Mr. Culley to Mr. Browning, whomounted them soas toshow their leading peculiarities. Close to these microscopes were placed some specimens of gutta percha insnlated wire freely marked by them.

Another novelty was an electrical gas-lighting apparatus exhibited by Mr. Thompson. This consisted of a very small portable apparatus, held easily in the hand. At the upper part was a curved rod with a bell cup to it, which was placed over the gas to be lighted; the lower part, near the handle, contains a small electrophorus, the upper plate of which was lifted by the thumb or finger of the hand holding the handle. The electric spark from this is arranged to pass across a small space where the gas has mixed with the atmosphere in such proportions as to become explosive. Immediately the spark passes, the gas is lighted. This instrument, though new in London, has been in use here for some three years.

OCEAN TELEGRAPHY.

BY GEORGE B. PRESCOTT.

Number II.

The workingspeed of ocean cables with the mirror system is as follows:

NUMBER OF WORDS PER MINUTE.

Weight of copper strands, lbs.	Knots, 1,000.	Knots, 1,500.	Knots, 2,000.	Knots, 2,500.
100	18·3	8·1	4·6	2·9
150	27·5	12·2	6·9	4·4
200	37·0	16·4	9·2	5·9
250	46·0	20·4	11·2	7·4
300	55·0	24·4	14·0	8·8
350	64·1	28·5	16·0	10·3
400	73·2	32·5	18·3	11·7

The apparatus employed in the transmission of communications through ocean cables is the invention of Professor Sir William Thomson. Ampère suggested, as early as the year 1820, the employment of a galvanometer for the purpose of telegraphing, and in 1833 Gauss and Weber used a reflecting galvanometer as an indicator upon a line about one mile in length, uniting the Observatory and the Physical Cabinet at Göttingen. Their alphabet was made up of combinations of right and left deflections. This apparatus, the first ever employed for practical telegraphy, has lately, in the hands of Professor Sir William Thomson, become the most sensitive of all telegraphic instruments. His reflecting galvanometer is the only instrument at present with which a cable 2,000 miles in length can he successfully worked by a battery of low tension. It consists of a needle formed of a piece of watch spring, three eighths of an inch in length. The needle is suspended by a thread of cocoon silk without torsion. The needle lies in the center of an exceedingly delicate galvanometer coil. A circular mirror of silvered glass is fixed to the needle, and reflects at right angles to it in the plane of its motion. It is so curved that, when the light of a lamp is thrown through a fine slit on it, the image of the slit is reflected on a scale about three feet off, placed a little above the front of the flame. Deflections to the extent of half an inch along any part of the scale are sufficient for one signal. In so delicate an instrument, the sluggish swing of the needle in finally settling into any position would destroy its usefulness. To rectify this, a strong magnet, about eight inches long and bent concave to the instrument, is made to slide up and down a rod placed in the line of the suspending thread above the instrument. This magnet can be easily shifted, as necessity may require. The oscillations of the needle due to itself are, bythe aid of the strong magnet, made so sudden and short as only to broaden the spot of light.

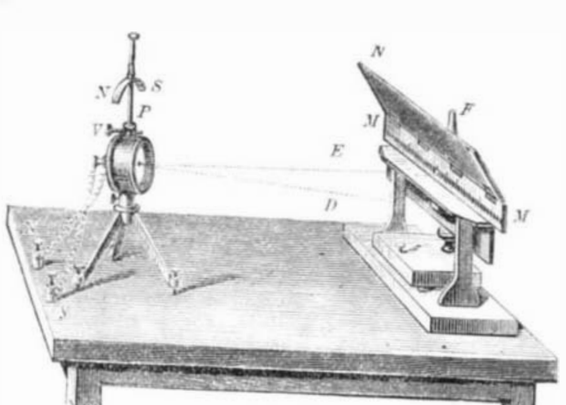

FIG. 6.

The above illustration (Fig. 6) shows the construction of the instrument. The galvanometer, P, contains the multiplication wire, divided into several layers and so arranged that it can be used for weak or strong currents, according to the requirements of the instrument. In the center of the coil the magnetic needle is suspended, to which is attached the tiny mirror, and close before it is to be found a small collective lens, whereof the focal point lies almost in the mirror, in order to produce a sharp figure of the prism on the scale.

