A MANUAL

OF

PHARMACY AND DISPENSING

BY

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PREFACE.

THIS work is intended as a text-book for *students,* and accordingly an effort has been made to secure clearness, especially in Part I, and at the same time to avoid superfluous matter. Hence, methods and apparatus used only in manufacturing houses have either been omitted entirely, or at most casually mentioned.

The same plan has been followed in preparing Part II. When treating of pharmacopœial methods, the author has endeavored to avoid useless repetition, and, therefore, the matter may be considered as explanatory notes upon official preparations. For details of methods the student is referred to the *Pharmacopœia* and the *National Formulary.* These books should always be at hand when studying this part of the text.

Part III treats primarily of the prescription. While dispensing receives some attention, the real information, showing the fundamental principles upon which the work of dispensing rests, is given under the various subjects in Part II. The author has long been of the opinion that pharmaceutical chemistry or the chemical compounds of the *Pharmacopœia* should form a separate work, hence these subjects have not been included in the present edition.

While conversant with all subjects mentioned in the present treatise, the author has earnestly desired to gather from various sources all that may prove most helpful and inspiring to the student of pharmacy. In grateful acknowledgment of assistance received in this direction, he mentions the names of such colleagues and fellow workers as Messrs. Remington, Caspari, Coblenz, MacEwen, Scoville, and Beal, whose able and scholarly works he has freely consulted.

A. B. S.

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PART III.

DISPENSING.

PHARMACY.

INTRODUCTORY.

Pharmacy is the science and art of preparing, compounding, preserving, and dispensing medicines. The term pharmacy is also applied to the place where the practice of pharmacy is conducted.

A pharmacopœia is a book describing medicinal substances, tests for strength, identity, and purity. It also contains formulas for the manufacture of various preparations. Civilized nations have either adopted a pharmacopœia of their own, or that of some other nation on whom they are dependent or to whom they are closely related. All pharmacopœias except that of the United States are issued by their respective governments.

The *United States Pharmacopœia* is issued by the authority of a convention composed of delegates from incorporated medical and pharmaceutical associations, societies, schools, and colleges; also from the American Chemical Society, the army, navy, and marine hospital service. The convention meets in Washington, D. C., on the second Tuesday in May of each year the numeral of which ends in zero. The convention elects a committee called the Committee of Revision, which completely revises the book and prepares it for publication. The convention also elects a Board of Trustees, who have charge of all business affairs connected with the revision and publication of the *Pharmacopœia.* The medicinal substances are arranged alphabetically according to their Latin names. The English name follows the Latin name. Common synonyms appear in the index only. The student should never take the *Pharmacopœia* at second hand, but should study the original, reading the introductory notes and the historical introduction, and carefully studying the general arrangement. An accurate knowledge of the tables is desirable and helpful.

The *National Formulary* consists of formulas for the preparation of medicinal substances not in the *Pharmacopœia* but more or less used in various parts of the United States. It is published by the American Pharmaceutical Association, and is revised by a committee appointed by the council of the Association. The *Pharmacopœia* and *National Formulary* have been adopted by the United States Government as legal standards for "The Food and Drugs Act." The latest editions of these books should form a part of the working library of every pharmacist and every student of pharmacy.

A dispensatory is the pharmacist's dictionary, containing general information upon official and unofficial material alike. The *National Standard Dispensatory* and the *United States Dispensatory* are in general use, nd every progressive pharmacist should own and diligently use one of them. King's *American Dispensatory* is intended especially for the use of the eclectic physician. Professor Beal in his work on *Prescription Practice and General Dispensing* has given an excellent list of text-books and periodicals. The pharmaceutical student should early form the habit of reading pharmaceutical literature and noting important articles. These notes may be arranged in the form of a card catalogue, a possession which increases in value and usefulness with increasing years.

PART I.

CHAPTER I.

METROLOGY.

Metrology is the science which treats of weights and measures. It includes measures of extension, volume, and weight.

ORIGIN AND DEVELOPMENT.

At the present time all systems of weights and measures are founded upon measures of extension. The standards selected are arbitrary and vary in different countries. Owing to the gradual transition now going on, more than one system is frequently used at the same time in the same country. Future generations will doubtless see a single system (the metric) of weights and measures in use throughout the civilized world. During the early centuries different nations used various arbitrary standards. The finger, thumb, hand, palm, and forearm have each served as measures of length, while handfuls and pinches were measures of bulk. Seeds were used as standards of weight and measures of length. John Quincy Adams states that the pound, ounce, foot, inch, and mile are derived from the Romans, and through them from the Greeks, as all Roman weights and measures were of Hellenic origin.

The yard or girth is of Saxon origin. After the Roman conquest it lost its meaning of *girth,* and the length of the arm of Henry the First (1100 to 1135) was substituted as the standard yard. In 1266 the English government declared that the sterling or English penny, round and unmutilated, should be the weight of 32 grains of wheat, dry and taken from the middle of the ear. Twenty pennyweights were to make one ounce, 12 ounces one pound, and 8 pounds a wine gallon. In 1324 the consecutive length of three round, dry barley corns were taken as the inch, 12 of these inches one foot, and three feet one yard. At the close of the fifteenth century the weight of the silver penny was changed to that of 24 grains of wheat. Hence, we have 24 grains one pennyweight, 20 pennyweights one ounce, 12 ounces one pound, which is the same as Troy weight, which had been introduced into England by the Lombardy merchants at the close of the thirteenth century. It is now confined to the weighing of gold, silver, and precious stones.

Apothecaries' weight was probably derived from Troy weight, and is used in the writing and dispensing of prescriptions.

Avoirdupois weight was brought into England by merchants at the beginning of British civilization. Its origin is not definitely known. *Avoir du pois,* to have weight, indicates French extraction, while the earlier spelling, averdupois, suggests Roman origin from *averare* (middle age Latin), meaning to verify.

In 1618 the London College of Physicians directed that Troy weight be used in their first Pharmacopœia. In 1736 the Royal Society attempted to reform their standards, and in 1760, under direction of the House of Commons, prepared a standard yard and a standard Troy pound. At last, in 1816, English scientists undertook to secure an indestructible standard. It was ascertained that the *length* of a pendulum vibrating seconds of time in a vacuum, at sea level and in the latitude of London, is 39.13929 inches. This furnished an indestructible, unchangeable standard. Hence, the inch was to be the standard from which all measures and weights (except the metric) were to be derived. This unit inch is described as of such length that it is contained 39.13929 times in the length of the described pendulum.

Weights and measures of capacity were derived from the inch as follows: A cubic inch of distilled water weighed 252.458 grains in air, at 62° F., and 30 inches barometric pressure. The Troy pound contained 5760 such grains and the avoirdupois pound contained 7000 grains. The Imperial gallon contained 10 avoirdupois pounds or 70,000 grains of distilled water at 62° F. at normal pressure, which is about 277.25 cubic inches. On January 1, 1826, the Imperial standards were legalized by Great Britain. The wine or fluid gallon used in the United States contains 231 cubic inches, or 58372.2 grains, at 62° F., and at normal pressure. In 1827 exact copies of the Imperial standards were furnished to the United States. These copies consisted of a bronze yard containing 36 inches, a brass Troy pound weighing 5760 grains, and a brass avoirdupois pound of 7000 grains. In 1836 the United States Congress furnished the different States with accurate copies of these standards.

THE SYSTEM IN PRESENT USE.

Although weights and measures have varied in size to correspond with the changes in standards, the denominations have remained the same for centuries. They are as follows:

Apothecaries' Weights (erroneously called Troy weight).—There are:

20 grains in 1 scruple.
3 scruples, or 60 grains in 1 dram.
8 drams, or 480 grains in 1 ounce.

Apothecaries' weights are used only in writing and compounding physicians' prescriptions. The quantities are expressed in Roman numerals and follow the symbols, thus; gr. xij equals 12 grains; ℈iij equals 3 scruples; ʒviij, equals 8 drams; ℥iiss, equals 2½ ounces. The grain and the ounce are of the same value as those of Troy weights.

Avoirdupois Weights.—There are:

437.5 grains in 1 ounce.
16 ounces, or 7000 gr., in 1 pound.

This system is used in the United States for commercial purposes only. The fractions of an ounce are expressed in halves, quarters, and eighths.

Wine or Fluid Measure.—There are:
60 minims in 1 fluidram.
8 fluidrams, or 480 minims, in 1 fluidounce.
16 fluidounces in 1 pint or octarius.
8 pints, or 128 fl. oz., in 1 gallon or congius, which contains 231 cubic inches.

The signs used in prescription writing are ♏ for minims, fl. ʒ for fluidrams, fl. ℥ for fluidounces, and O for pints.

1 fl. oz. of distilled water at 15.6° weighs 455.7 grains.
1 fl. oz. of distilled water at 25.0° weighs 454.6 grains.
1 minim of distilled water at 15.6° weighs 0.95 grain.
1 minim of distilled water at 25.0° weighs 0.947 grain.

Imperial Measure.—Used in British territory only. There are:
60 minims in 1 fluidram.
8 fluidrams, or 480 minims, in 1 fl. oz.
20 fluidounces in 1 pint.
8 pints, or 160 fl. oz., in 1 gallon, which contains 277.25 cubic inches.

The names, signs, and divisions are the same as in wine measure. However, not one of the denominations is of the same value as the corresponding denomination in wine measure.

1 fl. oz. of distilled water at 15.6° weighs 437.57 grains
1 minim of distilled water at 15.6° weighs 0.9116 grains.
1 fl. oz. is equivalent to 0.96 of a wine ounce.
1 pint is equivalent to 1.2 wine pints.
1 fl. oz. of distilled water at 15.6° is equivalent to 1.0 avoirdupois ounce.

In the United States three ounces, each of different size, are in use, viz., the apothecaries' ounce of 480 gr., the avoirdupois ounce of 437.5 gr., and the fluidounce of 455.7 gr. But in all three systems of weights and measures the grain is of the same value.

The Metric System.—The metric system of weights and measures is destined to become the universal system. Centuries may be required to accomplish its acceptance, but the system is steadily gaining in favor and its universal adoption is only a question of time. It is now used in scientific work, and is the legal standard of all civilized nations except the United States and Great Britain, but in both of these countries it is permissible by law. The metric is the only system recognized in the *United States Pharmacopœia.*

In 1790 Prince de Talleyrand submitted to the French Assembly a plan for a new system of weights and measures having a single universal standard. The standards considered were the pendulum, suggested by Huyghens, and the proportional part of the earth's circumference, by Picard. His plan, with some modifications, was approved by the Assembly August 22, 1790. A committee from the Academy of Science was appointed to select the standard. They reported in March, 1791, in favor of one-fourth of the meridian, and recommended that a ten-millionth part of it should be taken as the standard unit of linear measure. They also recommended that a cube representing one-tenth of this be accepted as the standard of weight and volume. Committees were appointed to determine the length of the meridian's arc and the weight of a standard volume of distilled water in vacuum. They were also to construct a scale and table of weights and measures. Without waiting for these committees to complete their labors, the French Government, in 1793, passed a law adopting the system and requiring it to take immediate effect. For their standard provisional meter they used measurements made more than fifty years before. In 1799 a new meter was adopted, which was about 0.01 of an inch shorter than the old meter. The principle nations have established a new standard, which is the length between two lines drawn upon a platiniridium bar and measured at the temperature of melting ice. Its length is as nearly as possible that of the old meter, and is equal to 39.37+ inches. This standard is preserved in the International Bureau of Weights and Measures in the archives of France. The unit of volume is a cube of one-tenth of the meter, and is called a Liter. It equals 33.8149 fluidounces. The unit of weight is the weight of 0.001 part of a liter of distilled water at 4° C. It is called a Gram or Gramme, equal to 15.432 gr. Denominations above this unit are obtained by multiplying by ten; those below are obtained by dividing by ten, using the same prefixes for measures of extensions, volume, and weight. The multiples are expressed by Greek prefixes, as, Deka, 10; Hecto, 100; Kilo, 1000; Myria, 10,000. The subdivisions are expressed by Latin prefixes, as, Deci, 0.1; Centi, 0.01; Milli, 0.001. The abbreviations of the units and multiples should begin with capital letters; those for the subdivisions with small letters.

Metric Measures.—

		METER.			LITER.			GRAM.
Myriameter,	Mm.=	10000.0	Myrialiter,	Ml.=	10000.0	Myriagram,	Mg.=	10000.0
Kilometer,	Km.=	1000.0	Kiloliter,	Kl.=	1000.0	*Kilogram,*	*Kg.*=	1000.0
Hectometer,	Hm.=	100.0	Hectoliter,	Hl.=	100.0	Hectogram,	Hg.=	100.0
Dekameter,	Dm.=	10.0	Dekaliter,	Dl.=	10.0	Dekagram,	Dg.=	10.0
Meter,	*M.*=	1.0	*Liter,*	*L.*=	1.0	*Gram,*	*Gm.*=	1.0
Decimeter,	*dm.*=	0.1	Deciliter,	dl.=	0.1	*Decigram,*	*dg.*=	0.1
Centimeter,	*cm.*=	0.01	Centiliter,	cl.=	0.01	*Centigram,*	*cg.*=	0.01
Millimeter,	*mm.*=	0.001	Milliliter,	ml.=	0.001	*Milligram,*	*mg.*=	0.001

Many of the above terms are rarely used. Those in italics are most frequently used, and of these, the decigram and centigram are frequently expressed by an equivalent in milligrams. The milliliter is the cube of the centimeter, and is commonly called *cubic centimeter,* Cc.

The micron or micromillimeter, mkm., or μ, is one-thousandth part of a millimeter, and is used in microscopy.

The cubic centimeter is usually considered as equivalent to a gram of distilled water, but this is true only when weighed in vacuo at four degrees centigrade. When weighed in air at 15.6° it weighs 0.998 Gm., and at 22° it weighs 0.9975 Gm.

APPROXIMATE EQUIVALENTS.

The following equivalents are not exact, but are sufficiently accurate for all practical purposes. When the equivalents of weight are given in volume it applies only to substances having the same specific gravity as water:

1 Meter equals 39.37 inches.

1 Gram equals 15.432 grains.

1 Gram equals 0.035 avoirdupois ounce.

1 Gram equals 0.032 apothecaries' ounce.

1 Cubic centimeter equals 16.23 apothecaries' minims

1 Cubic centimeter equals 16.9 Imperial minims.

1 Cubic centimeter equals 0.0338 apothecaries' fluidounce.

1 Cubic centimeter equals 0.035 Imperial fluidounce.

1 Grain equals 64.8 milligrams.

1 Grain equals 1.053 apothecaries' minims.

1 Grain equals 1.097 Imperial minims.

1 Apothecaries' ounce equals 31.1 grams.

1 Apothecaries' ounce equals 1.097 avoirdupois ounces.

1 Apothecaries' ounce equals 1.053 fluidounces.

1 Avoirdupois ounce equals 28.35 grams.

1 Avoirdupois ounce equals 0.911 apothecaries' ounce.

1 Avoirdupois ounce equals 0.961 fluidounce.

1 Avoirdupois ounce equals 1 Imperial fluidounce.

1 Avoirdupois pound equals 453.6 grams.

1 Imperial minim equals 0.9114 grain.

1 Imperial minim equals 0.059 cubic centimeter.

1 Imperial fluidounce equals 28.35 cubic centimeters.

1 Imperial fluidounce equals 0.96 apothecaries' ounce.

1 Imperial pint equals 567.6 cubic centimeters.

1 Imperial gallon equals 4.541 liters.

1 Apothecaries' minim equals 0.9493 grain.

1 Apothecaries' minim equals 0.0613 cubic centimeter.

1 Apothecaries' fluidounce equals 29.57 cubic centimeters.

1 Apothecaries' fluidounce equals 1.04 avoirdupois ounces.

1 Apothecaries' fluidounce equals 0.95 apothecaries' ounce.

1 Apothecaries' fluidounce equals 1.04 Imperial fluidounces.

1 Apothecaries' pint equals 473 cubic centimeters.

1 Apothecaries' gallon equals 3.496 liters.

Many other equivalents might be given, but it is unnecessary, as they can be obtained by moving the decimal point. For instance, one cubic centimeter equals 0.0338 of a fluidounce; hence one liter (1000 Cc.) equals 33.8 fluidounces. As the equivalent given is that of a unit quantity, any number of times the unit quantity may be obtained by multiplying its equivalent by the given amount. For example, one avoirdupois ounce equals 0.911 apothecaries' ounce. Therefore, 24 avoirdupois ounces equal 24 × 0.911, or 21.864 apothecaries' ounces.

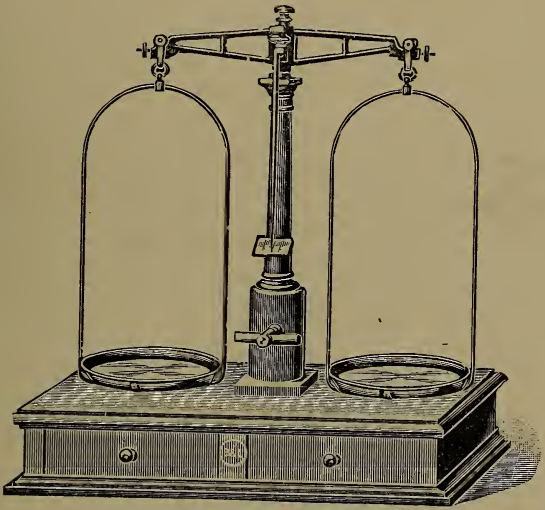
THE BALANCE.

The balance, or scale, as it is commonly called, is an instrument for determining the relative weights of bodies. Scales differ in size and construction, depending upon the purpose for which they were designed. Pharmaceutically, they may be divided into two classes: First, one employing the principle of the lever resting upon one or more knife-edges. The second employs the principle of the lever resting upon tightly stretched wires or bands. Those of the first class may be subdivided into (1) single beam, and (2) compound beam.

There are also two forms of the single beam balance, viz., those of equal and unequal arm.

The single beam equal arm principle is used in most analytical and prescription balances (Fig. 1). The beam should be as light as possible and still be rigid. In the finest balances this is usually obtained by giving the beam the truss form (Figs. 1 and 2). In the centre of the beam and at right angle with it is a short △ shaped bar of steel or agate "knife-edge." Its projecting ends rest upon stationary supports in such a

Fig. 1

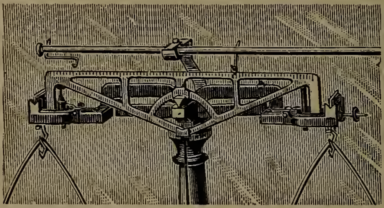


Single beam prescription balance.

manner that the beam may vibrate freely and also be lifted from its support when not in use, to prevent wear. The pans are suspended from similar knife-edges at the end of the beam. In all fine balances the knife-edges are of agate and vibrate on agate plains. The beam is so graduated that the smallest weights may be obtained by sliding a rider along the beam.

How to Test a Balance.—Place the balance in position and so adjust it that it is level. First, see that the arms are of equal length. This is done by placing a ten gram weight on each pan. Should either arm be longer than the other, that arm will descend, providing the weights are correct. This may be determined by reversing the weight, when, if the error is due to the weight, the opposite arm will fall. Secondly, to determine whether the knife-edges are parallel, balance the scale with weights and move the weights to different positions on the pan. The equilibrium should remain unaffected if the knife-edges are parallel. To test the sensitiveness of the balance, observe whether it responds readily to its lightest weight when either lightly or heavily loaded.

Fig. 2



Truss form of beam.

The fulcrum or central knife-edge should be slightly above the centre of gravity. If too high, the balance vibrates rapidly and comes to rest quickly, but is not sensitive. If the point of support is too low, the equilibrium is unstable. When the support is at the centre of gravity, the pans, when equally loaded, remain wherever they may be placed without coming to a horizontal position. When using a balance do not wait for the oscillations to cease, but observe the equality of the oscillation as shown by the indicator.

The life or sensitiveness of a balance is proportional to the care which it receives. Balances should be kept in closed cases, in order to protect them from dust or corrosion. Occasional cleaning with chamois skin is all that is necessary. Oil should not be used. The metallic parts should not be handled with bare hands, as the moisture from the skin is usually acid. Glass pans are preferable to metal ones, but are more easily broken. Never allow the beam of a balance to oscillate when not in use, nor add or remove weights from the pans when in motion. Never weigh corrosive or deliquescent substances on a scale pan, but use glass, tared vessels, or parchment paper. Return all weights to their proper places and clean the pans with chamois skin or soft cloth.

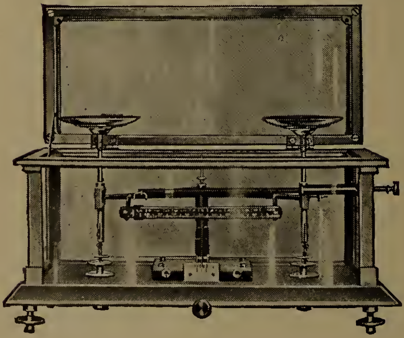
Compound Lever or Box Balances.—This scale differs from the preceding in the fact that the pans are placed above the beam. To accomplish this and retain the pans in an upright position the multiple lever system is employed. This increases the friction and decreases the sensitiveness.

Figs. 3 and 4 illustrate different styles of the box prescription balance, and Fig. 5 a compound lever counter balance.

Fig. 3

Box prescription balance.

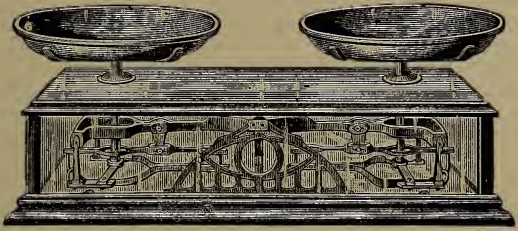
Fig. 4



Glass box prescription balance.

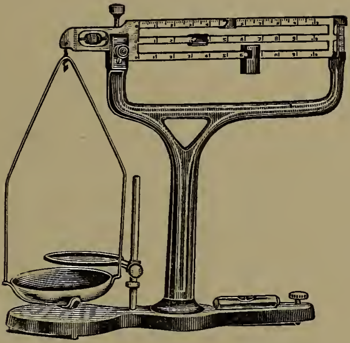
The Unequal Arm Balance.—The principle of the unequal arm balance is best seen in the old-fashioned steelyards. The longer arm of the beam is graduated to receive an adjustable weight. A number of balances have been constructed on this principle. Among the best is the triple beam balance (Fig. 6). However, it is a triple beam only in name. It has a single beam, the long arm of which is divided into three parts to

Fig. 5



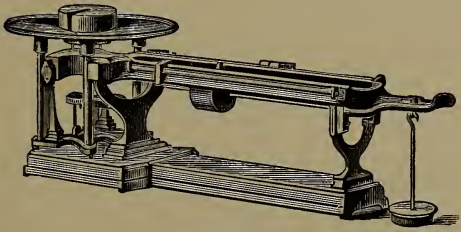
Compound lever balance.

Fig. 6



Unequal arm balance.

Fig. 7



Troemner's solution balance.

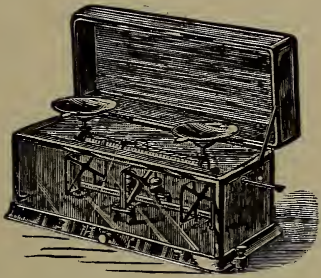
carry weights which increase in multiples of ten. The capacity is from 0.01 to 111 Gm.

Troemner's solution scales (Fig. 7) is a compound lever scale having unequal arms and a capacity from 1 Gm. to 20 kilos. It has two weighing bars supplied with sliding weights, and beneath the weighing beam is a bar with sliding poise attached which serves as a counterpoise for empty containers.

The Torsion Balance.—In the torsion balance the double beam and pan supports are fastened to thin bands stretched over rigid frames. These take the place of the knife-edges, and are at right angles with the beam. The middle frame is fastened securely to the bottom of the case, while the end frames support the pans in an upright position above the frames. The resistance of the wire to the twist, caused by the oscillations of the beam, is overcome by placing a weight above the centre of gravity. It is placed either directly above the central band or upon each side in such a manner that if either end of the beam be lowered, the weights are removed from the centre of gravity. The height of the weight may be so adjusted that the force of gravity exactly overcomes the resistance. If the weight be so adjusted that the resistance is in slight excess, the balance becomes very sensitive, responding to the lightest weight, yet returning to its horizontal position as soon as the weight is removed.

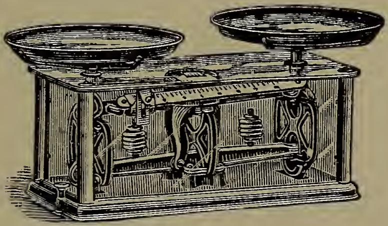
The prescription balance (Fig. 8) is provided with a small graduated bar and sliding weight. The divisions upon the upper edge are from one-eighth of a grain to eight grains. Those on the lower edge are from five milligrams to five decigrams. The torsion counter balance (Fig. 9) may be obtained with the beam graduated for avoirdupois, apothecaries', and metric weights.

Fig. 8



Torsion prescription balance.

Fig. 9



Torsion counter balance.

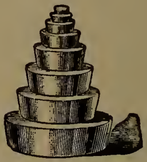
Weights used in weighing are made of metal, the kind depending upon the grade and sort of weight desired. Heavy weights and those used for common commercial purposes are made of iron. Weights for the counter and the finer balances are made of brass. These are put up in blocks (Fig. 10), in pyramids

(Fig. 11), or in cups (Fig. 12). The block or case is the best form, as the weights are better protected from atmospheric oxidation. The cases are usually made of wood, but are sometimes made of iron, and are used for all systems of weights. The pyramid form is generally used for avoirdupois weights. The cup or nest form is used principally for apothecaries' weights, though avoirdupois weights are occasionally seen in this form. Each cup weighs the same as its contents, *i. e.*, if the largest weight be 8 oz. the sum of the remaining weights is 8 oz.

Fig. 10

Block weights.

Fig. 11



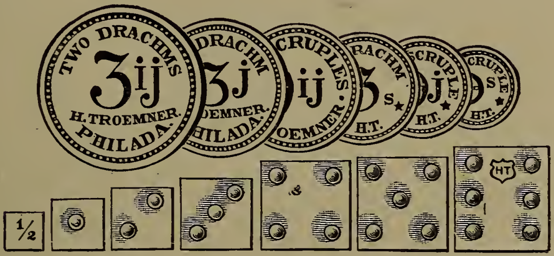
Pyramid weights.

Fig. 12

Cup weights.

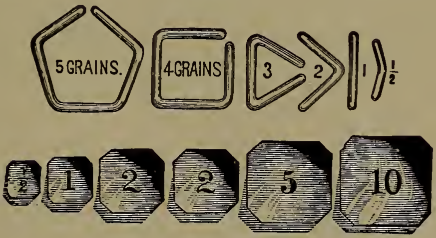
The grain weights are made of brass, nickel-silver, or aluminum. The last has the advantage of being light, thus making the weights correspondingly large, more conveniently handled, and less easily lost. They are made of nickel-silver, as in Fig. 13, or of aluminum, as in Fig. 14.

Fig. 13



Prescription weights. ½ to 6 grains (nickel-silver); ½ to 2 drams (brass).

Fig. 14



Aluminum grain weights.

Fine metric weights are generally put up in cases ranging from one centigram to fifty or one-hundred grams (Fig. 15). Milligrams are weighed by placing a rider on the graduated beam. Coarser weights are put up in blocks ranging from one gram to one kilogram.

Tare is the term applied to the weight of the container in which a substance is weighed or kept.

Fig. 15

Analytical weights.

Net weight is the weight of the substance alone.

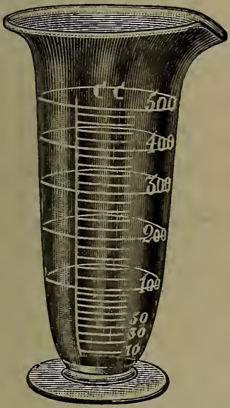
Gross weight is the weight of the container and substance.

In practice it is customary to counterpoise the retainer with shot or coarse sand, using two cups, with a spout at the side and a funnel top, so that the contents may be poured from one to the other as required.

MEASURES.

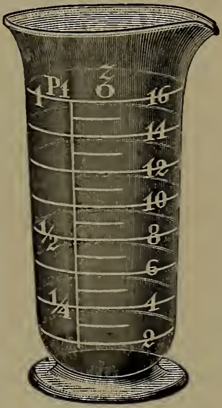
Measures used by pharmacists are made of metal or glass for determining the volume of liquids. Metal measures are only used for coarse work, and are made of tinned iron, enamelled sheet iron, and tinned copper. For ordinary manufacturing and prescription work glass measures are preferable. They are made in four forms, viz., conical, tumbler-shape, beaker-shape, and cylindrical, and graduated in either apothecaries' or metric system. The adhesion of the liquid to the glass gives a concave surface to most liquids. The correct reading for the contents should be made midway between the upper and lower edge of the meniscus. If the reading be made at the bottom of the meniscus

FIG. 16



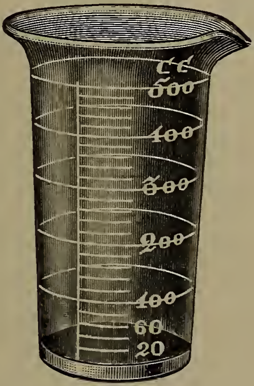
Cone shape.

FIG. 17



Tumbler shape.

FIG. 18



Acme beaker shape.

it will more nearly represent the amount of liquids delivered from the graduate. Finely graduated flasks usually have two marks on the neck. The lower one represents the volume of liquid the flask holds, while the upper represents the volume which the flask will deliver. The surface of the liquid should be level with the eye and the graduate in an upright position. A slightly oblique position of the graduate will cause a decided error in the reading of the contents. The greater the surface of the liquid the greater will be the liability to error. Hence the cylindrical form of graduate is preferable. Some prefer the conical form for small quantities, as the surface decreases with the

Fig. 19

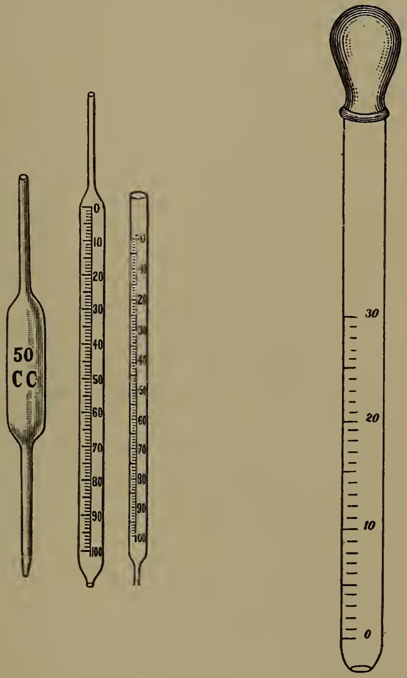
Cylindrical graduate.

Fig. 20

Minim graduate.

quantity. Pipettes (Fig. 21) should be used for the accurate measuring of small quantities, and these can be obtained graduated for minims as well as for tenths of a cubic centimeter. Several American firms guarantee the accuracy of their graduates. However, pharmacists should test all graduates used, either by comparison with standard graduates or by counterpoising the graduate on a balance and weighing the amount

Fig. 21



Pipettes.

of distilled water required for each of the principal divisions. A fluidounce of distilled water at 15.6° C. should weigh 455.7 grains; at 25° C., 454.6 grains.

Graduates having a curved lip should be selected, so that liquids will flow from the edge and not down the side of the graduate. Avoid graduates with grooves at the base, as they are difficult to keep clean. Avoid graduates that are graduated on one side for fluid measure and on the other for the metric system, as they create confusion and it is not so easy to see when the graduate is level. This can be more easily observed if separate graduates are used for each system and part of the graduations extend around the graduate. Graduates may be had with a hard rubber base, which are thus not so easily broken.

Approximate Measures.—

One teaspoonful equals about 1 fluidram, 4 cubic centimeters.

One dessertspoonful equals about 2 fluidrams, 7.5 cubic centimeters.

One tablespoonful equals about 4 fluidrams, 15 cubic centimeters.

One wineglassful equals about 2 fluidounces, 60 cubic centimeters.

One teacupful equals about 4 fluidounces, 120 cubic centimeters.

One tumblerful equals about 8 fluidounces, 240 cubic centimeters.

One drop is usually considered as equal to one minim; but it varies in size from three-fourths of a drop to four drops in one minim, depending upon the character of the liquid and the surface from which it is dropped. The broader the surface the greater the adhesive power exerted upon the liquid before it accumulates sufficient weight to cause it to fall; hence, the larger the drop. Therefore, when selecting tubes for droppers, the external diameter of the tube should be considered rather than that of the orifice.

Two forms of medicine droppers appear on the market. One form produces small drops, and is known as the eye dropper. The other form is called the medicine dropper, and produces 60 drops to the dram, or one drop to the minim of distilled water.

The following is the approximate number of drops to the minim of various liquids compared with one drop of water. Nearly all alcoholic liquids, as tinctures, fluidextracts, and spirits, afford from 2 to 2.5 drops. Most volatile oils and oleoresins afford 2 drops; ether, 3 drops; chloroform, 4 drops; hydrochloric acid, 1.2 drops; nitric acid, 1.6 drops; sulphuric acid, 2 drops; and diluted mineral acids, 1 drop.

CHAPTER II.

SPECIFIC GRAVITY.

Specific gravity may be defined as the relative weights of equal bulks or volumes of different bodies, water being the recognized standard for solids and liquids, and hydrogen or air the standard for gases.

Density should not be confused with specific gravity. They may have the same values and are frequently used interchangeably. Specific gravity is relative, while density is weight of a unit volume.

In taking the specific gravity of solids or liquids, the object sought is always the weight of a volume of water equal to that of a volume of the substance, the specific gravity of which we desire, whether that substance be soluble, insoluble, lighter or heavier than water. Then the weight of the substance divided by the weight of an equal volume of water gives the specific gravity. The specific gravity of liquids is usually taken with a specific gravity flask (pycnometer) or a hydrometer.

The volume of all bodies varies with change in temperature. It is therefore necessary that determinations should be made at a stated temperature. For scientific purposes 4° C. is selected, because it is the temperature at which water has its greatest density. For other reasons working-room temperature is to be preferred. The former is not always easily obtained and cannot be conveniently maintained. If a liquid be measured at a reduced temperature and weighed at a higher temperature, expansion occurs and part of the liquid is forced through the capillary tube in the cork and lost by evaporation before an accurate weighing can be made. This is especially true of very volatile liquids. Another source of error is the condensation of moisture from warm air upon a cold surface. The *United States Pharmacopœia* has adopted 25° C. as the temperature for taking specific gravity except in the case of a few liquids with a particularly low boiling point. Great Britain has adopted 15.6°; Germany and France, 15° C. In ordinary work barometric pressure is ignored. It is assumed to be normal, 760 mm. Usually the substance and the water are weighed at the same temperature, but as this is not always the case it is best to express the temperature thus:

$$\frac{25^\circ}{4^\circ}\text{ C.},\ \frac{25^\circ}{15^\circ}\text{ C.},\ \frac{25^\circ}{25^\circ}\text{ C.}$$

The numerator indicates that the substance was weighed at 25° and compared with an equal volume of water weighed at the temperature indicated by the figures in the denominator.

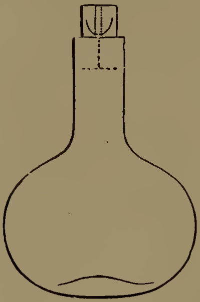
SPECIFIC GRAVITY FLASKS.

(Pycnometers.)

A common bottle or flask may be used for taking the specific gravity if an exact volume can be measured each time, but for convenience special flasks are made which are light and constructed to hold a given volume.

Fig. 22 is the ordinary form. The flask is filled, and when the stopper is inserted the excess flows out through a capillary opening in the stopper. These are usually made to hold 25, 50, or 100 gm. of water at a given temperature.

FIG. 22



Specific gravity flask.

Squibb's specific gravity flask (Fig. 23) is made with a graduated neck of sufficient length to cover the expansion of a liquid when raised from 4° C. to 25° C. They are made to hold either 25, 50, or 100 Gm. of water at 4° C. when filled to the zero at the bottom of the neck. If the volume occupied by the required weight of water be recorded at any temperature between zero and 25° C., the flask may be used for taking the specific gravity of any liquid at any time at that temperature, without subsequent weighing with water. The flask when filled should be placed in a bath, kept at the required temperature, until the height of the liquid in the scale does not change, which will prove that the contents of the flask is of the same temperature as the bath. With light liquids it may be necessary to place the lead collar over the neck of the bottle to keep in an upright position. To fill the flask to a given point the best method is to lower the temperature of the liquid a little below that required and fill to the

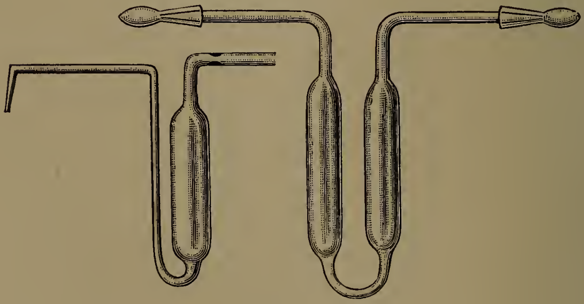
Fig. 23

Squibb's specific gravity flasks.

mark. When the required temperature is reached, remove the excess with a strip of blotting paper or a fine-pointed pipette. All external moisture should be removed before weighing. When weighing specific gravity flasks, especially the old form, the flask should not be held in the hands, as the warmth causes the liquid to expand.

The Sprengel tube (Fig. 24) is convenient for taking the specific gravity of small quantities of liquids, also for fats and oils. They can be easily made of any size, by anyone at all skilled in glass blowing. They are filled by placing one end in the liquid and applying suction to the other.

Fig. 24



The Sprengel tube.

The pycnometer should be either counterpoised or its weight accurately determined and subtracted from the weight of flask and liquid to obtain the net weight, which, divided by an equal weight of water, gives its specific gravity. If a pycnometer weighs 10 Gm. and holds 25 Gm. of water, and when filled with glycerin weighs 41.25 Gm., the weight of the glycerin will be 41.25 — 10 = 31.25 Gm. To find the specific gravity, divide 31.25 by 25, equals 1.25.

As glass contracts until two years old, all graduated flasks should be tested occasionally, but they ought not to be graduated until contraction ceases.

HYDROMETERS OR AREOMETERS.

A body which just floats on water will rise to a greater height in glycerin and to a still greater height in chloroform. *In each case a volume of the liquid equal to the weight of the body will be displaced.* The buoyant force of a liquid is proportional to its specific gravity. This principle is applied to the construction of hydrometers. They are usually made of glass, and consist of a stem and two bulbs (Fig. 25). The bulb at the end is loaded to keep the instrument in an upright position and to cause it to sink to the required depth. Specific gravity hydrometers are graduated so that the number at the surface of a liquid, in which it floats, is its specific gravity. A *universal hydrometer* has been made which may be used for taking the specific gravity for liquids heavier and lighter than water, but they are not accurate, as the stem must be large to avoid great length. Accuracy can be obtained only by using hydrometers with small stems. Hydrometers may be procured in sets of six instruments. One is for liquids lighter than water, and is graduated from 0.700 to 1.000. The remaining five are for liquids heavier than water. The first of these is graduated from 1.000 to 1.200; the second from 1.200 to 1.400;

Fig. 25

Hydrometer.

Fig. 26

United States Custom House hydrometer.

the third from 1.400 to 1.600; the fourth from 1.600 to 1.800; and the fifth from 1.800 to 2.000.

The *urinometer* is a hydrometer for determining the specific gravity of urine. The stem is made very small, so that fractions of a degree may be accurately read. The entire range is from 1.000 to 1.060.

In using hydrometers care should be taken to prevent the instrument from adhering to the sides of the cylinder. The scale on the inside of hydrometers may be incorrectly placed, or it may not be correctly graduated for the size of the stem. It is, therefore, important that new instruments be tested by placing in water to ascertain the zero point. They should also be tested by placing in other liquids of known specific gravity. Many hydrometers are graduated for technical purposes. *Tralle's* hydrometer is an alcoholometer for gauging spirits. It gives the percentage of alcohol by volume at 15.6° C. If the instrument be used at any other temperature, a correction must be made, since an increase in temperature causes a decrease in density. For each centigrade degree above 15.6°, subtract 0.27, and for each Fahrenheit degree above 60°, subtract 0.15. If the instrument sinks in alcohol to 95 at 25° C., we must subtract

$$(25 - 15.6) \times 0.27$$

from 95, equal to 92.46, as the percentage of absolute alcohol. For each degree below 15.6° C., add 0.27, and for each degree Fahrenheit below 60°, add 0.15.

Gay-Lussac's hydrometer is similar to the preceding, except that it is to be used at 15° C. instead of at 15.6°.

Richter's hydrometer gives the weight of absolute alcohol at 15.6° C. in 100 volumes.

United States Custom House hydrometer (Fig. 26) has three separate scales, Tralle's, Richter's, and the United States Custom House scale giving degrees above and below proof.

Saccharometers are for determining the percentage of sugar in syrup.

Baumé hydrometers are constructed for both heavy and light liquids. The degrees are arbitrary. For liquids heavier than water the zero mark is the point at which the instrument sinks in water, and 15° is the point at which it sinks in a 15 per cent. solution of salt. The intervening space is divided into 15 equal spaces, and the remainder of the stem into similar divisions. *For liquids lighter than water* the zero mark is the point at which the hydrometer sinks in a 10 per cent. solution of salt, and the 10° mark is the point at which it sinks in water. The intervening space is divided into ten equal parts, and the remainder of the stem into similar divisions.

Baumé degrees may be converted into specific gravity degrees as follows:

For liquids heavier than water, divide 145 by 145 minus the given number of degrees. Thus: $\frac{145}{145-60} = 1.7058$, which is the specific gravity equal to 60° B. For liquids lighter than water, divide 140 by 130 plus the given number of degrees. Thus: $\frac{140}{130+56} = 0.752$, which is the specific gravity equal to 56° B.

Carter's hydrometer is similar to Baumé's, except that 15° of the former are equal to 16° of the latter. Hence, Carter's degrees may be changed to Baumé's by multiplying by $\frac{15}{16}$.

Twaddell's hydrometer is used for liquids heavier than water. To change Twaddell's degrees to specific gravity degrees, multiply by 5 and add 1000. Sixty-five degrees Twaddell equals $(65 \times 5) + 1000$ or 1.325 specific gravity.

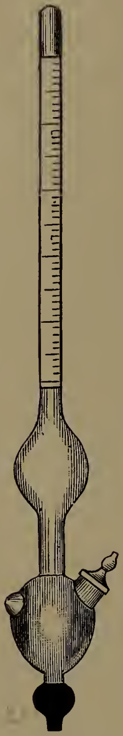
Eichhorn's areopycnometers (Fig. 27) are made in sets of three: two for liquids heavier than water, and one for liquids lighter than water. The lower bulb is filled with the liquid to be tested and the instrument placed in water. The extent to which it sinks is the specific gravity.

Rosseau's densimeter (Fig. 28) is intended for taking the specific gravity of small quantities of light liquids like volatile oils. The instrument is floated in water and exactly 1 Cc. of the oil is placed in the cup at the top of the stem. The degree to which it sinks multiplied by 0.05 will give the specific gravity of the oil.

Fahrenheit's and *Nicholson's hydrometers* differ from the preceding in that they are made to sink to a given point on the stem by the use of weights. Fahrenheit's is intended for liquids only, while Nicholson's may be used for both liquids and solids.

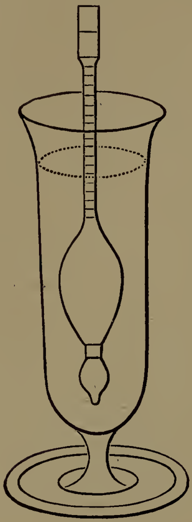
Nicholson's hydrometers are made of brass (Fig. 29). The instrument is placed in water and weights are placed on the pan until the hydrometer sinks to a given mark on the stem. This weight we will designate as normal weight. The weight of the instrument in air plus the normal weight gives the weight of the water displaced by the instrument. When placed in any other liquid and treated as before, the weight of the instrument plus the weights added is the weight of the liquid displaced, which, divided by the weight of the water displaced by the instrument, gives the specific gravity of the liquid used.

FIG. 27



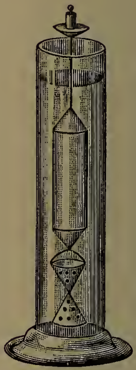
Eichhorn's areopycnometer.

FIG. 28



Rousseau's densimeter.

FIG. 29



Nicholson's hydrometer.

For solids, the substance is placed on the pan and weights added until the hydrometer sinks to the mark. The weight required, subtracted from the normal weight, gives the weight of the substance in air. If the substance be now placed in the cone *C*, and weights added to the pan as before, the required weight subtracted from the normal weight gives the weight of the substance in water. The weight in water subtracted from the weight in air gives the weight of water displaced, which is the weight of a volume of water equal to the volume of the substance.

If the solid should be lighter than water, the method is the same, except that when weighed in water the substance is placed under the cone *B*, which is perforated at the apex to allow the air to pass out. The normal weight subtracted from the weight required with the substance under water, plus the weight in air, is the weight of an equal volume of water.

SPECIFIC GRAVITY TAKEN WITH THE PLUMMET.

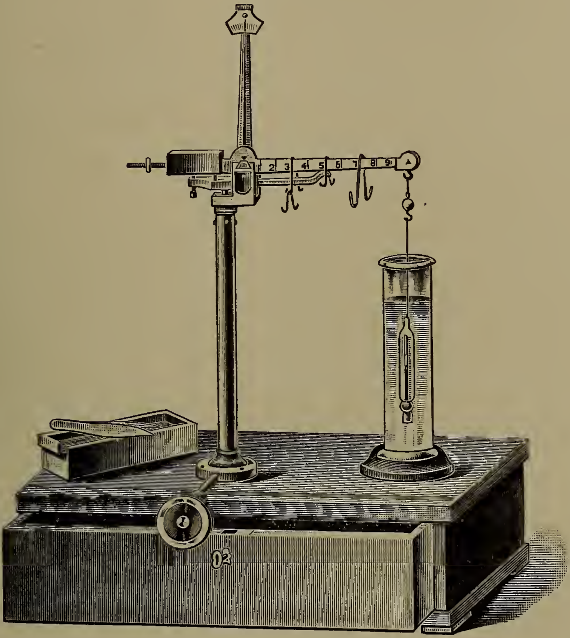
The specific gravity of liquids may also be taken with a balance and plummet. *When a solid is immersed in any liquid it displaces a weight of that liquid equal in volume to the volume of the solid.* By determining the weight of water displaced and the weight of any other liquid displaced by a given solid, the specific gravity is determined by dividing the weight of the liquid displaced by the weight of water displaced. Thus, suppose a piece of glass weighs 39 Gm. in air, 24 Gm. in water, and 20.25 Gm. in glycerin. Then $39-24=15$, the weight of water displaced; $39-20.25=$

18.75, the weight of glycerin displaced; 18.75÷15=1.25, the specific gravity of the glycerin.

NOTE.—If a piece of glass be made of such size that it will displace exactly ten grams of water, then the loss of weight in any liquid, divided by ten, will give the specific gravity. If the specific gravity of glass be 2.600, then a piece weighing 26 Gm. will displace 10 Gm. of water, 12.4 Gm. of glycerin, or 7.16 Gm. of ether.

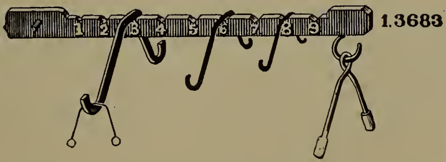
The Mohr and the Westphal specific gravity balances (Fig. 30) are constructed on the above principle. The plummet takes the form of a short thermometer, and is adjusted to displace exactly 10 Gm. of water at 15° C. This plummet is suspended, by a fine platinum wire, from a hook at the outer end of the balance beam, and is counterpoised by a weight at the opposite end of the beam. When the plummet is suspended in water a 10 Gm. weight upon this hook is required to restore equilibrium. If the plummet be suspended in glycerin, additional weight will be required to restore the equilibrium. The weights are in the form of riders, each weight being one-tenth of the weight of the next larger. The arm of the beam is divided into ten equal spaces. Since the large weight upon the hook represents ten grams, a weight of the same size at the second notch on the beam represents two grams. The next smaller weight at the fourth notch represents 0.4 Gm., the next smaller at the sixth notch represents 0.06 Gm., and the next at five represents 0.005 Gm., which give a specific gravity of 1.2465. Fig. 31 represents a specific gravity reading of 1.3683. The large Westphal balance is supplied with two cylinders, one displacing exactly 10 Gm. of water, and the other 1 Gm. The

Fig. 30



Westphal's specific gravity balance.

