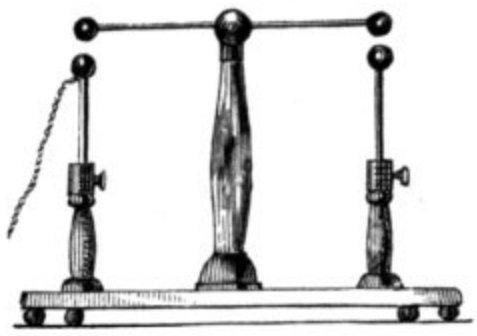
885. **Swan and Basin,** 1.25
886. **Flier** and stand, ... 1.25
887. **Tellurian**, with point and stand; used on the prime conductor or upon the *Insulated Support*, ... 1.75
888. **Tellurian**, mounted on insulated stand, ... 2.25
889. **Spider**, for attraction and repulsion, ...25
890. **Inclined Plane**; two parallel rods eighteen inches long, with a middle support on movable joint and stem to place it on the prime conductor or *Insulated Support*; a flier on a wire axis, . 5.00

No. 891.

No. 892.

No. 893.

891. **Float Wheel**, frame and stand, with a wire point for conductor, . 2.50
892. **Siphon**, and bucket to suspend to conductor, ... 1.00
893. **Revolving Globe**, with point and stand and movable ring. Place it on the *Universal Discharger*, bring the points near the globe distant a third of circumference apart; connect one point to machine, the other to the earth. Without the ring the globe will revolve after being set in motion, ... 2.75
894. **Piercing Glass Apparatus**; consists of a thick cylinder of glass, with a heavy and broad base three inches in diameter, ground plane on the bottom. A fine wire passes from the centre of the plane surface to a ball on the top. In use, the base is placed on the glass to be pierced, with a coating of thick copal varnish; to the opposite side a point with chain for the discharge. A six or eight inch length of spark will pass through a glass plate half an inch in thickness, ... 4.50
895. **Piercing Glass Apparatus**, for piercing a card or thin plate of glass, ... 5.00



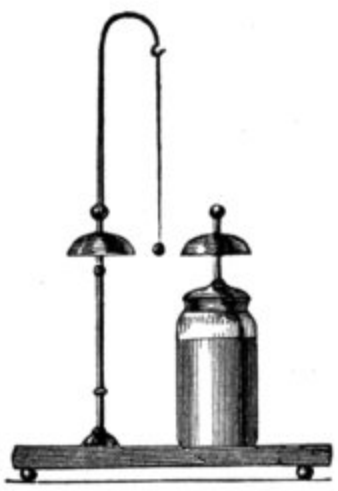
No. 896.

No. 897.

896. **Balance Discharges**, or Electrometer. Mahogany base, insulated pillar for the beam, sliding-rods on glass and mahogany side-pillars, and brass chains, ... 6.75

897. **Electrical Bells.** Two 3-inch bells suspended upon a wire frame; one by brass wire, the other by silk cord; the latter has a chain to make connection with the earth. An insulated ball is alternately attracted and repelled between the bells, ... 1.75

898. **Electrical Bells.** A set of three 3-inch bells, with frame to suspend to conductor or the *Insulated Support*, ... 2.00



No. 901.

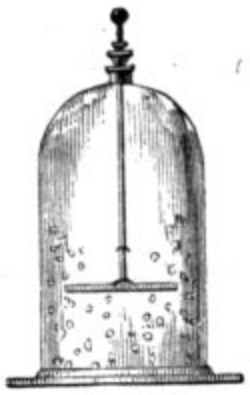
No. 899.

899. **Chime of Seven Bells,** mounted on a mahogany base and insulating pillar. The middle bell is six inches, and the surrounding bells three inches in diameter, ... 9.00

900. **Chime of Five Bells**, mounted similarly to No. 899, with seven bells, ... 8.00

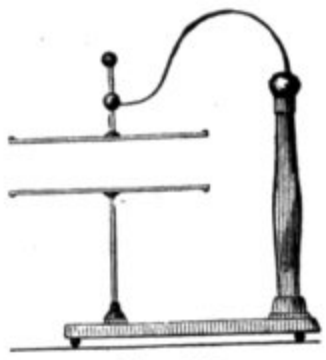
901. **Bells and Leyden Jar**; mahogany base, brass pillar and bell, and support for discharging-ball; Leyden jar of one quart capacity with bell; three-inch bells, ... 4.50

902. **Bells and Stand**, similar to No. 901, fitted for either one or two-quart jar; without the jar, ... 3.00



No. 906.

No. 908.



No. 909.

906. **Plate,** to screw to the *Sliding Rod*, for dancing pith-balls, to use with a *Capped Receiver*, ...75
907. **Pith Balls,** per dozen, in box, ...25
908. **Dancing Image Plates**, of brass, ten inches diameter, to suspend to prime conductor or to the *Insulated Support*, ... 1.50
909. **Dancing Image Plates**, mahogany base; the upper plate is attached to an insulating pillar, the lower plate supported on a pillar with sliding adjustment, ... 6.00
910. **Dancing Images of Pith**, painted; per pair, ...75

No. 911.

No. 912.

911. **Electric Spoon**, for igniting ether, ... 1.00
912. **Gas Pistol,** of japanned tin, with cork, ...75

No. 913.

No. 916.

No. 917.

913. **Gas Pistol**, with curved mahogany handle, ... 4.00
914. **Gas Pistol,** with curved mahogany handle; fitted also for voltaic current, ... 5.00
915. **Electrical Cannon**, brass mounted, ... 6.00
916. **Powder Bomb**; illustrates the effect of passing the discharge of a Leyden jar through water, ... 1.25
917. **Ivory Mortar** and Ball, ... 3.00
918. **Kinnersley's Electric Thermometer,** 5.00

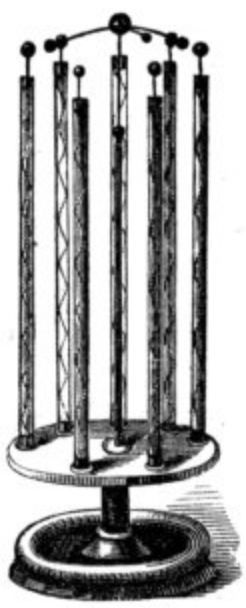
No. 920.

No. 921.

920. **Obelisk**, illustrating the lightning-rod. A pyramid of several parts resting upon a pedestal; a *lightning rod* passes down through a movable block; if this is placed so that the rod is *not* continuous, it is thrown out by the discharge of a Leyden jar, and the obelisk falls, ... 3.00

921. **Thunder House**, illustrating the lightning rod. The house is held together by magnets. The rod has a break, arranged so that if it is closed, the spark passes through the rod; but if turned, the spark passes through a gas pistol placed within, and the house is thrown down, ... 8.50

No. 922.



No. 924.

No. 925.

922. **Spiral Tube**, twenty inches long; spotted on the inside, with brass caps and ball; mahogany stand, ... 3.00

923. **Spiral Tube**, similar to No. 922; thirty inches long, ... 3.75

924. **Set of Spiral Tubes**; six tubes mounted on a mahogany base, central insulated pillar, and revolving star discharger, ... 20.00

925. **Profile of Franklin**; a plate of glass in a mahogany frame, mounted on stand and pillar, ... 4.50

926. **Luminous Star**, similar in mounting to No. 925, ... 4.50

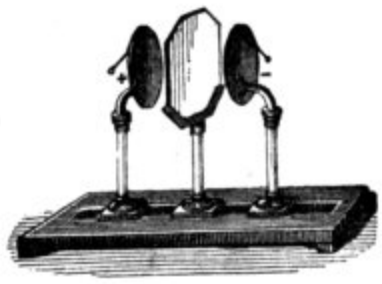
No. 929.

No. 931.

929. **Stand** for illuminating eggs, ... 1.25
931. **Luminous Words**, — "Light," "Union," &c., — on glass, in frame, with handle, ... 4.00
932. **Luminous Name** of Institution or Person, on plate glass fitted for suspension, ... 4.50

Condensation of Electricity.

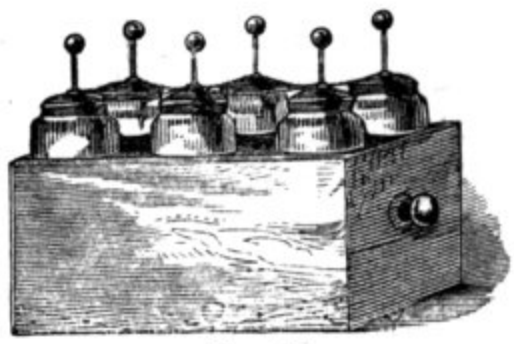
No. 938.



No. 933.

No. 939.

933. **Condenser of Æpinus**; plate of glass mounted upon a mahogany base and pillar, with two movable metal discs supported on insulated pillar, with electrometers, ... 12.00
934. **Illustration of the Leyden Jar**; plate of glass, with coatings and electrometers on each side, ... 4.00
935. **Miser's Plate**, with papered edges, ... 1.00
936. **Miser's Plate**, mahogany frame, ... 2.00
937. **Lightning Plate**, covered on one side by brass filings, on the reverse with tin foil, ... 1.00
938. **Leyden Jar**, with movable coatings; two quarts, ... 3.00
939. **Leyden Jar**, coated with heavy pure tin foil; mahogany cap, brass stem, ball and chain; one pint, ... 1.25
940. **Leyden Jar**, one quart, ... 1.50
941. **Leyden Jar**, two quarts, ... 2.00
942. **Leyden Jar**, four quarts, ... 2.50



No. 947.

943. **Electrical Battery** of four 1-quart Leyden jars, polished mahogany case. Negative discharging balls on the side, ... 9.00
944. **Electrical Battery**, four 1-quart jars, in neat walnut case, . . . 8.00
945. **Electrical Battery**, four 2-quart jars; mahogany case, ... 12.00
946. **Electrical Battery**, four 2-quart jars, walnut case, ... 11.00
947. **Electrical Battery**, six 2-quart jars; mahogany case, ... 15.00
948. **Electrical Battery**, six 2-quart jars; walnut case, ... 14.00
949. **Electrical Battery**, four 4-quart jars; mahogany case, ... 14.00
950. **Electrical Battery**, four 4-quart jars; walnut case, ... 13.00
951. **Morton's Cascade Battery**; eight plates of glass ten inches square, with coatings alternately connected, mounted in a case with insulated discharging pillars. The effects of an electrical discharge in a vacuum from the *Induction Coil*, are very much heightened by this battery, ... 12.00

No. 952.

No. 954.

No. 957.

952. **Electrometer Jar**, with a sliding removable discharger; one quart, 2.00
953. **Electrometer Jar**, two quarts, ... 2.50
954. **Diamond Jar**; perforated spots to show the inside points; two quarts, ... 3.00
955. **Diamond Jar**, four quarts, ... 3.75
956. **Atmospheric Leyden Jar**, with crooked stem and ball for suspension, movable ring with points; one quart, ... 2.00
957. **Atmospheric Jar**, two quarts, ... 2.50
958. **Lightning Jar**, with outer coat of filings, showing the zigzag lines of the current; one quart, ... 1.75
959. **Lightning Jar**, two quarts, ... 2.25

No. 962.

No. 967.

No. 961.

960. **Double Leyden Jars**; one and two quart Leyden jars, with plate and ball, ... 3.75

961. **Plate**, to screw upon the stem of a Leyden Jar, in place of the ball, to support another jar, ...50

962. **Set of Leyden Jars**; consists of a quart electrometer jar, plate, and a pint atmospheric jar, ... 3.75

963. **Set of Jars**, similar to No. 962, with two-quart and one-quart jars, . 4.50

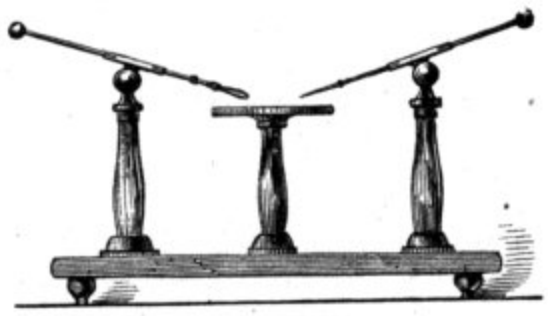
964. **Insulating Stand**, with two electrometers; for a *Leyden Jar*, . 4.00

965. **Sportsman and Birds**, used with an *Electrometer Jar*, ... 1.25

966. **Electric Birds**, Set of four, on stand, ... 1.00

967. **Plain Discharger**, glass handle, ... 2.25

No. 968.



No. 970.

No. 969.

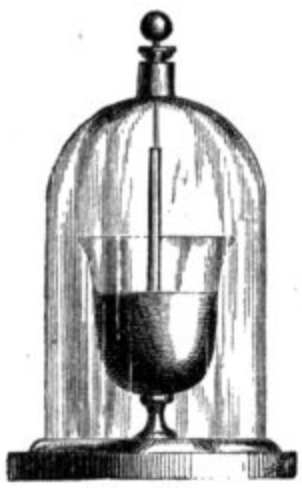
968. **Jointed Discharger**, glass handle, ... 3.50

969. **Jointed Discharger**, with two glass handles, ... 4.00

970. **Universal Discharger**, mahogany base, large table, insulating pillars with universal joints, sliding-rods with balls and points, . 12.00

971. **Universal Discharger**, black-walnut base, with a sliding-rod, point and ball; a glass pillar with a similar sliding-rod; each has motions in all directions; a glass table; neatly made, and as large and efficient as No. 970, ... 6.00


No. 974.


No. 975.


No. 979.


No. 982.

974. **Sets of Points** for Luminous Bell, to screw to the *Air Pump* and *Sliding Rod*. The electric discharge between the points, and the luminous covering of the negative wire, are very beautiful, . . 2.00

975. **Gassiot's Cascade**; a glass vase coated on the inside, and a glass tube through which the sliding-rod passes to connect with the inner coating. The flow of electricity is very brilliant in a darkened room. Four-inch vase, ... 1.25

976. **Gassiot's Cascade**; six-inch vase, ... 2.00

977. **Gassiot's Cascade**, of uranium glass, which with the electric light becomes *fluorescent;* four-inch vase, ... 2.00

978. **Gassiot's Cascade**, of uranium glass; six-inch vase, ... 2.75

979. **Electric Egg**; a strong globe with brass caps, sliding-rod, stop-cock, and stand for exhaustion, ... 7.50

980. **Electric Egg**, similar to No. 979, uranium glass, ... 8.25

981. **Aurora Tube** (see *Pneumatics*, No. 300), ... 6.50 and 8.00

982. **Abbe Nollet's Globe**; glass receiver with thick glass globe and movable cap to admit water; by adding some sulphate of quinine, the water becomes *fluorescent;* the electric flow is peculiarly beautiful; four-quart receiver, ... 5.00

983. **Abbe Nollet's Globe**; six-quart receiver, ... 6.00

984. **Abbe Nollet's Globe**; four-quart receiver of uranium glass, . . 7.75

985. **Abbe Nollet's Globe**; six-quart receiver of uranium glass, . . 6.75

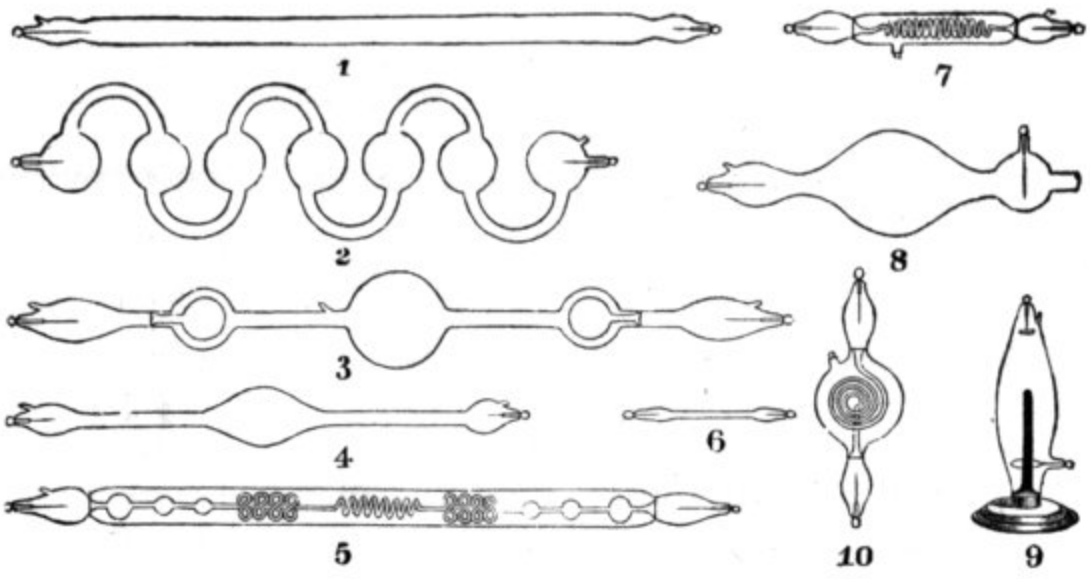
GEISSLER'S TUBES.

