**Scientific American Supplement, No. 613, October 1, 1887 eBook**

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**THE BRITISH ASSOCIATION.**

[Illustration:  *The* *British* *association* *at* *Manchester* *portraits* *of* *the* *president* *and* *presidents* *of* *sections* ]

The fifty-seventh annual meeting of the British Association was opened on Wednesday evening, Aug. 31, 1887, at Manchester, by an address from the president, Sir H.E.  Roscoe, M.P.  This was delivered in the Free Trade Hall.  The chair was occupied by Professor Williamson, who was supported by the Bishop of Manchester, Sir F. Bramwell, Professor Gamgee, Professor Milnes Marshall, Professor Wilkins, Professor Boyd Dawkins, Professor Ward, and many other distinguished men.  A telegram was read from the retiring president, Sir Wm. Dawson, of Montreal, congratulating the association and Manchester on this year’s meeting.  The new president, Sir H. Roscoe, having been introduced to the audience, was heartily applauded.

The president, in his inaugural address, said Manchester, distinguished as the birthplace of two of the greatest discoveries of modern science, welcomed the visit of the British Association for the third time.  Those discoveries were the atomic theory of which John Dalton was the author, and the most far-reaching scientific principle of modern times, namely, that of the conservation of energy, which was given to the world about the year 1842 by Dr. Joule.  While the place suggested these reminders, the time, the year of the Queen’s jubilee, excited a feeling of thankfulness that they had lived in an age which had witnessed an advance in our knowledge of nature and a consequent improvement in the physical, moral, and intellectual well-being of the people hitherto unknown.

**PROGRESS OF CHEMISTRY.**

A sketch of that progress in the science of chemistry alone would be the subject of his address.  The initial point was the views of Dalton and his contemporaries compared with the ideas which now prevail; and he (the president) examined this comparison by the light which the research of the last fifty years had thrown on the subject of the Daltonian atoms, in the three-fold aspect of their size, indivisibility, and mutual relationships, and their motions.

**SIZE OF THE ATOM.**

As to the size of the atom, Loschmidt, of Vienna, had come to the conclusion that the diameter of an atom of oxygen or nitrogen was the ten-millionth part of a centimeter.  With the highest known magnifying power we could distinguish the forty-thousandth part of a centimeter.  If, now, we imagine a cubic box each of whose sides had this length, such a box, when filled with air, would contain from sixty to a hundred millions of atoms of oxygen and nitrogen.  As to the indivisibility of the atom, the space of fifty years had completely changed the face of the

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inquiry.  Not only had the number of distinct, well-established elementary bodies increased from fifty-three in 1837 to seventy in 1887, but the properties of these elements had been studied, and were now known with a degree of precision then undreamt of.  Had the atoms of our present elements been made to yield?  To this a negative answer must undoubtedly be given, for even the highest of terrestrial temperatures, that of the electric spark, had failed to shake any one of these atoms in two.  This was shown by the results with which spectrum analysis had enriched our knowledge.  Terrestrial analysis had failed to furnish favorable evidence; and, turning to the chemistry of the stars, the spectra of the white, which were presumably the hottest stars, furnished no direct evidence that a decomposition of any terrestrial atom had taken place; indeed, we learned that the hydrogen atom, as we know it here, can endure unscathed the inconceivably fierce temperature of stars presumably many times more fervent than our sun, as Sirius and Vega.  It was therefore no matter for surprise if the earth-bound chemist should for the present continue to regard the elements as the unalterable foundation stones upon which his science is based.

**ATOMIC MOTION.**

Passing to the consideration of atoms in motion, while Dalton and Graham indicated that they were in a continual state of motion, we were indebted to Joule for the first accurate determination of the rate of that motion.  Clerk-Maxwell had calculated that a hydrogen molecule, moving at the rate of seventy miles per minute, must, in one second of time, knock against others no fewer than eighteen thousand million times.  This led to the reflection that in nature there is no such thing as great or small, and that the structure of the smallest particle, invisible even to our most searching vision, may be as complicated as that of any one of the heavenly bodies which circle round our sun.  How did this wonderful atomic motion affect their chemistry?

**ATOMIC COMBINATION.**

Lavoisier left unexplained the dynamics of combustion; but in 1843, before the chemical section of the association meeting at Cork, Dr. Joule announced the discovery which was to revolutionize modern science, namely, the determination of the mechanical equivalent of heat.  Every change in the arrangement of the particles he found was accompanied by a definite evolution or an absorption of heat.  Heat was evolved by the clashing of the atoms, and this amount was fixed and definite.  Thus to Joule we owe the foundation of chemical dynamics and the basis of thermal chemistry.  It was upon a knowledge of the mode of arrangement of atoms, and on a recognition of their distinctive properties, that the superstructure of modern organic chemistry rested.  We now assumed on good grounds that the atom of each element possessed distinct capabilities of combination.  The knowledge of the mode in which the atoms in the molecule are arranged had given to organic chemistry an impetus which had overcome many experimental obstacles, and organic chemistry had now become synthetic.

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Liebig and Wohler, in 1837, foresaw the artificial production in the laboratories of all organic substances so far as they did not constitute a living organism.  And after fifty years their prophecy had been fulfilled, for at the present time we could prepare an artificial sweetening principle, an artificial alkaloid, and salacine.

**SYNTHESIS.**

We know now that the same laws regulate the formation of chemical compounds in both animate and inanimate nature, and the chemist only asked for a knowledge of the constitution of any definite chemical compounds found in the organic world in order to be able to promise to prepare it artificially.  Seventeen years elapsed between Wohler’s discovery of the artificial production of urea and the next real synthesis, which was accomplished by Kolbe, when in 1845 he prepared acetic acid from its elements.  Since then a splendid harvest of results had been gathered in by chemists of all nations.  In 1834 Dumas made known the law of substitution, and showed that an exchange could take place between the constituent atoms in a molecule, and upon this law depended in great measure the astounding progress made in the wide field of organic synthesis.

Perhaps the most remarkable result had been the production of an artificial sweetening agent, termed saccharin, 250 times sweeter than sugar, prepared by a complicated series of reactions from coal tar.  These discoveries were not only of scientific interest, for they had given rise to the industry of coal tar colors, founded by our countryman Perkin, the value of which was measured by millions sterling annually.  Another interesting application of synthetic chemistry to the needs of everyday life was the discovery of a series of valuable febrifuges, of which antipyrin might be named as the most useful.

An important aspect in connection with the study of these bodies was the physiological value which had been found to attach to the introduction of certain organic radicals, so that an indication was given of the possibility of preparing a compound which will possess certain desired physiological properties, or even to foretell the kind of action which such bodies may exert on the animal economy.  But now the question might well be put, Was any limit set to this synthetic power of the chemist?  Although the danger of dogmatizing as to the progress of science had already been shown in too many instances, yet one could not help feeling that the barrier between the organized and unorganized worlds was one which the chemist at present saw no chance of breaking down.  True, there were those who professed to foresee that the day would arrive when the chemist, by a succession of constructive efforts, might pass beyond albumen, and gather the elements of lifeless matter into a living structure.  Whatever might be said regarding this from other standpoints, the chemist could only say that at present no such problem lay within his province.

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Protoplasm, with which the simplest manifestations of life are associated, was not a compound, but a structure built up of compounds.  The chemist might successfully synthesize any of its component molecules, but he had no more reason to look forward to the synthetic production of the structure than to imagine that the synthesis of gallic acid led to the artificial production of gall nuts.  Although there was thus no prospect of effecting a synthesis of organized material, yet the progress made in our knowledge of the chemistry of life during the last fifty years had been very great, so much so indeed that the sciences of physiological and of pathological chemistry might be said to have entirely arisen within that period.

**CHEMISTRY OF VITAL FUNCTIONS.**

He would now briefly trace a few of the more important steps which had marked the recent study of the relations between the vital phenomena and those of the inorganic world.  No portion of the science of chemistry was of greater interest or greater complexity than that which, bearing on the vital functions both of plants and of animals, endeavored to unravel the tangled skein of the chemistry of life, and to explain the principles according to which our bodies live, and move, and have their being.  If, therefore, in the less complicated problems with which other portions of our science have to deal, we found ourselves often far from possessing satisfactory solutions, we could not be surprised to learn that with regard to the chemistry of the living body—­whether vegetable or animal—­in health or disease, we were still farther from a complete knowledge of phenomena, even those of fundamental importance.

Liebig asked if we could distinguish, on the one hand, between the kind of food which goes to create warmth and, on the other, that by the oxidation of which the motions and mechanical energy of the body are kept up.  He thought he was able to do this, and he divided food into two categories.  The starchy or carbo-hydrate food was that, said he, which by its combustion provided the warmth necessary for the existence and life of the body.  The albuminous or nitrogenous constituents of our food, the flesh meat, the gluten, the casein out of which our muscles are built up, were not available for the purpose of creating warmth, but it was by the waste of those muscles that the mechanical energy, the activity, the motions of the animal are supplied.

Soon after the promulgation of these views, J.R.  Mayer warmly attacked them, throwing out the hypothesis that all muscular action is due to the combustion of food, and not to the destruction of muscle.

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What did modern research say to this question?  Could it be brought to the crucial test of experiment?  It could; but how?  In the first place, we could ascertain the work done by a man or any other animal; we could measure this work in terms of our mechanical standard, in kilogramme-meters or foot-pounds.  We could next determine what was the destruction of nitrogenous tissue at rest and under exercise by the amount of nitrogenous material thrown off by the body.  And here we must remember that these tissues were never completely burned, so that free nitrogen was never eliminated.  If now we knew the heat value of the burned muscle, it was easy to convert this into its mechanical equivalent and thus measure the energy generated.  What was the result?

Was the weight of muscle destroyed by ascending the Faulhorn or by working on the treadmill sufficient to produce on combustion heat enough when transformed into mechanical exercise to lift the body up to the summit of the Faulhorn or to do the work on the treadmill?

Careful experiment had shown that this was so far from being the case that the actual energy developed was twice as great as that which could possibly be produced by the oxidation of the nitrogenous constituents eliminated from the body during twenty-four hours.  That was to say, taking the amount of nitrogenous substance cast off from the body, not only while the work was being done, but during twenty-four hours, the mechanical effect capable of being produced by the muscular tissue from which this cast-off material was derived would only raise the body half way up the Faulhorn, or enable the prisoner to work half his time on the treadmill.  Hence it was clear that Liebig’s proposition was not true.

The nitrogenous constituents of the food did doubtless go to repair the waste of muscle, which, like every other portion of the body, needed renewal, while the function of the non-nitrogenous food was not only to supply the animal heat, but also to furnish, by its oxidation, the muscular energy of the body.  We thus came to the conclusion that it was the potential energy of the food which furnished the actual energy of the body, expressed in terms either of heat or of mechanical work.

But there was one other factor which came into play in this question of mechanical energy, and must be taken into account; and this factor we were as yet unable to estimate in our usual terms.  It concerned the action of the mind on the body, and although incapable of exact expression, exerted none the less an important influence on the physics and chemistry of the body, so that a connection undoubtedly existed between intellectual activity or mental work and bodily nutrition.  What was the expenditure of mechanical energy which accompanied mental effort was a question which science was probably far from answering; but that the body experienced exhaustion as the result of mental activity was a well-recognized fact.

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**CHEMISTRY OF VEGETATION.**

The phenomena of vegetation, no less than those of the animal world, had, however, during the last fifty years been placed by the chemist on an entirely new basis.

Liebig, in 1860, asserted that the whole of the carbon of vegetation was obtained from the atmospheric carbonic acid, which, though only present in the small relative proportion of four parts in 10,000 of air, was contained in such absolutely large quantity that if all the vegetation on the earth’s surface were burned, the proportion of carbonic acid which would thus be thrown into the air would not be sufficient to double the present amount.  That this conclusion was correct needed experimental proof, but such proof could only be given by long-continued and laborious experiment.

It was to our English agricultural chemists, Lawes and Gilbert, that we owed the complete experimental proof required, and this experiment was long and tedious, for it had taken forty-four years to give a definite reply.

At Rothamsted a plot was set apart for the growth of wheat.  For forty-four successive years that field had grown wheat without the addition of any carbonized manure, so that the only possible source from which the plant could obtain the carbon for its growth was the atmospheric carbonic acid.  The quantity of carbon which on an average was removed in the form of wheat and straw from a plot manured only with mineral matter was 1,000 lb., while on another plot, for which a nitrogenous manure was employed, 1,500 lb. more carbon was annually removed, or 2,500 lb. of carbon were removed by this crop annually without the addition of any carbonaceous manure.  So that Liebig’s prevision had received a complete experimental verification.

**CHEMICAL PATHOLOGY.**

Touching us as human beings even still more closely than the foregoing was the influence which chemistry had exerted on the science of pathology, and in no direction had greater progress been made than in the study of micro-organisms in relation to health and disease.  In the complicated chemical changes to which we gave the names of fermentation and putrefaction, Pasteur had established the fundamental principle that these processes were inseparately connected with the life of certain low forms of organisms.  Thus was founded the science of bacteriology, which in Lister’s hands had yielded such splendid results in the treatment of surgical cases, and in those of Klebs, Koch, and others, had been the means of detecting the cause of many diseases both in man and animals, the latest and not the least important of which was the remarkable series of successful researches by Pasteur into the nature and mode of cure of that most dreadful of maladies, hydrophobia.  The value of his discovery was greater than could be estimated by its present utility, for it showed that it might be possible to avert other diseases besides hydrophobia by the adoption of a somewhat similar method of investigation and of treatment.

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Here it might seem as if we had outstepped the boundaries of chemistry, and had to do with phenomena purely vital.  But recent research indicated that this was not the case, and pointed to the conclusion that the microscopist must again give way to the chemist, and that it was by chemical rather than biological investigation that the causes of diseases would be discovered, and the power of removing them obtained.  For we learned that the symptoms of infective diseases were no more due to the microbes which constituted the infection than alcoholic intoxication was produced by the yeast cell, but that these symptoms were due to the presence of definite chemical compounds, the result of the life of these microscopic organisms.  So it was to the action of these poisonous substances formed during the life of the organism, rather than to that of the organism itself, that the special characteristics of the disease were to be traced, for it had been shown that the disease could be communicated by such poisons in the entire absence of living organisms.

Had time permitted, he would have wished to have illustrated the dependence of industrial success upon original investigation, and to have pointed out the prodigious strides which chemical industry in this country had made during the fifty years of her Majesty’s reign.  As it was, he must be content to remark how much our modern life, both in its artistic and useful aspects, owed to chemistry, and therefore how essential a knowledge of the principles of the science was to all who had the industrial progress of the country at heart.  The country was now beginning to see that if she was to maintain her commercial and industrial supremacy, the education of her people from top to bottom must be carried out on new lines.  The question how this could be most safely and surely accomplished was one of transcendent national importance, and the statesman who solved this educational problem would earn the gratitude of generations yet to come.

In welcoming the unprecedentedly large number of foreign men of science who had on this occasion honored the British Association by their presence, he hoped that that meeting might be the commencement of an international scientific organization, the only means nowadays existing of establishing that fraternity among nations from which politics appeared to remove them further and further, by absorbing human powers and human work, and directing them to purposes of destruction.  It would indeed be well if Great Britain, which had hitherto taken the lead in so many things that are great and good, should now direct her attention to the furthering of international organizations of a scientific nature.  A more appropriate occasion than the present meeting could perhaps hardly be found for the inauguration of such a movement.  But whether this hope were realized or not, they all united in that one great object, the search after truth for its own sake, and they all, therefore, might join

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in re-echoing the words of Lessing:  “The worth of man lies not in the truth which he possesses, or believes that he possesses, but in the honest endeavor which he puts forth to secure that truth; for not by the possession of truth, but by the search after it, are the faculties of man enlarged, and in this alone consists his ever-growing perfection.  Possession fosters content, indolence, and pride.  If God should hold in his right hand all truth, and in his left hand the ever-active desire to seek truth, though with the condition of perpetual error, I would humbly ask for the contents of the left hand, saying, ’Father, give me this; pure truth is only for thee.’”

At the close of his address a vote of thanks was passed to the president, on the motion of the Mayor of Manchester, seconded by Professor Asa Gray, of Harvard College.  The president mentioned that the number of members is already larger than at any previous annual meeting, namely, 3,568, including eighty foreigners.

\* \* \* \* \*

**THE CRIMSON LINE OF PHOSPHORESCENT ALUMINA.**

Crookes has presented to the Royal Society a paper on the color emitted by pure alumina when submitted to the electric discharge *in vacuo*, in answer to the statements of De Boisbaudran.  In 1879 he had stated that “next to the diamond, alumina, in the form of ruby, is perhaps the most strikingly phosphorescent stone I have examined.  It glows with a rich, full red; and a remarkable feature is that it is of little consequence what degree of color the earth or stone possesses naturally, the color of the phosphorescence is nearly the same in all cases; chemically precipitated amorphous alumina, rubies of a pale reddish yellow, and gems of the prized ‘pigeon’s blood’ color glowing alike in the vacuum.”  These results, as well as the spectra obtained, he stated further, corroborated Becquerel’s observations.  In consequence of the opposite results obtained by De Boisbaudran, Crookes has now re-examined this question with a view to clear up the mystery.  On examining a specimen of alumina prepared from tolerably pure aluminum sulphate, shown by the ordinary tests to be free from chromium, the bright crimson line, to which the red phosphorescent light is due, was brightly visible in its spectrum.  The aluminum sulphate was then, in separate portions, purified by various processes especially adapted to separate from it any chromium that might be present; the best of these being that given by Wohler, solution in excess of potassium hydrate and precipitation of the alumina by a current of chlorine.  The alumina filtered off, ignited, and tested in a radiant matter tube gave as good a crimson line spectrum as did that from the original sulphate.

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A repetition of this purifying process gave no change in the result.  Four possible explanations are offered of the phenomena observed:  “(1) The crimson line is due to alumina, but it is capable of being suppressed by an accompanying earth which concentrates toward one end of the fractionations; (2) the crimson line is not due to alumina, but is due to the presence of an accompanying earth concentrating toward the other end of the fractionations; (3) the crimson line belongs to alumina, but its full development requires certain precautions to be observed in the time and intensity of ignition, degree of exhaustion, or its absolute freedom from alkaline and other bodies carried down by precipitated alumina and difficult to remove by washing; experience not having yet shown which of these precautions are essential to the full development of the crimson line and which are unessential; and (4) the earth alumina is a compound molecule, one of its constituent molecules giving the crimson line.  According to this hypothesis, alumina would be analogous to yttria.”—­*Nature.*

\* \* \* \* \*

**CARBONIC ACID IN THE AIR.**

By *Thomas* C. *Van* *Nuys* and *Benjamin* F. *Adams*, *Jr*.

During the month of April, 1886, we made eighteen estimations of carbonic acid in the air, employing Van Nuys’ apparatus,[1] recently described in this journal.  These estimations were made in the University Park, one-half mile from the town of Bloomington.  The park is hilly, thinly shaded, and higher than the surrounding country.  The formation is sub-carboniferous and altitude 228 meters.  There are no lowlands or swamps near.  The estimations were made at 10 A.M.

  [Footnote 1:  See *Sci*.  *Am*.  *Supplement* No. 577.]

The air was obtained one-half meter from the ground and about 100 meters from any of the university buildings.  The number of volumes of carbonic acid is calculated at zero C. and normal pressure 760 mm.

--------+----------+--------------+--------------------
----
| | Vols. *Co*\_{2} |
Date. | Bar. | in 100,000 | State of Weather.
| Pressure | Vols. Air. |
--------+----------+--------------+------------------------
April 2 | 743.5 | 28.86 | Cloudy, snow on ground.
" 5 | 743.5 | 28.97 | " " " "
" 6 | 735 | 28.61 | Snowing.
" 7 | 744.5 | 28.63 | Clear, snow on ground.
" 8 | 748 | 27.59 | " thawing.
" 9 | 747.5 | 28.10 | " "
" 12 | 744 | 28.04 | Cloudy.
" 13 | 744 | 28.10 | Clear.
" 14 | 743.5 | 28.98 | "
" 15 | 750.5 | 28.17 | Raining.
" 19 | 748 | 28.09 | Clear.
" 20 | 746 | 27.72 | "
" 21 | 746 | 28.16 | "
" 22 | 741.5 | 27.92 | "
" 23 | 740 | 28.12 | "

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" 24 | 738.5 | 28.15 | "
" 25 | 738.5 | 27.46 | "
" 28 | 738 | 27.34 | "
--------+----------+--------------+------------------------
/pre>

The average number of volumes of carbonic acid in
100,000 volumes of air is 28.16, the maximum number
is 28.98, and the minimum 27.34. These results
agree with estimations made within the last ten or
fifteen years. Reiset[2] made a great number of
estimations from September 9, 1872, to August 20,
1873, the average of which is 29.42. Six years
later[3] he made many estimations from June to November,
the average of which is 29.78. The average of
Schultze’s[4] estimations is 29 2. The
results of estimations of carbonic acid in the air,
made under the supervision of Munz and Aubin[5] in
October, November, and December, 1882, at the stations
where observations were made of the transit of Venus
by astronomers sent out by the French government,
yield the average, for all stations north of the equator
to latitude 29 deg. 54’ in Florida, 28.2 volumes
carbonic acid in 100,000 volumes air, and for all
stations south of the equator 27.1 volumes. The
average of Claesson’s[6] estimations is 27.9
volumes, his maximum number is 32.7, and his minimum
is 23.7. It is apparent, from the results of
estimations of carbonic acid of the air of various
parts of the globe, by the employment of apparatus
with which errors are avoided, that the quantity of
carbonic acid is subject to slight variation, and not,
as stated in nearly all text books of science, from
4 to 6 volumes in 10,000 volumes of air; and it is
further apparent that the law of Schloesing[7] holds
good. By this law the carbonic acid of an atmosphere
in contact with water containing calcium or magnesium
carbonate in solution is dissolved according to the
tension of the carbonic acid; that is, by an increased
quantity its tension increases, and more would pass
in solution in the form of bicarbonates. On the
other hand, by diminishing the quantity of carbonic
acid in the atmosphere, some of the bicarbonates would
decompose and carbonic acid pass into the atmosphere.
[Footnote 2:  Comptes Rendus, 88, 1007.] [Footnote 3:  Comptes Rendus, 90, 1144.] [Footnote 4:  Chem.  Centralblatt, 1872 and 1875.] [Footnote 5:  Comptes Rendus, 96, 1793.] [Footnote 6:  Berichte der deutsch chem.  Gesellschaft, 9, 174.] [Footnote 7:  Comptes Rendus, 74, 1552, and 75, 70.]
Schloesing’s law has been verified by R. Engel[8].

 [Footnote 8: Comptes Rendus, 101,
949.]

The results of estimations of bases and carbonic acid
in the water of the English Channel lead Schloesing[9]
to conclude that the carbonic acid combined with normal
carbonates, forming bicarbonates, dissolved in the
water of the globe is ten times greater in quantity
than that of the atmosphere, and on account of this
available carbonic acid, if the atmosphere should
be deprived of some of its carbonic acid, the loss
would soon be supplied.

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 [Footnote 9: Comptes Rendus, 90,
1410.]