Fig. 31



Showing the manner of reading the specific gravities.

smaller balances are supplied with but one cylinder, which displaces 5 Gm. of water. The largest weight is 5 Gm., the next smaller, 0.5 Gm., etc.

THE SPECIFIC GRAVITY OF SOLIDS.

For Solids Insoluble in and Heavier than Water.—Weigh the solid in air, after which suspend it from one arm of the balance by means of a silk thread. Then place a beaker of water on a bench, over the scale pan, in such a manner that the substance is immersed without touching or otherwise interfering with the free movements of the pan (Fig. 32), and again weigh. The weight of the substance in the water subtracted from the weight of the substance in air gives the weight of water displaced. This is equal in volume to the volume of the solid.

Example.—A piece of native lead sulphide weighs in air 108.75 Gm. and in water 93.75 Gm.

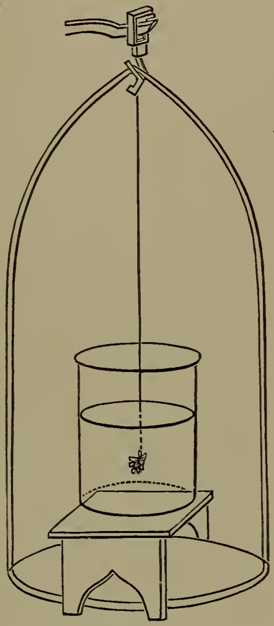
$108.75 - 93.75 = 15$, the weight in grams of water displaced.

$108.75 \div 15 = 7.25$, specific gravity of the lead sulphide.

When weighing a substance in water carefully remove all adhering air bubbles. The water also should be of the required temperature.

Solids Insoluble in but Lighter than Water.—A solid when floating in water displaces a weight of water equal to the weight of the solid, and a volume of water equal to that portion of the solid which is below the surface. To obtain the weight of water equal to the exposed part of the solid, the solid itself must be attached to a sinker of sufficient weight to cause the whole to be submerged. The difference between the weight of the sinker in water and the weight of both solid and sinker in water will give the weight of water equal to the volume of the solid that was exposed when floating. This, plus the weight of the solid in air, gives the weight of water displaced by the solid. For instance, a piece of wax weighs 2.16 Gm. in air. A piece of lead weighs

Fig. 32



Showing the manner of weighing a solid body in a liquid.

10.35 Gm. in water. The weight of both in water is 10.26 Gm. Then 10.35 − 10.26 + 2.16 = 2.25, the weight of water displaced by the wax; 2.16 ÷ 2.25 = 0.96, the specific gravity of the wax.

Solids Soluble in Water.—The method employed is the same as that used in taking the specific gravity of solids insoluble in water, except that in place of water some other liquid is used in which the substance is insoluble, as oil, alcohol, or turpentine. A correction is then made for the difference in the specific gravity of the liquid used and that of water, by multiplying by the specific gravity of the liquid.

Example.—A crystal of potassium bichromate weighs 19.705 Gm. in air and 13.27 Gm. in deodorized alcohol, specific gravity 0.816. What is the specific gravity of the potassium bichromate?

19.705 − 13.27 = 6.435, the loss of weight in alcohol.

19.705 ÷ 6.435 = 3.062, the specific gravity as compared with alcohol.

3.062 × 0.816 = 2.495, the specific gravity as compared with water.

Powders Insoluble in Water.—Fill a specific gravity flask with water and weigh. Empty the flask, introduce a weighed quantity of the powder, partially fill with water, and rotate gently to remove air. Completely fill with water and weigh. Subtract this weight from the weight of the flask filled with water plus the weight of the powder. The difference will be the weight of the water displaced by the powder. For instance, a flask filled with water weighs 58 Gm. The same flask containing 12 Gm. of sand and filled with water weighs 65.2 Gm.; 58 + 12 = 70 Gm.; 70 − 65.2 = 4.8 Gm., the weight of water displaced; 12 ÷ 4.8 = 2.5, the specific gravity of the sand.

Powders Soluble in Water.—The method employed is the same as that used in taking the specific gravity of powders insoluble in water, except that in the place of water some other liquid is used in which the substance is insoluble. A correction is then made for the difference in the specific gravities of the liquids used. (See Specific Gravity of Solids Soluble in Water, p. 62.)

Special Methods.—A graduated cylinder is partially filled with water and a weighed quantity of an insoluble solid substance introduced. Observe the increase in volume. Divide the weight of the substance by the increase in volume, which gives the approximate specific gravity.

The specific gravity of small quantities of any substance may sometimes be taken by preparing a liquid of such density that the substance will remain suspended in it. The liquid will then have the same specific gravity as the suspended substance, and the specific gravity of the substance may be determined by taking the specific gravity of the liquid in the usual manner. To illustrate, most fixed oils are insoluble in alcohol. Hence, a mixture of alcohol and water may be made of such density that the oil will float indifferently in the mixture.

Lovi's beads are constructed on this principle. They are small glass beads of varying densities. If several are placed in a liquid some will sink, others will rise to the surface, while a single one may remain suspended in the liquid. The mark upon this one shows the specific gravity of the liquid.

TO FIND THE SPECIFIC VOLUME OF A LIQUID.

Specific volume is the volumetric ratio existing between the same weights of different bodies, as compared with the volume of the same weight of water. It is therefore the reciprocal of specific gravity. In pharmaceutical practice its use is confined to liquids. Specific volume is obtained by dividing the volume of a given weight of the liquid by the volume of an equal weight of water.

Example.—100 gr. of glycerin measure 84 minims. 100 gr. of water measure 105 minims. What is the specific volume of the glycerin?

84 ÷ 105 = 0.8, the specific volume of the glycerin.

A given weight of liquid cannot be as accurately measured as a given volume of liquid can be weighed. Therefore, a better method is to find the specific gravity and divide 1 by the specific gravity.

Example.—The specific gravity of glycerin is 1.25.

1 ÷ 1.25 = 0.80, the specific volume of the glycerin. Therefore, to find the volume of a given weight of any liquid, multiply by its specific volume, or divide by its specific gravity. In the metric system this is all that is necessary, but in the use of other weights and measures a correction must be made for the difference in size of the denominations used.

Example.—To find the volume of ten pounds of chloroform. The specific gravity of chloroform is 1.49. Hence, the specific volume is $\frac{1}{1.49} = 0.671$, and $10 \times 0.671 = 6.71$. Correcting for the difference between the weight of the pounds and pints of distilled water, we have $6.71 \times 0.96 = 6.44$ pints. (See Equivalents, p. 28.)

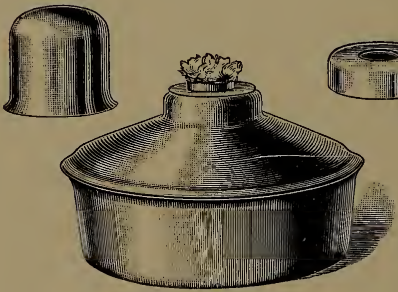
CHAPTER III.

HEAT.

FUELS.

Many pharmaceutical operations require heat obtained by the combustion of various kinds of fuel. The fuel selected depends upon the object to be obtained. Wood, charcoal, and anthracite coal, bituminous coal, and coke are now seldom used directly, but are used for the production of steam, which is the ideal heat for the manufacture of pharmaceutical products. Gas, gasoline, kerosene, and wood alcohol have been extensively used in minor operations. Now that denatured alcohol is available, it will doubtless to some extent replace wood alcohol, gasoline, and kerosene. Alcohol burns with a non-luminous blue flame, forming little deposit and producing intense heat. The alcohol

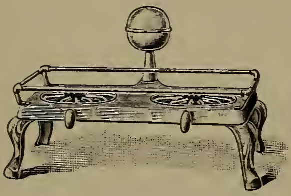
Fig. 33



Spirit lamp.

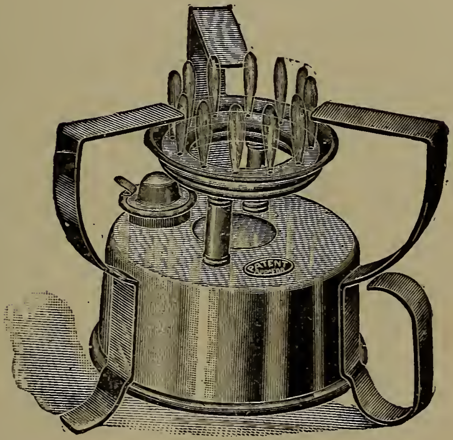
lamp (Fig. 33) burns from a wick, and has a cap which can be placed over the wick to reduce the size of the flame. The alcohol stoves giving the best results are those in which the alcohol is first vaporized. When the burner is once started the heat is sufficient to vaporize the alcohol. Such an alcohol stove is shown in Figs. 34 and 35. The apparatus for use in the burning of

Fig. 34



Alcohol vapor stove.

Fig. 35



Alcohol vapor stove.

other fluid or solid fuels is too familiar to require description.

Gas.—Gas is preëminently the fuel for the chemist and pharmacist. It is usually produced by the destructive distillation of soft coal, and consists principally of carburetted hydrogen (CH_4) associated with some of the lighter hydrocarbons, hydrogen, carbon monoxide and carbon dioxide, oxygen, and nitrogen. Gas burns with a luminous flame, and must be mixed with air to secure the best results for heating purposes.

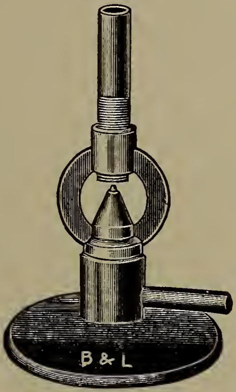
APPARATUS FOR COMBUSTION.

Burners and Gas Stoves.—Burners and gas stoves vary in size and construction, depending largely upon the purpose for which they are designed. The same principle prevails in all, and that is the Bunsen method of mixing air with gas before ignition or combustion. The principle is best illustrated in the *Bunsen burner* (Fig. 36). The gas enters the burner through a small orifice in the centre of the base, and mixes with air which enters through small openings (also at the base) on the sides of the tube. The amount of air admitted is regulated by turning a small band surrounding the base of the burner tube and having openings corresponding with those in the inner tube. In some burners the tube is supported by a side arm, and the gas passes through the air space, as in Fig. 37. The principle remains the same whether the tube be upright or horizontal as in Fig. 38. In a lighted Bunsen burner the flame appears to be divided into two parts. The inner cone consists of but partially consumed gas mixed with air. This reduces metallic oxide, and hence is called the reducing flame. In the outer cone the gas is wholly consumed, and because it oxidizes metals it is

FIG. 36

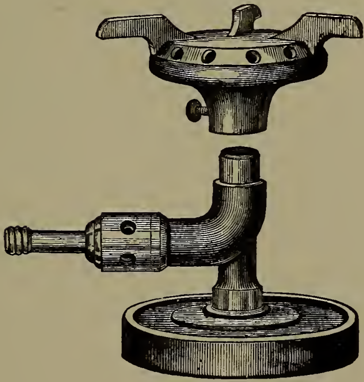
Bunsen burner.

FIG. 37



Bunsen burner.

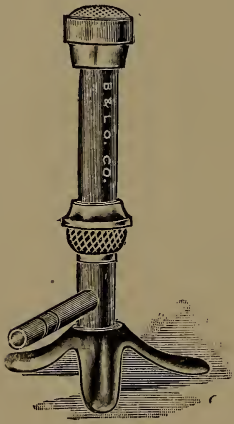
FIG. 38



Horizontal burner.

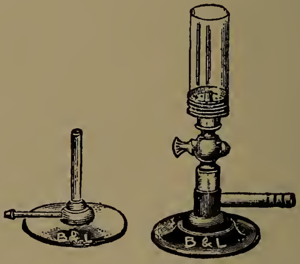
called the oxidizing flame. Usually it is unsafe to leave an ordinary burner burning when out of the room for any length of time. It is liable to ignite at the base, melt the rubber at that point, and burn the table. This is apt to occur when the flame is low. Burners with the tube somewhat contracted at the top are least apt to ignite at the base. The whole difficulty may be overcome by covering the top of the burner with a fine wire gauze, as in Fig. 39. When an extremely low flame is required, the "minim" burner (Fig. 40) may be used. This is so constructed that only a small jet of gas unmixed with air is burned. Many of the large burners or gas stoves are furnished with legs so short that it is unsafe to place them on a wood table without the protection of an iron plate or an asbestos slab.

Fig. 39



Fletcher's safety burner.

Fig. 40

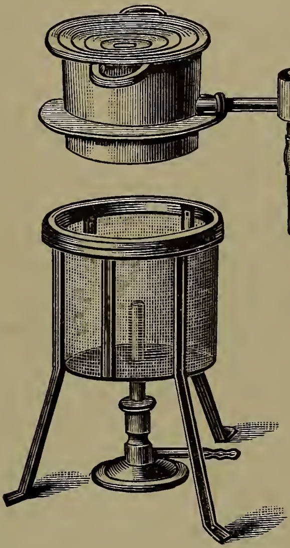


Minim burners.

Electric Stoves.—Electric stoves are extensively used as a source of heat, but are not in general use for pharmaceutical purposes.

Safety Burners.—Safety burners for the evaporation or distillation of inflammable liquids (Fig. 41) are constructed on the principle of the miner's safety lamp. The burner is surrounded by fine wire gauze and the substance to be heated placed on a water bath over the burner. Inflammable vapors may pass through the gauze and ignite on the inside, but the flame will not pass through the gauze and ignite the vapors without.

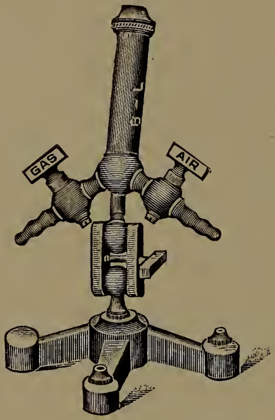
Fig. 41



Hood and constant level water bath, for use with inflammable liquids.

Blast Lamps (Fig. 42).—Blast lamps differ from the Bunsen burner in that the air is supplied under pressure from a foot bellows or water blast. By regulating the supply of gas and air perfect combustion and intense heat will be produced. In practice a frequent fault is that too much air is forced through the burner, thus reducing the temperature.

Fig. 42



Blast lamp.

THERMOMETERS.

Thermometers are used exclusively for measuring temperature. They consist of a capillary tube attached to a bulb and partially filled with mercury or colored alcohol. The air in the tube is exhausted before sealing. The scales for recording the temperature are arbitrary. Three systems are in vogue—the *Fahrenheit*, the *Celsius* or *Centigrade*, and *Réaumur*. The first two are used in the United States, the Fahrenheit for domestic uses, while Centigrade is employed almost exclusively for scientific purposes. The *United States Pharmacopœia* gives temperature in both Centigrade and Fahrenheit degrees, but prefers Centigrade. The scale graduation of different instruments is best understood by examining the accompanying illustration (Fig. 43), which shows the freezing and boiling points of water for each instrument. This shows the number of degrees between the freezing and boiling points, 180° F., 100° C., and 80° R.

Since 180° F. are equal to 100° C., each degree Fahrenheit is equal to $\frac{100}{180} = \frac{5}{9}$ of a degree Centigrade, or $\frac{80}{180} = \frac{4}{9}$ of a degree Réaumur. In a similar manner we find that one degree Centigrade is equal to $\frac{9}{5} = 1.8$ of a degree Fahrenheit, or $\frac{4}{5}$ of a degree Réaumur. One degree Réaumur is equal to $\frac{9}{4} = 2.25$ of a degree Fahrenheit, or $\frac{5}{4} = 1.25$ of a degree Centigrade.

The following formulas may be used to reduce degrees from one scale to those of another:

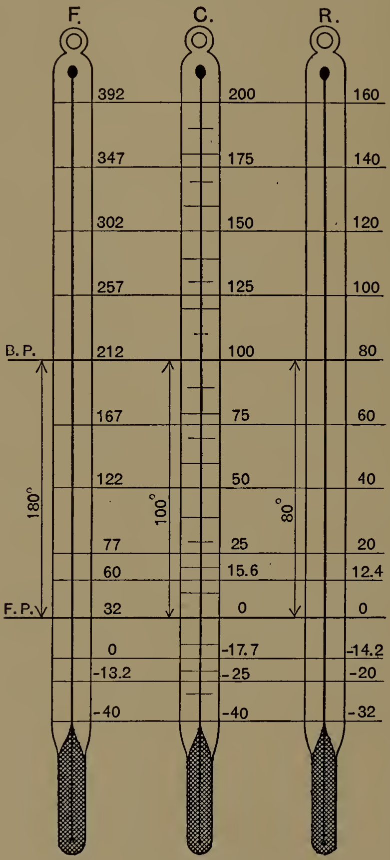
$$F^\circ - 32 \times \tfrac{5}{9} = C^\circ \qquad C^\circ \times \tfrac{9}{5} + 32 = F^\circ$$

$$F^\circ - 32 \times \tfrac{4}{9} = R^\circ \qquad R^\circ \times \tfrac{9}{4} + 32 = F^\circ$$

$$R^\circ \times \tfrac{5}{4} = C^\circ \qquad C^\circ \times \tfrac{4}{5} = R^\circ$$

The first two formulas should be learned, but the others are comparatively unimportant. If the construction on the instruments (Fig. 43) is understood, the formulas can be easily constructed.

Fig. 43



Thermometers.

It is good practice to apply these directions to the changing of the degrees given in the illustration to the corresponding degrees on the opposite scales. The forms or shapes of thermometers vary with their purpose or use. Those designed for chemical or pharmaceutical purposes are usually made of a thick glass capillary tube, or they consist of an inner and an outer tube with porcelain scale between. The accuracy of a thermometer may be tested as follows: Place it in water containing snow or broken ice and ascertain whether the zero point is correct. To determine the accuracy of the boiling point, suspend the thermometer in a flask of boiling water until the mercury becomes stationary. (See Boiling-point Determinations, p. 79.) To determine whether the capillary tube be of uniform diameter, place the instrument in a horizontal position and, with a slight jar, separate a portion of the mercury. Cause this mercury to traverse the entire length of the tube, frequently noting the number of degrees occupied by the separated column. This should be the same throughout the scale. The absence of air may be proved by inverting the thermometer, when the mercury should descend to its lowest point. Thermometers may also be tested by comparison with a standard instrument, or, in the absence of this, they may be sent to the Bureau of Standards, Washington, D. C., where they will be officially tested.

Clinical Thermometers.—Clinical thermometers are small self-registering instruments covering a range of from 90° to 110° F. They are intended for taking the temperature of the human body by placing the bulb of the instrument beneath the tongue for a period of five minutes. In Europe it is customary to place the thermometer bulb in the arm pit. After use, the register should be forced below the normal temperature (98.5°) by enclosing the thermometer in the hand so that the bulb is held between the thumb and forefinger. Raise the arm above the head and with a rapid forward stroke bring the hand to the side with a sudden stop. Thermometers are frequently broken by holding the instrument in one hand and striking it upon the other.

MELTING POINT.

The changing of a substance from a solid to a liquid form by the aid of heat is called fusing or melting. Many solids in a pure condition melt or fuse at a constant temperature. This is known as their melting point. Hence, it serves as an efficient means of determining their purity and identity. The melting point of substances easily powdered may be taken with an apparatus similar to that shown in Fig. 44. A similar apparatus may be made by filling a long-necked flask three-fourths full of sulphuric acid, and inserting a test-tube of such length that when the flange rests upon the top of the flask the bottom of the tube will be within about 12 mm. of the bottom. The test-tube should be filled with sulphuric acid to the level of the acid in the flask. Some prefer to leave the acid out of the test-tube, using it simply as an air bath. This is not advisable. The substance to be tested should be introduced into a capillary tube[1] to the depth of 12 mm. The tube when filled is attached to the thermometer with a platinum wire so that the bottom of the tube is nearly even with the bottom of the thermometer (Fig. 45). When many determinations are to be made, a convenient method of fastening the tube to the thermometer is to use a narrow band of platinum foil long enough to encircle the thermometer one and a half times. The capillary tube is then slipped under the overlapping end. The tube and thermometer are then inserted into the apparatus until one-half of the capillary tube is immersed in the acid. Heat is then carefully applied and the reading made at the moment the particles begin to run

Fig. 44

Melting-point apparatus.

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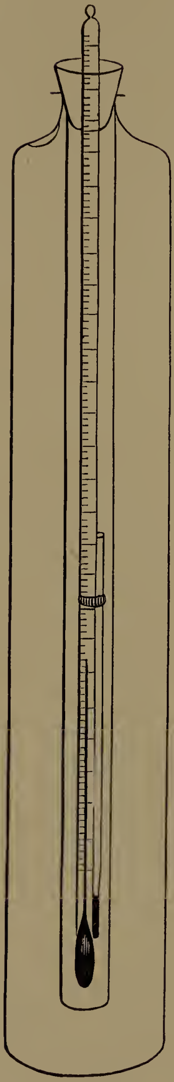
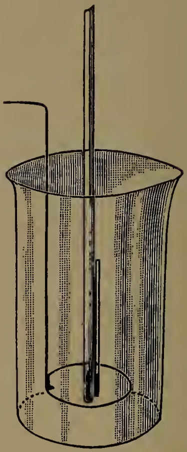
[1] A capillary tube may be made by heating an ordinary glass tube in a gas flame until very soft. Remove from the flame and slowly draw out to one or two millimeters in diameter. Cut into pieces six to eight centimeters long and seal at one end.

Fig. 45



Position of capillary tube.

Fig. 46



Beaker, with rod for stirring the acid.

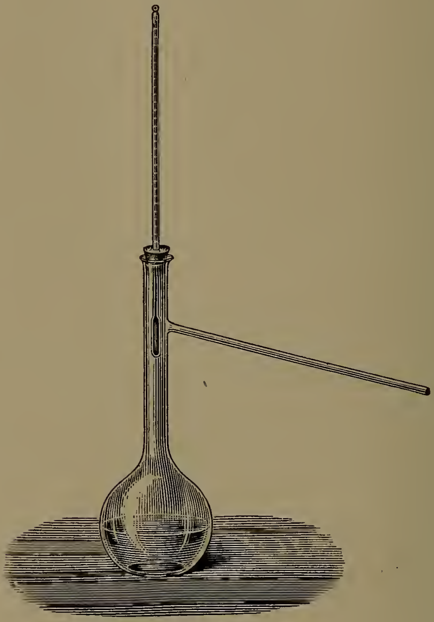
together, which is the melting point. Where great accuracy is not desired, an open beaker containing the acid may be used in place of the flask and tube. When the beaker is used the acid should be stirred frequently, best by raising and lowering a glass rod bent in the form of a large ring which encircles the thermometer (Fig. 46).

For determining the melting point of substances like fats and wax, the method is the same, except that a thin glass tube about 3 mm. in diameter is selected, drawn out, and sealed at one end; the substance is introduced in small pieces. Some prefer to melt the substance and draw a little of it into the tube before sealing. When this method is followed some time should elapse before making the test, as many complex fats, when melted and congealed, do not return to a constant melting point for several hours. With many substances it is advisable to record the degree at which they begin to soften and run and also the degree at which it runs together to form a clear liquid. It is always advisable to make an approximate determination first and then to make a second determination, applying the heat cautiously as the temperature approaches the melting point.

BOILING POINTS.

A liquid boils when the temperature reaches the point where its vapor tension equals the atmospheric pressure. This is definite for any given pressure, and the temperature at which a liquid boils, under normal pressure, 760 mm., is its boiling point. At normal pressure water boils at 100 C. At 658 mm. it boils at 96°. At 594 mm. it boils at 93.3°. Boiling points serve to determine the identity and purity of liquids. A simple apparatus for determining boiling points may be made as follows: A flask with a long neck containing a few cubic centimeters of the liquid to be tested is fitted with a perforated cork, through which passes a glass tube of such diameter that a thermometer may be admitted and sufficient space for the passage of vapor remains. The tube should be about 2.5 cm. shorter than the thermometer, which may be suspended from the top of the tube by passing a wire through the ring of the thermometer. The instrument should be adjusted, raising or lowering the inner tube, so that the bulb is just above the liquid.

FIG. 47



Boiling-point determination.

Heat is applied by means of a sand bath or water bath until the liquid boils freely and the vapors pass out at the top of the tube. When the mercury becomes stationary the temperature is recorded.

To determine the boiling point of the distillate during distillation, the bulb of the thermometer should be just below the exit tube of the distillation flask (Fig. 47).

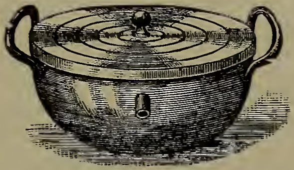
CHAPTER IV.

METHODS OF SECURING DIFFERENT DEGREES OF TEMPERATURE.

VARIOUS degrees of temperature may be obtained by the use of different baths.

Water Baths.—Water baths should always be used for the evaporation of solutions containing organic substances. Only sufficient heat to boil the liquid is necessary. Additional heat hastens the evaporation of the water in the bath without increasing the temperature of the solution. The temperature of a solution on a bath is always a few degrees below that of the bath itself. Water baths vary in shape, size, and material, as illustrated in Figs. 48, 49, and 50. Fig. 51 illustrates a bath with constant level attachment that holds only a little water, hence heats quickly. The constant level is maintained by the water flowing through the inlet (Fig. 49) until the water in the bath is level with the top of the outlet tube.

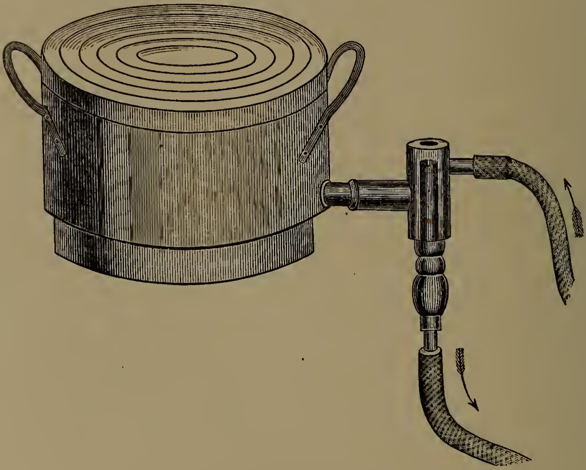
FIG. 48



Water bath.

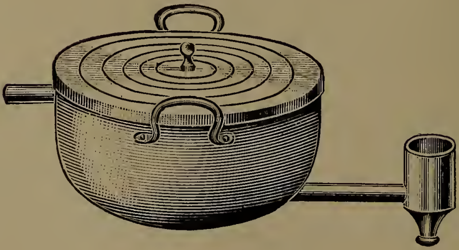
Steam Baths.—Steam baths are of two kinds. The open steam bath without pressure gives the same temperature as the boiling water bath. In the closed steam bath the steam is under pressure and gives a

Fig. 49



Iron water bath with constant level.

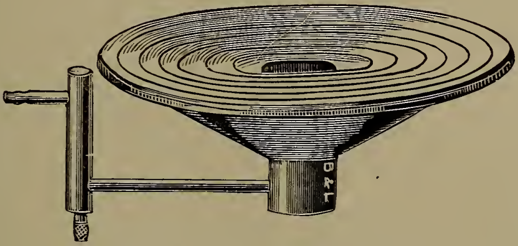
Fig. 50



Copper water bath.

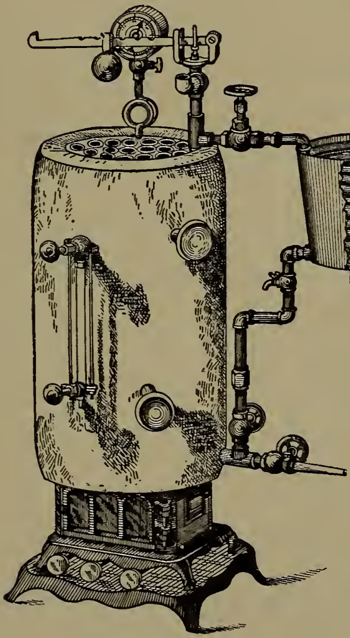
temperature increasing with increased pressure. Prof. Patch's tubular boiler (Fig. 52) is intended for small

Fig. 51



Kekulé's constant level water bath.

Fig. 52



Prof. Patch's steam boiler.

laboratories where steam is not available. It is twenty-two inches high, ten inches in diameter, and has a capacity of seven gallons. It is equipped with a water gauge and safety valve, and heated with gas, gasoline, or coal oil.

Salt Baths.—Salt baths are saturated solutions of various salts. The temperature obtainable varying with the salt used: Sodium Chloride, 108.4°; Sodium Nitrate, 121°; Calcium Nitrate, 151°; Calcium Chloride, 179°.

Glycerin Baths.—Glycerin baths may be used to obtain a temperature as high as 250°. Above this temperature disagreeable vapors of acrolein are given off.

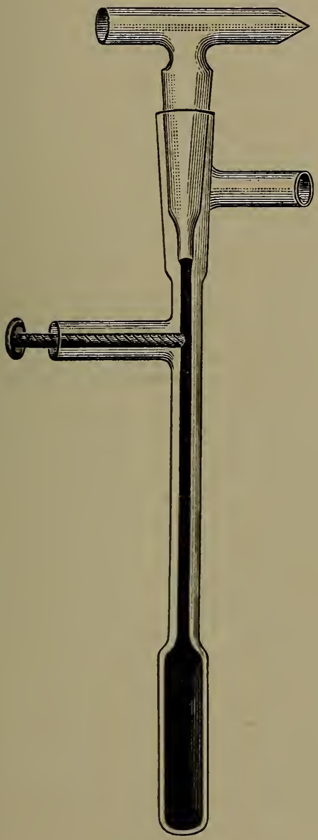
Oil Baths.—Oil baths are frequently used to obtain a temperature as high as 260°. Many fixed oils have been used, but above 175° nearly all give off disagreeable vapors. The best results are obtained by the use of petrolatum or paraffin.

Sand Baths.—Sand baths are used where it is not advisable to use the direct flame. It prevents sudden changes in temperature, and is therefore a protection to glass vessels. Shore sand only should be used, as bank sand is sharp and apt to scratch the vessels.

Not more than a cubic centimeter of sand should be between the bottom of the vessel and the bottom of the bath, but should be banked up well around the vessel. It is convenient to have two forms—one shallow, for evaporation, and another deep, for distillation.

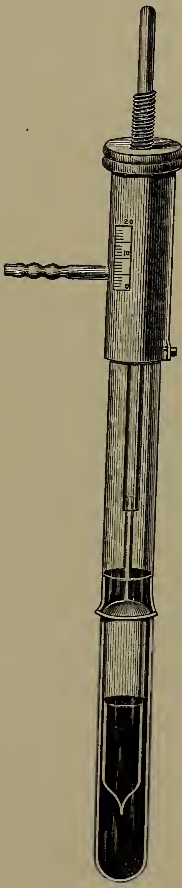
Air Baths.—Air baths may be used in place of a sand bath for many operations. A very convenient form is obtained by placing three inches of stovepipe on a cast-iron stovelid. Ordinary water-bath rings may be used to support the vessel to be heated.

Fig. 53



Reichert's thermostat.

Fig. 54



The Bunsen-Kemp gas regulator or thermostat.

Instead of using baths, wire gauze or sheets of asbestos are frequently used between the flame and the vessel. Asbestos is especially convenient, as, when wet, it can be moulded to any desired shape and retain the form when dry.

Constant Temperatures.—For most pharmaceutical operations a sufficiently uniform temperature may be maintained by regulating the supply of fuel. However, in operations requiring a great degree of accuracy, as in pepsin testing, a uniform temperature may be obtained by using a thermostat.

Thermostat.—There are several forms of this instrument, but the principle is practically the same in all. The instrument is placed in the bath or oven and connected with the gas in such a manner that the gas must pass through the thermostat on its way to the burner. When the desired temperature is reached the height of the mercury is adjusted with a screw, seen at the left of Fig. 53, by which the temperature is automatically controlled through the expansion and contraction of the mercury, which gradually closes the opening at the lower end of the hollow stopper. Just above the lower end of the stopper is a small pinhole, which permits sufficient gas to escape to keep the flame from being entirely extinguished. In the Bunsen-Kemp thermostat (Fig. 54) the adjustment is made by means of a screw at the top of the instrument, which raises and lowers the inner tube.

CHAPTER V.

VAPORIZATION.

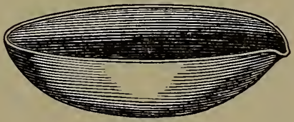
Vaporization is the process of changing a solid or liquid into a vaporous or gaseous form. It is, therefore, used in, or forms a part of, Evaporation, Granulation, Distillation, and Sublimation.

EVAPORATION.

The principal object of evaporation is concentration, as in the manufacture of extracts and for crystallization.

Spontaneous Evaporation.—Spontaneous evaporation is the term applied to the evaporation of liquids by exposure to the atmosphere, preferably in a warm, dry room or in a draught of dry air. It is used for the evaporation of volatile solvents and for the concentration of solutions of substances easily injured by direct heat. The greater the surface exposed the more rapid is the evaporation. Hence, broad shallow vessels similar to Fig. 55 are best for evaporation. These are usually made of porcelain, very thin and easily

Fig. 55



Evaporating dish.

broken, therefore they should not be heated over a direct flame. Stirring increases the evaporation surface and aids evaporation. Mechanical stirrers are very convenient.

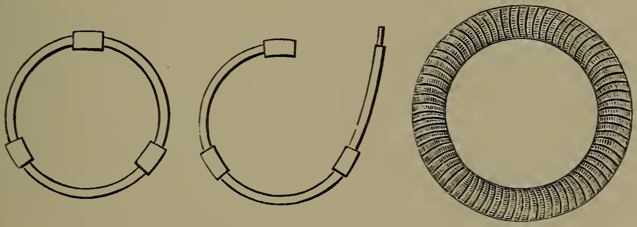
Use of Heat in Evaporation.—When two vessels of the same diameter are filled to different depths with the same liquid and heated to the same temperature, but below the boiling point, the amount of vapor given off will be the same. But if the liquid in each be made to boil, the vessel containing the least liquid will yield the greatest amount of vapor. This is due to the fact that the vapors producing ebullition form at the bottom of the vessel and rise more easily through a shallow depth of liquid than through a deeper one; hence evaporation proceeds faster.

If two vessels, one with a smooth and the other with a rough or corrugated bottom, but otherwise identical, are filled to the same depth and the boiling produced with the same amount of heat, evaporation will proceed more readily from the corrugated bottom. This is caused by the increased surface exposed to heat radiation.

Evaporation is accelerated by increasing the temperature and also by decreasing the atmospheric pressure. Substances injured by ordinary evaporation may be safely evaporated in a partial vacuum. Place the substance in a flask and connect it with an aspirator (see p. 118). Evaporation will then occur at a much lower temperature. Aqueous liquids may be concentrated by repeated freezing and removal of the ice, which consists principally of water.

Dense viscous liquids do not evaporate as readily as thin mobile liquids. Solutions containing organic matter should be evaporated over a steam or water bath and frequently stirred to prevent the formation of a pellicle over the surface, thus preventing the escape of the vapors. Caustic alkalies should be evaporated in polished iron or silver vessels, as they act on porcelain and glass. The evaporation of liquids yielding corrosive vapors should be conducted under a hood connected with a good flue. A liquid to be evaporated to a given weight should be evaporated in a tared vessel and during evaporation occasionally weighed. By subtracting the tare, the weight of the contents may be determined. If the evaporation is to be carried to a given volume, the desired volume should be placed in the vessel and the depth of its deepest part measured. The remainder of the liquid is then added and evaporation continued until the same depth is reached.

FIG. 56



Grommets.

Grommets.—Grommets are rings of straw, wood, or rubber for supporting evaporating dishes and round-bottomed vessels in an upright position. Old rubber tubing may be economically used for this purpose by cutting into proper lengths and uniting the ends with a piece of wood or tubing of smaller diameter (Fig. 56).

GRANULATION.

Very soluble or deliquescent substances cannot be easily prepared by crystallization. They are, therefore, usually obtained in the dry form by evaporating a solution to a coarse granular powder. This operation is best conducted in porcelain or agate-ware dishes. In case any part of the substance is organic, great care is necessary to prevent charring. Direct heat may be applied until the solution becomes quite concentrated. When a pellicle begins to form upon the surface the heat should be gradually decreased and the solution constantly stirred to prevent the formation of crusts or lumps upon the bottom. The product may be amorphous or crystalline. Many granular powders are obtained by disturbing the process of crystallization (see p. 170).

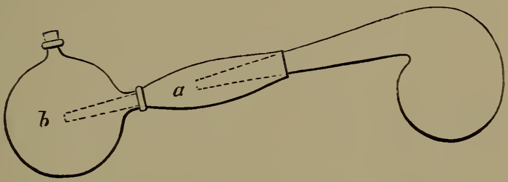
Granular Effervescent Salts.—Granular effervescent salts were formerly obtained in granular form by moistening the mixture with alcohol and passing the mass through a coarse sieve. At present the *Pharmacopœia* directs the mixture to be placed in an oven previously heated to from 93° to 104°. The water of crystallization liberated from the citric acid used softens the mass, which is then rubbed through a coarse sieve and dried. It should be closely watched, for if left too long the water of crystallization will be driven off, and the mass cannot then be granulated without the addition of moisture.

CHAPTER VI.

VAPORIZATION. DISTILLATION.

Distillation consists of two operations, viz., vaporization and condensation. The principles of vaporization have been considered in the preceding chapter. Condensation is the opposite of vaporization, and is the changing of a substance from a gaseous or vaporous form to a liquid condition. The apparatus used for distillation consists of three parts, viz., boiler or vaporizer, condenser, and the receiver. The apparatus varies with the kind of substance and the quantity to be distilled. In small laboratory operations the boiler usually consists of a retort or flask. Fig. 57 represents a plain retort with the adapter, *a*, and a tubulated receiver, *b*. Fig. 58 represents a tubulated retort with a plain receiver. The neck of the retort should be so shaped that the condensed liquid will

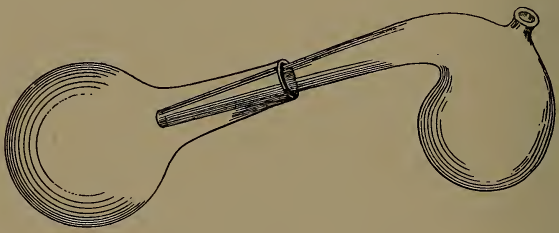
Fig. 57



Plain retort with adapter, *a*, and tabulated receiver, *b*.

not flow into the retort. The shape of the retort in Fig. 57 is good, while that in Fig. 58 is not so desirable. The opening should also be placed higher and in such a position that the thermometer, when introduced, will be in an upright position instead of at an angle. Plain retorts should be filled by inverting and placing a long-necked funnel in the neck of the retort in such a position that the liquid will not come in contact with the neck of the retort. A piece of rubber tubing placed over the lower end of the funnel tube will prevent the breakage of the retort. The vapors may be condensed by placing the receiver in cold or ice water, or by wrapping wet cloths around the neck of the retort.

Fig. 58



Tabulated retort and plain reciever.

Condensers.—Condensers are of various forms. Liebig's condenser (Fig. 59) consists of two tubes, one within the other. The inner tube is about one-quarter the diameter of the outer, and projects a few inches at each end. The outer tube at both ends is sealed to the inner tube, thus closing the space between them, and is provided with a small opening at or near each end. This is for the admission and discharge of cold water, which should enter at the bottom and be discharged at the top.

Squibb's upright condenser is a modification of Liebig's. The inner tube is made double, in the form of a U, with the outlet at the lower end.

Spiral or worm condensers are made in various sizes. Small ones are commonly made of glass (Fig. 61), and large ones are made of block tin. In all cases the worm is constantly surrounded by cold water.

Fig. 59

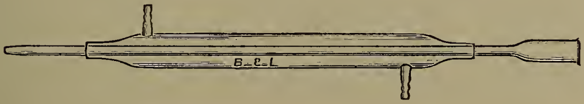
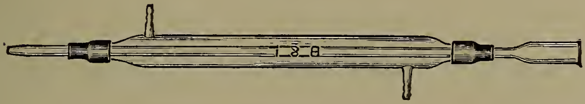


Fig. 60



Liebig's condensers.

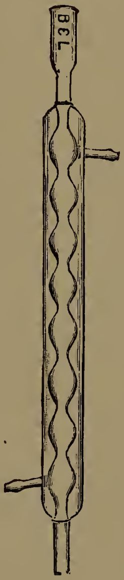
Reflex Condensers.—In many operations it is necessary that the vapors be condensed and returned to the distillation flask. For this purpose a short condenser with large condensing surface, similar to Figs. 61, 62, and 63, is especially suitable. Spherical condensers (Figs. 64 and 65) are made of glass or metal and occupy but little space.

Block tin or earthen condensing worms are generally used in large manufacturing establishments, though special condensers like the Beindorf and the Mitscherlich give good results.

Adapters.—Adapters are used to connect retorts with receivers. They are large at one end and gradually contract at the other, and may be either straight or curved as desired. Flasks have largely replaced retorts, as they are much cheaper and more convenient. The best form of distillation flask has a round bottom and a side arm (Fig. 66).

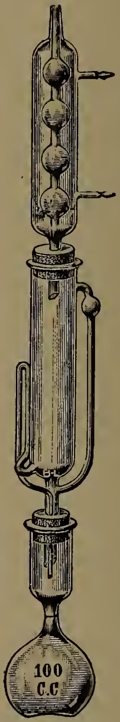
Fig. 61

Fig. 62



Reflex condensers.

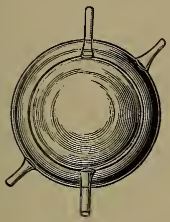
Fig. 63



Reflex condenser with Soxhlet's extraction apparatus.

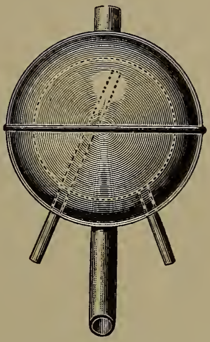
Lutes.—Lutes are sometimes used to make air-tight connections between retorts, receivers, or adapters, or

Fig. 64



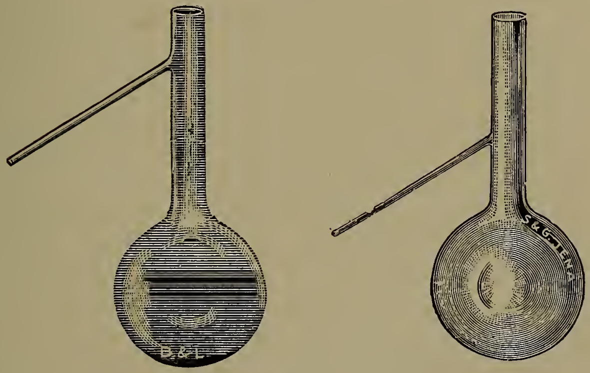
Glass spherical condenser.

Fig. 65



Copper condenser.

Fig. 66



Side arm distillation flasks.

to close the imperfections in corks used for distillation. A good lute may be easily prepared by making a stiff paste of linseed meal and boiling water. Porous corks may be made air-tight by painting them over with collodion or a solution of gelatin in water. Rubber tubing is generally used for connections but some distillates act upon rubber. In such cases animal membrane, as bladder, is softened in water and wrapped around the connection.

Flasks are frequently connected with condenser by means of perforated corks. For this purpose only the best corks should be used. The perforations are usually made with brass cork borers. These should be kept sharp by the judicious use of a file, or by means of a special sharpener. When using the borer the edge should never be forced against a hard surface. A piece of rubber fastened to the edge of the table or to the door casing at a convenient height is excellent to hold the cork against while boring. The beginner should bore the cork from one end only, holding it firmly against the rubber. Only an experienced operator can bore a cork from both ends and make the openings meet evenly. If the cork is very long it is best to withdraw the borer when half through, and remove the core before finishing. A much easier and smoother cut may be made by heating the borer until hot before cutting. The amount of heat required is easily learned by a few trials. When boring rubber cork keep the borer wet with a solution of sodium hydroxide.

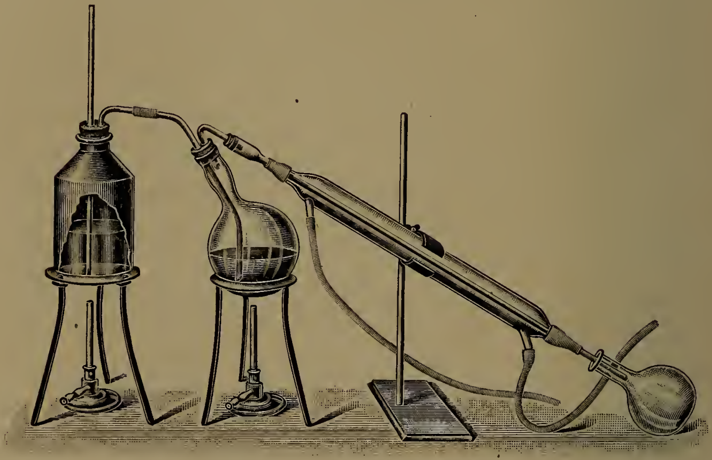
Cutting and Bending Glass Tubes.—When ordinary flasks are used for distillation they are connected with the condenser by means of glass tubing which should be as large as convenient. The pieces are cut the required length by making a sharp, but not deep, scratch with a three-cornered file. Then take the tube in both hands, with the thumbs opposite the mark, and by pressing outward the glass is easily broken. Smooth the sharp end by heating in a gas flame. The pieces may now be bent at any desired angle by heating in the carbon flame of a fan or fish-tail burner. Hold the tube between the thumb and fingers with the backs of the hands downward, rotating the tube to insure uniform heating. Keep the tube in the flame until quite soft. Remove, and bend the ends upward. When cold wipe off the carbon, and the result will be a smooth and even curve. *Never use a Bunsen burner for bending glass,* as the result is a sharp angle with thick glass on one side and thin on the other. This is easily broken and is also unsightly. When bending large tubes one end should be closed, and by blowing gently into the other end (while bending) the outside of the curve may be prevented from becoming flat.

DISTILLATION WITH STEAM.

Volatile oils and other volatile substances, not easily distilled by direct heat, may be distilled in a current of steam. Fig. 67 illustrates an apparatus similar to one used by the author for many years. The steam is generated in the can and carried within a half-inch of the bottom of the flask containing the substance to be distilled. The steam vaporizes and carries with it the volatile constituent. Sufficient heat should be applied to the flask to prevent the condensation of the steam in the flask before it is carried to the condenser. By placing the flask at an angle the non-volatile portions are not easily carried into the condenser by ebullition.

Fractional Distillation.—Fractional distillation is used for the separation of liquids having different boiling points. A thermometer is placed in the flask, heat applied, and when distillation begins the temperature is noted. Distillation is continued until the temperature rises, when the receiver is changed and distillation continued. There should be as many different fractions as there are different boiling-point liquids in the mixture. The separation is not sharp, as a low boiling-point liquid will carry over some from a higher boiling-point liquid. The boiling point of a mixture is some-

Fig. 67



Apparatus for distillation with steam.

what higher than the lowest boiling-point liquid in that mixture. Ether boils at about 35.5°, alcohol at 78°. The lowest boiling point of a mixture of one volume of alcohol and three volumes of ether is 37°. A mixture of three volumes of alcohol and one volume of ether boils at 43°. Ether can be more completely separated from alcohol if water be previously added to the mixture. If complete separation be desired, each fraction must again be fractionated. This must be repeated until each distillate has a constant boiling point.

Destructive Distillation.—Destructive distillation is the term applied to the heating of organic substances at such a temperature that decomposition takes place. New substances are formed, some of which are volatilized and condensed. The destructive distillation of wood and bituminous coal furnishes numerous medicinal products, as phenol, creosote, ammonia, etc.