Geissler's Tubes for electric light are sealed glass tubes containing a highly rarefied vapor or gas, with which the tubes were filled before the exhaustion. Platinum wires are sealed into the glass at each end, to conduct the electric current.

The brilliancy and beauty of the electric light with the *Induction Coil*, the great variety of effects of striæ, stratification, color, and fluorescence, are indescribable, and many of them are shown with fine effect with the *Holtz Machine*.

The great variety of forms and sizes renders it difficult to fix prices. A few forms are given on the following page, with approximate prices. We will endeavor to make, when desired, the best selection for amount required.

Geissler's Tubes.



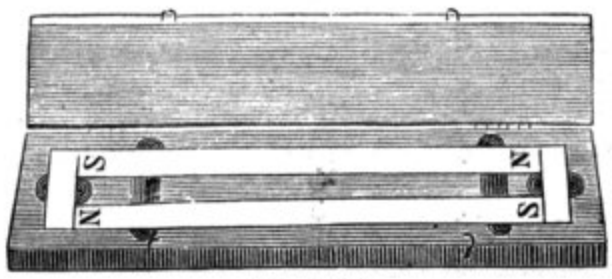
990. **Plain Tube** (Fig. 1); phosphorescent, of different colors, 3.25 and 4.75
991. **Plain Tubes** (Fig. 1), of large sizes, ... 6.50
992. **Cascade Tube** (Fig. 2); in the narrow tube the stratification is peculiarly marked, and the light in the balls is *phosphorescent*, . 3.50
993. **Cascade Tube** (Fig. 2), large size, ... 4.50
994. **Tube** (Fig. 3), with two divisions, with different gases; no communication exists between the portions; the illumination of the interior bulbs by *induction* is very beautiful, ... 6.00
995. **Tube** (Fig. 3), with three divisions, large size, ... 8.00
996. **Tube** (Fig. 4). The narrow and the enlarged portions produce peculiar effects upon the intensity and color of the light, and of the stratification, ... 3.50
997. **Combination Tubes** (Fig. 5), with interior narrow tube and bulbs of different-colored glass. The light and colors are very brilliant, 4.50
998. **Small Tubes** (Fig. 6), with variety of elements, ... 1.50
999. **Tubes** (Fig. 7), with interior spiral of fine tube. The outer one is to be filled with liquid for *fluorescence*, &c., . . 3.25, 5.40, and 6.40

NOTE. A solution of quinine, colorless, is of a rich blue, with electric light.

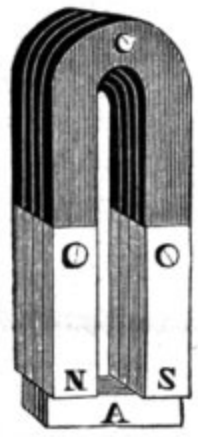
1000. **Tube** (Fig. 8), for showing stratification in broad planes, ... 5.50
1001. **Tube** (Fig. 8), similar to No. 1000, mounted, ...
1002. **Tube** (Fig. 9), for the rotation of the current round a magnet, . . 6.00
1003. **Globe** (Fig. 10), with interior flat spiral of fine tubing; the globe may be filled with a solution of chloride of gold, quinine, &c., . 3.50
1004. **Globe**, similar to No. 1003, inclosing rosette of small colored tube of different-colored glass, ... 3.25, 3.50, and 4.50
1005. **Tubes** similar in form to Fig. 7; the interior tube forms the words "Volta," or "Galvani," 4.00
1006. **Tubes** in form like Fig. 8, inclosing a uranium vase, 3.25, 4.50, and 6.50
1007. **Vacuum Tube**, in which the vacuum is so perfect that the current *will not pass* between the wires, although they are but one fourth of an inch apart, ...

Magnets.

No. 1039.



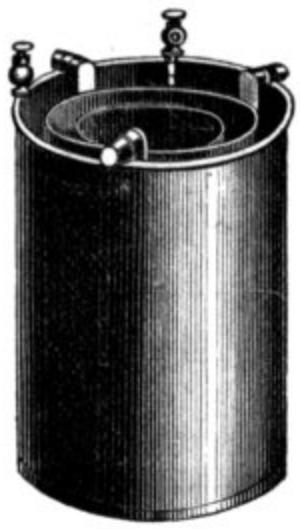
No. 1030



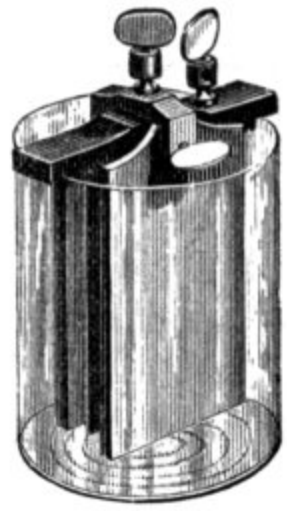
No. 1044.

1025. **Natural Lodestone**; piece, in box, ...50
1026. **Bar Magnet**; polished steel, six inches long, ...50
1027. **Bar Magnet**; polished steel, ten inches long, ...75
1028. **Bar Magnet**; two plates, connected by screws, eight inches long, . 2.50
1029. **Bar Magnet**; three plates, ten inches long, ... 3.50
1030. **Pair of Bar Magnets**; polished steel, with polished iron armatures; in mahogany box, ... 3.75
1031. **Breaking Magnet**, grooved to break into four pieces, ...15
1032. **Magnetic Needle**, four inches long, on stand and pivot, ... 1.00
1033. **Magnetic Needle**, six-inch, with agate cap, stand and pivot, . . 2.50
1034. **Collimator**; four-inch needle, in brass case, 6 by 1½ inches, graduated arc of 20 degrees; glass cover. The sides of base are parallel with the zero line. Accurately made and very sensitive, . 10.00
1035. **Dipping Needle**, four-inch; on brass stand, ... 3.50
1036. **Dipping Needle**; brass base and pillars, graduated arc, levelling screws and spirit level; needle ten inches; agate bearings, glass cover; giving the angle of the dip with great precision, . . . 25.00
1037. **Astatic Needle**, six inches long; with stand and pivot, ... 2.00
1038. **Astatic Needle**, six-inch; agate cap, stand and pivot, ... 2.75
1039. **U or Horseshoe Magnet**, four inches long; polished steel, painted for half its length to avoid tarnishing; with armature, ...50
1040. **U Magnet**, with armature; six inches long, ...75
1041. **U Magnet**, with armature; eight inches long, ... 1.25
1042. **U Magnet**, with armature; ten inches long, ... 2.00
1043. **U Magnet** and armature; ten inches with handle, ... 2.50
1044. **Compound U Magnet**; two plates six inches long and armature, 2.50
1045. **Compound U Magnet**; three plates eight inches long, ... 5.00
1046. **Wheel Armature**; revolves on U magnet, ...50
1047. **Pocket Compass**, in brass box, glass cover, ... 2.00
1048. **Pocket Compass**; agate cap, brass box, with cover, ... 3.00
1049. **Pocket Compass**; very delicate, silver case, ... 4.50
1050. **Magnetic Fish** or Swan, ...50

Voltaic Batteries.



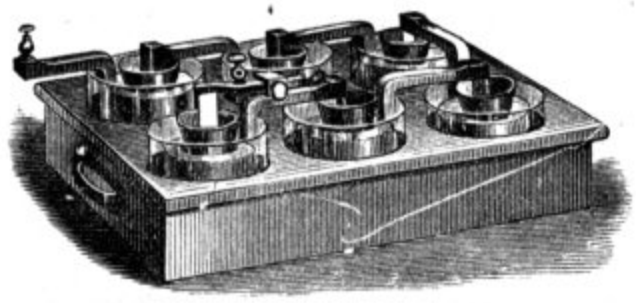
No. 1061.



No. 1062.

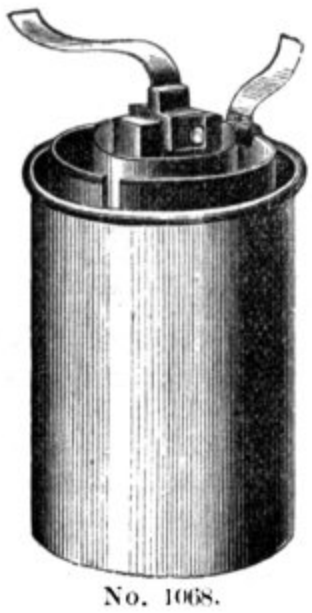
1059. **Galvanic Couple**, or Frog Battery, ... 1.00
1060. **Voltaic Couple**; glass cell, plates of copper and of zinc, with bar and wires for the current, ... 1.50
1061. **Sulphate of Copper Battery**; double cell of copper six inches high; cylinder of zinc, supported by wood insulators, ... 2.50
1062. **Smee's Battery**; glass cell, two quarts, zinc electrodes four by two inches; screw pole-cups, ... 3.50
1063. **Smee's Battery**; electrodes eight by four inches, ... 4.00
1064. **Daniel's Constant Battery**, ... 2.25

No. 1065.

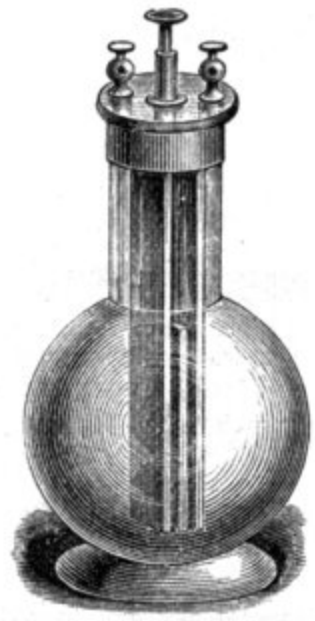


No. 1067.

1065. **Grove's Battery**; glass cell, heavy zinc cylinder; platinum electrode three inches long, ... 2.00
1066. **Grove's Battery**; four cells, in black-walnut box, ... 9.00
1067. **Grove's Battery**; six cells, in box, ... 13.00
1067*a*. **Leclanche Battery**; a glass cell, with a porous cell filled with peroxide of manganese and carbon enclosing the carbon electrode; a rod of zinc forms the negative electrode; the outer cell is to contain a diluted solution of sal-ammoniac; the power is feeble but very constant, ... 2.50



No. 1068.



No. 1072.

1068. **Bunsen's Battery**; two-quart glass cell, solid carbon electrode with improved screw-clamp connections, and stout copper bands, heavy cylinder of rolled zinc, with screw-clamp and copper ribbon. Clamps and bands are sent with a battery of four or more cells, to admit of their being united for *intensity* or *quantity*, . 2.50

1069. **Bunsen's Battery**, similar to No. 1068; one-gallon cell, . . . 3.50

1070. **Bunsen's Battery**; twenty 2-quart cells, ... 45.00

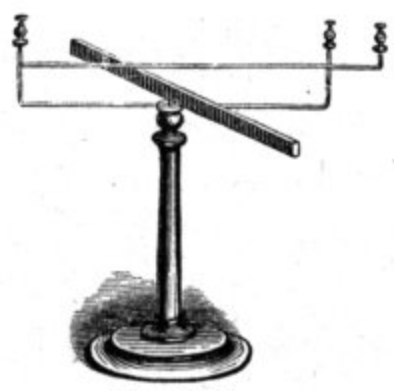
1071. **Bichromate of Potash Battery**; square cell, ... 4.00

1072. **Bichromate of Potash Battery**; glass globe with wide cylindrical neck, and cap. The carbon plates are stationary; the zinc electrode is connected to a brass sliding-rod, permitting it to be drawn out of the liquid. This is the best battery for general purposes, and can be kept always ready for use. It is inodorous and free from injurious fumes. Capacity, one quart, . 3.50

1073. **Bichromate of Potash Battery**; two quarts, ... 4.50

1074. **Bichromate of Potash Battery**; one gallon, ... 5.50

1075. **Galvanic Cell,** for projection. Two plates of plate glass, separated by a band of rubber, and confined together by brass plates with screws; copper and zinc electrodes and screw pole-cups, . 3.50



No. 1076.

1076. **Oersted's Galvanometer**; magnetic needle ten inches long, brass wire frame with three pole-cups, permitting the battery current to be passed over, under, or around the magnet; mahogany base and brass pillar, ... 4.00

No. 1080.

No. 1081.

1080. **Galvanometer,** Compass form; mahogany base, graduated compass-card, with magnetic needle seven inches long. A helix of insulated wire passes many times around the needle to pole-cups, ... 4.00

1081. **Galvanometer or Multiplier**; a coil of very fine silk-covered copper wire wound on a flat wooden bobbin; an astatic pair of needles, the upper one near the upper plane-surface of the helix, the under one in the middle section of the helix; the needles rest on an agate cap on a pivot; a graduated circle is placed under the upper needle; the coil rests on a mahogany base with levelling screws, and is covered by a glass shade, ... 17.00

1082. **Galvanometer or Multiplier**, similar in construction to No. 1081, with helix of very fine silk-covered wire; the astatic needle, carrying a small mirror, is suspended by a fibre of silk from a brass frame, with motions for elevation and adjustment; graduated scale. This instrument is extremely sensitive, and is used with the *Thermo-Pile* (see *Heat*, No. 405), ... 30.00

1083. **Tangent Galvanometer**; consists of a ring twelve inches in diameter and one inch in width, supported on a mahogany frame and base, with levelling screws. In the centre of the ring is placed a delicate magnetic needle, one inch in length, with a graduated circle, in brass cell and glass cover. In use, the ring is placed in the plane of the magnetic meridian, ... 20.00

1084. **Tangent Galvanometer**, similar to No. 1083, with three coils, for currents of high intensity, for great quantity, and for intermediate currents, ... 27.50

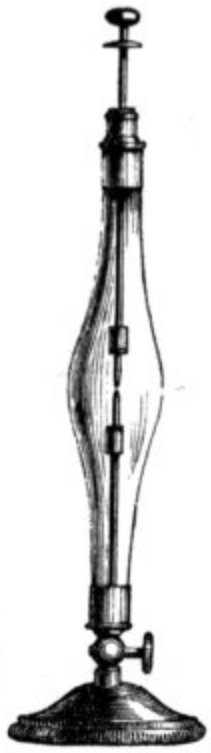
1085. **Galvanometer**; on horizontal helix supported on base and pillars. The needle carries a vertical index which is clearly visible over a white background. It is also arranged to be used with the lantern, and the image of the index *projected* upon the screen,.