As, in nearly all of the methods which were employed
for estimating carbonic acid in the air, provision
is not made for the exclusion of air not measured
containing carbonic acid from the alkaline fluid before
titrating or weighing, the results are generally too
high and show a far greater variation than is found
by more exact methods. For example, Gilm[10]
found from 36 to 48 volumes; Levy’s[11] average
is 34 volumes; De Luna’s[12] 50 volumes; and
Fodor’s,[13] 38.9 volumes. Admitting that
the quantity of carbonic acid in the air is subject
to variation, yet the results of Reiset’s and
Schultze’s estimations go to prove that the
variation is within narrow limits.
[Footnote 10:  Sitzungsher. d.  Wien.  Akad. d.  Wissenschaften, 34, 257.] [Footnote 11:  Ann. d. l’Observ. d.  Mountsouris, 1878 and 1879.] [Footnote 12:  Estudios quimicos sobre el aire atmosferico, Madrid, 1860.] [Footnote 13:  Hygien.  Untersuch., 1, 10.]
Indiana University
Chemical Laboratory,
Bloomington, Indiana.
—­*Amer.
Chem. Journal.*
\* \* \* \*
 \*

**ANALYSIS OF KOLA NUT.**

Alkaloids or crystallizable principles:

 Per
Cent.
 Caffeine.
 2.710
 Theobromine.
 0.084
 Bitter principle.
 0.018
 Total
alkaloids. ----- 2.812
 Fatty matters:
 Saponifiable fat or oil.
 0.734
 Essential oil.
 0.081
 Total
oils. ----- 0.815
 Resinoid matter (*sol. in abs. alcohol*)
 1.012

 Sugar:
 Glucose (*reduces alkaline
cuprammonium*). 3.312
 Sucrose? (*red. alk. cupram.
after inversion*)[1]. 0.602
 Total
sugars. ----- 3.914

Starch, gum, *etc*.:
Gum (*soluble in H2O at 90 deg. F*.). 4.876
Starch. 28.990
Amidinous matter (*coloring with iodine*). 2.130
Total gum and fecula. ----- 35.999
Albuminoid matters. 8.642
Red and other coloring matters. 3.670
Kolatannic acids. 1.204

Mineral matter:
Potassa.
 1.415
Chlorine.
 0.702
Phosphoric acid.
 0.371
Other salts, *etc*.
 2.330
Total ash.
 ----- 4.818
Moisture.
 9.722
Ligneous matter and loss.
 27.395
-------
100.000

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[Footnote 1: Inverted by boiling
with a 2.5 per cent. solution of
citric acid for ten minutes.]

Both the French and German governments are introducing
it into their military dietaries, and in England several
large contract orders cannot yet be filled, owing
to insufficiency of supply, while a well-known cocoa
manufacturing firm has taken up the preparation of
kola chocolate upon a commercial scale.—­*W.
Lascelles-Scott, in Jour. Soc. Arts.*
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**CHAPIN WROUGHT IRON.**

By W.H. *Searles*, Chairman of the Committee,
Civil Engineers’ Club of Cleveland, O.

Notwithstanding the wonderful development of our steel
industries in the last decade, the improvements in
the modes of manufacture, and the undoubted strength
of the metal under certain circumstances, nevertheless
we find that steel has not altogether met the requirements
of engineers as a structural material. Although
its breaking strain and elastic limit are higher than
those of wrought iron, the latter metal is frequently
preferred and selected for tensile members, even when
steel is used under compression in the same structure.
The Niagara cantilever bridge is a notable instance
of this practice. When steel is used in tension
its working strains are not allowed to be over fifty
per cent. above those adopted for wrought iron.

The reasons for the suspicion with which steel is
regarded are well understood. Not only is there
a lack of uniformity in the product, but apparently
the same steel will manifest very different results
under slight provocation. Steel is very sensitive,
not only to slight changes in chemical composition,
but also to mechanical treatment, such as straightening,
bending, punching, planing, heating, *etc*.
Initial strains may be developed by any of these processes
that would seriously affect the efficiency of the
metal in service.

Among the steels, those that are softer are more serviceable
and reliable than the harder ones, especially whereever
shocks and concussions or rapidly alternating strains
are to be endured. In other words, the more nearly
steel resembles good wrought iron, the more certain
it is to render lasting service when used within appropriate
limits of strain. Indeed, a wrought iron of fine
quality is better calculated to endure fatigue than
any steel. This is particularly noticeable in
steam hammer pistons, propeller shafts, and railroad
axles. A better quality of wrought iron, therefore,
has long been a desideratum, and it appears now that
it has at last been found.

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Several years since, a pneumatic process of manufacturing
wrought iron was invented and patented by Dr. Chapin,
and an experimental plant was erected near Chicago.
Enough was done to demonstrate, first, that an iron
of unprecedentedly good qualities was attainable from
common pig; and second, that the cost of its manufacture
would not exceed that of Bessemer steel. Nevertheless,
owing to lack of funds properly to push the invention
against the jealous opposition which it encountered,
the enterprise came to a halt until quite recently,
when its merits found a champion in Gustav Lindenthal,
C.E., member of this club, who is now the general
manager of the Chapin Pneumatic Iron Co., and under
whose direction this new quality of iron will soon
be put upon the market.

The process of manufacture is briefly as follows:
The pig metal, after being melted in a cupola and
tapped into a discharging ladle, is delivered into
a Bessemer converter, in which the metal is largely
relieved of its silicon, sulphur, carbon, *etc*.,
by the ordinary pneumatic process. At the end
of the blow the converter is turned down and its contents
discharged into a traveling ladle, and quickly delivered
to machines called ballers, which are rotary reverberatory
furnaces, each revolving on a horizontal axis.
In the baller the iron is very soon made into a ball
without manual aid. It is then lifted out by
means of a suspended fork and carried to a Winslow
squeezer, where the ball is reduced to a roll twelve
inches in diameter. Thence it is taken to a furnace
for a wash heat, and finally to the muck train.

No reagents are employed, as in steel making or ordinary
iron puddling. The high heat of the metal is
sufficient to preserve its fluidity during its transit
from the converter to the baller; and the cinder from
the blow is kept in the ladle.

The baller is a bulging cylinder having hollow trunnions
through which the flame passes. The cylinder
is lined with fire brick, and this in turn is covered
with a suitable refractory iron ore, from eight to
ten inches thick, grouted with pulverized iron ore,
forming a bottom, as in the common puddling furnace.
The phosphorus of the iron, which cannot be eliminated
in the intense heat of the converter, is, however,
reduced to a minimum in the baller at a much lower
temperature and on the basic lining. The process
wastes the lining very slightly indeed. As many
as sixty heats have been taken off in succession without
giving the lining any attention. The absence of
any reagent leaves the iron simply pure and homogeneous
to a degree never realized in muck bars made by the
old puddling process. Thus the expense of a reheating
and rerolling to refine the iron is obviated.
It was such iron as here results that Bessemer, in
his early experiments, was seeking to obtain when
he was diverted from his purpose by his splendid discoveries
in the art of making steel. So effective is the
new process, that even from the poorest grades of pig
may be obtained economically an iron equal in quality
to the refined irons made from the best pig by the
ordinary process of puddling.

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Numerous tests of the Chapin irons have been made
by competent and disinterested parties, and the results
published. The samples here noted were cut and
piled only once from the muck bar.

Sample A was made from No. 3 mill cinder pig.

Sample B was made from No. 4 mill pig and No. 3 Bessemer
pig, half and half.

Sample C was made from No. 3 Bessemer pig, with the
following results:

Sample. A B C
Tensile strength per sq. in. 56,000 60,772 64,377
Elastic limit. 34,000 .... 36,000
Extension, per cent. 11.8 .... 17.0
Reduction of area, per cent. 65.0 16.0 33.0

The tensile strength of these irons made by ordinary
puddling would be about 38,000, 40,000, and 42,000
respectively, or the gain of the iron in tensile strength
by the Chapin process is about fifty per cent.
Not only so, but these irons made in this manner from
inferior pig show a higher elastic limit and breaking
strain than are commonly specified for refined iron
of best quality. The usual specifications are
for refined iron: Tensile strength, 50,000; elongation,
15 per cent.; elastic limit, 26,000; reduction, 25
cent.

Thus the limits of the Chapin iron are from 12 to
20 per cent. above those of refined iron, and not
far below those of structural steel, while there is
a saving of some four dollars per ton in the price
of the pig iron from which it can be made. When
made from the best pig metal its breaking and elastic
limits will probably reach 70,000 and 40,000 pounds
respectively. If so, it will be a safer material
than steel under the same working strains, owing to
its greater resilience.

Such results are very interesting in both a mechanical
and economical point of view. Engineers will
hail with delight the accession to the list of available
building materials of a wrought iron at once fine,
fibrous, homogeneous, ductile, easily weldable, not
subject to injury by the ordinary processes of shaping,
punching, *etc*., and having a tensile strength
and elastic limit nearly equal to any steel that could
safely be used in the same situation.

A plant for the manufacture of Chapin iron is now
in course of erection at Bethlehem, Pa., and there
is every reason to believe that the excellent results
attained in Chicago will be more than reached in the
new works.—­*Proceed. Jour. Asso.
of Eng. Societies*.

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**CELLULOID.**

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Professor Sadler, of the University of Pennsylvania,
has lately given an account of the development and
method of the manufacture of celluloid. Alexander
Parkes, an Englishman, invented this remarkable substance
in 1855, but after twelve years quit making it because
of difficulties in manipulation, although he made
a fine display at the Paris Exposition of 1867.
Daniel Spill, also of England, began experiments two
years after Parkes, but a patent of his for dissolving
the nitrated wood fiber, or “pyroxyline,”
in alcohol and camphor was decided by Judge Blatchford
in a suit brought against the Celluloid Manufacturing
Company to be valueless. No further progress was
made until the Hyatt Brothers, of Albany, N.Y., discovered
that gum camphor, when finely divided, mixed with
the nitrated fiber and then heated, is a perfect solvent,
giving a homogeneous and plastic mass. American
patents of 1870 and 1874 are substantially identical
with those now in use in England. In France there
is only one factory, and there is none elsewhere on
the Continent, one in Hanover having been given up
on account of the explosive nature of the stuff.
In this country pure cellulose is commonly obtained
from paper makers, in the form of tissue paper, in
wide rolls; this, after being nitrated by a bath of
mixed nitric and sulphuric acids, is thoroughly washed
and partially dried. Camphor is then added, and
the whole is ground together and thoroughly mixed.
At this stage coloring matter may be put in.
A little alcohol increases the plasticity of the mass,
which is then treated for some time to powerful hydraulic
pressure. Then comes breaking up the cakes and
feeding the fragments between heated rolls, by which
the amalgamation of the whole is completed. Its
perfect plasticity allows it to be rolled into sheets,
drawn into tubes, or moulded into any desired shape.—­*Jewelers’
Journal.*
\* \* \* \*
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**APPARATUS FOR TESTING CHAMPAGNE BOTTLES AND CORKS.**

Mr. J. Salleron has devised several apparatus which
are destined to render valuable service in the champagne
industry. The apparently simple operation of
confining the carbonic acid due to fermentation in
a bottle in order to blow the cork from the latter
with force at a given moment is not always successful,
notwithstanding the skill and experience of the manipulator.
How could it be otherwise?

Everything connected with the production of champagne
wine was but recently unknown and unexplained.
The proportioning of the sugar accurately dates, as
it were, from but yesterday, and the measurement of
the absorbing power of wine for carbonic acid has but
just entered into practice, thanks to Mr. Salleron’s
absorptiometer. The real strength of the bottles,
and the laws of the elasticity of glass and its variation
with the temperature, are but little known. Finally,
the physical constitution of cork, its chemical composition,
its resistance to compression and the dissolving action
of the wine, must be taken into consideration.
In fact, all the elements of the difficult problem
of the manufacture of sparkling wine show that there
is an urgent necessity of introducing scientific methods
into this industry, as without them work can now no
longer be done.

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No one has had a better opportunity to show how easy
it is to convert the juice of the grape into sparkling
wine through a series of simple operations whose details
are known and accurately determined, so we believe
it our duty to recommend those of our readers who are
particularly interested in this subject to read Mr.
Salleron’s book on sparkling wine. We shall
confine ourselves in this article to a description
of two of the apparatus invented by the author for
testing the resistance of bottles and cork stoppers.

It is well, in the first place, to say that one of
the important elements in the treatment of sparkling
wine is the normal pressure that it is to produce
in the bottles. After judicious deductions and
numerous experiments, Mr. Salleron has adopted for
the normal pressure of highly sparkling wines five
atmospheres at the temperature of the cellar, which
does not exceed 10 degrees. But, in a defective
cellar, the bottles may be exposed to frost in winter
and to a temperature of 25 deg. in summer, corresponding
to a tension of ten atmospheres. It may naturally
be asked whether bottles will withstand such an ordeal.
Mr. Salleron has determined their resistance through
the process by which we estimate that of building
materials, *viz*., by measuring the limit of their
elasticity, or, in other words, the pressure under
which they take on a new permanent volume. In
fact, glass must be assimilated to a perfectly elastic
body; and bottles expand under the internal pressure
that they support. If their resistance is insufficient,
they continue to increase in measure as the pressure
is further prolonged, and at every increase in permanent
capacity, their resistance diminishes.

[Illustration: Fig. 1.—­MACHINE FOR
TESTING BOTTLES.]

The apparatus shown in Fig. 1 is called an elasticimeter,
and permits of a preliminary testing of bottles.
The bottle to be tested is put into the receptacle,
A B, which is kept full of water, and when it has
become full, its neck is played between the jaws of
the clamp, *p*. Upon turning the hand wheel,
L, the bottle and the receptacle that holds it are
lifted, and the mouth of the bottle presses against
a rubber disk fixed under the support, C D. The pressure
of the neck of the bottle against this disk is such
that the closing is absolutely hermetical. The
support, C D, contains an aperture which allows the
interior of the bottle to communicate with a glass
tube, *a b*, which thus forms a prolongation
of the neck of the bottle. This tube is very
narrow and is divided into fiftieths of a cubic centimeter.
A microscope, *m*, fixed in front of the tube,
magnifies the divisions, and allows the position of
the level of the water to be ascertained to within
about a millionth of a cubic centimeter.

A force and suction pump, P, sucks in air through
the tube, *t*, and compresses it through the
tube, *t’*, in the copper tube, T, which
communicates with the glass tube, *a b*, after
passing through the pressure gauge, M. This pump,
then, compresses the air in the bottle, and the gauge
accurately measures its pressure.

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To make a test, after the bottle full of water has
been fastened under the support, C D, the cock, *s*,
is opened and the liquid with which the small reservoir,
R, has been filled flows through an aperture above
the mouth of the bottle and rises in the tube, *a
b*. When its level reaches the division, O,
the cock, *s*, is closed. The bottle and
its prolongation, *a b*, are now exactly full
of water without any air bubbles.

The pump is actuated, and, in measure as the pressure
rises, the level of the liquid in the tube, *a b*,
is seen to descend. This descent measures the
expansion or flexion of the bottle as well as the
compression of the water itself. When the pressure
is judged to be sufficient, the button, *n*,
is turned, and the air compressed by the pump finding
an exit, the needle of the pressure gauge will be seen
to redescend and the level of the tube, *a b*,
to rise.

If the glass of the bottle has undergone no permanent
deformation, the level will rise exactly to the zero
mark, and denote that the bottle has supported the
test without any modification of its structure.
But if, on the contrary, the level does not return
to the zero mark, the limit of the glass’s elasticity
has been extended, its molecules have taken on a new
state of equilibrium, and its resistance has diminished,
and, even if it has not broken, it is absolutely certain
that it has lost its former resistance and that it
presents no particular guarantee of strength.

The vessel, A B, which must be always full of water,
is designed to keep the bottle at a constant temperature
during the course of the experiment. This is
an essential condition, since the bottle thus filled
with water constitutes a genuine thermometer, of which
*a b* is the graduated tube. It is therefore
necessary to avoid attributing a variation in level
due to an expansion of the water produced by a change
in temperature, to a deformation of the bottle.

The test, then, that can be made with bottles by means
of the elasticimeter consists in compressing them
to a pressure of ten atmospheres when filled with
water at a temperature of 25 deg., and in finding
out whether, under such a stress, they change their
volume permanently. In order that the elasticimeter
may not be complicated by a special heating apparatus,
it suffices to determine once for all what the pressure
is that, at a mean temperature of 15 deg., acts upon
bottles with the same energy as that of ten atmospheres
at 25 deg.. Experiment has demonstrated that
such stress corresponds to twelve atmospheres in a
space in which the temperature remains about 15 deg..

In addition, the elasticimeter is capable of giving
other and no less useful data. It permits of
comparing the resistance of bottles and of classifying
them according to the degree of such resistance.
After numerous experiments, it has been found that
first class bottles easily support a pressure of twelve
atmospheres without distortion, while in those of
an inferior quality the resistance is very variable.
The champagne wine industry should therefore use the
former exclusively.

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Various precautions must be taken in the use of corks.
The bottles that lose their wine in consequence of
the bad quality of their corks are many in number,
and it is not long since that they were the cause
of genuine disaster to the champagne trade.

Mr. Salleron has largely contributed to the improving
of the quality of corks found in the market.
The physical and chemical composition of cork bark
is peculiarly favorable to the special use to which
it is applied; but the champagne wine industry requires
of it an exaggerated degree of resistance, inalterability,
and elasticity. A 11/4 inch cork must, under
the action of a powerful machine, enter a 3/4 inch
neck, support the dissolving action of a liquid containing
12 per cent. of alcohol compressed to at least five
atmospheres, and, in a few years, shoot out of the
bottle and assume its pristine form and color.
Out of a hundred corks of good quality, not more than
ten support such a test.

In order to explain wherein resides the quality of
cork, it is necessary to refer to a chemical analysis
of it. In cork bark there is 70 per cent. of
suberine, which is soluble in alcohol and ether, and
is plastic, ductile, and malleable under the action
of humid heat. Mixed with suberine, cerine and
resin give cork its insolubility and inalterability.
These substances are soluble in alcohol and ether,
but insoluble in water.

According to the origin of cork, the wax and resin
exist in it in very variable proportion. The
more resinous kinds resist the dissolving action of
wine better than those that are but slightly resinous.
The latter soon become corroded and spoiled by wine.
An attempt has often been made, but without success,
to improve poor corks by impregnating them with the
resinous principle that they lack.

Various other processes have been tried without success,
and so it finally became necessary simply to separate
the good from the bad corks by a practical and rapid
operation. A simple examination does not suffice.
Mr. Bouche has found that corks immersed in water finally
became covered with brown spots, and, by analogy, in
order to test corks, he immersed them in water for
a fortnight or a month. All those that came out
spotted were rejected. Under the prolonged action
of moisture, the suberine becomes soft, and, if it
is not resinous enough, the cells of the external
layer of the cork burst, the water enters, and the
cork becomes spotted.

It was left to Mr. Salleron to render the method of
testing practical. He compresses the cork in
a very strong reservoir filled with water under a
pressure of from four to five atmospheres. By
this means, the but slightly resinous cork is quickly
dissolved, so that, after a few hours’ immersion,
the bad corks come out spotted and channeled as if
they had been in the neck of a bottle for six months.
On the contrary, good corks resist the operation,
and come out of the reservoir as white and firm as
they were when they were put into it.

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[Illustration: Fig. 2.—­SALLERON’S
APPARATUS FOR TESTING CORKS.]

Fig. 2 gives a perspective view of Mr. Salleron’s
apparatus for testing corks. A reservoir, A B,
of tinned copper, capable of holding 100 corks, is
provided with a cover firmly held in place by a clamp.
Into the cover is screwed a pressure gauge, M, which
measures the internal pressure of the apparatus.

A pump, P, sucks water from a vessel through the tubulure,
*t’*, and forces it through the tubulure,
*t*, into the reservoir full of corks. After
being submitted to a pressure of five atmospheres in
this apparatus for a few hours, the corks are verified
and then sorted out. In addition to the apparatus
here illustrated, there is one of larger dimensions
for industrial applications. This differs from
the other only in the arrangement of its details,
and will hold as many as 10,000 corks.—­*Revue
Industrielle.*
\* \* \* \*
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**IMPROVED BISCUIT MACHINE.**

The accompanying illustration represents a combined
biscuit cutting, scrapping, and panning machine, specially
designed for running at high speeds, and so arranged
as to allow of the relative movements of the various
parts being adjusted while in motion. The cutters
or dies, mounted on a cross head working in a vertical
guide frame, are operated from the main shaft by eccentrics
and vertical connecting rods, as shown. These
rods are connected to the lower strap of the eccentric
by long guide bolts, on which intermediate spiral springs
are mounted, and by this means, although the dies are
brought quickly down to the dough, they are suffered
to remain in contact therewith, under a gradually
increasing pressure, for a sufficient length of time
to insure the dough being effectually stamped and completely
cut through.

[Illustration: IMPROVED BISCUIT MACHINE.]

Further, the springs tend to counteract any tendency
to vibration that might be set up by the rapid reciprocation
of the cross head, cutters, and their attendant parts.
Mounted also on the main shaft is one of a pair of
reversed cone drums. These, with their accompanying
belt and its adjusting gear, worked by a hand wheel
and traversing screw, as shown, serve to adjust the
speed of the feed rollers, so as to suit the different
lengths of the intermediate travel or “skip”
of the dough-carrying web.

Provision is made for taking up the slack of this
belt by mounting the spindle of the outer coned drum
in bearings adjustable along a circular path struck
from the axis of the lower feed roller as a center,
thus insuring a uniform engagement between the teeth
of the small pinion and those of the spur wheel with
which the drum and roller are respectively provided.

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The webs for carrying forward the dough between the
different operations pass round rollers, which are
each operated by an adjustable silent clutch feed,
in place of the usual ratchet and pawl mechanism.
Movement is given to each feed by the connecting links
shown, to each of which motion is in turn imparted
by the bell crank lever placed beside the eccentric.
This lever is actuated by a crank pin on the main
shaft, working into a block sliding in a slot in the
shorter or horizontal arm of the lever, while a similar
but adjustable block, sliding in the vertical arm,
serves to impart the motion of the lever to the system
of connecting links, the adjustable block allowing
of a longer or shorter stroke being given to the different
feeds, as desired.

The scraps are carried over the roller in rear of
the cutters, and so to a scrap pan, while the stamped
biscuits pass by a lower web into the pans. These
pans are carried by two endless chains, provided with
pins, which take hold of the pans and carry them along
in the proper position. The roller over which
these chains pass is operated by a silent clutch,
and in order to give an additional motion to the chains
when a pan is full, and it is desired to bring the
next pan into position, an additional clutch is caused
to operate upon the roller. This clutch is kept
out of gear with its pulley by means of a projection
upon it bearing against a disk slightly greater in
diameter than the pulley, and provided with two notches,
into which the projection passes when the additional
feed is required.

The makers, H. Edwards & Co., Liverpool, have run
one of these machines easily and smoothly at a hundred
revolutions per minute, at which speed, and when absorbing
about 3.5 horse power, the output would equal 4,000
small biscuits per minute.—­*Industries.*
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**IMPROVED CREAM SEPARATOR.**

A hand separator of this type was exhibited at the
Royal Show at Newcastle by the Aylesbury Dairy Company,
of 31 St. Petersburg Place, Bayswater, England.