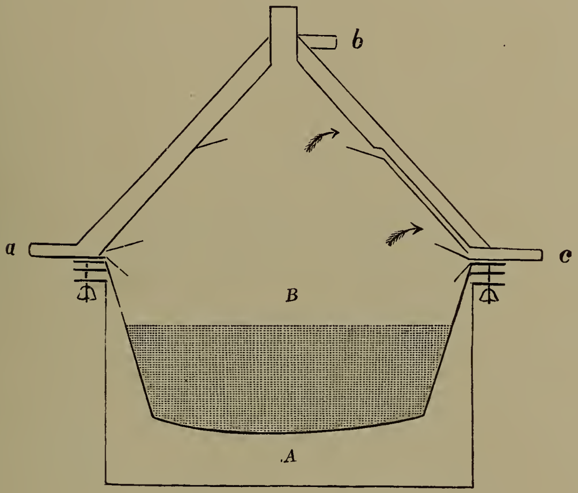
Rectification.—Rectification is the term applied to redistillation. It is employed for the purpose of purifying liquids.

Bumping.—Bumping is the term applied to the sudden ebullition of vapors from the bottom of a distillation flask or retort. Bumping is annoying, and various devices have been proposed to cause the liquid to boil quietly. Pieces of glass are sometimes placed in the liquid. Pieces of pumice stone heated to a red heat immediately dropped in water, just before placing in the flask, produce good results. The author prefers to use several pieces of prepared capillary glass tubing. Heat ordinary tubing until very soft, draw out to about

1 mm. in diameter, cut into pieces about one and one-fourth the diameter of the flask, and introduce. Before placing in the flask, the lower end should be softened and slightly curved, but not sealed. Otherwise the sharp edges may scratch the flask. Bumping may also be prevented by placing a capillary tube through the cork and nearly to the bottom of the flask. Connect the receiver with an aspirator, which will cause a constant stream of air to pass through the tube, thus keeping the liquid in motion. Vapors cannot then accumulate at the bottom of the flask.

Pharmaceutical Stills.—Pharmaceutical stills in common use are of two forms. First, those in which the vapors are condensed in a chamber directly over the vaporizer. This is the commonest form. It is the principle of the alembic, which is doubtless the most ancient form of still known. In the original the vapors were condensed by contact with the inner surface of the dome-shaped head, and cooled by the atmosphere. The distillate flowed down to a gutter at the base of the dome, and was discharged from a spout on one side. Later, the head of the still was kept cold by covering with cold water. Pharmaceutical stills of this type are commonly made of tinned copper and used for the recovery of alcohol in the manufacture of extracts, etc. Formerly the chamber containing the cold water was left open, but in the more improved forms it is closed, as in the *Beck still* (Fig. 68). This consists of a water bath, *A*, the still or basin, *B*, containing the liquid to be distilled, and the dome or condenser, which is double. The cold water enters through *a* and is discharged through *b*. The vapors from *B* are condensed by coming in contact with the cold inner surface of the condenser, and pass down the sides and are collected in two gutters with a common exit at *c*. Rubber or leather is placed between the water bath, basin, and condenser, and the whole clamped together by bolts.

Fig. 68

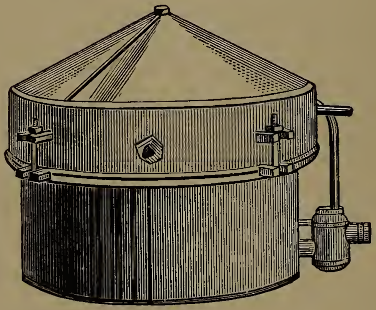


Beck's pharmaceutical still.

On one side of the water bath is a tube for the escape of steam. The flow of the water through the condenser should be so regulated that when it leaves the condenser at *b* the temperature should be about 40°. If the condenser be kept too cold, the vapors condense in the chamber before coming in contact with the surface and drop back into the still. The *Anderson still* is similar to Beck's, and may be used for the recovery of alcohol, but is especially intended for the continuous distillation of water. It has a constant level water attachment (Fig. 69) supplied with water that flows through the condenser.

The second form of pharmaceutical still, of which there are many modifications, is one in which the condenser is separated from the vaporizer, but so connected with it that the vapors pass from the boiler into the condenser. Pharmaceutical stills of this type are represented by the Remington (Fig. 70) and the Prentiss (Fig. 71). In the *Remington,* the opening in the still head is at one side and connects directly with the condenser, which is constructed on the principle of the tubular boiler. The body of the condenser contains several parallel tubes opening into a common chamber at each end. These tubes are surrounded by cold water. This arrangement affords large condensing

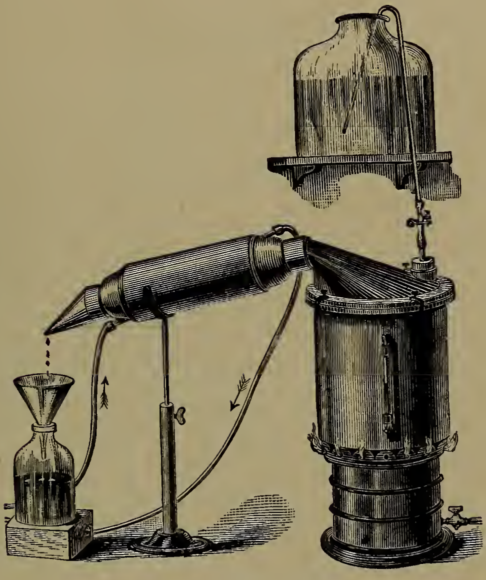
Fig. 69



The Anderson automatic still.

surface in a very short space. The *Prentiss still* is intended for the recovery of alcohol. Above the boiler is an upright column, *B*, which contains a rod bearing perforated disks. The vapors in passing through these disks become somewhat reduced in temperature, so that the water, which is vaporized with the alcohol and has a higher boiling point, is condensed and returned to the boiler, while the alcohol passes through the tube *C* to the condenser *D*. The distillate flows out at *G*.

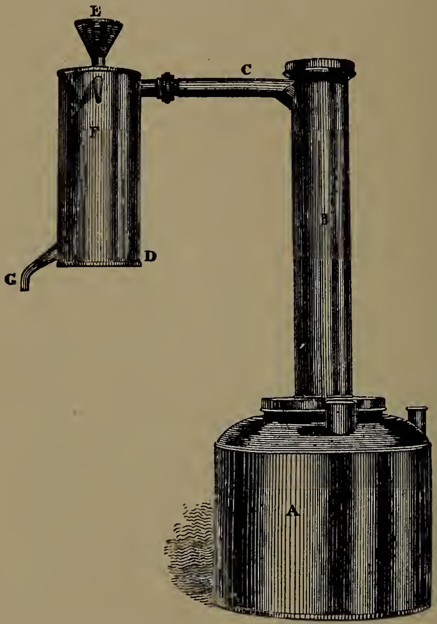
FIG. 70



The Remington still.

Steam is preferred for the distillation of alcohol. The evaporating pan is partially enclosed in a steam-tight copper jacket. The steam is admitted through a tube at the side, and the condensed water passes out at the bottom. In some cases only one tube is used to carry the steam to the still and return the condensed water to the boiler. Dr. Rice has devised a small steam still occupying but little space.

Fig. 71



The Prentiss alcohol reclaimer.

CHAPTER VII.

VAPORIZATION. SUBLIMATION.

SUBLIMATION is the vaporization and condensation of volatile solids. The apparatus used varies with the substance to be sublimed. The subliming vessel may be of iron, earthenware, or glass, and is connected with a condenser. If the temperature of the condensing chamber be a few degrees below that of the sublimer, the vapors will condense on the wall in a compact mass, or the sublimate may remain liquid and flow down the sides and be run into moulds, as in stick sulphur. If the condensing chamber be kept cold the sublimate will condense in the form of a crystalline powder, as in sublime sulphur or mercurous chloride. Vapors of mercurous chloride are usually carried into a chamber filled with steam, which causes it to condense and fall into the condensed water. This dissolves any mercuric chloride that may have been formed. Sublimation is seldom used for manufacturing purposes except on a large scale. It is occasionally used in a small way for the purification of volatile solids, as in the preparation of iodine for volumetric analysis. In such cases the substance to be sublimed may be placed in an evaporating dish and covered with an inverted funnel, which serves as a condenser. When a substance to be sublimed is associated with a considerable quantity of a non-volatile substance which melts at the temperature used, as in the sublimation of benzoic acid from benzoin, it should be mixed with sand. The heat should be applied very gradually and carefully regulated, as too high a temperature causes a loss of sublimate and, when organic matter is present, produces destructive distillation, which contaminates the sublimate. A convenient apparatus for use where the sublimate is desired in powder may be prepared by cutting off the stem of an ordinary retort close to the body, and connecting it with a wooden box. Such an apparatus may be made of any size to suit the operation. Care should be taken to see that the neck of the retort does not become closed with the sublimate.

CHAPTER VIII.

DESICCATION, EXSICCATION, CALCINATION, CARBONIZATION, INCINERATION, AND TORREFACTION.

Desiccation is the complete removal of moisture from solids. Drugs are dried as a means of preservation and as an aid to comminution. In small operations this is usually accomplished in drying ovens, which are usually made of copper or aluminum. Hot-water drying ovens can be used only for temperatures below 100°, while hot-air drying ovens may be used for either high or low temperatures. Drying closets or rooms are used for drying large quantities of materials. These are commonly heated with steam coils placed near the bottom of the closet. The shelves should be removable and made of slats covered with muslin or burlap. Substances easily injured by heat are frequently dried by spreading in a thin layer, in a dry room or attic, with free access of air but protected from the sun. *Desiccators* are used for drying very small quantities of substances. They vary in size and shape, but are usually made of glass, and contain a receptacle for sulphuric acid or calcium chloride, substances having a strong affinity for water. Desiccators are generally used in quantitative analysis for bringing substances to constant weight or to prevent their absorbing moisture while they are cooling before weighing.

Exsiccation is desiccation applied to the removing of water of crystallization by heat. The product is usually in the form of powder; dried or exsiccated sulphate of iron is an example. Substances that melt in their water of crystallization should be allowed to effloresce in warm dry air before heating, otherwise it will be difficult to remove the water by heat.

Calcination is the formation of oxides from inorganic salts, as carbonates, sulphates, and nitrates, by subjecting them to a high degree of heat, as in the manufacture of magnesium and calcium oxides from their carbonates.

Carbonization is the heating of substances without air until the organic matter is reduced to carbon, as in the manufacture of wood and animal charcoal.

Incineration is the ignition of a substance in air until the organic matter is completely destroyed and only inorganic ash remains, as in the manufacture of bone ash.

Torrefaction, or roasting, is the heating of an organic substance to a point just short of carbonization, as in the roasting of coffee.

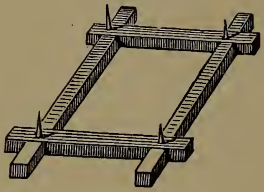
CHAPTER IX.

COLATION AND FILTRATION.

Colation.—The practical difference between colation or straining, and filtration is, that colation is applied to the separation of coarse particles from liquids, while filtration is the removal of fine particles by pouring the mixture through suitable porous media. Various porous fabrics, as gauze, muslin, flannel, and canton or cotton flannel, have been used for straining. The strainer should be thoroughly wet before the mixture is poured on, otherwise a longer time is required for the liquid to penetrate the strainer. For purposes of straining, muslin and canton flannel are cheap and very serviceable. Muslins should be washed to remove sizing. Strainers may be folded like a filter and placed in a funnel or made into a bag and suspended from a ring or hook, or a square piece may be placed on a *tenaculum,* a frame having sharp brass or copper spikes in the corners and sides (Fig. 72). If after draining has ceased it is desirable to express the liquid from the precipitate, bring the two opposite edges of the strainer together, fold one over the other, then taking the strainer by the ends, twist in opposite directions. If straining fails to remove the fine particles, the liquid must be filtered in order to obtain it perfectly clear. During the straining the edges of the strainer should never be allowed to hang over the edge of the frame or funnel, as the liquid will be carried over the edges by capillary attraction.

Felt is used for the filtration of large quantities of syrup, elixirs, oils, and melted fats. Cone-shaped felt filters may be obtained ready for use. The felt filter devised by W. R. Warner, for the filtration of oils, may also be used for the filtration of other liquids, as it combines pressure filtration with upward filtration. It consists of two tanks, one above the other. The substance to be filtered is placed in the upper tank, from which it passes through a tube to the lower tank, then upward through the filter, which is firmly held between two rings.

Fig. 72



Tenaculum.

Absorbent cotton placed in the neck of a funnel is convenient and economical for straining small quantities of liquid in manufacturing or prescription work.

Filters.—Filters are made of paper pulp, asbestos, glass-wool, sand, charcoal, and unglazed earthenware. Filter papers are either white or gray in color. The latter are sometimes used for filtering colored liquids, as fluidextracts and tinctures. Many salts dissolve some of the coloring matter from gray filter paper, hence, white filter paper only should be used for filtering such substances. The quality of white filter paper is variable. Those best known are French, German, Swedish, Scotch, and English. Manufacturers make different grades. A firm porous paper is best for pharmaceutical uses. Filters for quantitative analysis are especially prepared and treated with a mixture of hydrochloric and hydrofluoric acids to remove inorganic substances, in order to obtain a filter as nearly ash free as possible. The label of the best grades states the amount of ash in each filter. *Hardened filters* are prepared by partial nitration of the cellulose with nitric acid. They are especially valuable for pressure filtration, and when it is desirable to remove the precipitate from the filter without loss or contamination with particles from the filter itself. Filter papers may be purchased in large square sheets or cut in round form of different sizes, the latter being preferred.

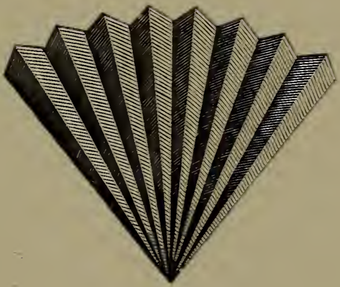
FOLDING FILTERS.—Filters are folded in various ways. The plain filter is the one most commonly used when the precipitate is to be collected. It is prepared by folding through the middle, the edges of the filter forming a half circle. This is again folded through the centre, so that the edges form a quarter circle. The filter is then opened and placed in the funnel so that one thickness of paper will rest on one side of the funnel and three thicknesses upon the other.

ROTHER'S FILTER is also called the economical filter, because two filters are made from one round filter by cutting it through the centre. Each piece has then one straight edge and one half circle. By folding through the centre, a quarter circle and a right angle are formed. Fold the cut edges over about one-eighth of an inch. Then fold again the same width; open the filter and place in the funnel, holding the folds in place until it is wet.

Plaited filters (Fig. 73) have an advantage over the plain ones because the entire filter is exposed to the action of the liquid. They are folded as follows: Place the filter paper flat upon the table and do not remove it until all folds are made. Grasp the edge nearest the operator and fold it upon the opposite edge, so that the edges form a semicircle. Fold again through the centre, thus making a fold at right angles to the first one. Now open the last fold and fold the two corners to the line formed by the second fold, making folds at an angle of 45° to the first one made. Open these and make folds midway between each of those already formed. If all of these have been folded over from the operator without removing the filter from the table, the grooves formed by the folds will be upon the upper side of the paper. Now begin at one edge and plait the filter by making folds backward in the opposite direction, one between each of those previously made, so that the edges of each new fold will be turned upward. The filter will then have the appearance of Fig. 74. This completes the plaited filter, which may be opened and placed in the funnel. When pressing the folds down, the pressure should be very light where the lines meet at the point, as they tend to weaken the filter, causing it to break when the liquid is poured upon it. When pouring liquid upon a filter the stream should strike the side, as it tends to puncture the filter if poured directly upon the point.

Fig. 73

Fig. 74

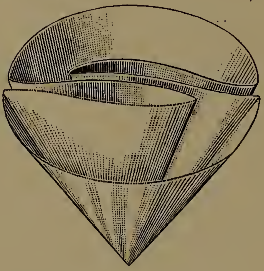


Plaited filters.

R. A. Fessenden's method of folding a filter for rapid filtration is as follows:

Fold through the centre, open and fold again through the centre so that the grooves formed are at right angles to those already made and all grooves on the upper side. Make one fold backward through the centre so that this fold will be between and at an angle of 45° to the other folds, but with the edge of the fold in an opposite direction. Then open the filter so that the upper side will have two opposite edges and four grooves. Take the two upper edges formed by the last fold, bring them together and past each other (Fig. 75), so that the remainder of the filter will take the form of the funnel. When wet, these folds will fall to the sides of the funnel; these should be kept in the centre of the funnel, that the liquid may act upon the entire surface. Do this by placing between each fold the end of a glass rod bent in the form of a hair pin.

Fig. 75

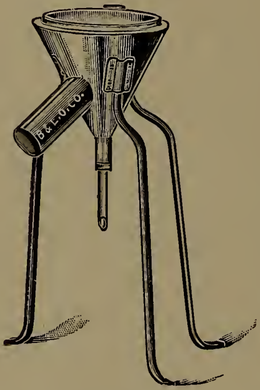


Plaited filter.

Funnels.—When selecting funnels, see that the sides of the funnel are straight and at an angle of 60° to each other. This is easily determined by folding an ordinary plain filter, which when opened and placed inside the funnel should touch at all points. If the funnel curves away from the filter or the paper near the neck, it leaves the point unprotected. The end of the stem should be cut at right angles in order to form a point from which the liquid will drop. When the filtrate is received in an open vessel the point of the funnel should rest against the vessel's side, lest the liquid dropping from the funnel upon that in the vessel may throw some of it outside and cause it to be lost. When filtering a quantity of liquid the funnel should be covered to protect from dust and prevent evaporation. When filtering volatile liquids into a flask or bottle the funnel is sometimes allowed to rest upon the bottle without a support. This often closes the opening so that the air cannot readily escape, thus retarding the flow of the filtrate and sometimes stopping it altogether. This may be prevented by placing a piece of cord or small roll of filter paper on one side between the bottle and the funnel. When filtering volatile liquids, cover the funnel with a piece of glass to prevent evaporation, and at the same time admit sufficient air to secure prompt filtration.

Continuous Filtration.—When large quantities are to be filtered the filter should be kept well filled. This is conveniently done by placing the entire menstruum in a bottle closed with a perforated cork containing a short glass tube, the inner diameter of which is at least 35 mm. Cut the outer end of the tube at an angle of 45°. Close the tube with the finger and invert the bottle over the funnel, in such a position that the end of the tube is somewhat below the edge of the filter. Upon removing the finger, the liquid flows into the filter until it rises to the level of the end of the tube. This prevents the air from entering the bottle and stops the flow until more fluid passes through the filter. It will now act automatically. The same arrangement is convenient for washing bulky precipitates.

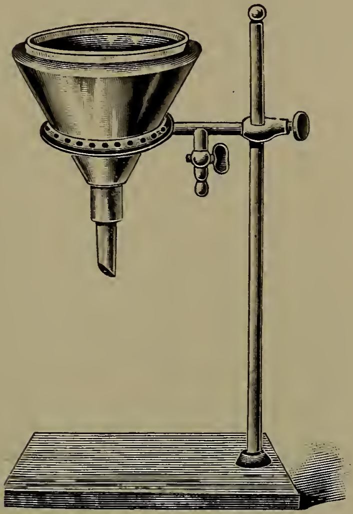
Fig. 76



Hot-water funnel, with side arm.

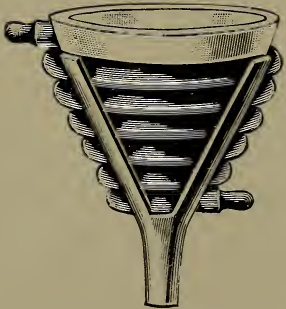
Hot Filtration.—Heat aids the filtration of thick and viscous liquids. Hot solutions of salts liable to crystallize on cooling, and substances solid at ordinary temperatures, as fat, wax, etc., must be filtered while hot. This is accomplished by the use of a jacketed or hot-water funnel (Figs. 76 and 77). An ordinary glass funnel is enclosed in a copper jacket. The space between funnel and jacket is filled three-fourths full of water and heated by a lamp or burner under the side arm or ring burner. The hot water rising to

Fig. 77



Hot-water funnel with ring burner.

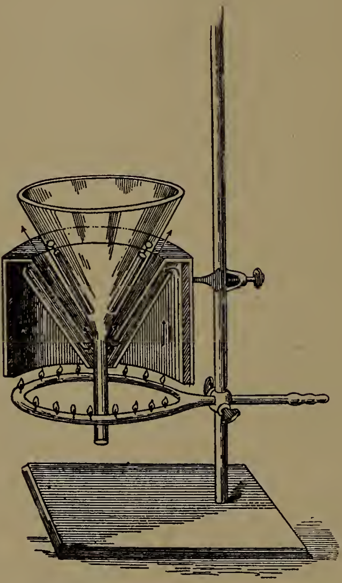
Fig. 78



Jacketed funnel for hot water or steam.

the surface causes a continuous circulation. Hot-air funnels like Fig. 79 are convenient. They are made with double walls between the funnel and the flame, the heat passing between the walls as indicated by the arrows.

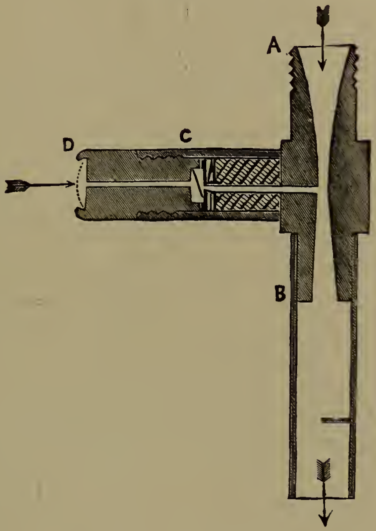
Fig. 79



Hot-air funnel.

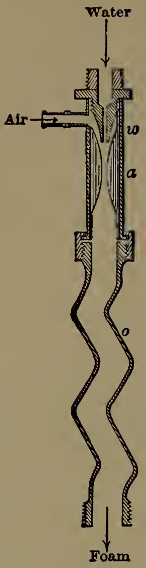
Rapid Filtration.—Methods for aiding filtration depend upon the formation of a partial vacuum in the receiver, which is connected with the funnel. In cities where water pressure is available a good filter pump or *aspirator* is most convenient. The neck of the funnel passes through a perforated cork into the receiver, which is connected with the pump by a tube. Filter pumps are of various styles, but the principle is the same in all. Water is forced through a narrow opening, carrying with it air received from a small tube which enters the pump at the side and connects with the receiver (Figs. 80 and 81). Figs. 82 and 83 show laboratory glass pumps. When using a water pump, if for any reason the water should suddenly cease to flow, it will be drawn backward into the receiver. To guard against such an accident a bottle should be placed between the receiver and the pump. In the Chapman pump the valve at *c* prevents the entrance

Fig. 80



Chapman's filter pump.

Fig. 81



Richards' filter pump.

Fig. 82

Geissler's glass filter pump.

Fig. 83

Muencke's filter pump.

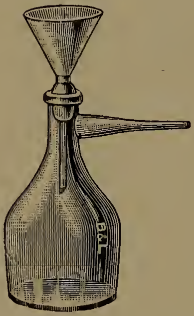
of water into the receiver. In the absence of water pressure an arrangement similar to Fig. 84 may be used, or the tube from the receiving flask may be con-

Fig. 84

Pressure filtration apparatus.

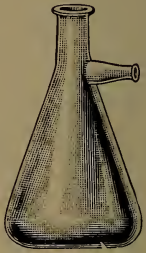
nected with the top of a bottle or can previously filled with water, and having an outlet tube through the cork extending to the bottom. If the bottle be placed in an elevated position and the outlet connected with a tube reaching to the floor, or, better still, into the basement, and the flow of water started by suction, a partial vacuum will be produced in the bottle which in turn acts as an exhaust to the receiver. A rope and pulley may be used for raising the bottle and for lowering to be filled. In pressure filtration the point of the filter must be protected by placing in the funnel a small perforated platinum cone. Side arm filtering flasks are better than ordinary flasks, from receivers, for rapid filtration (Figs. 85 and 86).

Fig. 85



Side-arm flask with funnel.

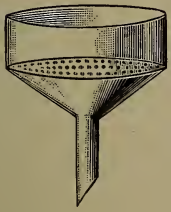
Fig. 86



Side-arm flask.

Buechner's funnels (Fig. 87) are convenient for filtering liquids through paper pulp or asbestos. The bottom of the funnel is flat and finely perforated. This supports the filter and at the same time allows the liquid to pass through. A good substitute for a Buechner funnel is a perforated disk placed in an ordinary funnel (Fig. 88). When filter paper is used, moisten it carefully and press around the edges to prevent the precipitate from working underneath the filter.

FIG. 87



Buechner's funnel.

FIG. 88

Perforated disk in ordinary funnel.

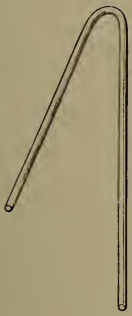
Paper pulp is easily prepared by placing scraps of filter paper in a bottle with a dilute solution of sodium hydroxide, agitating until in fine shreds, pouring into a funnel and washing until free from alkali. The alkali may be omitted if desired, but the pulp will not be so fine.

CHAPTER X.

DECANTATION. SEPARATION OF IMMISCIBLE SOLVENTS.

Decantation is the process of pouring a liquid from one vessel into another for the purpose of separating it from some underlying substance, as a precipitate, or a heavier immiscible liquid. Decantation is frequently used for washing bulky precipitates to free them from soluble salts. The washing is generally completed by thoroughly mixing the precipitate with a large volume of water, allowing separation to take place, and decanting the supernatant liquid, repeating the operation as often as necessary. Some skill is required to prevent the liquid from flowing down the sides of the vessel. If the rim of the vessel be perfectly dry and a moistened glass rod or pencil held against the edge of the vessel the liquid will follow the rod. Some prefer to grease the rim when the vessel has a straight edge or is nearly full. A little practice makes the operation easy. A siphon may be used instead of decantation to draw off liquids (Fig. 89). Place the short arm of the siphon in the liquid, and start the liquid by applying suction to the end of the long arm. The form illustrated in Fig. 90 is designed to prevent the liquid from flowing into the mouth, as the lower end is closed with the finger while suction is applied to the upper end of the lateral tube. When the siphon is filled, the finger is removed and the liquid continues to flow. The same result may be obtained by placing a rubber tube over the end of a plain siphon and applying suction to the free end of the tube. As soon as the

FIG. 89



Plain siphon.

FIG. 90

Glass siphon with lateral suction tube.

FIG. 91

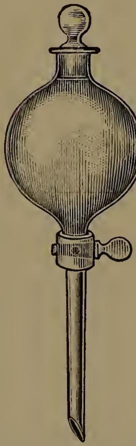
Siphon with short arm curved.

siphon is filled, close the tube by pinching between the thumb and finger until it can be removed from the siphon, when the liquid will continue to flow. Another method of starting the siphon is to fill the inverted siphon with water and close the end of the long arm with the finger. Place the short arm in the liquid, remove the finger, and the liquid immediately flows. When the ordinary siphon is used, the current produced by the flow of the liquid often draws some of the precipitate into the siphon, especially when removing the last of the supernatant liquid. This may be in a measure overcome by using the form illustrated in Fig. 91.

SEPARATION OF IMMISCIBLE SOLVENTS.

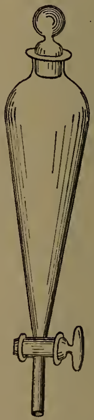
Liquids like ether, chloroform, and benzine when mixed with water by agitation and allowed to remain at rest soon separate into two layers.

Fig. 92



Separator, globe shape.

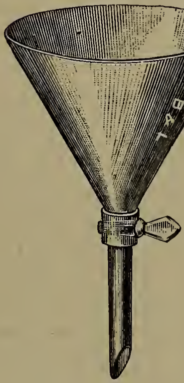
Fig. 93



Separator (Squibb's).

The layers may be easily separated from each other by means of a separator or separatory funnel (Figs. 92, 93, and 94). The liquid is poured into the separator and the lower layer drawn off by means of the stopcock. Special separators are made to be used when it is necessary to wash a heavier liquid with a lighter one, but the same result may be reached by the use of two separators. For general use, and especially in alkaloidal assay work, either the pear-shaped or Squibb's separator (Fig. 93) is recommended.

FIG. 94



Separatory funnel.

CHAPTER XI.

CLARIFICATION AND DECOLORIZATION.

CLARIFICATION.

Liquids frequently contain fine floating particles impossible of removal by ordinary filtration, even when double filters are used. Such liquids may frequently be clarified by adding magnesium carbonate, precipitated calcium phosphate, pumice stone, purified talc, or paper pulp.

The first two are slightly soluble, and may impart a slight alkalinity to the liquid. Paper pulp makes a good filter, but is a poor clarifying agent. After thorough agitation with the clarifying agent the liquid is filtered. If the filtrate be not clear it should be returned again and again to the funnel until the insoluble particles close the pores of the filter. Liquids containing albuminous matter may be clarified by boiling. This process coagulates the albumin and occludes the floating particles. Albumin is sometimes added to liquids to clarify them, in the proportion of the white of one egg to a gallon of liquid. It is first mixed with a small quantity of the liquid, then strained into the remainder, and the whole thoroughly agitated. The liquid is then gradually boiled and skimmed. Do not use albumin in liquids containing substances with which it is incompatible, as alcohol, tannic acid, lead, copper, and mercury salts. Fruit juices are clarified by partial fermentation. The alcohol formed causes a precipitation of the albuminous and mucilaginous matters. Alcohol is sometimes added to liquids for this same purpose.

DECOLORIZATION.

Many organic substances may be decolorized by agitating their solutions with purified animal charcoal, and filtering. In some cases the solutions are filtered through *beds* of animal charcoal. However, it should be remembered that decolorization is attended with considerable loss of the substance, as this also is absorbed by the charcoal. The best charcoal is obtained from blood or bones, and is itself purified by treating with dilute hydrochloric acid to remove soluble inorganic salts. Charcoal, wholly free from inorganic salts, is not a good decolorizer. Animal charcoal in granular condition gives the best results.

CHAPTER XII.

PRECIPITATION.

PRECIPITATION is the process by which substances in solution are caused to assume an insoluble form. That which is thrown out of solution is termed the *precipitate;* that which causes the precipitation is called the *precipitant.* Precipitation may be produced in various ways.

Causes of Precipitation.—Change of temperature may cause precipitation. Cold reduces the solubility of most substances, hence many saturated solutions deposit on reduction of temperature. Fluidextracts often precipitate on change of temperature. Few substances are more soluble in cold than in hot water, therefore, in these cases, an elevation of temperature will cause precipitation of the saturated solution. This is true of calcium hydroxide, calcium citrate, calcium sulphate, and a few others.

Change of menstruum may also cause precipitation. For instance, water precipitates alcoholic solutions of resins and many oils, while alcohol precipitates aqueous solutions of gums and of many salts.

Chemical change causes precipitation by the formation of new compounds which are insoluble, as, when a solution of silver nitrate is mixed with a solution of sodium chloride, an insoluble silver chloride is precipitated. Solutions of silver salts with organic compounds, and many other substances, are precipitated by light, which acts as a reducing agent, and thus causes chemical change.

Physical Character of Precipitates.—The physical appearance of precipitates is designated as light, heavy, amorphous, crystalline, granular, flocculent, and gelatinous. The condition under which precipitation takes place often determines its physical character. For example, hot concentrated solutions yield dense precipitates, while cold dilute solutions yield light precipitates. Heavy magnesium carbonate is obtained by mixing hot concentrated solutions of magnesium sulphate and sodium carbonate and evaporating to dryness before washing out the sulphate. The light magnesium carbonate is made from cold dilute solutions. If lead iodide be precipitated from a hot solution, it is crystalline, but if precipitated from a cold solution, it is amorphous. In the precipitation of ferric hydroxide the solution should be cold and dilute. Otherwise, the precipitate is apt to contain oxyhydrate. The order in which solutions are mixed frequently determines the character of the precipitate. To obtain a yellow mercurous iodide, the potassium iodide must be slowly added to the mercurous nitrate, so that an excess of the nitrate is always present. If the operation be reversed, a green iodide will be formed. Generally it is inadvisable to use a large excess of the precipitant, as many precipitates are more or less soluble in solutions of other salts. In the manufacture of mercuric iodide, the *Pharmacopœia* directs that the solutions of mercuric chloride and potassium iodide shall be simultaneously poured in thin streams into water, because if either of the two solutions be in excess, the precipitate will be dissolved. Stir the liquid constantly during precipitation, as impurities are less liable to be occluded in the precipitate. When the precipitate retains a large proportion of water it is termed a *magma.*

Precipitation is best conducted in deep precipitating jars especially constructed for that purpose. In the absence of these, deep beakers may be used, but the end of the stirring rod ought to be capped with rubber to prevent the breaking of the beakers.

Washing Precipitates.—When possible, it is best to allow the precipitate to remain in the liquid for some hours or longer, as the precipitate becomes more dense and is more easily washed. The clear supernatant liquid may be removed by a siphon or by decantation. The precipitate is purified by continued washing, which may be accomplished by adding fresh portions of water and decanting after the precipitate subsides. Or it may also be done by pouring the precipitate upon a filter or strainer and washing by the addition of water. In many cases it is advisable to combine the two methods. When the impurities are difficult of removal by washing on the filter or strainer, the precipitate should be returned to the jar and thoroughly stirred with a fresh portion of water and then returned to the filter. In case the precipitate is in the form of a magma, the water may be removed by gentle but oft-repeated pressure. This is more effectual than sudden forcible expression. When the precipitate is bulky and easily oxidized, or absorbs carbon dioxide from the atmosphere, as in the manufacture of magnesium magma, the wash water should be freshly boiled and the J. Boehm's method of washing employed. Place the mixture in a large stoppered percolator, and cover the top with a filter paper placed between two pieces of well-washed muslin, tied securely over the top. Invert the percolator in a vessel and pour water through the neck of the percolator until the precipitate is washed. Pressure filtration may be easily combined with this method by connecting the inverted percolator with the neck of a second percolator, in an upright position, by means of a tube. The wash water is then placed in the second percolator, which is elevated until the desired pressure is obtained.

Fractional Precipitation.—Fractional precipitation is sometimes used to purify or separate two or more substances. In such cases the precipitant should be added in small quantities, and the precipitate separated after each addition. This method is not satisfactory, and is only used in special cases where other methods cannot be employed.

CHAPTER XIII.

COMMINUTION

Under this head we may group all the methods whereby drugs are mechanically subdivided. The method of comminution varies with the character of the drug and the object to be attained. Vegetable drugs are seldom collected by the pharmacist or chemist except for special investigation. The cultivated drugs are usually grown and collected under careful supervision, while those growing wild are generally collected by irresponsible parties. In either case they are thoroughly dried to prevent decomposition, but in a moist atmosphere drugs frequently absorb so much moisture that they become soft and pliable. Hence they must be dried again to make them brittle before they can be ground or powdered. They should also be garbled before grinding. *Garbling* is the removal of all foreign substances, as stems, mouldy or decayed parts, dust from roots, epidermis from barks, etc.; in short, everything that reduces the quality of the drug. Drugs should be kept in cool, dry rooms protected from light. Only those drugs readily attacked by insects should be placed in air-tight containers, or those possessing strong odoriferous principles easily lost, or those liable to contaminate other drugs.

Comminution aids solution by exposing a greater surface to the action of the solvent, whether it be in the laboratory or in the stomach. Before vegetable drugs can be thoroughly extracted they must be brought into such a fine state of division that the solvent can act upon each particle. Drugs of loose, coarse structure may be coarsely ground, while those of close, dense structure should be reduced to fine powder. Few pharmacists grind or powder their own drugs, but depend upon the drug miller for their supply. Doubtless the miller has the advantage of special mills for various kinds of drugs, but adulterations of various kinds are more difficult to detect in powder than in the whole drug. Unscrupulous millers frequently take advantage of this fact to palm off worthless or wormeaten drugs. Many coarse or fibrous stems must be cut in pieces before they can be ground. It is a mistake to undertake to grind the drug fine by running it through the mill but once. Time and labor will be saved by grinding coarse first, and running it through a second or even a third time if necessary, setting the plates a little closer each time. It is also advisable to sift the drug each time, returning only the coarse portion to the mill.

CONTUSION.

Deep iron or brass mortars are used for the contusion or bruising of small quantities of drugs. The best results are obtained when only a thin layer is placed between the mortar and pestle. To prevent the loss of powder when contusing a dry substance, the mortar should be covered with a pasteboard having a hole in the centre to receive the pestle. When grinding or powdering poisonous drugs, like corrosive sublimate, the mouth and nose of the operator should be covered with a piece of moist muslin or moist sponge. To prevent jarring when contusing drugs, place the mortar upon a firm foundation unconnected with cases or work tables. The placing of the mortar in a box or barrel of sand has been recommended. Glass, wedgewood, or porcelain mortars should not be used for comminution.

TRITURATION.

Trituration is the process of reducing a substance to powder by grinding or rubbing in a mortar with a pestle. For this purpose, shallow porcelain or wedgewood mortars are used. The pestle is held firmly in the hand, and given a circular motion, beginning in the centre and gradually increasing the circle toward the outside of the mortar. Then, reversing, work toward the centre, and repeat the operation until the required degree of fineness is secured. Always hold the pestle in such a position that the handle is at right angles to that part of the surface of the mortar with which it is in contact. If the drug be inclined to pack or to adhere to the mortar and pestle, remove it frequently with a spatula. Trituration is also applied to the mixing of powders in a mortar. Wedgewood mortars are porous, and should never be used with drugs that are readily absorbed or produce a stain. When mortars become stained or saturated with powerful odors, they should be washed with a little potassium or sodium dichromate and sulphuric acid. The handles of wedgewood pestels are usually of wood, and frequently become loosened. In this case they should be warmed, the cement removed, and the handle reset with a fused mixture of shellac, two parts; yellow wax, one part; and balsam fir, one part.

PULVERIZATION BY INTERVENTION.

Many substances not easily powdered alone may be readily pulverized by the intervention of some foreign substance. Camphor and boric acid may be more easily powdered by the addition of a little alcohol, which readily evaporates when pulverization is completed. Some insoluble substances may be powdered by trituration with potassium sulphate, which may be removed later by dissolving in water. For the purpose of aiding the solution of iodine, triturate it with an equal weight of sand. Some metals are granulated by fusing and pouring into water, or by agitating the fused metal with powdered chalk, or, as in the case of phosphorus, melting under water and agitating until cold.

LEVIGATION.

Levigation is the process of reducing inorganic substances to powder by trituration in a mortar with a liquid with which they are insoluble. A sufficient quantity of liquid is used to form a thin paste and the trituration continued until perfectly smooth.

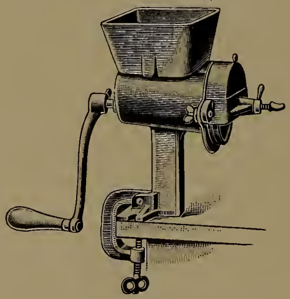
PORPHYRIZATION.

Porphyrization is like levigation, except that a stone slab and a muller take the place of the mortar and pestle.

MILLS.

Mills are generally used for grinding vegetable drugs. Quite inexpensive and very satisfactory small mills may now be obtained. The best small mill is the Quaker City, No. 4 (Fig. 95). It grinds rapidly and is easily cleaned. This mill may be purchased in larger sizes if desired. In practically all the hand mills the drug is ground between two chilled-iron castings, with concentric rows of sharp teeth. One of the plates is stationary, while the other is made to revolve. In the Enterprise (Fig. 96) the plates are vertical, while

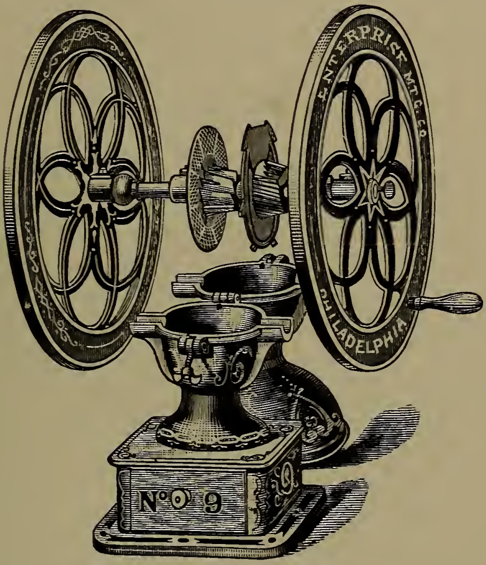
Fig. 95



No. 4 Quaker mill.

in the Swift (Fig. 97) and the Hance (Fig. 98) the plates are horizontal. In addition to the larger sizes of hand mills already referred to, there is a variety of special mills run by power. Mead's disintegrator (Figs. 99 and 100) consists of a vertical revolving steel plate to which are riveted hardened steel beaters that drive the drug with great force against a corrugated plate until the drug is fine enough to pass between the revolving plate and the corrugated surface. It is then caught by beaters placed upon the opposite side and forced against a screen. This screen is made

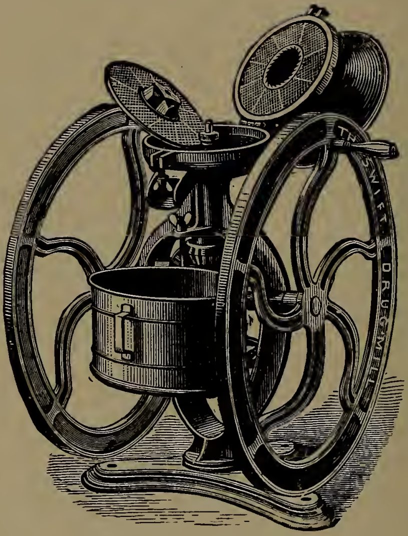
Fig. 96



Enterprise drug mill (open).

of square steel bars each two inches long, and placed at right angles to the revolving plate in such a position that the drug is forced against the sharp angles of the bars. When it is sufficiently fine to pass between the bars it is discharged from the mill. The steel plate makes three thousand revolutions per minute and the mill grinds from 150 to 600 pounds of drug per hour.

Fig. 97



New *B* Swift mill (open).

The Bogardus Eccentric Mill.—This mill has two horizontal grinding plates revolving rapidly in the same direction, upon centres about two inches apart. This peculiar motion both twists and grinds the drug.

These mills are supplied with extra plates of different degrees of fineness, and grind anything from coarse drugs to the hardest seeds or stones.

Fig. 98

Hance's drug mill

Chaser Mills.—Chaser mills are so called because they consist of two large stone wheels following each other around a common centre. These revolve upon a stationary stone, and the drug is reduced to powder by

Fig. 99

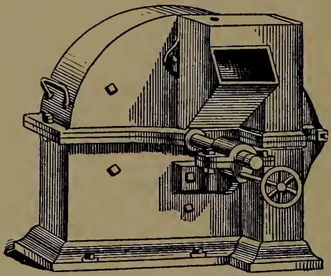
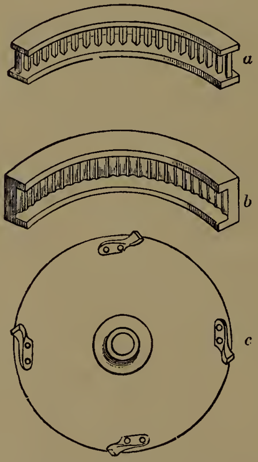


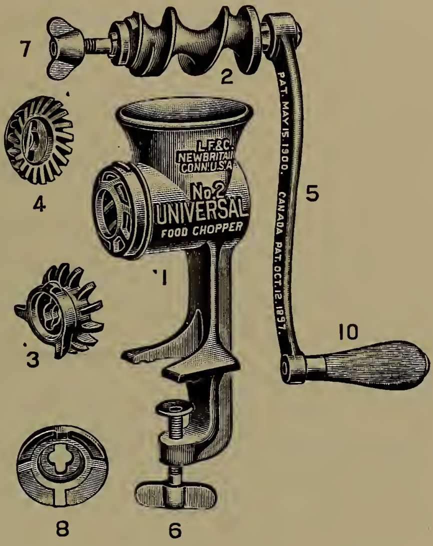
Fig. 100



Mead's disintegrator. *a*, section of steel screen; *b*, section of corrugated ring; *c*, steel disk with beaters attached.

crushing and by the twisting motion produced when a broad wheel is made to turn in a narrow space. When the material becomes very fine it rises, and by centrifugal force is carried against the sides and falls to the bottom.

Fig. 101



Universal food chopper. 1, body; 2, forcer; 3, reversible cutter, coarse, medium, fine; 4, pulverizer; 5, crank; 6, clamp screw; 7, thumb nut; 8, nut butter grinder; 10, handle screw and washer stuffing attachment.

Buhr Stone Mills.—Buhr stone mills are similar in construction to those used in flour mills.

Ball or Pebble Mills.—Ball or pebble mills consist of a jar or cylindrical vessel containing several flint or porcelain balls. A peculiar hard pebble is also used for the same purpose. The substance to be powdered is placed in the jar, which is securely closed and caused to revolve. The material is ground between the rolling balls as well as between the balls and the jar.

Mills should be thoroughly cleaned after use by running through a little clean sawdust, and afterward brushing or wiping out any remaining particles. In some cases it may even be necessary to remove the plates and wash them in hot water, after which dry rapidly to prevent rusting. Fresh vegetable drugs, and vanilla, or those apt to clog an ordinary mill, may be run through a meat cutter (Fig. 101).

SIFTING.

In the manufacture of pharmaceutical preparations it is necessary that ground or powdered drugs should be of a uniform degree of fineness. This is accomplished by grinding the drug until it will pass through a sieve of the required fineness, designated by the number of meshes to the linear inch. Those in common use are Nos. 20 (coarse), 40 (moderately coarse), 50 (moderately fine), 60 (fine), and 80 (very fine). As the size of the openings between the wires is affected by the size of the wire used, the *Pharmacopœia* now requires that a wire of a given gauge number shall be used in the manufacture of each number of sieve.[1]

Some portions of a drug are brittle and easily reduced to powder, while other portions of the same drug are tough, fibrous, and difficult to grind. In such cases,

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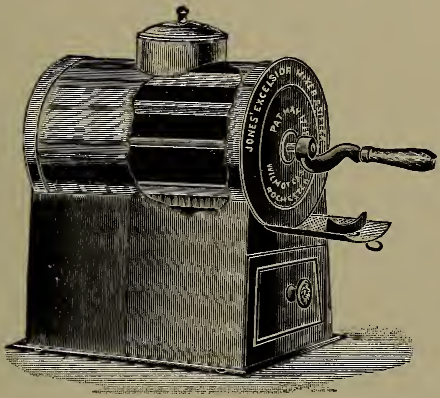
[1] Introductory Notes, U. S. Pharmacopœia.

when a uniform powder is desired, the finer particles are removed by sifting each time the drug is passed through the mill, and only the coarser particles returned to be reground.

The proper motion to be given a sieve is best learned by experience, but force should *never* be used, as it not only stretches the wire and bags the sieve, but it increases the size of the mesh. Mechanical sieves of various kinds have been devised. Probably the most convenient small apparatus is the combined Jones mixer and sifter (Fig. 102). The sieve is placed in the bottom of the cylinder and the drug continued in motion by revolving fans and brushes. When used as a mixer the sieve is covered. It is made in 3 sizes to hold from 6 to 25 pounds.

FIG. 102



Jones' mixer and sifter.

ELUTRIATION.

Elutriation is the separation of a substance into different degrees of fineness by thoroughly mixing with water, and after the coarser particles have settled, the supernatant liquid is decanted or drawn off. This is allowed to stand until the next coarser particles have settled. By repeating this operation, powders of various degrees of fineness may be obtained. *Trociscation* is the method used in the formation of drop-chalk from the magma formed by the elutriation of crushed or ground chalk.

CHAPTER XIV.

SOLUTIONS.

A SOLUTION is a homogeneous liquid formed by the union of one substance with another. This union may occur between a solid and a liquid, as the solution of salt or sugar in water, or between a gas and a liquid, as in the solution of ammonia gas in water or alcohol. It may also occur between two liquids, as glycerin in water or alcohol, or between two solids, as chloral and camphor. The term *solvent* is applied to the substance causing liquefaction. When a solvent has absorbed as much of any substance as it will retain under normal conditions, it is said to be saturated, and the product is termed a *saturated solution*. A solution saturated with one salt may still dissolve a very large amount of another salt, and in some cases one salt will aid in the solution of another. Corrosive sublimate is sparingly soluble in water, but dissolves readily in a solution of ammonium chloride. It sometimes happens that a solution saturated at a high temperature will on cooling, without agitation, retain all the substance in solution. However, if jarred, it will deposit or crystallize rapidly. Such a solution is termed *supersaturated*. The degree of solubility is commonly expressed in parts by weight, as, one part of sodium bromide is soluble in 1.7 parts of water, or in 12.5

parts of alcohol at 25° C. When a large amount of substance dissolves quickly, it is said to be very soluble, but when little is dissolved, it is called sparingly soluble.