Heating Effects of the Current.

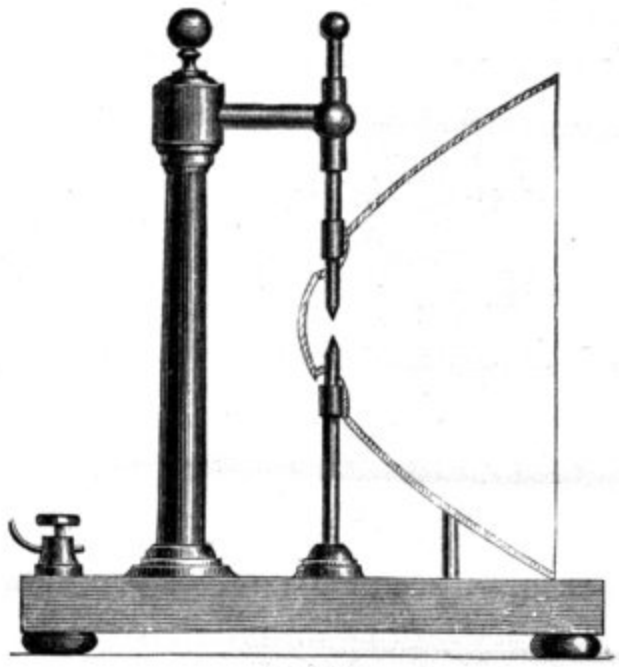
1088. **Powder Cup.** Brass cup, with platinum wire, ... 1.00

1089. **Voltaic Gas Pistol**, brass barrel, mahogany carved handle, insulated screw-cap, with platinum wire for firing gas, ... 4.00

1090. **Voltaic Gas Pistol**; similar to No. 1089, fitted also for static electricity. (See No. 914.) 5.00



No. 1096.



No. 1099.

1096. **Apparatus** for the Electric Light in a Vacuum; glass globe with stop-cock, sliding-rods with carbon holders, ... 8.00

1097. **Carbon Points**, for electric light; per dozen, ... 2.00

1098. **Electric Lamp**; mahogany base and pillar, through which passes a conductor which connects to a brass arm and sliding-bar, fitted with clamps for a carbon. A brass pillar rests on the base, holding also a carbon. A divided cone of metal is fitted to each pole, to hold metals for deflagration, and platinum wire; pole-cups for battery wires, ... 8.00

1099. **Electric Lamp**, similar to No. 1098, with a parabolic nickel-plated reflector, ten inches in diameter, ... 12.00

1100. **Electric Lamp**; small automatic lamp, Browning's form, . . . 12.00

1101. **Electric Lamp**; automatic action, with adjustment for keeping the light at the same height or separating the carbons to any required distance, ... 15.00

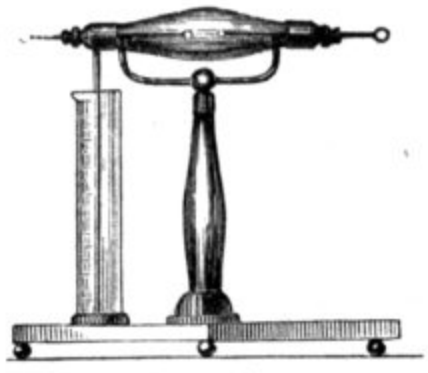
1102. **Browning's Regulator.** For the electric light in this lamp both the carbons are moved by the electricity of the battery employed; the light remains uniform in height and very steady in action. From 25 to 50 cells of Bunsen's or Bichromate battery should be used, ... B. 52.00

1103. **Duboscq's Regulator.** This well-known and approved electric lamp has the movements of both carbons regulated by the battery current; the light remains uniform in height and very steady. From 25 to 50 cells are required, ... D. 55.00

1104. **Foucault's Regulator.** This regulator is specially used in light-houses, and is very desirable for use with the lantern. The light is automatically kept constantly illuminated, . . . D. 100.00

Chemical Effects.

No. 1110.



No. 1111.

1108. **Electrolysis of Salts.** A bent tube, with platinum electrodes and conducting wires, ... 1.50

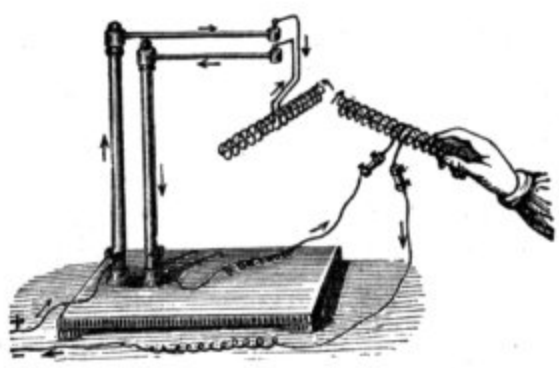
1109. **Electrolysis of Salts**; bent tube upon a base, with platinum electrodes and conducting wires, ... 3.00

1110. **Decomposing Cell.** A glass vase, mahogany top, with tubes and platinum electrodes, and brass pole-cups, ... 2.50 and 3.00

1111. **Decomposing and Recomposing** Water Apparatus. A strong glass receiver, capped at each end, with sliding-rods and platinum electrodes; mahogany base and pillar, with graduated jar to measure the gas evolved by the displacement of water. To recompose, turn the electrodes into the gas, and pass the electric spark, ... 10.00

1112. **Decomposing Tank**; plate glass sides, brass clamps and screws, with platinum electrodes, for *projection*, ... 3.50

On the Laws of Currents.



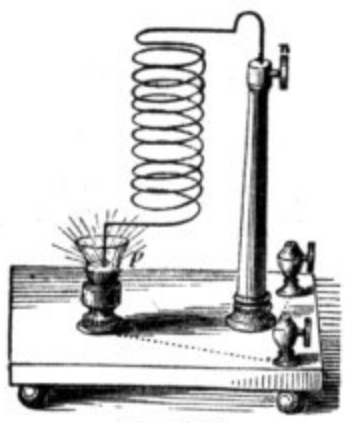
Nos. 1113, 1114.

1113. **Ampère's Frame**; mahogany base, brass pillars and arms with mercury cups; a set of five forms, and solenoid, of insulated copper wire; showing the action of magnets upon the currents, the action of terrestrial magnetism, and the action of currents upon currents, ... 18.50

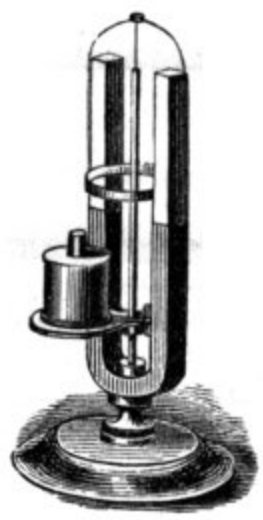
1114. **Solenoid, or Helix**, to exhibit the phenomena of attraction and repulsion as a bar magnet, ... 2.00

1118. **Ampere's Table**; consists of a mahogany base, upon which are two brass columns, between which is a sliding mercury cup. One of the columns stands upon a sliding-bar, and carries upon a sliding arm a multiplier, or square frame, upon which twenty turns of insulated wire are laid. Supported by the other column are frames of wire of different forms, through which the current passes to the mercury cup below. This apparatus demonstrates the attractions and repulsions of currents by currents in the most perfect manner, ... 27.50

1119. **De la Rive's Ring**; a floating battery and coil, to be used with a bar magnet; illustrating attraction and repulsion of a *current* by a *magnet*, ... 1.50



No. 1120.



No. 1125.

1120. **Contracting Helix**; mahogany base and pillar, copper helix, . 3.75

1121. **T Bar**, of copper and iron, with bismuth plates, for thermo-electric current, ... 2.50

1122. **Thermo-Electric Plates**; pair, ...50

1123. **Thermo-Electric Plates**; a series of five elements, ... 2.00

1124. **Melloni's Thermo-Multiplier** or Galvanometer (see No. 1082).

1125. **Thermo-Electric Revolving Arch**; consists of a steel U magnet on stand. A brass pillar is placed between the poles with an agate cap, on which rests, by a pivot, an arch and ring, and also a plate, holding a spirit-lamp, ... 5.50

1126. **Thermo-Electric Arch**, similar to No. 1125; the arch revolves around one of the arms of the magnet, ... 5.00

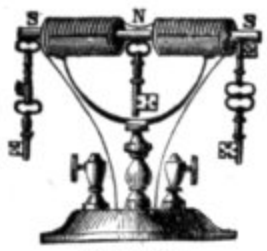
1127. **Rotation of an Horizontal Conductor** by the Earth's Action; mahogany base, annular vase of mercury with central pillar, and revolving conductor with pendants to the mercury, ...

1128. **Magnet** revolving around a conductor, ... 10.00

1129. **Magnet** revolving on its axis parallel to conductor, ... 8.00

Magnetization by Currents.

1130. **Ampere's Helix**; a small glass tube, around which is coiled an insulated copper wire, with ball and binding-screw at each end; for magnetizing steel needles by the *Leyden Jar* or by the *Voltaic Current*. Right and left handed spirals, each, ... 2.50



No. 1136.

No. 1137.

1135. **Helix on Stand**; a coil of insulated copper wire, resting upon a brass pillar and frame; mahogany stand, brass pole-cups, movable rod of soft iron, ... 3.00

1136. **Helix with three Poles**. The helix is divided into two sections, wound in opposite directions, ... 3.50

1137. **Helix and Ring Armature** of soft iron, divided into two semicircles, with brass handles, ... 3.50

1138. **Terrestrial Helix**, seven inches diameter, to use with magnetic needle, ... 2.00

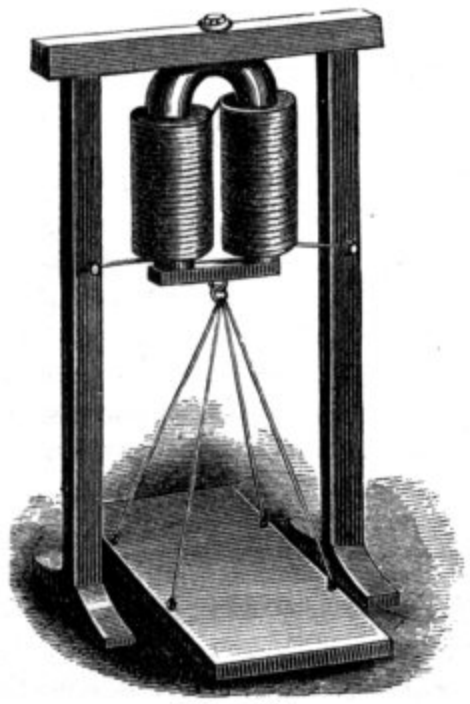
1139. **Globe and Helix**, with iron core and dipping-needle on stand, . 4.00

1140. **Lifting Coil**. Helix four inches long, of insulated copper wire, and rod, for suspension. The helix is made of form to be suitable for a great many experiments, ... 3.00

1141. **Electro-Magnet**. A soft iron bar, bent with parallel arms, each surrounded by a helix of copper wire; four inches long, . . . 2.00

1142. **Electro-Magnet**, five inches long, ... 2.50

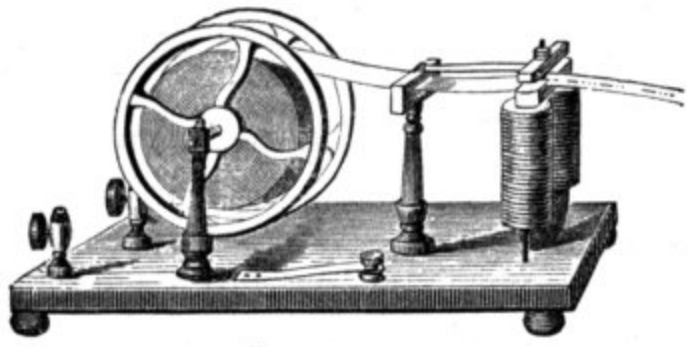
1143. **Electro-Magnet**, seven inches long, ... 3.50



No. 1144.

1144. **Electro-Magnet in Frame**; mahogany frame, supporting a magnet six inches long, with armature, ring for weights and binding-screws, ... 8.00

1145. **Electro-Magnet**, in frame, similar to No. 1144, eight inches long, 13.00
1146. **Electro-Magnet**, in frame, similar to No. 1144, with magnet ten inches long, with armature and platform, ... 16.00

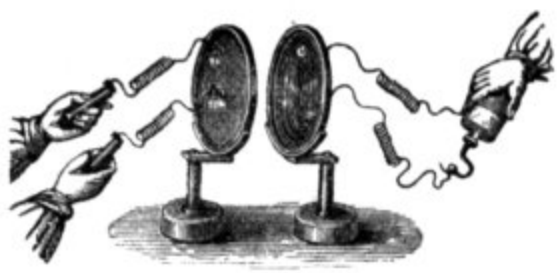


No. 1147.

No. 1157.

1147. **Model of Telegraph Receiver**; mahogany base, electro-magnet, armature with spring and point, spool of paper; with signal-key on same base, ... 7.00
1148. **Model of Telegraph**, similar to No. 1147, with a signal-key on a separate base, and wire to extend around the room, ... 8.50
1149. **Model of Relay Magnet**, with pole-cups for primary current and for local battery, to work No. 1148, ... 8.50
1150. **Signal Key**, for making and breaking a battery circuit; mahogany base, ... 1.50
1151. **Telegraph Sounder**, as used on the lines, ... 7.00
1152. **Telegraph Register**, on black walnut base, ... 40.00
1153. **Copy of B. A. Unit or Ohm**, as issued by the Committee, imported to order, ... 15.00
1154. **Unit or Ohm**, which we warrant the exact equivalent of the B. A. Unit. A coil of German-silver wire, ... 5.00
1155. **Reflecting Galvanometer**, Sir William Thompson's, with astatic needles, tripod pattern, short thick wires; with lamp-stand and scale; with 1500 ohms resistance. Imported to order,. . . . 75.00
1156. **Set of Shunts** for No. 1155, 1-9, 1-99, 1-999 resistance, . . . 21.00
1157. **Page's Revolving Electro-Magnet**; steel permanent magnet on a stand; an electro-magnet revolves between the poles, . . 7.00
1158. **Page's Bell-Engine**, similar to No. 1157, with a bell which is sounded by a hammer propelled by the revolving magnet, . . 10.00
1159. **Insulated Copper Wire**, cotton-covered up to No. 12 per lb., . .75
1160. **Insulated Copper Wire**; No. 20, 1.00; do. No. 30, ... 2.25
1161. **Silk-covered Copper Wire**; No. 24, 2.50; No. 30, ... 4.25
1162. **Silk-covered Copper Wire**, No. 36, ... 7.50
1163. **Platinum Foil** and thin strips; per grain weight, ... 7.50
1164. **Binding-Screws** of brass, with two screws to connect to wires, . .37
1165. **Binding-Screw**, with taper screw or nut, with two screws, . . .50
1166. **Binding-Clamp**, for firmly connecting copper ribbons, ...37
1167. **Battery Porous Cells**, Zincs, and Carbon Electrodes, of all kinds.