The magnetic needle has a length of only $\frac{3}{8}$ of an inch, a breadth of $\frac{1}{32}$ of an inch, and a thickness of $\frac{1}{72}$ of an inch. The mirror connected with the needle has a thickness of only $\frac{1}{240}$ of an inch. The magnetic needle is made from a small piece of a very fine watch spring, and the little mirror, from one of the thinnest microscopic cover glasses. The magnetic needle and mirror used for signaling across the Atlantic weigh only $1\frac{1}{2}$ grains.

The entire box which encloses these parts is hermetically closed. The ends of the multiplicator wires are soldered inside the box to two screw posts, x y, wherewith the instrument is connected with the cable.

A curved steel magnet, N S, is fixed to a brass bar, P, in such a way that, by turning the micrometer screw, V, any required removal, upwards or downwards or to the right or left, can be given to it; and by this means the magnetic needle, when in a state of rest, is kept in such a position that the picture of the slit, D, which is reflected from the middle of the mirror, and likewise returns through the lens, appears upon the zero mark of the scale, M M.

Opposite the galvanometer, the scale, M M, and the lamp, F, are to be seen. The light from the lamp penetrates through the slit, D, in an oblique direction to the looking glass, and is thrown back from it to the scale somewhat upwards, in the direction, F, where the picture of the slit is to be seen as a fine light line. The screen, N, can be turned up andserves to keep the lamp light from the scale. The instrument is necessarily used in a darkened room.

The transmitting key is shown in Fig. 7. It consists of two separate levers, L and E, moving on axes at the upper end in the figure. They are kept, by springs, pressing against the cross plate, C, which is in connection with one of the poles of the battery. L is connected with the cable and E to the earth. When either key is pressed down, it falls on the plate, Z, in connection with the other pole of the battery. In the normal position of the key, the cable is connected, through L, C, and E, to earth, and Z is insulated; and it is easy to see how a positive or negative current is put to line according as L or E is depressed.

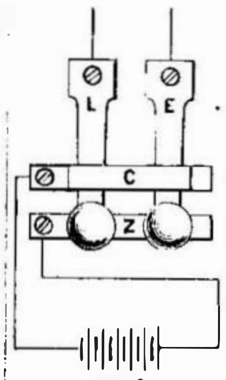

FIG. 7.

The alphabet is made by opposite movements produced by one or other of the keys. The signals need not be made from zero as a starting point. The eye can easily distinguish, at any point in the scale to which the spot of light may be deflected, the beginning and the end of a signal, and when its motion is caused by the proper action of the needle or by currents. It is thus that the mirror galvanometer is adapted to cable signaling, not only by its extreme delicacy, but also by its quickness. The deflections of the spot of light have been aptly compared to a handwriting, no one letter of which is distinctly formed, but yet is quite intelligible to the practised eye. Signals in this way follow each other with wonderful rapidity. A low speed of from twelve to sixteen words perminute is adopted for public messages; but when the operators communicate with each other, a speed of twenty-four words per minute is sometimes attained.

Condensers are used at both ends of the Atlantic cables, by means of which the speed is very considerably increased. The term condenser has long been used among electricians to denote an arrangement, in a moderate compass, equivalent to a Leyden jar of enormous capacity. It is composed of alternate layers of mica or parafined paper and tinfoil. One coating of this Leyden jar is put in direct communication with the conductor of the cable, and the other is joined to the sending key. At the other end of the cable one coating of the condenser is connected with the cable and the other coating with the receiving instrument. The condensers are each equal to about 70 miles of the cable. The condenser serves two purposes: it lessens the delay caused by induction, and prevents the disturbance of the signals by earth currents. The cable and condenser being insulated, there is no voltaic circuit, and no way whereby earth currents can enter and leave the line.