[Illustration: IMPROVED CREAM SEPARATOR.
Fig. 1.]

[Illustration: IMPROVED CREAM SEPARATOR.
Fig. 2.]

Fig. 1 is a perspective view of the machine, Fig.
2 being a vertical section. The drums of these
machines, which make 2,700 revolutions per minute
for the large and 4,000 for the small one, have a diameter
of 27 in. and 151/2 in. respectively, and are capable
of extracting the cream from 220 and 115 gallons of
milk per hour. These drums are formed by hydraulic
pressure from one piece of sheet steel. To avoid
the possibility of the machines being overdriven, which
might happen through the negligence of the attendant
or through the governing gear on the engine failing
to act, an ingenious controlling apparatus is fixed
to the intermediate motion of the separator as shown
in Fig. 3. This apparatus consists of a pair

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of governor balls pivoted near the center of the arms
and attached to the main shaft of the intermediate
gear by means of a collar fixed on it. The main
shaft is bored out sufficiently deep to admit a steel
rod, against which bear the three ends of the governor
arms. The steel rod presses against the counterbalance,
which is made exactly the right weight to withstand
the force tending to raise it, when the intermediate
motion is running at its designed speed. The
forks between which the belt runs are also provided
with a balance weight. This brings them to the
loose pulley, unless they are fixed by means of the
ratchet. Should the number of revolutions of
the intermediate increase beyond the correct amount,
the extra centrifugal force imparted to the governor
balls enables them to overcome the balance weight,
and in raising this they raise the arm. This
arm striking against the ratchet detent releases the
balance weight, and the belt is at once brought on
to the loose pulley.

[Illustration: IMPROVED CREAM SEPARATOR.
Fig. 3.]

The steel drum is fitted with an internal ring at
the bottom (see Fig. 2), into which the milk flows,
and from which it is delivered, by three apertures,
to the periphery of the drum, thus preventing the
milk from striking against the cone of the drum, and
from mixing with the cream which has already been
separated. The upper part of the drum is fitted
with an annular flange, about 11/2 in. from the top,
reaching to within one-sixteenth of an inch of the
periphery. After the separation of the skim milk
from the cream, the former passes behind and above
this flange through the aperture, B, and is removed
by means of the tube, D, furnished with a steel tip
projecting from the cover of the machine into the
space between the top of the drum and the annular
flange, a similar tube, F, reaching below this flange,
removing the cream which collects there. The skim
milk tube is provided with a screw regulator, the
function of which is to enable cream of any desired
consistency to be obtained, varying with the distance
between the skim milk and cream points from the center
of the drum. Another point about these tubes
is their use as elevating tubes for the skim, milk
and cream, as, owing to the velocity at which the
drum is rotating, the products can be delivered by
these tubes at a height of 8 or 10 feet above the
machine if required, thus enabling scalding and cooling
of either to be carried on while the separator is
at work, and saving hand labor.—­*Iron.*
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**GAS FROM OIL.**

At the twenty-fourth annual meeting of the Gas Institute,
which was recently held in Glasgow, Dr. Stevenson
Macadam, F.R.S.E., lecturer on chemistry, Edinburgh,
submitted the first paper, which was on “Gas
from Oil.”

He said that during the last seventeen years he had
devoted much attention to the photogenic or illuminating
values of different qualities of paraffin oils in
various lamps, and to the production of permanent
illuminating gas from such oils. The earlier experiments
were directed to the employment of paraffin oils as
oils, and the results proved the great superiority
of the paraffin oils as illuminating agents over vegetable
and animal oils, alike for lighthouse and ordinary
house service.

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The later trials were mainly concerned with the breaking
up of the paraffin oils into permanent illuminating
gas. Experiments were made at low heats, medium
heats, and high heats, which proved that, according
to the respective qualities of the paraffin oils employed
in the trials, there was more or less tendency at
the lower heats to distill oil instead of permanent
gas, while at the high heats there was a liability
to decarbonize the oil and gas, and to obtain a thin
gas of comparatively small illuminating power.
When, however, a good cherry red heat was maintained,
the oils split up in large proportion into permanent
gas of high illuminating quality, accompanied by little
tarry matter, and with only a slight amount of separated
carbon or deposited soot.

The best mode of splitting up the paraffin oils, and
the special arrangements of the retort or distilling
apparatus, also formed, he said, an extensive inquiry
by itself. In one set of trials the oil was distilled
into gaseous vapor, and then passed through the retort.
In another set of experiments, the oil was run into
or allowed to trickle into the retorts, while both
modes of introducing the oil were tried in retorts
charged with red hot coke and in retorts free from
coke.

Ultimately, it was found that the best results were
obtained by the more simple arrangement of employing
iron retorts at a good cherry red heat, and running
in the oil as a thin stream direct into the retort,
so that it quickly impinged upon the red hot metal,
and without the intervention of any coke or other
matter in the retorts. The paraffin oils employed
in the investigations were principally: (1) Crude
paraffin oil, being the oil obtained direct from the
destructive distillation of shale in retorts; (2)
green paraffin oil, which is yielded by distilling
or re-running the crude paraffin oil, and removing
the lighter or more inflammable portion by fractional
distillation; and (3) blue paraffin oil, which is obtained
by rectifying the twice run oil with sulphuric acid
and soda, and distilling off the paraffin spirit,
burning oil, and intermediate oil, and freezing out
the solid paraffin as paraffin scale. The best
practical trials were obtained in Pintsch’s apparatus
and in Keith’s apparatus.

After describing both of these, Dr. Macadam went on
to give in great detail the results obtained in splitting
up blue paraffin oil into gas in each apparatus.
He then said that these experimental results demonstrated
that Pintsch’s apparatus yielded from the gallon
of oil in one case 90.70 cubic feet of gas of 62.50
candle power, and in the second case 103.36 cubic
feet of 59.15 candle gas, or an average of 97.03 cubic
feet of 60.82 candle power gas.

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In both cases, the firing of the retorts was moderate,
though in the second trial greater care was taken
to secure uniformity of heat, and the oil was run
in more slowly, so that there was more thorough splitting
up of the oil into permanent gas. The gas obtained
in the two trials was of high quality, owing to its
containing a large percentage of heavy hydrocarbons,
of which there were, respectively, 39.25 and 37.15
per cent., or an average of 38.2 per cent., while the
sulphureted hydrogen was nothing, and the carbonic
acid a mere trace. Besides testing the gas on
the occasion of the actual trials, he had also examined
samples of the gas which he had taken from various
cylinders in which the gas had been stored for several
months under a pressure of ten atmospheres, and in
all cases the gas was found to be practically equal
to the quantity mentioned, and hence of a permanent
character.

By using Keith’s apparatus the results obtained
were generally the same, with the exception that an
average of 0.27 per cent. of carbonic acid gas and
decided proportions of sulphureted hydrogen were found
to be present in the gas. Dr. Macadam devoted
some remarks to the consideration of the question
as to how far the gas obtained from the paraffin oil
represented the light power of the oil itself, and
then he proceeded to say that, taking the crude paraffin
oil at 2d. a gallon, and with a specific gravity of
850 (water = 1,000), or 81/2 lb. to the gallon, there
were 264 gallons to the ton, at a cost of L2 4s. per
ton. The sperm light from the ton of oil as gas
being 3,443 lb., he reckoned that fully 6 lb. of sperm
light were obtained from a pennyworth of the crude
oil as gas.

Then, taking the blue paraffin oil at 4d. per gallon,
and there being 255 gallons to the ton, it was found
that the cost of one ton was L4 5s., and as the sperm
light of a ton of that oil as gas was 5,150 lb., it
was calculated that 5 lb. of sperm light were yielded
in the gas from a pennyworth of the blue oil.
The very rich character of the oil gas rendered it
unsuitable for consumption at ordinary gas jets, though
it burned readily and satisfactorily at small burners
not larger than No. 1 jets.

In practical use it would be advisable to reduce the
quality by admixture with thin and feeble gas, or
to employ the oil gas simply for enriching inferior
gases derived from the more common coals. On
the question of dilution, he said that he preferred
to use carbonic oxide and hydrogen, and most of the
remainder of his paper was devoted to an explanation
of the best mode of preparing those gases (water gases).

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He concluded by saying: The employment of paraffin
oil for gas making has advantages in its favor, in
the readiness of charging the retorts, as the oil
can be run in continuously for days at a time, and
may be discontinued and commenced again without opening,
clearing out residual products, recharging and reclosing
the retorts. There is necessarily, therefore,
less labor and cost in working, and as the gas is
cleaner or freer from impurities, purifying plant and
material will be correspondingly less. Oil gas
is now employed for lighthouse service in the illumination
of the lanterns on Ailsa Craig and as motive power
in the gas engines connected with the fog horns at
Langness and Ailsa Craig lighthouse stations.
It is also used largely in the lighting of railway
carriages. Various populous places are now introducing
oil gas for house service, and he felt sure that the
system is one which ought to commend itself for its
future development to the careful consideration and
practical skill of the members of the Gas Institute.

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**THE MANUFACTURE OF SALT NEAR MIDDLESBROUGH.[1]**

 [Footnote 1: Abstract of paper read
before the Institution of
 Civil
Engineers, May 17, 1887.]

By Sir LOWTHIAN BELL, Bart., F.R.S.

The geology of the Middlesbrough salt region was first
referred to, and it was stated that the development
of the salt industry in that district was the result
of accident. In 1859, Messrs. Bolckow & Vaughan
sank a deep well at Middlesbrough, in the hope of obtaining
water for steam and other purposes in connection with
their iron works in that town, although they had previously
been informed of the probably unsuitable character
of the water if found. The bore hole was put
down to a depth of 1,200 feet, when a bed of salt rock
was struck, which proved to have a thickness of about
100 feet. At that time one-eighth of the total
salt production of Cheshire was being brought to the
Tyne for the chemical works on that river, hence the
discovery of salt instead of water was regarded by
some as the reverse of a disappointment. The
mode of reaching the salt rock by an ordinary shaft,
however, failed, from the influx of water being too
great, and nothing more was heard of Middlesbrough
salt until a dozen years later, when Messrs. Bell
Brothers, of Port Clarence, decided to try the practicability
of raising the salt by a method detailed in the paper.
A site was selected 1,314 yards distant from the well
of Messrs. Bolckow & Vaughan, and the Diamond Rock
Boring Company was intrusted with the work of putting
down a hole in order to ascertain whether the bed
of salt extended under their land. This occupied
nearly two years, when the salt, 65 feet in thickness,
was reached at a depth of 1,127 feet. Other reasons
induced the owners of the Clarence iron works to continue
the bore hole for 150 feet below the bed of salt;
a depth of 1,342 feet from the surface was then reached.
During the process of boring, considerable quantities
of inflammable gas were met with, which, on the application
of flame, took fire at the surface of the water in
the bore hole. The origin of this gas, in connection
with the coal measures underlying the magnesian limestone,
will probably hereafter be investigated.

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For raising the salt, recourse was had to the method
of solution, the principle being that a column of
descending water should raise the brine nearly as
far as the differences of specific gravity between
the two liquids permitted—­in the present
case about 997 feet. In other words, a column
of fresh water of 1,200 feet brought the brine to
within 203 feet of the surface. For the practical
application of this system a hole of say 12 inches
in diameter at the surface was commenced, and a succession
of wrought iron tubes put down as the boring proceeded,
the pipes being of gradually decreasing diameter,
until the bottom of the salt bed was reached.
The portion of this outer or retaining tube, where
it passed through the bed of salt, was pierced with
two sets of apertures, the upper edge of the higher
set coinciding with the top of the seam, and the other
set occupying the lower portion of the tube.
Within the tube so arranged, and secured at its lower
extremity by means of a cavity sunk in the limestone,
a second tube was lowered, having an outer diameter
from two to four inches less than the interior diameter
of the first tube. The latter served for pumping
the brine. The pump used was of the ordinary bucket
and clack type, but, in addition, at the surface, there
was a plunger, which served to force the brine into
an air vessel for the purposes of distribution.
The bucket and clack were placed some feet below the
point to which the brine was raised by the column of
fresh water descending in the annulus formed between
the two tubes. In commencing work, water was
let down the annulus until the cavity formed in the
salt became sufficiently large to admit of a few hours’
pumping of concentrated brine. On the machinery
being set in motion, the stronger brine was first
drawn, which, from its greater specific gravity, occupied
the lower portion of the cavity. As the brine
was raised, fresh water flowed down. The solvent
power of the newly admitted water was of course greater
than that of water partially saturated, and being
also lighter it occupied the upper portion of the excavated
space. The combined effect was to give the cavity
the form of an inverted cone. The mode of extraction
thus possessed the disadvantage of removing the greatest
quantity of the mineral where it was most wanted for
supporting the roof, and had given rise to occasional
accidents to the pipes underground. These were
referred to in detail, and the question was started
as to possible legal complications arising hereafter
from new bore holes put down in close proximity to
the dividing line of different properties, the pumping
of brine formed under the conditions described presenting
an altogether different aspect from the pumping of
water or natural brine.

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The second part of the paper referred to the uses
to which the brine was applied, the chief one being
the manufacture of common salt. For this purpose
the brine, as delivered from the wells, was run into
a large reservoir, where any earthy matter held in
suspension was allowed to settle. The clear solution
was then run into pans sixty feet long by twenty feet
wide by two feet deep. Heat was applied at one
end by the combustion of small coal, beyond which longitudinal
walls, serving to support the pan and to distribute
the heat, conducted the products of combustion to
the further extremity, where they escaped into the
chimney at a temperature of from 500 deg. to 700 deg.
Fahr. On the surface of the heated brine, kept
at 196 deg. Fahr., minute cubical crystals speedily
formed. On the upper surface of these, other
small cubes of salt arranged themselves in such a way
that, in course of time, a hollow inverted pyramid
of crystallized salt was formed. This ultimately
sank to the bottom, where other small crystals united
with it, so that the shape became frequently completely
cubical. Every second day the salt was “fished”
out and laid on drainers to permit the adhering brine
to run back into the pans. For the production
of table salt the boiling was carried on much more
rapidly, and at a higher temperature than for salt
intended for soda manufacture. The crystals were
very minute, and adhered together by the solidification
of the brine, effected by exposure on heated flues.
For fishery purposes the crystals were preferred very
coarse in size. These were obtained by evaporating
the brine more slowly and at a still lower temperature
than when salt for soda makers was required. At
the Clarence works experiments had been made in utilizing
surplus gas from the adjacent blast furnaces, instead
of fuel, under the evaporating pans, the furnaces
supplying more gas than was needed for heating air
and raising steam for iron making. By means of
this waste heat, from 200 to 300 tons of salt per
week were now obtained.

The paper concluded with some particulars of the soda
industry. The well-known sulphuric acid process
of Leblanc had stood its ground for three-quarters
of a century in spite of several disadvantages, and
various modes of utilizing the by-products having been
from time to time introduced, it had until recent
years seemed too firmly established to fear any rivals.
About seven years ago, however, Mr. Solvay, of Brussels,
revived in a practical form the ammonia process, patented
forty years ago by Messrs. Hemming & Dyar, but using
brine instead of salt, and thus avoiding the cost
of evaporation. This process consisted of forcing
into the brine currents of carbonic acid and ammoniacal
gases in such proportions as to generate bicarbonate
of ammonia, which, reacting on the salt of the brine,
gave bicarbonate of soda and chloride of ammonium.
The bicarbonate was placed in a reverberatory furnace,
where the heat drove off the water and one equivalent

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of carbonic acid, leaving the alkali as monocarbonate.
Near Middlesbrough, the only branch of industry established
in connection with its salt trade was the manufacture
of soda by an ammonia process, invented by Mr. Schloesing,
of Paris. The works were carried on in connection
with the Clarence salt works. It was believed
that the total quantity of dry soda produced by the
two ammonia processes, Solvay’s and Schloesing’s,
in this country was something under 100,000 tons per
annum, but this make was considerably exceeded on the
Continent.

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**COTTON INDUSTRIES OF JAPAN.**

The cotton plant principally cultivated in Japan is
of the species known as *Gossypium herbaceum*,
resembling that of India, China, and Egypt. The
plant is of short stature, seldom attaining a growth
of over two feet; the flower is deciduous, with yellow
petals and purple center, and the staple is short,
but fine. It is very widely cultivated in Japan,
and is produced in thirty-seven out of the forty-four
prefectures forming the empire, but the best qualities
and largest quantities are grown in the southern maritime
provinces of the mainland and on the islands of Kiusiu
and Shikoku. Vice consul Longford, in his last
report, says that the plant is not indigenous to Japan,
the seed having been first imported from China in the
year 1558. There are now many varieties of the
original species, and the cultivation of the plant
varies in its details in different localities.
The variations are, however, mostly in dates, and the
general grinding principles of the several operations
are nearly the same throughout the whole country.
The land best suited for cotton growing is one of
a sandy soil, the admixture of earth and sand being
in the proportion of two parts earth to one of sand.
During the winter and spring months, crops of wheat
or barley are raised on it, and it is when these crops
have attained their full height during the month of
May that the cotton is sown. About fifty days
prior to the sowing a manure is prepared consisting
of chopped straw, straw ashes, green grass, rice,
bran, and earth from the bottom of the stagnant pools.
These ingredients are all carefully mixed together
in equal proportions, and the manure thus made is
allowed to stand till required for use. Ten days
before the time fixed for sowing, narrow trenches,
about one inch in depth, are dug in the furrows, between
the rows of standing wheat or barleys and the manure
is liberally sprinkled along them by hand. For
one night before sowing the seed is steeped in water.
It is then taken out, slightly mixed with straw ashes,
and sown in the trenches at intervals of a few inches.
When sown, it is covered with earth to the depth of
half an inch, and gently trampled down by foot.
Four or five days after sowing, the buds begin to
appear above the earth, and almost simultaneously the
wheat or barley between which they grow is ripe for

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the sickle. While the latter is being harvested,
the cotton may be left to itself, but not for very
long. The buds appear in much larger numbers than
the soil could support if they were allowed to grow.
They have accordingly to be carefully thinned out,
so that not more than five or six plants are left
in each foot of length. The next process is the
sprinkling of a manure composed of one part night
soil and three parts water, and again, subsequent
to this, there are two further manurings; one of a
mixture of dried sardines, lees of oil, and lees of
rice beer, which is applied about the middle of June,
when the plant has attained a height of four inches;
and again early in July, when the plant has grown
to a height of six or seven inches, a further manuring
of night soil, mixed with a larger proportion of water
than before. At this stage the head of the plant
is pinched off with the fingers, in order to check
the excessive growth of the stem, and direct the strength
into the branches, which usually number five or six.
From these branches minor ones spring, but the latter
are carefully pruned off as they appear. In the
middle of August the flowers begin to appear gradually.
They fall soon after their appearance, leaving in their
place the pod or peach (*momo*), which, after
ripening, opens in October by three or four valves
and exposes the cotton to view. The cotton is
gathered in baskets, in which it is allowed to remain
till a bright, sunshiny day, when it is spread out
on mats to dry and swell in the sun for two or three
days. After drying, the cotton is packed in bags
made of straw matting, and either sold or put aside
until such time as the farmer’s leisure from
other agricultural operations enables him to deal
with it. The average yield of cotton in good
districts in Japan is about 120 lb. to the acre, but
as cotton is only a secondary crop, this does not
therefore represent the whole profit gained by the
farmer from his land. The prefectures in which
the production is largest are Aichi on the east coast,
Osaka, Hiogo, Hiroshima, and Yamaguchi on the inland
sea, and Fukui and Ishikawa on the west coast.
Vice-consul Longford says that the manufacture of
cotton in Japan is still in all its stages largely
a domestic one. Gin, spindle, and loom are all
found in the house of the farmer on whose land the
cotton is grown, and not only what is required for
the wants of his own family is spun and woven by the
female members thereof, but a surplus is also produced
for sale.

Several spinning factories with important English
machinery have been established during the last twenty
years, but Consul Longford says that he has only known
of one similar cotton-weaving factory, and that has
not been a successful experiment. Other so called
weaving factories throughout the country consist only
of a collection of the ordinary hand looms, to the
number of forty or fifty, scarcely ever reaching to
one hundred, in one building or shed, wherein individual
manufacturers have their own special piece goods made.

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The first operation in the manufacture is that of
ginning, which is conducted by means of a small implement
called the *rokuro*, or windlass. This consists
of two wooden rollers revolving in opposite directions,
fixed on a frame about 12 inches high and 6 inches
in width, standing on a small platform, the dimensions
of which slightly exceed that of the frame. The
operator, usually a woman, kneels on one side of the
frame, holding it firm by her weight, works the roller
with one hand, and with the other presses the cotton,
which she takes from a heap at her side, between the
rollers. The cotton passes through, falling in
small lumps on the other side of the frame, while
the seeds fall on that nearest the woman. The
utmost weight of unginned cotton that one woman working
an entire day of ten hours can give is from 8 lb.
to 10 lb., which gives, in the end, only a little
over 3 lb. weight of ginned cotton, and her daily earnings
amount to less than 2d. A few saw gins have been
introduced into Japan during the last fifteen years,
but no effort has been made to secure their distribution
throughout the country districts. After ginning,
a certain proportion of the seed is reserved for the
agricultural requirements of the following year, and
the remainder is sent to oil factories, where it is
pressed, and yields about one-eighth of its capacity
in measurement in oil, the refuse, after pressing,
being used for manure. The ginning having been
finished in the country districts, the cotton is either
packed in bales and sent to the dealers in the cities,
or else the next process, that of carding, is at once
proceeded with on the spot.

This process is almost as primitive as that of the
ginning. A long bamboo, sufficiently thin to
be flexible, is fastened at its base to a pillar or
the corner of a small room. It slopes upward into
the center of the room, and from its upper end a hempen
cord is suspended. To this is fastened the “bow,”
an instrument made of oak, about five feet in length,
two inches in circumference, and shaped like a ladle.
A string of coarse catgut is tightly stretched from
end to end of the bow, and this is beaten with a small
mallet made of willow, bound at the end with a ring
of iron or brass. The raw cotton, in its coarse
state, is piled on the floor just underneath the string
of the bow. The string is then rapidly beaten
with the mallet, and as it rises and falls it catches
the rough cotton, cuts it to the required degree of
fineness, removes impurities from it, and flings it
to the side of the operator, where it falls on a hempen
net stretched over a four-cornered wooden frame.
The spaces of the net are about one-quarter of an inch
square, and through these any particles of dust that
may still have adhered to the cotton fall to the floor,
leaving piled on top of the net the pure cotton wool
in its finished state. This work is always performed
by a man, and by assiduous toil throughout a long day,
one man can card from ten to twenty pounds weight

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of raw cotton. Payment is made in proportion
to the work done, and in the less remote country districts
is at the rate of about one penny for each pound carded.
As regards spinning and weaving, in the first of these
branches of cotton manufacture the Japanese have largely
had recourse to the aid of foreign machinery, but
it is still to a much greater extent a domestic industry,
or at best carried on like weaving in the establishments
of cotton traders, in which a number of workers, varying
from 20 to 100 or more, each with his own spinning
wheel, are collected together. Consul Longford
says the spinning wheel used in Japan differs in no
respect from that used in the country 300 years ago
or (except that bamboo forms an integral part of the
materials of which it is made) from that used in England
prior to the invention of the jenny. The cost
of one of the wheels is about 9d., it will last for
five or six years, and with it a woman of ordinary
skill can spin about 1 lb. of yarn in a day of ten
hours, earning thereby about 2d. There are at
present in various parts of Japan, in all, 21 spinning
factories worked by foreign machinery. Of four
of these there is no information, but of the remainder,
one has 120 spindles; eleven, 2,000 spindles; two,
3,000 spindles; two, 4,000 spindles; and one, 18,000
spindles.—­*Journal Soc. of Arts.*
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[Continued from SUPPLEMENT, No. 612, page 9774.]