Voltaic Induction.



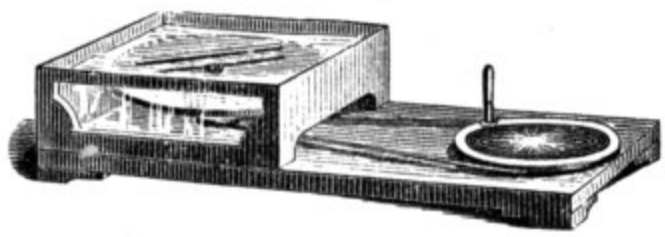
No. 1170.

1170. **Matteucci's Apparatus**, for induction of the voltaic current from the Leyden jar; two coils of insulated copper wire wound in single spiral upon plate-glass, mounted on stands, ... 18.50

1171. **Flat Spiral**; ribbon of copper, insulated, with pole-screws, . . .

1172. **Henry's Secondary Currents**, of different orders, producing an intensity current from a quantity current, and the converse; series of flat helices of coarse and fine insulated wire, ...

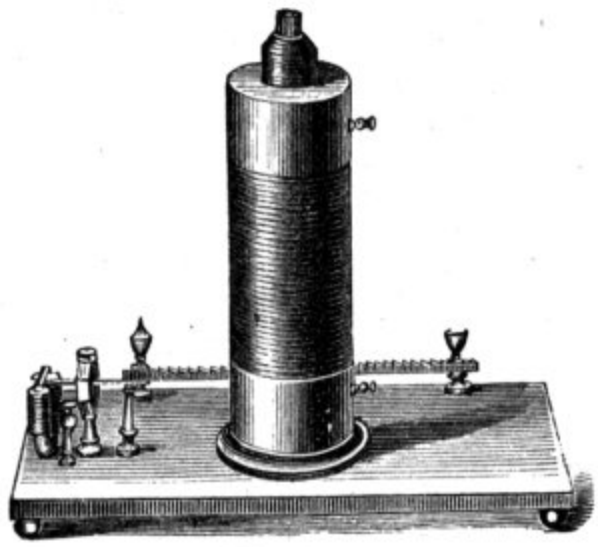
1173. **Flat Helices**, of coarse and fine insulated wire, mounted upon, but not attached to stands, ... 18.00



No. 1174.

1174. **Arago's Apparatus**; consists of a mahogany base and frame, with cover of parchment, upon which is placed a magnetic needle, and beneath which is a rotating disc of copper, with spindle-pulley, driving-pulley and crank, ... 16.50

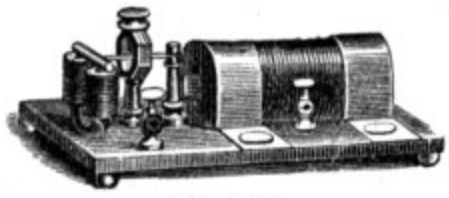
1175. **Three Discs**, for Arago's Apparatus; copper, with radial slit, zinc and glass, ... 4.50



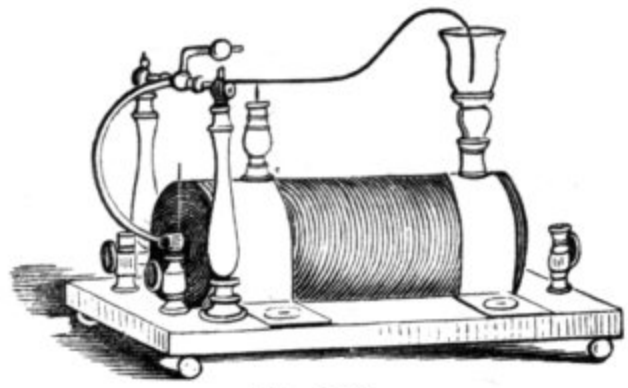
No. 1176.

1176. **Double Helices**; consists of a primary helix attached to a mahogany base, within which is a core of separable soft iron wires, and

surrounding it is placed a movable helix of fine insulated wire, vibrating electrotome, and rasp break-piece, ... 12.00



No. 1178.



No 1179.

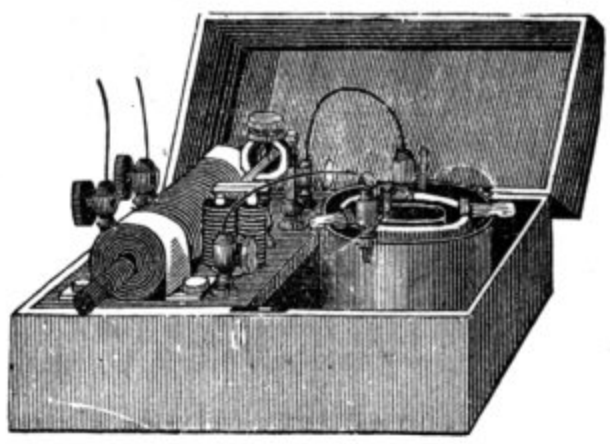
1178. **Page's Shocker**, or double helices and vibrating electrotome; on mahogany base, with screw-cups for battery and induced currents. The iron wire core is movable, for varying the force of the shocks, ... 7.50

1179. **Page's Vibrating Armature** and Electrotome. The circuit break is through a cup of mercury; the *extra current* is shown by brilliant flashes, ... 9.00

1180. **Handles for Shocks**, of brass; pair, with wires, ... 1.50

1181. **Handles for Shocks**, with rosewood insulations; pair, ... 2.00

1182. **Set of Wires**, coarse and fine, for connections, insulated, ...50



No. 1183.

1183. **Apparatus for Shocks**, for medical use, includes a battery, double helices, handles, and sponge handle, with wires; complete, in box, ... 12.00

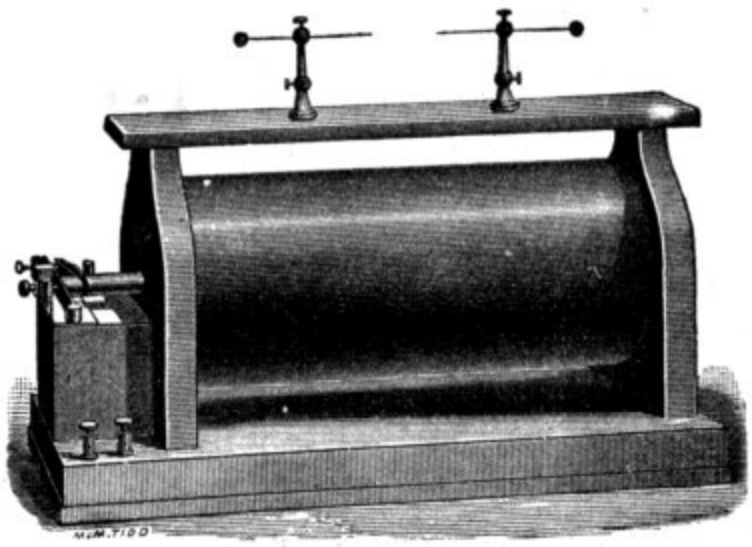
1184. **Delezenne's Circle**, Illustrating Induction by the Action of the Earth. Consists of a wooden ring two feet in diameter, fixed to an axis with crank; the axis is placed in a square frame movable upon centres supported upon a base with pillars; around the ring are wound many turns of insulated copper wire, the terminals passing through a commutator with pole-cups, for conducting wires to a galvanometer, ... 25.00

THE INDUCTION COIL.

The Induction Coil is constructed upon the principle of the *Double Helices* due to Henry, Page and Faraday, with the addition, by Fizeau, of the condenser (which is virtually a large Leyden jar formed of sheets of oiled silk and tin-foil), to the *Interrupter;* with this the tension of the discharge is immensely increased.

Up to 1857 no coil had been constructed giving sparks over three inches, and but very rarely over one inch in length, owing to the great difficulty in effecting the required insulation. At that time E. S. Ritchie devised the mode of winding the secondary helix in strata, in planes perpendicular to the axis, requiring but slight insulation, and rendering the increase of the tension, and length of the spark to two or three feet, practicable. This mode he published in *Silliman's Journal*, which was copied into foreign scientific publications; and it has been universally adopted by all makers of the instrument.

The power of the coil is far greater in volume of discharge than of any *Electrical Machine*, and it has the great advantage of not being affected by moisture in the atmosphere. In the larger coils we make the *break-piece* to be operated by a ratchet-wheel and crank, which is very convenient for many experiments, and valuable in the production of varied effects, and for the obtaining of sparks of greater length and volume. When desired, an automatic action is added.

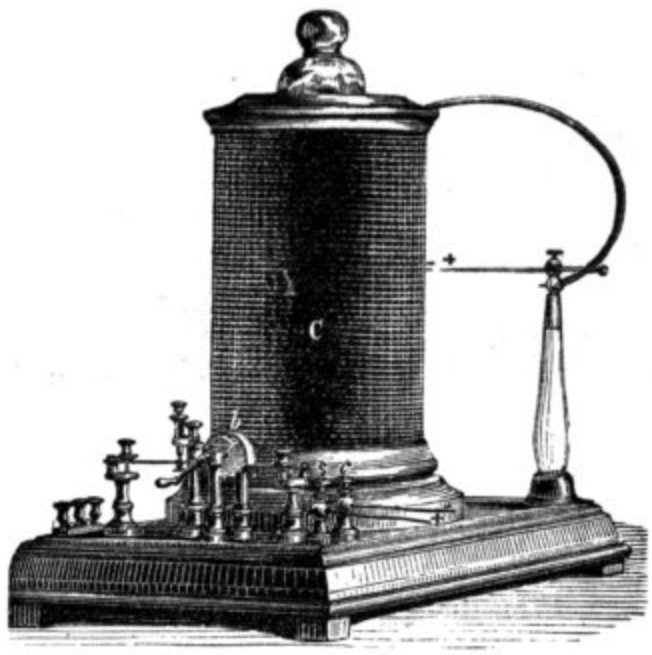


Nos. 1190—1197.

Induction Coil, plain form, horizontal helix; mounted on a mahogany base and supports; the dischargers are placed on a bar over the helices; the vibrating break-piece is adjustable; brass screw-cups for battery connections.

One to three cells of Bunsen's or Bichromate of Potash Battery will suffice, though for best effects more elements should be used; and for the larger coils, doubling the series of cells.

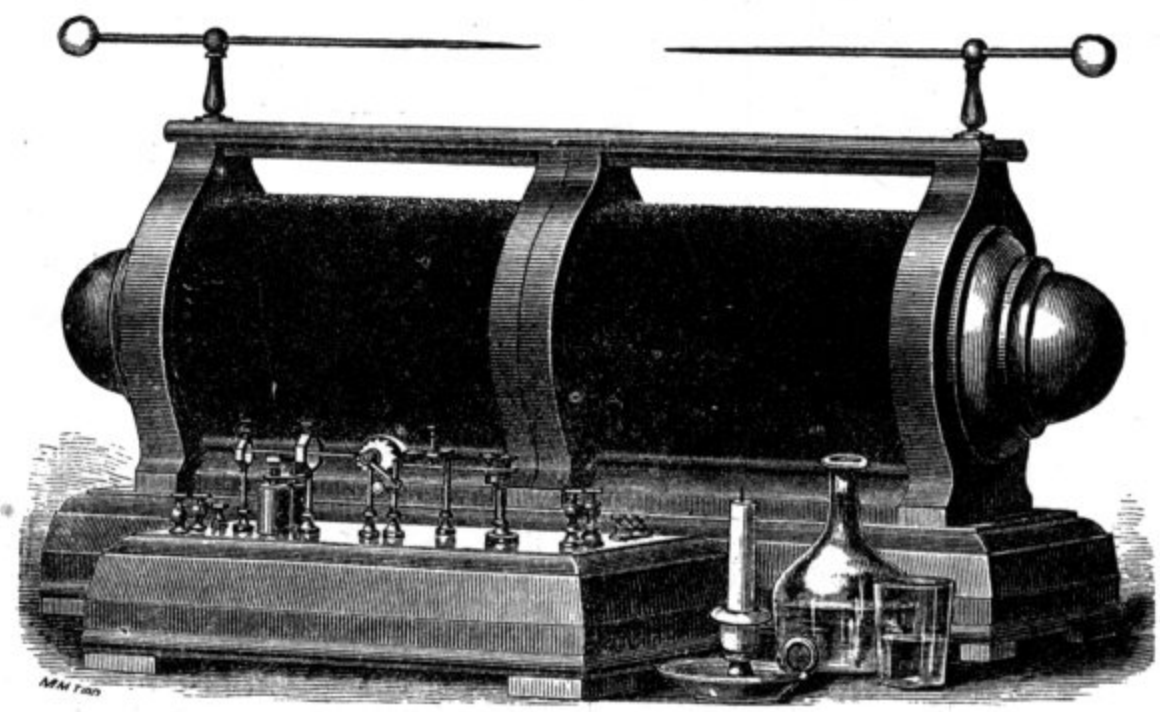
1190. **Induction Coil,** capable of throwing sparks ½ inch, ... 25.00
1191. **Induction Coil,** " " " 1 " 40.00
1192. **Induction Coil,** " " " 2 inches, ... 60.00
1193. **Induction Coil,** " " " 3 " 85.00
1194. **Induction Coil,** " " " 4 " 125.00
1195. **Induction Coil,** " " " 6 " 175.00
1196. **Induction Coil,** " " " 8 " 225.00
1197. **Induction Coil,** " " " 10 " 275.00
1198. **Miniature Coil,** giving sparks ⅛ inch, 6.00; ¼ inch, ... 12.00



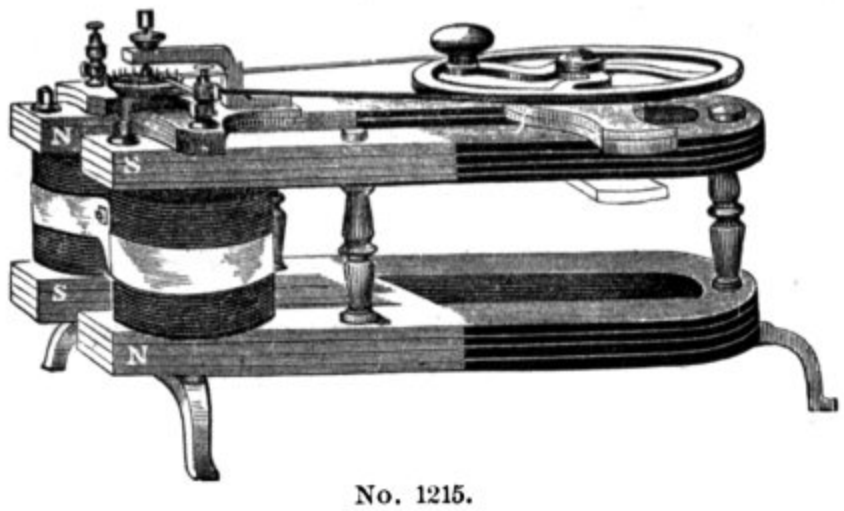
Nos. 1201—1205.