Two kinds of solutions are generally recognized. They are physical or simple solutions, and chemical or complex solutions. *Simple solutions* are those in which solution takes place without chemical change, and the substance can be recovered in its original condition. A solution of sugar in water is an example of a physical or simple solution. The term *chemical solution* is applied to solutions following chemical action, and the substance in solution is wholly different from the original. This term will doubtless continue to be used, though incorrect. Mercury is insoluble in water, but nitric acid acts upon it to form a nitrate of mercury, and the resulting solution is not a solution of mercury in nitric acid, but a solution of the nitrate in water.

Reduction of temperature always takes place when solids are dissolved without chemical change, but chemical action causes an elevation of temperature. The fact that an elevation of temperature takes place during the solution of anhydrous salts is due to the fact that part of the water unites with the salt to replace the water of crystallization, and the heat produced is greater than that absorbed by the solution.

Aids to Solution.—The more perfect the contact between the substance and the solvent the more rapid the solution. Therefore, trituration hastens solution by breaking up the substance which increases the surface exposed to the action of the solvent, and like agitation places fresh portions of the solvent in contact with the solid. If sugar be placed in a beaker of water, it sinks to the bottom. The water in actual contact becomes saturated and owing to its increased density remains at the bottom, thus protecting the undissolved sugar from the action of the water. But if the mixture be stirred or agitated, unsaturated water comes in contact with the sugar and it quickly dissolves. Substances which agglutinate readily, like acacia and the scale salts of iron, should not be finely powdered before adding the water.

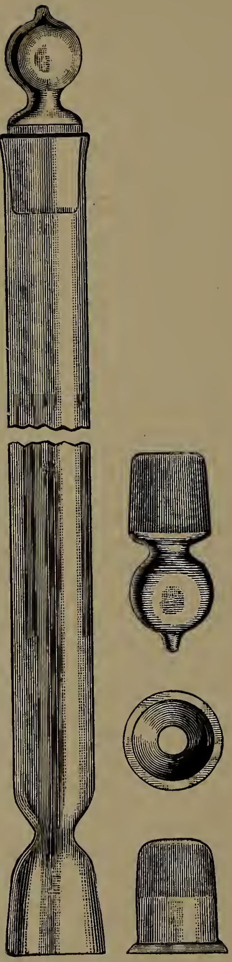
Heat generally aids solution. The heated liquid rises to the surface, thus causing a circulation which brings fresh portions of the liquid into contact with the solid. A few substances are less soluble in hot than in cold water, as calcium oxide, calcium sulphate, and calcium citrate. Sodium sulphate increases in solubility until the temperature reaches 34°, when it decreases, requiring nearly twice as much water for solution at 100° C. as it does at 34° C. Sodium chloride is little more soluble in hot than in cold water, requiring 2.8 parts at 25° C., and 2.5 parts at 100° C.

Circulatory Displacement.—Circulatory displacement is the term applied to the manufacture of solutions by confining the substance in a piece of muslin and suspending it in the top of the liquid. As the substance dissolves, it increases the density of the solution and sinks to the bottom, bringing fresh liquid in contact with the substance, thus producing constant circulation until the substance is dissolved or the solution becomes saturated. Mr. W. C. Alpers has improved this method by placing a wooden hook inside the muslin. The muslin is thus extended so that the substance remains upon the surface of the liquid instead of sinking beneath it as the bulk decreases. The same result may be obtained by an arrangement similar to a dialyzer, except that muslin is used in place of animal membrane. (See Dialysis.) In manufacturing and in prescription work, where time is an object, the most convenient method of preparing solutions without heat is to triturate the substance in a mortar with a small quantity of the menstruum, until a saturated solution is obtained. Then decant and add fresh solvent, repeating the operation until all is dissolved.

The Determination of Solubilities.—When the solvent is non-volatile, place a convenient quantity of it in a test-tube and add an excess of the substance previously powdered. Place the test-tube in a water bath heated somewhat above the desired temperature. Shake or stir frequently for a half-hour, then stopper and allow the tube to remain at 25° C. for twenty-four hours with occasional agitation. Next filter through a dry filter and reject the first portion that came through, as the filter may have absorbed some of the substance from the solution. From the remainder, collect a convenient quantity in a tared weighing bottle and weigh. Pour into a tared evaporating dish, rinse the bottle thoroughly with distilled water, and pour the washing into the evaporating dish. Evaporate to dryness and weigh. The weight of the solution minus the weight of the solid gives the weight of water, which divided by the weight of the solid gives the number of parts of water required to dissolve one part of the salt.

Lysimeter.—When the solvent is volatile, greater care is necessary to prevent evaporation during the processes of filtering and weighing. This is especially true when determining the solubility of a substance at the boiling point of a solvent. It may be accurately done, however, by means of a simple and convenient apparatus called the lysimeter, devised by Dr. Charles Rice (Fig. 103). It consists of a glass tube about six inches long, contracted near one end. Each end of the tube is fitted with a ground-glass stopper. A thimble-shaped piece of glass, with an opening in the small end, is so ground that it may replace the stopper in the contracted end of the tube. To prepare the instrument for use, close it at the upper end, place a pledget of absorbent cotton in the thimble, which is inserted in the lower end of the tube, and hold it in position by a piece of platinum wire placed over the end of the thimble and around the neck of the tube. The lysimeter is then slowly lowered into a large test-tube of the boiling solution, containing an excess of the substance the solubility of which is to be determined. When the instrument has attained the temperature of the liquid, the stopper is removed, allowing the solution to filter through the cotton into the lysimeter. When the solution in the instrument has reached the level of the solution in the tube, the upper end is again closed, the instrument removed from the solution, and inverted. The thimble is also removed and the stopper inserted. The lysimeter is then washed with a portion of the solvent, cooled, and weighed. The remainder of the operation is the same as the preceding. The

Fig. 103



Rice's lysimeter.

following is a list of the solvents used in pharmacy, given in the order of their importance, viz., water, alcohol, glycerin, acetone, ether, petroleum benzin, chloroform, benzene, and carbon disulphide. The solvent power of each will be better understood as we study the preparations into which they enter.[1]

Immiscible Solvents.—Solvents that mix in different proportions are said to be miscible, while those that do not mix are termed *immiscible.* Water, alcohol, glycerin, and acetone are miscible, while water is immiscible with all the other solvents, but will dissolve small quantities of ether and chloroform. Alcohol and acetone are miscible with ether and chloroform.

Solution of Gases.—A number of important pharmaceutical products are solutions of gases in water, as ammonia, hydrochloric acid, chlorine, etc. Most gases are somewhat impure as they come from the generator, and must be washed by passing them through a wash bottle partially filled with water. From the wash bottle the gas passes into the receiver, which should be surrounded by cold or ice water, as gases are more soluble in cold than in hot solvents. The gas should be carried to the bottom of the solutions, and the flow so regulated that it bubbles slowly through the liquid. Occasional agitation of the receiver aids solution. On a large scale, the method is made continuous by passing the gas through a series of receivers, each connected with the other by a tube passing from

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[1] For the solubility of various substances, see the United States Pharmacopœia or Seidell, Solubilities of Organic and Inorganic Substances.

the top of the first to the bottom of the second, etc. When the first is saturated it is replaced by number two and a fresh receiver placed at the end of the line.

All gases increase the volume of the solvent. Some increase the density, as, 40 per cent. hydrochloric acid has a specific gravity of 1.1995 at 25° C. Others decrease the density, as 35 per cent. ammonium water has a specific gravity of 0.8769 at 25° C.

Percentage Solutions.—When the strengths of solutions are expressed by per cent., all ingredients must be weighed unless it be definitely stated that per cent. by volume is intended. And as per cent. means parts in a hundred, parts may be represented by any weight in any system. A 10 per cent. solution of salt contains 10 gr. in 100 gr. of the solution, or 10 Gm. in 100 Gm., or 10 lbs. in 100 lbs. To prepare two apothecaries' ounces (960 gr.) of a 4 per cent. solution of zinc sulphate we must take 0.04 × 960 or 38.4 gr., and dissolve it in 960 — 38.4 = 921.6 gr. of water. The operation consists in multiplying the desired quantity by the per cent., which gives the amount of substance required. This substance is then dissolved in sufficient solvent to make the required amount. In practice, the quantity ordered is commonly expressed in fluid measure, which must be changed to weight in order to calculate the weight of substance required. If 4 fl. oz. of a 5 per cent. solution of boric acid in glycerin be required, the 4 fl. oz. must be changed to weight by multiplying by the number of grains in a fluidounce, and then by the specific gravity to obtain the weight of the 4 fl. oz. of glycerin.

4 × 455.7 = 1822.8 gr. of water in 4 fl. oz.
1822.8 × 1.25 = 2278.5 gr. of glycerin in 4 fl. oz.
2278.5 × 0.05 = 113.9 gr. of boric acid required.
2278.5 − 113.9 = 2164.6 gr. of glycerin.

The above does not give *exactly* 4 fl. oz., as there is no exact method of calculating the volume occupied by the boric acid, but this method is sufficiently accurate for practical purposes. For further work upon percentage solutions, and alligation applied to percentage solutions, see *Arithmetic of Pharmacy* (Stevens). The physiological salt solution, sometimes called *normal* solution, which is used by physicians, contains about 6 per cent. of salt. Normal solutions used in volumetric analysis, and sometimes used as test reagents, are based upon molecular equivalents. (See *United States Pharmacopœia*, p. 544.)

CHAPTER XV.

EXTRACTION.

EXTRACTION is the term applied to any method used for the separation of the soluble from the insoluble constituents of plants.

Maceration, as used in pharmacy, is the process of moistening a drug or placing it in a liquid, and allowing it to remain for a given time at the temperature of the room.

Digestion is maceration at an elevated temperature—between 30° and 40° for pharmaceutical purposes.

Infusions and **decoctions** are terms applied to certain classes of pharmaceutical preparations (see p. 194).

Maceration or digestion and subsequent filtration are processes used to extract drugs that form an adhesive mass when moistened with a solvent, as aloes, asafetida, and benzoin. In foreign countries maceration and expression are used almost exclusively for the extraction of drugs. The points in favor of this method are, that it is more convenient, requires less skill, and the product is more uniform than that secured by percolation. The objection is that the drug is not completely exhausted, as the liquid remaining in the drug is as strong medicinally as the portion removed.

PERCOLATION.

Percolation is the method of separating the soluble from the insoluble constituents of the drug by passing the liquid through the drug. This method is often called displacement, because the solvent as it becomes saturated flows downward by virtue of its own gravity, and the pressure of the liquid above, less the capillary force of the powder, and is replaced by a fresh solvent. The principle of the method has been for centuries applied in the manufacture of lye from wood ashes, and was termed *leaching* or *lixiviation.* Count Real was the first to apply the principle to the extraction of drugs. In 1833 his method was modified by M. Boullay, a French pharmacist. The *United States Pharmacopœia* was the first to adopt it. This was accomplished in 1840, mainly through the efforts of Prof. Proctor and A. Duhamel. It remained, however, for Prof. Graham to make the method practical, which was done by requiring that the drug be of uniform fineness and thoroughly and uniformly moistened before packing in the apparatus called the *percolator.* The solvent placed upon the drug is called the *menstruum;* after it passes through the drug it is called the *percolate.* After the drug is exhausted it is called the *marc.*

Percolators.—Percolators are made of glass, tin, and tinned copper. A variety of percolators have been manufactured, varying in shape from the funnel or conical to the cylindrical form. The conical percolator is sometimes recommended for the manufacturers of weak tinctures, and for drugs apt to swell, especially with aqueous menstruum. The best form of percolator for general use is nearly cylindrical, the top slightly wider than at the bottom, which is somewhat funnel-shaped. The *Pharmacopœia* directs that the neck should gradually become narrower toward the orifice, so that a perforated cork may be inserted *from within* (Fig. 104). A better form is one in which the neck gradually widens from the shoulder to the orifice, in such manner that the perforated cork may be inserted *from without*, as in the Oldberg percolator (Fig. 105). Insert a short glass tube in the cork so that the end of the tube shall be even with the upper end, but not

Fig. 104

U. S. P. percolator.

Fig. 105

Oldberg percolator.

project beyond the cork. Let the tube project about 4 cm. below the cork. To this attach a piece of rubber tubing one and one-fourth times the length of the percolator, and to its lower end attach a short U-shaped tube.

Preparation of the Drug for Percolation.—Grind the drug uniformly, the degree of fineness depending upon the character of the drug. If the drug be of a close, dense structure, it must be finely ground that the menstruum may penetrate every particle of the cell formation. Drugs of coarse, porous structure do not require to be so finely ground. In the case of official drugs the fineness of the drug as well as the amount of menstruum used in moistening are given. Moisten by placing in a basin or evaporating dish, adding the required amount of menstruum and stirring with a spatula or rod until evenly mixed. It is then passed through a coarse sieve to break up any lumps and to insure uniform moistening. Cover closely to prevent evaporation, and allow it to stand from one-half to two hours, that the drug may swell. A piece of purified cotton is placed in the bottom of the percolator. This acts as a filter and prevents small particles from closing the tube.

Process of Percolation.—The drug is then placed in the percolator, the operator being careful to distribute the drug evenly. A scoop or large watch crystal is convenient for this purpose. Some prefer to place the moistened powder on a glazed paper, and, bringing the sides of the paper together, take it in one hand, holding the percolator in the other, pour the drug slowly in, constantly revolving the percolator. This insures an even distribution of both coarse and fine particles over the surface. The *Pharmacopœia* directs the operator to place the entire quantity of the drug in the percolator as soon as moistened, and after standing the required time apply pressure to the top of the drug. This method is good for small quantities, as in the making of tinctures, but for larger quantities, especially when deep percolators are used, the result is unsatisfactory, as the drug in the bottom of the percolator is practically without pressure.

A better method is to add the drug in divided portions, packing each portion separately. Pack the first portion very lightly, increasing the pressure with the subsequent portions as the top is approached. In any case, the degree of pressure depends upon the character of the drug, the degree of fineness, and the kind of menstruum used. A drug with porous structure and in coarse powders should be packed more firmly than one possessing a fine, dense structure. Alcohol has a contracting and hardening effect upon vegetable tissue, while water causes the drug to swell. Hence, when a strong alcoholic menstruum is used the drug should be packed more firmly than when a weak or aqueous menstruum is employed. Let the pressure be uniform over the entire surface. Should greater pressure be applied to one side than to the other, the menstruum naturally takes the course of least resistance and flows unevenly through the mass. A cork on the end of a stick or a strong glass rod is convenient for packing. After packing, cover with a close-fitting piece of filter paper held in place by a glass stopper or pieces of broken glass. Add the menstruum through a funnel, or in any manner that will not disturb the drug. If the percolator be properly packed, the menstruum passes slowly and evenly through the drug. When the percolate reaches the bottom of the percolator, fasten the lower end of the tube to the top of the percolator and cover to prevent evaporation. Allow the whole to stand and macerate during the required length of time, after which percolation is started by lowering the tube until the percolate drops at the rate of from two to five drops per minute for each 1000 Gm. of drug when manufacturing fluidextracts or extracts. But when a much larger proportion of menstruum to drug is employed, the rate of flow may be increased to ten or fifteen drops per minute.

Do not receive the percolate in open graduates, as too large a surface is exposed to evaporation. Specially graduated receiving jars may be obtained, or may be easily made by pasting a strip of paper on the outside of an ordinary bottle, and graduating by measuring into the bottle definite volumes of the liquid. Keep the surface of the drug constantly covered with menstruum; otherwise air enters the drug, and when fresh menstruum is applied the air escapes and forms fissures through which the menstruum flows without exhausting the drug. A convenient method for insuring a constant supply of menstruum and, at the same time, a constant pressure upon percolator, is to employ the method given for continuous filtration (see page 115). If the percolation has been properly conducted, the first percolate is nearly saturated, and when the percolation is complete the drug is practically exhausted, in which case the final percolate does not materially differ from the menstruum in taste, odor, or color. However, in many drugs the active constituent is far more soluble in the menstruum used than is the coloring matter. In such cases we may determine, either by the taste or by some suitable test, whether the percolation be complete, as in case of resinous drugs. When the percolate no longer shows cloudiness with water, the drug is exhausted. Odor is of little value except in a few cases of odoriferous drugs. When the menstruum is not specified, the rule should be to select a menstruum having power to dissolve the greatest amount of active constituent with the least amount of inert material, and this requires a thorough knowledge of the nature and constituents of the drug.

The marc, after exhaustion, is always saturated with the menstruum and is of sufficient value to pay for recovery. One method is to recover only that which can be obtained by expression. Another is to place the contents of the percolator in a still and recover by distillation.

Repercolation.—Repercolation is the process of obtaining a concentrated extract by using a partially saturated menstruum upon a fresh portion of drug. This method was devised by Dr. Squibb for the manufacture of fluidextracts. The method will be considered in detail under fluidextracts.

Fractional Percolation.—Fractional percolation is the term applied to a modification of repercolation, the object being the same.[1]

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[1] See Diehl's method for the manufacture of fluidextracts, p. 239.

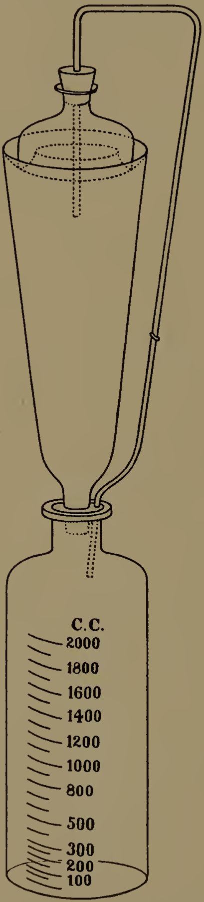
Continuous Percolation.—Continuous percolation is the process of extracting a drug with a small volume of volatile menstruum. The percolate is received in a flask placed over a steam or water bath. The liquid is vaporized and passes through a tube to a reflux condenser placed above the percolator, in which the vapors are condensed and returned to the percolator. By this means the menstruum is used again and again until the drug is exhausted.

Soxhlet's extraction apparatus (Fig. 63, p. 94) is convenient for small quantities of drugs. In this extraction the percolation is intermittent. The distillate collects in the extractor until it rises somewhat above the top of the side tube, when the pressure causes the percolate to flow through the tube, which then acts as a siphon to empty the extractor.

Percolation of Volatile Liquids.—When percolating with extremely volatile liquids like ether, it is desirable to have the apparatus air-tight to prevent loss by evaporation; also to guard against fire. In Fig. 106 the side tube permits the air to pass from the receiver to the top of the percolator, while in Fig. 107 the air passes through a tube in the centre of the percolator.

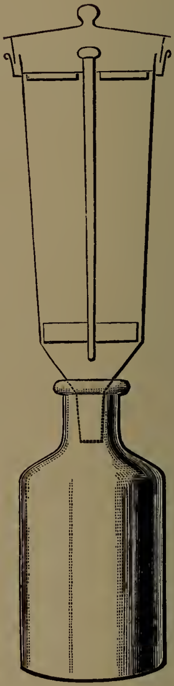
Squibb's Well-tube Percolator.—The well-tube percolator (Fig. 108) is a simple arrangement by which any suitable jar of any size may serve as a percolator. Place several pieces of flannel or some absorbent cotton in the bottom of the jar. Also place a large glass tube in the centre, and some flannel or cotton around the bottom to prevent particles of the drug from entering the tube. The moistened drug is then packed around the tube and covered with menstruum, as in ordinary percolation. When the menstruum is placed on the

Fig. 106



Glass percolator for use with volatile menstruum.

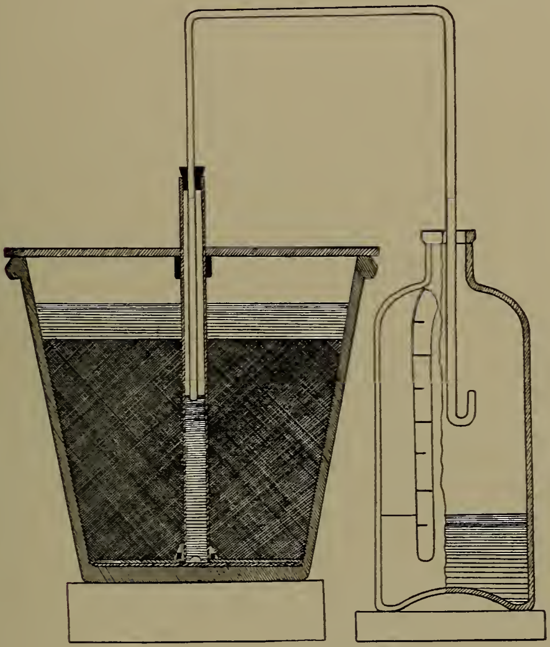
Fig. 107



Tin percolator for volatile liquids.

drug it passes through and enters the bottom of the well tube, rising until it is on a level with the top of the menstruum in the percolator. The top of the well is closed with a perforated cork through which passes a small glass tube, bent as shown in the illustration. By applying suction to the outer end of the tube it is filled by the liquid from the well, after which it continues to act as a siphon. The rate of flow may be regulated by raising or lowering the tube in the well. The upward

Fig. 108



Squibb's well-tube percolator.

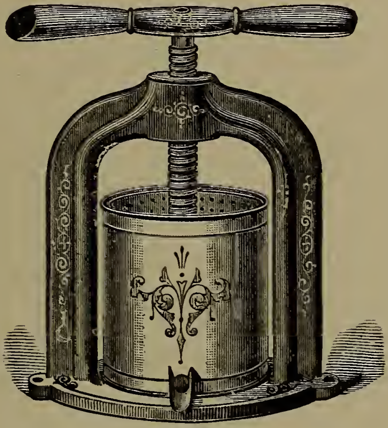
curve given to the outer end of the tube prevents the siphon from being emptied, as the curved end is a little higher than the end of the siphon in the well. The percolate ceases to flow when the surface of the liquid in the well is level with the top of the upturned tube.

Pressure Percolation.—In pressure percolation the drug is moistened and at once firmly packed in a special percolator. An adjustable cover is placed upon the drug and securely fastened in position. The inventors claim that when the drug expands the particles are so forced against each other that all intervening spaces are closed, so that the menstruum when applied must pass through the particles instead of around them. The menstruum is supplied from a reservoir suspended from the ceiling in such manner that the percolator receives the pressure of a column of liquid ten or more feet in height. Doubtless the first pressure percolator was that used by Count Real, modifications and improvements of which have been made by Anderson, Berry, Lentz, Rosenwasser, and Schmit. By attaching to the lower end of the Anderson percolator a tube long enough to extend to the floor or even to the basement, an additional force may be obtained. Hence the name, "double pressure percolator."

Expression.—In the manufacture of galenical preparations by percolation or by maceration a large amount of solvent remains in the marc. Most of this solvent may be recovered by subjecting the marc to strong pressure. Fig. 109 illustrates the ordinary tincture press. It consists of an outer metallic vessel with an opening at the bottom to discharge the expressed liquid

There is also an inner perforated cylinder. All parts in contact with the drug should be thoroughly tinned to prevent rusting, or the action of tannic acid. When ready to use, a straining cloth is placed inside the cylinder, the marc added, firmly packed, and the cloth folded evenly over the top. A metal plate is placed over and in contact with this and pressure *gradually* applied by turning the screw downward. A little time should elapse that the liquid may flow out of the drug before applying additional pressure.

Fig. 109



Tincture press.

In the enterprise spiral press (Fig. 110) the marc is placed directly in the hopper and is carried forward by the tapering screw. The liquid passes out through a perforated plate in the bottom, while the marc is discharged at the small end of the press. The exit may be opened or closed by a thumb screw, thus increasing or decreasing the pressure. This press is sometimes called a fruit press, as it is largely used for the expression of fruit juices.

Centrifugal machines are extensively used for the separation of liquids from solids. The substance is placed within a perforated cylinder making several thousand revolutions per minute, which forces the liquid through the perforations into the outer chamber. Centrifugal separators of various shapes and sizes may be purchased, for hand or power use.

Fig. 110

Enterprise press.

Lever, wedge, and double screw presses are now no longer used in pharmacy. Powerful knee presses and hydraulic presses are useful in manufacturing houses, but require no description here.

CHAPTER XVI.

CRYSTALLIZATION.

Many substances, when passing from gaseous or liquid condition to a solid state, assume definite forms with plain faces and angles. Such substances are said to be *crystalline,* while bodies without definite form are termed *amorphous.* All crystalline bodies have their own peculiar forms, and these forms have been the subject of scientific study. This study has resulted in the division of these forms into six general classes: The regular, tetragonal, hexagonal, rhombic, monoclinic, and triclinic forms. A thorough study of these classes requires more space than is allowed in a work of this character, and the student is referred to Krauss' *Essentials of Crystallography,* Dana's *Mineralogy,* and E. Kopp's *Krystallographie.*

Crystallization takes place under various conditions. Crystals are formed by sublimation, by fusion and cooling, by precipitation, and by deposition from solutions. The more slowly crystallization takes place the larger and more beautiful the crystalline form.

Depositions.—Depositions from solutions is the method most frequently employed in crystallization, and is commonly used for the purpose of purification. One method is to make a saturated solution and allow it to evaporate spontaneously, when the crystals form slowly. A more common method is to prepare a supersaturated solution by the aid of heat, and when the temperature of the solution has reached that of the surrounding atmosphere and allowed to remain for a time, crystallization is completed. The remaining solution is known as the *mother liquor*. It may be decanted and concentrated, when additional crystals may be obtained. If the solution be concentrated and cooled rapidly, with constant stirring, fine individual crystals will result. This method is sometimes called disturbed crystallization or *granulation*, because the crystals appear in the form of fine granular powder (see Granulation, p. 90). If a supersaturated solution is allowed to remain at rest, cooling slowly, the result is a mass of large crystals more beautiful in appearance than the smaller ones, but not always pure, for the crystals may have formed upon each other, overlapping and often enclosing portions of the mother liquor within the spaces. Crystals grow by accretion, so that it is possible to build large and perfect crystals by selecting small well-defined ones, and placing them in a solution which is slightly more than saturated. As the solution becomes weaker through crystallization, more supersaturated solution is added. Crystals form more rapidly upon rough surfaces, and in some cases, where crystallization refuses to take place, it may be compelled by introducing a few crystals of the substance. Sticks or strings are frequently introduced, as in the manufacture of rock candy from syrup, sugar of milk, etc.

Precipitation.—Crystalline precipitates frequently form, as a result of chemical change, but this can scarcely be considered as a method of crystallization. Precipitation may be induced by changing the solvent properties of some liquids by the addition of another liquid. For instance, a saturated solution of sulphate of iron is precipitated by the addition of alcohol. The sulphate of iron is then thrown out of solution as an amorphous precipitate, and rapidly changes to the crystalline form. In many operations the crystals first obtained are impure, and must be repeatedly recrystallized before the impurities are removed.

Water of Crystallization—During crystallization many substances unite with water which forms part of the crystal. Water so united is known as the water of crystallization. Some substances are capable of forming only one crystalline compound with water, while others form several, as, sodium carbonate forms crystalline compounds with 1, 5, 8, and 10 molecules of water. The first is now the official salt. Many crystalline bodies containing water of crystallization part with it on exposure to dry atmosphere. They then lose their crystalline form, falling into powder. Such substances are termed *efflorescent.* Substances which slowly absorb moisture from the atmosphere are called *hydroscopic,* and those taking up moisture rapidly and becoming liquid are *deliquescent.*

Interstitial Water.—Interstitial water, or water of decrepitation, is water that is mechanically enclosed in the interstices of the crystals. When heated, the expansion of the liquid causes a rupture of the crystals, accompanied by minute explosions. The phenomenon is termed *decrepitation.*

CHAPTER XVII.

DIALYSIS.

Dialysis is the term applied to the separation of crystallizable substances, or *crystalloids*, from non-crystallizable substances or *colloids*. If a solution of these substances be placed in a dialyzer and suspended in water, the crystalloid passes through the diaphragm into the water, and is called the *diffusate*. The colloids remain upon the surface of the diaphragm, and are called the *dialysate*. The dialyzer used consists of parchment paper or animal membrane stretched over a short cylinder of glass or hard rubber. (Beef or hog bladder makes an excellent dialyzer. After thoroughly washing the bladder, the liquid may be placed in it and floated upon water. Dialysis takes place rapidly at first, and gradually decreases as the strength of the diffusate increases, until the strengths of the diffusate and dialysate are equal, when dialysis ceases. Hence it is advisable to change the water frequently. Warm temperatures are favorable to dialysis.)

All crystalloids are not crystallizable, but those that are not usually unite with other substances to form crystallizable compounds.

Collodion Sacs.—Collodion sacs as prepared by Dr. F. G. Novy make excellent dialyzers. Select a glass test-tube of the desired size, blow a small hole in the bottom and then close it by touching the hole with a cork dipped in collodion, being careful to prevent any of the collodion from entering the tube. Then dip the tube in collodion and rotate until evenly coated. After removal from the collodion continue rotation until the solvent evaporates in order to secure a uniform thickness of the membrane. When, after about fifteen minutes, the coating has set and is no longer sticky, submerge the tube in water. Then, after filling the tube with water, blow into it, accompanying the blowing with a gradual pressing and twisting of the membrane, commencing at the lower end. The water will thus be forced through the opening and between the glass and the membrane, enabling the latter to be easily removed.

PART II.

PRACTICAL PHARMACY.

INTRODUCTION.

In the arrangement of subjects the writer has been influenced by the character of the solvents used in the manufacture of galenical preparations, rather than by the physical character of the substances employed, though the latter has received consideration.

Elixirs are used as a connecting link between the aqueous and alcoholic preparations, and are placed between syrups and wine because they contain both syrup and alcohol. Glycerin is a triatomic alcohol. Hence, the glycerites are placed after those preparations containing alcohol. No attempt has been made to separate the galenical preparations from the extemporaneous or magistral preparations, as the general principles involved in their manufacture are so closely related that absolute separation is impracticable. Furthermore, many of the preparations cannot be classified under either of the above heads. Nitrate of mercury ointment, glycerite of boroglycerin, and the oleates require chemical action, and cannot well be made extemporaneously. Neither are they galenical, since galenical preparations are those made from vegetable drugs without chemical action. The order of study is as follows:

Waters.
Solutions.
Infusions.
Decoctions.
Honeys.
Mucilages.
Mixtures.
Emulsions.
Syrups.
Wines.
Vinegars.
Elixirs.
Spirits.
Tinctures.
Fluidextracts.
Extracts.
Oleoresins.
Resins.
Collodions.
Glycerites.
Oleates.
Liniments.
Ointments.
Cerates.
Plasmas.
Pastes.
Poultices.
Plasters.
Suppositories.
Powders.
Triturations.
Wafers.
Pills.
Tablets.
Troches.

General statements applying to a *class* of preparations will be given, followed by such comments upon the *individual* preparation as is necessary to enable the student to understand both the manipulation and the chemical changes where such occur. These should be studied in connection with the *Pharmacopœia* and the *National Formulary.*

CHAPTER XVIII.

AQUÆ. WATERS.

Official waters are also termed medicated waters. All except common and distilled waters are aqueous solutions of volatile substances. Those made from volatile oils are intended to become saturated solutions, and are sometimes called aromatic waters. Volatile oils are sparingly soluble in water; hence, various substances have been used to aid solution by finely dividing the oil, thus increasing the surface exposed to the action of the water. In previous editions of the *Pharmacopœia*, the substances used for this purpose have been magnesium carbonate, calcium phosphate, and absorbent cotton. The eighth pharmacopœial revision directs the use of purified talc, but also permits the use of paper pulp, direct solution in hot water, or by distillation if the product corresponds in all respects with the official requirement. The product should be clear, free from floating particles, or foreign substances in solution. Magnesium carbonate yields a clear and beautiful solution, but is slightly soluble in water, making it alkaline. It also unites with acids and resins, which are present in some oils, thus forming soluble compounds, which enter the solution. Calcium phosphate is not a good absorbent, and is liable to contain soluble impurities. Commercial white talc should be purified (as directed by the *Pharmacopœia*), as it contains soluble impurities, and extremely fine particles, which pass through the filter. These are rejected during purification. The oil should be triturated with the talc and the water gradually added during constant trituration, and filtered. Return the filtrate to the filter until perfectly clear. A few waters, like those made from almond oil, creosote, and chloroform, are prepared by direct agitation with cold water. Camphor water is prepared by rubbing the camphor with alcohol before mixing with the talc. Many prepare camphor water by keeping a stock bottle filled with distilled water, on the surface of which an excess of coarsely powdered camphor is continually floating. The water soon becomes saturated and it is only necessary to filter when wanted.

Aromatic waters are sometimes made by dropping the oil upon shredded filter paper and agitating in a stone jug with hot water. Filter the solution when cold. Stronger orange-flower water, stronger rose water, and hamamelis water are prepared by distillation. In Europe all aromatic waters are so made.

In many cases the product has a more agreeable odor than when made from the oil, due to the fact that other volatile compounds, as ethers or acids, are frequently associated with the oil. In the distillation of the oil they are carried over by the steam, but being soluble in water remain there and do not separate with the oil. Distilled water *only* should be used in the manufacture of official waters. Ordinary water is generally laden with impurities from the air and from the soil through which it passes. Though these impurities may not be injurious to health, they are incompatible with many preparations dispensed in official waters. The permanent hardness of water is due to calcium sulphate, and temporary hardness to calcium bicarbonate. The latter, on boiling, is decomposed into the less soluble carbonates and carbon dioxide. The carbonate is deposited and the carbon dioxide is driven off. When distilling ordinary water, the *Pharmacopœia* directs the operator to discard the first 10 per cent. of the distillate, as this is liable to be contaminated with volatile organic constituents. Only the next 80 per cent. of the water is collected, as further distillation tends to decompose non-volatile ammonium compounds and organic matter.

Preservation.—Official waters are best preserved in a cool, dry place, in sterilized glass containers, so arranged that the water may be drawn with a siphon. Also, so arranged that the air which enters the container must pass through cotton, thus barring the entrance of spores, which produce a growth of microörganisms. Water so kept has a more agreeable odor than water in airtight containers. Use no preservatives. Alcohol when present in small quantities is easily decomposed, and aids in decomposition or organic growths. Ammonia water, either strong or weak, deteriorates rapidly through loss of ammonia gas, hence should be kept in a cool place, closely stoppered, and frequently tested. Hydrogen dioxide water decomposes easily and should be frequently tested by pharmacopœial methods. A small quantity of acid added tends to prevent decomposition.

CHAPTER XIX.

LIQUORES. SOLUTIONS.

It has been customary to define the *liquores* of the *United States Pharmacopœia* as aqueous solutions of non-volatile substances, but this definition no longer holds true. There are twenty-five official solutions, and in six of them the principal ingredients are either volatile at ordinary temperatures, or can be volatilized by boiling. The principal solvent is water, but one is one-fourth alcohol. Nine solutions are made by dissolving the ingredients directly in the solvent. The remaining sixteen solutions involve chemical action.

Liquor Acidi Arsenosi.—*Solution of Arsenous Acid.*—This contains 1 per cent. of arsenic trioxide, which changes to arsenous acid in solution. The hydrochloric acid merely acts as a solvent for the trioxide.

Reaction:

$$\underset{\text{Arsenic trioxide.}}{As_2O_3} + \underset{\text{Water.}}{3H_2O} = \underset{\text{Arsenous acid.}}{2H_3AsO_3}.$$

Liquor Ammonii Acetatis.—*Solution of Ammonium Acetate, or Spirit of Mindererus.*—This should contain not less than 7 per cent. of ammonium acetate. Only translucent pieces of the carbonate should be used. Otherwise it will be deficient in ammonia and the product will be excessively acid. The official ammonium carbonate consists of ammonium bicarbonate and carbamate.

$$\underset{\text{Bicarbonate.}}{NH_4HCO_3}.\underset{\text{Carbamate.}}{H_4NH_2CO_2}.$$

On exposure to air it loses ammonia and the bicarbonate remains.

Reaction:

$$\underset{\text{Ammonium carbonate.}}{NH_4HCO_3NH_4NH_2CO_2}+\underset{\text{Acetic acid.}}{3HC_2H_3O_2}=\underset{\text{Ammonium acetate.}}{3NH_4C_2H_3O_2}+\underset{\text{Carbon dioxide.}}{3CO_2}+\underset{\text{Water}}{H_2O}.$$

This solution should be freshly prepared when wanted.

Liquor Antisepticus.—*Antiseptic Solution.*—This is a hydro-alcoholic solution of boric acid, benzoic acid, thymol, and eucalyptol, with the oils of peppermint, wintergreen, and thyme. This preparation must not be confused with liquor antisepticus alkalinus, alkaline antiseptic of the *National Formulary.*

Liquor Arseni et Hydrargyri Iodidi.—*Solution of Arsenous and Mercuric Iodide. Donovan's Solution.*—This contains 1 per cent. each of arsenous iodide and mercuric iodide. The arsenous iodide dissolves the mercuric iodide, which is either colorless or of a pale yellow color. If red from the liberation of iodine, the preparation should be discarded.

Liquor Calcis.—*Solution of Calcium Hydroxide, or Lime Water.*—Lime water is a saturated solution containing not less than 0.14 per cent. of $Ca\ (OH)_2$.

Reaction :

$$\underset{\text{Calcium oxide.}}{CaO}+\underset{\text{Water.}}{H_2O}=\underset{\text{Calcium hydroxide.}}{Ca(OH)_2}.$$

The water used to slake the lime is rejected, as it may contain alkaline carbonates and possibly other soluble impurities. Do not filter lime water until wanted for use, as it absorbs carbon dioxide, forming the insoluble carbonate. If an excess of oxide be present, and it be occasionally agitated, the solution remains saturated. Since calcium hydroxide is more soluble in cold than in hot water, the solution should be discarded if cloudiness does not appear upon boiling.

Liquor Chlori Compositus.—*Compound Solution of Chlorine, or Chlorine Water.*—This water should contain about 0.4 per cent. of chlorine, with some oxides of chlorine, and some potassium chloride. It results from the action of hydrochloric acid upon potassium chlorate.

Reaction:

$KClO_3$	+	$6HCl$	=	$3Cl_2$	+	KCl	+	$3H_2O$; also
Potassium chlorate.		Hydrochloric acid.		Chlorine.		Potassium chloride.		Water.

$KClO_3$	+	$2HCl$	=	Cl	+	ClO_2	+	KCl	+	H_2O.
Potassium chlorate.		Hydrochloric acid.		Chlorine.		Oxide of chlorine.		Potassium chloride.		Water.

Liquor Cresolis Compositus.—*Compound Solution of Cresol.*—This is a 50 per cent. preparation of cresol, held in solution by soap formed from the linseed oil and potassium hydroxide. The addition of a small quantity of alcohol before heating aids saponification.

Liquor Ferri Chloridi.—*Solution of Ferric Chloride.*—This solution should contain not less than 29 per cent. of $FeCl_3$ equal to 10 per cent. of iron. It is prepared from iron wire by the action of hydrochloric acid, which is added in three separate portions. The acid must be of the required strength, as the strength of the finished product depends upon the amount of ferrous chloride formed by the first portion of acid added.

Reaction:

$$\underset{\text{Iron.}}{Fe} + \underset{\text{Hydrochloric acid.}}{2HCl} = \underset{\text{Ferrous chloride.}}{FeCl_2} + \underset{\text{Hydrogen.}}{H_2}.$$

The second portion is to form the ferric chloride when oxidized by nitric acid.

Reaction:

$$\underset{\substack{\text{Ferrous}\\ \text{chloride.}}}{3FeCl_2} + \underset{\substack{\text{Hydrochloric}\\ \text{acid.}}}{3HCl} + \underset{\substack{\text{Nitric}\\ \text{acid.}}}{HNO_3} = \underset{\substack{\text{Ferric}\\ \text{chloride.}}}{3FeCl_3} + \underset{\substack{\text{Nitric}\\ \text{oxide.}}}{NO} + \underset{\text{Water.}}{2H_2O}.$$

The last portion of nitric acid must be cautiously added, as it is extremely difficult to remove an excess without considerable loss of ferric chloride and the formation of a large amount of oxychloride. A small amount would be redissolved by the third portion of hydrochloric acid which is added for that purpose.

Reaction:

$$\underset{\substack{\text{Ferric}\\ \text{oxychloride.}}}{FeOCl} + \underset{\substack{\text{Hydrochloric}\\ \text{acid.}}}{2HCl} = \underset{\text{Ferric chloride.}}{FeCl_3} + \underset{\text{Water.}}{H_2O}.$$

The formula for ferric oxychloride is only approximate, as the proportion of oxygen to chlorine may vary.

Liquor Ferri et Ammonii Acetatis.—*Solution of Iron and Ammonium Acetate. Basham's Mixture.*—This is prepared from tincture of ferric chloride, acetic acid, and solution of ammonium acetate. The latter must not be alkaline, as a basic salt will be formed. This preparation must be freshly prepared when desired for use.

Reaction:

$$\underset{\text{Ferric chloride.}}{FeCl_3} + \underset{\substack{\text{Ammonium}\\ \text{acetate.}}}{3NH_3HC_2H_3O_2} = \underset{\text{Ferric acetate.}}{Fe(C_2H_3O_2)_3} + \underset{\substack{\text{Ammonium}\\ \text{chloride.}}}{3NH_4Cl}.$$

Liquor Ferri Subsulphatis.—*Solution of Ferric Subsulphate. Monsel's Solution.*—This contains basic ferric sulphate equal to not less than 13.57 per cent. of metallic iron. Its chemical composition is variable, but the manipulations and reactions are similar to those given for ferric tersulphate, the principal difference being that it contains less sulphuric acid.

Liquor Ferri Tersulphatis.—*Solution of Ferric Sulphate.*—This preparation should contain 36 per cent. of $Fe_2(SO_4)_3$, equal to 10 per cent. of iron. This solution and the preceding are prepared by oxidizing ferrous sulphate to ferric sulphate by the aid of nitric acid, in the presence of sulphuric acid.

Reaction :

$$\underset{\text{Ferrous sulphate.}}{6FeSO_4} + \underset{\text{Sulphuric acid.}}{3H_2SO_4} + \underset{\text{Nitric acid.}}{2HNO_3} = \underset{\text{Ferric sulphate.}}{3Fe_2(SO_4)_3} + \underset{\text{Water.}}{4H_2O} + \underset{\text{Nitric oxide.}}{2NO.}$$

The black compound formed in the solution during oxidation is $(FeSO_4)_2NO$. It is decomposed by the addition of sufficient nitric acid to oxidize all the ferrous sulphate to ferric sulphate, with the liberation of the nitric oxide. An excess of nitric acid must be avoided, as it is not easily removed by boiling.

Liquor Formaldehydi.—*Solution of Formaldehyde.*—This solution should contain at least 37 per cent. of absolute formaldehyde, HCOH. It is obtained by the oxidation of methyl alcohol.

Reaction :

$$\underset{\text{Methyl alcohol.}}{CH_3OH} + \underset{\text{Oxygen.}}{O} = \underset{\text{Formaldehyde.}}{HCOH} + \underset{\text{Water.}}{H_2O.}$$

Liquor Hydrargyri Nitratis.—*Solution of Nitrate of Mercury.*—It should contain about 60 per cent. of mercuric nitrate, $Hg(NO_3)_2$, and is prepared by dissolving red mercuric oxide in nitric acid.

Reaction :

HgO	+	$2HNO_3$	=	$Hg(NO_3)_2$	+	H_2O.
Mercuric oxide.		Nitric acid.		Mercuric nitrate.		Water.

Liquor Iodi Compositus.—*Compound Solution of Iodine. Lugol's Solution.*—It contains not less than 5 per cent. of iodine and 10 per cent. of potassium iodide. It is made by direct solution of the ingredients. The potassium iodide is used to aid in dissolving the iodine.

Liquor Magnesii Citratis.—*Solution of Magnesium Citrate.*—The solution is formed by dissolving magnesium carbonate in citric acid, thus producing an acid citrate.

Reaction :

$(MgCO_3)_4Mg(OH)_2$	+	$5H_3C_6H_5O_7$	=	$5MgHC_6H_5O_7$	+	$4CO_2$	+	$6H_2O$.
Magnesium carbonate.		Citric acid.		Magnesium citrate.		Carbon dioxide.		Water.

The normal citrate has little cathartic action and is sparingly soluble, which accounts for the deposit frequently found in commercial solutions. The bottles should always lie on their sides to keep the stoppers wet and prevent loss of carbon dioxide.

Liquor Plumbi Subacetatis.—*Solution of Lead Subacetate. Goulard's Solution.*—It contains at least 25 per cent. of lead subacetate [approximately $Pb_2O(C_2H_3O_2)_2$], formed by boiling a solution of lead acetate with lead oxide.

Reaction :

PbO	+	$Pb(C_2H_3O_2)_2$	=	$Pb_2O(C_2H_3O_2)_2$.
Lead oxide.		Lead acetate.		Lead subacetate.

Keep the solution well stoppered, as it rapidly absorbs carbon dioxide from the atmosphere, forming insoluble lead carbonate.

Liquor Plumbi Subacetatis Dilutus.—*Dilute Solution of Lead Subacetate. Lead Water.*—Lead water, properly made, contains about 1 per cent. of lead subacetate, formed by mixing a solution of lead subacetate with freshly boiled distilled water. The object of the boiling is to remove any carbon dioxide that may have been absorbed from the atmosphere, otherwise lead carbonate will be formed.

Liquor Potassii Arsenitis.—*Solution of Potassium Arsenite. Fowler's Solution.*—This solution contains potassium arsenite corresponding to 1 per cent. of arsenic trioxide. It is prepared by boiling the arsenic trioxide and potassium bicarbonate with water, and coloring with compound tincture of lavender.

Reaction:

$$\underset{\substack{\text{Arsenic}\\\text{trioxide.}}}{As_2O_3} + \underset{\substack{\text{Potassium}\\\text{bicarbonate.}}}{KHCO_3} = \underset{\substack{\text{Potassium}\\\text{arsenite.}}}{2K_2HAsO_3} + \underset{\text{Water.}}{H_2O} + \underset{\substack{\text{Carbon}\\\text{trioxode.}}}{4CO_2}.$$

KH_2AsO_3 may also be formed.

There is an excess of potassium bicarbonate, which is converted into carbonate by boiling, and makes the solution slightly alkaline.

Reaction:

$$\underset{\substack{\text{Potassium}\\\text{bicarbonate.}}}{2KHCO_3} + \text{boiling} = \underset{\substack{\text{Potassium}\\\text{carbonate.}}}{K_2CO_3} + \underset{\text{Water.}}{H_2O} + \underset{\substack{\text{Carbon}\\\text{dioxide.}}}{CO_2}.$$

Liquor Potassii Citratis.—*Solution of Potassium Citrate. Neutral Mixture.*—This contains not less than 8 per cent. of potassium citrate ($K_3C_6H_5O_7$), and, when needed, should be freshly prepared by mixing solutions of citric acid and potassium bicarbonate.

Reaction :

$H_3C_6H_5O_7$	+	$3KHCO_3$	=	$K_3C_6H_5O_7$	+	$3H_2O$	+	CO_2.
Citric acid.		Potassium bicarbonate.		Potassium citrate.		Water.		Carbon dioxide.

Liquor Potassii Hydroxidi.—*Solution of Potassium Hydroxide.*—This solution contains about 5 per cent. of potassium hydroxide (KOH), and is made by dissolving the hydroxide in water.

Liquor Sodii Hydroxidi.—*Solution of Sodium Hydroxide.*—This solution contains 5 per cent. of sodium hydroxide (NaOH), made by dissolving the hydroxide in water. The *Pharmacopœia* directs that solutions of both potassium and sodium hydroxide shall be kept in green glass bottles, because they are less soluble in strong alkalies than are the clear glass ones.

Liquor Sodæ Chlorinatæ.—*Solution of Chlorinated Soda. Labarraque's Solution.*—This should contain 2.4 per cent. of available chlorine, and is made by triturating chlorinated lime with water, filtering, and mixing with a hot solution of monohydrated sodium carbonate. Calcium carbonate is precipitated, and removed by filtration. The sodium carbonate solutions should be hot when added, otherwise the precipitate is apt to be gelatinous and refuse to separate unless the solution is heated, which would cause a loss of chlorine. According to Odling, chlorinated lime, $2CaClOCl$, decomposes in water to $Ca(ClO)_2 + CaCl_2$. The reaction with sodium carbonate would then be:

Reaction :

$Ca(OCl)_2$	+	$CaCl_2$	+	$2Na_2CO_3$	=	$2NaOCl$	+	$2NaCl$	+	$2CaCO_3$.
Calcium hypochlorite.		Calcium chloride.		Sodium carbonate.		Sodium hypochlorite.		Sodium chloride.		Calcium carbonate.