**CENTRIFUGAL EXTRACTORS.**

By ROBERT F. GIBSON.

SUGAR MACHINES.—­Besides separating the
crystalline sugar and the sirup, secondary objects
are to wash the crystals and to pack them in cakes.
The cleansing fluid or “white liquor” is
introduced at the center of the basket and is hurled
against and passes through the sugar wall left from
draining. The basket may be divided into compartments
and the liquor guided into each. The compartments
are removable boxes and are shaped to give bars or
cakes or any form desired of sugar in mass. These
boxes being removable cannot fit tightly against the
liquor guides, and the liquor is apt to escape.
This difficulty is overcome by giving the guides radial
movement or by having rubber packing around the edges.

Sugar machines proper are of two kinds—­those
which are loaded, drained and then unloaded and those
which are continuous in their working. The various
figures preceding are of the first kind, and what has
been said of vibrations applies directly to these.

The general advantages claimed for continuous working
over intermittent are—­that saving is made
of time and motive power incident to introducing charge
and developing velocity, in retarding and stopping,
and in discharging; that, as the power is brought into
the machine continuously, no shifting of belts or
ungearing is necessary; and that there are less of
the dangers incident to variable motion, either in
the machine itself or the belting or gearing.
The magma (the mixture of crystalline sugar and sirup)
is fed in gradually, by which means it is more likely
to assume a position of equilibrium in the basket.

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There are two methods of discharging in continuous
working—­the sugar is thrown out periodically
as the basket fills, or continuously. In neither
case is the speed slackened. In the first either
the upper half of the basket has an upward motion,
on the lower half a downward motion (Pat. 252,483);
and through the opening thus made the sugar is thrown.
Fig. 22 (R.B. Palmer & Sons) is a machine of this
kind. The bottom, B, with the cone distributor,
*a*, have downward motion.

[Illustration: Fig. 22.]

Continuous discharge of the second kind may be brought
about by having a scoop fixed to the curb (or casing),
extending down into the basket and delivering the
sugar over the side (Pat. 144,319). Another method
will be described under “Beet Machines.”

BASKET.—­The construction of the basket
is exceedingly important. Hard experience has
taught this. When centrifugals were first introduced,
users were compelled by law to put them below ground;
for they frequently exploded, owing to the speed being
suddenly augmented by inequalities in the running
of the engine or to the basket being too weak to resist
the centrifugal force of the overcharge. Increasing
the thickness merely adds to the centrifugal force,
and hence to the danger, as even a perfectly balanced
basket may sever.

One plan for a better basket was to have more than
one wall. For example, there might be an inner
wall of perforated copper, then one of wire gauze,
and then another of copper with larger perforations.
Another plan was to have an internal metallic cloth,
bearing against the internally projecting ridges of
the corrugations of the basket wall. A further
complication is to give this internal gauze cylinder
a rotation relative to the basket.

The basket wall has been variously constructed.
In one case it consists of wire wound round and round
and fastened to uprights, commonly known as the “wire
basket;” in another case of a periphery without
perforations, but spirally corrugated and having an
opening at the bottom for the escape of the extracted
liquid; in still another of a series of narrow bars
or rings, placed edgewise, packed as close as desired.
An advantage of this last style is that it is easily
cleaned.

The best basket consists of sheet metal with bored
perforations and having bands or flanges sprung on
around the outside. The metal is brass, if it
is apt to be corroded; if not, sheet iron. The
perforations may be round, or horizontally much longer
than wide vertically. One method for the manufacture
of the basket wall (Pat. 149,553) is to roll down
a plate, having round perforations, to the required
thickness, causing narrowing and elongation of the
holes and at the same time hardening the plate by
compacting its texture. Long narrow slots are
well adapted to catch sugar crystals, and this is not
an unimportant point. Round perforations are usually
countersunk. Instead of flanges, wire bands have
been used, their lapping ends secured by solder.

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As to comparative wear, it maybe remarked that one
perforated basket will outlast three wire ones.

As to size, sugar baskets vary from 80 inches in diameter
by 14 in. depth to 54 by 24. They are made, however,
in England as large as 6 feet in diameter—­a
size which can be run only at a comparatively slow
speed.

A peculiar complication of basket deserves notice
(Pat. 275 874). It had been noticed that when
a charge of magma was put into a centrifugal in one
mass, the sugar wall on the side of the basket was
apt to form irregularly, too thick at base and of varied
color. To remedy this it was suggested to have
within and concentric with the basket a charger with
flaring sides, into which the mixture was to be put.
When this charger reached a certain rotary velocity,
the magma would be hurled out over the edge by centrifugal
force and evenly distributed on the wall of the main
basket.

SPINDLE.—­The spindle as now made is solid
cast steel, and the considerations governing its size,
form, material, *etc*., are identical with those
for any spindle. In order that the basket might
be replaced by another after draining, the shaft has
been made telescopic, but at the expense of stability
and rigidity. In Fig. 16 is shown a device to
avoid crystallizations, which are apt to occur in large
forgings, and would prove fatal should they creep
into the upper part of the spindle proper in a hanging
machine. It consists of the secondary spindle,
*c*.

DISCHARGING.—­The drained sugar may either
be lifted over the top of the basket (in machines
which stop to be emptied), or be cast through openings
in the bottom provided with valves. A section
of the best form of valve may be seen in Figs. 15
and 17. Fig. 23 is a plan of the openings.
The valve turns on the basket bearing. It may
be constructed to open in the same direction in which
the basket turns; so that when the brake is put on,
the inertia of the valve operates to open it and while
running to keep it closed. There are many other
styles, but no other need be mentioned.

[Illustration: Fig. 23.]

CASING.—­The different styles of casing
may be seen by reference to the various drawings.
In one machine (not described) the casing is rigidly
fixed to the basket, space enough being left between
the bottom of the basket and the bottom of the casing
to hold all the molasses from a charge. This
arrangement merely adds to the bulk of the revolving
parts, and no real advantage is gained.

BEARINGS.—­The various styles of bearings
can be seen by reference to the figures. One
which deserves special attention is shown in Fig. 16
and Fig. 19. In one case it consists of loose
disks, in the other of loose washers, rotating on
one another. They are alternately of steel and
hard bronze (copper and tin).

“There is probably no machine so little understood
or so imperfectly constructed by the common manufacturer
of sugar supplies as the high speed separator or centrifugal.”
Unless the product of experience and good workmanship,
it is a dangerous thing at high velocities. Besides,
its usual fate is to have an incompetent workman assigned
to it, who does not use judgment in charging and running.
So that designers and manufacturers have been forced
not only to take into account the disturbing forces
inherent in revolving bodies, but also to make allowance
for poor management in running and neglect in cleaning.

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CANE AND BEET MACHINES.—­The first step
in the process of sugar making is the extraction of
the juice from the beet or cane. This juice is
obtained by pressure. The operation is not usually,
but may be, performed in a special kind of centrifugal.
One style (Pat. 239,222) consists of a conical basket
with a spiral flange within on the shaft, and turning
on the shaft, and having a slight rotary motion relative
to the basket. The material is fed in and moves
downward under increased pressure, the sirup released
flying out through the perforations of the basket,
the whole revolving at high velocity. The solid
portion falls out at the bottom. Another plan
suggested (Pat. 343,932) is to let a loose cover of
an ordinary cylindrical basket screw itself down into
the basket, by reason of its slower velocity (owing
to inertia), causing pressure on the charge.

Various other applications of the different styles
of sugar machines are the defibration of raw sugar
juice, freeing beet crystals of objectionable salts,
freeing various crystals of the mother liquor, drying
saltpeter.

DRIERS.—­Another important division of this
first class of centrifugals is that of driers or,
as they are variously styled, whizzers, wringers,
hydro-extractors. The charge in these is never
large in weight compared to a sugar charge, and its
initial distribution can be made more symmetrical.
The uses of driers are various, such as extracting
water from clothes, cloth, silk, yarns, *etc*.
Water may be introduced at the center of the basket
from above or below to wash the material before draining.
A typical form of drier is shown in Fig. 24. (Pat.
Aug. 22, 1876—­W.P. Uhlinger.) Baskets
have been made removable for use in dyeing establishments,
basket and load together going into dyeing vat.
Yarn and similar material can be drained by a method
analogous to that of hanging it upon sticks in a room
and allowing the water to drip off. It is suspended
from short sticks, which are held in horizontal layers
around the shaft in the basket, and the action is such
during the operation as to cause the yarn to stand
out in radial lines.

[Illustration: Fig. 24.]

Driers are not materially different from sugar machines.
Any of the devices before enumerated for meeting vibrations
in the latter may be applied to the former. There
is one curious invention which has been applied to
driers only (Pat. 322,762—­W.H. Tolhurst).
See Fig. 25. A convex shaft-supporting step resting
on a concave supporting base, with the center of its
arc of concavity at the center of the upper universal
joint, has been employed, and its movements controlled
by springs, but the step was apt to be forced from
its support. The drawing shows the improvement
on this, which is to give the shaft-supporting step
a less radius of curvature.

[Illustration: Fig. 25.]

An interesting form of drier has its own motor, a
little steam engine, attached to the frame of the
machine. See Fig 24. This of course demands
fixed bearings. The engine is very small.
One size used is 3"x4”. When a higher velocity
of basket is required, we have the arrangement in
Fig. 26.

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[Illustration: Fig. 26.]

MOTORS.—­This naturally introduces the subject
of motive power. We may have the engine direct
acting as above, or the power may be brought on by
belting. Fig. 27 shows a drier with pulley for
belting. Fig. 28 (W.H. Tolhurst) shows a
very common arrangement of belting and also the fast
and loose pulleys. When the heaviest part of the
engine is so far from the vertical shaft as to overhang
the casing on one side, there is apt to be an objectionable
tremor. To remedy this, it is suggested to put
these heavy parts as near the shaft as possible.
It has been suggested also to use the Westinghouse
type of engine, although the type shown in Fig. 24
works faultlessly in practice.

[Illustration: Fig. 27.]

One plan (Pat. 346,030), designed to combine the advantages
of a direct acting motor and an oscillating shaft,
mounts the whole machine, motor and all, on a rocking
frame. The spindle is of course in fixed bearings
in the frame. However, the plan is not practical.

[Illustration: Fig. 28.]

In driers the direct acting engine has many advantages
over the belt. The atmosphere is always very
moist about a whizzer, and there are frequently injurious
fumes. The belt will be alternately dry and wet,
stretched and limp, and wears out rapidly and is liable
to sever. In all machines in which the shaft
oscillates, if the center of oscillation does not
lie in the central plane of the belt, the tension
of the latter is not uniform. This affects badly
both the belt and the running. A reference to
the various figures will show the best position for
the pulley.

The greatest difficulty experienced with belting is
in getting up speed and stopping. The basket
must not be started with a sudden impulse. Its
inertia will resist and something must give way.
A gradual starting can be obtained by the slipping
of the belt at first, but this is expensive.
The best plan is to conduct the power through a species
of friction clutch—­an iron disk between
two wooden ones. This has been found to work
admirably.

BRAKES.—­The first centrifugals had no brakes.
They ran until the friction of the bearings was sufficient
to stop them. This occasioned, however, rapid
wearing and too great a loss of time. The best
material for a brake consists of soft wood into which
shoe pegs have been driven, and which is thoroughly
saturated with oil. The wooden disks referred
to just above are of the same construction. The
center of oscillation ought to be in the central plane
of the brake as well as that of the pulley, but the
preference is given to the pulley.

Figs. 15 and 16 (I) give sectional views of a brake
for hanging machines. Figs. 19, 20, and 21 give
two sections and a view of a brake which can be used
on both hanging and standing machines. A very
simple form of brake is shown in Figs. 24, 26, and
27 (A), a mere block pressing on the rim of the basket.

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OIL AND FAT.—­A machine in most respects
like a whizzer is used for the “extraction of
oil and fat and oily and fatty matters from woolen
yarns and fabrics, and such other fibrous material
or mixtures of materials as are from their nature
affected in color or quality when hydrocarbons are
used for the purpose of extracting such oily or fatty
matters, and are subsequently removed from the material
under treatment by the slow process of admitting steam,
or using other means of raising the temperature to
the respective boiling points of such hydrocarbons,
and so driving them off by evaporation.”
In the centrifugal method carbon-bisulphide, or some
other volatile agent, is admitted and is driven through
the material by centrifugal force, when the necessary
reactions take place, and is allowed to escape in the
form of hydrocarbons. A machine differing only
in slight particulars from the above is used for cleansing
wool.

LOOSE FIBER.—­Another application is the
drying of loose fiber. Two distinctive points
deserve to be noticed in the centrifugal used for
this purpose. An endless chain or belt provided
with blades moves the material vertically in the basket,
and discharges it over the edge. During its upward
course the material is subjected to a shower of water
to wash it.

OIL FROM METAL CHIPS.—­Very material savings
are made in many factories by collecting the metal
chips and turnings, coated and mixed with oil, which
fall from the various machines, and extracting the
oil centrifugally. The separator consists of
a chip holder, having an imperforate shell flaring
upward and outward from the spindle (in fixed bearings)
to which it is attached. When filled, a cover
is placed upon it and keyed to the spindle. Between
the cover and holder there is a small annular opening
through which oil, but not chips, can escape.
Fig. 29 (Pat. 225,949—­C.F. Roper) is
designed (like the greater part of the drawings inserted)
to show relative position of parts merely, and not
relative *size*. This style of machine can
be used for sugar separating (Pat. 345,994—­F.P.
Sherman) and many other purposes, to which, however,
there are other styles more especially adapted.

[Illustration: Fig. 29.]

FILTERERS.—­There are two distinct kinds
of centrifugal filterers, working on different principles.
Petroleum separators (Pat. 217,063) are of the first
kind. They are in form in all respects like a
sugar machine. The flakes of paraffine, stearine,
*etc*., which are to be extracted, when chilled
are very brittle and would be disintegrated upon being
hurled against a plain wire gauze and would escape.
Even a woven fabric presents too harsh a surface.
It is necessary to have a very elastic basket lining
of wool, cotton, or other fibrous material. The
basket itself may be either wire or perforated, but
must have a perfectly smooth bottom.

As the pressure of the liquor upon the filtering medium
per unit of surface depends entirely upon its radial
depth, mere tubes, connecting a central inlet with
an annular compartment, will serve the purpose quite
as well as a whole basket. In this style of machine
(Pat. 10,457) the filtering material constitutes a
wall between two annular compartments. The outer
one is connected with a vacuum apparatus.

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Filterers of the second kind work on the following
principle: If a cylinder be rapidly revolved
in a liquid in which solid particles are suspended,
the liquid will be drawn into a like rotation and the
heavy particles will be thrown to the outer part of
the receptacle. If a perforated cylinder is used
as stirrer, the purified liquid will escape into it
through the perforations and may be conducted away.
The impurities, likewise, after falling down the sides
of the receptacle, are carried off. The advantages
of this method are that no filtering material is needed
and the filtering surface is never in contact with
anything but pure liquor.

Very fine sawdust is, to a considerable extent, employed
in sugar refineries as a filtering medium. By
such use the sawdust becomes mixed with sand, fine
particles of cane, *etc*. As sawdust of such
fineness is expensive, it is desirable to purify it
in order to reuse it. A centrifugal (Pat. 353,775—­J.V.V.
Booraem) built on the following principle is used
for this purpose. It has been observed that by
rotating rather *slowly* small particles of various
substances in water, the finer particles will be thrown
outward and deposit near the circumference of the
vessel, while the heavier and coarser particles will
deposit nearer to or at the center, their centrifugal
force not being sufficient to carry them out.
A mere rod, extending radially in both directions,
serves by its rotation to set the water in motion.

Another form of filter of this second kind (Pat. 148,513)
has a rotating imperforate basket into which the impure
liquor is run. Within and concentric with it
is another cylinder whose walls are of some filtering
medium. The liquid already partly purified by
centrifugal force passes through into the inner cylinder,
thus becoming further purified. Centrifugal filters
are used also to cleanse gums for varnishes.

HONEY.—­The simplest form of honey extractor
(Pat. 61,216) consists of a square framework, symmetrical
with respect to a vertical spindle. This framework
is surrounded by a wire gauze. The combs, after
having the heads of the cells cut off, are placed
in comb-holders against the wire netting on the four
sides, the cells pointing outward. The machine
is turned by hand. The honey is hurled against
the walls of a receiving case and caught below.
But few improvements have been made on this. The
latest machines are still hand-driven, as a sufficiently
high velocity can be obtained in this manner.
In one style the combs are placed upon a floor which
rests upon springs. The rotating box is given
a slight vertical and horizontal reciprocatory motion,
by which the combs are made to grate on the wire gauze
sides, breaking the cells and liberating the honey.
Thus the labor of cutting the cells is saved.
Every comb has two sides, and to present each side
in succession to the outside without removing from
the basket, several devices have been patented.

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In some the comb holders are hinged in the corners
of the basket, and have an angular motion of ninety
degrees. Decreasing the speed is sufficient to
swing these. The other side is then emptied by
revolving in the opposite direction. In one case
each holder has a spindle of its own, connected with
the main spindle by gearing and, to present opposite
side, turns through 180 deg.. The usual number
of sides and hence of comb holders is four, but eight
have been used. There are minor differences in
details of construction, looking to the most convenient
removal and insertion of comb, the reception of the
extracted honey in cups, buckets, *etc*., and the
best method of giving rapid rotation, which cannot
be touched upon. The product of the operation
is white and opaque, but upon heating regains its golden
color and transparency.

STARCH.—­A centrifugal to separate starch
from triturated grain, carried in suspension in water,
is as follows. (Pat. 273,127—­Mueller &
Decastro.) The starch water is led to the bottom of
a basket, and, as starch is heavier than the gluten
with which it is mixed, the former will be immediately
compacted against the periphery of the basket, lodging
first in the lower corner, the starch and gluten forming
two distinct strata. A tube with a cutting edge
enters the compacted mass so deeply as to peel off
the gluten and part of the starch, which is carried
through the tube to another compartment of the basket,
just above, where the same operation is performed,
and so on. There may be only one compartment,
the tube carrying the gluten directly out of the machine.
These machines are continuous working, and hence some
way must be devised to carry the water off. The
inner surface of the water is, as we have seen, a
cylinder. When the diameter of this cylinder becomes
too small, overflow must be allowed. One plan
is to have an overflow opening made in the bottom
of the basket in such a way that as the starch wall
thickens, the opening recedes toward the center.
The starch wall is either lifted out in cakes or put
again in suspension by spraying water on it and conducting
the mixture off.

A centrifugal (Pat. 74,021) to separate liquids from
paints depends on building a wall of paint on the
sides of the basket and carrying the liquids off at
the center.

A centrifugal (Pat. 310,469) for assorting wood pulp,
paper pulp, *etc*., works by massing the constituents
in two or three cylindrical strata, and after action
severing and removing these separately.

BREWING.—­In brewing, centrifugals are quite
useful. After the wort has been boiled with hops,
albuminous matters are precipitated by the tannic
acid, which must be extracted. Besides these the
mixture frequently contains husk, fiber, and gluten.
The machine (Pat. 315,876), although quite unique
in construction, has the same principle of working
as a sugar centrifugal, and need not be described.
There is one point, however, which might be noticed—­that
air is introduced at about the same point as the material,
and has an oxidizing and refrigerating effect.

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Class I. includes also centrifugals for the following
purposes: The removal of must from the grape
after crushing, making butter, extracting oils from
solid fats, separating the liquid and solid parts
of sewerage, drying hides, skins, spent tan and the
like, drying coils of wire.

HORIZONTAL CENTRIFUGALS.—­Only vertical
machines have been and will be dealt with. Horizontal
centrifugals, that is, those whose spindles are horizontal
have been made, but the great inconvenience of charging
and discharging connected with them has occasioned
their disuse; though in other respects for liquids
they are quite as good as vertical separators.
Their underlying theory is practically the same as
that hereinbefore discussed.

CLASS II., CREAMERS.—­Centrifugals of the
second class separate liquids from liquids. There
are two main applications in this class—­to
separate cream from milk and fusel oil from alcoholic
liquors. When a liquid is to be separated from
a liquid, the receptacle must be imperforate.
The components of different specific gravity become
arranged in distinct concentric cylindrical strata
in the basket, and must be conducted away separately.
In creamers the particles of cream must not be broken
or subjected to any concussion, as partial churning
is caused and the cream will, in consequence, sour
more rapidly.

The chief cause of oscillations in machines of this
class, where the charge is liquid, is the waves which
form on the inner surface. They may be met by
allowing a slight overflow over the inner edge of the
rim of the basket; or by having either horizontal
partitions, or vertical, radial ones, special cases
of which will be noticed. Oscillations may also
be met in the same manner as in sugar machines, by
allowing the revolving parts to revolve about an axis
through their common center of gravity. (Pat. 360,342—­J.
Evans.)

The crudest form of creamer contains a number of bottles,
with their necks all directed toward the spindle,
filled with milk. The necks, in which the cream
collects, are graduated to tell when the operation
is complete.

Many methods for introducing the milk into creamers
have been devised. It may run in from the top
at the center, or emerge from a pipe at the bottom
of the basket; or the spindle may be hollow and the
milk sucked up through it from a basin below.
It is usual to let the milk enter under hydrostatic
pressure (Pat. 239,900—­D. M. Weston)
and let the force of expulsion of the cream be dependent
on this pressure. This renders the escape quiet,
and prevents churning. Gravity, too, is made
effective in carrying the constituents off.

The cream may escape through a passage in the bottom
at the center, and the skim milk at the lower outer
corner; or by ingeniously managed passages both may
escape at or near center. The rate of discharge
can be managed by regulating the size of opening of
exit passages.

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A curious method consists in having discharge pipes
provided with valves and floats at their lower ends,
dipping into the liquid (Pat. 240,175). “The
valves are opened and closed, or partially opened or
closed, by the floats attached to them, these floats
being so constructed and arranged with reference to
their specific gravity and the specific gravity of
the component parts of the liquids operated upon,
that they will permit only a liquid of a determinate
specific gravity to escape through the pipes to which
they are respectively attached.”

We may have tubes directed into the different strata
with cutting edges. (Pat. 288,782.) A remarkable fact
noticed in their use is that these edges wear as rapidly
as if solids were cut instead of liquids.

The separated fluids may be received into recessed
rings, having discharge pipes, the proportionate quantity
discharged being regulated by the proximity of the
discharge lips to the surface of the ring, and the
centrifugal force being availed of to project the liquids
through the discharge pipes.