Induction Coil, Ritchie's Improved Form; mahogany base supporting the primary coil, over which is placed a movable glass cylinder and movable secondary helix; glass discharging-pillars, and crank interrupter.

1201. **Induction Coil**, capable of throwing the spark 4 inches, . . . 150.00
1202. **Induction Coil**, " " " 6 " . . . 200.00
1203. **Induction Coil**, " " " 9 " . . .
1204. **Induction Coil**, " " " 12 " . . .
1205. **Induction Coil**, " " " 15 " . . .
1206. **Commutator**, for reversing the battery current, ... 5.50



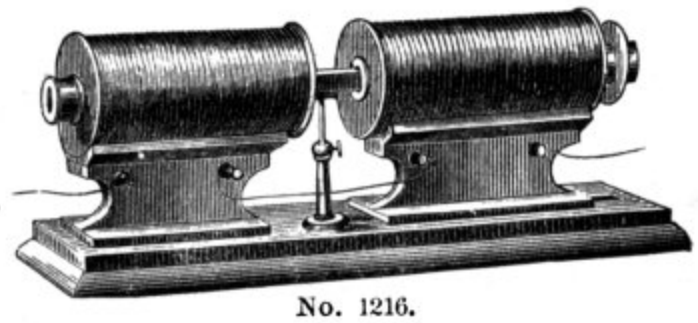
Induction coils of large size, similar to those made for the Stevens Institute, U. S. Military Academy, and several Universities, will be made to order.



No. 1215.

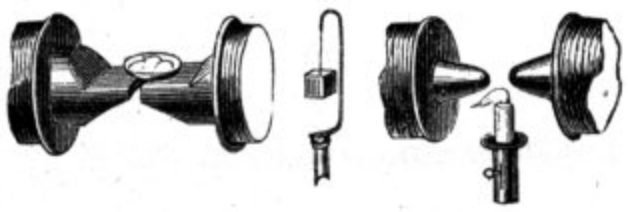
1215. **Magneto-Electric Machine**, of improved construction; two large compound magnets, between which revolve armatures surrounded by large coils of insulated copper wire. The instrument is arranged for giving shocks or for decomposing water. The magnets are finely polished half their length, the remaining portion japanned. All the parts except the coils and magnets are of brass. Four magnets, ten inches long, ... 30.00

1216. **Magneto-Electric Machine**, similar to No. 1215, with six magnets, twelve inches in length, ... 40.00



No. 1216.

1217. **Faraday's Dia-magnetic Apparatus**; consists of two very powerful electro-magnets, supported on a strong mahogany base, one of which is movable in the line of their axes. The cores of each are soft iron tubes, in which Nicol's prisms are fitted, as analyzer and polarizer. To the inner ends of the tubes



are fitted soft iron armatures, for showing the dia-magnetism of solids and liquids. An arrangement is made for Foucault's *Revolving Disc* experiment.

The instrument will be made to order of any desired size.

GEODESY.

No. 1226.

No. 1227.

1220. **Surveyor's Compass**; needle 5 inches, plate 16 inches, with ground levels, sight-vanes; very superior work; in box, . . . 34.00

1221. **Surveyor's Compass**; needle 6 inches, plate 18 inches, ground levels; very superior and accurate; in box, ... 37.00

1222. **Surveyor's Compass**, similar to No. 1221, with vernier, ... 47.00

1223. **Surveyor's Compass**; 7-inch needle, plate 19 inches, ... 41.00

1224. **Surveyor's Compass**; 7-inch needle, with vernier, ... 51.00

1225. **Tripod**, for the surveyor's compass, ... 8.00

1226. **Plain Transit**, 6¼-inch circle, with two double verniers reading to minutes; two rows of figures in opposite directions; vernier opening large, and covered with plate glass; 4½-inch needle; adjustment for vertical plane of telescope, improved spring tangent-screws and lower tangent-screw, shifting arrangement to set instrument over a given point; 10½-inch telescope of finest quality of lenses. Telescope balanced and reverses at both ends, with improved split-leg tripod. Finished in highest class of workmanship, and complete with wrench, screw-driver, adjustable plumb-bob, magnifying glass and manual. Mahogany box with leather strap, &c., ... 200.00

1227. **Engineer's Wye-Level**; 18-inch telescope, aperture 1⅜ inches, eye-piece with improved screw arrangement, for focus adjustment of the wires; adjustable stop to telescope, line of collimation true on all distances; objects erect; the rings and centre very stout and made of hard bell-metal; cross-bar hollow with ribs. Very sensitive and perfect level, 8 inches long. Mahogany case with straps and hooks, contains sun-shade, wrench, screw-driver, &c., with manual, ... 145.00

1228. **Levelling Rod**, Boston pattern, ... 15.00

1229. **Chain**, 100 feet, 100 links, best steel wire, brazed links and rings, . 15 00

1230. **Chain**, 100 feet, 100 links spring-temper steel, ... 8.00

1231. **Chain**, 50 feet, 50 links, best steel wire, brazed links and rings, . . 8.00

1232. **Chain**, 50 feet, 50 links, spring-temper steel, ... 4.50

1233. **Chain**, four rods, in 100 links, ... 4.00

1234. **Marking-Pins**, eleven in set; spring tempered, ... 2.00

1235. **Metallic Tape-Measure**; 100 feet, in tenths; leather case, . . 5.50

1236. **Metallic Tape-Measure**; 50 feet, ... 3.50

ASTRONOMY.

Nos. 1250, 1256.

Nos. 1254, 1258.

Joslyn's Terrestrial and Celestial Globes. These globes are considered the most accurate and superior of any now made. The maps are copper-plate prints; the meridians are accurately graduated on brass; the workmanship throughout of first class; the varnish is clear, and will not crack or peel of. The globes are fully warranted in every respect. Each globe will be packed in a case, without additional charge.

1250. **6-inch Terrestrial** semi-frame; has the leading political divisions separately colored, the principal cities, bays, rivers, capes, &c., ... 3.25

1251. **6-inch Celestial**; semi-frame; contains stars of 5th magnitude, . 3.25

1252. **9½-inch Terrestrial**; semi-frame; has the separate states and territories, Isothermal lines, graduated brass semi-meridian; polished stand, ... 7.75

1253. **9½-inch Celestial**; semi-frame; graduated meridian, stars to 7th magnitude, ... 7.75

1254. **9½-inch Terrestrial**, full frame of cherry, with margin; graduated brass meridian, hour-dial and index; all appliances for problems, ... 11.00

1255. **9½-inch Celestial**; full frame, mounted like No. 1254, ... 11.00

1256. **12-inch Terrestrial**; semi-frame; the maps of finest description, with all the details desirable on a globe; black-walnut stand, graduated arc, ... 11.00

1257. **12-inch Celestial**; semi-frame; has stars to 9th magnitude, . . 11.00

1258. **12-inch, Full Frame**; graduated meridian, hour-dial index, and horizon; handsome frame of cedar and cherry, ... 14.25

1259. **12-inch Low Bronze-metal Frame**; rotary motion, wrought-iron conical bearing; handsomely ornamented, ... 16.25

1262. **12-inch Bronze Pedestal**, rotary stand of ornamented metal, with casters; combining light weight with symmetry and strength; nickel-plated meridian, hour-dial, &c., ... 24.50

1263. **16-inch Low Bronze Rotary Frame**, Terrestrial, meridian to half degrees, brass hour-circles to both poles. The maps are unequalled in fullness and accuracy, with as much detail as is consistent with legibility, ... 32.60

1264. **16-inch Terrestrial Bronze Pedestal**; rotary, mounted similar to 1263; height 3 feet 6 inches, ... 42.00

1265. **16-inch Celestial Globes.** Similar to the terrestrial, ... 42.00

1266. **Slated Globes**, of either the above sizes, at 15 per cent. less.

No. 1267.

1267. **Solar Telluric Globe**, six inches diameter, originally designed by Mr. Joslyn, illustrating the causes of the changes of seasons, and other phenomena which are related to them. A descriptive manual of thirty pages accompanies the globe, ... 10.00

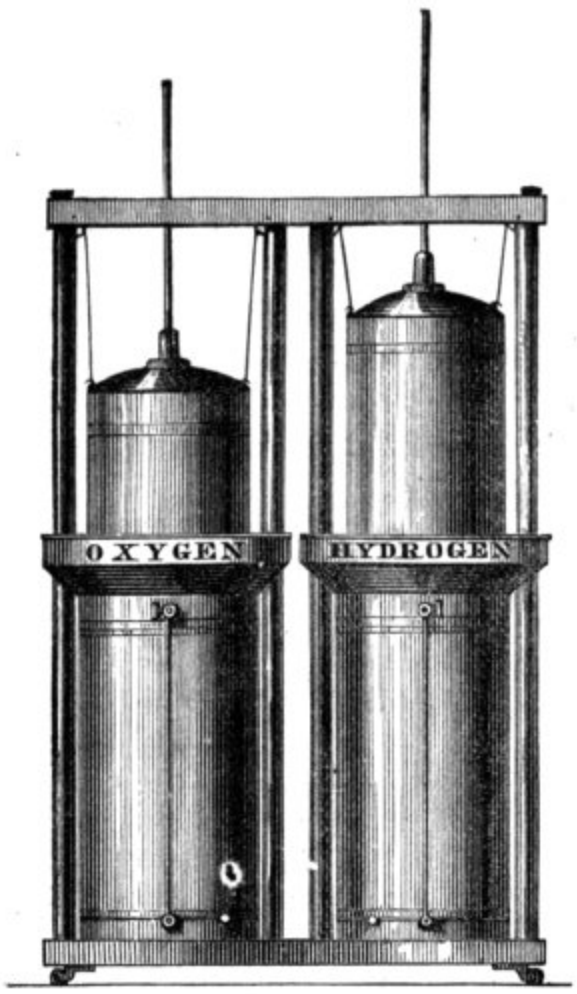
1268. **Tellurian**; showing the motions of the earth around the sun, the inclination and parallelism of the earth's axis, the causes of the seasons, the revolution of the moon around the earth, the moon's nodes, the revolution of the sun and earth on their axes; 5-inch sun, 3-inch terrestrial globe; mahogany base and pillar, 10.00

1269. **Whital's Movable Planisphere**; showing the position of the heavens at any time; 16 inches square; plain, 2.00; colored, . 3.00

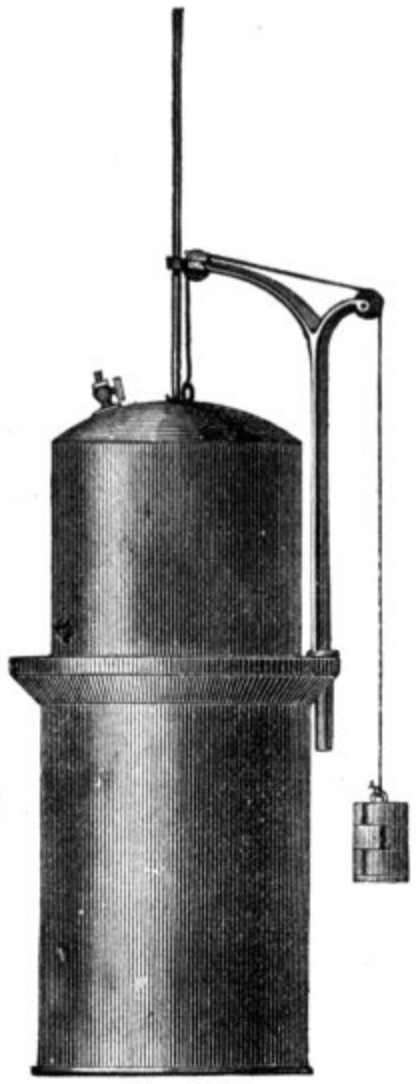
1270. **Fitz's Terrestrial Globe**, mounted in an entirely novel manner. The stand supports on its upper surface a metallic disc revolving on an axis, representing the progress of the earth in its orbit. The disc has concentric circles, with the names of the months, signs of the ecliptic, and subdivisions for each day of the month. It is also graduated to degrees, with index. Attached to the disc, at an angle of 66½°, is a rod representing the axis of the earth, upon which the globe revolves, its centre being vertically over the centre of the disc; an index points towards the centre of the globe, representing a central ray of solar light. The divisions of day and night, line of twilight, and horizon line, are shown by brass rings. A *manual* accompanies each globe. The globe is Joslyn's 12-inch Terrestrial, ... 24.00

CHEMISTRY.

Gasometers.



No. 1280.



No. 1282.

1280. **Gasometers**; a pair of copper, mounted on base, with casters, side-tubes for the balance-weights, brass inlet and outlet tubes with stop-cocks, cylindrical iron pressure-weights; substantially made and japanned; the bells are 9¼ inches in diameter by 31 inches in length, ...

1281. **Gasometers**; a pair of copper, similar to No. 1280, with bells 7½ inches diameter, and 17 inches long, ... 50.00

1282. **Gasometer**; cylindrical inverted bell with stop-cock in a cistern; a movable metal crane with pulleys and balance-weights in sections; the whole equals the weight of bell. By removing one or more of the weights, a corresponding pressure is exerted on the gas. The rising cylinder is 16 inches diameter by 26 inches high; it is made of galvanized iron. They are strong, economical, and durable; capacity 22 gallons, ... 30.00

1283. **Gasometer**, similar to No. 1282. The bell is 11 inches diameter by 24 inches in length; capacity 9 gallons, ... 25.00

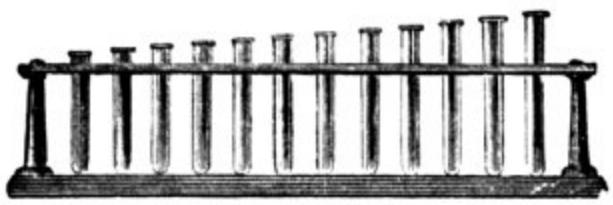
No. 1310.

No. 1307.

No. 1318.

No. 1309.

1300. **Gas Bag**, of Rubber, spherical form with socket, one gallon, . . 2.25
1301. **Gas Bag**, spherical, with socket, two gallons, ... 2.75
1302. **Gas Bag**, spherical, with socket, three gallons, ... 3.50
1303. **Gas Bag**, spherical, with socket, four gallons, ... 4.00
1304. **Gas Bag**, of stout vulcanized rubber cloth, twenty-four by eighteen inches, with socket and stop-cock, ... 10.00
1305. **Gas Bag**, thirty by twenty-four inches; with socket and stop-cock, 12.50
1306. **Gas Bag**, forty by thirty inches; with socket and stop-cock, . . . 16.00
1307. **Oxygen Flask**, of copper; thick bottom, with ground cap; one quart, ... 4.50
1308. **Oxygen Flask**, of copper, thick bottom, with gallows-screw cap, one quart, ... 5.75
1309. **Lamp Stand**, with three bows and binding screws, ... 1.00
1310. **Hydrogen Generator**, of glass, with inverted bell and stop-cock, and ball of zinc. The cover is held by screws beneath a flange. Three quarts capacity, ... 5.50
1311. **Hydrogen Generator**, similar to No. 1310, with addition of a copper basket for granulated zinc, ... 6.00
1312. **Hydrogen Generator**, similar to No. 1310; six quarts capacity, 7.50
1313. **Hydrogen Generator**, of copper, similar in form and size to No. 1312; with basket for zinc, ... 9.50
1314. **Hydrogen Generator**, of copper, 24 inches high by 10 in diameter, with handles and cover; an interior inverted bell of copper, with overflow tube, copper zinc holder and stop-cock. The generator will supply a constant flow of gas for the oxy-hydrogen light, ... 25 00
1315. **Purifier**; a copper cylinder with screw cap; a diaphragm with holes is near the bottom; it is screwed upon the generator, and filled with pieces of lime, which purifies and desiccates the gas, 5 00
1316. **Platinum Sponge**, jet, and holder, to attach to the *Hydrogen Generator*, ... 1.75
1317. **Platinum Sponge**, without holder, ...75
1318. **Woulfe's Bottle**, with three necks; pint, ...85
1319. **Woulfe's Bottle**, with three necks; quart, ... 1.15



No. 1320.