Liquor Sodii Arsenitis.—*Solution of Sodium Arsenate.*—This solution contains 1 per cent. of exsiccated sodium arsenate and is prepared by direct solution.

Liquor Sodii Phosphatis Compositus.—*Compound Solution of Sodium Phosphate.*—Each cubic centimeter of the solution contains 1 Gm. of sodium phosphate held in solution by sodium nitrate and citric acid. This is sometimes prescribed as liquid sodium phosphate (one dram in one fluidram).

Liquor Zinci Chloridi.—*Solution of Zinc Chloride.*—This solution contains about 50 per cent. of zinc chloride, prepared by dissolving zinc in hydrochloric acid.

Reaction :

Zn	+	$2HCl$	=	$ZnCl_2$	+	H_2.
Zinc.		Hydrochloric acid.		Zinc chloride.		Hydrogen.

The clear solution is decanted and nitric acid added. It is then evaporated at a temperature not exceeding 115° C., until a portion solidifies on cooling. The nitric acid is added to oxidize to the ferric condition any iron that may be present.

Reaction :

$3FeCl_2$	+	$3HCl$	+	HNO_3	=	$3FeCl_3$	+	$2H_2O$	+	NO.
Ferrous chloride.		Hydrochloric acid.		Nitric acid.		Ferric chloride.		Water.		Nitric oxide.

Any excess of nitric or hydrochloric acid is removed by the evaporation. The residue is dissolved in water and zinc carbonate added, which precipitates the iron as ferric hydroxide.

Reaction :

$2FeCl_3$	+	$3ZnCO_3$	+	$3H_2O$	=	$2Fe(OH)_3$	+	$3ZnCl_2$	+	$3CO_2$.
Ferric chloride.		Zinc carbonate.		Water.		Ferric hydroxide.		Zinc chloride.		Carbon dioxide.

After the precipitate and the excess of zinc carbonate have been allowed to settle, the clear solution is decanted. Filtration cannot be used, as a strong solution of zinc chloride acts on filter paper. If the solution be evaporated at a temperature higher than 115°, a portion of the zinc chloride will be volatilized.

The *National Formulary* contains formulas for forty-eight *liquores.* Many of them are very simple, while others are quite complex, involving chemical changes.

Liquor Alumini Acetatis.—*Solution of Aluminum Acetate.*—It is prepared by the action of acetic acid on calcium carbonate, forming calcium acetate.

Reaction:

$$\underset{\text{Calcium carbonate.}}{CaCO_3} + \underset{\text{Acetic acid.}}{2HC_2H_3O_2} = \underset{\text{Calcium acetate.}}{Ca(C_2H_3O_2)_2} + \underset{\text{Carbon dioxide.}}{CO_2} + \underset{\text{Water.}}{H_2O}.$$

The solution of calcium acetate is then mixed with a solution of aluminum sulphate. The calcium sulphate is precipitated, leaving the aluminum acetate in solution.

Reaction:

$$\underset{\text{Calcium acetate.}}{Ca(C_2H_3O_2)_2} + \underset{\text{Aluminum sulphate.}}{Al_2(SO_4)_3} = \underset{\text{Calcium sulphate.}}{CaSO_4} + \underset{\text{Aluminum acetate.}}{2Al(C_2H_3O_2)_3}.$$

Liquor Alumini Acetotartratis.—*Solution of Aluminum Acetotartrate.*—This is formed by the action of a mixture of acetic and tartaric acids on aluminum hydroxide. Aluminum hydroxide is formed by precipitating aluminum sulphate with sodium carbonate.

Reaction:

$$\underset{\text{Aluminum sulphate.}}{Al_2(SO_4)_3} + \underset{\text{Sodium carbonate.}}{3Na_2CO_3}.\ \underset{\text{Water.}}{10H_2O} = \underset{\text{Aluminum hydroxide.}}{2Al(OH)_3} + \underset{\text{Carbon dioxide.}}{CO_2} + \underset{\text{Sodium sulphate.}}{3Na_2SO_2} + \underset{\text{Water.}}{7H_2O}.$$

$$\underset{\text{Aluminum hydroxide.}}{Al(OH)_3} + \underset{\text{Acetic acid.}}{3HC_2H_3O_2} = \underset{\text{Aluminum acetate.}}{Al(C_2H_3O_2)_3} + \underset{\text{Water.}}{3H_2O}.$$

or

$$\underset{\text{Aluminum hydroxide.}}{2Al(OH)_3} + \underset{\text{Tartaric acid.}}{3H_2C_4H_4O_6} = \underset{\text{Aluminum tartrate.}}{Al_2(O_4H_4O_6)_3} + \underset{\text{Water.}}{6H_2O}.$$

Liquor Ammonii Acetatis Concentratus.—*Concentrated Solution of Ammonium Acetate.*—This is prepared by neutralizing acetic acid with ammonium acetate. (See Pharmacopœial Solution of Ammonium Acetate.)

Liquor Ammonii Citratis.—*Solution of Ammonium Citrate.*—It is prepared by neutralizing citric acid with stronger ammonia water.

Reaction :

$H_3C_6H_5O_7$	+	$3NH_4OH$	=	$(NH_4)_3C_6H_5O_7$	+	$3H_2O$.
Citric acid.		Ammonium hydroxide.		Ammonium citrate.		Water.

Liquor Antisepticus Alkalinus.—*Alkaline Antiseptic Solution.*—The effervescence which occurs when alkaline antiseptic solution is prepared is due to the reaction between glycerin and borax forming glyceryl borate and sodium metaborate.

Reaction:

$C_3H_5(OH)_3$	+	$Na_2B_4O_7$	=	$C_3H_5BO_3$	+	$2NaBO_2$	+	$3H_2O$.
Glycerin.		Sodium borate.		Glyceryl borate.		Sodium metaborate.		Water.

The glyceryl borate is decomposed by water forming glycerin and boric acid.

Reaction:

$C_3H_5BO_3$	+	$3H_2O$	=	$C_3H_5(OH)_3$	+	H_3BO_3.
Glyceryl borate.		Water.		Glycerin.		Boric acid.

The boric acid then unites with the potassium bicarbonate to form potassium borate, and carbon dioxide is liberated.

Reaction:

H_3BO_3	+	$KHCO_3$	=	KBO_2	+	CO_2	+	$2H_2O$.
Boric acid.		Potassium bicarbonate.		Potassium metaborate.		Carbon dioxide.		Water.

Liquor Calcis Sulphuratæ.—*Solution of Sulphurated Lime. Vleminckx's Solution.*—The reactions and manipulation in the manufacture of this solution are practically identical with the first step in the manufacture of precipitated sulphur. The lime and sulphur unite to form calcium disulphide and thiosulphate.

Reaction:

$$\underset{\substack{\text{Calcium}\\\text{oxide.}}}{3CaO} + \underset{\text{Sulphur.}}{6S} + \text{boiling} = \underset{\substack{\text{Calcium}\\\text{sulphide.}}}{2CaS_2} + \underset{\substack{\text{Calcium}\\\text{thiosulphate.}}}{CaS_2O_3}.$$

Liquor Ferri Albuminati.—*Solution of Albuminate of Iron.* **Liquor Ferri Peptonati.**—*Solution of Peptonate of Iron.*—They are complex organic compounds of iron of indefinite composition, the solution of ferric oxychloride being used in both preparations.

Liquor Ferri Oxychloridi.—*Solution of Ferric Oxychloride.*—The manufacture of this preparation depends upon the fact that the ferric chloride is capable of dissolving a large amount of freshly precipitated ferric hydroxide. The ferric hydroxide is best formed by precipitating a solution of ferric tersulphate with ammonia water.

Reaction:

$$\underset{\substack{\text{Ferric}\\\text{sulphate.}}}{Fe_2(SO_4)_3} + \underset{\substack{\text{Ammonium}\\\text{hydroxide.}}}{6NH_4HO} = \underset{\substack{\text{Ferric}\\\text{hydroxide.}}}{2Fe(OH)_3} + \underset{\substack{\text{Ammonium}\\\text{sulphate.}}}{3(NH_4)_2SO_4}.$$

It is important that the solutions be cold, otherwise less soluble basic compounds are apt to be formed. E. H. Squibb recommends precipitation with a very dilute solution of sodium hydroxide containing a little sugar, which tends to prevent basic compounds. If much sugar be used it will prevent precipitation. After washing, the precipitate is dissolved by the addition of a little hydrochloric acid, forming ferric chloride, which acts as a solvent for the remainder of the hydroxide, oxyhydrochloride of indefinite composition being formed.

Reaction:

$Fe_2(HO)_3$	+	$6HCl$	=	$2FeCl_3$	+	$3H_2O$.
Ferric hydroxide.		Hydrochloric acid.		Ferric chloride.		Water.

Liquor Ferri Iodidi.—*Solution of Ferrous Iodide.*—This solution is prepared by the action of iodide on iron wire, and is preserved by the hypophosphorous acid, which prevents oxidation.

Reaction:

Fe	+	I_2	=	FeI_2.
Iron.		Iodide.		Ferrous iodide.

Liquor Ferri Oxysulphatis.—*Solution of Oxysulphate of Iron.*—The solution is prepared by oxidizing ferrous sulphate with nitric acid. The product doubtless consists of ferric sulphate and nitrate, according to the following reaction:

Reaction:

$3FeSO_4$	+	$4HNO_3$	=	$Fe_2(SO_4)_3$	+	$Fe(NO_3)_3$	+	$2H_2O$	+	NO.
Ferric sulphate.		Nitric acid.		Ferric sulphate.		Ferric nitrate.		Water.		Nitric oxide.

Liquor Ferri Protochloridi. — *Solution of Ferrous Chloride.*—It is prepared by the action of hydrochloric acid on iron wire and preserved by hypophosphorous acid.

Reaction:

Fe	+	$2HCl$	=	$FeCl_2$	+	H_2.
Iron.		Hydrochloric acid.		Ferrous chloride.		Hydrogen.

Liquor Magnesii Sulphatis Effervescens.—*Effervescent Solution of Magnesium Sulphate.*—This is put up in the same manner as the *United States Pharmacopœia* effervescent solution of magnesium citrate. The effervescence is due to the action of citric acid upon the potassium bicarbonate.

Reaction:

$$\underset{\text{Citric acid.}}{H_3C_6H_5O_7} + \underset{\text{Potassium bicarbonate.}}{3KHCO_3} = \underset{\text{Solution magnesium citrate.}}{K_3C_6H_5O_7} + \underset{\text{Water.}}{3H_2O} + \underset{\text{Carbon dioxide.}}{3CO_2}.$$

Liquor Phosphatum Acidus.—*Solution of Acid Phosphates.*—This solution is prepared from bone ash and sulphuric acid. Bone ash consists principally of tricalcic phosphate. A portion of the calcium is removed by the sulphuric acid as insoluble calcium sulphate and the calcium acid phosphates pass into solution.

Reaction:

$$\underset{\text{Tribasic calcium phosphate.}}{Ca_3(PO_4)_2} + \underset{\text{Sulphuric acid.}}{H_2SO_4} = \underset{\text{Calcium sulphate.}}{CaSO_4} + \underset{\text{Dibasic calcium phosphate.}}{2CaHPO_4}.$$

or

$$Ca_3(PO_4)_2 + 2H_2SO_4 = 2CaSO_4 + \underset{\text{Monobasic calcium phosphate.}}{CaH_4(PO_4)_2}.$$

Liquor Potassæ Chlorinatæ.—*Solution of Chlorinated Potassa. Javelle Water.*—The potassium carbonate precipitates the calcium as a carbonate, leaving the chlorinated potassa in the solution. For reaction, see Solution of Chlorinated Soda, p. 187.

Liquor Sodii Boratis Compositus.—*Compound Solution of Sodium Borate. Dobell's Solution.*—For the reaction between the glycerin, borax, and bicarbonate, see Alkaline Antiseptic Solution, p. 190.

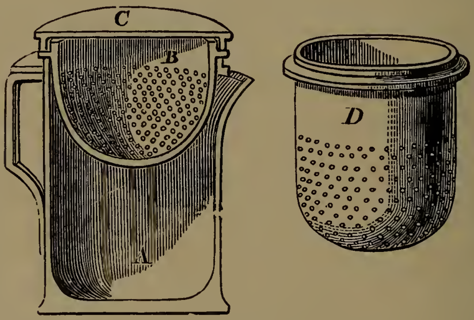
CHAPTER XX.

INFUSIONS AND DECOCTIONS.

INFUSA. INFUSIONS.

Infusions are solutions of the active constituents of drugs in either hot or cold water. When cold water is used they are made by maceration and percolation. When hot water is employed, the drug is placed in a suitable vessel, boiling water is poured over it, then tightly covered and allowed to macerate from one-half to one hour. Express, strain, and wash the dregs with sufficient water to make the required volume. Fig. 111 illustrates an infusion pot, which acts on the principle

Fig. 111



Squire's infusion pot.

of circulatory displacement, but has no advantage over the method of placing the drug loosely in a piece of muslin, pouring hot water over it, and suspending in the top of the liquid. This principle has also been applied in the manufacture of aluminum coffee pots. The drug should be bruised or reduced to a moderately coarse powder. In the manufacture of infusions or decoctions, eliminate the inert material as far as possible, as its presence aids decomposition. Gum and sugar are soluble in both hot and cold water, starch only in hot water, and albumin in cold water alone. When the strength of unofficial infusions is not specified by the physician, they should be made in the proportion of 5 Gm. of the drug to 100 Cc. of finished infusion. The strength of infusions of powerful or energetic drugs should be specified by the physician. Infusions and decoctions ought not to be made from fluid extracts or tinctures, as the different menstrua employed in their manufacture may extract different constituents. Besides, they are frequently prescribed when the alcohol in the fluidextract or tincture would be objectionable. If a physician desires a fluidextract or tincture, let him prescribe it.

Pharmacopœial Infusions.

Infusum Digitalis.—*Infusion of Digitalis.*—This contains 1.5 Gm. in 100 Cc., with alcohol and cinnamon water as preservatives.

Infusum Pruni Virginianæ.—*Infusion of Wild Cherry.* —It contains 4 Gm. in 100 Cc., and is made by maceration and percolation. Wild cherry bark contains a glucoside similar, if not identical, with amygdalin, and also an enzyme. Upon moistening with cold water the enzyme splits the glucoside into benzaldehyde, hydrocyanic acid, and glucose.

Reaction:

$$\underset{\text{Amygdalin.}}{C_{20}H_{27}NO_{11}} + \underset{\text{Water.}}{2H_2O} + \text{enzyme} = \underset{\text{Benzaldehyde.}}{C_6H_5COH} + \underset{\substack{\text{Hydrocyanic}\\ \text{acid.}}}{HCN} + \underset{\text{Glucose.}}{2C_6H_{12}O_2}.$$

Heat destroys the enzyme, hence prevents fermentation and the formation of hydrocyanic acid; or if fermentation be allowed to take place first, the heat would drive off the hydrocyanic acid.

Infusum Sennæ Compositum.—*Compound Infusion of Senna. Black Draught.*—This contains senna, 6 Gm.; manna and magnesium sulphate, each, 12 Gm.; and fennel, 2 Gm., in 100 Cc.

National Formulary Infusions.

Infusum Gentianæ Compositum Fortius.—*Stronger Compound Infusion of Gentian.*—This preparation is made so that one volume can be mixed with three volumes of water to make the compound infusion of gentian. It is made with dilute alcohol, hence it is not properly an infusion, but a tincture.

Infusum Rosæ Compositum.—*Compound Infusion of Rose.*—This infusion is made with heat, and contains a small quantity of dilute sulphuric acid to improve the color.

Infusions of brayera and cinchona were formerly placed in the *Pharmacopœia,* but are now considered in the *National Formulary.*

DECOCTA. DECOCTIONS.

Decoctions are solutions of the active constituents of vegetable drugs. They are made by placing the drug in a suitable vessel, pouring cold water over it, covering and afterward boiling for fifteen minutes. Cool to 40° C. Express, strain, and wash with water sufficient to make the required volume. Most vegetable drugs contain albumin, which is coagulated when the drug is placed in water already boiling. This tends to retard the solution of the active constituents. Hence, the drug should be placed in cold water and gradually raised to the boiling point. Do not make decoctions from drugs containing a large amount of starch, as the starch is soluble in boiling water and forms a thick mucilaginous mass.

Glass, earthen, or porcelain vessels are preferred in the manufacture of decoctions, though tinned copper may be used. Do not use iron vessels, as many drugs contain tannin. Crush the drug or reduce to coarse powder. Decoctions are not elegant preparations, and frequently deposit on cooling. The deposit generally consists of inert matter, which could be removed by straining. In some cases it may be active, hence it is better to dispense with a "shake" label. There are no pharmacopœial decoctions, but a general formula is given directing to make their strength 5 Gm. to 100 Cc. In the case of powerful or energetic drugs the strength should be prescribed by the physician.

National Formulary Decoctions.

Decoctum Aloes Compositum.—*Compound Decoction of Aloes.*—This contains aloes, myrrh, saffron, licorice, potassium bicarbonate, and tincture of cudbear.

Decoctum Cetrariæ.—*Decoction of Irish Moss.*—The cetraria is first macerated in cold water, and later expressed to remove the bitter principle. This is rejected.

Decoctum Sarsaparillæ Compositum.—*Compound Decoction of Sarsaparilla.*—This contains sarsaparilla, sassafras, guaiacum wood, licorice, and mezereum.

SPECIES.

This is the term frequently applied to very coarse powders or bruised drugs to be used for the manufacture of infusions or decoctions. They are sometimes called *teas.* Three such preparations may be found in the *National Formulary.* They are *Species Emollientes,* Emollient Species; *Species Laxantes,* St. Germain Tea; *Species Pectorales, Breast Tea.*

CHAPTER XXI.

HONEYS, MUCILAGES, AND MIXTURES.

MELLITA. HONEYS.

MEDICINAL honeys are made by mixing the medicinal substance with clarified honey.

Mel Depuratum.—*Clarified Honey* (*Mel Despumatum,* U. S. P., 1890).—It contains 5 per cent. glycerin, which is added to prevent crystallization.

MUCILAGINES. MUCILAGES.

The term mucilage is applied to viscid adhesive liquids or to a plastic mass formed by the action of water on mucilaginous substances. They should be freshly prepared when desired for use, as none are stable.

Mucilago Acaciæ.—*Mucilage of Acacia.*—It contains 34 per cent. of acacia, and is made by washing the acacia to remove foreign matter and afterward dissolving in distilled water and lime water. The latter is added to neutralize the acid and prevent decomposition. As the solution becomes sticky it is difficult to agitate, and many prefer to manufacture it by circulatory displacement. Others prepare the mucilage when wanted, using granulated acacia and triturating in a mortar. This process requires only a few minutes, and insures a fresh preparation.

Mucilago Tragacanthæ.—*Mucilage of Tragacanth.*—This mucilage contains 6 per cent. of tragacanth and 18 per cent. of glycerin. It forms a plastic mass. The glycerin is intended as a preservative, but the preparation keeps but a short time only.

MISTURÆ. MIXTURES.

The term mixture is indiscriminately used. It is frequently applied to a compound of two or more substances, regardless of the physical character of the substances employed or the product formed. Preparations of this class will be considered under the subject of *dispensing*. The term mixtures, in its more restrictive meaning, is applied to a class of preparations similar to those of that name in the *Pharmacopœia*. These preparations contain some insoluble substance, usually held in suspension by some substance of a viscid character. The insoluble substance should be powdered, and then, with few exceptions, rubbed with a small quantity of the liquid until a smooth, creamy paste is produced, when the remaining liquid may be added. Oxides which take up water of hydration, like magnesia, when treated as above, generally form a granular or gelatinous mass. In this case, sift the fine powder into the liquid while stirring. Mixtures are not intended to be stable preparations, and should always be dispensed with a "shake" label.

Mistura Ferri Composita.—*Compound Iron Mixture.*—This mixture contains ferrous carbonate formed by the action of the potassium carbonate on ferrous sulphate.

Reaction:

$$\underset{\text{Ferrous sulphate.}}{FeSO_4} + \underset{\text{Potassium carbonate.}}{K_2CO_3} = \underset{\text{Ferrous carbonate.}}{FeCO_3} + \underset{\text{Potassium sulphate.}}{K_2SO_4}.$$

There is a large excess of potassium carbonate, which unites with the myrrh and forms a resin soap. This mixture should be freshly prepared, as the ferrous carbonate quickly oxidizes.

Mistura Glycyrrhizæ Compositæ.—*Compound Mixture of Licorice. Brown Mixture.*—If pure extract of licorice be used as directed, the product will be a *clear* brown solution. The ordinary extract is only partially soluble, thus producing a brown *mixture.*

Mistura Rhei et Sodæ.—*Mixture of Rhubarb and Soda.*—In this mixture, the sodium bicarbonate unites with the resinous constituents of the rhubarb, rendering them more soluble in the aqueous liquid.

The *National Formulary* contains a number of formulas for mixtures, most of which may be prepared extemporaneously when wanted, and do not require special comment.

Mistura Adstringens et Escharoticæ.—*Villate's Solution.*—This is a mixture of solution of lead subacetate, copper sulphate, and zinc sulphate in acetic acid. The lead is precipitated as a sulphate, which is separated by decantation, using only the clear liquid. The probable reaction would be:

$$\underset{\text{Lead subacetate.}}{Pb_2O(C_2H_3O_2)_2} + \underset{\text{Acetic acid.}}{2HC_2H_3O_2} = \underset{\text{Lead acetate.}}{2Pb(C_2H_3O_2)_2} + \underset{\text{Water.}}{H_2O}.$$

$$\underset{\text{Lead acetate.}}{Pb(C_2H_3O_2)_2} + \underset{\text{Copper sulphate.}}{CuSO_4} = \underset{\text{Lead sulphate.}}{PbSO_4} + \underset{\text{Copper acetate.}}{Cu(C_2H_3O_2)_2}.$$

Misturæ Copaibæ.—*Copaiba Mixtures.*—The first of these is *Lafayette's Mixture,* which contains copaiba, spirits of nitrous ether, tincture of lavender compound, and solution of potassium hydroxide. The potassium hydroxide is used to partially saponify the copaiba, which aids in its emulsification.

The second, *Chapman's Mixture,* differs from Lafayette's, as it contains tincture of opium but no potassium hydroxide. No directions are given for its manufacture. The copaiba should be emulsified with the mucilage of acacia, before adding the other constituents.

Mistura Rhei Composita.—*Squibb's Rhubarb Mixture.*—This is nearly identical with the pharmacopœial mixture of rhubarb and soda, as it contains the same ingredients, but it is only about four-fifths as strong.

CHAPTER XXII.

EMULSA. EMULSIONS.

EMULSIONS are opaque, milky mixtures which contain oils, fats, resinous, or other immiscible substances, held in suspension in water by mucilaginous or albuminous bodies. The emulsified substance should be in a finely divided condition, each particle surrounded by a mucilaginous coating which prevents the globules from coalescing. Milk is the best type of an emulsion. The butter fat exists in minute globules, surrounded by a film of casein, which prevents the particles of fat from uniting. The quality of the emulsifier is judged by the fineness of the globules produced, rather than by the quantity of oil emulsified. The finer the oil globules the more easily the emulsion is assimilated.

Emulsifying Agents.—*Acacia* is the most satisfactory emulsifier for general use, as it yields a permanent white emulsion with finely divided oil globules. *Casein* has been strongly recommended. Though it decomposes easily, it produces a fine palatable emulsion when used in a fresh condition. Otherwise, it has no advantage over acacia. *Condensed milk* is a good emulsifier, but, like casein, should only be employed in emulsions to be used within a few days. *Yolk of eggs* is an excellent aid to emulsification, but as it decomposes easily it is best used in the form of the glycerite of the *National Formulary.* It is advantageously employed in emulsions containing acid, acid salts, or other substance that precipitates acacia.

Tragacanth ranks next to acacia as a general emulsifier. It is capable of emulsifying a much larger quantity of oil, but the globules are not so fine nor the emulsion so white. However, it is less apt to separate into two layers. Doubtless the best results are obtained by using a combination in the proportion of one part tragacanth to ten parts of acacia. *Irish Moss* behaves similarly to tragacanth, and is sometimes used with acacia, especially when manufacturing emulsions by machinery and upon a large scale. It is generally used in the form of mucilage (*National Formulary*). It has no advantage over tragacanth, with the positive disadvantage of decomposing more easily.

Extract of malt is sometimes prescribed with oil. If acid, it should be neutralized with sodium bicarbonate and placed in a warm mortar. Add the oil gradually, stirring rapidly. The oil does not readily separate, but it is not in a state of fine division. *Extract* of licorice is not a good emulsifier. It can be used with other emulsifiers to disguise the taste of cod-liver oil. *Dextrin* has been recommended as an emulsifier, but it is unsatisfactory. Its chief recommendation is its cheapness. *Pancreatin* is sometimes prescribed with oil, when it may be used as an emulsifier. It should be used in alkaline solution and the oil warmed to 50° C., when the ferment digests a portion of the oil, and the product aids in emulsification.

Tincture of quillaia and other substances containing saponin are good emulsifiers. They have been recommended for emulsions containing free acid, or other constituents that precipitate gums. It possesses no special advantage over yolk of egg, and its acrid taste is a decided objection.

NATURAL AND ARTIFICIAL EMULSIONS.

Emulsions are divisible into two classes, natural and artificial.

Natural Emulsions.—Natural emulsions are those formed in nature, as milk, the juices of many plants, yolks of eggs. Upon microscopic examination they are seen to consist of minute globules of oil, separated by a viscid fluid.

Artificial Emulsions.—To this class belong emulsions made from seeds, gum resin, fats, fixed and volatile oils, etc. A perfect emulsion may separate into two layers, as cream from milk, but there should never be a separation of the unemulsified substance.

SEED EMULSIONS may be made from all seeds containing oils and albuminous substances, by triturating with water. Most seeds contain these necessary constituents. In the manufacture of seed emulsions it is important that a small quantity of water be present when crushing the seeds, otherwise the oil will be expressed and not be so easily emulsified. When the seeds are finely divided, more water may be added and trituration continued until a homogeneous creamy mixture results. Then strain, and wash the strainer and contents with sufficient water to make the required amount. The almond emulsion of the *Pharmacopœia* is a type of this class. It contains sugar and acacia, but these are unnecessary for emulsification, though they add to the permanency of the emulsion. The seeds should be first blanched by soaking in hot water until the testa or seed coat softens, when it may be removed by pressing between the fingers.

GUM-RESIN EMULSIONS are prepared by coarsely powdering the gum resin, and triturating with a small quantity of water until it becomes a smooth paste. The remainder of the water may be slowly added and the emulsion strained to remove foreign particles. Only selected tears should be used, as in time the fine powder, by dehydration, becomes so changed that emulsification is impossible.

FIXED OIL EMULSIONS are usually prepared in a mortar, which *should* be flat-bottomed, and with a pestle of such shape that the greatest possible surface is in contact with the mortar. The pestle should be held loosely between the thumb and fingers, combining the wrist and finger movement in such a manner that the pestle will always be at right angles to the surface with which it is in contact, at the same time maintaining a light but rapid motion in one direction until completed.

Acacia is more frequently used in dispensing than is any other emulsifier. Two methods of using acacia are generally employed, viz., the English and the Continental methods.

ENGLISH METHOD.—In this method a thick mucilage of acacia is placed in a mortar and the oil is added in small quantities. Each portion of oil is thoroughly emulsified before another portion is added. Perfect emulsification may be recognized by the smooth, cream-like appearance. Should the emulsion become too thick, caused by the too rapid addition of the oil or the use of too thin mucilage, a few drops of water should be added. Otherwise the emulsion may become cracked, which may be recognized by the accompanying cracking noise, the pearly appearance of the mixture, and the separation of the oil from the mucilage. In this case the only remedy is to make a fresh portion of mucilage, to which add the cracked emulsion, as though it were an oil.

CONTINENTAL METHOD.—There are three different ways of applying the Continental method, but it is necessary to consider only that one which yields the best results. If the directions be carefully followed, success is sure to come. It is immaterial how much water or syrup is prescribed, but the initial quantity directed for the emulsification of the oil *must be strictly used.* When the emulsion is formed the remainder of the water and other ingredients may be added. *The initial quantities are: Oil, four parts; water, two parts; powdered acacia, one part; or, half as much water as oil, and half as much acacia as water.* Place the powdered acacia in a dry mortar, add the oil all at once, and employ barely sufficient trituration to moisten the acacia. Immediately add the water and triturate until the emulsion is formed. The water will gradually dissolve the acacia and form a mucilage which envelops the oil, forming a uniform creamy mixture. Other ingredients may now be added. If the acacia be left too long in contact with the oil, it becomes insoluble in the water. In hot weather it is better to cool both the oil and the water, as heat interferes with the emulsification. Alkalies assist emulsification by combining with the oil to form a soap which is also a good emulsifier, but should be used only when prescribed. Strong alcoholic solutions precipitate gums; hence, it should be well diluted and added in small quantities to the emulsion. Acids, glycerin, and salts take up water from the mucilage and cause the oil to separate. Therefore, they should be dissolved or diluted and added to the emulsion slowly, and with constant shaking or stirring.

VOLATILE OIL EMULSIONS.—These may be made in a mortar, but are usually prepared in a bottle. Place the powdered emulsifier in a dry bottle, add the oil, and shake until the powder is wet. Then add the water and agitate until the emulsification is complete. Use the same proportions of water, acacia, and oil as in the Continental method. A more permanent emulsion may be made by adding from one-third to two-thirds as much almond oil as volatile oil, and using a mortar. The acacia must be proportionately increased.

FATS, WAXES, ETC., should be melted and the water and mortar heated to the melting point of the substance to be emulsified. Proceed as in the case of fixed oils, using one part of acacia, one part fat, and one and one-half parts of water.

RESINOUS SUBSTANCES, CAMPHOR, MENTHOL, THYMOL, SALOL, AND PHOSPHORUS.—These and similar substances are best emulsified by first making a solution in some bland oil, like sweet almond oil, and then emulsifying in the usual manner.

LYCOPODIUM, LUPULIN.—These are resinous substances, which may be emulsified by rubbing in a mortar with a little water until a granular mass is obtained. Add an equal weight of granulated acacia and triturate, gradually adding the water.

Mechanical Emulsifiers.—Fine emulsions may be made with an egg-beater used in the place of the mortar and pestle. The very best emulsifier is the hard-rubber syringe, as recommended by Charles F. Hartwig and De Forrest.[1] The materials are mixed, as in the Continental method. The mixture is then drawn into the syringe and rapidly ejected, preferably holding the end near the surface of the mixture. By this means even a cracked or poor emulsion may also be quickly redeemed. In the manufacture of emulsions on a large scale, the Sparrow mixer, the Phœnix emulsifier, Morton's egg beater, or the best forms of churns may be used.

PRESERVATION.—Emulsions should be freshly prepared when wanted, but if necessary to keep them for a length of time a preservative must be added. The addition of from 6 to 10 per cent., by volume, of alcohol is sometimes used. From 0.5 to 1 per cent. of chloroform is doubtless an equally good preservative, and less objectionable. The formulas of the *Pharmacopœia* and *National Formulary* do not require special comment.

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[1] Am. Pharm. Association, vol. xxiv, p. 85, and vol. xliii, p. 561.

CHAPTER XXIII.

SYRUPI. SYRUPS.

Syrups are medical or aromatic substances contained in a nearly saturated solution of sugar. The principal solvent is water, but in many cases alcohol is present in small quantities, having been used as a solvent for the drug. However, in but seven pharmacopœial syrups and eight *National Formulary* syrups is the amount sufficient to act as a preservative. On the other hand, it frequently aids decomposition, by itself undergoing acetic fermentation. Several syrups contain acetic acid as a solvent. A pure, dry granulated sugar which meets the requirements of the *Pharmacopœia,* and sterilized freshly boiled distilled water should be used. The term syrup or simple syrup is applied to a solution containing 85 Gm. of sugar in 100 Cc. of syrup having a specific gravity of about 1.313 at 25°. The amount of water present in the 100 Cc. of syrup is 46.3 Gm. Hence, the volume occupied by the 85 Gm. of sugar is about 54 Cc., which is approximately two-thirds of the 85 Gm. *Therefore, sugar when dissolved in a liquid increases the volume of the liquid by a volume equal to approximately two-thirds of the weight of the sugar dissolved.* Syrups containing only aromatic substances are used as vehicles, and are called aromatic syrups. Those containing substances medicinally active are called medicinal syrups.

Preparation.—Medicinal syrups are prepared both by mixing a solution of the substance with syrup, and also by dissolving the sugar in a solution of the substance, either by agitation, by percolation, or with the aid of heat. Formerly, syrups were frequently prepared by dissolving the sugar in an infusion or decoction of vegetable drug, or in fruit juices. In this case heat was essential as it coagulates the albuminous substance and acts as a clarifying agent. At the present time, syrups of vegetable drugs are commonly prepared from alcoholic or hydro-alcoholic preparations of the drug which are comparatively free from albuminous matter. When the alcoholic preparation contains oil or resinous matter which would be precipitated by mixing with water, the alcoholic preparation should be first triturated with some absorbent powder-like talc or magnesium carbonate to keep the precipitate which forms, in a finely divided condition, in order that a greater surface may be exposed to the action of the solvent. When time is an object, or when the solvent contains some viscid substance which retards solution, like acacia, heat may be applied to hasten the process. In no case should the heat be continued longer than necessary to bring the syrup to the boiling point. Continued heat, particularly in the presence of an acid, converts the sugar into reducing or inverted sugar, and in many cases heat has an injurious effect upon the drug itself, especially upon one containing aromatic substances.

In 1871 L. Orinsky suggested the manufacture of syrups by percolation. Since that time the process has gradually grown in favor, and at present the *Pharma-*

copœia gives methods for the manufacture of eight different syrups by percolation. The method might well be applied to other syrups also, as it affords a beautifully clear product that keeps well and requires no filtration. A tall cylindrical percolator should be selected for this purpose, the neck loosely filled with absorbent cotton moistened with a few drops of water. The dry sugar is then introduced without packing or jarring, the surface levelled and covered with a piece of filter paper, and the solvent added. The first percolate should be returned until it comes through clear. The rate of flow for from 500 Gm. to 2000 Gm. of sugar should be from 50 to 100 drops per minute.

Preservation.—Syrups should be kept in a cool place, in completely filled bottles of such size that when opened the contents will be used within a few weeks. Syrups kept in partially filled bottles and subject to varying temperatures rapidly spoil. Vapors of water fill the air space when the temperature is warm, and when cold, the vapors condense upon the sides of the bottle, quickly forming a layer of weak syrup over the surface, thus furnishing an excellent medium for the growth of microörganisms. Thoroughly cleanse and dry all syrup bottles before refilling. With proper precaution, syrups will keep as long as required without the use of preservatives, but when fermentation has appeared they should be thrown away.

There are twenty-nine pharmacopœial syrups, seven of which are prepared by mixing solutions, tinctures, or fluidextracts directly with simple syrup. These may be freshly made when wanted. Of these, *Syrupus Acidi*

Hydriodici, Syrup of Hydriodic Acid, and *Syrupus Ferri Quininæ et Strychninæ Phosphatum,* Phosphate of Iron, Quinine, and Strychnine, sometimes called Easton's Syrup, darken on standing. *Syrupus Krameriæ,* Syrup of Krameria, contains 22 per cent. of alcohol, by volume, and is the strongest alcoholic syrup made. Twelve syrups are prepared by direct solution.

Syrupus Acaciæ.—*Syrup of Acacia.*—This syrup quickly becomes sour; hence, it should be freshly prepared when wanted. This may be easily done by using granulated acacia, sugar, and warm water.

Syrupus Acidi Citrici.—*Syrup of Citric Acid.*—It is a good substitute for syrup of lemon, and as it is so easily prepared should be freshly made when needed.

Syrupus Calcii Lactophosphatis.—*Syrup of Calcium Lactophosphate.*—Calcium carbonate is first dissolved in lactic acid to form calcium lactate, carbon dioxide, and water.

Reaction:

$$\underset{\text{Calcium carbonate.}}{CaCO_3} + \underset{\text{Lactic acid.}}{2HC_3H_5O_3} = \underset{\text{Calcium lactate.}}{Ca(C_3H_5O_3)_2} + \underset{\text{Carbon dioxide.}}{CO_2} + \underset{\text{Water.}}{H_2O}.$$

Upon the addition of phosphoric acid the tricalcic phosphate is first precipitated, then redissolved in the excess of phosphoric acid to form the soluble calcium acid phosphate, and lactic acid.

Reactions:

$$\underset{\text{Calcium lactate.}}{3Ca(C_3H_5O_3)_2} + \underset{\text{Phosphatic acid.}}{2H_3PO_4} = \underset{\text{Calcium phosphate.}}{Ca_3(PO_4)_2} + \underset{\text{Lactic acid.}}{6HC_3H_5O_3}.$$

$$\underset{\text{Calcium phosphate.}}{Ca_3(PO_4)_2} + \underset{\text{Phosphatic acid.}}{H_3PO_4} = \underset{\text{Calcium acid phosphate.}}{3CaHPO_4}.$$

Syrupus Calcis.—*Syrup of Lime.*—In the manufacture of this syrup the calcium oxide, when heated with water, forms the hydroxide.

Reaction:

$$CaO + H_2O = CaH_2O_2$$

The mixing with sugar and boiling aids the chemical action, and part of the sugar unites with the calcium hydroxide to form calcium saccharates, which are more soluble than calcium hydroxide.

Reaction:

$$\underset{\text{Calcium hydroxide.}}{CaH_2O_2} + \underset{\text{Sugar.}}{C_{12}H_{22}O_{11}} = \underset{\text{Calcium saccharate.}}{CaO.C_{12}H_{22}O_{11}} + \underset{\text{Water.}}{H_2O.}$$

This accounts for the fact that the syrup contains more lime than is present in lime water. Bright copper or tinned iron receptacles are used in boiling the syrup, as hot calcium hydroxide acts upon glass. The syrup should be protected from the air, especially while filtering, to prevent the absorption of carbon dioxide, which precipitates the lime as a carbonate.

Syrupus Ferri Iodidi.—*Syrup of Iodide of Iron.*—The iodine unites with the iron to form ferrous iodide.

Reaction:

$$Fe + I_2 = FeI_2.$$

The reaction increases rapidly, and is due to the facts, first, that the chemical change produces heat which aids the reaction, and secondly, that the iodide formed is a solvent for the iodine. Do not allow the reaction to become too violent, as part of the iodine will be volatilized and thus lost. Ferrous iodide is easily oxidized, hence part of the sugar is added to the hot solution to prevent oxidation. The syrup should be protected from air, but light acts as a reducing agent and prevents oxidation. Hypophosphorous acid is also added as a preservative to prevent oxidation, and to reduce any iodine that may be liberated.

Syrupus Hypophosphitum Compositus.—*Compound Syrup of Hypophosphites.*—The sodium citrate aids the solution of the iron and manganese hypophosphites, possibly forming double salts. The free alkaloids, quinine and strychnine, are dissolved by the hypophosphorous acid forming the hypophosphites.

Reaction:

$$\underset{\text{Quinine.}}{C_{20}H_{24}N_2O_2} + \underset{\text{Hypophosphorous acid.}}{HPH_2O_2} = \underset{\text{Quinine hypophosphite.}}{C_{20}H_{24}N_2O_2.HPH_2O_2}$$

$$\underset{\text{Strychnine.}}{C_{21}H_{22}N_2O_2} + \underset{\text{Hypophosphorous acid.}}{HPH_2O_2} = \underset{\text{Strychnine hypophosphite.}}{C_{21}H_{22}N_2O_2HPH_2O_2.}$$

Syrupus Ipecacuanhæ.—*Syrup of Ipecac.*—This is prepared by shaking the fluidextract together with water containing acetic acid. The acid holds the active principle in solution, while the inert matter is precipitated. After standing twenty-four hours the liquid is filtered, mixed with the glycerin, which acts as a preservative, and the sugar, dissolved by agitation.

Syrupus Picis Liquidæ.—*Syrup of Tar.*—The object of triturating the tar with sand is to increase the surface exposed to the action of the solvent. It is first washed with water to remove pyroligneous acid and other objectionable substances.

Syrupus Pruni Virginianæ.—*Syrup of Wild Cherry.*—This syrup is prepared, by percolation, from the wild cherry bark. The percolate is received in a vessel containing glycerin, which prevents the precipitation of the tannin. Formerly the glycerin was used as part of the menstruum, but this increases the amount of the tannin and produces a darker preparation without increasing the active constituent. The sugar must be dissolved without heat, as heat drives off the hydrocyanic acid which has been formed by the action of enzyme on the amygdalin, thus forming benzaldehyde, hydrocyanic acid, and glucose.

Reaction:

$$C_{20}H_{27}NO_{11} + 2H_2O + \text{enzyme} = C_6H_5COH + HCN + 2C_6H_{12}O_6.$$

Syrupus Rhei.—*Syrup of Rhubarb.*

Syrupus Rhei Aromaticus.—*Aromatic Syrup of Rhubarb.*—In these syrups the potassium carbonate is used to combine with the resinous matter, and prevent its precipitation.

Syrupus Rosæ.—*Syrup of Rose.*—This syrup contains sulphuric acid, which improves both flavor and color.

Syrupus Scillæ Compositus.—*Compound Syrup of Squill. Hive Syrup.*—In this syrup, talc is used as a clarifying agent. Magnesium carbonate cannot be used on account of the acetic acid in the fluidextract of squill employed. The manufacture of four syrups involves chemical action to some extent.

In the *National Formulary* there are formulas for thirty-nine syrups. Many of these are intended for extemporaneous compounding, and are prepared either from fluidextracts or tinctures. This is the reason why nearly half of the syrups contain alcohol. In a few cases more alcohol is present than is necessary, and the amount will doubtless be reduced in the next edition.

In most cases the formulas are sufficiently explicit, and explanatory notes are unnecessary.

Syrupus Calcii Iodidi.—*Syrup of Calcium Iodide.*—In the manufacture of this syrup the first portion of the iodine unites with the iron wire to form ferrous iodide, $Fe + I^2 = FeI^2$, which is separated from the excess of iron, and the remainder of the iodine added, which is dissolved by the ferrous iodide. This does not unite to form the ferric iodide, as is generally supposed, but the iron is oxidized by the iodine to the ferric hydroxide upon the addition of calcium and heat, so that the final reaction may be expressed as follows:

Reaction:

$$2FeI_2 + I_2 + 3CaCO_3 + 3H_2O = 2Fe(OH)_3 + 3CaI_2 + 3CO_2.$$

Syrupus Eriodictyi Aromaticus.—*Aromatic Syrup of Yerba Santa. Syrup of Corrigens.*—This syrup contains potassium hydroxide to hold the resinous matter of the eriodictyon in solution.

Syrupus Ferri Citro-iodidi.—*Tasteless Syrup of Iodide of Iron.*—The first portion of iodine added to the iron forms ferrous iodide, and the second portion used is dissolved by the ferrous iodide. This when mixed with potassium citrate forms a green solution of unknown composition. It is commonly called citro-iodide of iron.

Syrupus Ferri Saccharati Solubilis.—*Syrup of Soluble Saccharated Iron.*—In this syrup the solution of ferric chloride is mixed with syrup, thus preventing the precipitation of ferric hydroxide when the sodium hydroxide is added. When this solution is poured into five times its volume of boiling water and boiled for a few minutes the iron is precipitated as ferric oxide. After washing, this precipitate is mixed with sugar and boiled. Sodium hydroxide is then cautiously added until the magma is dissolved. Probably the solution consists of ferri oxysaccharate of indefinite composition. It is protected from light to prevent the reducing action which light has upon ferric compounds in the presence of organic matter.

Syrupus Phosphatum Compositus.—*Compound Syrup of the Phosphates. Chemical Food.*—The carbonates of calcium, potassium, and sodium are dissolved in citric and phosphoric acids, and then mixed with a solution of iron and ammonium phosphate. The resultant mixture, though designated as phosphates, doubtless consists of double salts or citrophosphates of unknown composition.

CHAPTER XXIV.

VINEGARS AND WINES.

ACETA. VINEGARS.

The official vinegars are solutions of medicinal substances in dilute acetic acid, containing 6 per cent. of absolute acid. They are made by maceration and expression. There are two pharmacopœial vinegars only.

Acetum Opii.—*Vinegar of Opium.*—This is prepared by maceration and expression. Each 100 Cc. contains 10 Gm. of opium, 3 Gm. of myristica, and 20 Gm. of sugar.

Acetum Scillæ.—*Vinegar of Squill.*—Each 100 Cc. contains 10 Gm. of squill. The expressed liquid is heated to the boiling point before filtering, to remove albuminous matter. The *National Formulary* contains three vinegars, Acetum Aromaticum (Aromatic Vinegar), Acetum Lobeliæ (Vinegar of Lobelia), and Acetum Sanguinariæ (Vinegar of Sanguinaria).

VINA. WINES.

Pharmacopœial wines are either natural wines or solutions of medicinal substances in natural wine. The *Pharmacopœia* recognizes two natural wines.

Vinum Album.—*White Wine.*—This is the fermented juice of the fresh grape free from seeds, skins, and stems. It should be a dry wine containing from 7 per cent. to 12 per cent. of absolute alcohol by weight, equalling from 8.5 per cent. to 15 per cent. by volume. White wine is commonly preferred for the manufacture of medicinal wines, as it contains less tannic acid. Wines containing much tannic acid cannot be dispensed with alkaloids or iron preparations. Wines may be detannated by adding 5 Gm. of finely powdered gelatin to each liter of wine and agitating occasionally for forty-eight hours and then filtering. The wine should be kept as cold as possible to prevent the solution of the gelatin. Good white wine containing only a trace of tannic acid can be obtained. This need not be detannated.

Vinum Rubrum.—*Red Wine.*—This is the juice of fresh red grapes fermented with the skins. The alcoholic strength is the same as that of white wine. The *Pharmacopœia* furnishes tests for the detection of artificial colorings in wines, and methods for determining their alcoholic strengths.

Table of Wines.

Official name.	Ingredient.	Gm. or Cc. in 100.	Abs. alc. % by vol.
Vinum antimonii.	Antimony and potassium tartrate.	0.4	28.0
Cocæ.	Fluidextract of coca.	6.5	23.0
Colchici seminis.	Fluidextract of colchicum seed.	10.0	32.0
Ergota.	Ergot.	20.0	25.7
Ferri.	Iron and ammonium citrate.	4.0	17.0
Ferri amarum (bitter wine of iron).	Iron and quinine citrate.	5.0	14.0
Ipecacuanhæ.	Fluidextract of ipecac.	10.0	28.0
Opii.	Opium.	10.0	27.0

Medicated Wines.—Alcohol is added as a preservative to all except two of the medicinal wines. With a single exception, all medicated wines are made by direct solution. Wine of opium is made by maceration.

CHAPTER XXV.

ELIXIRIA. ELIXIRS.

Elixirs are aromatic sweetened hydro-alcoholic vehicles, or medicated preparations. They have been designated as elegant pharmaceuticals, because of their beautiful appearance when properly made, but in American pharmacy their sole purpose is to improve the taste of medicines. Formerly the term *elixir* was applied by alchemists to powders supposedly capable of converting the baser metals into gold and silver. Later the term was also applied to a few very disagreeable tasting liquids, as Elixir Proprietatis, which is similar to compound tincture of aloes, and Elixir Salutis, similar to compound tincture of senna. What might be termed the elixir "fad" reached its height about the year 1883, when J. U. Lloyd published a most interesting work on elixirs, giving their complete history and containing formulas for two hundred and fifty of them.

The third edition of the *National Formulary* presents eighty-eight elixirs. The alcoholic strength varies from 7 per cent. to 62 per cent. by volume. The average alcoholic strength of elixirs is about that of aromatic elixir, which is 23 per cent. by volume. There are twenty-one elixirs containing less than 20 per cent., forty-three containing between 20 per cent. and 30 per cent., twenty-one between 30 per cent. and 40 per cent., and three containing more than 40 per cent. The majority of elixirs may be prepared by mixing or dissolving the medicinal substance in aromatic or adjuvant elixirs. For this reason the *Pharmacopœia* has given formulas for only three elixirs.