The question is often asked: "What is the velocity of electricity?" or "how long does electricity take to go across the Atlantic Ocean?" Electricity cannot properly be said to have a velocity, but differs with the circumstances under which it travels. For about two tenths of a second after contact is made with the conductor of an Atlantic cable, no effect is perceptible on the opposite side of the ocean, even by the most delicate instrument. After fourtenths of a second, the received current is about 7 per cent of the maximum permanent current which the battery could produce in the circuit. One second after the first contact, the current will reach about half its final strength, and after about three seconds its full strength. The current does not arrive all at once, like a bullet, but grows gradually from a minimum to a maximum.

The Direct United States Cable, which is now being laid between Ireland and Nova Scotia, and thence to Rye Beach, New Hampshire, is 3,060 nautical miles in length. The core is composed of a thick copper wire encircled by eleven very fine copper wires, weighing 480 pounds per mile, and is served with four coatings of gutta percha, measuring about three eighths of an inch in diameter. After the serving with gutta percha comes a serving with manilla hemp, which brings the core up to a thickness of three fourths of an inch; and then follows the sheathing with iron wire, which forms the outer covering of all. Ten iron wires are employed for this purpose: but before being applied to the cable, they are each wound with five strings of manilla hemp, so as to impart greater strength, and protect them from the action of water. The hemp covered wires are served with a species of black compound resembling tar or pitch; and after being twisted around the core, they are again served in this manner, and finally whipped with Italian hemp, which, however, can scarcely be said to do more than hold the strands in their places until the whole becomes hard and dry. This is the deep sea portion of the cable.

The shore ends are of varying sizes, graduating from about $2\frac{1}{4}$ inchesdown to $\frac{3}{4}$ of an inch.

The Direct United States Company expect to obtain a speed of about nine words per minute, or about one half that of the present Newfoundland and Ireland cables.

The French Atlantic Cable, laid in 1869 between Brest and St. Pierre, has 400 pounds of copper per mile, is 2,584 knots in length, and has a working speed of fifteen words per minute.

The contract price of the Direct United States Cable, laid down, is $6,055,000. The cost of the Anglo-American Cable —between Ireland and Newfoundland—laid down, was $1,500 per mile.

The Direct United States Cable has been laid from Ireland to within a distance of about 200 miles of Nova Scotia; but owing to unfavorable weather it had to be cut and buoyed. It will probably be recovered again as soon as favorable weather ensues, and its laying be successfully completed. When this is accomplished, there will be five working cables across the North Atlantic and one across the South Atlantic oceans.

Submarine telegraph cables now extend across the North and South Atlantic, Indian, and German Oceans; the Mediterranean, Red, North, Baltic, Chinese, Oriental, Japan, Java, and Caribbean Seas; the Gulfs of Biscay, Bengal, Mexico, and St. Lawrence, and the straits of Bass and Malacca: thus placing North and South America, the West Indies, Europe, India, Java, Australia, Tasmania, and Siberia in constant and instantaneous telegraphic communication, as well as affording communication with the most important ports in China and Japan.

The following is a list of the more important cables which are in working order at the present time:

Date.	From	Length in Miles.
1851.	Dover, England, to Calais, France	25
1852.	Holyhead, Wales, to Howth, Ireland	65
	Port Patrick, Scotland, to Donaghadee, Ireland	25
	Prince Edward Island to New Brunswick	12
1853.	Denmark, across the Belt	18
	Dover, England, to Ostend, Belgium	80½
	Port Patrick, Scotland, to Donaghadee, Ireland	25
1854.	Port Patrick, Scotland, to Whitehead, Ireland	27
	Sweden to Denmark	12
	Holyhead, Wales, to Howth, Ireland	65
1856.	Prince Edward Island to New Brunswick	1
	Crete or Candia to Syra, Greece	170
	St. Petersburgh to Cronstadt, Russia	10
	Across the Amazon	105
1857.	Ceylon to Hindostan	30
	Norway across the Fiords	49
1858.	England to Holland	140
1859.	Denmark to Heligoland	46
	Isle of Man to Whitehaven, England	36
	Sweden to Gottland	64
	Folkestone, England, to Boulogne, France	24
	Malta to Sicily	60
	Jersey to Pirou, France	21
1860.	Great Belt, Denmark (two cables)	14
	Cape St. Martin, Spain, to Iviza	76
	Iviza to Majorca	74
1861.	Corfu to Otranto, Italy	90
	Dieppe, France, to Newhaven, England	80
1862.	Wexford, Ireland, to Aberman, Wales	63
	Lowestoft, England, to Zandvoort, Holland	125
1864.	Fao, Persia, to Bushire, Persia	204
	Bushire, Persia, to Masandam, Persia	450
	Masandam, Persia, to Gwadar, Beloochistan	447
	Gwadar, Beloochistan, to Kurrachee, British India	346
	Otranto, Italy, to Avlona, Turkey	50
1865.	Trelleborg to Rugen, Germany	55
	South Foreland, England, to Cape Grisuez, France	25
1866.	Ireland to Newfoundland	1,896
	Lyall's Bay to White's Bay	41
	Crimea to Circassia	40
	Colonia to Buenos Ayres	30
	England to Hanover	224
	Cape Ray, Newfoundland, to Aspee Bay, Cape Breton	91
	Leghorn, Italy, to Corsica	65
	Persian Gulf	160
1867.	South Foreland, England, to La Panne, France	47
	Malta to Alexandria, Egypt	925
	Placentia, Newfoundland, to St. Pierre	118
	St. Pierre to Sydney, Cape Breton	126
	Arendal, Norway, to Hirtshals, Denmark	68
1868.	Italy to Sicily	5
	Havana to Key West, Florida	125
1869.	Peterhead, Scotland, to Egersand, Norway	250
	Grisselhamn, Sweden, to Nystadt, Russia	96
	Newbiggin to Sondervig	334
	Malta to Sicily	54
	Tasmania to Australia	176
	Scilly Isles to Land's End, England	27
	Ithaca to Cephalonia	7
	Bushire, Persia, to Jask, Beloochistan	505
	Brest, France, to St. Pierre	2,584
	St. Pierre to Duxbury, U. S	749
	Moen to Bornholm, Sweden	80
	Bornholm, Sweden, to Libau	230
1870.	Scotland to Orkney Isles	37
	Salcombe, England, to Brignogan, France	101
	Beachy Head, England, to Cape Autifec, France	70
	Suez, Egypt, to Aden, Arabia	1,460
	Aden, Arabia, to Bombay, India	1,818
	Portheurno, England, to Lisbon, Portugal	823
	Lisbon to Gibraltar	331
	Gibraltar to Malta	1,120
	Marseilles, France, to Bona, Africa	447
	Bona, Africa, to Malta	386
	Madras to Penang	1,408
	Penang to Singapore	400
	Singapore to Batavia	557
	Malta to Alexandria, Egypt	904
	Batabano, Cuba, to Santiago, Cuba	520
	Jersey to Guernsey, Channel Islands	16
	Guernsey to Alderney, " "	18
	Santa Maura to Ithaca	7
	Zante to Trepito	11
	Sunium to Thermia	25
	Patras, Greece, to Lepanto	2
	Dartmouth, England, to Guernsey	66
	Guernsey to Jersey	15