1320. **Test Tubes**, with stand of hard wood and pins for draining, . . 1.50
1321. **Pneumatic Trough**, of stout galvanized iron, 20 inches long by 15 wide and 12 inches deep, with movable shelf; japanned, . . 9.00
1322. **Pneumatic Cisterns**, made to order, ...
1323. **Cork Borers**; set of three, ... 1.75
1324. **Cork Borers**; set of six, ... 2.25
1325. **Blowpipe**, plain, of brass, ...50
1326. **Blowpipe**, with condensing bulb, ...75
1327. **Blowpipe**, cylindrical bulb, platinum tip, and ivory mouthpiece, . 2.50
1328. **Blowpipe**, Oxy-hydrogen. (See *Heat*, No. 370.)
1329. **Crucible Tongs**, of iron, ...75
1330. **Crucible Tongs**, of polished steel, eight inches long, ... 1.25
1331. **Crucible Tongs**, of German silver, ... 2.00
1332. **Copper Foil**, in sheets 24 by 5 inches, ...50
1333. **Evaporating Dishes**, of porcelain, in nests of five, ... 1.50
1334. **Crucibles**, porcelain, with covers, 1 inch, 15 cents; 1½ inches, 30 cents; 2 inches, 60 cents; 3 inches, ...75
1335. **Crucibles**, Hessian, in nest of four, ...25
1336. **Filtering Paper**, in packages of 100 sheets, 4-inch, 35 cents; 6-inch, 50 cents; 10-inch, ... 1.00
1337. **Mercury Trough**, of iron, with cistern, ten by seven inches, . . 6.00
1338. **Mercury Trough**, of porcelain; holds 5 pounds, ... 1.00
1339. **Mortar and Pestle**, of cast iron; 1 pint, 1.28; 1 quart, ... 1.50
1340. **Mortar and Pestle**, porcelain, 4-inch, 1.15; 6-inch, 1.50; 8-inch, 1.75
1341. **Mortar, of Agate**, 1½ inch, 2.25; 2 inches, 3.00; 2½ inches, . . 5.00
1342. **Mouthpiece**, for inhaling gas, with stop-cock, ... 2.75
1343. **Nipper Tube Holder**; brass, screw-clamp with cork jaws, . . 2.50
1344. **Pendent Socket**, for tapers, ...25
1345. **Platinum Spatula**, per grain, ...03
1346. **Platinum Forceps**, ... 1.50 and 2.00
1347. **Rubber Tube**, calibre ⅛ to ¼ inch per foot, ...15
1348. **Rubber Tube**, calibre ⅜ to ½ inch per foot, ...28
1349. **Rubber Tube**, calibre ¾ inch, ...30
1350. **Sockets** of brass, with screw connections for tubes, ...50
1351. **Rubber Corks**, ⅜ to 1½ inch diameter, per doz., ...12 to .50
1352. **Sheet Rubber**; per square foot, from . . . . . .40 to .50
1353. **Dissolved Rubber**, in tin box, ...50
1354. **Set for Blowpipe Analyses**, consisting of oil-lamp mounted on stand, blowpipe with platinum tips, crusher, hammer and anvil, agate mortar, charcoal borer, cupels and holder, mould for charcoal crucibles, and platinum-tipped forceps, ...
1355. **Pinch-Cock**, spring-wire, ...25

1362. **Acid Bottles**, long stoppers, for applying a drop, 1-oz., 30; 2-oz., . .35
1363. **Adapters**, straight; diameter 1 to 1½ inches, 25 cents; 2 inches, 35 cents; 2½ inches, ... 45
1364. **Adapters**, bent; diameter 1 to 1½ inches, 30 cents; 2 inches, 40 cents; 2½ inches, ... 50
1365. **Arsenic Apparatus**, Marsh's; on a support, ... 3.00
1366. **Arsenic Tubes**, Marsh's; each, ... 10
1367. **Beaker Glasses**, in nest of three, 2 to 4 oz., 38 cents; nest of five, 1 to 8 oz., 75 cents; of six, 2 oz. to pint, ... 1.10
1368. **Burettes**, or Dropping Tubes; Gay Lussac's, graduated to 10 c.c., 1.50; to 25 c.c., 1.75; to 50 c.c., 2.00; to 100 c.c., ... 2.50
1369. **Brand's Tube**, with two bulbs for condensation, ...50
1370. **Bolt Heads**, pint, .60; quart, ...75
1371. **Bologna Vials**, unannealed glass; per doz., ... 1.75
1372. **Carbonic Acid** Apparatus, Geissler's; in box, ... 1 00
1373. **Condenser**, Liebig's, of brass, ... 2.00
1374. **Chloride of Calcium** Tube, ...25
1375. **Eudiometer**, Volta's, graduated, ... 3.00
1376. **Eudiometer**, Ure's, graduated, ... 3.00
1377. **Flasks**. Bohemian glass, with rim necks; 4-oz. 18 cents; half pint, 25 cents; pint, 35 cents; quart, ...50
1378. **Flasks**, flat bottom or digesters; 2-oz., 16 cents; 4-oz., 18 cents; half pint, 25 cents; pint, 30 cents; quart, ...40
1379. **Funnels**; gill, 20 cents; half pint, 30 cents; pint, 40 cents; quart, .50
1380. **Globe Receivers**, tubulated, half pint, 60 cents; pint, 65 cents; quart, ...90
1381. **Litre Bottles**; ¼ litre, 75 cents; ½ do., 1.00; 1 do., 1.20; 2 do. . 1.50
1382. **Nitrogen Bulb**, ...65
1383. **Ounce Measures**, graduated; 2-oz., 40 cents; 4-oz., 60 cents; 8-oz., .80
1384. **Pipettes**, graduated; up to 5 c.c., 25 cents; to 20 c.c., 35 cents; to 50 c.c., 50 cents; to 100 c.c., ...80
1385. **Potash Bulb**, ...75
1386. **Receivers**, of different forms. See *Pneumatics*.
1387. **Retorts**; Bohemian glass, plain, gill, 30 cents; half pint, 40 cents; pint, 55 cents; quart, ...80
1388. **Retorts**; Bohemian glass, tubulated, 3-oz., 40 cents; 4-oz., 45 cents; half pint, 55 cents; pint, 65 cents; quart, ...90
1389. **Rupert's Drops**; unannealed glass; per dozen, ...65
1390. **Safety Tubes**; straight, 30; bent, with bulbs, ...50
1391. **Specific Gravity** Bottles; 10 grammes, 1.50; 50 grammes, 2.25; 100 grammes, 2.50; 500 grammes, ... 2.75
1392. **Stirring-Rods**; set of six, ...25
1393. **Sulphuretted** Hydrogen Generator, with glass stopper, ... 3.50
1394. **Tubes**, test, with rim and lip; per dozen, 4-inch, .45; 6-inch, .65; 8-inch, ... 1.30
1395. **Tubes**, cylindrical, graduated to 50 cubic centimetres, ... 1.30
1396. **Tube**; barometer closed at one end, ... 1.00
1397. **Tubing**, thick barometer; per pound, ...75
1398. **Tubing**, glass, free from lead, ⅛ to ⅜ inch calibre, per lb., . . . 1.25
1399. **Tubing**, for combustion, ½ to ¾ inch, ... 1.00
1400. **Tubes**, drying; Liebig's; each, ...65

SELECTIONS

OF

SCHOOL APPARATUS,

COMPILED FROM THE

CATALOGUE.

SET No. 1.

Laws of Matter.

No.		Price.
7.	Capillary Tubes,	1.25
22.	Inertia Apparatus,	.50
23.	Collision Balls,	3.00
31.	Leaning Tower,	2.25
60.	Whirling Ring,	3.00
81.	Compound Levers,	3.75
91.	Illustration of Pulleys,	18.00
97.	Set of Weights,	3.00

Hydrostatics.

136.	Equilibrium Tubes,	3.00
145.	Upward Pressure,	2.00
162.	Siphon,	.75
174.	Lifting Pump,	4.00

Pneumatics.

200.	Air-Pump,	15.00
229.	Receiver,	1.50
253.	Hand-Glass,	1.00
265.	Expansion Apparatus,	.75
269.	Magdeburg Hemispheres,	5.50
280.	Fountain in Vacuo,	5.00
297.	Barometer Tube,	1.25
300.	Guinea and Feather Tube,	6.75
307.	Sheet Rubber,	.75
337.	Collars and Oil,	.75

Heat.

361.	Spirit Lamp,	.75
374.	Fire Syringe,	2.00
379.	Bar and Gauge,	1.75
408.	Wire Gauze,	.50
410.	Conductometer,	2.00
418.	Principles of Ventilation,	2.50
446.	Palm Glass,	.75

Optics.

No.		Price.
701.	Prism,	.75
723.	Demonstration Lenses,	2.50
730.	Newton's Disc,	3.00
766.	Model of the Eye,	5.50
771.	Zoetrope,	3.00
785.	Microscope,	5.00

Electricity.

837.	Electrical Machine,	18.00
877.	Electrometer,	.75
886.	Flier,	1.25
897.	Electrical Bells,	1.75
920.	Obelisk,	3.00
922.	Spiral Tube,	3.00
962.	Set of Leyden Jars,	3.75
967.	Discharger,	2.25
1027.	Bar Magnet,	.75
1032.	Magnetic Needle,	1.00
1072.	Bichromate Battery,	3.50
1088.	Powder Cup,	1.00
1138.	Helix and Ring,	3.50
1141.	Electro-Magnet,	2.00
1157.	Revolving Magnet,	7.00
1178.	Shocker,	7.50
1180.	Handles,	1.50
1182.	Set of Wires,	.50

Recapitulation.

LAWS OF MATTER,	$34.75
HYDROSTATICS,	9.75
PNEUMATICS,	37.50
HEAT,	10.25
OPTICS,	19.75
ELECTRICITY,	62.75
	$175.00

SET No. 2.

ARRANGED BY US FOR, AND ADOPTED BY THE SCHOOL COMMITTEE FOR THE BOSTON GRAMMAR SCHOOLS.

Laws of Matter.

No.		Price.
2.	Cohesion Hemispheres,	.75
4.	Capillary Plates,	1.50
7.	Capillary Tubes,	1.25
21.	Inertia Apparatus,	1.00
23.	Collision Balls,	3.00
30.	Centre of Gravity,	8.00
44.	Pendulum,	2.75
60.	Whirling Ring,	3.00
81.	Compound Levers,	3.75
91.	Illustration of Pulleys,	18.00
97.	Set of weights,	3.00

Hydrostatics.

136.	Equilibrium Tubes,	3.00
145.	Pressure of Liquids,	2.00
147.	Archimedes Principle,	2.75
162.	Siphon,	.75
165.	Tantalus' Cup,	1.50
178.	Set of Pumps,	16.00

Pneumatics.

201.	Air Pump,	35.00
228.	Receiver,	1.00
244.	Receiver,	3.50
253.	Hand-glass,	1.00
265.	Expansion Apparatus,	.75
269.	Magdeburg Hemispheres,	5.50
288.	Weight and Buoyancy,	8.00
300.	Guinea and Feather Tube,	6.75
330.	Sliding Rod,	2.25
337.	Collars and Oil,	.50
343.	Coupler and Plug,	1.00

Heat.

361.	Spirit Lamp,	.75
379.	Bar and Gauge,	1.75
382.	Compound Bar,	1.00
408.	Wire Gauze,	.50
411.	Conductometer,	3.00
418.	Principles of Ventilation,	2.50
422.	Pair of Reflectors,	12.00
446.	Palm-Glass,	.75

Acoustics.

515.	Violoncello Bow,	2.00
517.	Bell in Vacuum,	2.50
533.	Diapason,	7.00
574.	Pipe with Piston,	4.50
593.	Sonometer,	21.50
616.	Screw Press,	5.50
619.	Vibrating Plate, 12-inch,	3.75

Optics.

No.		Price.
702.	Prism,	1.25
714.	Multiplying Prism,	.50
715.	Pair of Lenses,	2.00
717.	Pair of Lenses,	2.50
730.	Newton's Disc,	3.00
766.	Model of the Eye,	5.50

Electricity.

831.	Friction Cylinder,	.50
851.	Holtz Machine,	40.00
856.	Cat's Skin,	.50
863.	Insulated Conductor,	8.00
872.	Insulating Stool,	4.50
877.	Electrometer,	.75
886.	Flier,	1.25
902.	Bells and Stand,	3 00
906.	Plate,	.75
907.	Pith Balls,	.25
911.	Ether Spoon,	1.00
912.	Gas Pistol,	.75
916.	Powder Bomb,	1.25
922.	Spiral Tube,	3.00
938.	Movable Coatings Jar,	3.00
963.	Set of Leyden Jars,	4.50
967.	Discharger,	2.25
1027.	Bar Magnet,	.75
1032.	Magnetic Needle,	1.00
1042.	U Magnet,	2.00
1046.	Wheel Armature,	.50
1072.	Bichromate Battery,	3.50
1076.	Galvanometer,	4.00
1088.	Powder Cup,	1.00
1137.	Helix and Ring,	3.50
1142.	Electro-Magnet,	2.50
1148.	Model of Telegraph,	8.50
1157.	Revolving Magnet,	7.00
1178.	Shocker,	7.50
1180.	Handles and Wires,	2.00

Recapitulation.

LAWS OF MATTER,	$46 00
HYDROSTATICS,	26.00
PNEUMATICS,	65.25
HEAT,	22.25
ACOUSTICS,	46.75
OPTICS,	14.75
ELECTRICITY,	119.00
	$340.00

SET No. 3.