Elixir Adjuvans.—*Adjuvant Elixir.*—This contains 12 Cc. of fluidextract of licorice and 88 Cc. of aromatic elixir. It is especially intended for disguising the bitter taste of drugs or alkaline or neutral salts. It should not be used with acids, as they precipitate the sweet principle of licorice.

Elixir Aromaticum.—*Aromatic Elixir. Simple Elixir.* —This is a sweet hydro-alcoholic solution flavored with compound spirits of orange.

Elixir Ferri Quininæ et Strychninæ Phosphatum.—*Elixir of the Phosphates of Iron, Quinine, and Strychnine.*—Better results will be obtained in the manufacture of this elixir if the phosphoric acid be diluted with aromatic elixir before adding to the alkaloids. The ammonium acetate, formed from acetic acid and ammonium carbonate, is added to the solution of the alkaloids to prevent precipitation when the iron solution is added. This is a good formula if the directions as to neutralization, etc., be carefully followed; otherwise, it results in failure. This elixir is very sensitive to the action of light, and should be kept and dispensed in amber-colored bottles.

The methods for the manufacture of the *National Formulary* elixirs are so simple that special comment is unnecessary. A number of these elixirs have been introduced to meet the demands of physicians, without special regard to their therapeutic value.

Elixir Digestivum Compositum.—*Digestive Elixir.*—This contains pepsin, pancreatin, and diastase in an acid elixir. The first two are incompatible and should not be prescribed in the same mixture.

Elixir Pepsini Bismuthi et Strychninæ.—*Elixir Pepsin, Bismuth, and Strychnine.*—This is a decided improvement upon the old formula, as it is acid, and pepsin should be prescribed only in acid solutions. Bismuth has been said to be incompatible with pepsin, and it has been proved that pepsin rapidly becomes inactive in alcoholic solutions having the strength of ordinary elixirs. In the third edition of the *National Formulary* an attempt has been made to reduce the quantity of alcohol in all pepsin elixirs, and to preserve them by the use of glycerin instead. It is a marked improvement.

Elixir Acidi Salicylici.—*Elixir of Salicylic Acid.*—Here the potassium citrate is used to dissolve the salicylic acid, which is only sparingly soluble in aqueous menstruum.

Elixir Ammonii Valeratis.—*Elixir of Ammonium Valerate.*—This elixir develops a most disagreeable odor due to the presence of free valeric acid, caused by the loss of ammonium which occurs upon standing. Hence a few drops of ammonia water should be added before dispensing.

Elixir Gentianæ.—*Elixir of Gentian.*—In this elixir, 35 Cc. of solution of tersulphate of iron should be used to furnish sufficient ferric hydroxide to insure the complete removal of the tannin-like substance in the fluidextract of gentian.

CHAPTER XXVI.

SPIRITUS. SPIRITS.

SPIRITS are alcoholic or hydro-alcoholic solutions of volatile substances. Most of them are simple alcoholic solutions of volatile oils. One is made by chemical action, one by volatilization and solution of gas, and two by distillation. Altogether, there are twenty pharmacopœial spirits.

Spiritus Ætheris Compositus.—*Compound Spirits of Ether.*—It is frequently called Hoffman's anodyne, but it is not identical with the Hoffman's anodyne of commerce. The latter is a by-product from the distillation of ether, and contains heavy and light oils of wine.

Spiritus Ætheris Nitrosi.—*Spirits of Nitrous Ether.*—This should contain not less than 4 per cent. of ethyl nitrite. It is prepared by the action of sulphuric acid on sodium nitrite and alcohol.

Reactions:

$$\underset{\text{Sodium nitrite.}}{2NaNO_2} + \underset{\text{Sulphuric acid.}}{H_2SO_4} = \underset{\text{Sodium sulphate.}}{Na_2SO_4} + \underset{\text{Nitrous acid.}}{2HNO_2}$$

$$\underset{\text{Alcohol.}}{C_2N_5OH} + \underset{\text{Nitrous acid.}}{HNO_2} = \underset{\text{Ethyl nitrite.}}{C_2H_5NO_2} + \underset{\text{Water.}}{H_2O}$$

The ethyl nitrite is separated, and washed with ice-cold water and monohydrated sodium carbonate to remove acid. It is then shaken with potassium carbonate to remove the water, and, finally, diluted with alcohol to the required strength. It should be kept in small amber-colored vials, and in a cool dark place. Unless so kept, it soon becomes worthless.

In the method of assay the spirits are decomposed by sulphuric acid, in the presence of potassium iodide. It is represented by the following equation:

$$\underset{\text{Ethyl nitrite.}}{2C_2H_5NO_2} + \underset{\text{Sulphuric acid.}}{2H_2SO_4} + \underset{\text{Potassium iodide.}}{2KI} =$$

$$\underset{\text{Alcohol.}}{2C_2H_5OH} + \underset{\text{Nitric oxide.}}{2NO} + \underset{\text{Potassium acid sulphate.}}{2KHSO_4} + \underset{\text{Iodine.}}{I_2}$$

The nitric oxide gas is measured. For details of method, see *United States Pharmacopœia.*

Spiritus Ammoniæ.—*Spirits of Ammonia.*—This spirit should contain 10 per cent. of ammonia gas (NH_3). It is made by gently heating stronger ammonia water and collecting the gas in alcohol which has been recently distilled and kept in a glass receptacle. Ordinary alcohol is liable to contain organic impurities received from the barrels, and is darkened by the ammonia.

Spiritus Ammoniæ Aromaticus.—*Aromatic Spirits of Ammonia.*—The *Pharmacopœia* directs the use of ammonium carbonate in translucent pieces consisting of ammonium acid carbonate and carbamate. When dissolved in the presence of ammonium water, both are converted into normal ammonium carbonate. Thus:

Reaction:

$$\underset{\substack{\text{Ammonium and}\\\text{bicarbonate.}}}{NH_4HCO_3} \;.\; \underset{\substack{\text{Ammonium}\\\text{carbamate.}}}{NH_4NH_2CO_2} + \underset{\text{Ammonia.}}{NH_4HO} = \underset{\substack{\text{Ammonium}\\\text{carbonate.}}}{2(NH_4)_2CO_3.}$$

When the pharmacopœial carbonate becomes opaque, it consists principally of the bicarbonate, which is insoluble in alcohol. If this be used in the manufacture of the spirits, the ammonia water will be insufficient to convert it into the normal carbonate.

Spiritus Glycerylis Nitratis.—*Spirit of Glyceryl Trinitrate. Spirit of Nitroglycerin. Spirit of Glonoin.*—This contains 1 per cent. by weight of glyceryl trinitrate, $C_3H_5(NO_3)_3$. It should be kept in tin cans in a cool place. In case it should be spilled, it should be decomposed by pouring over it a solution of potassium hydroxide. Otherwise there is danger of an explosion when the alcohol has evaporated.

CHAPTER XXVII.

TINCTURA. TINCTURES.

TINCTURES are alcoholic or hydro-alcoholic solutions. They may contain vegetable, mineral, or animal substances, and be volatile or non-volatile. They differ from spirits, as most of them are solutions of non-volatile substances. The majority of them are made by percolation, but a number are made by maceration, and a few by direct solution. The intention has been to so adjust the alcoholic strength of the menstruum that it will dissolve all the active constituents with the least amount of inert matter. It is intended also to make as weak an alcoholic preparation as possible—an advantage when dispensing—as tinctures are less apt to cause precipitation on mixing with aqueous liquids. In a number of cases glycerin has been used to hold the dissolved constituents in solution, especially in the case of those containing astringent principles. Of such tinctures two contain ammonia and one acetic acid. Deposits in tinctures are often caused by exposure to strong light, air, and varying temperature. The deposits usually consist of inert matter, which may be rejected. Tinctures should be kept at a uniform temperature, and preferably in amber-colored bottles. The following tabulation is not intended to be used in manufacturing, but is arranged for convenient study, placing the tinctures in the order of their drug strength.

Official Tinctures Arranged According to Strength of Drugs.

Official name.	Ingredient.	Drug in 100 Cc.*	Menstruum.†				Method.
			U. S. P. alcohol.	Water.	Glycerin.	Absolute alcohol.	
Tinctura—							
Opii Camphorata	Opium. Benzoic acid Camphor Oil of Anise	0.4 0.4 0.4 0.4	48	48	4.0	46	Maceration
Lavendulæ Composita	Oil of Lavender Fl. Oil of Rosemary Saigon Cinnamon Cloves Myristica Red Saunders	0.8 0.2 2.0 0.5 1.0 1.0	75	25		70	Maceration
Gambir Composita	Gambir Saigon Cinnamon	5.0 2.5	50	50		48	Maceration
Kino	Kino	5.0	65	20	15.0	61	Heat
Moschi	Musk	5.0	50	50		48	Maceration
Cardamomi Composita	Cardamom Saigon Cinnamon Caraway Cochineal	2.5 2.5 1.2 0.5	50	50		48	Maceration
Iodi	Iodine Potassium Iodide	7.0 5.0	100			94	Solution

* The number of grams of the substance given in 100 Cc. of a preparation multiplied by 0.57 will give the number of grains in a fluidram.

† The figures represent the volume in 100 volumes of the menstruum, those under absolute alcohol are necessarily approximate, as alcohol and water contract when mixed, thus increasing the strength by volume. However, in the finished tincture this is more than counterbalanced by the moisture and extractive taken from the drug. The moisture and extractive could be determined for each drug, which in a few cases amounts to from 10 to 15 per cent. Tolu reduces the alcoholic strength from 94 per cent. in the menstruum to 80 per cent. in the tincture; but it would only be approximate, as the amount varies with different samples of the same drug.

Official name.	Ingredient.	Drug in 100 Cc.	Menstruum.				Method.
			U. S. P. alcohol.	Water.	Glycerin.	Absolute alcohol.	
Tinctura—							
Aconiti	Aconite	10.0	70	30		65	Percolation
Belladonnæ Fol.	Belladonna Leaves	10.0	50	50		48	Percolation
Cannabis Indicæ	Indian Cannabis	10.0	100			94	Percolation
Cantharidis	Cantharides	10.0	100			94	Percolation
Capsici	Capsicum	10.0	95	5		90	Percolation
Colchici Seminis	Colchicum Seed	10.0	60	40		56	Percolation
Digitalis	Digitalis	10.0	50	50		48	Percolation
Gelsemii	Gelsemium	10.0	65	35		61	Percolation
Hyoscyami	Hyoscyamus	10.0	50	50		48	Percolation
Lobeliæ	Lobelia	10.0	50	50		48	Percolation
Nucis Vomicæ	Extract of Nux Vomica, 2 Gm.	10.0	75	25		71	Solution
Opii	Opium	10.0	50	50		48	Inf. & percol.
Opii Deodorati	Opium	10.0	80	20		19	Sp. remarks
Physostigmatis	Physostigma	10.0	100			94	Percolation
Sanguinariæ	Sanguinaria	10.0	60	40	acetic acid 2.0	56	Percolation
Scillæ	Squill	10.0	75	25		70	Maceration
Stramonii	Stramonium	10.0	50	50		48	Percolation
Strophanthi	Strophanthus	10.0	65	35		61	Percolation
Vanillæ	Vanilla	10.0	65			61	Mac. and Per.
Veratri	Veratrum	10.0	100			94	Percolation
Ferri Chloridi	Ferric Chloride (Sol. 35 Cc.)	13.3	65			62	Solution
Gentianæ Composita	Gentian Bitter Orange Peel Cardamom	10.0 4.0 1.0	60	40		56	Percolation
Aloes	Aloes Licorice	10.0 20.0	50	50		48	Maceration
Aloes et Myrrhæ	Aloes Myrrh Licorice	10.0 10.0 10.0	75	25		62	Maceration
Ipecacuanhæ et Opii	Ipecac Opium	10.0 10.0				12	Special
Cinchonæ Composita	Cinchona Bitter Orange Peel Serpentaria	10.0 8.0 2.0	67.5	25	7.5	63	Percolation

Official name.	Ingredient.	Drug in 100 Cc.	Menstruum.				Method.
			U. S. P. alcohol.	Water.	Glycerin.	Absolute alcohol.	
Tinctura—							
Benzoini Composita	Benzoin Aloes Storax Balsam Tolu	10.0 2.0 8.0 4.0	100			94	Maceration
Arnicæ	Arnica	20.0	50	50		48	Maceration
Asafœtidæ	Asafetida	20.0	100			94	Maceration
Aurantii Amari	Bitter Orange Peel	20.0	60	40		56	Percolation
Benzoini	Benzoin	20.0	100			94	Maceration
Calendulæ	Calendula	20.0	100			94	Percolation
Calumbæ	Calumba	20.0	60	40		56	Percolation
Cardamomi	Cardamom	20.0	50	50		48	Percolation
Cimicifugæ	Cimicifuga	20.0	100			94	Percolation
Cinchonæ	Cinchona	20.0	67.5	25	7.5	63	Percolation
Cinnamomi	Saigon Cinnamon	20.0	67.5	25	7.5	63	Percolation
Gallæ	Nutgall	20.0	90		10.0	85	Percolation
Guaiaci	Guaiac	20.0	100			94	Maceration
Guaiaci Ammoniata	Guaiac	20.0	(Arom. Sp. Am.)			66	Maceration
Hydrastis	Hydrastis	20.0	65	35		61	Percolation
Krameriæ	Krameria	20.0	50	50		48	Percolation
Myrrhæ	Myrrh	20.0	100			94	Maceration
Pyrethri	Pyrethrum	20.0	100			94	Percolation
Quassiæ	Quassia	20.0	35	65		33	Percolation
Quillajæ	Quillaja	20.0	35	65		33	Decoction
Serpentariæ	Serpentaria	20.0	65	35		61	Percolation
Tolutana	Tolu	20.0	100			94	Maceration
Valerianæ	Valerian	20.0	75	25		70	Percolation
Valerianæ Am.	Valerian	20.0	(Arom. Sp. Am.)			66	Percolation
Zingiberis	Ginger	20.0	100			94	Percolation
Rhei	Rhubarb Cardamom	20.0 4.0	50	40	10	47	Percolation
Rhei Aromatica	Rhubarb Saigon Cinnamon Cloves Myristica	20.0 4.0 4.0 2.0	50	40	10	47	Percolation
Aurantii Dulcis	Sweet Orange Peel	50.0	100			75	Percolation
Lactucarii	Lactucarium	50.0	50	q. s.	25	37	Percolation
Lemonis	Lemon Peel	50.0	100			75	Maceration
Herbarium Recentium	Fresh Herbs	50.0	100			Var.	Maceration

Tinctura Aconiti.—*Tincture of Aconite.*—This has been reduced in strength from 35 Gm. to 10 Gm. of aconite in 100 Cc. of tincture, and should be standardized by assay to contain 0.045 Gm. of aconitine in 100 Cc. of tincture. Aconitine decomposes readily in aqueous solutions. Accordingly, when preparations of aconite are prescribed in water they should not be used after standing twenty-four hours.

Tinctura Aloes.—*Tincture of Aloes.*—It contains licorice, to disguise the disagreeable taste of the aloes.

Tinctura Auranti Dulcis.—*Tincture of Sweet Orange.*—This tincture should be made by shaving or grating the thin *outer* rind only, which contains the oil cells. When made in this manner it has a much finer flavor and odor than when made from the oil. This applies equally to the tincture of lemon.

Tinctura Belladonnæ.—*Tincture of Belladonna.*—It is made from the leaves of the plant, and should be standardized by assay to contain 0.03 Gm. of alkaloid in 100 Cc. of tincture.

Tinctura Benzoini Compositæ.—*Compound Tincture of Benzoin.*—It is similar to Friar's, Turlington's, Persian, and Swedish balsams.

Tinctura Cinchonæ.—*Tincture of Cinchona.*—This should be standardized to contain 0.75 Gm. of anhydrous ether-soluble alkaloids in 100 Cc. of tincture. The *compound tincture of cinchona* is not assayed, but should be made from assayed bark. In both cinchona tinctures glycerin is employed to prevent the deposit of oxidation products from cinchotannic acid.

Tinctura Colchici Seminis.—*Tincture of Colchicum Seed.*—This should be standardized by assay to contain 0.04 Gm. of colchicine in 100 Cc. of tincture.

Tinctura Ferri Chloridi.—*Tincture of Chloride of Iron.*—This should be prepared at least three months before using to permit the acid in the solution to convert part of the alcohol into ethers. Ferric salts in the presence of organic substances are reduced to the ferrous condition by strong light. Hence, the tincture should be kept in amber-colored bottles.

Tinctura Hydrastis.—*Tincture of Hydrastis.*—It should be standardized by assay to contain 0.4 gm. of hydrastine in 100 Cc. of tincture.

Tinctura Hyoscyami.—*Tincture of Hyoscyamus.*—It should be standardized by assay to contain 0.007 Gm. of mydriatic alkaloid in 100 Cc. of tincture.

Tinctura Iodi.—*Tincture of Iodine.*—This contains some potassium iodide which is added as a preservative and also to prevent precipitation by water.

Tinctura Ipecacuanhæ et Opii.—*Tincture of Ipecac and Opium.*—This may be considered as a liquid form of Dover's Powder, but is an improvement upon that preparation because made from the deodorized tincture. It is prepared by evaporating 100 Cc. of the deodorized tincture to 85 Cc., and adding 10 Cc. of fluidextract of ipecac; then add dilute alcohol to 100 Cc.

Tinctura Lactucarii.—*Tincture of Lactucarium.*—This is used principally in the manufacture of the syrup. It is, therefore, important that it should mix readily with water or glycerin without precipitation. This is accomplished by first extracting with benzin. This removes the inert caoutchouc-like substance without dissolving the active constituents. The sand is used to break up the mass and to increase the surface exposed to the action of the solvent.

Tinctura Lemonis.—*Tincture of Lemon.*—This tincture is used in place of the former spirit of lemon made from the oil. (See Tincture of Orange.)

Tinctura Nucis Vomicæ.—*Tincture of Nux Vomica.*—This tincture is made from the extract and standardized by assay to contain 0.1 Gm. of strychnine in 100 Cc. of tincture. This is practically equivalent to 10 Gm. of standard drug.

Tinctura Opii.—*Tincture of Opium. Laudanum.*—Laudanum is prepared by macerating opium with hot water, and adding sufficient alcohol to make the menstruum equivalent to dilute alcohol. It would be a decided improvement to exhaust 100 Gm. of opium with water, and evaporate to 500 Cc. Then add alcohol to make 1000 Cc. and allow to stand twenty-four hours, and filter. The tincture should be standardized by assay to contain between 1.2 and 1.25 Gm. of morphine in 100 Cc. of tincture.

Tinctura Opii Deodorati.—*Deodorized Tincture of Opium.*—This tincture is prepared by extracting opium with water, concentrating, and removing the odor and the caoutchouc-like substance by washing with purified benzin. The last of the benzin is removed by evaporation, the residue dissolved in water, and the alcohol added as a preservative. It should be standardized by assay to contain between 1.2 and 1.25 Gm. of morphine in 100 Cc. of tincture.

Tinctura Physostigmatis.—*Tincture of Calabar Bean.*—This should be standardized by assay to contain 0.014 Gm. of ether-soluble alkaloid in 100 Cc. of tincture.

Tinctura Sanguinariæ.—*Tincture of Blood Root.*—This tincture contains acetic acid, put in to render the alkaloid more soluble and to preserve the tincture.

Tinctura Stramonii.—*Tincture of Stramonium.*—This is made from the leaves, and is standardized to contain 0.025 Gm. of mydriatic alkaloids in 100 Cc. of tincture.

Tinctura Strophanthi.—*Tincture of Strophanthus.*—This deposits fatty matter which should be rejected. According to Scoville and Lowe, this can be completely removed by placing the tincture in a freezing mixture for two hours and filtering while cold.

Tinctura Vanillæ.—*Tincture of Vanilla.*—The bean is partially extracted to remove the bulk of the soft extractive. The dregs are then triturated with sugar, to aid in comminution. Further extraction is made by percolation.

CHAPTER XXVIII.

FLUIDEXTRACTA. FLUIDEXTRACTS.

Fluidextracts are alcoholic, hydro-alcoholic, or acetic preparations of such strength that each cubic centimeter represents one gram of the drug. They are, therefore, concentrated preparations, uniform in strength and containing sufficient alcohol to make them permanent. All fluidextracts are made by percolation, but the methods of manipulation may differ. The *Pharmacopœia* furnishes a method for each fluidextract, but in its introduction permission is given to use repercolation. Later, in the "Additional Notices, May 1, 1907," permission is given to use other methods so long as the finished product is identical with that made by the official method. This is only just, since, when manufacturing on a large scale, it is frequently necessary to modify the details of a method. The general principles of the official method may be briefly stated as follows:

Official Method.—The drug of the required degree of fineness is moistened with a given quantity of menstruum and packed in a percolator. The menstruum is then poured on. When the percolate begins to drop from the percolator the lower orifice is closed and the drug macerated for a given time. Percolation is then allowed to proceed slowly until the drug is exhausted.

The first 700 Cc. to 900 Cc. of the percolate (for each 1000 Gm. of drug) is reserved, and the remainder evaporated to a soft extract, at a temperature not exceeding 50° C. This extract is then dissolved in the reserve portion, sufficient menstruum being added to make 1000 Cc. The active constituents of organic drugs are injured to a greater or less degree by the continued application of heat. For this reason the strong first percolate is reserved, and only the weaker percolate heated, which contains not more than from 10 to 30 per cent. of the extractive matter. The reason for evaporating to a soft extract instead of to the required volume is, that the percolate contains some water which formed part of the menstruum, or was taken from the drug or atmosphere. During distillation or evaporation the alcohol will pass off first. Consequently, the last portion consists principally of water, which added to the reserve portion would change the alcoholic strength and cause precipitation. Some recommend using the reserve portion as finished fluidextract, discarding the marc without exhausting it. It is thereby assumed that from 70 per cent. to 80 per cent. of the active constituents of the drug is dissolved in the first 70 Cc. or 80 Cc. of the percolate from each 100 Gm. of drug. This would doubtless be a saving of time and expense, and dispense with the use of heat, but would require greater care and skill to insure a uniform strength.

Repercolation.—This is the name given by Dr. Squibb to that method of manufacturing fluidextracts in which the percolate evaporated by the official method is reserved for the percolation of fresh portions of the drug. By this method 1000 Gm. of the drug are moistened and percolated, as in the official method, until 750 Cc. of percolate are obtained. This is reserved as finished fluidextract. Percolation is then continued until 4000 Cc. of percolate are obtained. These are received in four separate portions of 1000 Cc. each, marked Nos. 1, 2, 3, and 4, in the order in which received. It will be recalled that in the preceding operation there were no reserves, and the official menstruum must necessarily be used. For this reason only 750 Cc. of the first percolate were considered as finished fluidextract. When it is desired to make more of the same extract, 1000 gm. of the drug must be moistened with a sufficient quantity of reserve percolate No. 1. It is then packed in the percolator and the remainder of the No. 1 poured on. When this disappears beneath the surface it is followed by No. 2, then by No. 3, and finally by No. 4. As each of these reserves contains a gradually decreasing amount of extractive, they must not be allowed to mix before passing into the drug. The first 1000 Cc. of percolate is finished fluidextract. The second 1000 Cc. forms reserve No. 1, and the third 1000 Cc. forms reserve No. 2, etc. It is evident that 4000 Cc. of reserves will be insufficient to furnish 5000 Cc. of percolate, and supply that held by the marc. Therefore, when the reserves are used up fresh menstruum must be added. This should always be the official menstruum, and in case the official menstruum is not the same throughout, only the *initial menstruum* should be used. For example, the initial menstruum for

1000 Gm. of cinchona is: Glycerin, 100 Cc.; water, 100 Cc.; and alcohol, 800 Cc. The above operation may be repeated as often as more fluidextract is required. This method furnishes a fine product without the aid of heat or unnecessary waste of material. The objection usually raised is the expense of keeping the reserves, but this has been greatly exaggerated, as a very simple calculation will prove.

Fractional Percolation.—This is the name applied by Prof. C. Lewis Diehl to a method for the manufacture of fluidextracts in which 1000 Gm. of drug are divided into three portions of 500 Gm., 325 Gm., and 175 Gm. each. The first 500 Gm. are moistened and percolated in the usual manner, until 1675 Cc. of percolate are obtained. The first 175 Cc. of percolate are put aside as reserve percolate. The next portion is used to moisten the 325 Gm. of drug. The remainder of the percolate is used as menstruum for the second portion of drug until 975 Cc. of percolate are obtained. Of this, the first 375 Cc. of percolate are reserved and the remainder, in the order in which received, is used to moisten and percolate the third portion of drug until 500 Cc. of percolate are obtained. These 500 Cc. are mixed with the two portions previously reserved, making 1000 Cc. of finished fluidextract.

Deposits in Fluidextracts.—Deposits in fluidextracts are usually caused by light, air, changes in temperature, and the change which occurs in the alcoholic strength of the menstruum as percolation proceeds. The first portion contains a larger per cent. of moisture and soluble constituents, which, when mixed with the stronger menstruum that follows, causes precipitation. The deposit consists chiefly of inert matter, of which the greater part usually forms during the first few weeks or months. The fluidextract should be decanted or filtered.

Since fluidextracts are uniform in strength, each cubic centimeter representing one gram of drug, the most important point remaining is the consideration of the character and strength of the menstruum used. Accordingly they will be studied in the order of their alcoholic strengths excepting those which contain glycerin. These will be considered in a separate class. The parts of menstruum given are by volume.

Pharmacopœial Fluidextracts Arranged According to Their Alcoholic Strength, Together with the Percentage of Absolute Alcohol in Their Menstrua.

Alcohol. *Absolute Alcohol,* 94.9 per cent.

Fluidextractum:

Aromaticum, Aromatic Powder.
Capsici, Capsicum.
Cannabis Indicæ, Indian Hemp.
Cimicifugæ, Black Cohosh.
Cubebæ, Cubebs.
Gelsemii, Yellow Jasmine.
Sabinæ, Sabin.
Veratri, Veratrum.
Zingiberis, Ginger.

Alcohol, 4. **Water,** 1. *Absolute Alcohol,* 75.9 per cent.

Fluidextractum:

Belladonnæ Radicis, Belladonna Root.
Eriodictyi, Yerba Santa.
Euonymi, Wahoo.
Mezerei, Mezereum.
Podophylli, Mandrake.
Rhei, Rhubarb.
Scopolæ, Scopola.
Serpentariæ, Virginia Snake Root.
Staphisagriæ, Stavesacre.

Alcohol, 3. **Water,** 1. *Absolute Alcohol,* 71 per cent.

Fluidextractum:

Aconiti, Aconite.
Buchu, Buchu.
Calami, Calamus.
Eucalypti, Eucalyptus.
Grindeliæ, Grindelia.
Ipecacuanhæ, Ipecac.
Leptandræ, Culver's Root.
Matico, Matico.
Nucis Vomicæ, Nux Vomica.
Sumbul, Musk Root.
Valerianæ, Valerian.
Xanthoxyli, Prickly Ash.

Alcohol, 7. **Water,** 3. *Absolute Alcohol,* 66 per cent.

Fluidextractum:

Calumbæ, Calumba.

Alcohol, 2. **Water,** 1. *Absolute Alcohol,* 63 per cent.

Fluidextractum:

Aurantii Amaræ, Bitter Orange.
Colchici Seminis, Colchicum Seed.
Hyoscyami, Henbane
Senegæ, Senega, Snake Root.
Stramonii, Stramonium.
Viburni Opuli, Cramp-bark
Viburni Prunifolii, Black Haw.

Alcohol, 6.5. **Water,** 3.5. *Absolute Alcohol,* 61.7 per cent.

Fluidextractum:

Convallariæ, Lily-of-the-Valley.

Alcohol, 1. **Water,** 1. *Absolute Alcohol,* 48.9 per cent.
(Diluted Alcohol).

Fluidextractum:

Berberidis, Oregon Snake Root.
Chimaphila, Pipsissewa.
Chiratæ, Chirata.
Cocæ, Coca.
Cornii, Poison Hemlock.
Cypripedii, Lady's Slipper.
Digitalis, Foxglove.
Eupatorii, Boneset or Thoroughwort.
Gentianæ, Gentian.
Guaranæ, Guarana.
Krameriæ, Rhatany
Lappæ, Burdock Root.
Phytolaccæ, Poke Root.
Pilocarpi, Jaborandi.
Quillajæ, Soap Bark.
Rubi, Rubris, Blackberry.
Scutellariæ, Skull Cap.
Sennæ, Senna.
Spigeliæ, Pinkroot.
Stillingiæ, Queen's Root.
Taraxaci, Dandelion.

Alcohol, 2. **Water,** 3. *Absolute Alcohol,* 38 per cent.

Fluidextractum:

Rhamni Purshianæ, Cascara Sagrada.

Alcohol, 5. **Water,** 8. *Absolute Alcohol,* 36.44 per cent.

Fluidextractum:

Frangulæ, Buckthorn.

Alcohol, 1. **Water,** 2. *Absolute Alcohol,* 31.5 per cent.

Fluidextractum:

Quassiæ, Quassia. Sarsaparillæ, Sarsaparilla.

Alcohol, 1. **Water,** 3. *Absolute Alcohol,* 23.7 per cent.

Fluidextractum:

Tritici, Couch Grass.

FLUIDEXTRACTS CONTAINING GLYCERIN.

Alcohol, 8. **Water,** 1. **Glycerin,** 1. *Absolute Alcohol,* 75.9 per cent.

Fluidextractum:

Cinchonæ, Cinchona.

Alcohol, 6. **Water,** 3. **Glycerin,** 1. *Absolute Alcohol,* 57 per cent.

Fluidextractum:

Apocyni, Canadian Hemp. Hydrastis, Golden Seal.
Geranii, Cranesbill. Pareiræ, Pareira.

Alcohol, 5. **Water,** 2.5. **Glycerin,** 2.5. *Absolute Alcohol,* 48.9 per cent.

Fluidextractum:

Rhamni Purshianæ Aromaticum, Aromatic Cascara Sagrada.

Diluted Alcohol, 9. **Glycerin,** 1. *Absolute Alcohol,* 44 per cent.

Fluidextractum:

Granati, Pomegranate.	Rhois Glabræ, Rhus Glabra.
Quercus, Oak Bark.	Rosæ, Red Rose.

Sarsaparillæ Compositum, Compound Sarsaparilla.

Alcohol, 3. **Water,** 6. **Glycerin,** 1. *Absolute Alcohol,* 28.5 per cent.

Fluidextractum:

Hamamelidis Foliorum, Witch-hazel.

Alcohol, 2. **Water,** 6. **Glycerin,** 2. *Absolute Alcohol,* 18.8 per cent.

Fluidextractum:

Pruni Virginianæ, Fluidextract of Wild Cherry.

Alcohol, 2. **Water,** 5. **Glycerin,** 3. *Absolute Alcohol,* 18.8 per cent.

Fluidextractum:

Uvæ Ursi, Bearberry.

Alcohol, 2. **Water,** 5. **Glycerin,** 2.5. **Ammonia Water,** 0.5. *Absolute Alcohol,* 18 per cent.

Fluidextractum:

Glycyrrhizæ, Licorice.

Acetic Acid, 10 **per cent.**

Fluidextractum:

Lobeliæ,	Lobelia.
Sanguinariæ,	Blood Root.
Scillæ,	Squill.

EXPLANATORY NOTES.

Fluidextractum Belladonnæ Radicis.—This is assayed and standardized to contain 0.4 Gm. of mydriatic alkaloids in 100 Cc.

Fluidextractum Scopoliæ.—It is assayed and standardized to contain 0.5 Gm. of mydriatic alkaloids in 100 Cc.

Fluidextractum Aconiti.—It is standardized by volumetric assay to contain 0.4 Gm. of aconitine in 100 Cc.

Fluidextractum Ipecacuanhæ.—This is standardized by volumetric assay to contain 1.5 Gm. of alkaloid in 100 Cc.

Fluidextractum Nucis Vomicæ.—This is standardized by volumetric assay to contain 1 Gm. of strychnine in 100 Cc. of fluidextract. Five per cent. of acetic acid is added to the menstruum to aid the solution of the alkaloid.

Fluidextractum Colchici Seminis.—This is standardized by gravimetric assay to contain 0.4 Gm. of colchicine in 100 Cc.

Fluidextractum Hyoscyami.—It is standardized by volumetric assay to contain 0.075 Gm. of alkaloids in 100 Cc.

Fluidextractum Senegæ.—The menstruum contains 3 per cent of solution of potassium hydroxide to prevent the gelatinization of pectinous compounds.

Fluidextractum Stramonii.—This is standardized to contain 0.25 Gm. of mydriatic alkaloids in 100 Cc.

Fluidextractum Cocæ.—It is standardized by volumetric assay to contain 0.5 Gm. of ether-soluble alkaloids in 100 Cc.

Fluidextractum Cornii.—Two per cent. of acetic acid is added to unite with the volatile alkaloid and form a more stable compound. It is standardized by gravimetric assay to contain 0.45 Gm. of coniine in 100 Cc.

Fluidextractum Guaranæ.—It is standardized by gravimetric assay to contain 3.5 Gm. of alkaloid in 100 Cc.

Fluidextractum Pilocarpi.—It is standardized by volumetric assay to contain 0.4 Gm. of alkaloid in 100 Cc.

Fluidextractum Sennæ.—The drug is first exhausted with alcohol to remove the resins. These are discarded, as they produce a griping effect.

Fluidextractum Taraxaci.—The menstruum contains 5 per cent. of potassium hydroxide to neutralize the acids present in the drug, and to prevent precipitation.

Fluidextractum Tritici.—The drug is exhausted with boiling water, and evaporated. The alcohol is then added, and the whole filtered to exclude albuminous matter.

Fluidextractum Cinchonæ.—This is standardized by gravimetric assay to contain 4 Gm. of anhydrous, ether-soluble alkaloids.

Fluidextractum Hydrastis.—It is standardized by gravimetric assay to contain 2 Gm. of hydrastine in 100 Cc. of extract.

Fluidextractum Rhamni Purshianæ Aromaticum.—The cascara is macerated with magnesium oxide and water for twelve hours, and then dried to render the bitter principle insoluble.

Fluidextractum Sarsaparillæ Compositum.—This contains sarsaparilla, licorice, sassafras, and mezereum.

Fluidextractum Pruni Virginianæ.—The alcohol is not strong enough to interfere with the action of the enzyme. (See Syrups, p. 215.) Percolation is continued to 1000 Cc. without evaporation, as heat would drive off the hydrocyanic formed.

Fluidextractum Glycyrrhizæ.—The licorice is exhausted with boiling water, evaporated, and part of the inert albuminous matter precipitated with alcohol. The alcohol is distilled and finally adjusted to the strength of the above solvent. The ammonia is added to form a more soluble and a sweeter compound of glycyrrhizic acid.

The *National Formulary* gives directions for the manufacture of thirty-eight fluidextracts, most of which are less frequently used than those of the *Pharmacopœia.* The bitterless fluidextract of cascara sagrada differs from the aromatic fluidextract of the *Pharmacopœia* in the use of lime instead of magnesium oxide to render the bitter principle insoluble. Further, the oils of coriander and anise are used in the place of compound spirits of orange and licorice.

CHAPTER XXIX.

EXTRACTA. EXTRACTS.

Extracts are obtained by evaporating a solution of the medicinal constituents of drugs to dryness, or to a pilular consistency. The method of obtaining the solution is practically the same as that used in the manufacture of extracts, infusions, and decoctions. They are sometimes designated as alcoholic, hydro-alcoholic, aqueous, or acetic, according to the solvent used. The evaporation should be conducted with great care, as heat is prone to decompose organic matter. For many extracts the *Pharmacopœia* directs that the temperature shall not exceed 50° C. The flat-bottomed evaporating dish or a dinner plate will be found useful in the manufacture of extracts. Evaporation will be hastened by frequent stirring, especially when the liquid is becoming thick. The active constituents of a drug generally form but a small percentage of its bulk, and when extracted are associated with a large quantity of inert extractive. Therefore, the menstruum employed should be one capable of extracting the active constituents together with the least amount of inert matter. In all cases the standard menstruum should be used. *Apothem* is a substance formed when the aqueous solution of a drug is subjected to heat for some time. If the clear solution of a drug, like opium, be evaporated to dryness, a large part of it becomes insoluble. If this in turn be removed by filtration, and the clear filtrate be again evaporated to dryness, an additional quantity is formed. This may be repeated until the extractive matter is nearly all removed. However, when precipitation occurs, or insoluble matter separates from a solution, it invariably holds a small quantity of the active constituent. Apothem is practically insoluble in cold water, sparingly soluble in boiling water, partially soluble in alcohol, and readily soluble in alkalies.

Variation in strength is greater in extracts than in any other class of preparations. This is due to variation in the amount of extractive in the drug, and also in the degree of concentration. The latter may be in part due to the interpretation given to the pharmacopœial directions to evaporate to a pilular consistency. To meet this requirement, the extract should permit rolling into pill form, and yet retain its shape. Changes in temperature render it difficult to obtain a product always capable of conforming to this requirement. Those on the market vary from dry to a semifluid condition.

Extracts should be carefully preserved in *well-closed retainers,* as they frequently lose or absorb moisture, which is an additional source of variation. Glycerin is added to a few extracts to preserve them in a moist condition. Wherever practicable they are made in powdered form, which is a decided advantage in dispensing. The present *Pharmacopœia* endeavors to adjust the strength of more than one-half of the official extracts, either by assay or by making the finished product bear a definite relation to the drug. In the latter case the extract is evaporated to dryness, and powdered licorice is added to bring it to the desired weight. Licorice is better than sugar of milk to keep the extract in a pulverulent condition in a warm or damp atmosphere.

The following tabulation will be found convenient for study and comparison.

TABLE OF EXTRACTS.

Official and common name.	Menstruum.	Maximum temperature used.	Physical condition.	Yield.	Alkaloidal strength.
Extractum:					
Aloes	Boiling Water	100	Dry	50.0	
Belladonnæ Foliorum, Belladonna Leaves	Alcohol, 2 vols. Water, 1 vol.	50	Pilular		1.4
Cannabis Indicæ, Indian Hemp	Alcohol	100	Pilular	14.0	
Cimicifugæ, Black Cohosh	Fluidextract (Alcohol)	70	Dry	25.0	
Colchici Cormi, Colchicum Corm	Acetic Acid, 35 Water, 150	80	Pilular		1.4
Colocynthidis, Colocynth	Dil. Alcohol	100	Dry	40.0	
Colocynthidis Comp., Comp. Extr. Colocynth	See notes	120	Dry		
Digitalis, Foxglove	Fluidextract: dil. alco.	50	Pilular	25.0	
Ergotæ, Ergot	Alcohol, 10 Water, 4	50	Soft	12.5	
Euonymi, Wahoo	Fluidextract Alcohol, 8 Water, 2	70	Dry	25.0	
Gentianæ, Gentian	Water	100	Pilular	30.0	
Glycyrrhizæ, Licorice	. . . .	. .	Rolls		
Glycyrrhizæ, Purum	Ammoniated Water	100	Pilular	25.0	
Hematoxyli, Logwood	Water,	100	Dry	8.0	
Hyoscyami, Henbane	Fluidextract Alcohol, 2 Water, 1	50	Pilular		0.3
Krameriæ, Rhatany	Water	70	Dry	8.0	
Leptandriæ, Culver's Root	Fluidextract Alcohol, 3 Water, 1	70	Dry	25.0	

TABLE OF EXTRACTS.

Official and common name.	Menstruum.	Maximum temperature used.	Physical condition.	Yield.	Alkaloidal strength.
Malti, Malt	Water	55	Thick honey	60.0	
Nucis Vomicæ, Nux Vomica	Acetic Acid, 5 Water, 13	100	Dry		5.0
Opii, Opium	Water	100	Dry		20.0
Physostigmatis, Calabar Bean	Alcohol	50	Dry		2.0
Quassiæ, Quassia	Water	100	Dry	10.0	
Rhamni Purshianæ, Cascara Sagrada	Alcohol, 1 Water, 7	70	Dry	25.0	
Rhei, Rhubarb	Fluidextract Alcohol, 4 Water, 1	50	Pilular	30.0	
Scopolæ, Scopola	Fluidextract Alcohol, 4 Water, 1	50	Pilular		2.0
Stramonii, Thornapple	Fluidextract Alcohol, 2 Water, 1	50	Pilular		1.0
Sumbul, Musk root	Fluidextract Alcohol, 3 Water, 1	70	Pilular		
Taraxaci, Dandelion	Alcohol, 1 Water, 7	100	Pilular	14.0	

EXPLANATORY NOTES.

Extractum Colocynthidis Compositum.—This contains extract of colocynth, 16 Gm.; purified aloes, 50 Gm; cardamom, 6 Gm.; resin scammony, 14 Gm., and soap, 14 Gm. The *Pharmacopœia* directs that the aloes be heated on a water bath until melted, before adding the other ingredients. Purified aloes will not melt over a water bath. A better method is to mix all the ingredients except the cardamom, add 10 Cc. of alcohol, and heat at a temperature not exceeding 120°, until a homogeneous mass is secured. Then incorporate the cardamom.

Extractum Ergotæ.—In the manufacture of this extract the percolate is concentrated and mixed with water and hydrochloric acid to precipitate inert matter. Upon filtering, the acid is neutralized with sodium carbonate. The extract should be completely soluble in water.

Extractum Glycyrrhizæ Purum.—The licorice is extracted with water containing ammonia. The latter is added to form the soluble, sweet ammoniated glycyrrhizin. The pure extract is completely soluble, while the commercial extract frequently contains 40 per cent. of insoluble matter.

Extractum Nucis Vomicæ.—This is prepared by extracting the drug with acetic acid, which forms the soluble acetate of strychnine, but does not dissolve the oil. The percolate is concentrated and mixed with three and one-third times its volume of alcohol to precipitate the albuminous matter. The solution is then evaporated and the residue standardized to contain 5 per cent. of strychnine.

Extractum Opii.—This is an aqueous extract, standardized to contain 20 per cent. of morphine.

The *National Formulary* furnishes directions for the manufacture of two extracts, viz., Extractum Ferri Pomatum, or ferrated extract of apples, and Extractum Glycyrrhizæ Depuratum, or the purified extract of licorice. The latter is only an aqueous extract of commercial stick licorice, and should not be confused with the pharmacopœial pure extract which is prepared from the root.

Inspissated juices are used to some extent, but are not at present recognized by the *United States Pharmacopœia.* They are prepared by bruising the fresh plants and expressing the juice, gradually heating to 55° C., and straining. This separates the chlorophyl. The filtrate is first heated to 95° C. and filtered, thereby coagulating and removing the albumin. Afterward evaporate to a soft extract. By returning the chlorophyl after the removal of the albumin, the extract receives a green color, but is reduced in strength.

CHAPTER XXX.

OLEORESINS AND RESINS.

OLEORESINÆ. OLEORESINS.

THE oleoresins of the *Pharmacopœia* should not be confused with such natural oleoresins as copaiba, turpentine, etc., which are natural exudations and consist of resins and volatile oils. Oleoresins are oily liquids principally composed of resins with fixed or volatile oils, and small quantities of other constituents soluble in the menstruum used. They are more closely related to extracts, and have been called ethereal extracts, because formerly made by percolating the drug with ether and afterward removing by distillation or evaporation. At present they are made in the same manner, with the use of acetone as a menstruum for all except cubebs, which is extracted with alcohol. Since acetone is a volatile and inflammable liquid, care should be exercised to prevent evaporation and fire. There are six official oleoresins.

Oleoresina Aspidii.—*Oleoresin of Male Fern.*—The root yields about 15 per cent. As aspidium deteriorates rapidly, only fresh roots having a green color should be used. The oleoresin is a greenish black, oily liquid, which usually deposits a granular crystalline substance consisting principally of *felicic acid,* which should be mixed thoroughly with the liquid before using.

Oleoresina Capsici.—*Oleoresin of Red Pepper.*—The yield is from 5 to 8 per cent. It is a light brownish red liquid which frequently deposits fatty matter, which should be rejected.

Oleoresina Cubebæ.—*Oleoresin of Cubebs.*—The yield is about 20 per cent. It is of a brownish green color, and upon standing deposits a waxy, crystalline mass largely consisting of cubebin. Only the liquid portion should be used.

Oleoresina Lupulini.—*Oleoresin of Lupulin.*—The yield is about 60 per cent., and is a reddish brown, soft extract.

Oleoresina Piperis.—*Oleoresin of Black Pepper.*—The yield is about 6 per cent. This is a thick, black liquid, depositing crystals of piperin. These crystals should be removed by straining, and only the liquid portion used.

Oleoresina Zingiberis.—*Oleoresin of Ginger.*—The yield is about 5 to 8 per cent., and is a light reddish liquid.

RESINÆ. RESINS.

The official resins are either in solid or powdered form, and are soluble in alcohol, but insoluble in water. All except rosin are prepared by making a strong alcoholic tincture and pouring it slowly into acidulated water, which precipitates the resin comparatively free from other inert matter. The precipitate is collected on a strainer, washed, and dried.

Resina.—*Rosin.*—This is a by-product left from the distillation of oil of turpentine.

Resina Jalapæ.—*Resin of Jalap.*—The yield is from 6 to 12 per cent., and occurs in yellow or brownish masses or fragments. It is very apt to be impure, hence should be tested according to methods furnished in the *United States Pharmacopœia.*

Resina Podophylli.—*Resin of Podophyllin, Mandrake or May Apple.*—This yield is 4 per cent., and occurs in grayish white or greenish yellow amorphous powder.

Resina Scammonii.—*Resin of Scammony.*—It is prepared from the gum-resin scammony, and occurs in yellowish brown or brownish yellow fragments or masses.

Balsams.—Balsams are closely related to resins. They contain resins, volatile oil, and benzoic or cinnamic acid, or both. The *Pharmacopœia* recognizes two, viz., Balsamum Peruvianum and Balsamum Tolutanum. Both of these balsams contain cinnamic and benzoic acids. *Benzoin* is a balsamic resin containing benzoic acid.

CHAPTER XXXI.

COLLODIA. COLLODIONS.

The *Pharmacopœia* furnishes formulas for the manufacture of four collodions, two of which are used as vehicles for medication. Collodion is a solution of pyroxylin or soluble guncotton in a mixture of alcohol, one volume, and ether, three volumes. Pyroxylin is insoluble in either of the above solvents when used alone, but dissolves readily in the mixture, after allowing it to remain for fifteen minutes in the ether before adding the alcohol. It is also soluble in acetone, which, with the addition of a little camphor, has been recommended as a solvent for the official collodion. Collodion leaves a thin, waterproof membrane when painted over a surface and the solvent allowed to evaporate. The official collodion should be used when a contractile membrane is desired. If a flexible membrane be desired, the following should be employed.

Collodium Flexile.—*Flexible Collodion.*—This is prepared by adding Canada turpentine and castor oil to collodion.

The medicinal collodions are prepared by dissolving the medicinal substance *directly* in one of the above vehicles, or by adding the substance previously dissolved in alcohol, ether, or chloroform. Pharmacopœial medicinal collodions are:

Collodium Cantharidatum.—*Cantharidal Collodion.*—This may be considered as 60 per cent. strong, since 100 Gm. contain the cantharidin from 60 Gm. of cantharides. It is prepared by extracting with chloroform, evaporating and dissolving the residue in flexible collodion.

Collodium Stypticum.—*Styptic Collodion.*—This contains 20 Gm. of tannic acid in 100 Cc. of collodion.

The *National Formulary* furnishes directions for the preparation of four collodions, viz., Collodium Iodatum, 5 per cent.; Collodium Iodoformatum, 5 per cent.; Collodium Tiglii, 10 per cent.; Collodium Salicylatum Compositum. Corn collodion contains 11 per cent. salicylic acid, and 2 per cent. extract of cannabis indica. Dr. E. H. Squibb recommends the use of 10 per cent. of fluidextract of cannabis indica instead of the extract, and also the use of the contractile collodion in place of the flexible collodion.

CHAPTER XXXII.

GLYCERITA. GLYCERITES.

WITH a single exception, the glycerites of the *Pharmacopœia* are solutions of medicinal substances in glycerin. One of them is a plastic mass. They are permanent preparations miscible with water and alcohol.

Glyceritum Acidi Tannici.—*Glycerite of Tannic Acid.*—This forms a convenient solution for prescription purposes. Avoid contact with metallic vessels.

Glyceritum Amyli.—*Glycerite of Starch.*—This contains about 20 per cent. of starch in the form of a thick jelly. The powdered starch should be uniformly mixed with the water and added to the glycerin previously heated to 140° C. This temperature is necessary to burst the starch cells and render them soluble. It is maintained until a translucent jelly is formed, stirring constantly during the process. A sand or air bath should be used, as direct heat is liable to scorch the starch.