Date.	From	Length in miles.
	Porto Rico to St. Thomas	110
	Santiago, Cuba, to Jamaica	140
	Port Patrick, Scotland, to Donaghadee, Ireland	25
	Anjer, Java, to Telok Betong, Sumatra	55
	Banjoewangle, Java, to Port Darwin, Australia	1,082
	St. Thomas to St. Kitts	133
	St. Kitts to Antigua	90
1871.	Javea to Iviza, Balearic Islands	53
	Majorca to Minorca	35
	Villa Real to Gibraltar	155
	Marseilles, France, to Algiers, Africa	447
	Singapore to Saigon, Cochin China	620
	Key West to Punta Rassa	120
	Saigon to Hong Kong	975
	Hong Kong to Shanghai	1,100
	Shanghai, China, to Nagasaki, Japan, thence to Wladiwostock, Siberia	1,200
	Rhodes to Marmarice	22
	Latakia to Cyprus	86
	Samos to Scala Nuova	11
	Mytelene to Alvali	13
	Khania to Retimo	32
	Rhetimo to Candia	41
	Candia to Rhodes	201
	Chios to Chesmeh	6
	Zante to Corfu	150
	Zante to Cephalonia	18
	Lowestoft, England, to Greitseil, Germany	223
	Antigua to Demarara, connecting the West India Windward Islands	1,029
	Porto Rico to Jamaica	582
1872.	Lizard, England, to Bilbao, Spain	460
	British Columbia to Vancouver Island	18
1873.	Falmouth England, to Lisbon, Portugal	1,150
	Caithness to Orkney	8
	Valencia to Newfoundland	1,900
	Key West to Havana	120
	Placentia, Newfoundland, to Sydney, Cape Breton	300
	Heligoland to Cuxhaven, Germany	40
	England to Denmark	450
	France to Denmark	550
	Denmark to Sweden	10
	Pernambuco, Brazil, to Para, Brazil	1,382
	Alexandria, Egypt, to Candia or Crete	390
	Candia to Zante	240
	Zante to Otranto, Italy	190
	Alexandria, Egypt, to Brindisi, Italy	930
1874.	Lisbon, Portugal, to Madeira, Madeira Islands	633
	Madeira to St. Vincent, Cape de Verde Islands	1,360
	St. Vincent to Pernambuco, Brazil	1,953
	Jamaica to Colon, South America	600
	Pernambuco, Brazil, to Bahia, Brazil	450
	Bahia, Brazil, to Rio Janeiro	1,240
	Italy to Sicily	7
	Jamaica to Porto Rico	582
	Rio Janeiro to Rio Grande do Sul	840
	Rye Beach, U. S., to Tarr Bay, Nova Scotia	550
	Barcelona, Spain, to Marseilles, France	200
	Shetland to Orkney	60
	Valencia to Newfoundland	1,900

The following is a list of the principal submarine telegraph companies, with the amount of their capital:

Anglo-American Telegraph Company: Ireland to Newfoundland; Newfoundland to Cape Breton; Brest to St. Pierre; St. Pierre to Duxbury, U. S. (five cables)—$35,000,000.

Brazilian Submarine Telegraph Company: Portugal to Brazil—$6,500,000.

Cuba Submarine Telegraph Company: Santiago to Havana—$800,000.

Direct Spanish Submarine Telegraph Company: England to Bilbao, Spain—$650,000.

Direct United States Submarine Telegraph Company: Ireland to Nova Scotia; Nova Scotia to the United States—$6,500,000.

Eastern Submarine Telegraph Company: England to Bombay *via* Mediterranean and Red Sea—$15,000,000.

Eastern Extension, Australian and China Submarine Telegraph Company: Madras to China and Japan; Java to Australia—$8,315,500.

Great Northern of Copenhagen Telegraph Company: England to Denmark, Norway, Sweden, and Russia—$2,000,000.

Great Northern China and Japan Extension: Siberia to Hong Kong and Japan—$3,000,000.

International Ocean Telegraph Company: Florida to Havana—$1,500,000.

Mediterranean Extension Telegraph Company: Sicily to Malta and Corfu—$760,000.

Montevidean and Brazilian Telegraph Company: Montevideo to Brazilian Frontier—$675,000.

Platino-Brazilian Telegraph Company Rio Janeiro to Uruguay—$2,000,000.

Submarine Telegraph Company: England to France, to Belgium, and to Holland—$2,093,200.

Western and Brazilian Telegraph Company: Coast of Brazil—$6,750,000.

West India and Panama Telegraph Company: Cuba to West India Islands and South America—$9,500,000.

Sanitary Sense.

Dr. W. W. Hall, in his *Journal of Health*, says a great many truthful things in his peculiar way. These are, and certainly should be, extensively read; for they include so much excellent advice that their influence can be for nothing else but good. The last number of the *Journal* is before us now, opened with the intention of clipping an article here and there; but after reading it all through, we really cannot decide that any one subject is better treated than the rest. Consequently, we have culled a few ideas which strike us as especially good and interesting, and these we give below:

Dyspepsia—says the opening paragraph of a short sermon on that wretched malady—means a difficulty in preparing the food eaten so that the nutriment can be extracted from it to supply the wants of the system. Eating too fast and too much are prolific causes; the first because the food, being swallowed in too large pieces, begins to ferment before it can digest, and the second because the stomach cannot cope with the quantity forced upon it. A limited supply of gastric juice is another cause, and this implies bad blood. Out of door life, moderate exercise until hungry, and simple food are the best remedies.