No.	Laws of Matter.	Price.
2.	Cohesion Hemispheres,	.75
3.	Adhesion Disc,	.75
4.	Capillary Plates,	1.50
7.	Capillary Tubes,	1.25
21.	Inertia Apparatus,	1.00
23.	Collision Balls,	4.50
30.	Centre of Gravity,	8.00
41.	Pendulum,	2.75
60.	Whirling Ring,	3.00
70.	Gyroscope,	6.00
81.	Compound Levers,	3.75
87.	Screw in Frame,	4.00
89.	Wedge,	1.50
91.	Illustration of Pulleys,	18.00
97.	Set of weights,	3.00
	Hydrostatics.	
136.	Equilibrium Tubes,	3.00
146.	Pressure of Liquids,	2.50
147.	Archimedes Principle,	2.75
150.	Hydrometer,	1.25
153.	Hydrometer Jar,	1.00
162.	Siphon,	.75
165.	Tantalus' Cup,	1.50
166.	Hydraulic Press,	12.00
178.	Set of Pumps,	16.00
181.	Hero's Fountain,	7.50
	Pneumatics.	
201.	Air Pump,	35.00
215.	Condenser,	6.50
228.	Receiver,	1.00
244.	Receiver,	3.50
253.	Hand-glass,	1.00
257.	Condensing Chamber,	7.25
264.	Expansion Apparatus,	1.50
269.	Magdeburg Hemispheres,	5.50
276.	Freezing Apparatus,	3.00
277.	Bacchus Illustration,	2.25
287.	Weight and Buoyancy,	9.00
293.	Barometer Apparatus,	6.50
	Mercury,	1.75
300.	Guinea and Feather Tube,	6.75
306.	Rubber Bag,	2.00
326.	Revolving Jet,	2.50
332.	Air-Gun Barrel,	1.00
330.	Sliding Rod,	2.25
337.	Collars and Oil,	.75
343.	Coupler,	.50
347.	Screw Plug,	.50
	Heat.	
361.	Spirit Lamp,	.75
374.	Fire Syringe,	2.00
379.	Bar and Gauge,	1.75
381.	Pyrometer,	5.00
382.	Compound Bar,	1.00
397.	Thermometer for Liquids,	1.25
408.	Wire Gauze,	.50
411.	Conductometer,	3.00
418.	Principles of Ventilation,	2.50
423.	Pair of Reflectors,	16.00
432.	Specific Heat,	1.75
447.	Palm-Glass, mounted,	2.50
452.	Wollaston's Engine,	4.00
	Acoustics.	
515.	Violoncello Bow,	2.00
517.	Bell in Vacuum,	2.50
530.	Savart's Wheel,	6.00
533.	Diapason,	7.00
574.	Pipe with Piston,	4.50
589.	Reed Pipe,	4.00
593.	Sonometer,	21.50
606.	Four Rods of Fir,	2.00
608.	Brass Rod and Ball,	3.75
616.	Screw Press,	5.50
619.	Vibrating Plate,	3.75
	Optics.	
672.	Pair of Mirrors,	4.75
677.	Kaleidoscope,	2.50
704.	Mounted Prism,	3.00
706.	Achromatic Prism,	7.00
714.	Prismatic Lens,	.50
715.	Pair of Lenses,	2.00
717.	Pair of Lenses,	2.50
733.	Revolving Disc Apparatus,	6.00
734.	Set of Discs,	2.50
766.	Model of the Eye,	5.50
767.	Illustration of the Eye,	6.00
771.	Zoetrope,	3.00
	Electricity.	
831.	Friction Cylinder,	.50
851.	Holtz Machine,	40.00
856.	Cat's Skin,	.50
863.	Insulated Conductor,	8.00
872.	Insulating Stool,	4.50
877.	Electrometer,	.75
886.	Flier,	1.25
887.	Tellurian,	1.75
898.	Electrical Bells,	2.00
902.	Bells and Stand,	3.00
906.	Plate,	.75
907.	Pith Balls,	.25
911.	Ether Spoon,	1.00
912.	Gas Pistol,	.75
916.	Powder Bomb,	1.25
922.	Spiral Tube,	3.00
938.	Movable Coatings Jar,	3.00
954.	Diamond Jar,	3.00
963.	Set of Leyden Jars,	4.50
968.	Discharger,	3.50
974.	Luminous Points,	2.00
976.	Gassiot's Cascade,	2.00
1027.	Bar Magnet,	.75
1032.	Magnetic Needle,	1.00
1043.	U Magnet,	2.50
1046.	Wheel Armature,	.50
1073.	Bichromate Battery,	4.50
1076.	Galvanometer,	4.00
1088.	Powder Cup,	1.00
1110.	Decomposing Cell,	3.00

SETS OF APPARATUS.

No.		Price.
1120.	Contracting Helix	3 75
1138.	Helix and Ring,	3.50
1140.	Lifting Coil,	3.00
1142.	Electro-Magnet,	2.50
1148.	Model of Telegraph,	8.50
1157.	Revolving Magnet,	7.00
1178.	Shocker,	7.50
1180.	Handles and Wires,	2.00

Recapitulation.	Price.
LAWS OF MATTER,	$59.75
HYDROSTATICS,	48.25
PNEUMATICS,	100.00
HEAT,	42.00
ACOUSTICS,	62.50
OPTICS,	45.25
ELECTRICITY,	142.25
	$500.00

SET No. 4.

No.	Laws of Matter.	Price.
2.	Cohesion Hemispheres,	.75
3.	Adhesion Disc,	.75
4.	Capillary Plates,	1.50
7.	Capillary Tubes,	1.25
9.	Endosmeter,	1.50
19.	Dissected Cone,	2 00
21.	Inertia Apparatus,	1.00
24.	Collision Balls,	4.50
26.	Illustration of Momentum,	12.00
28.	Resultant Motion,	10.00
30.	Centre of Gravity,	8.00
44.	Pendulum,	2.75
48.	Cycloid Frame,	3.00
60.	Whirling Ring,	3 00
70.	Gyroscope,	6.00
81.	Compound Levers,	3.75
85.	Inclined Plane,	6.00
87.	Screw in Frame,	4.00
89.	Wedge,	1.50
91.	Illustration of Pulleys,	18.00
97.	Set of weights,	3.00

Hydrostatics.

136.	Equilibrium Tubes,	3.00
141.	Equilibrium Apparatus,	5.00
143.	Illustration of Buoyancy,	7.50
144.	Masson's Apparatus,	13.50
146.	Pressure of Liquids,	2.50
147.	Archimedes Principle,	2.75
148.	Balloon and Car,	3.00
150.	Hydrometer,	1.25
153.	Hydrometer Jar,	1.00
155.	Nicholson's Hydrometer,	2.50
157.	Specific Gravity Balance,	12.50
162.	Siphon,	.75
165.	Tantalus' Cup,	1.50
166.	Hydraulic Press,	12.00
178.	Set of Pumps,	16.00
181.	Hero's Fountain,	7.50

Pneumatics.

204.	Air Pump,	48.00
215.	Condenser,	6.50
228.	Receiver,	1.00
234.	Tall Receiver,	2.25
236.	Jar for do.	1.50
244.	Receiver,	3.50
253.	Hand-glass,	1.00
257.	Condensing Chamber,	7.25
260.	Resistance Fan,	1.00

No.		Price.
264.	Expansion Apparatus,	1.50
269.	Magdeburg Hemispheres,	5.50
276.	Freezing Apparatus,	3.00
277.	Bacchus Illustration,	2.25
287.	Weight and Buoyancy,	9.00
291.	Upward Pressure,	7.50
	Mercury,	1.75
299.	Barometer Apparatus,	6.50
300.	Guinea and Feather Tube,	6.75
306.	Rubber Bag,	2.00
317.	Mariotte's Law,	10.50
323.	Plate Paradox,	1.50
326.	Revolving Jet,	2.50
330.	Sliding Rod,	2.25
332.	Air-Gun Barrel,	1.00
336.	Rubber Hose,	3.00
337.	Collars and Oil,	.75
343.	Coupler,	.50
347.	Screw Plug,	.50

Heat.

361.	Spirit Lamp,	.75
374.	Fire Syringe,	2.00
379.	Bar and Gauge,	1.75
381.	Pyrometer,	5.00
382.	Compound Bar,	1.00
397.	Thermometer for Liquids,	1.25
408.	Wire Gauze,	.50
411.	Conductometer,	3.00
418.	Principles of Ventilation,	2.50
423.	Pair of Reflectors,	16.00
426.	Leslie's Cubes,	2.25
432.	Specific Heat,	1.75
447.	Palm-Glass, mounted,	2.50
452.	Wollaston's Engine,	4.00
454.	Hero's Engine,	7.50

Undulations.

476.	Cord of Wire,	2.50
496.	Lyman's Wave Apparatus,	37.50

Acoustics.

501.	Eight Pieces of Wood,	1.50
512.	Rose Jet and Tube,	4.75
515.	Violoncello Bow,	2.00
517.	Bell in Vacuum,	2.50
530.	Savart's Wheel,	6.00
533.	Diapason,	7.00
571.	Pipe with Slider,	3.00
574.	Pipe with Piston,	4.50

SETS OF APPARATUS.

No.		Price.
589.	Reed Pipe,	4.00
593.	Sonometer,	21.50
606.	Four Rods of Fir,	2.00
608.	Brass Rod and Ball,	3.75
609.	Kaleidophone,	3.50
616.	Screw Press,	5.50
619.	Vibrating Plate,	3.75
623.	Glass Plate,	2.75
627.	Hopkins' Tube,	5.00
	Optics	
670.	Convex Mirrors,	2.50
671.	Concave Mirrors,	2.75
704.	Mounted Prism,	3.00
705.	Achromatic Prism,	7.00
714.	Prismatic Lens,	.50
721	Set of Lenses,	7.00
733.	Revolving Disc Apparatus,	6.00
734.	Set of Discs,	2.50
766.	Model of the Eye,	5.50
767.	Illustration of the Eye,	6.00
770.	Persistency of Vision,	3.50
771.	Zoetrope,	3.00
	Electricity.	
831.	Friction Cylinder,	.50
834.	Electrophorus,	8.00
852.	Holtz Machine,	50.00
856.	Cat's Skin,	.50
862.	Insulated Conductor,	10.00
867.	Hollow Sphere,	8.00
872.	Insulating Stool,	4.50
877.	Electrometer,	.75
879.	Gold-leaf Electrometer,	3.75
886.	Flier,	1.25
887.	Tellurian,	1.75
898.	Electrical Bells,	2.00
902.	Bells and Stand,	3 00
906.	Plate,	.75
907.	Pith Balls,	.25
908.	Dancing Image Plates,	1.50
910.	Dancing Images,	.75
911.	Ether Spoon,	1.00
912.	Gas Pistol,	.75
916.	Powder Bomb,	1.25
922.	Spiral Tube,	3.00
937.	Lightning Plate,	1.00
938.	Movable Coatings Jar,	3.00
954.	Diamond Jar,	3.00
963.	Set of Leyden Jars,	4.50
968.	Discharger,	3.50
974.	Luminous Points,	2.00
976.	Gassiot's Cascade,	2.00
1030.	Pair of Bar Magnets,	3.75
1032.	Magnetic Needle,	1.00
1035.	Dipping Needle,	3.50
1043.	U Magnet,	2.50
1046.	Wheel Armature,	.50
1073.	Bichromate Battery,	4.50
1076.	Galvanometer,	4.00
1088.	Powder Cup,	1.00
1110.	Decomposing Cell,	3 00
1114.	Solenoid,	2.00
1119.	De la Rive's Ring,	1.50
1120.	Contracting Helix,	3.75
1123	Thermo-Electric Plates,	2 00
1136.	Helix with three Poles,	3.50
1137.	Helix and Ring,	3.50
1138.	Terrestrial Helix,	2.00
1140.	Lifting Coil,	3.00
1142.	Electro-Magnet,	2.50
1148.	Model of Telegraph,	8.50
1157.	Revolving Magnet,	7.00
1176.	Double Helices,	12.00
1180.	Handles and Wires,	2.00

Recapitulation.

LAWS OF MATTER,	94.25
HYDROSTATICS,	92.25
PNEUMATICS,	140.25
HEAT,	51.75
UNDULATIONS,	40.00
ACOUSTICS,	83.00
OPTICS,	49.25
ELECTRICITY,	197.25
	$750.00

IN compiling the above Sets, which are given to assist in making a selection, we have endeavored to include the instruments which best illustrate, and to cover as many, principles as the limits of the amount of each will permit; to avoid duplications of experiments and to represent proportionately each department; and also to make each set of articles such as would be suitable for a portion of a relatively larger set, by subsequent additions.

It will be observed that neither the larger, nor many of the most valuable and important, but comparatively expensive instruments, are included in either of the Sets, but only those that are generally required. The purchaser can substitute other sizes, or make such changes as may be desirable.

E. S. RITCHIE & SONS.

We make discounts from Catalogue prices, but not the same on all articles. We shall be glad to fill out our best prices on any list sent us.

Testimonials.

CAMBRIDGE, Sept. 10, 1852.

This may certify that Mr. E. S. Ritchie is well known to us as a manufacturer of the best Philosophical Instruments used in Academies and Colleges. He is not content with supplying the usual apparatus found in all the Catalogues, but he is ambitious to add to it new articles which illustrate fresh discoveries in science, or which excite a scientific curiosity. His integrity, his urbanity, and his skill, all equally entitle him to the confidence of those who purchase or use Philosophical Apparatus.

JOSEPH LOVERING,
Hollis Professor of Mathematics and Nat. Philosophy in Harvard College.

JOSIAH P. COOKE, JR.,
Irving Prof. of Chemistry and Mineralogy in Harvard College.

BOSTON, Aug. 10, 1857.

I take pleasure in bearing testimony to the great skill, faithfulness, and ingenuity of Mr. Ritchie as a maker of Philosophical Instruments. Uniting an ample knowledge of scientific principles to large experience in the mechanical details of his profession, his work commends itself not only to Institutions seeking apparatus for lecture-room illustration, but to men of science pursuing original research.

WILLIAM B. ROGERS.

AMHERST, June 5, 1869.

I have for many years been acquainted with Mr. E. S. Ritchie, as a designer and manufacturer of Philosophical Apparatus, and am prepared to speak in high terms of his intelligence and mechanical skill, as well as his courteous attention to those who apply to him for counsel or aid in his line of business. I am glad to look over the new Catalogue of Apparatus for Schools, which Ritchie & Sons are just issuing, and to recommend it to the attention of all who wish to become purchasers. The improvements which they have made in many of the common Philosophical Instruments, have more than doubled their value. Teachers and experimenters may rely on the strict fidelity of the Messrs. Ritchie in regard to the quality and adaptedness of the articles which they furnish.

E. S. SNELL,
Prof. of Nat. Philosophy, Amherst College.

May 23, 1873.

It gives me pleasure to certify that the set of School Apparatus manufactured by E. S. Ritchie & Sons, which was arranged for and adopted several years ago, by the School Committee of the City, for our Grammar Schools, has given, so far as I know, entire satisfaction in every respect. From the same firm, Physical Apparatus has been furnished for our City High Schools, whenever needed, and it has always been regarded as the very best in quality which the country afforded.

I can bear testimony, not only to the scientific knowledge and mechanical skill of Mr. Ritchie and his sons, but to their reliability and integrity in their dealings. As to the quality of the articles made by them, their word may be depended upon.

JOHN D. PHILBRICK,
Supt. of Public Schools of Boston.

DARTMOUTH COLLEGE,
HANOVER, N. H., May 22, 1868.

I take pleasure in bearing witness to the excellence of the Philosophical Apparatus manufactured by E. S. Ritchie & Sons. I have never found anything better in respect to accuracy of workmanship, and efficiency of operation. Their efforts to promote science by being the first manufacturers in the country to construct the Induction Coil, and the Holtz Electrical Machine, have deserved and obtained for them the regard of all American scientific men, and given them even a European reputation.

C. A. YOUNG,
Prof. of Nat. Philosophy and Astronomy.

CORNELL COLLEGE,
MT. VERNON, IOWA, May 18, 1875.

MESSRS. E. S. RITCHIE & SONS.

It affords me great pleasure to offer my testimony in favor of the excellent Philosophical Instruments constructed by you for Cornell College; they have given entire satisfaction. I have always found them carefully made. Your aim seems to be to keep pace with the advancement of science, and to improve upon the best instruments manufactured abroad. You are certainly entitled to the support of all who cultivate Physical science.