Glyceritum Boroglycerini.—*Glycerite of Boroglycerin.*—This contains 50 per cent. of glyceryl borate prepared by heating thirty-one parts of boric acid with forty-six parts of glycerin, until the water is drawn off and the mixture is reduced to fifty parts. The reaction is as follows:

$$\underset{\text{Glycerin.}}{C_3H_5(OH)_3} + \underset{\text{Boric acid.}}{H_3BO_3} = \underset{\text{Glyceryl borate.}}{C_3H_5BO_3} + \underset{\text{Water.}}{3H_2O}.$$

Glyceritum Ferri, Quininæ et Strychninæ Phosphatum.—*Glycerite of the Phosphates of Iron, Quinine, and Strychnine.*—100 Cc. of the glycerite contains 8 Gm. of soluble ferric phosphate, 10.4 Gm. of quinine, and 80 mg. of strychnine dissolved in 20 Cc. of phosphoric acid. This glycerite is used for the extemporaneous manufacture of the syrup.

Glyceritum Hydrastis.—*Glycerite of Hydrastis.*—This is of the same strength as the fluidextract. It is prepared by exhausting the drug with alcohol, evaporating the alcohol and pouring the thick residue into cold water, which precipitates the greater part of the berberine and inert matter. Allow it to stand twenty-four hours and filter. Add the required amount of water and glycerin.

Glyceritum Phenolis.—*Glycerite of Phenol. Glycerite of Carbolic Acid.*—It contains 20 per cent. by volume of liquefied phenol, equivalent to about 17 Gm. of absolute or 18 Gm. of U. S. P. phenol in each 100 Cc.

In the *National Formulary* five glycerites are considered, of which but two need here be mentioned.

Glyceritum Bismuthi.—*Glycerite of Bismuth.*—This is prepared by dissolving bismuth subnitrate in nitric acid.

Reaction :[1]

$Bi(OH)_2NO_3$	+	$2HNO_3$	=	$Bi(NO_3)_3$	+	$2H_2O$.
Bismuthi subnitrate.		Nitric acid.		Bismuthi trinitrate.		Water.

Tartaric acid is added to the solution, and then sodium bicarbonate, when the insoluble bismuth tartrate is precipitated.

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[1] These reactions are only approximate, as bismuth also forms $BiO(NO_3)$ in water.

Reaction :

$$\underset{\text{Bismuth nitrate.}}{2Bi(NO_3)_3} + \underset{\text{Tartaric acid.}}{3H_2C_4H_4O_6} + \underset{\text{Sodium bicarbonate.}}{6NaHCO_3} = \underset{\text{Bismuth tartrate.}}{Bi_2(C_4H_4O_3)_3} +$$

$$\underset{\substack{\text{Sodium}\\\text{nitrate.}}}{6NaNO_3} + \underset{\substack{\text{Carbon}\\\text{dioxide.}}}{6CO_2} + \underset{\text{Water.}}{6H_2O.}$$

The precipitate, after washing, is dissolved in a solution of sodium tartrate formed from tartaric acid and sodium bicarbonate.

Reaction:

$$\underset{\text{Tartaric acid.}}{H_2C_4H_4O_6} + \underset{\substack{\text{Sodium}\\\text{bicarbonate.}}}{2NaHCO_3} = \underset{\text{Sodium tartrate.}}{Na_2C_4H_4O_6} + \underset{\substack{\text{Carbon}\\\text{dioxide.}}}{2CO_2} + \underset{\text{Water.}}{2H_2O}$$

The product is doubtless a double tartrate.

Glycerite of bismuth is used in the preparation of elixir of bismuth, and also in the solution of bismuth.

Glyceritum Guaiaci.—*Glycerite of Guaiac.*—Here the solution of potassium hydroxide unites with the resin to form a compound that will be soluble in water and glycerin. The remaining glycerites do not require special comment.

CHAPTER XXXIII.

LINIMENTS AND OLEATES.

LINIMENTA. LINIMENTS.

Liniments are fluid or semifluid preparations to be applied externally and followed by friction. The medicinal substance is either in solution, or is mixed with a saponaceous, alcoholic, hydro-alcoholic, or oily vehicle. There are eight pharmacopœial liniments, a number of which are simple mixtures.

Linimentum Ammoniæ.—*Ammonia Liniment. Volatile Liniment.*—The cotton-seed oil is not easily saponified by the ammonia, and would readily separate on standing; but the ammonia easily unites with the oleic acid to form a soap, which emulsifies the oil on shaking. Alcohol aids both saponification and absorption, and also prevents saponaceous liniments from thickening.

In the manufacture of *soap liniment* only the purest castile soap should be used. The commercial powdered soap is largely prepared from animal fats, which contain a considerable quantity of palmitates or stearates. This forms a soap only sparingly soluble in the hydro-alcoholic solvent used. Hence, it gradually deposits when made into a liniment.

There are eight *National Formulary* liniments, of which two only are here mentioned.

Linimentum Ammonii Iodidi.—*Liniment of the Iodide of Ammonia.*—The ammonia iodide is prepared by adding ammonia water to an alcoholic solution of iodine. When iodine and ammonia react, there is always a probability of the formation of the iodide of nitrogen ($N_2H_3I_3$). This separates as a brown deposit, which, when dry, is very explosive. For this reason such residue should be decomposed while it is moist, by the addition of nitric acid.

Linimentum Terebinthinæ.—*Liniment of Turpentine. St. John Long's Liniment. Stokes' Liniment.*—This is practically an egg emulsion of turpentine, containing acetic acid.

OLEATA. OLEATES.

Oleates are chemical combinations of oleic acid with an organic or inorganic base. Like liniments, they are intended for external application. *Normal oleates* are those in which there is just sufficient acid to unite with the base. In consistency they vary from soft ointment-like substances to dry solids. Some of the official oleates are solutions of normal oleates in oleic acid, or in oils. The strengths of oleates are usually expressed in percentage, which, in the case of inorganic oleates, refers to the amount of metallic oxide present. In organic oleates it refers to the amount of alkaloids present. The following table shows the relative strengths of normal and official oleates:

TABLE OF NORMAL AND OFFICIAL OLEATES.

Oleate.	Percentage in normal oleates.	Percentage in official oleates.	Base.
Oleate of Aconitine, N. F.	69.6	2.0	Aconitine
Oleate of Atropine, U. S. P.	56.6	2.0	Atropine
Oleate of Cocaine, U. S. P.	51.6	5.0	Cocaine
Oleate of Morphine	50.3		Morphine
Oleate of Quinine, U. S. P.	53.46	25.0	Quinine
Oleate of Strychnine,	54.22		Strychnine
Oleate of Veratrine, U. S. P.		2.0	Veratrine
Oleate of Bismuth	22.0		Bismuth
Oleate of Copper	12.7		Cupric Oxide
Oleate of Iron	8.8		Ferric Oxide Anhydrous
Oleate of Lead (Lead Plaster, U. S. P.)	28.23	28.28	Lead Oxide
Oleate of Mercury, U. S. P.	28.4	25.0	Mercuric Oxide
Oleate of Zinc, N. F.	12.9	12.9	Zinc Oxide

Strychnine oleates should be made 2 per cent. strong, and morphine 5 per cent. strong, unless otherwise ordered.

Preparation.—Alkaloidal oleates are prepared by triturating the alkaloid with a little alcohol in a mortar until smooth, then adding about one-tenth of the acid and gently warming the mortar until the alcohol is evaporated. The remainder of the acid is then added and warmed until it is dissolved. Some prefer to omit the alcohol and to rub the alkaloid with a small quantity of the acid until smooth. Finally, the remainder of the acid is added. The *Pharmacopœia* uses the first method for atropine, cocaine, and veratrine, with olive oil as part of the diluent, and the second method for quinine. Metallic oleates may be prepared by dissolving the oxide in oleic acid, first rubbing them to a smooth creamy mixture with a little alcohol or water. The mixture should be then kept at a temperature not exceeding 50° C. until dissolved. The reaction is very slow, and the substance requires frequent stirring. A high temperature cannot be employed, as oleates are easily decomposed. A better method is to prepare them by double decomposition, using a solution of pure castile soap and some soluble salt of the desired metal. The acetates are commonly preferred. The metallic oleate is precipitated, and washed several times with hot water to free it from the soluble salt. The product is not a true oleate, but is an oleopalmitate, because the castile soap contains some palmitic acid. A somewhat purer oleate may be obtained by preparing the sodium oleate from oleic acid and sodium hydroxide. The *Pharmacopœia* does not require that oleic acid shall be free from the higher fatty acids, but it is important that the acid used shall meet the requirements of the *Pharmacopœia.* The *Pharmacopœia* directs to prepare mercuric oleate from the oxide. If it be prepared from the salt, the precipitate must be washed in cold water or at most with only warm water, as it is easily decomposed by heat. Mercuric oleate should be diluted only when wanted, as the dilute oleate decomposes more easily.

Oleates are frequently mixed with fats like lard, lanolin, or petrolatum to form ointments. When the strength is given, it should express the percentage of oleate present in the ointment, and *not* the percentage of alkaloid or metallic oxide present.

Stearates are best prepared by double decomposition like the oleates, using sodium or potassium stearate instead of oleate.

CHAPTER XXXIV.

OINTMENTS AND CERATES.

Some pharmacopœias make no distinction between these two classes of preparations, but regard them both as ointments. The fatty constituents used as vehicles and the methods of manufacture are practically the same. The only ground for separation is the difference in the melting point.

Unguenta.—*Ointments* are soft fatty solids intended for application to the skin by inunction. They melt or gradually become liquid at the temperature of the body.

Cerata.—*Cerates* are firmer than ointments, and while they soften at the temperature of the body, they do not become liquid.

VEHICLES FOR OINTMENTS AND CERATES.

Adeps.—*Lard.*—Lard is one of the most important vehicles, but quickly becomes rancid on exposure to the air of a warm room. The change is more rapid when it contains water. Lard should be rendered during the winter or early spring. For many years the writer has habitually rendered during each winter a quantity sufficient for the following year. Only the firm leaf lard should be selected, washed, dried, and the outer membrane and bloody portions removed. It is then passed through a food chopper to break up the cells, and heated over a water bath in a deep vessel at a temperature not exceeding 60° C. until clear. A portion of the fat is then strained, poured into cans, and sealed while hot. Or it may be allowed to cool and be then carefully covered with a layer of paraffin. The remainder of the lard may be benzoinated by adding two parts of benzoin for each 100 parts of lard and the heat continued for two hours. Strain and seal as above. This method furnishes a supply of plain and benzoinated lard that remains perfect until used, and also avoids the necessity of preparing it during warm weather. If for any purpose lard is melted during warm weather, it should be artificially cooled with continued stirring. Otherwise the lard will become granular, due to the separation of the lard oil from the higher melting-point fats. The preparation should be as free from moisture as possible, therefore some dehydrating agents, such as calcium chloride, are sometimes added to the lard while it is rendering.

Adeps Lanæ Anhydrous.—*Wool Fat.*—Wool fat, melting point 40° C., is very tenacious, and when cold will not readily assimilate water, but when melted may be readily mixed with three times its weight of that liquid.

Adeps Lanæ Hydrosus.—*Hydrous Wool Fat. Lanolin.*—This contains 30 per cent. of water, and is capable of taking up twice its own weight. This fact makes it especially valuable in the manufacture of ointments containing water or glycerin. It does not easily become rancid. Its tenacious quality is an objection for some purposes, but the objection may be partially overcome by the addition of a little petrolatum.

Petrolatum.—*Petrolatum.*—Its melting point should be between 45° C. and 48° C. Because of its stable character it is a favorite vehicle, but because it does not easily mix with water and is not readily absorbed it is not useful for certain ointments.

Oils, both animal and vegetable, are frequently combined with higher melting-point fats and used as vehicles. The following substances are used principally to raise the melting point of ointments and cerates.

Resina.—*Calophony or Rosin.*—Melting point, above 100° C. This substance is used only in cerates. When mixed with soft fats it increases the melting point and becomes sticky or adhesive.

Cera.—*Beeswax.*—Melting point, 62° C. to 65° C. Beeswax is used to increase the melting point, especially in cerates. White wax soon becomes rancid, and should be used only when the color of yellow wax is objectionable.

Paraffinum.—*Paraffin.*—Melting point, 51.6° C. to 57.2° C.

Cetaceum.—*Spermaceti.*—Melting point, 42° C. to 50° C. It becomes yellow and rancid on long exposure to the air.

Sevum Præparatum.—*Suet.*—Melting point, 45° C. to 50° C. It becomes rancid on exposure to air.

Many attempts have been made to prepare a vehicle less objectionable than fats for external application, and one that will prove a good substitute for them. Glycerite of starch has been used to some extent. It is not easily decomposed and is readily removed by washing. Dr. Unna gives a formula for casein ointments which may be used as a vehicle, but it is practically a petrolatum emulsion containing, besides casein and petrolatum, glycerin, phenol, and zinc oxide. In the selection of a vehicle, the therapeutic results to be obtained should be considered, as shown by the following therapeutic classification of Prof. Halberg.

Epidermatic.—Epidermic or non-absorbent vehicles are used when the action is to be purely external, as in the case of antiseptics, germicides, protectives, counter-irritants, and astringents. For such ointments petrolatum is the best vehicle.

Endermatic.—Endermic nutritive or absorbent vehicles are used when the medicinal substance is to be absorbed by the skin, thus producing a local effect, as anodynes, alteratives, irritants, resolvents, sedatives, and stimulants. For such ointments pure lard or cacao butter should be used.

Diadermatic Vehicles.—Systemic or constitutional effects are produced by substances that pass through the skin and enter the circulation. When such an effect is desired hydrated wool fat is doubtless the best vehicle. Various intermediate effects may be obtained by a combination of the above vehicles.

Preparation of Ointments and Cerates.—With the exception of nitrate of mercury ointment these preparations are mechanical mixtures made by trituration or stirring, either with or without heat. If the vehicle be too hard to mix easily with a spatula or pestle, it should be softened or melted. Apply the heat as sparingly as possible. *When mixing substances having different melting points, the substance having the highest melting point should be melted first. Then the one having the next highest should be added, and this one liquefied before adding the next.* If this order be not observed, the addition of the lower melting point substance will cause part of the higher one to solidify before they have become mixed, thus producing a lumpy vehicle. The melting point of the mixture is between the highest and lowest melting points, but cannot be calculated from the proportion used. The mixture should be stirred until it stiffens, especially when oils are mixed with wax or spermaceti. Otherwise the higher melting point substance will congeal first, thus producing a granular mixture. Long-continued stirring yields a whiter and softer product, but it is more apt to become rancid through the admixture of air. When preparing ointments without heat, small quantities are more conveniently made on an ointment slab, using a broad spatula. When much liquid is to be incorporated it is better done in a mortar.

Dry substances, with few exceptions, should be reduced to fine powder and thoroughly mixed with a small quantity of the vehicle before adding the remainder. If the powder be bulky, or a large amount is to be incorporated, it is better to triturate with a little oil or with some of the melted vehicle, as in the method for the manufacture of the pharmacopœial ointment of zinc oxide. When a substance is *gritty,* like yellow mercuric oxide, some prefer to levigate it with a little water, as in the pharmacopœial process; the author prefers to levigate with alcohol. When perfectly smooth, but before the alcohol commences to evaporate around the edges, add a little of the vehicle and rub or triturate until the alcohol evaporates. A few substances like opium should be rubbed to a smooth paste with water before mixing with the vehicle. Very soluble substances like potassium iodide may be dissolved in a little water and then incorporated. With less soluble substances there is danger that the water will evaporate and the substance crystallize, thus making a gritty product which is unpardonable in an ointment.

Extracts should be softened with a little water, or diluted with alcohol. *Iodine* should be dissolved in a little water with the aid of potassium iodide. *Alkaloidal salts* when in small quantities should be dissolved in water, but if in large quantities they should be treated like insoluble powders. *Free alkaloids* should be triturated in a warm mortar with a little oleic acid, which converts most of the alkaloid into an oleate. The oleate is more readily absorbed. Substances which are soluble in oils or fats, like phenol, camphor, etc., should be dissolved in part of the melted vehicle. Care should be taken not to drive off substances that are especially volatile. Small quantities of liquids like water or glycerin may be mixed with lard, but in most cases it is advisable to use a little lanolin in place of part of the vehicle. This prevents the liquid from separating.

Horn or hard rubber spatulas should be used in contact with substances which readily act upon steel, but substances having only a slight action upon steel when moist do not attack it when mixed with oil or fat. When necessary, mortars should be warmed by placing in warm water or by burning a little alcohol in them. Never heat over a direct flame, as they are easily broken. A slab may be warmed by burning alcohol upon it.

Preservation.—When possible, ointments and cerates should be freshly prepared, as they either become rancid or separate upon standing. Those that must be kept in stock should be prepared in small quantities and placed in amber or opaque glass containers, closely covered and kept in a cool dry place. Thoroughly cleanse the containers, when empty, with soap and hot water before using again. Earthenware jars should not be used, as the glazing quickly checks and fills with fat. This becomes rancid and is not easily removed. When made in large quantities they should be placed in small containers and sealed, or covered with melted paraffin, to prevent exposure to the air.

Dispensing.—*Never* dispense a rancid or granular ointment or cerate. See that they are perfectly homogeneous and free from gritty particles. Dispense stiff ointments and cerates in amber or opaque jars only. Use collapsible tubes for those which are not too hard to be pressed through the opening. Ointments will keep longer in collapsible tubes than in any other way, as they are completely protected from the air. The tubes may be easily filled by placing the ointment on glazed paper, and rolling it so that it may be inserted clear to the bottom of the tube. Then by drawing the paper out between the fingers the ointment will remain in the tube. Should the tubes be compressed or bent, they may be straightened by introducing a pencil and rolling them on a table or other smooth surface. The labels for tubes should be printed on paper sufficiently long to overlap when pasted around the top of the tube. Greasy jars or utensils may be cleaned with sawdust or soft dampened paper, then washed with soap and water. The odor of iodoform or other noxious odors may be removed from both utensils and hands by rubbing freely with linseed meal.

SPECIAL COMMENTS.

Unguentum Aquæ Rosæ.—*Ointment of Rose Water.*—In this preparation it is important that the melted fat should be cooled to about 40° C. before the rose water solution of sodium borate is added. The solution should be previously warmed to the same temperature. This will insure a uniform creamy mixture.

Unguentum Hydrargyri.—*Ointment of Mercury.*—Oleate of mercury is used in the manufacture of mercurial ointment. Its office is to aid in the emulsification of the mercury.

Unguentum Hydrargyri Nitratis.—*Citrine Ointment.*—The mercury is dissolved in part of the nitric acid, forming, with the aid of heat, mercuric nitrate. The remainder of the acid is heated with the lard to form elaidin, a solid substance formed by the oxidation of the liquid olein which is present in non-drying fats and oils. If the heat be not continued long enough, the reaction between the lard and acid will not be complete; but if it be heated at too high a temperature the ointment will be brown. It should be of a light yellow or citrine color.

Unguentum Picis Liquidæ.—*Ointment of Tar.*—The tar should be homogeneous, and should not be added to the mixture until it begins to congeal.

Unguentum Potassii Iodidi.—*Ointment of Potassium Iodide.*—The potassium carbonate is added to prevent the liberation of free iodine said to be due to the action of hydrogen dioxide, formed by the action of light on the water. However, the fatty acid present in rancid lard will produce the same effect, and this will be neutralized by the carbonate.

Ceratum Cantharides.—*Cantharides, or Blistering Cerate.*—The cantharides is macerated with liquid petrolatum to aid in the extraction of the cantharidin. This is further facilitated by digestion for one hour in the melted fat.

CHAPTER XXXV.

PLASMAS, PASTES, AND POULTICES.

PLASMA. PLASMAS.

The substitution of plasmas for ointments is the result of an attempt to prepare a vehicle that would take the place of and be less objectionable than fats. Plasmas usually consist of starch, gelatin, gums, or soap, together with an excess of fat, and made into a paste with water or glycerin, or a mixture of the two. Those made with glycerin keep well, but if much water be added they quickly mould, unless some preservative be used.

Glycerite of starch is frequently employed. When starch is to be made into a plasma or paste it should be first mixed with sufficient cold water to form a homogeneous mixture, and then added, with constant stirring, to the water or glycerin previously heated to 100° C. The heat should then be continued until a transparent jelly is formed. Do not use direct heat, as the mixture easily burns and becomes brown.

Mucilage of tragacanth has also been recommended. The official preparation contains 18 per cent. of glycerin, which might be increased to advantage, but the mucilage keeps very well, especially when dispensed in collapsible tubes.

Jelly of chondrus may be prepared by following the *National Formulary* directions for the manufacture of the mucilage, except that after straining, the mucilage should be evaporated until its weight equals ten times the weight of the Irish moss taken.

Jelly of cetraria may be prepared by following the *National Formulary* directions for the decoction of cetraria, except that after straining, the decoction is evaporated over a water bath until its weight is seven times the weight of cetraria taken.

Gelatin may be made into a jelly by using about 3 per cent. of gelatin. It should be first soaked in cold water until soft, and then dissolved with heat. If a glycerin solution be desired, the soft gelatin should be dissolved in glycerin. The water may be removed by evaporation, but it is better to allow it to remain. *Agar-agar* may be used, but has no advantage over gelatin. It is largely employed as a culture medium in bacteriological work.

Plasmas are usually applied like ointments, but are sometimes warmed and applied with a brush. The method of medication is similar to that employed in the preparation of ointments.

PASTA. PASTES.

The *National Formulary* contains several formulas for the manufacture of pastes used by dermatologists. The vehicle consists of a paste made with dextrine, glycerin, and water, or with soap, lard, petrolatum, or some oil stiffened with starch or zinc oxide. They are of about the consistence of ointments. The medicinal agent is incorporated in a manner similar to ointments, and should be done with the same care, that a uniformly smooth mixture, free from grit, may be obtained.

CATAPLASMA. POULTICES.

Poultices are soft, pasty preparations, usually prepared from substances containing a large amount of gum or albuminous matter, and capable of absorbing and retaining a quantity of liquid. Poultices are not usually prepared by pharmacists, but pharmacists should be able to give directions for their preparation. Poultices made from a substance like linseed meal are usually prepared by pouring boiling water over the substance, constantly stirring until the required consistence is obtained. Bread poultice is prepared by rubbing bread, free from crust, with hot milk. Poultices are thickly spread on cloth and applied to the affected parts while as hot as can be borne. They are then covered with heavy cloth to retain the heat. Poultices act by keeping the parts warm and moist. They may be reheated as often as required by occasionally supplying the water that may have been lost by evaporation.

The mustard poultice has been largely replaced by mustard plasters. It is best prepared by mixing the mustard with an equal weight of flour or linseed meal, and making the paste with lukewarm water. Hot water should not be used, as it decomposes the glucoside, thus destroying the enzyme which liberates the active volatile oil. It should not be applied as thick as a poultice, and a thin soft cloth should be placed between the poultice and the skin. Cataplasma kaolin of the *Pharmacopœia* has to some extent proved a substitute for other poultices. In the manufacture of this preparation carefully observe the direction to heat to 100° C. for one hour, as it is important that the kaolin should be dry.

Fomentation.—Fomentation is the term given to the application of woollen cloths saturated with hot water or other liquids, or to poultices of herbs applied hot.

CHAPTER XXXVI.

EMPLASTRA. PLASTERS.

The term plaster is applied to solid substances intended for external application, whether they are in mass or spread in sheets. They are adhesive at the temperature of the body, but are harder than cerates. The mass must be softened by heat to admit of spreading. The base of all pharmacopœial plasters is lead plaster or adhesive plaster, and the latter is composed of lead plaster, petrolatum, and rubber.

Preparation.—The method of preparing the plaster mass is similar to that used for cerates. The substance having the highest melting point should be melted first, and the other constituents in the order of *their* melting points. When necessary, the mixture should be strained before adding the medicinal substances, which if solid should be reduced to fine powder and incorporated with the base immediately before congealing. Stir until cold. Extracts should be softened with a suitable solvent, using the alcohol as strong as possible. Evaporate fluidextracts to a syrupy consistence. Resinous substances may be added in fine powder, or dissolved in alcohol and evaporated also to a syrupy consistence. Volatile oils and aromatic substances must be added last to avoid loss by evaporation. When sufficiently cool, roll the mass into cylinders about one and one-half or two inches in diameter, wrap in paraffin paper and keep in air-tight containers until wanted for use. Never spread plasters until needed, as they oxidize and become brittle.

Spreading Plasters.—Plasters are spread on muslin or on thin white leather called plaster skin. The latter is stretched upon a smooth board with the rough side up. The shape of the plaster may be drawn on the surface, and strips of stiff glazed paper placed around it in such a manner that an open space will be left the exact size and shape of the desired plaster. Also, the form of the plaster may be drawn upon paper and the centre cut out so that the opening will be of the required size and shape. Then place over the skin or muslin and fasten with thumb tacks. The form should be drawn so that the edges will lie close to the surface and not allow the warm mass to work beneath. A good plan is to make the form of thin pasteboard, of the same thickness as the desired plaster. The mass should be warmed in a casserole or evaporating dish over a water bath and constantly worked with a spatula. Otherwise a portion will become too warm before the remainder is soft enough to spread. It should be soft enough to spread easily and adhere to the skin or muslin support, but not hot enough to pass through it. The mass is then poured on to the side of the form nearest the operator and spread with a warm spatula. It is best to use two spatulas, keeping one in hot water while the other is in use. Work rapidly, that the plaster may be finished before it becomes cold. In smoothing the surface, work from the edges toward the centre, to prevent forcing a portion of the mass underneath the edges. When the surface is made smooth and the plaster uniform in thickness, pass the edge of a warm spatula around the edge of the plaster close to the form, which may then be easily removed. This leaves the edges smooth. The skin or muslin should now be neatly trimmed so that an even half-inch margin is left around it. The surface of the plaster should be covered with wax or paraffin paper. Some prefer to paste strips on to the leather. In this case they should be kept moist, or they become difficult to remove. Cantharides or blistering cerate should not be warmed, but should be spread with a warm spatula. Formerly special forms and irons were used to assist in spreading plasters. But the pharmacist is now so seldom called upon to spread plasters at all that the above directions are sufficient. At present nearly all plasters are manufactured with a rubber base, and are made by manufacturing houses using special machinery. Physicians usually specify the size and shape of the plasters ordered.

A preparation closely allied to plasters is official under the name of *Charta Sinapis.* The fixed oil is removed from the mustard by percolating with benzin. The dried mustard is then mixed with a solution of rubber in benzin, and carbon disulphide, and is then applied to thick, well-sized paper. Place in warm water for about fifteen seconds before applying to the skin. This allows the enzyme to act upon the glucoside, thus liberating the active volatile oil.

Unguenta Extensa.—*Salve Mulls. Plaster Mulls. Steatina. Steatins.*—Under this head the *National*

Formulary includes formulas for salve mulls of zinc oxide, salicylic acid, mercuric chloride, and salicylated creosote. These were introduced by Dr. Unna. They contain from 65 to 90 per cent. of benzoinated suet, the remainder being benzoinated lard, together with the medicinal agent. They are to be spread on muslin or "mull." This is done by stretching a piece of moist parchment paper on a board, removing the excess of moisture, and covering with a piece of unsized gauze, held in place by thumb tacks. The melted and partially cooled salve is then evenly spread over the muslin, using a flat brush. The surface is smoothed with spatulas, kept warm by immersing in warm water, and wiping dry each time before using. The muslin is then removed from the parchment and hung up until cold, when it may be covered with paraffin paper and rolled for dispensing.

CHAPTER XXXVII.

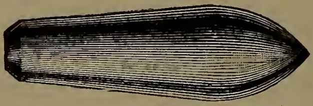
SUPPOSITORIA. SUPPOSITORIES.

Suppositories are solid substances at ordinary temperature, and are intended for introduction into the body. Cacao butter, glycerinated gelatin, and sodium stearate are the vehicles usually selected, as they liquefy at body temperature.

Size and Shape.—The size and shape varies with the material and purpose for which they are designed. Rectal suppositories should be cone or spindle-shaped, and weigh 2 Gm. when made from cacao butter, or 3 to 4 Gm. when glycerinated gelatin is used. Urethral and nasal suppositories, also called bougies, should be pencil-shaped and pointed at one end. The length should be 7 cm. and the weight 2 Gm. when made from cacao butter. When glycerinated gelatin is employed, they should be 14 cm. long and weigh 4 Gm. Vaginal suppositories may be either globular, uniform, or conical in shape, and should weigh about 4 Gm. when made from cacao butter, or 10 Gm. when made from glycerinated gelatin.

Owing to the difficulty of introducing conical-shaped rectal suppositories caused by the contraction of the sphincter muscles, W. S. Wellcome has recommended the shape illustrated in Fig. 112. When the pointed end is introduced past its greatest diameter, the tapering form aided by the muscular contraction tends to carry the suppository inward. Suppositories of cacao butter may be made by fusion, without heat, by compression or by hand.

FIG. 112



Wellcome suppository.

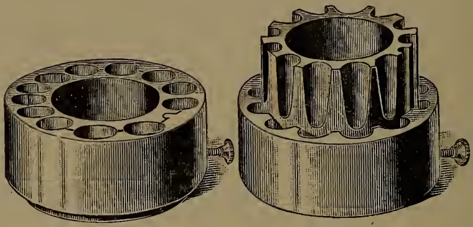
By Fusion.— Medicinal substances like camphor or phenol should be dissolved in the melted fat. Dry substances should be finely powdered. Extracts should be softened with suitable solvents, thoroughly mixed with about one-fourth of the grated cacao butter, and then added to the remainder, which has been previously melted by a very gentle heat. A casserole or evaporating dish with a lip may be employed. Stir constantly, and when the mixture is of about the consistence of syrup and a film has begun to form upon the surface, pour at once into well-cooled moulds. Success depends upon a few important points. The moulds should be kept clean, and just before using should be wiped out with soap liniment or glycerin.

The cacao butter should be barely fluid when the portion containing the medicinal substance is added, otherwise substances like extracts will separate and cannot again be homogeneously mixed. If the mixture be not sufficiently cool when poured into the mould, the medicinal substance will settle to the point of the suppository and the mass adhere to the moulds so that they cannot be easily removed. If not convenient to obtain ice with which to cool the moulds, they may be cooled by spraying with ether or by placing them in water and adding sufficient ammonium nitrate or sodium thiosulphate to produce the saturated solution. The cold produced by the solution of the salt will cool the moulds sufficiently. When cold the end of the suppository should be slightly convex, but will be concave if the mixture was too warm when poured. If the suppositories have been properly made, a slight jar or pressure upon the point will cause them to drop out of the moulds when opened.

Some pharmacists favor the addition of from 5 to 20 per cent. of wax or spermaceti when making suppositories in summer, or in warm countries. This may be done when the medicinal substance lowers the melting point, as with phenol, camphor, volatile oils, chloral hydrate, etc. But wax or spermaceti should not be used without knowing the melting point of the product, which must be below the body temperature. This body temperature is no higher in summer than in winter, or in a hot than in a cold climate. It should also be remembered that certain substances raise the melting point of cacao butter. This is especially true of some of the salts of iron, silver, lead, bismuth, and zinc. Mr. Clague (*The Chemist and Druggist,* xxxviii, 800) found that 20 per cent. of tannic acid increased the melting point 7° C., which would raise it above the body temperature.

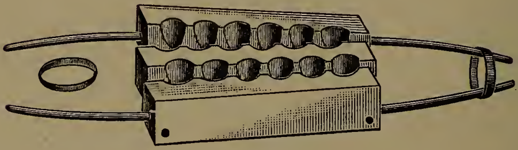
Suppository Moulds.—Figs. 113, 114, 115, and 116 illustrate a few of the different varieties of moulds in general use. As moulds vary in size, the capacity of those used should be tested and recorded, that the operator may know how full to fill them in order to

Fig. 113



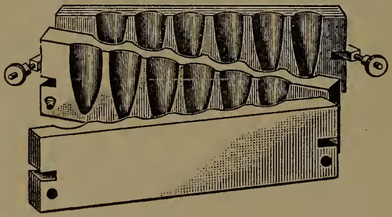
See's suppository mould.

Fig. 114



Wirz's suppository mould.

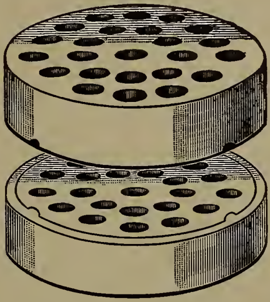
Fig. 115



Hinged suppository mould.

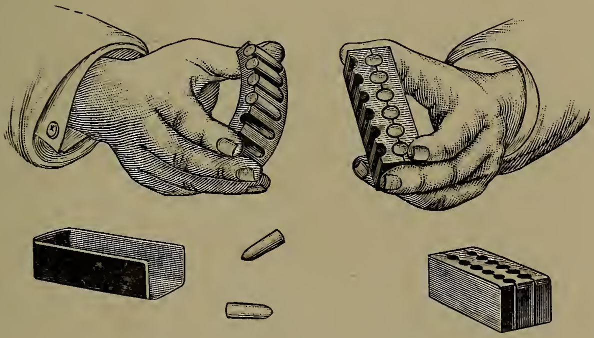
secure a suppository of a given weight. Cone-shaped paper moulds may be made by sharpening a pencil or piece of wood and wrapping a piece of glazed paper around it. The form and upright position may be retained by pressing them into sand, or into a hole punched in a pasteboard box. Very convenient rubber moulds may be obtained (Fig. 117), but they have no

Fig. 116



Blackman's suppository mould.

Fig. 117



Remington's suppository mould.

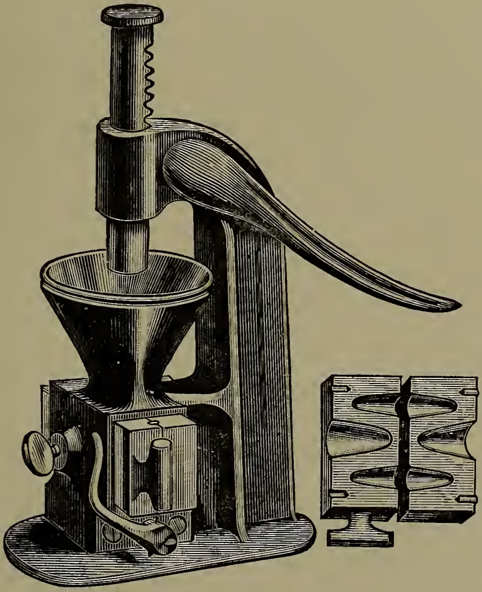
special advantage over metallic moulds, especially when used by a competent pharmacist.

Cacao Butter Suppositories Made without Heat.—The medicinal substance should be thoroughly mixed in a mortar with a small portion of shaved or grated cacao butter, and the remainder added then kneaded into a homogeneous plastic mass. If necessary, one or two drops of almond or castor oil may be added for each suppository. The mass is then placed upon a board, rolled into a cylinder by means of a pill roller, and divided into the required number of suppositories. Then, picking up each piece with a bit of muslin, roll between the fingers into a globular shape. Place upon the board, and with a pill roller, held at a slight angle, roll quickly into the desired shape. Porcelain, glass or metal surfaces are not good for this purpose, as the surface of the mass becomes chilled, causing it to crumble. In this event the mass should be softened between the fingers and again rolled. A piece of paper placed over the slab frequently prevents the mass from chilling and adhering to the slab. In hot weather the slab may be dusted with a little powdered castile soap. This is unnecessary except in extreme cases. If the mass be too soft, it will usually stiffen if allowed to lie a short time while partially forming the other suppositories. *Never use starch, lycopodium,* or any other dusting powder that will prevent the surface of the suppository from melting or becoming slippery when brought into contact with the warm moist sensitive membrane. When suppositories contain large amounts of some insoluble powder like quinine it is advisable to coat them by impaling on the point of a pin and dipping them for an instant in pure melted cacao butter. The cacao butter must be barely melted, but must not be hot.

The manufacture of suppositories by hand requires a certain skill, which is easily acquired by practice. It will then be possible to turn out suppositories comparing favorably with those made by a machine or in moulds, and have the advantage of being as easily made of any size or shape as pills. Also, the medicinal substance is uniformly distributed through the mass.

Compressed Suppositories.—The preparation of a mass for compressed suppositories is the same as when

Fig. 118



Whitall suppository machine.

made by hand. The mass is then placed in a machine and forced into moulds. There are two classes of

Fig. 119

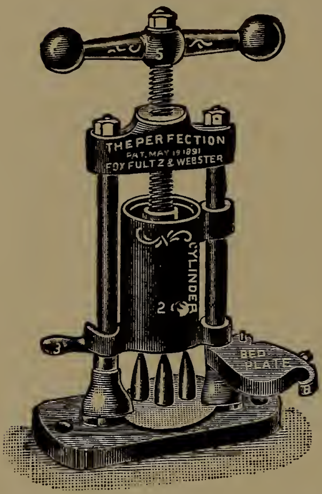
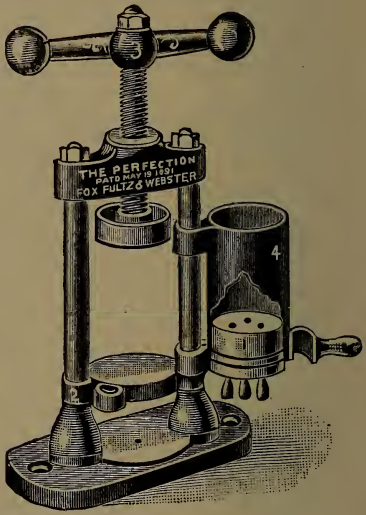
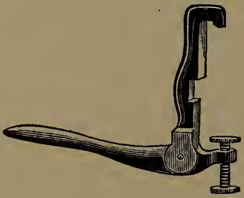


Fig. 120



The "Perfection" suppository mould.

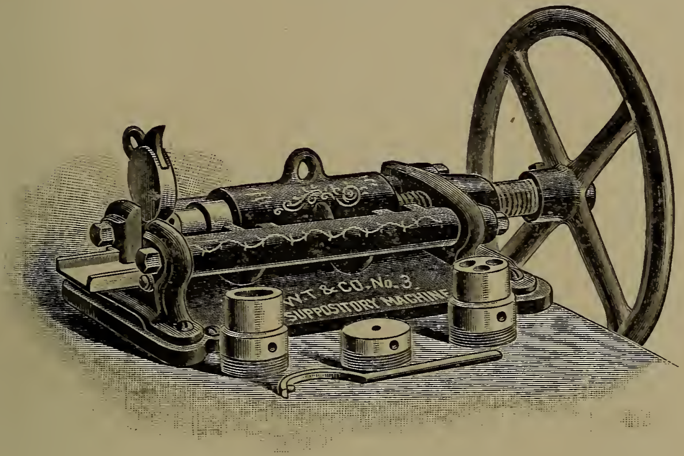
Fig. 121



The "Perfection" mould starter.

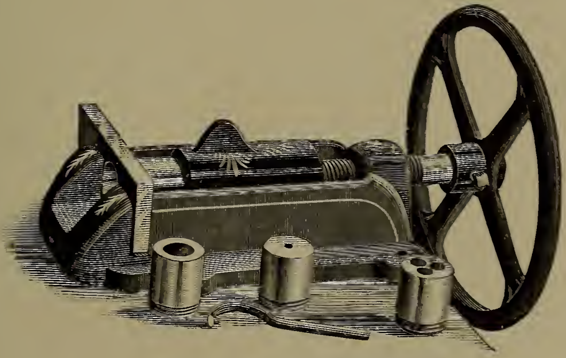
machines in use. Those like the Archibald and Whitall-Tatum (Fig. 118) force the butter into the large end of the mould, which opens in the centre to allow the removal of the suppository. There is also the "Perfection" (Figs. 119 and 120), Whitall (Fig. 122), and the Pearl (Fig. 123), which force the mass into the mould through a

FIG. 122



Whitall's suppository machine.

FIG. 123



Pearl suppository machine.

small opening in the point. By removing the plate at the opposite end of the mould and giving another turn of the screw, the suppositories are ejected. Each machine is supplied with interchangeable moulds for different sizes of suppositories. Warm the mould when difficult to remove, but in no case strike them directly with a hammer or other metallic substance, as the moulds are of soft metal and easily ruined by denting. If force must be used, deaden the blow of the hammer by a piece of soft wood placed on the metal. A mould starter (Fig. 121) is supplied with the "Perfection" machines.

Glycerinated Gelatin Suppositories.—The *Pharmacopœia* gives directions for the manufacture and size of glycerin jelly suppositories, and a formula for glycerinated gelatin containing 50 per cent. of gelatin. The medicinal substance is to be dissolved in a little water, if soluble. If insoluble, it is to be levigated with glycerin, and sufficient glycerin added to make the weight equal to one-half that of the finished mass. This is then incorporated with an equal weight of glycerinated gelatin and poured into moulds previously greased with a small quantity of petrolatum. The finished product contains 25 per cent. of gelatin. When a firmer mass is desired, a portion of the water or glycerin may be replaced by mucilage of acacia. If a softer mass be required increase the amount of glycerin. The general formula answers for most cases. Hydroscopic drugs require the addition of acacia, while large amounts of insoluble powders may require a softer mass. Metal urethral moulds should be warmed to allow the mixture to flow their entire length.

Glycerin Suppositories.—The vehicle for glycerin suppositories is stearin soap, which is prepared by the action of the stearic acid on the monohydrated sodium carbonate.

Reaction :

$$\underset{\text{Stearic acid.}}{2HC_{18}H_{35}O_2} + \underset{\substack{\text{Sodium}\\\text{carbonate.}}}{Na_2CO_3} = \underset{\substack{\text{Sodium}\\\text{stearate.}}}{2NaC_{18}H_{35}O_2} + \underset{\substack{\text{Carbon}\\\text{dioxide.}}}{CO_2} + \underset{\text{Water.}}{H_2O.}$$

Suppositories containing hydroscopic substances are sometimes coated with paraffin, wax, or collodion by impaling them on the point of a pin and dipping them quickly in the collodion or melted paraffin. A great objection is that the patient frequently neglects to remove the coating, directions for which should always accompany coated suppositories. A better coating is cacao butter, which does not require removal.

Cacao butter shells and *gelatin suppository capsules* to be filled with the medicinal substance have been introduced, but are seldom used, as they have no advantage over other suppositories. If they are ordered, the medicinal agent should be thoroughly mixed with grated cacao butter, divided into doses and placed in the shells. Those made with cacao butter may be sealed by warming the end of the shell before replacing the cover. Those made of gelatin are like ordinary gelatin capsules, but having a cone-shaped cover. If necessary, they may be sealed by dipping the edges in a little water spread on the pill tile.

Suppositories are usually dispensed in special boxes provided with divisions to prevent the suppositories adhering to each other. They may be also dusted with a little powdered castile soap when necessary.

CHAPTER XXXVIII.

STILI. PENCILS.

Pencils are small cylinders about 5 mm. thick and 5 cm. long. The *Pharmacopœia* does not recognize them as a class, but gives directions for the manufacture of moulded silver nitrate. When silver nitrate is fused and moulded it is brittle and easily broken. To prevent this, the *Pharmacopœia* directs the addition of 4 per cent. of official hydrochloric acid. Mitigated silver nitrate is made in the same manner, but contains 66.6 per cent. of potassium nitrate.

A few other chemicals may be formed into pencils by melting and pouring into moulds which should be absolutely clean, and warmed to prevent the too sudden cooling of the melted mass. A sudden fall in temperature causes the pencils to become brittle. The mass should be only slightly above its fusing point. Copper sulphate pencils are sometimes formed by scraping or filing selected crystals. They may also be made by fusion and are sometimes diluted with alum.

Stili Dilubiles.—*Paste Pencils.*—The *National Formulary* furnishes two formulas with directions for the manufacture of paste pencils, which may serve as examples of this class of preparations. The medicinal substance is incorporated with the vehicle, composed of tragacanth, 5 per cent.; dextrine, 35 per cent.; sugar, 20 per cent., and sufficient starch to make 100 per cent., including the medicinal agent. Water is then added to form a firm plastic mass, which is rolled into cylinders about 5 mm. in diameter and 5 cm. long. Dry on parchment or paper, at room temperature, and wrap in tin foil. Gelatin is sometimes used. Pencils are also made with wax and fats, employing the same methods used in the manufacture of urethral suppositories.

CHAPTER XXXIX.

PULVERES. POWDERS.

THE method of obtaining various substances in powdered form has already been considered under Comminution. There, however, remains for consideration the class of preparations known as powders. These usually consist of two or more substances intimately mixed in a finely divided condition. For the preparation of such substances a shallow mortar should be used (Fig. 124). Each substance should be powdered separately and then all mixed together. When mixing powders in a mortar, the pressure should be light, in order to prevent the formation of compact layers upon the mortar and pestle.

FIG. 124

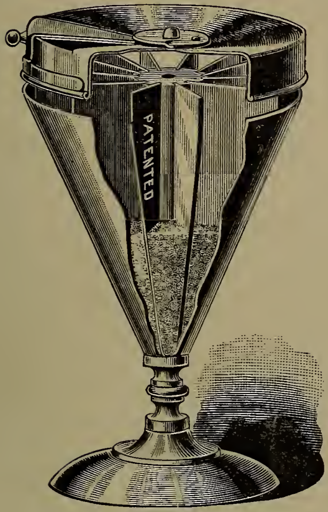
Mortar and pestle.

Begin triturating at the centre and gradually increase the circle toward the edge of the mortar; then diminish to the centre. During trituration the substance adhering to the sides of the mortar should be scraped occasionally to the centre of the mortar with a spatula. When potent medicines are to be mixed with less active substances, mix them thoroughly with about an equal volume of the less active substance, and the remainder gradually added. When a very heavy substance is to be mixed with a lighter body, the lighter substance should be gradually added to the heavier. When it is desirable to mix substances which decompose easily or form explosive compounds, as the hydrophosphites and the chlorates in contact with organic substances, they should be powdered separately and later carefully mixed on paper, using a horn or hard rubber spatula. This may be accomplished also by repeated siftings. Many substances become electrified by trituration. This may be prevented by moistening with alcohol or ether, which quickly evaporate. Otherwise it may be necessary to let the powder stand before dispensing until the electric condition passes away. Large quantities of powder are most successfully mixed in a mechanical mixer (Fig. 102, p. 145), or by continued agitation in a partially filled bottle. Finally, it is advisable to sift all powders after mixing, and in no case to press or triturate after sifting.

Dispensing Powders.—At present it is customary to dispense in powdered form only such substances as are insoluble or are free from objectionable flavor. It is frequently necessary to give powders to children when they cannot be induced to swallow a more solid substance; or to adults who imagine they cannot swallow a pill or capsule. When undivided powders are prescribed, they may be dispensed in round paper boxes, but it is better to use the salt mouth bottles, and if a selected cork be not used, place a piece of thin parchment paper over the mouth of the bottle before inserting the cork. The methods of dividing powders differ even in the best pharmacies. Doubtless the most accurate method is to divide the total weight by the number of powders to be made to obtain the weight of each powder which should be weighed separately. To many this appears to be a tedious method, but a little practice enables one to weigh them very rapidly. Others prefer to place the powder on a pill tile or a graduated powder board, and with the spatula form the powder into a rectangular shape, and divide. Should the pile be high in the centre, smooth the surface and again adjust. In no case should it be pressed down with a spatula, as this decreases the height only without decreasing the quantity. Others distribute the powders upon the papers with a spatula and judge of the size by the eye. While we must admit that some become expert and attain a high degree of accuracy, yet the method cannot be recommended.

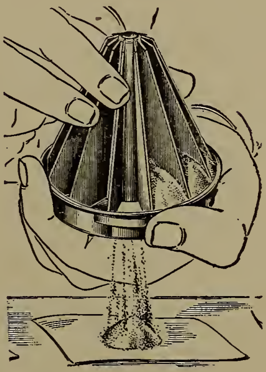
For the division of powders there are several good mechanical dividers. Figs. 125 and 126 illustrate Michael's powder divider, which is furnished with three sets of dividers for 8, 10, and 12 powders. By using divisions or multiples of these, any number of powders may be obtained. If the divider for 12 be placed in the machine, 6 powders will be obtained by turning it until 2 powders drop on each paper. In a

Fig. 125



Filled.