There is a very simple device by which a very rapid
circulation of the liquid is brought about. (Pat.
358,587—­C.A. Backstrom.) The basket
has radial vertical partitions, all but one having
communicating holes, alternately in upper and lower
corners. The milk is delivered into the basket
on one side of this imperforate partition and must
travel the whole circuit of the basket through these
communicating holes, until it reaches the partition
again, and then passes into a discharge pipe.
Thus during this long course every particle of cream
escapes to the center. As the holes are close
to the walls of the basket, the cream has not the
undulatory motion of the milk, which would injure it.
The greater the number of partitions, the longer is
the travel of the milk, and the more rapid the circulation.
Blades have been devised similar to the above, having
communicating passages extending the whole width of
the blade, but we see that here the cream would circulate
with the milk; which must not be allowed. Curved
blades have been used, and paddles and stirrers, to
set the milk in motion, but to them the same objection
may be made.

[Illustration: Fig. 30]

Fig. 30 (Pat. 355,048—­C.A. Backstrom)
illustrates one of the latest and best styles of creamers.
The milk enters at C. The skim milk passes into tube,
T, and the cream goes to the center and passes out
of the openings in the bottom, *k^{l}*, *k^{2}*,
and *k^{3}*, out of the slit, k, and thence out
through D^{5}. The skim milk moves through T,
becoming more thoroughly separated all the while, and
at each of the radial branch tubes, T^{1}, T^{2},
T^{3}, and T^{4}, some cream leaves it and goes to
the center, while it passes down out of slit, t^{3},
and thence out of D^{6}.

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Fig. 31 (Pat. 355,050—­C.A. Backstrom)
shows another very late style of creamer. A pipe
delivers the milk into P^{4}. Passing out of the
tube separation takes place, and cream falls down
the center to P^{2} and out of O^{3}. When the
compartment under the first shelf becomes full of
the skim milk, the latter passes up through the slot,
S, strikes a radial partition, R, and its course is
reversed. Here more cream separates and passes
to center and falls directly, and so on through the
whole series of annular compartments, until the top
one, when the skim milk enters tube T^{2} and passes
out of O^{2}. By this operation there are substantially
repeated subjections of specified quantities of milk
to the action of centrifugal force, bringing about
a thorough separation. By changing the course
of the milk in direction, its path is made longer.
This machine can run at much lower speed than many
other styles, and yet do the same work.

[Illustration: Fig. 31]

CLASS III., SOLIDS FROM SOLIDS.—­As for
grain machines, which are in this class, it may be
said that in centrifugal flour bolters, bran cleaners,
and middlings purifiers, though theoretically centrifugal
force plays an important part in their action, yet
practically the real separation is brought about by
other agencies: in some by brushes which rub
the finer particles through wire netting as they rotate
against it.

The principle exhibited in a separator of grains and
seeds is very neat. (Pat. 167,297.) See Fig. 32.
That part of the machine with which we have to do
consists essentially of a horizontal revolving disk.
The mixed grains are cast on this disk, pass to the
edge, and are hurled off at a tangent. Suppose
at A. Each particle is immediately acted on by three
forces. For all particles of the same size and
having the same velocity the resistance of the air
may be taken the same, that is, proportional to the
area presented. The acceleration of gravity is
the same; but the inertia of the heavier grain is
greater. The resultant of the two conspiring
forces R and (M\_v\_^{2})/2 varies, and is greater for
a heavier grain. Therefore, the paths described
in the air will vary, especially in length; and how
this is utilized the drawing illustrates.

[Illustration: Fig. 32.]

ORE.—­In ore machines there is one for pulverizing
and separating coal (Pat. 306,544), in which there
is a breaker provided with helical blades or paddles,
partaking of rapid rotary motion within a stationary
cylinder of wire netting. The dust, constituting
the valuable part of the product, is hurled out as
fast as formed. In this style of machine, beaters
are necessary not only for pulverizing, but to get
up rotary motion for generating centrifugal force.
In the classes preceding, the friction of the basket
sufficed for this latter purpose; but here there is
no rotating basket and no definite charge. As
the material falls through the machine, separation
takes place. Various kinds of ore may be treated
in the same manner.

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An “ore concentrator” (Pat. 254,123),
as it is called, consists of a pan having rotary and
oscillatory motions. Crushed ore is delivered
over the edge in water. The heavy particles of
the metal are thrown by centrifugal force against
the rim of the pan, overcoming the force of the water,
which carries the sand and other impurities in toward
the center and away.

AMALGAMATORS.—­The best ore centrifugal
or separator is what is called an “amalgamator.”
The last invention (Pat. 355,958, White) consists
essentially of a pan, a meridian section of which would
give a curve whose normal at any point is in the direction
of the resultant of the centrifugal force at that
point and gravity. There is a cover to this pan
whose convexity almost fits the concavity of the pan,
leaving a space of about an inch between. Crushed
ore with water is admitted at the center between the
cover and the pan, and is driven by centrifugal force
through a mass of mercury (which occupies part of this
space between the two) and out over the edge of the
pan. The particles of metal coming in contact
with the mercury amalgamate, and as the speed is regulated
so that it is never great enough to hurl the mercury
out, nothing but sand, water, *etc*., escape.
There have been many different constructions devised,
but this general principle runs through all. By
having annular flanges running down from the cover
with openings placed alternately, the mixture is compelled
to follow a tortuous course, thus giving time for
all the gold or other metal to become amalgamated.
There are ridges in the pan, too, against which the
amalgam lodges. It is claimed for this machine
that not a particle of the precious metal is lost,
and experiments seem to uphold the claim.

A machine for separating fine from coarse clay for
porcelain or for separating the finer quality of plumbago
from the coarser for lead pencils uses an imperforate
basket, against the wall of which the coarser part
banks and catches under the rim. The finer part
forms an inner cylindrical stratum, but is allowed
to spill over the edge of the rim. The mixture
is introduced at the bottom of the basket at the center.

CLASS IV., GASES AND SOLIDS.—­There is a
very simple contrivance illustrating machines of this
class used to free air from dust or other heavy solid
impurities which may be in suspension. See Fig.
33. The air enters the passage, B (if it has
no considerable velocity of itself, it must be forced
in), forms a whirlpool in the conically shaped receptable,
A, and passes up out of the passage, D. The heavy particles
are thrown on the sides and collect there and fall
through opening, C, into some closed receiver.

[Illustration: Fig. 33]

CLASS V., GASES AND LIQUIDS.—­The occluded
gases in steel and other metal castings, if not separated,
render the castings more or less porous. This
separation is effected by subjecting the molten metal
to the action of centrifugal force under exclusion
of air, producing not only the most minute division
of the particles, but also a vacuum, both favorable
conditions for obtaining a dense metal casting.

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Most of the devices for drying steam come under this
head. Such are those in which the steam with
the water in suspension is forced to take a circular
path, by which the water is hurled by centrifugal force
against the concave side of the passage and passes
back to the water in the boiler.

SPEED.—­The centrifugal force of a revolving
particle varies, as we have seen, as the square of
the angular velocity, so that the effort has been
to obtain as high a number of revolutions per minute
as was consistent with safety and with the principle
of the machine. For example, creamers which are
small and light make 4,000 revolutions per minute,
though the latest styles run much more slowly.
Driers and sugar machines vary from 600 to 2,000,
while on the other hand the necessity of keeping the
mercury from hurling off in an amalgamator prevents
its turning more rapidly than sixty or eighty times
a minute.

However, speed in another sense, the speed with which
the operation is performed, is what especially characterizes
centrifugal extractors. In this particular a
contrast between the old methods and the new is impressive.
Under the action of gravity, cream rises to the milk’s
surface, but compare the hours necessary for this to
the almost instantaneous separation in a centrifugal
creamer. The sugar manufacturer trusted to gravity
to drain the sirup from his crystals, but the operation
was long and at best imperfect. An average sugar
centrifugal will separate 600 pounds of magma perfectly
in three minutes. Gold quartz which formerly
could not pay for its mining is now making its owners’
fortunes. It is boasted by a Southern company
that whereas they were by old methods making twenty-five
*cents* per ton of gold quartz, they now by the
use of the latest amalgamator make twenty-five *dollars*.
Centrifugal force, as applied in extractors, has opened
up new industries and enlarged old ones, has lowered
prices and added to our comforts, and centrifugal
extractors may well command, as they do, the admiration
of all as wonderful examples of the way in which this
busy age economizes time.

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**A NEW TYPE OF RAILWAY CAR.**

[Illustration: Fig. 1.—­CAR WITH LATERAL
PASSAGEWAYS.]

Figs. 1 and 2 give a perspective view and plan of
a new style of car recently adopted by the Bone-Guelma
Railroad Company, and which has isolated compartments
opening upon a lateral passageway. In this arrangement,
which is due to Mr. Desgranges, the lateral passageway
does not extend all along one side of the car, but
passes through the center of the latter and then runs
along the opposite side so as to form a letter S.
The car consists in reality of two boxes connected
beneath the transverse passageway, but having a continuous
roof and flooring. The two ends are provided
with platforms that are reached by means of steps,
and that permit one to enter the corresponding half

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of the car or to pass on to the next. The length
from end to end is 33 feet in the mixed cars, comprising
two first-class and four second-class compartments,
and 32 feet in cars of the third class, with six compartments.
The width of the compartments is 5.6 and 5 feet, according
to the class. The passageway is 28 inches in width
in the mixed cars, and 24 in those of the third class.
The roof is so arranged as to afford a circulation
of cool air in the interior.

[Illustration: Fig. 2.—­PLAN.]

The application of the zigzag passageway has the inconvenience
of slightly elongating the car, but it is advantageous
to the passengers, who can thus enjoy a view of the
landscape on both sides of the train.—­*La
Nature.*
\* \* \* \*
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**FOUNDATIONS OF THE CENTRAL VIADUCT OF CLEVELAND, O.**

The Central viaduct, now under construction in the
city of Cleveland, is probably the longest structure
of the kind devoted entirely to street traffic.
The superstructure is in two distinct portions, separated
by a point of high ground. The main portion, extending
across the river valley from Hill street to Jennings
avenue, is 2,840 feet long on the floor line, including
the river bridge, a swing 233 feet in length; the
other portion, crossing Walworth run from Davidson
street to Abbey street, is 1,093 feet long. Add
to these the earthwork and masonry approaches, 1,415
feet long, and we have a total length of 5,348 feet.
The width of roadway is 40 feet, sidewalks 8 feet each.
The elevation of the roadway above the water level
at the river crossing is 102 feet. The superstructure
is of wrought iron, mainly trapezoidal trusses, varying
in length from 45 feet to 150 feet. The river
piers are of first-class masonry, on pile and timber
foundations. The other supports of the viaduct
are wrought iron trestles on masonry piers, resting
on broad concrete foundations. The pressure on
the material beneath the concrete, which is plastic
blue clay of varying degrees of stiffness mixed with
fine sand, is about one ton per square foot.

The Cuyahoga valley, which the viaduct crosses from
bluff to bluff, is composed mainly of blue clay to
a depth of over 150 feet below the river level.
No attempt is made to carry the foundation to the rock.
White oak piles from 50 to 60 feet in length and 10
inches in diameter at small end are driven for the
bridge piers either side of the river bed, and these
are cut off with a circular saw 18 feet below the
surface of the water. Excavation by dredging was
made to a depth of 3 feet below where the piles are
cut off to allow for the rising of the clay during
the driving of the piles. The piles are spaced
about 2 feet 5 inches each way, center to center.
The grillage or platform covering the piles consists
of 14 courses of white oak timber, 12 inches by 12
inches, having a few pine timbers interspersed so as

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to allow the mass to float during construction.
The lower half of the platform was built on shore,
care being taken to keep the lower surface of the
mass of timber out of wind. The upper and lower
surfaces of each timber were dressed in a Daniels planer,
and all pieces in the same course were brought to
a uniform thickness. The timbers in adjacent
courses are at right angles to each other. The
lower course is about 58 feet by 22 feet, the top course
about 50 by 24 feet, thus allowing four steps of one
foot each all around. The first course of masonry
is 48 feet by 21 feet 8 inches; the first course of
battered work is 41 feet 81/2 inches by 16 feet 3 inches.
Thus the area of the platform on the piles is 1,856
square feet, and of the first batter course of masonry
777.6 square feet, or in the ratio of 2.4 to 1.
The height of the masonry is 78 feet above the timber,
or 731/2 feet above the water. The number of
piles in each foundation is 312. The average
load per pile is about 11 tons, and the estimated
pressure per square inch of the timber on the heads
of the piles is about 200 pounds.

To prevent the submersion of the lower courses of
masonry during construction, temporary sides of timber
were drift-bolted to the margin of the upper course
of the timber platform, and carried high enough to
be above the surface of the water when the platform
was sunk to the head of the piles by the increasing
weight of masonry.

The center pier is octagonal, and is built in the
same general manner as to foundations as the shore
piers, but the piles are cut off 22 feet below water,
and there are eighteen courses of timber in the grillage.
The diameter of the platform between parallel sides
is 53 feet, while that of the lower course of battered
masonry is but 37 feet. The areas are as 2,332
to 1,147, or as 2 to 1 nearly. The pressure per
square inch of timber on the heads of the piles is
about the same as stated above for the shore piers.
The number of piles under the center pier is 483.

The risks and delays by this method of constructing
the foundations were much less, and the cost also,
than if an ordinary coffer dam had been used.
Also the total weight of the piers is much less, as
that portion below a point about two feet below the
water adds nothing to their weight.

The piles were driven with a Cram steam hammer weighing
two tons, in a frame weighing also two tons.
The iron frame rests directly upon the head of the
pile and goes down with it. The fall of the hammer
is about 40 inches before striking the pile.
The total penetration of the piles into the clay averaged
27 feet. The settlement of the pile during the
final strokes of the hammer varied from one quarter
to three quarters of an inch per blow.

There are 122 masonry pedestals, of which eight are
large and heavy, carrying spans of considerable length.
They will all be built upon concrete beds, except
a few near the river on the north side, where piles
are required.

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The four abutments with their retaining walls are
of first-class rock-faced masonry. The footing
courses are stepped out liberally, so as to present
an unusually large bottom surface. They rest on
beds of concrete 4 feet thick. The foundation
pits are about 50 feet below the top of the bluffs,
and are in a material common to the Cleveland plateau,
a mixture of blue sand and clay, with some water.
The estimated load of masonry on the earth at the
bottom of the concrete is one and seven tenths tons
to the square foot. Two of the large abutments
were completed last season. They show an average
settlement of three eighths of an inch since the lower
footing courses were laid.

The facts and figures here given regarding the viaduct
were kindly furnished by the city civil engineer,
C.G. Force, who has the work in charge.—­*Jour.
Asso. of Eng. Societies.*
\* \* \* \*
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For sticking paper to zinc, use starch paste with
which a little Venice turpentine has been incorporated,
or else use a dilute solution of white gelatine or
isinglass.

\* \* \* \*
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**CENTRIFUGAL PUMPS AT MARE ISLAND NAVY YARD, CALIFORNIA.[1]**

 [Footnote 1: Built by the Southwark
Foundry and Machine Company,
 of
Philadelphia.]

By H.R. CORNELIUS.

In December, 1883, bids were asked for by the United
States government on pumping machinery, to remove
the water from a dry dock for vessels of large size.

The dimensions of the dock, which is situated on San
Pablo Bay, directly opposite the city of Vallejo,
are as follows:

Five hundred and twenty-nine feet wide at its widest
part, 36 feet deep, with a capacity at mean tide of
9,000,000 gallons.

After receiving the contract, several different sizes
of pumps were considered, but the following dimensions
were finally chosen: Two 42 inch centrifugal
pumps, with runner 66 inches in diameter and discharge
pipes 42 inches, each driven direct by a vertical engine
with 28 inch diameter cylinder and 24 inch stroke.

These were completed and shipped in June, 1885, on
nine cars, constituting a special train, which arrived
safely at its destination in the short space of two
weeks, and the pumps were there erected on foundations
prepared by the government.

From the “Report of the Chief of Bureau of Yards
and Docks” I quote the following account of
the official tests:
“The board appointed to make the test resolved to fill the dock to about the level that would attain in actual service with a naval ship of second rate in the dock, and the tide at a stage which would give the minimum pumping necessary to free the dock.  The level of the 20th altar was considered as the proper point, and the water was admitted through two of the gates of the caisson until this level was reached; they were then closed.  The contents of the dock at this point is 5,963,921 gallons.
 “The trial was
commenced and continued to completion without
 any interruption in
a very satisfactory manner.

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“In the separate trials had of each pump, the average discharge per minute was taken of the whole process, and there was a singular uniformity throughout with equal piston speed of the engine.“It was to be expected, and in a measure realized, that during the first moments of the operations, when the level of the water in the dock was above the center of the runner of the pumps, that the discharge would be proportioned to the work done, where no effort was necessary to maintain a free and full flow through the suction pipes; but as the level passed lower and farther away from the center there was no apparent diminution of the flow, and no noticeable addition to the load imposed on the engine.  The variation in piston speed, noted during the trial, was probably due to the variation of the boiler pressure, as it was difficult to preserve an equal pressure, as it rose in spite of great care, owing to the powerful draught and easy steaming qualities of the boilers.“After the trial of the second pump had been completed the dock was again filled through the caisson, and as both pumps were to be tried, the water was admitted to a level with the 23d altar, containing 7,317,779 gallons, which was seven feet above the center of the pumps; this was in favor of the pumps for the reasons before stated.  In this case all the boilers were used.“Everything moved most admirably, and the performance of these immense machines was almost startling.  By watching the water in the dock it could be seen to lower bodily, and so rapidly that it could be detected by the eye without reference to any fixed point.“The well which communicates with the suction tunnel was open, and the water would rise and fall, full of rapid swirls and eddies, though far above the entrance of these tunnels.  Through the man hole in the discharge culvert the issuance from the pipes could be seen, and its volume was beyond conception.  It flowed rapidly through the culvert, and its outfall was a solid prism of water, the full size of the tunnel, projecting far into the river.“During a pumping period of 55 minutes, the dock had been emptied from the twenty-third to two inches above the sixth altar, containing 6,210,698 gallons, an average throughout of 112,922 gallons per minute.  At one time, when the revolutions were increased to 160 per minute, the discharge was 137,797 gallons per minute.  This is almost a river, and is hardly conceivable.  After the pumps were stopped, on this occasion, tests were made with each in succession as to the power of the ejectors with which each is fitted to recharge the pumps.“The valves in the discharge pipe were closed and steam admitted to the ejector, the pump being still and no water in the gauge glass on the pump casing, which must be full before the pumps will work.  The suction pipe of

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the ejector is only two and a half inches in diameter, the steam pipe one inch in diameter.  To fully charge the pumps at this point required filling the pump casing and the suction pipe containing about 2,000 gallons; this was accomplished in four minutes, and when the gauge glass was full the pump operated instantly and with certainty, discharging its full volume of water.“I went on several occasions down in the valve pits on the ladder of the casing, and to all accessible parts while in motion at its highest speed, and there was no undue vibration, only a uniform murmur of well-balanced parts, and the peculiar clash of water against the sides of the casing as its velocity was checked by the blank spaces in the runner.“The pumps are noisy while at work, due to the clashing of the water just mentioned, but it affords a means of detecting any faulty arrangements of the runner or unequal discharge from any of its openings.  While moving at a uniform speed, this clashing has a tone whose pitch corresponds with that velocity of discharge, and if this tone is lacking in quality, or at all confused, there is want of equality of discharge through the various openings of the runner.  To this part I gave close attention, and there was nothing that the ear could detect to indicate aught but the nicest adjustment.  The bearings of the runners worked with great smoothness, and did not become at all heated.  Through a simple, novel arrangement, these bearings are lubricated and kept cool.  There is a constant circulation of water from the pumps by means of a small pipe, which completes a circuit to an annular in the bearings back to the discharge pipe while the pump is in motion, requiring no oil and making it seemingly impossible to heat these bearings.“The large cast steel valves placed in the embouchement of the casing, it was thought, might act to check the free discharge, and arrangements were provided for raising and keeping them open by a long lever key attached to their axes of revolution, but, to our great surprise, at the first gush from the pumps these valves, weighing nearly 1,500 pounds, were lifted into their recessed chambers, giving an unobstructed opening to the flow, and they floated on its surface unsupported, save by the swiftly flowing water, without a movement, while the pump was in operation.
 “The steam-actuated
valves in the suction and discharge pipes
 worked very well, and
the water cushion gave a slow, uniform
 motion, and without
shock, either in opening or closing them.

 “The engines worked
noiselessly, without shock or labor. At
 no time during the trial
was the throttle valve open more
 than three-eighths of
an inch.

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“The indicator cards taken at various intervals gave 796 horse power, and the revolutions did not exceed 160 at any time, though it was estimated that 900 horse power and 210 revolutions would be necessary to attain the requisite delivery.  So that there is a large reserve of power available at any time.“The erection of this massive machinery has been admirably done.  The parts, as sent from the shops of the contractor, have matched in all cases without interference here; and, when lowered into place, its final adjustment was then made without the use of chisel or file, and has never been touched since.“The joints of the steam and water connections were perfect, and the method of concentrating all valves, waste pipes, and important movements at the post of the engineer in charge gives him complete control of the whole system of each engine and pump without leaving his place, and reduces to a minimum the necessary attendance.  All the parts are strong and of excellent design and workmanship; simple, and without ornamentation.
 “Looking down
upon them from a level of the pump house
 gallery, they are impressive
and massive in their simplicity.
“The government is well worth of congratulation in possessing the largest pumping machinery of this type and of the greatest capacity in the world, and the contractors have reason to be proud of their work.”—­*Proc.  Eng.  Club.*
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**THE PART THAT ELECTRICITY PLAYS IN CRYSTALLIZATION.**

Since the discovery of the multiplying galvanometer,
we know for an absolute certainty that in every chemical
action there is a production of electricity in a more
or less notable quantity, according to the nature
of the bodies in presence. Though, in the play
of *affinity*, there is a manifestation of electricity,
is it the same with *cohesion*, which also is
a chemical force?

We know, on another hand, that, on causing electricity
to intervene, we bring about the crystallization of
a large number of substances. But is the converse
true? Is spontaneous crystallization accompanied
with an appreciable manifestation of electricity?
If we consult the annals of science and works treating
on electricity in regard to this subject, we find
very few examples and experiments proper to elucidate
the question.

Mr. Mascart is content to say: “Some experiments
seem to indicate that the solidification of a body
produces electricity.” Mr. Becquerel does
more than doubt—­he denies: “As
regards the disengagement of electricity in the changing
of the state of bodies, we find none.”
This assertion is too sweeping, for further along we
shall cite facts that prove, on the contrary, that
in the phenomena of crystallization (to speak of this
change of state only) there is an unequivocal production
of electricity. Let us remark, in the first place,
that when a number of phenomena of physical and chemical
order incontestably testify to the very intimate correlation
that exists between the molecular motions of bodies
and their electrical state, it would not be very logical
to grant that electricity is absent in crystallization.

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Thus, to select an example from among physical effects,
the vibratory phenomena that occur in telephone transmissions,
under the influence of a very feeble electric current,
show us that the molecular constitution of a solid
body is extremely variable, although within slight
limits. The feeblest modification in the electric
current may be shown by molecular motions capable
of propagating themselves to considerable distances
in the conducting wire. Conversely, it is logical
to suppose that a modification in the molecular state
of a body must bring electricity into play. If,
in the phenomena of solidification, and particularly
of crystallization, we collect but small quantities
of electricity, that may be due to the fact that,
under the experimental conditions involved, the electricity
is more or less completely absorbed by the work of
crystal building.