ALONZO COLLIN,
Prof. of Natural Science.

UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN. May 8, 1875.

MESSRS. E. S. RITCHIE & SONS.

GENTLEMEN:—It gives me great pleasure to add my testimony in favor of the excellence of the apparatus that you have placed in my hands during the last six or seven years. In all those qualities which make Physical Apparatus desirable, I have found yours unsurpassed by any manufactured in this country.

S. F. PECKHAM,
Professor of Chemistry.

HILLHOUSE HIGH SCHOOL,
NEW HAVEN, CONN., May 31, 1875.

I have been in the habit of buying apparatus of Mr. E. S. Ritchie for twenty-five years. It has always given more than satisfaction. Its use has been an unfailing pleasure. It has required no tinkering or nursing to make it do good work. Within his range of work Mr. Ritchie makes the best apparatus I have ever seen, whether American or foreign.

T. W. T. CURTIS.

MT. PLEASANT, N. C., Dec. 23, 1859.

MR. E. S. RITCHIE.

DEAR SIR:—The lot of Philosophical Apparatus ordered from you has safely come to hand. We are all highly pleased with the exactness, the practical working, and superior mechanical finish, of your Instruments; and take pleasure in recommending all Institutions, desirous of making a similar purchase, to your establishment.

D. H. BITTLE,
Pres't North Carolina College.

TESTIMONIALS.

UNIVERSITY OF PENNSYSVANIA,
PHILADELPHIA, July 10, 1857.

Having used with much satisfaction a variety of apparatus manufactured by Mr. E. S. Ritchie, I take great pleasure in bearing testimony to his ingenuity and scientific skill as a Philosophical Instrument maker. R. E. ROGERS,
Prof. of Chemistry in the University of Pennsylvania.

UNIVERSITY OF PENNSYLVANIA,
PHILADELPHIA, June 18, 1875.

I am very glad to avail myself of this opportunity to express my appreciation of the service which the firm of Edw. S. Ritchie & Sons is doing the cause of science in the United States, first, by the manufacture of so much excellent and original apparatus, both for purposes of research and of demonstration; and second, by the importation, at a reasonable rate, of the special apparatus requiring the maker's guarantee, such as that of Kœning and Browning.

My own purchases from the Messrs. Ritchie have proved entirely satisfactory, and my dealings with them have always been most pleasant.

GEO. F. BARKER,
Professor of Physics.

VIRGINIA AGRICULTURAL AND MECHANICAL COLLEGE,
BLACKSBURG, VA., May 12, 1875.

The Philosophical Apparatus, including a Holtz machine, recently ordered of Messrs. E. S. Ritchie & Sons, for this College, is of superior workmanship and finish, and the prices paid for the same compare favorably with the catalogue prices of other manufacturers of similar articles.

JAMES H. LANE,
Prof. of Nat. Phil. and Tactics.

NOTRE DAME, INDIANA, May 8, 1875.

GENTLEMEN:—Your instruments give entire satisfaction. They are what they are represented to be—substantially made and finely finished. Indeed, I have been so well pleased with them that I have not hesitated to recommend to several educators the apparatus of your manufacture as superior in power, neatness, and simplicity, to all others. J. S. ZAHN, C. S. C.

CINCINNATI, May 9, 1875.

MR. E. S. RITCHIE.

DEAR SIR:—It gives me great pleasure to indorse your apparatus, both as to its appearance and its working. That which I bought of you last September has proved highly satisfactory as far as I have been able to test it. The Induction Coil, especially, has been in constant use for spectroscopic purposes, and has given the best possible results. F. W. CLARKE,
Prof. of Physics, University of Cincinnati

ST. LOUIS, MO., May 28, 1859.

I am now using the Philosophical and Chemical Apparatus of E. S. Ritchie & Sons. Everything which I have seen of their manufacture has borne marks of mechanical skill, scientific knowledge, and the honesty which gives skill and knowledge their best results. C. S. PENNELL,
Prin. of Mary Inst., a Department of Washington University.

TESTIMONIALS.

UNIVERSITY OF THE PACIFIC,
SAN JOSE, CALIFORNIA, Oct. 3, 1877.

Having purchased, during the past year, of Messrs. E. S. Ritchie & Sons a large quantity of Philosophical Apparatus, I take pleasure in testifying to the excellence of these Instruments in simplicity, durability, accuracy, neatness, and finish. As manufacturers of Physical Instruments, I think them unsurpassed; while their manner of transacting business makes it a pleasure to deal with them.

S. C. GEORGE, *Prof. of Nat. Science.*

GAMBIER, OHIO, June 7, 1856.

The undersigned would beg leave to commend to the favorable notice of such Institutions as may be desirous of obtaining the most perfect Philosophical Apparatus, the establishment of Mr. E. S. Ritchie of Boston. The Electrical and Pneumatic Apparatus furnished by him for Kenyon College, surpass in beauty of finish and satisfactory performance anything of a similar kind we have seen.

LORIN ANDREWS,
Pres. Kenyon College.

HAMILTON L. SMITH,
Prof. of Natural Science.

STATE AGRICULTURAL COLLEGE,
AMES, IOWA, May 15, 1875.

The apparatus of E. S. Ritchie & Sons has been used extensively by me, and has given universal satisfaction. I heartily recommend them to the public, as, in my opinion, responsible dealers, and well worthy of patronage.

J. K. MACOMBER.

WILLIAMSBURG, VA., Nov. 14, 1859.

MR. E. S. RITCHIE.

DEAR SIR:—The Chemical and Philosophical Instruments selected by Prof. William B. Rogers, from your establishment, for the College of William and Mary, have been received. In accuracy, in completeness, in finish, and indeed in all respects, they give entire satisfaction.

I take pleasure in recommending you as an accomplished artist, with whom it is most agreeable to form business relations.

BENJ. S. EWELL,
Prof. of Nat. Philosophy and Chemistry, College of William and Mary.

EAST HAMPTON, June 5, 1869.

Mr. E. S. Ritchie has made a large amount of Philosophical Apparatus for me, at different times, and it has given me great satisfaction. In simplicity of design, accuracy of operation, and perfection of workmanship, it is not surpassed. His Patent Air Pump is a very great improvement upon anything of the kind before constructed. It easily makes a vacuum nearly as complete as can be obtained by the laborious process of the mercury pump. The exhibition of the electric light in the vacua produced by it is equal to that in the best Geissler tubes.

MARSHALL HENSHAW,
President Williston Seminary.

TESTIMONIALS.

UNITED STATES MILITARY ACADEMY,
WEST POINT, N. Y., June 4, 1869.

The best portion of the apparatus in use in the Chemical Department of this Institution, has been made under the direction of Mr. E. S. Ritchie of Boston. In all respects, everything that has been received from him, whether ordered in person or by letter, gives complete satisfaction. His Electrical and Pneumatical Instruments are of unequalled excellence.

I have found Mr. Ritchie to be not only an entirely reliable gentleman, but one whose scientific attainments make him a valuable adviser.

H. L. KENDRICK,
Prof. Chemistry, &c., U. S. Military Academy.

CARLETON COLLEGE,
NORTHFIELD, MINN., May 15, 1875.

MESSRS. E. S. RITCHIE & SONS.

GENTLEMEN:—For nearly a year we have had in use two pieces of costly apparatus of your manufacture, viz.: Ritchie's Rotary Air Pump, and Ritchie's Induction Electrical Machine. It gives us great pleasure to say that these pieces are most convenient and tasteful in design, very durable in structure, and for range of work most gratifying and excellent. For extent of power in nice experiments, they are all you claim for them.

WM. W. PAINE,
Prof. Mathematics and Natural Philosophy.

MERCER UNIVERSITY,
MACON, GA., May, 1875.

MESSRS. E. S. RITCHIE & SONS.

DEAR SIRS:—The Philosophical and Chemical Apparatus purchased from you, at different times, by this University, has given great satisfaction in the lecture room.

J. E. WILLET,
Prof. Chem. and Nat. Phil.

From Mr. John P. Gassiot, Vice-President of the Royal Society.

LONDON, March 7, 1859.

DEAR SIR:—I have great pleasure in assuring you that the Induction Coil, which, through the introduction of my friend, Prof. Wm. B. Rogers, you constructed for me, answers most admirably. With five of Grove's nitric acid battery cells, I obtain eleven and a half inch sparks. The Vibrating Contact Breaker, which you subsequently sent, has enabled me to repeat all the experiments with my Vacua Tubes, while the three divisions in your Coil afford facilities for varying the experiments in a manner that can be well appreciated by those who have worked with this apparatus.

JOHN P. GASSIOT.

TO EDWARD S. RITCHIE, BOSTON, U. S. A.

NEW ENGLAND NATIONAL BANK.
BOSTON, Feb. 1, 1878.

MESSRS. EDWARD S. RITCHIE & SONS.

GENTLEMEN:—In my opinion your house may be relied on for faithfully performing all its promises and obligations; and this I declare, not only from a sufficient knowledge of it, but also from an intimate acquaintance with its members of longer standing than the establishment.

THOMAS LAMB, *President.*

TESTIMONIALS.

E. S. RITCHIE & SONS have filled orders generally in large amounts to the following named Institutions; to the Professors and Principals of which they would respectfully refer.

MAINE.

Bowdoin College.
State Agricultural College, Orono.
State Normal School, Farmington.
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High Schools, Portland and Auburn.
Maine Wesleyan Semi., Kent's Hill.
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NEW HAMPSHIRE.

Dartmouth College.
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VERMONT.

Middlebury College.
State Normal School, Randolph.
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Vermont Academy, Saxton's River.
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Institute of Technology, Boston.
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Mass. Agricultural College, Amherst.
Wellesley College, Wellesley.
Ladies' Collegiate Institute, Worcester.
Worcester Free Institute, Worcester.
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Maplewood Music School, Pittsfield.
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Phillips Academy, Andover.
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High School, Great Barrington.
High School, Dorchester.
High School, Woburn.
High School, Westfield.
High School, North Bridgewater.
High School, Wareham.
High School, Lee.

RHODE ISLAND.

Normal School, Bristol.
St. Mary's School, Newport.
High School, Newport.
High School, Woonsocket.

CONNECTICUT.

Yale College.
Sheffield Scientific School, N. Haven.
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High School, Stamford.
Durham Academy.
Norwich Free Academy.
Hillhouse High School, New Haven.
Superintendent of Schools, N. Haven.
High School, Putnam.

NEW YORK.

Military Academy, West Point.
Columbia College, New York.
College of City of New York.
State Agricultural College, Ovid.
Vassar College, Poughkeepsie.
Hobart College, Geneva.
Union College, Schenectady.
Rensselaer Polytechnic Inst., Troy.
Institute for Deaf and Dumb, N. Y.
St. Agnes School, Albany.
St. Lawrence University, Canton.
Cornell University, Ithaca.
Syracuse University.
State Normal School, Oswego.
State Normal School, Fredonia.
State Normal School, Cortland.
Normal School, Buffalo.
Normal School, Albany.
Buffalo Female Academy.
Ilion Academy.
Hudson Academy, Hudson.
St. Agnes School, Albany.
Park Institute, Rye.
High School, Fonda.

NEW JERSEY.

Stevens Institute, Hoboken.
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Girard College, Philadelphia.
Alleghany College, Meadville.
Pennsylvania College, Gettysburg.
Washington & Jefferson Coll. Wash.
Lafayette College, Easton.
Lehigh University, South Bethlehem.
State Normal School, Edinboro'.
Central High School, Philadelphia.
Central High School, Pittsburg.
High School, Pottsville.

MARYLAND.

Naval Academy, Annapolis.
Peabody Institute, Baltimore.
Johns Hopkins University, Baltimore.
St. John's Academy, Annapolis.
National Deaf Mute Coll., Wash'n.
Woodstock College, Woodstock.

VIRGINIA.

University of Virginia.
William and Mary College.
Richmond College.
Central University, Richmond.
Va. Agr. & Mech. Coll., Blacksburg.

NORTH CAROLINA.

North Carolina College.
Wesleyan Female College.
Davidson College, Charlotte.
Peace Institute, Raleigh.
High School, Monroe.

SOUTH CAROLINA.

Winyan Indigo School, Georgetown.

GEORGIA.

University of Georgia.
Emory College, Oxford.
Macon University.
Mercer University, Macon.
Atalanta University.

ALABAMA.

Southern University.
Dallas Academy, Selma.
Oxford Male & Female Coll., Oxford.

MISSISSIPPI.

University of Mississippi.

LOUISIANA.

State University, Baton Rouge.

TEXAS.

Baylor University, Independence.
Masonic Female Institute, Marshall.
Southwestern Univ., Georgetown.

OHIO.

Kenyon College, Gambier.
Western Reserve College, Hudson.
Otterbein University, Westerville.
Antioch College, Yellow Springs.
Agricultural and Mechan'l Coll., Col.
Buchtel College, Akron.
University of Wooster, Wooster.
University of Cincinnati, Cincinnati.
Marietta College.
Oberlin College.
Conneaut Academy.
Hughes High School, Cincinnati.
Woodbury High School, Cincinnati.
Public Schools, London.
High School, Toledo.
Public Schools, Ironton.
Public Schools, Fostoria.

INDIANA.

University of Indiana.
Northwestern Christian University.
University of Notre Dame.
Wabash College, Crawfordsville.
High School, La Porte.
Butler University, Irvington.
Purdue University, Lafayette.
St. Mary's Academy, Notre Dame.
Indiana Institute for Deaf and Dumb, Indianapolis.

ILLINOIS.

Northwestern University, Evanston.
So. Illinois Normal University.
St. Ignatius College, Chicago.
Illinois College, Jacksonville.
Knox College, Galesburg.
High School, Moline.
Lake View High School, Chicago.
High School, Decatur.
Westerfield College, Westerfield.

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University of Michigan.
Hillsdale College.
State Agricultural Coll., Lansing.
State Normal School, Ypsilanti.
High School, Detroit.
High School, Allegan.
Union School, Battle Creek.
Public Schools, Saginaw City.
Public Schools, Clinton.
Public Schools, Marshall.

IOWA.

State Agricultural College, Ames.
Cornell College, Mt. Vernon.
Parsons College, Fairfield.
Public Schools, Council Bluffs.

WISCONSIN.

University of Wisconsin.
Racine College.
Ripon College.

KENTUCKY.

Bowling Green Academy.
Millersburg University.

TENNESSEE.

University of the South, Sewanee.
Nashville Institute.
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MISSOURI.

University of Missouri.
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Arkansas Industrial Univ., Verona.
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MINNESOTA.

University of Minnesota.
Carleton College, Northfield.
Public Schools, Minneapolis.
High School, Winona.

KANSAS.

Kansas State University.
State Normal School, Emporia.
State Agricultural Coll., Manhattan.

NEBRASKA.

University of Nebraska.

MONTANA.

Helena School District.

NEVADA.

State University, Elko.

COLORADO.

Denver Public Schools.

CALIFORNIA.

University of California.
University of the Pacific, Santa Clara.
St. Ignatius College, San Francisco.
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Convent of Notre Dame, San Jose.
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E. S. RITCHIE & SONS warrant to all purchasers of Apparatus, that the articles received shall be fully equal or superior in quality of the materials used, and in workmanship, to the corresponding articles furnished to the above-mentioned purchasers.