Bitters, the names of the multitudinous varieties of which disfigure the fences and scenery of the country, come in for severe handling, on account of their alcoholic composition. A list of thirty-four of these mixtures is given, including all we ever heard of and a great many which we did not know existed; and in every instance they are shown to contain alcohol. In brief, while persons are using bitters as a medicine, they are often drinking, three times a day, a more concentrated form of alcohol than is found in the purest whiskies and brandies. It should be set down as a settled rule that bitters in any form is alcohol in disguise.

Localities of life should be high. Elevated stations are generally exempt from the ravages of consumptive disease. The air is lighter and contains less oxygen; but as the lungs live on oxygen, as it is the oxygen which they bring in contact with the blood at every breath, it is that which purifies and gives it its life-giving power. If each breath of air does not give a sufficient amount of oxygen, instinct prompts a fuller breath; this distends the lungs more fully, and thus develops and strengthens them. A statement is given of the elevation of several American cities: New Orleans is relatively given as 10, New York and Philadelphia 35, Boston 40, Chicago 585, Nebraska City 1,000, and Winona, Miss., 1,500.

Many a family mansion, says the editor, speaking of healthy houses, has been built with the accumulations of the savings of half a lifetime to make the graves of half the household in a few months, from neglect of the precautions for thorough drainage and a proper water supply for drinking and cooking. Never select a house over a filling; prefer sandy soil or the top of a hill.

In Munich, the bodies of the dead are kept for forty-eight hours before burial, and the fingers are connected with a wire so that, in case the person should revive, his least movement will ring a bell and so give warning. This is not applied to babies; but it is suggested that, if the plan be adopted here, the wire should be attached to the child's toes, as all babies begin to kick as soon as awake.

With reference to winter garments, sufficient clothing, it is said, should be worn to keep off a feeling of chilliness when about usual avocations. Less than that subjects one to an attack of dangerous pneumonia at any day or hour. More than that oppresses. Steadily aim, by all possible ways and means, to keep off a feeling of chilliness, which always indicates that a cold has been taken.

Instinct teaches that less exertive power is required to keep moving than, after coming to a standstill, to set the body in motion again. The frequent stoppages of stages and street cars kill off the horses. Instinct also teaches the requisite expenditure of strength according to the circumstances of the season. No one walks as fast in summer as in winter. We get up in the morning with a certain amount of strength, and much may be gained by economizing during the day.

Spectacles become necessary when you first notice yourself going to the window instinctively for a better light, or when your eye gets tired by looking at any small thing near at hand, or a dimness or watering is manifested, so as to cause indistinctness. First purchase No. 20; and as you observe the symptoms above named, get No. 18, and so on. The glasses should be near enough to the eye almost to touch the lashes; they should be washed every morning in cold water and carried in a pocket by themselves. Brazilian pebble makes the best lenses. Avoid reading before sunrise and after sunset. Read as little as possible before breakfast, or by artificial light; do not sew on dark material at night, and use no other eyewash then pure, tepid, soft water. Babies' eyes are often injured by allowing the glaring sunlight to fall upon them.

Exercise is worth more than all the medicines in maintaining health. If it rains, take an umbrella and let it rain on; if it is cold, walk or work faster; if it is windy, turn around and go the other way; if it rains, hails, snows, and blows, all at once, so that you have to stay indoors, then live on bread and water that day, not an atom else, and you will need no exercise to work it up.

It should always be borne in mind that a large share of our little aches and pains would pass off about as soon by letting them alone as by doing or taking something; and the more we "take," the greater is the necessity for "taking."

The best way to enjoy things is to use them, and thus get the worth of our money out of them. There is no sense in gorgeous parlors kept in darkness.

Sometimes the reading of a single sentiment in a newspaper makes an impression on the mind which tinges the whole subsequent life for good.