On another hand, the behavior of electricity shows
in advance the multiple role that this agent may play
in the various physical, chemical, and mechanical
phenomena.

There is no doubt that electricity exists immovable
or in circulation everywhere, latent or imperceptible,
around us, and within ourselves, and that it enters
as a cause into the majority of the chemical, physical,
and mechanical phenomena that are constantly taking
place before our eyes. A body cannot change state,
nature, temperature, form, or place, even, without
electricity being brought into play, and without its
accompanying such modifications, if it presides therein.
Like heat, it is *the* natural agent *par excellence*;
it is the invisible and ever present force which,
in the ultimate particles of matter, causes those
motions, vibrations, and rotations that have the effect
of changing the properties of bodies. Upon entering
their intimate structure, it orients or groups their
atoms, and separates their molecules or brings them
together. From this, would it not be surprising
if it did not intervene in the wonderful phenomenon
of crystallization? Crystallization, in fact,
depends upon *cohesion*, and, in the thermic
theory, this force is not distinct from affinity,
just as solution and dissociation are not distinct
from combination.

On this occasion, it is necessary to say that, between
affinity, heat, and electricity there is such a correlation,
such a dependency, that physicists have endeavored
to reduce to one single principle all the causes that
are now distinct. The mechanical theory of heat
has made a great stride in this direction.

The equivalence of the thermic, mechanical and chemical
forces has been demonstrated; the only question hereafter
will be to select from among such forces the one that
must be adopted as the sole principle, in order to
account for all the phenomena that depend upon these
causes of various orders. But in the present state
of science, it is not yet possible to explain completely
by heat or electricity, taken isolatedly, all the
effects dependent upon the causes just mentioned.
We must confine ourselves for the present to a study
of the relations that exist between the principal
natural forces—­affinity, molecular forces,
heat, electricity, and light. But from the mutual
dependence of such forces, it is admitted that, in
every natural phenomenon, there is a more or less
apparent simultaneous concurrence of these causes.

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In order to explain electric or magnetic phenomena,
and also those of crystallization, it is admitted
that the atoms of which bodies are composed are surrounded,
each of them, with a sort of atmosphere formed of
electric currents, owing to which these atoms are attracted
or repelled on certain sides, and produce those varied
effects that we observe under different circumstances.
According to this theory, then, atoms would be small
electro-magnets behaving like genuine magnets.
Entirely free in gases, but less so in liquids and
still less so in solids, they are nevertheless capable
of arranging themselves and of becoming polarized
in a regular order, special to each kind of atom,
in order to produce crystals of geometrical form characteristic
of each species. Thus, as Mr. Saigey remarks
in “Physique Moderne” (p. 181): “So
long as the atmospheres of the molecules do not touch
each other, no trace of cohesion manifests itself;
but as soon as they come together force is born.
We understand why the temperatures of fusion and solidification
are fixed for the same body. Such effects occur
at the precise moment at which these atmospheres,
which are variable with the temperature, have reached
the desired diameter.”

[Illustration: Figs. 1., 2., and 3.]

Although the phenomenon of crystallization does not
essentially depend upon temperature, but rather upon
the relative quantity of liquid that holds the substance
in solution, it will be conceived that a moment will
arrive when, the liquid having evaporated, the atmospheres
will be close enough to each other to attract each
other and become polarized and symmetrically juxtaposed,
and, in a word, to crystallize.

Before giving examples of the production of electricity
in the phenomenon of crystallization, it will be well
to examine, beforehand, the different circumstances
under which electricity acts as the determining cause
of crystallization or intervenes among the causes
that bring about the phenomenon. In the first
place, two words concerning crystallization itself:
We know that crystallization is the passage, or rather
the result of the passage, of a body from a liquid
or gaseous state to a solid one. It occurs when
the substance has lost its cohesion through any cause
whatever, and when, such cause ceasing to act, the
body slowly returns to a solid state.

Under such circumstances, it may take on regular,
geometrical forms called crystalline. Such conditions
are brought about by different processes—­fusion,
volatilization, solution, the dry way, wet way, and
electric way. Further along, we shall give some
examples of the last named means.

Let us add that crystallization may be regarded as
a general property of bodies, for the majority of
substances are capable of crystallizing. Although
certain bodies seem to be amorphous at first sight,
it is only necessary to examine their fracture with
a lens or microscope to see that they are formed of
a large number of small juxtaposed crystals.
Many amorphous precipitates become crystalline in
the long run.

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In the examination of the various crystallizations
that occupy us, we shall distinguish the following:
(1) Those that are produced through the direct intervention
of the electric current; (2) those in which electricity
is manifestly produced by small voltaic couples resulting
from the presence of two different metals in the solution
experimented with; (3) those in which there are no
voltaic couples, but in which it is proved that electricity
is one of the causes that concur in the production
of the phenomenon; (4) finally, those in which it is
rational, through analogy with the preceding, to infer
that electricity is not absent from the phenomenon.

I. We know that, by means of voltaic electricity or
induction, we can crystallize a large number of substances.

Despretz tried this means for months at a time upon
carbon, either by using the electricity from a Ruhmkorff
coil or the current from a weak Daniell’s battery.
In both cases, he obtained on the platinum wires a
black powder, in which were found very small octohedral
crystals, having the property of polishing rubies
rapidly and perfectly—­a property characteristic
of diamonds.

The use of voltaic apparatus of high tension has allowed
Mr. Cross to form a large number of mineral substances
artificially, and among these we may mention carbonate
of lime, arragonite, quartz, arseniate of copper,
crystalline sulphur, *etc*.

As regards products formed with the concurrence of
electricity (oxides, sulphides, chlorides, iodides,
*etc*.), see “Des Forces Physico-Chimiques,”
by Becquerel (p. 231).

There is no doubt as to the part played by electricity
in the chemical effects of electro-metallurgy, but
it will not prove useless for our subject to remark
that when, in this operation, the current has become
too weak, the deposit of metal, instead of forming
in a thin, adherent, and uniform layer, sometimes
occurs under the form of protuberances and crystalline,
brittle nodules. When, on the contrary, the current
is very strong, the deposit is pulverulent, that is,
in a confused crystallization or in an amorphous state.

Further along, we shall find an application of this
remark. We obtain, moreover, all the intermediate
effects of cohesion, form, and color of galvanic deposits.

When, into a solution of acetate of lead, we pass
a current through two platinum electrodes, we observe
the formation, at the negative pole, of numerous arborizations
of metallic lead that grow under the observer’s
eye (Fig. 1). The phenomenon is of a most interesting
character when, by means of solar or electric light,
we project these brilliant vegetations on a screen.
One might believe that he was witness of the rapid
growth of a plant (Fig. 2). The same phenomenon
occurs none the less brilliantly with a solution of
nitrate of silver. A large number of saline solutions
are adapted to these decompositions, in which the
metal is laid bare under a crystalline form.
Further along we shall see another means of producing
analogous ramifications, without the direct use of
the electric current.—­*C. Decharme,
in La Lumiere Electrique.*

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**ELECTRIC TIME.**

By M. LIPPMANN.

The unit of time universally adopted, the second,
undergoes only very slow secular variations, and can
be determined with a precision and an ease which compel
its employment. Still it is true that the second
is an arbitrary and a variable unit—­arbitrary,
in as far as it has no relation with the properties
of matter, with physical constants; variable, since
the duration of the diurnal movement undergoes causes
of secular perturbation, some of which, such as the
friction of the tides, are not as yet calculable.

We may ask if it is possible to define an absolutely
invariable unit of time; it would be desirable to
determine with sufficient precision, if only once
in a century, the relation of the second to such a
unit, so that we might verify the variations of the
second indirectly and independently of any astronomical
hypothesis.

Now, the study of certain electrical phenomena furnishes
a unit of time which is absolutely invariable, as
this magnitude is a specific constant. Let us
consider a conductive substance which may always be
found identical with itself, and to fix our ideas let
us choose mercury, taken at the temperature of 0 deg.
C., which completely fulfills this condition.
We may determine by several methods the specific electric
resistance, [rho], of mercury in absolute electrostatic
units; [rho] is a specific property of mercury, and
is consequently a magnitude absolutely invariable.
Moreover, [rho] is *an interval of time*.
We might, therefore, take [rho] as a unit of time,
unless we prefer to consider this value as an imperishable
standard of time.

In fact, [rho] is not simply a quantity the measure
of which is found to be in relation with the measure
of time. It is a concrete interval of time, disregarding
every convention established with reference to measures
and every selection of unit. It may at first sight,
appear singular that an interval of time is found
in a manner hidden under the designation *electric
resistance*. But we need merely call to mind
that in the electrostatic system the intensities of
the current are speeds of efflux and that the resistances
are times, *i.e*., the times necessary for the
efflux of the electricity under given conditions.
We must, in particular, remember what is meant by
the specific resistance, [rho] of mercury in the electrostatic
system. If we consider a circuit having a resistance
equal to that of a cube of mercury, the side of which
= the unit of length, the circuit being submitted
to an electromotive force equal to unity, this circuit
will take a given time to be traversed by the unit
quantity of electricity, and this time is precisely
[rho]. It must be remarked that the selection
of the unit of length, like that of the unit of mass,
is indifferent, for the different units brought here
into play depend on it in such a manner that [rho]
is not affected.

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It is now required to bring this definition experimentally
into action, *i.e*., to realize an interval of
time which may be a known multiple of [rho].
This problem may be solved in various ways,[1] and
especially by means of the following apparatus.

 [Footnote 1: In this system
the measurement of time is not
 effected, as ordinarily, by
observing the movements of a
 material system, but by experiments
of equilibrium. All the
 parts of the apparatus remain
immovable, the electricity alone
 being in motion. Such
appliances are in a manner clepsydrae. This
 analogy with the clepsydrae
will be perceived if we consider the
 form of the following experiment:
Two immovable metallic plates
 constitute the armatures of
a charged condenser, and attract
 each other with a force, F.
If the plates are insulated, these
 charges remain constant, as
well as the force, F. If, on the
 contrary, we connect the armatures
of resistance, R, their
 charges diminish and the force,
F, becomes a function of the
 time, *t*; the time,
*t*, inversely becomes a function of P. We
 find *t* by the following
formula:

 t
= [rho] x (lS / S[pi]es) x log hyp(F0/F)
F0 and F being the values of the force at the beginning and at the end of the time, *t*.  The above formula is independent of the choice of units.  If we wish *t* to be expressed in seconds, we must give [rho] the corresponding value ([rho] = 1.058 X 10^-16).  If we take [rho] as a unit we make [rho] = 1, and we find the absolute value of the time by the expression:
 (lS)
/ (8[pi]es) log hyp(F0/F)
We remark that this expression of time contains only abstract numbers, being independent of the choice of the units of length and force.  S and *e* denote surface and the thickness of the condenser; *s* and *l* the section and the length of a column of mercury of the resistance, R. This form of apparatus enables us practically to measure the notable values of *t* only if the value of the resistance, R, is enormous, the arrangement described in the text has not the same inconvenience.]
A battery of an arbitrary electromotive force, E,
actuates at the same time the two antagonistic circuits
of a differential galvanometer. In the first
circuit, which has a resistance, R, the battery sends
a continuous current of the intensity, I; in the second
circuit the battery sends a discontinuous series of
discharges, obtained by charging periodically by means
of the battery a condenser of the capacity, C, which
is then discharged through this second circuit.
The needle of the galvanometer remains in equilibrium
if the two currents yield equal quantities of electricity
during one and the same time, [tau].

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Let us suppose this condition of equilibrium
realized and the needle remaining motionless at zero;
it is easy to write the conditions of equilibrium.
During the time, [tau], the continuous current yields
a
E
quantity of electricity = —­ [tau]; on the
other hand, each charge of
R
the condenser = CE, and during the time, [tau], the
number of
[tau]
discharges = -----, t being the fixed time between
two discharges;
t
[tau] and t are here supposed to be expressed by the
aid of an arbitrary unit of time; the second circuit
yields, therefore, a
[tau]
quantity of electricity equal to CE x -----.
The condition of
t
E [tau]
equilibrium is then ---[tau] = CE x ----- ; or, more
simply, t = CR.
R t
C and R are known in absolute values, *i.e*., we
know that C is equal to *p* times the capacity
of a sphere of the radius, *l*; we have, therefore,
C = *pl*; in the same manner we know that R is
equal to *q* times the resistance of a cube of
mercury having l for its side. We
l [rho]
have, therefore, R = q[rho] --- = q ----- ; and consequently
t = pq[rho].
l squared l

Such is the value of *t* obtained on leaving
all the units undetermined. If we express [rho]
as a function of the second, we have *t* in seconds.
If we take [rho] = 1, we have the absolute value [Theta]
of the same interval of time as a function of this
unit; we have simply [Theta] = *pq*.

If we suppose that the commutator which produces the
successive charges and discharges of the condenser
consists of a vibrating tuning fork, we see that the
duration of a vibration is equal to the product of
the two abstract numbers, *pq*.

It remains for us to ascertain to what degree of approximation
we can determine *p* and *q*. To find
*q* we must first construct a column of mercury
of known dimensions; this problem was solved by the
International Bureau of Weights and Measures for the
construction of the legal ohm. The legal ohm
is supposed to have a resistance equal to 106.00 times
that of a cube of mercury of 0.01 meter, side measurement.
The approximation obtained is comprised between 1/50000
and 1/200000. To obtain *p*, we must be able
to construct a plane condenser of known capacity.
The difficulty here consists in knowing with a sufficient
approximation the thickness of the stratum of air.
We may employ as armatures two surfaces of glass, ground
optically, silvered to render them conductive, but
so slightly as to obtain by transparence Fizeau’s
interference rings. Fizeau’s method will
then permit us to arrive at a close approximation.
In fine, then, we may, *a priori*, hope to reach
an approximation of one hundred-thousandth of the
value of *pq*.

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Independently of the use which may be made of it for
measuring time in absolute value, the apparatus described
possesses peculiar properties. It constitutes
a kind of clock which indicates, registers, and, if
needful, corrects automatically its own variations
of speed. The apparatus being regulated so that
the magnetic needle may be at zero, if the speed of
the commutator is slightly increased, the equilibrium
is disturbed and the magnetic needle deviates in the
corresponding direction; if on the contrary the speed
diminishes, the action of the antagonistic circuit
predominates, and the needle deviates in the contrary
direction. These deviations, when small, are proportional
to the variations of speed. They may be, in the
first place, observed. They may, further, be
registered, either photographically or by employing
a Redier apparatus, like that which M. Mascart has
adapted to his quadrant electrometer; finally, we
may arrange the Redier to react upon the speed so
as to reduce its variations to zero. If these
variations are not completely annulled, they will still
be registered and can be taken into account.

As an indicator of variations this apparatus can be
of remarkable sensitiveness, which may be increased
indefinitely by enlarging its dimensions.

With a battery of 10 volts, a condenser of a microfarad,
10 discharges per second, and a Thomson’s differential
galvanometer sensitive to 10^{-10} amperes, we obtain
already a sensitiveness of 1/1000000, *i.e*., a
variation of 1/1000000 in the speed is shown after
some seconds of a deviation of one millimeter.
Even the stroboscopic method does not admit of such
sensitiveness.

We may therefore find, with a very close approximation,
a speed always the same on condition that the solid
parts of the apparatus (the condenser and the resistance)
are protected from causes of variation and used always
at the same temperature. Doubtless, a well-constructed
astronomical clock maintains a very uniform movement;
but the electric clock is placed in better conditions
for invariability, for all the parts are massive and
immovable; they are merely required to remain unchanged,
and there is no question of the wear and tear of wheel-work,
the oxidation of oils, or the variations of weight.
In other words, the system formed by a condenser and
a resistance constitutes a standard of time easy of
preservation.

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**NEW METHOD OF MAINTAINING THE VIBRATION OF A PENDULUM.**

A recent number of the *Comptes Rendus* contains
a note by M.J. Carpentier describing a method
of maintaining the vibrations of a pendulum by means
of electricity, which differs from previous devices
of the same character in that the impulse given to
the pendulum at each vibration is independent of the
strength of the current employed, and that the pendulum
itself is entirely free, save at the point of suspension.
The vibrations are maintained, not by direct impulsion,
but by a slight horizontal displacement of the point
of suspension in alternate directions.

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This, as M. Carpentier observes, is the method which
we naturally adopt in order to maintain the amplitude
of swing of a heavy body suspended from a cord held
in the hand. The required movement of the point
of suspension is effected by means of a polarized relay,
through the coils of which the current is periodically
reversed by the action of the pendulum, in a manner
which will presently be explained. The armature
of the relay oscillates between two stops whose distance
apart is capable of fine adjustment.

It is clear, therefore, that the impulse is independent
of the strength of the current in the relay, provided
that the armature is brought up to the stop on either
side. The reversal of the current is effected
by means of a small magnet carried by the bob of the
pendulum, and which as it passes underneath the point
of suspension is brought close to a soft iron armature,
which has the form of an arc of a circle described
about the point of suspension. This armature is
pivoted at its center, and thus executes vibrations
synchronously with those of the pendulum. These
vibrations are adjusted to a very narrow range, but
are sufficient to close the contacts of a commutator
which reverses the current at each semi-vibration
of the pendulum.

The beauty and ingenuity of this device will readily
be appreciated.

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**DR. MORELL MACKENZIE.**

The name of the great English laryngologist, which
has long been honored by scientists of England and
the Continent, has lately become familar to everyone,
even in unprofessional circles, in Germany because
of his operations on the Crown Prince’s throat.
If his wide experience and great skill enable him
to permanently remove the growth from the throat of
his royal patient, if his diagnosis and prognosis
are confirmed, so that no fear need be entertained
for the life and health of the Crown Prince, the English
specialist will certainly deserve the most sincere
thanks of the German nation. Every phase of this
treatment, every new development, is watched with suspense
and hope.

Many have been unable to suppress the expression of
regret that this important case was not under the
care of a German, and part of the press look upon
it as unjust treatment of the German specialists.
But science is international, it knows no political
boundaries, and the choice of Dr. Mackenzie by the
family of the Crown Prince, whose sympathy with England
is natural, cannot be considered a slight to German
physicians when it is taken into consideration that
the German authorities pronounced the growth suspicious
and advised a difficult and doubtful operation, and
that Prof. v. Bergman recommended that a foreign
authority be consulted. As Dr. Mackenzie removed
the obstruction, which had already become threatening
and, in fact, dangerous, causing a loss of voice,
and promised to remove any new growth from the inside

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without danger to the patient, the Crown Prince naturally
trusted him. Since Virchow has made a microscopic
examination of the part which was cut away, and has
declared the new growth to be benign, all Germans
should watch the results of Dr. Mackenzie’s
operations with sympathy, trusting that all further
growth will be prevented, and that the Crown Prince
will be restored to the German people in his former
state of health.

[Illustration: DR. MORELL MACKENZIE.]

Dr. Morell Mackenzie has lately reached his fiftieth
year, and has attained the height of his fame as an
author and practitioner. He was born at Leytonston
in 1837, and studied first in London. At the age
of twenty-two he passed his examination, then practiced
as physician in the London Hospital, and obtained
his degree in 1862. A year later he received
the Jackson prize from the Royal Society of Surgeons
for his treatment of a laryngeal case.

He completed his studies in Paris, Vienna (with Siegmund),
and Budapest. In the latter place he worked with
Czermak, making a special study of the laryngoscope.
Later he published an excellent work on “Diseases
of the Throat and Nose,” which was the fruit
of twelve years’ work. The evening before
the day on which this work was to have been issued,
the whole edition was destroyed by a fire which occurred
in the printing establishment, and had to be reprinted
from the proof sheets, which were saved. In 1870
his work “On Growths in the Throat” appeared,
and he has also published many articles in the *British
Medical Journal*, the *Lancet*, *Medical
Times and Gazette*, *etc*., which have been
translated into different languages, making his name
renowned all over Europe.

Since he founded the first English hospital for diseases
of the throat and chest, in London in 1863, and held
the position of lecturer on diseases of the throat
in the London Medical College, his career has been
watched with interest by the public, and his practice
in England is remarkable. Therefore it is no
wonder that his lately published work “On the
Hygiene of the Vocal Organs” has reached its
fourth edition already. This work is read not
only by physicians, but also by singers and lecturers.

As a learned man in his profession, as an experienced
diagnostician, and as a skillful and fortunate practitioner,
he is surpassed by none; and his ability will be well
known far beyond the borders of Great Britain if fortune
favors him and he restores the future Emperor of Germany
to his former strength and vigor, without which we
cannot imagine this knightly form. The certainty
with which Dr. Mackenzie speaks of permanent cures
which he has effected in similar cases, together with
the clear and satisfactory report of the great pathologist
Virchow, lead us to look to the future with confidence.—­*Illustrirte
Zeitung.*
\* \* \* \*
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**HYPNOTISM IN FRANCE.[1]**

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 [Footnote 1: Translated for *Science*
from *Der Spinx*.]

The voluntary production of those abnormal conditions
of the nerves which to-day are denoted by the term
“hypnotic researches” has manifested itself
in all ages and among most of the nations that are
known to us. Within modern times these phenomena
were first reduced to a system by Mesmer, and, on
this account, for the future deserve the attention
of the scientific world. The historical description
of this department, if one intends to give a connected
account of its development, and not a series of isolated
facts, must begin with a notice of Mesmer’s
personality, and we must not confound the more recent
development of our subject with its past history.

The period of mesmerism is sufficiently understood
from the numerous writings on the subject, but it
would be a mistake to suppose that in Braid’s
“Exposition of Hypnotism” the end of this
subject had been reached. In a later work I hope
to show that the fundamental ideas of biomagnetism
have not only had in all periods of this century capable
and enthusiastic advocates, but that even in our day
they have been subjected to tests by French and English
investigators from which they have issued triumphant.

The second division of this historical development
is carried on by Braid, whose most important service
was emphasizing the subjectivity of the phenomena.
Without any connection with him, and yet by following
out almost exactly the same experiments, Professor
Heidenhain reached his physiological explanations.
A third division is based upon the discovery of the
hypnotic condition in animals, and connects itself
to the *experimentum mirabile*. In 1872 the
first writings on this subject appear from the pen
of the physiologist Czermak; and since then the investigations
have been continued, particularly by Professor Preyer.

While England and Germany were led quite independently
to the study of the same phenomena, France experienced
a strange development, which shows, as nothing else
could, how truth everywhere comes to the surface,
and from small beginnings swells to a flood which carries
irresistibly all opposition with it. This fourth
division of the history of hypnotism is the more important,
because it forms the foundation of a transcendental
psychology, and will exert a great influence upon
our future culture; and it is this division to which
we wish to turn our attention. We have intentionally
limited ourselves to a chronological arrangement,
since a systematic account would necessarily fall
into the study of single phenomena, and would far
exceed the space offered to us.