The Musconetcong Tunnel.

The tunnel through Musconetcong Mountain, New Jersey, for the line of the Easton and Perth Amboy railroad, was opened on the 16th of December. The work was begun on April 10, 1872, from which date to August of the same year labor was devoted to making an open cut on the west side of the mountain. Tunneling was then started at both ends through formations of limestone and syenitic gneiss. Considerable trouble was experienced during the progress of the boring by irruptions of water from a subterranean lake. The tunnel is almost exactly one mile in length.

ERRATUM.—In our article on the hydrocarbons produced on iron and steel, published in our last week's issue, it is stated that the least volatile portions of the bromated product were "set aside to be treated with an alcoholic solution," "of potassa" should be added to complete the sense.

[For the Scientific American.]

THE ARITHMETICAL OPERATIONS OF MULTIPLICATION AND DIVISION.

We think that most of our readers will agree with the assertion that there is less probability of mistakes, on the part of the ordinary calculator, in making additions and subtractions of numbers than in multiplying and dividing. The reason is that the latter operations are more complex, requiring the use of all the fundamental rules of arithmetic. There is a simple artifice, employed by many in multiplying and dividing, which reduces these operations to cases requiring the application of the rules of division and subtraction only. The method referred to is tolerably well known, but not as generally as it should be; and we think that there are many of our readers who will be interested in receiving an explanation. The method finds its principal application in cases where different numbers are to be multiplied or divided by the same number, as, for instance, in the preparation of tables. We can best illustrate it by giving an example.

According to our observation, a question frequently arising with those who are engaged in mechanical pursuits is the determination of the circumference of a circle when the diameter is known. It is not always convenient or practicable to consult a book in which the properties of circles are given, but one can nearly always carry a few cards upon which useful numbers are written. Let us suppose that one of these cards contains the following:

CIRCUMFERENCE OF CIRCLE.

Diameter. Multiplied by	Diameter. Multiplied by
1= 3·1416	6=18·8496
2= 6·2832	7=21·9912
3= 9·4248	8=25·1328
4=12·5664	9=28·2744
5=15·7080	

and that the circumference of a circle whose diameter is 130·0402 feet is required. Below is the solution:

```
       3·1416
     130·0402
     --------
        62832
      1256640
     9424800
    31416
  -----------
  408·53429232
```

It will be observed that the multiplier is placed beneath the multiplicand, as in the ordinary method; but that instead of actually performing the operation of multiplying the multiplicand by each term of the multiplier, the several products are taken at once from the card and placed in their proper positions, so that we have only to add them to get the whole product. It will be advisable, in following this plan, to use small cards, with only one set of numbers on one side of each, to avoid confusion; and in preparing a card for a given number, it is well to form the several multiples by adding the number first to itself and then to each successive sum, repeating this operation nine times, so as to check the accuracy of the work. Below is given an illustration:

Areas of circles.	Square of diameter multiplied by
	0·7854=1
add 0·7854	1·5708=2
" "	2·3562=3
" "	3·1416=4
" "	3·9270=5
" "	4·7124=6
" "	5·4978=7
" "	6·2832=8
" "	7·0686=9
" "	7·8540=10

It is evident, from simple inspection, that the last quantity is ten times the first, and this affords a strong presumption that the intermediate calculations are also correctly made.

An example is appended, showing the application of this method to division:

REDUCTION OF CUBIC INCHES TO CUBIC FEET.

Cubic in. Divided by	Cubic in. Divided by
1= 1,728	6=10,368
2= 3,456	7=12,096
3= 5,184	8=13,824
4= 6,912	9=15,552
5= 8,640	

Question: How many cubic feet are there in 901,314,564·268 cubic inches?

```
1,728 ) 901,314,564·268 ( 521,594·076+
        8640
        ----
         3731
         3456
         ----
          2754
          1728
          ----
          10265
           8640
          -----
           16256
           15552
           -----
             7044
             6912
             ----
             13226
             12096
             -----
              11308
              10368
              -----
                940
```

A simple inspection of the card shows the successive figures of the dividend, and gives the products of the divisor by these figures, so that the operation is reduced to a series