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James Braid’s writings, although they were discussed
in detail in Littre and Robin’s “Lexicon,”
were not at all the cause of Dr. Philips’ first
books, who therefore came more independently to the
study of the same phenomena. Braid’s theories
became known to him later by the observations made
upon them in Beraud’s “Elements of Physiology”
and in Littre’s notes in the translation of Mueller’s
“Handbook of Physiology;” and he then wrote
a second brochure, in which he gave in his allegiance
to braidism. His principal effort was directed
to withdrawing the veil of mystery from the occurrences,
and by a natural explanation relegating them to the
realm of the known. The trance caused by regarding
fixedly a gleaming point produces in the brain, in
his opinion, an accumulation of a peculiar nervous
power, which he calls “electrodynamism.”
If this is directed in a skillful manner by the operator
upon certain points, it manifests itself in certain
situations and actions that we call hypnotic.
Beyond this somewhat questionable theory, both books
contained a detailed description of some of the most
important phenomena; but with the practical meaning
of the phenomena, and especially with their therapeutic
value, the author concerned himself but slightly.
Just on account of this pathological side, however,
a certain attention has been paid to hypnotism up
to the present time.

In the year 1847 two surgeons in Poictiers, Drs. Ribaut
and Kiaros, employed hypnotism with great success
in order to make an operation painless. “This
long and horrible work,” says a journal of the
day, “was much more like a demonstration in
a dissecting room than an operation performed upon
a living being.” Although this operation
produced such an excitement, yet it was twelve years
later before decisive and positive official intelligence
was given of these facts by Broca, Follin, Velpeau,
and Guerinau. But these accounts, as well as
the excellent little book by Dr. Azam, shared the fate
of their predecessors. They were looked upon
by students with distrust, and by the disciples of
Mesmer with scornful contempt.

The work of Demarquay and Giraud Teulon showed considerable
advance in this direction. The authors, indeed,
fell back upon the theory of James Braid, which they
called stillborn, and of which they said, “*Elle
est restee accrochee en route*;” but they
did not satisfy themselves with a simple statement
of facts, as did Gigot Suard in his work that appeared
about the same time. Through systematic experiments
they tried to find out where the line of hypnotic phenomena
intersected the line of the realm of the known.
They justly recognized that hypnotism and hysteria
have many points of likeness, and in this way were
the precursors of the present Parisian school.
They say that from magnetic sleep to the hypnotic
condition an iron chain can be easily formed from
the very same organic elements that we find in historical
conditions.

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At the same time, as if to bring an experimental proof
of this assertion, Lasigue published a report on catalepsy
in persons of hysterical tendencies, which be afterward
incorporated into his larger work. Among his
patients, those who were of a quiet and lethargic
temperament, by simply pressing down the eyelids, were
made to enter into a peculiar state of languor, in
which cataleptic contractions were easily produced,
and which forcibly recalled hypnotic phenomena.
“One can scarcely imagine,” says the author,
“a more remarkable spectacle than that of a
sick person sunk in deep sleep, and insensible to
all efforts to arouse him, who retains every position
in which he is placed, and in it preserves the immobility
and rigidity of a statue.” But this impulse
also was in vain, and in only a few cases were the
practical tests followed up with theoretical explanations.

Unbounded enthusiasm and unjust blame alike subsided
into a silence that was not broken for ten years.
Then Charles Richet, a renowned scientist, came forward
in 1875, impelled by the duty he felt he owed as a
priest of truth, and made some announcements concerning
the phenomena of somnambulism; and in countless books,
all of which are worthy of attention, he has since
then considered the problem from its various sides.

He separates somnambulism into three periods.
The word here is used for this whole class of subjects
as Richet himself uses it, *viz*., *torpeur*,
*excitation*, and *stupeur*. In the
first, which is produced by the so-called magnetic
passes and the fixing of the eyes, silence and languor
come over the subject. The second period, usually
produced by constant repetition of the experiment,
is characterized chiefly by sensibility to hallucination
and suggestion. The third period has as its principal
characteristics supersensibility of the muscles and
lack of sensation. Yet let it be noticed that
these divisions were not expressed in their present
clearness until 1880; while in the years between 1872
and 1880, from an entirely different quarter, a similar
hypothesis was made out for hypnotic phenomena.

Jean Martin Charcot, the renowned neurologist of the
Parisian Salpetriere, without exactly desiring it,
was led into the study of artificial somnambulism
by his careful experiments in reference to hysteria,
and especially by the question of *metallotherapie*,
and in the year 1879 had prepared suitable demonstrations,
which were given in public lectures at the Salpetriere.
In the following years he devoted himself to closer
investigation of this subject, and was happily and
skillfully assisted by Dr. Paul Richer, with whom were
associated many other physicians, such as Bourneville,
Regnard, Fere, and Binet. The investigations
of these men present the peculiarity that they observe
hypnotism from its clinical and nosographical side,
which side had until now been entirely neglected, and
that they observe patients of the strongest hysterical
temperaments. “If we can reasonably assert
that the hypnotic phenomena which depend upon the
disturbance of a regular function of the organism demand
for their development a peculiar temperament, then
we shall find the most marked phenomena when we turn
to an hysterical person.”

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The inferences of the Parisian school up to this time
are somewhat the following, but their results, belonging
almost entirely to the medical side of the question,
can have no place in this discussion. They divide
the phenomena of hystero-hypnotism, which they also
call *grande hysterie*, into three plainly separable
classes, which Charcot designates catalepsy, lethargy,
and somnambulism.

Catalepsy is produced by a sudden sharp noise, or
by the sight of a brightly gleaming object. It
also produces itself in a person who is in a state
of lethargy, and whose eyes are opened. The most
striking characteristic of the cataleptic condition
is immobility. The subject retains every position
in which he is placed, even if it is an unnatural
one, and is only aroused by the action of suggestion
from the rigor of a statue to the half life of an
automaton. The face is expressionless and the
eyes wide open. If they are closed, the patient
falls into a lethargy.

In this second condition, behind the tightly closed
lids, the pupils of the eyes are convulsively turned
upward. The body is almost entirely without sensation
or power of thought. Especially characteristic
of lethargy is the hyper-excitability of the nerves
and muscles (*hyperexcitabilite neuromusculaire*),
which manifests itself at the slightest touch of any
object. For instance, if the extensor muscles
of the arm are lightly touched, the arm stiffens immediately,
and is only made flexible again by a hard rubbing of
the same muscles. The nerves also react in a
similar manner. The irritation of a nerve trunk
not only contracts all the small nerves into which
it branches, but also all those muscles through which
it runs.

Finally, the somnambulistic condition proceeds from
catalepsy or from lethargy by means of a slight pressure
upon the *vertex*, and is particularly sensitive
to every psychical influence. In some subjects
the eyes are open, in others closed. Here, also,
a slight irritation produces a certain amount of rigor
in the muscle that has been touched, but it does not
weaken the antagonistic muscle, as in lethargy, nor
does it vanish under the influence of the same excitement
that has produced it. In order to put an end to
the somnambulistic condition, one must press softly
upon the pupil of the eye, upon which the subject
becomes lethargic, and is easily roused by breathing
upon him. In this early stage, somnambulism appears
very infrequently.

Charcot’s school also recognize the existence
of compound conditions, the history of whose symptoms
we must not follow here. These slightly sketched
results, as well as a number of other facts, were only
obtained in the course of several years; yet in 1882
the fundamental investigations of this school were
considered virtually concluded. Then Dumont-Pallier,
the head of the Parisian Hospital Pitie, came forward
with a number of observations, drawn also exclusively
from the study of hystero-hypnotism, and yet differing
widely from those reached by the physicians of the
Salpetriere. In a long series of communications,
he has given his views, which have in their turn been
violently attacked, especially by Magnin and Berillon.
I give only the most important points.

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According to these men, the hyper-excitability of
the nerves and muscles is present not only in the
lethargic condition, but in all three periods; and
in order to prove this, we need only apply the suitable
remedy, which must be changed for each period and every
subject. Slight irritations of the skin prove
this most powerfully. A drop of warm water or
a ray of sunshine produces contractions of a muscle
whose skin covering they touch.

Dumont-Pallier and Magnin accede to the theory of
intermediate stages, and have tried to lay down rules
for them with as great exactness as Charcot’s
school. They also are very decided about the three
periods, whose succession does not appear to them
as fixed; but they discovered a new fundamental law
which regulates the production as well as the cessation
of the condition—­*La cause qui fait, defait*;
that is, the stimulus which produces one of the three
periods needs only to be repeated in order to do away
with that condition. From this the following
diagram of hypnotic conditions is evolved:

[Illustration]

And, furthermore, Dumont-Pallier should be considered
as the founder of a series of experiments, for he
was the first one to show in a decisive manner that
the duality of the cerebral system was proved by these
hypnotic phenomena; and his works, as well as those
of Messrs. Berillon and Descourtis, have brought to
light the following facts: Under hypnotic conditions,
the psychical activity of a brain hemisphere may be
suppressed without nullifying the intellectual activity
or consciousness. Both hemispheres may be started
at the same time in different degrees of activity;
and also, when the grade is the same, they may be
independently the seat of psychical manifestations
which are in their natures entirely different.
In close connection with this and with the whole doctrine
of hemi-hypnotism, which is founded upon these facts,
stand the phenomena of thought transference, which
we must consider later.

As an addition to the investigations of Charcot and
Dumont-Pallier, Bremaud, in 1884, made the discovery
that there was a fourth hypnotic state, “fascination,”
which preceded the three others, and manifested itself
by a tendency to muscular contractions, as well as
through sensitiveness to hallucination and suggestion,
but at the same time left to the subject a full consciousness
of his surroundings and remembrance of what had taken
place. Descourtis, in addition, perceived a similar
condition in the transition from hypnotic sleep to
waking, which he called *delire posthypnotique*,
and, instead of using the word “fascination”
to express the opening stage, he substituted “captation.”
According to him, the diagram would be the following:

[Illustration]

This whole movement, which I have tried to sketch,
and whose chief peculiarity is that it considers hypnotism
a nervous malady, and one that must be treated clinically
and nosographically, was opposed in 1880 in two directions—­one
source of opposition producing great results, while
the other fell to the ground. The latter joined
itself to the theory of the mesmerists, and tried,
by means of exact experiments, to measure the fluid
emanating from the human body—­an undertaking
which gave slight promise of any satisfactory result.

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Baillif in his thesis (1878) and Chevillard in his
(for spiritualists) very interesting books, tried,
by means of various arguments, to uphold the fluidic
explanation. Despine also thought that by its
help he had been able to explain the phenomena; but
it was Barety who, in the year 1881, first turned
general attention in this direction. According
to him, mankind possesses a nerve force which emanates
from him in different kinds of streams. Those
coming from the eyes and fingers produce insensibility
to pain, while those generated by the breath cause
hypnotic conditions. This nerve force goes out
into the ether, and there obeys the laws that govern
light, being broken into spectra, *etc*.

Claude Perronnet has more lately advanced similar
views, and his greatest work is now in press.
Frederick W.H. Myers and Edmund Gurney sympathize
with these views, and try to unite them with the mesmerist
doctrine of personal influence and their theory of
telepathy. The third champion in England of hypnotism,
Prof. Hack Tuke, on the contrary, sympathizes
entirely with the Parisian school, only differing
from them in that he has experimented with satisfactory
results upon healthy subjects. In France this
view has lately been accepted by Dr. Bottey, who recognizes
the three hypnotic stages in healthy persons, but
has observed other phenomena in them, and vehemently
opposes the conception of hypnotism as a malady.
His excellently written book is particularly commended
to those who wish to experiment in the same manner
as the French investigator, without using hysterical
subjects.

The second counter current that opposed itself to
the French neuropathologists, and produced the most
lasting impression, is expressed by the magic word
“suggestion.” A generation ago, Dr.
Liebault, the patient investigator and skillful physician,
had endeavored to make a remedial use of suggestion
in his clinic at Nancy. Charles Richet and others
have since referred to it, but Professor Bernheim
was the first one to demonstrate its full significance
in the realm of hypnotism. According to him,
suggestion—­that is, the influence of any
idea, whether received through the senses or in a
hypersensible manner (*suggestion mentale*)—­is
the key to all hypnotic phenomena. He has not
been able in a single case to verify the bodily phenomena
of *grandehypnotisme* without finding suggestion
the primary cause, and on this account denies the
truth of the asserted physical causes. Bernheim
says that when the intense expectance of the subject
has produced a compliant condition, a peculiar capacity
is developed to change the idea that has been received
into an action as well as a great acuteness of acceptation,
which together will produce all those phenomena that
we should call by the name of “pathological
sleep,” since they are only separable in a gradual
way from the ordinary sleep and dream conditions.
Bernheim is particularly strenuous that psychology
should appear in the foreground of hypnotism, and
on this point has been strongly upheld by men like
Professors Beaunis and Richet.

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The possibility of suggestion in waking conditions,
and also a long time after the sleep has passed off
(*suggestions posthypnotiques ou suggestions a (longue)
echeance*), as well as the remarkable capacity
of subjects to change their personality (*changement
de la personnalite objectivation des types*), have
been made the subject of careful investigation.
The voluntary production of bleeding and stigmata
through spiritual influence has been asserted, particularly
by Messrs. Tocachon, Bourru, and Burot. The judicial
significance of suggestion has been discussed by Professor
Liegeois and Dr. Ladame. Professor Pitres in
Bordeaux is one of the suggestionists, though differing
in many points from the Nancy school.

This whole tendency brings into prominence the psychical
influence, while it denies the production of these
results from purely physical phenomena, endeavoring
to explain them in a different manner. These
explanations carry us into two realms, the first of
which has been lately opened, and at present seems
to abound more in enigmas than in solutions.
 *Metallotherapie*, which was called into existence
by Dr. Burg, and further extended by Dr. Gelle, contains
a special point of interest—­the so-called
transference in the case of hysterically or hypnotically
affected persons. Transference is caused by electro-magnetism,
which has this peculiarity—­that in the case
of specially sensitive persons it can transfer the
bodily affection from left to right, and *vice versa*.
The transference of paralysis, the cures attempted
on this plan, and the so-called “psychical transference,”
which contains special interest for graphologists,
are at the present time still open questions, as well
as the closely connected theory of human polarity;
and the odic experiments of Dr. Chazarain are yet
waiting for their confirmation. At present the
problem of the connection between magnetism and hypnotism
is under investigation, and in such a manner that
we may hope for a speedy solution.

Still stranger than these reports are the accounts
of the distant operation of certain bodies; at least,
they seem strange to those unacquainted with psychometry
and the literature of the past century relating to
this subject. Two physicians in Rochefort, Professors
Bourru and Burot, in treating a hystero-epileptic person,
found that gold, even when at a distance of fifteen
centimeters, produced in him a feeling of unbearable
heat. They continued these experiments with great
care, and, after a number of trials, came to this
conclusion—­that in some persons certain
substances, even when carefully separated from them
by long distance, exercise exactly the same physiological
influence as if introduced into their organism.
In order to explain these phenomena, they refer to
the radiating force of Barety, an explanation neither
satisfactory to themselves nor to others. Lately
the distinguished Parisian physician, Dr. Luys, has
confirmed by his experiments the existence of these
phenomena, but he thinks the explanation referable
to hyper-sensitiveness of the “*regions emotives
et intellectuelles de l’encephale*”
yet even he has not reached the kernel of the difficulty.

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In close connection with action at a distance is the
question of distant production of hypnotic sleep.
For an answer to this problem, they are experimenting
in both France and England; and Frederick W.H.
Myers has thrown an entirely new light upon the subject
by the investigations he is making upon a purely experimental
basis. In Italy they have limited themselves
to the study of isolated cases of hystero-hypnotism,
except as the phenomena of magnetic fascination investigated
by Donato have given rise to further research; but
all the books I have seen upon this subject, as well
as many by French authors, suffer from ignorance of
the latest English discoveries.

With this I think that I have given a slight outline
of the history of hypnotic investigation to the end
of the year 1886. I shall attempt a criticism
of this whole movement at some other time, as space
is not afforded to me here; but I should like to make
this statement now, that two of the characteristic
indications of this period are of the gravest import—­first
the method ("Our work,” says Richet, “is
that of strictly scientific *testing*, *observation*,
and *arrangement*"); and, secondly, the result.
Hypnotism has been received into the realm of scientific
investigation, and with this the foundation of a true
experimental psychology has been laid.

MAX DESSOIR.

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**THE DUODENUM:  A SIPHON TRAP.**

By MAYO COLLIER, M.S. Lond., F.R.C.S. Eng.;
Senior Assistant Surgeon, North-West London Hospital;
Assistant Demonstrator of Anatomy, London Hospital
Medical College.

We may take it for granted that all gases generated
in the jejunum, ileum, and large intestines pass onward
toward the anus, and there sooner or later escape.
Fetid gases—­except those generated in the
stomach and duodenum—­never pass upward,
not even during vomiting due to hernia, obstruction,
and other causes. Physiologists, it would appear,
have never busied themselves to find an explanation
for this apparent breach of the laws of gravity.
The intestinal canal is a tube with various dilatations
and constrictions, but at no spot except the pylorus
does the constriction completely obliterate the lumen
of the tube, and here only periodically. It is
perfectly evident, then, that, unless some system
of trap exists in the canal, gases are free to travel
from below upward in obedience to the laws of gravity,
and would, as a matter of fact, sooner or later do
so. From the straight, course and vertical position
of the oesophagus, a very slight pressure of gas in
the stomach easily overcomes the closure of its cardiac
sphincter and allows of escape. When the stomach
has digested its contents and the pylorus is relaxed,
gases generated in the duodenum can and do ascend
into the stomach and so escape. Normally, no
fetid gases are generated in the stomach or duodenum.
If we follow the course of the intestines down, we
find that the duodenum presents a remarkable curve.

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Now, there are some points of great interest in connection
with this remarkable, almost circular, curve of the
duodenum. In the first place, this curve is a
constant feature in all mammalians. Mr. Treves
says it is one of the most constant features in the
anatomy of the intestines in man, and, speaking of
mammalians in general, that the curve of the duodenum
varies in shape, but is never absent, becoming more
complex in some of the higher primates, but seldom
less distinct than in man. In birds the duodenum
always forms a long loop embracing the pancreas.

A second point of great interest is the absolute constancy
and fixation of its terminal portion at the point
of junction with the jejunum, more correctly termed
second ascending or fourth portion. Mr. Treves
says that this fourth portion is never less than an
inch, and is practically constant. It extends
along the side of the left crus of the diaphragm opposite
the second lumbar vertebra, and is there firmly fixed
to the front of the aorta and crus of the diaphragm
by a strong fibro-muscular band, slinging it up and
absolutely retaining it in position. This band
has been termed the “musculus suspensorius duodeni,”
but is chiefly composed of white fibrous tissue, and
is more of the native of a ligament than a muscle.
This ligament is always present, and its position
is never altered. The curve of the duodenum may
descend as far as the iliac fossa, but the terminal
portion is always maintained by this band in its normal
position.

Another point of great constancy is the position of
the pancreas and its relation to the curve of the
duodenum. The duodenum always curves round the
head of the pancreas and is, as it were, moulded on
it and retained in position by it. In birds the
duodenum always forms a long loop embracing the pancreas.
Further, the ducts of the liver and pancreas always
open into the center Of the duodenum, either separately
or by a common opening.

[Illustration]

Now, the absolute constancy of the curve of the duodenum,
the complete fixation of its fourth portion, the position
of the pancreas, and the place of entry of the ducts
of the pancreas and liver, are all component parts
of a siphon trap, whereby gases generated below the
duodenum are prevented from passing upward. A
reference to the accompanying diagrams will make this
quite clear. A is a diagram of a siphon trap
copied from Parkes’ hygiene. B is a very
diagrammatic outline of the stomach and duodenum,
*a* is intended to mark the position of the fibrous
band, or musculus suspensorius duodeni; and *b*
the position of entry of the ducts of the liver and
pancreas. The duodenum, then, is a siphon trap,
and a most efficient one. Now, the efficiency
of a siphon trap depends not only on its shape, but
what is absolutely essential is that the curve must
be kept constantly full of fluid, without which it
ceases to be a trap, and would allow gases to ascend
freely. The position of the place of entry of

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the ducts of the pancreas and liver assures that this
*sine qua non* shall be present. The discharge
of the secretions of the pancreas and liver, although
more active during and after feeding, is practically
constant, and so insures in an admirable manner that
the curve on which the efficiency of the trap depends
shall be constantly kept full not only with fluid,
but, as I would suggest, antiseptic fluid. There
is no other trap in the intestinal canal, but the
peculiar position of the colon would no doubt have
more or less effect in preventing gases ascending through
the ileo-caecal valve.—­*Lancet.*
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**WISCONSIN CRANBERRY CULTURE.**

Among the many thousands of well informed persons
with whom the cranberry is a staple article of food
throughout the autumn and winter, and who especially
derive from its pungent flavor sharp relish for their
Thanksgiving and Christmas turkey, not one in ten has
any definite idea as to where the delicious fruit
comes from, or of the method of growing and harvesting
it. Most people are, however, aware that it is
raised on little “truck patches” somewhere
down in New Jersey or about Cape Cod, and some have
heard that it is gleaned from the swamps in the Far
West by Indians and shipped to market by white traders.
But to the great majority its real history is unknown.

Yet the cranberry culture is an industry in which
millions of dollars are invested in this country,
and it gives employment, for at least a portion of
each year, to many thousands of people. In the
East, where the value of an acre of even swamp land
may run up into the thousands of dollars, a cranberry
marsh of five or ten acres is considered a large one,
and, cultivated in the careful, frugal style in vogue
there, may yield its owner a handsome yearly income.
But in the great, boundless West, where land, and
more especially swamp land, may be had for from $1
to $5 an acre, we do these things differently, if not
better.

The State of Wisconsin produces nearly one-half of
the cranberries annually grown in the United States.
There are marshes there covering thousands of acres,
whereon this fruit grows wild, having done so even
as far back as the oldest tradition of the native red
man extends. In many cases the land on which
the berries grow has been bought from the government
by individuals or firms, in vast tracts, and the growth
of the fruit promoted and encouraged by a system of
dikes and dams whereby the effects of droughts, frost,
and heavy rainfalls are counteracted to almost any
extent desired. Some of these holdings aggregate
many thousands of acres under a single ownership; and
after a marsh of this vast extent has been thoroughly
ditched and good buildings, water works, *etc*.,
are erected on it, its value may reach many thousands
of dollars, while the original cost of the land may
have been merely nominal.

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Large portions of Jackson, Wood, Monroe, Marinette,
Juneau, and Green counties are natural cranberry marshes.
The Wisconsin Valley division of the Chicago, Milwaukee
& St. Paul Railway runs through a closely continuous
marsh, forty miles long and nearly as wide, as level
as a floor, which is an almost unbroken series of
cranberry farms. The Indians, who inhabited this
country before the white man came, used to congregate
here every fall, many of them traveling several hundred
miles, to lay in their winter supply of berries.
Many thousands of barrels are now annually shipped
from this region; and thus this vast area, which to
the stranger looking upon it would appear utterly
worthless, is as valuable as the richest farming lands
in the State.

In a few instances, however, this fruit is cultivated
in Wisconsin in a style similar to that practiced
in the East; that is, by paring the natural sod from
the bog, covering the earth to a depth of two or three
inches with sand, and then transplanting the vines
into soil thus prepared. The weeds are then kept
down for a year or two, when the vines take full possession
of the soil, and further attention is unnecessary.
The natural “stand” of the vines in the
sod is so productive, however, and the extent of country
over which bountiful nature has distributed them so
vast, that few operators have thought it necessary
to incur the expense of special culture.

One of the best and most perfectly equipped marshes
in Wisconsin is owned by Mr. G.B. Sackett, of
Berlin. It is situated four miles north of that
village, and comprises 1,600 acres, nearly all of which
is a veritable bog, and is covered with a natural
and luxuriant growth of cranberry vines. A canal
has been cut from the Fox River to the southern limit
of the marsh, a distance of 4,400 ft. It is 45
ft. wide, and the water stands in it to a depth of
nine feet, sufficient to float fair sized steamboats.
At the intersection of the canal with the marsh steam
water works have been erected, with flood gates and
dams by means of which the entire marsh may be flooded
to a depth of a foot or more when desired. There
are two engines of 150 horse power each, and two pumps
that are capable of raising 80,000 gallons per minute.

When, in early autumn, the meteorological conditions
indicate the approach of frost, the pumps may he put
to work in the afternoon and the berries be effectually
covered by water and thus protected before nightfall.
At sunrise the gates are opened and the water allowed
to run off again, so that the pickers may proceed
with their work. The marsh is flooded to a depth
of about two feet at the beginning of each winter
and allowed to remain so until spring, the heavy body
of ice that forms preventing the upheaval that would
result from freezing and thawing—­a natural
process which, if permitted, works injury to the vines.

There is a three-story warehouse on the marsh, with
a capacity of 20,000 barrels of berries, and four
large two-story houses capable of furnishing shelter
for 1,500 pickers. The superintendent’s
residence is a comfortable cottage house, surrounded
by giant oaks and elms, and stands near the warehouse
on an “island,” or small tract of high,
dry land near the center of the great marsh.
The pickers’ quarters stand on another island
about 200 yards away.

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A plank roadway, built on piles, about two feet above
the level of the ground, leads from the mainland to
the warehouse and other buildings, a distance of more
than half a mile. Several wooden railways diverge
from the warehouse to all parts of the marsh, and on
them flat cars, propelled by hand, are sent out at
intervals during the picking season to bring in the
berries from the hands of the pickers. Each picker
is provided with a crate, holding just a bushel, which
is kept close at hand. The berries are first
picked into tin pans and pails, and from these emptied
into the crates, in which they are carried to the
warehouse, where an empty crate is given the picker
in exchange for a full one. Thus equipped and
improved, the Sackett marsh is valued at $150,000.
Thirteen thousand barrels have been harvested from
this great farm in a single season. The selling
price in the Chicago market varies, in different seasons,
from $8 to $16 per barrel. There are several
other marshes of various sizes in the vicinity.

The picking season usually begins about Sept. 1, and
from that time until Oct. 1 the marshes swarm with
men, women, and children, ranging in age from six
to eight years, made up from almost every nationality
under the sun. Bohemians and Poles furnish the
majority of the working force, while Germans, Irish,
Swedes, Norwegians, Danes, negroes, Indians, and Americans
contribute to the motley contingent. They come
from every direction and from various distances, some
of them traveling a hundred miles or more to secure
a few days’ or weeks’ work. Almost
every farmer or woodsman living anywhere in the region
of the marshes turns out with his entire family; and
the families of all the laboring men and mechanics
of the surrounding towns and cities join in the general
hegira to the bogs, and help to harvest the fruit.
Those living within a few miles go out in the morning
and return home at night, taking their noon-day meal
with them, while those from a distance take provisions
and bedding with them and camp in the buildings provided
for that purpose by the marsh owners, doing their
own cooking on the stoves and with the fuel furnished
them.

The wages vary from fifty cents to a dollar a bushel,
owing to the abundance or scarcity of the fruit.
A good picker will gather from three to four bushels
a day where the yield is light, and five to six bushels
where it is good. The most money is made by families
numbering from half a dozen to a dozen members.
Every chick and child in such families over six years
old is required to turn out and help swell the revenue
of the little household, and the frugal father often
pockets ten to twenty dollars a day as the fruits
of the combined labors. The pickers wade into
the grass, weeds, and vines, however wet with dew or
rain, or however deeply flooded underneath, making
not the slightest effort to keep even their feet dry,
and after an hour’s work in the morning are
almost as wet as if they had swum a river. Many

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of them wade in barefooted, others wearing low cowhide
shoes, and their feet, at least, are necessarily wet
all day long. In many cases their bodies are
thinly clad, and they must inevitably suffer in frosty
mornings and evenings and on the raw, cold, rainy
days that are frequent in the autumn months in this
latitude; yet they go about their work singing, shouting,
and jabbering as merrily as a party of comfortably
clad school children at play. How any of them
avoid colds, rheumatism, and a dozen other diseases
is a mystery; and yet it is rarely that one of them
is ill from the effects of this exposure. As many
as 3000 or 4000 pickers are sometimes employed on
a single marsh when there is a heavy crop, and an
army of such ragamuffins as get together for this
purpose, scattered over a bog in confusion and disorder,
presents a strange and picturesque appearance.

Indians are not usually as good pickers as white people,
but in the sparsely settled districts, where many
of the berry farms are situated, it is impossible
to get white help enough to take care of the crop
in the short time available for the work, and owners
are compelled to employ the aborigines. A rake,
with the prongs shaped like the letter V, is used
for picking in some cases, but owing to the large
amount of grass and weeds that grow among the vines
on these wild marshes, this instrument is rarely available.
After being picked the berries are stored in warehouses
for a period varying from one to three weeks.
They are washed and dried by being passed through a
fanning mill made for the purpose, and are then allowed
to cure and ripen thoroughly before they are shipped
to market.

From statistics gathered by the American Cranberry
Growers’ Association it is learned that in 1883
Wisconsin produced 135,507 bushels, in 1884 24,738
bushels, in 1885 264,432 bushels, and in 1886 70,686
bushels of this fruit. By these figures it will
be seen that the yield is very irregular. This
is owing, principally, to the fact that many of the
marshes are not yet provided with the means of flooding,
and of course suffer from worms, droughts, late spring
or early autumn frosts, and extensive fires started
by sparks from the engines on railroads running through
the marshes. These and various other evils are
averted on the more improved farms. So that, while
handsome fortunes have in many cases been made in cranberry
growing, many thousands of dollars have, on the other
hand, been sunk in the same industry. Only the
wealthier owners, who have expended vast sums of money
in improving and equipping their property, can calculate
with any degree of certainty on a paying crop of fruit
every year.

Chicago is the great distributing point for the berries
produced in Wisconsin, shipments being made thence
to nearly every State and Territory in the Union,
to Canada, to Mexico, and to several European countries.
Berries sent to the Southern markets are put up in
watertight packages, and the casks are then filled
with water, this being the only means by which they
can be kept in hot weather. Even in this condition
they can only be kept a few days after reaching hot
climates.—­*American Magazine.*

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**SOUDAN COFFEE.**

(*Parkia biglobosa.*)

There are valuable plants on every continent.
Civilized Europe no longer counts them. Mysterious
Africa is no less largely and spontaneously favored
with them than young America and the ancient territory
of Asia.

The latter has given us the majority of the best fruits
of our gardens. We have already shown how useful
the butter tree (*Butyrospermum Parkii*) is in
tropical Africa, and we also know how the *gourou*
(*Sterculia acuminata*) is cultivated in the same
regions. But that is not all, for the great family
of Leguminosae, whose numerous representatives encumber
this continent, likewise furnishes the negro natives
a food that is nearly as indispensable to them as
the *gourou* or the products of the baobab—­another
valuable tree and certainly the most widely distributed
one in torrid Africa. This leguminous tree, which
is as yet but little known in the civilized world,
has been named scientifically *Parkia biglobosa*
by Bentham. The negroes give it various names,
according to the tribe; among the Ouloffs, it is the
*houlle*; among the Mandigues, *naytay*;
in Cazamance (Nalon language), it is *nayray*;
in Bornou, *rounuo*; in Haoussa, *doroa*;
in Hant-fleure (Senegal), *nayraytou*. On
the old mysterious continent it plays the same role
that the algarobas do in young America. However,
it is quite a common rule to find in the order Leguminosae,
and especially in the section Mimosae, plants whose
pods are edible. Examples of this fact are numerous.
As regards the Mediterranean region, it suffices to
cite the classic carob tree (*Ceratonia siliqua*),
which also is of African nationality, but which is
wanting in the warm region of this continent.

Throughout the tropical region of Africa, the aborigines
love to consume the saccharine pulp and the seed contained
in the pod of the *houlle*. Prepared in
different ways, according to tribe and latitude, these
two products constitute a valuable aliment. The
pulp is consumed either just as it is or as a fermented
beverage. As for the seeds, they serve, raw or
roasted, for the production of a tea-like infusion
(whence the name “Soudan coffee"), or, after
fermentation in water, for making a national condiment,
which in certain places is called *kinda*, and
which is mixed with boiled rice or prepared meats.
This preparation has in most cases a pasty form or
the consistency of cohesive flour; but in order to
render its carriage easier in certain of the African
centers where the trade in it is brisk, it is compressed
into tablets similar to those of our chocolate.
As these two products are very little known in Europe,
it has seemed to us that it would be of interest to
give a description and chemical analysis of them.
We shall say but little of the plant, which has sufficiently
occupied botanists.

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[Illustration: Figs. 1 TO 6.—­PODS
OF THE HOULLE AND MICROSCOPIC DETAILS.]

The houlle (*Parkia biglobosa*) is a large tree
from 35 to 50 feet in height, with a gray bark, many
branches, and large, elegant leaves. The latter
are compound, bipinnate (Fig. 7), and have fifty pairs
of leaflets, which are linear and obtuse and of a
grayish green. The inflorescence is very pleasing
to the eye. The flowers, say the authors of the
*Florae Senegambiae Tentamen*, form balls of a
dazzling red, contracted at the base, and resembling
the pompons of our grenadiers (Fig. 8). The support
of this latter consists only of male flowers.
The fruit that succeeds these flowers is supported
by a club-shaped receptacle. It consists of a
large pod, which at maturity is 13 inches in length
by 10 in width (Fig. 1). This pod is chocolate
brown, quite smooth or slightly tubercular, and is
swollen at the points where the seeds are situated.
The pods are straight or slightly curved. The
aborigines of Rio Nunez use the pods for poisoning
the fishes that abound in the watercourses. We
do not know what the nature of the toxic principle
is that is contained in these hard pods, but we well
know the nature of the yellowish pulp and of the seeds
that entirely fill the pods.

[Illustration: Fig. 7.—­PARKIA BIGLOBOSA.]

Although the pulp forms a continuous whole, each seed
easily separates from the following and carries with
it a part of the pulp that surrounds it and that constitutes
an independent mass (Fig. 2). This pulpy substance,
formed entirely of oval cells filled with aleurone,
consists of two distinct layers. The first, an
external one of a beautiful yellow, is from 10 to
15 times bulkier than the internal one, which likewise
is of a beautiful yellow.

[Illustration: Fig. 8—­FLOWERS OF PARKIA.]

It detaches itself easily from the seed, while the
internal layer, which adheres firmly to the exterior
of the seed, can be detached only by maceration in
water. This fresh pulp has a sweet and agreeable
although slightly insipid taste. Upon growing
old and becoming dry, it takes on a still more agreeable
taste, for it preserves its sweetness and gets a perfume
like that of the violet.

As for the seed, which is of a brown color and provided
with a hard, shining skin, that is 0.4 inch long,
0.3 inch wide, and 0.2 inch thick. It is oval
in form, with quite a prominent beak at the hilum
(Fig. 4). The margin is blunt and the two convex
sides are provided in the center with a gibbosity
limited by a line parallel with the margin, and this
has given the plant its specific name of *biglobosa*.
The mean weight of each seed is 41/2 grains. The
skin, though thick, is not very strong. It consists,
anatomically, of four layers (Fig. 5) of a thick cuticle,
*c*; of a zone of palissade cells, *z p*;
of a zone of cells with thick tangential walls arranged
in a single row; and of a zone tougher than the others,
formed of numerous cells with thick walls, without
definite form, and filled with a blackish red coloring
matter, *cs*. This perisperm covers an exalbuminous
embryo formed almost entirely of two thick, greenish
yellow cotyledons having a strong taste of legumine.

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When examined under the microscope, these cotyledons,
the alimentary part of the seed, have the appearance
represented in Fig. 6, where *ep* is the epidermic
layer and *cp* constitutes the uniform parenchyma
of the cotyledonary leaf. This parenchymatous
mass consists of oval cells filled with fatty matter
and granules of aleurone.

According to some chemical researches made by Professor
Schlagdenhauffen, the pulp has the following composition
per 100 parts:

 Fatty matter
 2.407
 Glucose
 33.92
 Inverted sugar
 7.825
 Coloring matter and free acids
 1.300
 Albuminous matter
 5.240
 Gummy matter
 19.109
 Cellulose
 8.921
 Lignose
 17.195
 Salts
 4.080
 -------
 Total
 100.000

The salient point of these analytical results is the
enormous quantity of matter (nearly 60 per cent.)
formed almost exclusively by sugar. It is not
surprising, from this that this product constitutes
a food both agreeable and useful.

An analysis of the entire seed, made by the same chemist,
has given the following results:

Solid fatty matter
 21.145
Unreduced sugar 6.183
Undetermined matters 5.510
Gummy " 10.272
Albuminoid " 24.626
Cellulosic " 5.752
Lignose and losses 20.978
Salts 5.534
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Total 100.000

The presence in these seeds of a large quantity of
fatty matters and sugar, and especially of albuminoid
matters (very nutritive), largely justifies the use
made of them as a food. The innate instinct of
the savage peoples of Africa has thus anticipated
the data of science.—­*La Nature.*
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**THE HEIGHT OF SUMMER CLOUDS.**

A knowledge of the heights and movements of the clouds
is of much interest to science, and of especial importance
in the prediction of weather. The subject has
therefore received much attention during recent years
from meteorologists, chiefly in this country and in
Sweden. In the last published report of the Meteorological
Council for 1885-86 will be found an account of the
steps taken by that body to obtain cloud photographs;
and in the *Meteorologische Zeitschrift* for
March last, M.M. Ekholm and Hagstrom have published
an interesting summary of the results of observations
made at Upsala during the summers of 1884-85.
They determined the parallax of the clouds by angular
measurements made from two stations at the extremities

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of a base of convenient length and having telephonic
connection. The instruments used were altazimuths,
constructed under the direction of Prof. Mohn,
specially for measuring the parallax of the aurora
borealis. A full description of these instruments
and of the calculations will be found in the *Acta
Reg Soc. Sc. Ups.*, 1884. The results
now in question are based upon nearly 1,500 measurements
of *heights*; the *motions* will form the
subject of a future paper. It was found that
clouds are formed at all levels, but that they occur
most frequently at certain elevations or stages.
The following are, approximately, the mean heights,
in feet, of the principal forms: Stratus, 2,000;
nimbus, 5,000; cumulus (base) 4,500, (summit) 6,000;
cumulo-stratus (base), 4,600; “false-cirrus”
(a form which often accompanies the cumulo-stratus),
12,800; cirro cumulus, 21,000; cirrus, 29,000 (the
highest being 41,000). The maximum of cloud frequency
was found to be at levels of 2,300 and 5,500 feet.

Generally speaking, all the forms of cloud have a
tendency to rise during the course of the day; the
change, excepting for the cumulus form, amounting
to nearly 6,500 feet. In the morning, when the
cirrus clouds are at their lowest level, the frequency
of their lowest forms—­the cirro-cumulus—­is
greatest; and in the evening, when the height of the
cirrus is greatest, the frequency of its highest forms—­the
cirro-stratus—­is also greatest. With
regard to the connection between the character of
the weather and the height of the clouds, the heights
of the bases of the cumulus are nearly constant in
all conditions. The summits, however, are lowest
in the vicinity of a barometric maximum. They
increase in the region of a depression, and attain
their greatest height in thunderstorms, the thickness
of the cumulo stratus stretching sometimes for several
miles. The highest forms of clouds appear to
float at their lowest levels in the region of a depression.
The forms of clouds are identical in all parts of the
world, as has been shown in papers lately read by the
Hon. R. Abercromby before the English and Scottish
Meteorological Societies.—­*Nature*.

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**ON THE CAUSE OF IRIDESCENCE IN CLOUDS.**

By G. JOHNSTONE STONEY.

When the sky is occupied by light cirro-cumulus cloud,
an optical phenomenon of the most delicate beauty
sometimes presents itself, in which the borders of
the clouds and their lighter portions are suffused
with soft shades of color like those of mother-of-pearl,
among which lovely pinks and greens are the most conspicuous.
Usually these colors are distributed in irregular
patches, just as in mother-of-pearl; but occasionally
they are seen to form round the denser patches of
cloud a regular colored fringe, in which the several
tints are arranged in stripes following the sinuosities
of the outline of the cloud.

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I cannot find in any of the books an explanation of
this beautiful spectacle, all the more pleasing because
it generally presents itself in delightful summer
weather. It is not mentioned in the part of Moigno’s
great *Repertoire d’Optique* which treats
of meteorological optics, nor in any other work which
I have consulted. It seems desirable, therefore,
to make an attempt to search out what appears to be
its explanation.

At the elevation in our atmosphere at which these
delicate clouds are formed the temperature is too
low, even in midsummer, for water to exist in the
liquid state; and accordingly, the attenuated vapor
from which they were condensed passed at once into
a solid form. They consist, in fact, of tiny
crystals of ice, not of little drops of water.
If the precipitation has been hasty, the crystals will,
though all small, be of many sizes jumbled together,
and in that case the beautiful optical phenomenon
with which we are now dealing will not occur.
But if the opposite conditions prevail (which they
do on rare occasions), if the vapor had been evenly
distributed, and if the precipitation took place slowly,
then will the crystals in any one neighborhood be
little ice crystals of nearly the same form and size,
and from one neighborhood to another they will differ
chiefly in number and size, owing to the process having
gone on longer or taken place somewhat faster, or
through a greater depth, in some neighborhoods than
others. This will give rise to the patched appearance
of the clouds which prevails when this phenomenon presents
itself. It also causes the tiny crystals, of which
the cloud consists, to grow larger in some places
than others.

Captain Scoresby, in his “Account of the Arctic
Regions,” gives the best description of snow
crystals formed at low temperatures with which I am
acquainted. From his observations it appears—­(a)
that when formed at temperatures several degrees below
the freezing point, the crystals, whether simple or
compound, are nearly all of symmetrical forms; (b)
that thin tabular crystals are extremely numerous,
consisting either of simple transverse slices of the
fundamental hexagon or, more frequently, of aggregations
of these attached edgewise and lying in one plane;
and (c) that, according as atmospheric conditions
vary, one form of crystal or another largely preponderates.
A fuller account of these most significant observations
is given in the appendix to this paper.

Let us then consider the crystals in any one neighborhood
in the sky, where the conditions that prevail are
such as to produce lamellar crystals of nearly the
same thickness. The tabular plates are subsiding
through the atmosphere—­in fact, falling
toward the earth. And although their descent
is very slow, owing to their minute size, the resistance
of the air will act upon them as it does upon a falling
feather. It will cause them, if disturbed, to
oscillate before they settle into that horizontal

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position which flat plates finally assume when falling
through quiescent air. We shall presently consider
what the conditions must be, in order that the crystals
may be liable to be now and then disturbed from the
horizontal position. If this occasionally happens,
the crystals will keep fluttering, and at any one
moment some of them will be turned so as to reflect
a ray from the sun to the eye of the observer from
the flat surface of the crystal which is next him.
Now, if the conditions are such as to produce crystals
which are plates with parallel faces, and as they are
also transparent, part only of the sun’s ray
that reaches the front face of the crystal will be
reflected from it; the rest will enter the crystal,
and, falling on the parallel surface behind, a portion
will be there reflected, and passing out through the
front face, will also reach the eye of the observer.

These two portions of the ray—­that reflected
from the front face and that reflected from the back—­are
precisely in the condition in which they can interfere
with one another, so as to produce the splendid colors
with which we are familiar in soap bubbles. If
the crystals are of diverse thicknesses, the colors
from the individual crystals will be different, and
the mixture of them all will produce merely white
light; but if all are nearly of the same thickness,
they will transmit the same color toward the observer,
who will accordingly see this color in the part of
the cloud occupied by these crystals. The color
will, of course, not be undiluted; for other crystals
will send forward white light, and this, blended with
the colored light, will produce delicate shades in
cases where the corresponding colors of a soap bubble
would be vivid.

We have now only to explain how it happens that on
very rare occasions the colors, instead of lying in
irregular patches, form definite fringes round the
borders of the cloudlets. The circumstances that
give rise to this special form of the phenomenon appear
to be the following: While the cloud is in the
process of growth (that is, so long as the precipitation
of vapor into the crystalline state continues to take
place), so long will the crystals keep augmenting.
If, then, a cloudlet is in the process of formation,
not only by the springing up of fresh crystals around,
but also by the continued growth of the crystals within
it, then will that patch of cloud consist of crystals
which are largest in its central part, and gradually
smaller as their situation approaches the outside.
Here, then, are conditions which will produce one
color round the margin of the cloud, and that color
mixed with others, and so giving rise to other tints,
farther in. In this way there comes into existence
that iris-like border which is now and then seen.

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The occasional upsetting of the crystals, which is
required to keep them fluttering, may be produced
in any of three ways. The cloudlets may have
been formed from the blending together of two layers
of air saturated at different temperatures, and moving
with different velocities or in different directions.
Where these currents intermix, a certain amount of
disturbance will prevail, which, if sufficiently slight,
would not much interfere with the regularity of the
crystals, and might yet be sufficient to occasion
little draughts, which would blow them about when
formed. Or, if the cold layer is above, and if
it is in a sufficient degree colder, there need not
be any previous relative motion of the two layers;
the inevitable convection currents will suffice.
Another, and probably the most frequent, cause for
little breezes in the neighborhood of the cloudlets
is that when the cloudlets are formed they immediately
absorb the heat of the sun in a way that the previously
clear air had not done. If they absorb enough,
they will rise like feeble balloons, and slight return
currents will travel downward round their margins,
throwing all crystals in that situation into disorder.

I do not include among the causes which may agitate
the crystals another cause which must produce excessively
slight currents of air, namely, that arising from
the subsidence of the cloudlets owing to their weight.
The crystals will fall faster wherein cloud masses
than in the intervening portions where the cloud is
thinner. But the subsidence itself is so slow
that any relative motions to which differences in
the rate of subsidence can give rise are probably too
feeble to produce an appreciable effect. Of course,
in general, more than one of the above causes will
concur; and it is the resultant of the effects which
they would have separately produced that will be felt
by the crystals.

If the precipitation had taken place so very evenly
over the sky that there were no cloudlets formed,
but only one uniform veil of haze, then the currents
which would flutter the crystals may be so entirely
absent that the little plates of crystals can fixedly
assume the horizontal position which is natural to
them. In this event the cloud will exhibit no
iridescence, but, instead of it, a vertical circle
through the sun will present itself. This, on
some rare occasions, is a feature of the phenomenon
of parhelia.

It thus appears that the occasional iridescence of
cirrus clouds is satisfactorily accounted for by the
concurrence of conditions, each of which is known
to have a real existence in nature....—­*Phil.
Mag., July 1887.*
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