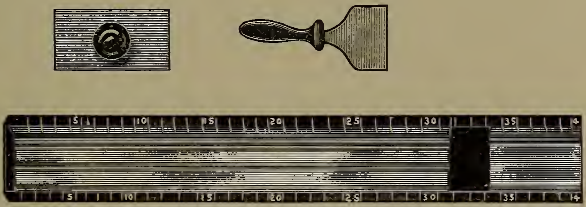
Fig. 126



Discharging the powder.

Michael's powder divider.

Fig. 127



Diamond powder divider.

similar manner 3 powders upon each paper will give 4 powders, or 4 upon each will give 3 powders, etc. In the Diamond divider (Fig. 127) the bottom of the trough is broad and flat and the powder is adjusted with the leveller by a sliding motion and not by pressure. The powders are then divided and removed with the broad spatula. Cup-shaped dividers are frequently recommended for the division of Seidlitz powders, but accurate division can be attained only by special care, as slight variations in pressure or in the dryness of the powder will cause variation in the weight of the powder. They are not to be recommended, but if used should be frequently tested.

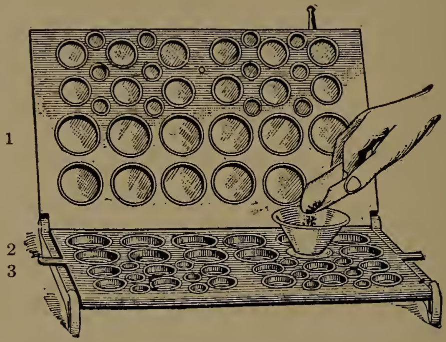
Folding of Powders.—The most important part of the dispensing of powders is the selection of the paper with reference to quantity and size. Parchment or thin, white calendered paper should be used and cut into different sizes. The length of each should be at least one and one-half times its width. When the powders are ready to divide, make a single fold one-eighth inch from the edge in the required number of papers. Place close together near the edge of the table, with the folded edge away from the operator. After the powder is placed upon the table, and the second finger of each hand placed upon the paper at the end, then the edge nearest the operator is raised with the thumb and folded over until it rests in the previously made fold, when, with the forefingers, the edges are folded backward to the centre. The ends are then creased by pressing them over the sides of a powder box, or, better still, with an adjustable powder folder (Fig. 128). The ends may also be folded over a spatula. Some press down the folds of the paper with the spatula. In doing this care should be taken to prevent pressing the powder, as, with some powders, it tends to form hard cakes. One end should then be tucked within the fold of the other. If this be not done the natural spring of the paper causes the ends to assume a position at a greater or less angle from the body of the powder. This tension frequently causes the powders to spring out of the box when opened. In Europe the papers are frequently kept in readiness, being folded lengthwise. The powders are weighed and placed in narrow horned spoons. Then the required number of papers are all folded over at one end and held in the hand, while the contents of the spoons are poured into the papers; then the upper ends are folded over a spatula. In any case skill is acquired only by practice. Substances liable to change on exposure to air, especially those that are volatile or deliquescent, should be wrapped in parchment paper. Powders are frequently dispensed in capsules or wafers. (See Capsules, p. 324.)

Fig. 128

Adjustable powder folders.

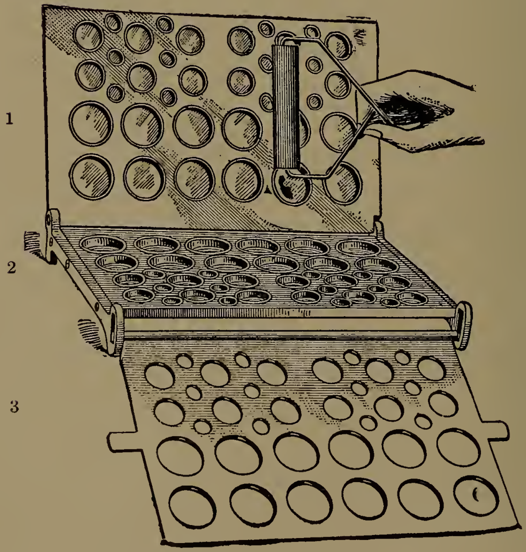
Wafers are made of rice flour and put up in different forms. Square or round sheets have been practically replaced by *cachets* or *konseals,* which are concave disks. The powder is placed in one of them and another is used as a cover. They are sealed by dampening the edges of the cover and pressing together. This may be

Fig. 129



Konseal apparatus filled with konseals.

Fig. 130



Konseal apparatus empty.

easily accomplished by pressing the edges between the lips of two bottles of proper size. A better method is to use a special machine, of which there are several upon the market.

Figs. 129 and 130 illustrate the use of J. N. Grosvener & Co.'s konseal filling and closing apparatus. In Fig. 129 the konseals are placed between plates 2 and 3 and filled by means of the hopper. Before removing the hopper the powder is gently pressed into form with a thimble, not shown. In Fig. 130, plate 3 is opened and the konseal covers in plate 1 are being moistened, after which plate 1 is folded over on to 2. A slight pressure with the hand is then sufficient to seal the konseals.

Fig. 131

Sealed konseals.

The *Pharmacopœia* contains formulas for nine powders, a few of which are especially mentioned.

EXPLANATORY NOTES.

Pulvis Effervescens Compositus.—*Compound Effervescent Powders. Seidlitz Powder.*—This consists of sodium bicarbonate and rochelle salt put up in blue paper, and tartaric acid accompanying it enclosed in white paper. When mixed and moistened or dissolved in water the acid acts on the carbonate, liberating carbon dioxide.

Reaction:

$$\underset{\text{Sodium bicarbonate.}}{2NaHCO_3} + \underset{\text{Tartaric acid.}}{H_2C_4H_4O_6} = \underset{\text{Sodium tartrate.}}{Na_2C_4H_4O_6} + \underset{\text{Carbon dioxide.}}{2CO_2} + \underset{\text{Water.}}{H_2O}.$$

The powders should be divided by weight, not by measure, and should also be kept in a dry place to prevent absorption of moisture. When taken, the powders should be dissolved separately and the acid solution gradually added to the other. Some prefer to dissolve the contents of the blue paper in two-thirds of a glass of water, and then add the contents of the white paper.

Pulvis Glycyrrhizæ Compositus.—*Compound Licorice Powder.*—The object of mixing the oil of fennel with a portion of the sugar is to insure a more uniform distribution of the oil than would occur if triturated with the mixed powders.

Pulvis Ipecacuanhæ et Opii.—*Powdered Ipecac and Opium. Dover's Powder.*—Contains 10 per cent. each of opium and ipecac. Sugar of milk in No. 30 powder is directed to be used as a diluent because the crystals are hard, and during the necessary trituration insures a uniform mixture of the ipecac and opium.

Pulvis Rhei Compositus.—*Compound Rhubarb Powder.*—Observe that it is directed to add the magnesium oxide to the other ingredients previously mixed, which is in accord with previous directions to mix very light substances with heavier ones.

The *National Formulary* contains formulas and directions for the manufacture of a number of powders.

Effervescent Powders.—Effervescent powders are those which contain the medicinal substance incorporated with sugar, tartaric acid, and sodium or potassium bicarbonate. Each substance should be dry and well powdered, then uniformly mixed and kept in closely stoppered bottles. If dampness occurs, the acid and alkaline bicarbonate unite and do not liberate the carbon dioxide when dissolved. The reaction is the same as that given under compound effervescing powder.

Granular Effervescent Salts.—These are similar to effervescent powders, but are prepared in the granular form and citric acid is substituted for part of the tartaric acid, as the mixture is more easily granulated. In the *National Formulary* sugar is present in all the effervescent salts, but is not present in those of the *Pharmacopœia.*

Granulation.—There are two methods of granulating effervescent salts. In the first, heat is used to soften the powder by means of the molecule of water in the citric acid. The *National Formulary* directs that the mixture be heated in an evaporating dish, placed over a water bath, and maintained at from 60° C. to 71° C. Stir constantly with a wooden spatula until the powder is dry and uniformly granular. The *Pharmacopœia* directs to place the mixture on a glass plate or suitable vessel in an oven previously heated to between 93° and 104° C. until the mixture softens. With a wooden spatula rub through a No. 6 tinned iron sieve and dry at a temperature not exceeding 54° C. If the mixture be slowly heated it gradually loses the water and becomes dry without softening. Therefore, it cannot be granulated without the addition of moisture. If the mixture be made too moist or be heated too high, it loses carbon dioxide, and will not effervesce when dissolved. In the second method the mixture is moistened with alcohol until the particles are sufficiently adhesive to unite in small granules when stirred. The size of the granules may be regulated by the amount of moisture added. When sufficiently granular it is spread upon paper or cloth and allowed to dry. In damp weather they should be dried in an oven or over a radiator. Avoid too high a temperature as the granules are apt to become yellow. The granules may be made uniform by passing through a series of sieves and regranulating those too large or too small.

Salts containing much water of crystallization, like magnesium sulphate or sodium phosphate, should be dried before mixing with substances to be granulated. Otherwise the mixture becomes too wet and the alkali and acid react.

TRITURATIONES. TRITURATIONS.

Triturates contain 10 per cent. of the medicinal substance in 90 per cent. of sugar of milk. They are prepared by triturating the finely powdered medicinal substances with an equal weight of powdered sugar of milk, until uniformly mixed. The remainder is gradually added, triturating after each addition and continuing the trituration until a uniformly fine powder results. The crystals of sugar of milk are hard, hence they are especially fitted for trituration with other substances to produce a fine powder. The only medicated triturate recognized by the *Pharmacopœia* is **Trituratio Elaterini**, *Trituration of Elaterin*.

OLEOSACCHARA. OIL SUGARS.

Oil sugars are prepared by triturating one part of some volatile oil with thirty parts of powdered cane sugar. They are seldom ordered, and should be freshly prepared when wanted.

CHAPTER XL.

PILULÆ. PILLS.

PILLS are spherical, ovoid, or lenticular bodies for internal administration, and should be soluble in the fluids of the stomach or bowels. They should weigh from 0.03 Gm. to 0.06 Gm. (1 gr. to 10 gr.) When large the oval form is more easily swallowed.

Boluses are larger than pills, and are used principally in veterinary practice.

Palvules are smaller than pills and contain potent remedies in small doses. They are usually sugar coated either pink or red.

Granules are either very small pills coated with sugar, or they are medicated sugar pellets.

Pills are a favorite form of medication on account of their compact form, accurate dosage, ease of administration, and stability. A thorough knowledge of the physical characteristics of the constituent of a pill is essential in order to obtain the best results in their manufacture. The active constituents should be evenly distributed throughout the mass in order to secure uniformity in the doses. Solids and crystalline bodies should be reduced to fine powder. Soft extracts should be weighed on counterpoised pieces of paraffin paper, or paper dusted with lycopodium. Most extracts can be easily removed from ordinary paper by wetting the back of the paper. Hard extracts, incapable of being powdered, should be softened either by heat or by the judicious addition of the proper solvent, preferably the same used in their manufacture. Extracts frequently contain acids, which should be neutralized before mixing with carbonates, or, if mixed with a carbonate, the mass should be warmed to expel the carbonic oxide before rolling out the mass. Strong alkaloids or other substances administered in small doses should be first carefully triturated with a little sugar of milk or some other powder with which they may be prescribed. When prescribed alone, sufficient inert powder like sugar of milk should be added so that the finished pill may weigh about 0.06 Gm. (one grain). When small quantities of a poisonous drug are to be weighed, it is better carefully to prepare a triturate (see Triturates, p. 306) in such proportions that correct amounts may be accurately weighed. For weighing fractions of a grain, a triturate made in the proportion of one part to eleven of sugar of milk is convenient; in which case 1 gr. $= \frac{1}{12}$; 2 gr. $= \frac{1}{6}$; 3 gr. $= \frac{1}{4}$; 4 gr. $= \frac{1}{3}$; 6 gr. $= \frac{1}{2}$; 8 gr. $= \frac{2}{3}$. For decimal fractions a triturate of one in ten or one in one hundred is most convenient. All of the constituents should be thoroughly and uniformly mixed before attempting to form the mass. Success in the manufacture of pills depends upon the proper formation of the mass. This should be plastic, so that it may readily be formed into the desired shape, and sufficiently firm to retain that shape; but it should not be permitted to become so hard or insoluble that it will not dissolve or disintegrate when placed in warm water for a short time. Badly made pills have been known to pass through the body unchanged. The mass is formed by the cautious addition of some inert substance. In the case of powders, employ some moist excipient, but in the use of oils or moist substances an absorbent powder must be added.

Pill Excipients.—The excipient used may vary to suit the individual case. The particles must be bound together by some adhesive substance. Many substances, like opium, aloes, and gum resins, contain sufficient gum or other adhesive material to form a mass by the simple addition of some solvent, as water. In such cases it is advisable to add a little soap, otherwise the pill hardens and dissolves with difficulty. Many substances are non-adhesive, and will not unite to form a mass without the addition of some adhesive substance.

Tragacanth is frequently used as an excipient, but should *never* be used without glycerin to prevent hardening. Mucilage of tragacanth contains glycerin, and is useful in the manufacture of small pills, but it is objectionable for large ones, as it increases the size.

Acacia with glycerin has been used, but should not be recommended, as it hardens and has no advantage over other excipients.

Glycerite of starch is similar to tragacanth.

Syrupy glucose is an excellent excipient for many substances, such as powdered drugs, alkaloids, synthetics, reduced iron, ferrous salts, mercurous salts, and salts generally that are not easily reduced. In addition to its adhesive properties it acts as a preservative for substances easily oxidized. Glucose with a little althea or licorice is a good excipient for camphor, thymol, chloral, etc., and especially for combinations of these which liquefy on mixing. Glycerite of starch is very adhesive, a small quantity being sufficient to form a mass. Consequently, it does not increase the size and does not harden at ordinary temperatures. When too thick it may be diluted.

Honey is a good excipient for colored pills, but has no particular advantage over glucose.

Confection of rose was formerly much used as an excipient, but enjoys no advantage over honey or glucose.

Soap is a desirable excipient for resinous substances, as it forms a good mass and increases the solubility. However, it should not be used with metallic salts, as decomposition results, forming oleates, palmitates, and stearates.

General Pill Excipient.—This is also erroneously called "universal" pill excipient. A universal pill excipient is impossible, but several formulas have been proposed which may be quite generally used for powdered drugs and dry substances that are not adhesive. One of the best general pill excipients is a mixture of equal parts of glycerite of tragacanth and syrupy glucose. Remington's general pill excipient contains glucose, 4 oz.; glycerin, 1 oz.; acacia, 90 gr.; and benzoic acid, 1 gr. Few of the general excipients possess any advantage over glucose, which is an especially good excipient for metallic oxides. These oxides should not be massed with excipients containing glycerin. In many cases oxides so massed unite to form an insoluble cement.

Petrolatum and *cacao butter* are used for easily reducible substances like *potassium permanganate, silver oxide or nitrate,* and also for very *deliquescent salts.* Potassium permanganate and the silver compounds are usually administered in small doses. It is, therefore, necessary to mix them first with sufficient inert substance like kaolin to make the combined weight one grain (64 mg.). Then mass by the cautious addition of the excipient.

Potassium borotartrate, with half its weight of water, is recommended by Caspari as an excipient for very *deliquescent* substances, two drops being sufficient for sixty grains of chloral hydrate, with one-sixth grain of tragacanth to each pill.

Mattison's excipient powder is composed of tragacanth, one part; finely powdered elm bark, seven parts; and is recommended for *scale salts, metallic salts, reduced iron, camphor,* and *lupulin.* One part of the powder to ten of the substance suffices in most cases. Mass with a little syrup.

Phosphorus may be made into pills by following the directions for their manufacture found in the *United States Pharmacopœia.* (See Explanatory Notes, p. 318.)

Absorbent Powders.—Many substances are too soft to form into pills without the addition of some absorbent powder, but this should be sparingly used so that the size of the pill need not be unduly increased. Furthermore, the large amount of gum in althea is likely to interfere with the solubility of the pill. A little sugar should be used with althea. When the active principle is not volatile nor injured by heat, remove the excess of moisture by spreading upon a plate and gently warming. Althea or licorice root is useful for soft extracts, but when something more adhesive is desired, the extract of licorice may be used. Althea or licorice root combined with soap is a good absorbent for volatile oils and similar substances. *Tragacanth* or *acacia* should not be used, as the pills harden and dissolve with difficulty unless glycerin be used. In this case the pills are too large. When a white absorbent is desired, use starch or flour. Magnesia has largely been used as an absorbent, but it is a questionable practice, as magnesia slowly unites with water, forming a hard mass which in a few hours becomes practically insoluble. It combines with resins and the acids of some oils like copaiba. The action is more rapid in the presence of a little water. Formerly the mass of copaiba contained one-sixteenth of its weight of magnesia.

Soap forms a more soluble compound, and should be used instead of magnesia. It is also a good absorbent for balsams, oleoresins, hydrocarbons, creosote, phenol, and volatile oil in proportion of one-half grain for each minim of the oil.

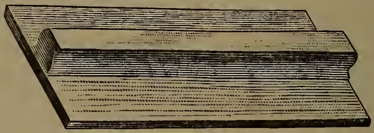
Pepsin or *pancreatin* also makes a good excipient for creosote, guaiacol, phenol, and volatile oils in the proportion of about one grain to each minim of the oil and mix with a little water, about three drops for ten pills.

Formation of the Pill Mass.—The pill mass should be formed in a deep mortar, using a pestle sufficiently long to prevent contact between the fingers and the edge of the mortar. The pestle should be long, and the upper end broad to protect the hand (Fig. 132). A stiff spatula with a broad end is convenient for massing and rolling pills. Form the mass by kneading rather than by trituration, keeping it well in the centre of the mortar by frequently scraping from the side with the spatula.

FIG. 132

Pill pestle.

FIG. 133

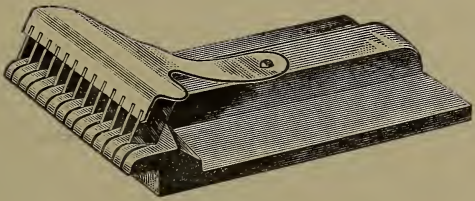


Pill roller.

Add the excipient cautiously, remembering that it is easier to add more when needed, but impossible to remove a surplus. The spatula used in the mortar should never be used to remove the excipient from its container. Should the mass become too soft, an absorbent powder may be added, but this unnecessarily increases the size of the pill. Remember that a small pill is far more easily swallowed than a large one. A mass that appears too dry may frequently become soft enough by continual kneading. A properly made mass when ready to roll is firm enough to retain its shape, and not soft enough to stick to the fingers. The mass is then placed upon the pill tile, and with a spatula, or preferably with a pill roller (Fig. 133), roll into pipes or cylinders of such length that they may be accurately divided into the required number of pills. In rolling care should be exercised to prevent the cylinder from becoming thicker in one part than another. A uniform diameter must be secured, and the end should be frequently squared by pressing with the spatula. Should the mass adhere to the tile, use a dusting powder. For colored pills use lycopodium or powdered licorice root; for white pills use starch or talcum.

Division of Cylinders into Pills.—When dividing into pills on an ordinary graduated pill tile the cylinder should be held in place with one hand, and cut with the spatula held in the other. Otherwise the cylinder moves with each cut, and the last pill will be larger than the others. The Diamond pill cutter and roller (Fig. 134) cuts pills by pressing a spring, carrying the knives downward upon the cylinder, and when the spring is released forces the pills from between the knives. Cooper's pill machine (Fig. 135) is used exclusively by many pharmacists, and is especially convenient for manufacturing large numbers of pills. The machine may be obtained furnished with three sets of grooved reversible plates, capable of cutting and rolling six

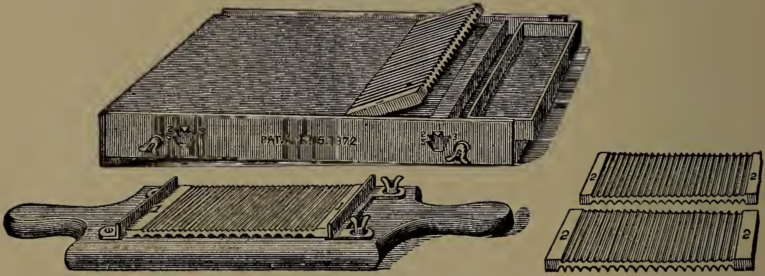
FIG. 134



Diamond pill roller and cutter.

different sizes of pills. On each side of the machine are brass plates, capable of adjustment for rolling cylinders of proper diameter for each size of pill. By placing the cylinders on the grooved plates and gently pressing upon them with the corresponding plate, at the same time moving it backward and forward, the pills will not only be divided, but will assume their proper form. When pills are too large or too small to be formed in the grooves of a machine, or when divided on a pill tile, it will be necessary to shake them by hand, rolling them between the thumb and first two fingers. This should be practised until one or more pills can be rapidly shaped in each hand at the same time. The beginner should never be allowed to use two hands to roll one pill. Some pharmacists prefer to shape the pill hastily and then finish all at once under a pill finisher (Figs. 136 and 137). The pills are collected on the slab beneath the finisher, which has a projecting rib to keep them from rolling out. The motion of the finisher

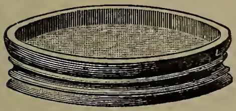
Fig. 135



The Cooper patent pill machine.

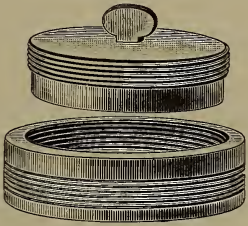
should be of the form of a figure 8, which brings all parts of the pill into contact with the finisher much better than a continuous circular motion. If the pills be firm and a little dusting powder be used, it is unnecessary to place any powder in the box. An oval shape may be given pills by rolling them, after they are finished, in one direction between the thumb and fingers, or under the finisher. The *Pharmacopœia* contains fourteen formulas for pills. Little difficulty is experienced in their manufacture, since the kind of excipient necessary is directed in each case.

Fig. 136



Pill finisher.

Fig. 137



Adjustable pill finisher.

EXPLANATORY NOTES.

Pilulæ Aloes et Ferri.—*Pills of Aloes and Iron.*—Confection of rose used as an excipient, as sugar and honey prevent the oxidation of the ferrous sulphate.

Pilulæ Aloes et Mastiches.—*Pills of Aloes and Mastic. Lady Webster Dinner Pills.*—The solubility of these pills could be improved by using confection of rose and a few drops of water in place of the powdered red rose and diluted with alcohol.

Pilulæ Ferri Carbonatis.—*Pills of Carbonate of Iron. Blaud's Pills.*—The ferrous carbonate is formed from potassium carbonate and ferrous sulphate.

Reaction:

$$\underset{\text{Potassium carbonate.}}{K_2CO_3} + \underset{\text{Ferrous sulphate.}}{FeSO_4} = \underset{\text{Ferrous carbonate.}}{FeCO_3} + \underset{\text{Potassium sulphate.}}{K_2SO_4}.$$

The sulphate of iron is triturated with sugar before mixing with the carbonate, to prevent oxidation. H. B. Dunning uses licorice and glucose instead of glycerin, althea, and tragacanth. The mass is not so tough and is not so easily oxidized.

Pilulæ Ferri Iodidi.—*Pills of Ferrous Iodide.*—The ferrous iodide is formed by the action of the iodine on reduced iron, which is in excess, to prevent oxidation.

Reaction:

$$\underset{\text{Iron.}}{Fe} + \underset{\text{Iodine.}}{I_2} = \underset{\text{Ferrous iodide.}}{FeI_2}.$$

It is directed that the iodine be gradually added to the iron. Otherwise the reaction is too violent, and the heat produced causes a volatilization of part of the iodine. As ferrous iodide is easily oxidized, the pills are coated with tolu. (See Dunning's Method, p. 319.)

Pilulæ Phosphorici.—*Pills of Phosphorus.*—Phosphorus is very inflammable even in warm air; therefore, the necessity of *keeping and cutting it under water.* Even the slight friction of cutting in dry air may cause it to ignite. In weighing, a watchglass containing water should be counterpoised on the balance and the pieces of phosphorus taken from its container by means of forceps, dried between filter paper, and at once dropped into the watchglass. After weighing, the pieces should again be dried between the papers and placed at once in a test-tube containing chloroform; heat gently without agitation. The remaining directions should be carefully followed, and the pill at once coated with tolu.

Coating Pills.—Doubtless the original object in coating pills was to conceal their disagreeable taste, but it also tends to preserve them in their normal condition and prevents atmospheric action. It is for the latter purpose that the *Pharmacopœia* directs pills of phosphorus and ferrous iodide to be coated with tolu. Pills to be coated should be firm and perfectly free from dust. If dusting powder has been used in their manufacture, it must be removed by shaking them in a sieve or rolling them on muslin.

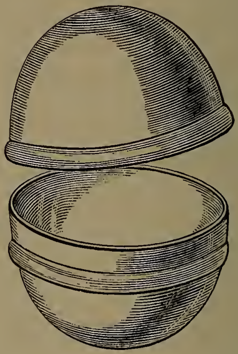
Tolu Coating.—This is also called varnishing, because the coating is resinous. Tolu hardened by the loss of part of its volatile oil is preferable. The formula furnished by H. A. B. Dunning gives the best results. Five grains of tolu are dissolved in 20 Cc. of alcohol and 5 Cc. of ether. His method is to rotate the pill in the lid of an ointment jar, previously coated with a thin layer of the solution. Then pour them into a second lid and rotate to remove excess of solution. They are then transferred to a third lid previously rubbed with oil, and rotated until dry. Repeat the operation if necessary, but remember that only a thin coating is desired.

Sugar Coating.—Sugar coating is best applied to the coating of pills in large quantities, but a good extemporaneous coating may be given at the prescription counter. Moisten the surface of the pills by rolling them on a filter paper saturated with mucilage of acacia. Then place them in a round box, or, better still, in a hollow sphere (Figs. 138 and 139), containing a mixture of starch, one part; acacia, one part; sugar of milk, five parts, and rotate briskly. Generally this is sufficient, but should a heavier coat be desired the operation may be repeated. Or a finer appearance may be produced by using talcum in place of sugar, especially for the second coating. A *pearl* coating is made in a similar manner by talcum alone. Finely powdered elm bark may be used in place of sugar. It makes a good coating and at the same time a pill that is easily swallowed. Gold and silver leaf have also been used. Very good

Fig. 138

Pill coater closed.

Fig. 139



Pill coater open.

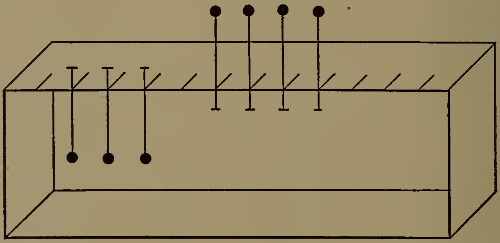
results may be obtained by the similar use of powdered aluminum.

Enteric Pills.—Enteric pills are those which do not dissolve in the acid fluids of the stomach but are soluble in the alkaline fluids of the intestines. This is desirable for medicines which interfere with digestion or irritate the stomach, or when it is desirable to have the medicine act directly upon the bowels. In order to prevent solution of the pills in the stomach, they were formerly coated with *keratin,* a substance prepared from horn, hoof, etc. (See *National Formulary,* "Pill Coating.") *Salol* answers the same purpose and is far more convenient. The pills may be easily coated by impaling them on pin points and dipping them for an instant in melted salol. The salol quickly cools, after which the pin may be withdrawn and the whole closed by touching it with the head of a pin previously warmed in the flame of a burner, or by applying a little of the melted salol. Some recommend an ether solution of salol applied in the same manner as in coating with tolu. Mr. Dunning uses approximately one grain of salol for each three-grain pill, and directs that it be melted in an evaporating dish placed over a water bath. It is then removed from the bath and allowed to cool until the dish is barely warm to the hands. The pills are then added and rotated until cold. The operation is repeated two or three times, using only half as much salol each time, and the last time using only enough to coat the evaporating dish. Have the dish quite warm when the pills are added. Finally, transfer to a cold dish and rotate until the pills are cold.

Gelatin Coating.—Gelatin coating permits the pharmacist to produce a uniformly and perfectly coated pill within a brief time and at slight expense. Various solutions of gelatin have been recommended. The following formula by Prof. Patch gives good results:

Best French gelatin, 70 Gm. Macerate in 206 Cc. of distilled water until soft, then dissolve over a water bath. Add 7.5 Gm. of boric acid and 60 Cc. of mucilage of acacia. When the acid is dissolved, strain the mixture and keep closely covered. When ready to use, the mass is melted over a water bath. The pills are impaled on the points of pins and dipped just deep enough into the solution to cover the pills. Upon removing them from the liquid they should be held a moment to allow the surplus solution to settle, when it can be removed by touching the pill to the side of the vessel or to the surface of the liquid. Then rotate the pills in the air for a few minutes until the gelatin cools. This prevents the coating from thickening on one side. The coating should then be allowed to dry by pressing the pin into a slit made in the edge of an open pasteboard box (Fig. 140).

Fig. 140



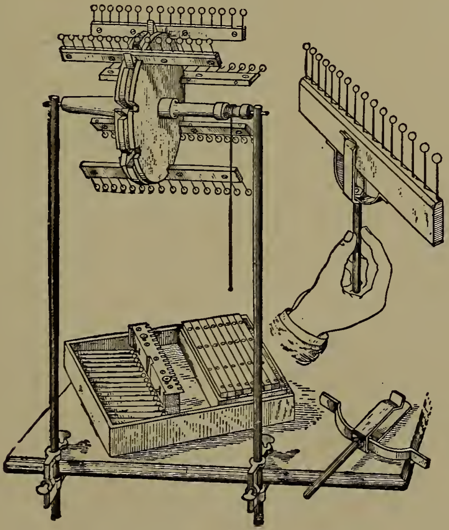
Box with pins for holding the pills while drying.

When they are no longer sticky the pills may be removed from the pins and the gelatin that surrounded the pins also removed with scissors, or, if allowed to become perfectly dry, may be broken off by agitating in a bottle.

Keep the solution at a temperature of about 75° C., and just before the pills are dipped remove the scum which forms upon the surface. Glycerin used as an excipient is apt to soften the coating. If the mass be not very firm the contraction of the gelatin coating may, upon drying, force part of the mass out of the opening made by the pin.

Pill Coaters.—A number of very convenient pill coaters may be obtained. The principle and method of

Fig. 141



Prof. Patch's gelatin coater.

use is the same in all, but the technique differs. The best are Wells' Porcupine, Franciscus', Maynard's, and Patch's. Each coater is accompanied by complete directions. Fig. 141 illustrates Patch's coater and the method of keeping the pills in motion while cooling and drying. There are several large coating machines which render the use of pins unnecessary. The pills are held on the end of a small tube by an exhaust pump. One side is coated then rapidly dried, when the other side is similarly treated.

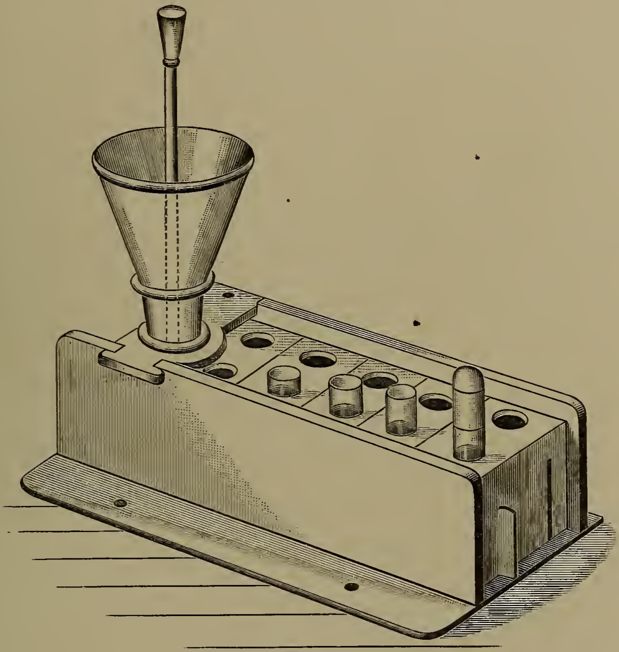
Capsules.—Many disagreeable tasting medicines are dispensed in capsules instead of in the form of coated pills. The capsules are prepared from gelatin and glycerin. By varying the amount of glycerin the manufacturer is able to make either hard or soft capsules. Hard capsules consist of two small cups: one long, to contain the medicine, and the other shorter, to serve as a cover. Medicines having a disagreeable flavor are usually dispensed in the form of coated pills or wafers, or in capsules. Capsules may be filled with the dry substance or it may be made into a mass. Medicinal substances generally occupy less space when massed than when dry; consequently, a small capsule may be used. This is an advantage to the patient who has difficulty in swallowing large capsules, and will usually meet with the approval of the best physicians. To form the mass, proceed as in the manufacture of pills, only the mass need not be so firm, and each pill should be rolled into cylinders long enough to be easily introduced into the shell. When the mass has been divided and shaped the fingers should then be washed and dried. The capsule is then taken between the thumb and finger of one hand and the cover removed by taking it between the upper part of the thumb and forefinger of the other hand. The cylinder is grasped by the lower part of the thumb and the second finger and placed within the shell, and the cover returned. This prevents the medicinal substance from coming in contact with the outside of the capsule. Another excellent method is to pick up the cylinder with a pin so that it does not come in contact with the fingers. It should be remembered that the object of the capsule is to conceal the taste of the medicine, and this is not accomplished should part of the medicine be on the outside of the capsule. In some cases it may be desirable to fill the capsules with the medicine in powdered form. In this case the medicine is prepared and divided into doses and then put into the capsules. For this purpose the fingers should be perfectly dry, and the capsule taken between the thumb and finger of one hand and the cover in the other. They are then repeatedly shoved through the powder until it is all scooped up, or, if the powder packs easily, the capsules may be filled by pressing them down upon the powder until it is all taken up. A still better method is to use one of the numerous capsule fillers, as the Eastman combined capsule filler and divider or the Remington (Fig. 142). These are made with holders of different sizes for the different-sized capsules. The long shell is placed in the holder and then under the hopper and the powder packed in with a small plunger. Fig. 143 shows the Acme Capsule Filler. The holder is of wood with grooves intersecting the openings for the capsules. When the block is shoved along in its metallic case the capsule is raised so that the cover may be put on and it may be easily removed from the filler. Dry-filled capsules are apt to leave particles of the medicine adhering, and should be thoroughly wiped with a dry cloth or washed with alcohol. They may also be cleaned by shaking with washed sand. Remington's capsule cleaner is very convenient for this purpose. It consists of a closed tin box containing a coarse sieve. The capsules are placed in the box with some clean

Fig. 142

Remington capsule machine.

sand, which is then inverted and shaken. Upon placing it in an upright position the sand passes through the sieve, leaving the capsules clean. Hard capsules may also be used for dispensing alcoholic or oily liquids.

FIG. 143



Acme capsule filler.

Such capsules may be filled with a medicine dropper or pipette, and then sealed by dipping the end of the cover in a little water, spread on a pill tile or glass plate. When the cover is put on the water softens the gelatin so that the joint will be sealed.

Soft Capsules.—Soft capsules are made especially for liquids. They are uniform, having an elongated neck to assist in filling. The neck is removed with a pair of scissors and the liquid introduced with a medicine dropper, pipette, or burette, care being exercised to prevent the liquid from coming in contact with the outside of the capsule. After filling, they are sealed by just touching the opening with the side of a rod previously dipped in a melted mass of gelatin, 3 Gm.; water, 5 Cc.; and glycerin, 2 Gm. Keep them in an upright position while filling and sealing. To do this place in sockets formed by drilling holes in a block of wood, or by forcing holes through a pasteboard box with a pencil.

CHAPTER XLI.

TABELLÆ. TABLETS.

Tablets are not recognized by the *Pharmacopœia* or *National Formulary*, but two kinds are found upon the market, viz., *Compressed Tablets* and *Tablet Triturates.*

Compressed Tablets.—Compressed tablets are formed by forcing the dry granulated substance into lenticular-shaped disks under high pressure. The best results are obtained only when the granules are of uniform size, about No. 20 usually preferred. Many soluble substances, like ammonium chloride, potassium chlorate, etc., may be obtained on the market in uniform granular powder which needs no further preparation. Or they may be granulated by evaporating a concentrated solution to dryness, stirring constantly (see "Granulation," p. 90), and when dry, crushing the coarser particles and passing them through a sieve. Other crystalline salts may be ground in a mill and by careful sifting obtained in the proper degree of fineness. Other substances must be especially treated. They should first be finely powdered, then moistened with a suitable excipient, whose character will depend upon the nature of the material. Water, diluted alcohol, syrup, and glucose are sometimes used. Syrup is doubtless the most general excipient, as it furnishes not only the moistener, but also the necessary adhesiveness. Sugar is frequently mixed with the substance before granulating. Substances *which contain gum* or are *naturally adhesive* may be moistened with water or diluted alcohol. The latter is usually preferred, as it does not act so rapidly and may be more evenly distributed throughout the mixture. For this purpose an atomizer will be found very convenient. For *resinous drugs* alcohol may be used. Most *insoluble substances* should be mixed with 0.1 per cent. of sugar and moistened with syrup, but when *very light* and *bulky,* like magnesia or charcoal, 25 per cent. of sugar will be necessary and the granules must be much finer. Extracts should be dissolved and mixed with sugar or used to moisten other constituents with which they may be ordered. *Tinctures* and *fluidextracts* may be concentrated and used in the same manner. *Volatile oils* when used with other materials should be added after granulation. *Effervescing tablets* should be prepared by granulating the acid and alkalies separately, and uniformly mixing. *Incompatibles* should also be granulated separately.

Granulation.—The substance to be granulated should be placed in a mortar and lightly triturated, with the excipient slowly added, until the mixture is uniformly moist and slightly adhesive. The mixture is then forced through a No. 20 sieve, collected on sheets of paper, and dried at a low temperature. Substances like salol, which have low melting points, should be dried in warm air without heat. After drying, the mixture should again be passed through the sieve. Substances which, when moist, act upon a sieve or form a tough mass, should be carefully moistened and dried. They are then run through a mill or powdered in a mortar, sifting frequently to remove the particles as soon as they are small enough to pass through the sieve. *Insoluble substances* like salol, when granulated and compressed without the addition of any foreign substance, form tablets that do not disintegrate and will pass through the alimentary tract without action. To overcome this difficulty it is recommended to use about 20 per cent. of *freshly* dried starch or powdered arrow root, which must be added just before compressing. If a lubricant be needed, it should be added before the starch. If the starch has previously absorbed moisture, it will not expand and cause the tablet to disintegrate when placed in water.

Hypodermic Tablets.—Hypodermic tablets are made with pure cane sugar and granulated with alcohol or with sodium sulphate or chloride. If lubrication be necessary, 1 per cent. of boric acid may be used.

Lubricants.—It is important that the granulated substance should flow uniformly and evenly into the mould, otherwise the size of the tablet will vary. This is accomplished by the addition of some lubricant, as talcum, boric acid, lycopodium, starch, petrolatum, or cacao butter. Lubricants also help to keep the tablets from adhering to the moulds.

Talcum is a good lubricant, but owing to its insoluble character it should be used as sparingly as possible. Not more than 3 per cent. should be used. It should never be used for tablets expected to form a clear solution when dissolved.

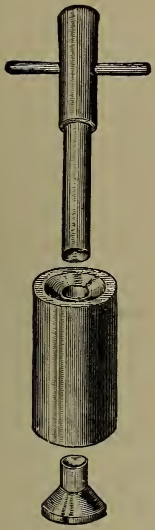
Lycopodium has no advantage over talc, and cannot be used except for colored tablets. Boric acid is generally used for hypodermic tablets and for those intended to form a clear solution. Not more than 2 per cent. should be used.

Petrolatum or liquid petrolatum is a good lubricant and may be used in the proportion of about 1 per cent. It is best applied with an atomizer, using a 25 per cent. solution in ether. The powder should be stirred frequently to insure an even distribution of the oil, and the ether allowed to evaporate. In difficult cases it is better to use both talc and petrolatum than to use an excess of either.

Cacao butter is used as combined granulator and lubricator in the proportion of one ounce of cacao butter to six ounces each of ether and alcohol.

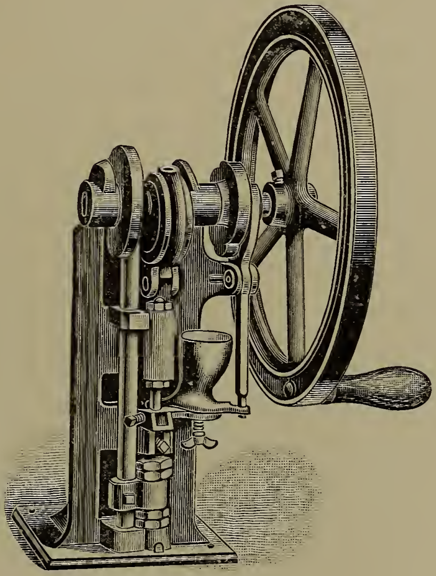
Compressors or Tablet Machines.—Fig. 144 illustrates a simple compressor intended only for small quantities at the prescription counter. The cylinder is placed over the base and the amount of granulated substance required for a single tablet is poured into the cylinder, the piston introduced and compressed by a sharp blow with a wooden mallet. On removing the base and giving a gentle tap the tablet is expelled. The same principle is used in several cheap machines, in which the compression is applied with a lever. One of the best of this type is the Freck Tablet Compressor. It has an automatic feeder and tablet ejector. The pressure may be adjusted so that the tablets will be of uniform thickness. By using interchangeable moulds and piston, tablets of different diameters may be made. Two pistons are supplied with each cylinder; the upper for compressing the tablet and the lower to expel the finished tablet. The weight of the tablet is regulated by raising or lowering the lower piston, which increases or decreases the capacity of the cylinder. Raising the upper piston decreases the pressure, and lowering it increases the pressure. What has been said of the Freck Compressor also applies to the Eureka Tablet Machine (Fig. 145), which makes a tablet with each revolution of the wheel, and when properly adjusted, from seventy-five to one hundred tablets may be made in a minute. Complete directions accompany each machine, so that a detailed description is unnecessary.

Fig. 144



Tablet compressor.

Fig. 145



The Eureka tablet machine.

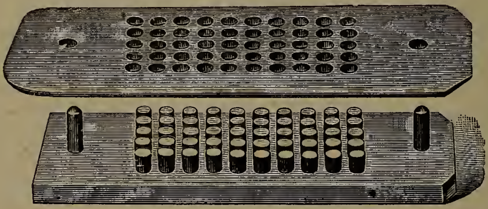
Tablet Triturates.—In 1878 Dr. R. M. Fuller prepared tablets from triturates; hence the name, "Tablet Triturate." *Triturates* are prepared by triturating the active ingredient with some diluent. Formerly sugar of milk was used entirely, but now cane sugar is sometimes substituted, and many prefer a mixture of the two in the proportion of one part of cane sugar to five parts of sugar of milk. When preparing a triturate of substances like potassium permanganate and silver compounds, kaolin or prepared chalk should be used as a diluent. In any case the active ingredient when solid should be triturated with an equal bulk of the diluent until uniformly mixed, then the remainder gradually added. After this pass through a No. 120 sieve.

Tinctures when in small amounts may be used as moistening agents. Otherwise, they should be mixed with part of the sugar of milk and then evaporated to dryness at a low temperature, and powdered before adding the remainder of the diluent. Extracts may be triturated with sufficient sugar of milk to form a uniform powder and the remainder of the diluent added, or they may be dissolved in some solvent, preferably as strongly alcoholic as possible, and then treated similarly to tinctures. To make into tablets, the triturate is moistened with some liquid, if possible one in which the triturate is only sparingly soluble. The amount of moistening agent to be used will vary with the character of the tablet mixture and the nature of the liquid used. Water, absolute alcohol, chloroform, and mixtures of these in varying proportions are used for very deliquescent substances, but these are not usually made into tablets.

From 75 per cent. to 85 per cent. of alcohol will be found to give the best results in most cases. Stronger alcohol will be required for those containing cane sugar than for those containing only sugar of milk, as the former is much more soluble than the latter. If too damp, moisture will show on the surface of the tablet when filling the mould, and the tablet will be too hard when dry. If the mixture be not moist enough, the tablet does not retain its form under ordinary conditions. The mixture should not be damp enough to form a plastic mass, but only sufficient to form an adhesive mass when lightly pressed. If the alcohol be too strong, the tablet will be friable; if too weak, it must be cautiously added or the tablet will be too hard. When a large number of tablets are to be prepared, it is advisable to moisten the mixture in small quantities as required, or to keep the moistened mixture covered with a damp cloth. Otherwise, the mixture will dry out and the tablets will not be uniform in weight or hardness.

Moulding.—Fig. 146 illustrates the form of mould in general use. The upper plate is placed on a smooth surface, preferably of glass, and the dampened mass is pressed into the moulds with a broad horn or hard rubber spatula, shaped like a putty knife. When the openings are filled and the surface smoothed, the mould is inverted and the other side treated in a similar manner, if necessary. A little finely powdered sugar of milk is then brushed over the surface of the tablets. The mould is then placed over the plate bearing the pegs, in such a manner that the numbered or marked ends are together and the large holes in the upper plate are over the guide pins of the lower plate. When the plates are pressed together the tablets will be forced out of the mould and remain on the ends of the pegs. In a few minutes the mould may be turned over, when the tablets will fall off or may be removed with a soft brush. Tablets should be dried in warm air or at ordinary room temperature, on a sieve or cheese cloth stretched on a frame and protected from dust. To accurately adjust the dose in each tablet it is necessary to know the amount of diluent to be added to the medicament to make the required number of tablets. This must be determined experimentally, and each experiment should be carefully recorded for future use. First, prepare a few tablets, using the diluent only, after which dry and weigh them. Then measure the volume of the required weight of the medicament, and reserve an equal volume of the diluent from the amount required to make the given number of tablets. Mix the medicament with the remaining diluent and fill the moulds. Should the mixture be insufficient, more of the reserve diluent must be added. If the mixture more than fills the moulds,

Fig. 146



Hard rubber tablet mould.

the excess must be dried, weighed, and, with the reserve mixture, deducted from the original amount. After a few experiments it will be found quite easy to accurately construct a formula. However, it should be remembered that equal volumes of different dry substances do not occupy equal spaces on moistening. Tablets—when dried, powdered, again moistened, and put into moulds usually occupy less space than before. Varying the amount of moisture and pressure will cause a corresponding variation in the weight of the tablets.

Tablet Saturates.—Tablet saturates are blank tablets of sugar of milk or a mixture of cane sugar and sugar of milk. They are medicated when wanted by saturating them with an alcoholic preparation, such as a fluidextract or tincture, which may be applied by dropping the required dose on each tablet, or by pouring the alcoholic solution over the tablets and decanting the surplus. With the latter method the dose is regulated by determining the amount absorbed by the tablet and concentrating, or diluting the alcoholic preparation accordingly.

Hypodermic Tablets.—Hypodermic tablets are small tablet triturates about one-eighth of an inch in diameter. Diluents can be pure sugar of milk or cane sugar, though some use sodium sulphate or chloride.

Lamels are small medicated, glycerinated gelatin disks to be placed beneath the eyelid, and are sometimes used in the preparation of hypodermic solutions.

Orbicules are small sugar disks flat on the one side and convex upon the other. They are medicated by saturating them with a solution of the medicinal substance, like homeopathic pellets.

CHAPTER XLII.

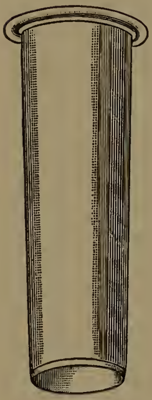
TROCHES AND CONFECTIONS.

TROCHISCI. TROCHES.

TROCHES, or lozenges, are solid flat masses, either round, oval, octagonal, square, or diamond-shaped, and some are cylindrical. They are usually intended for local application, and should be slowly dissolved in the mouth without mastication. The medicinal ingredients are uniformly mixed with sugar and acacia or tragacanth, and formed into a mass with water, syrup, or honey. Sometimes the gum is added in the form of a mucilage. The solubility of the lozenge is largely controlled by the amount and kind of gum used. They are less soluble when made with acacia than with tragacanth. About 25 per cent. of acacia is required, or 3 per cent. of tragacanth. Only the finest confectioner's sugar should be used. For small quantities the mass is formed in a mortar, similarly to the formation of a pill mass, except that the mass should be softer. It must be thoroughly kneaded after each addition of excipient, otherwise it will become *too* soft. When the mass is properly formed, it is weighed and placed upon a tile or troche board, previously dusted with powdered starch, sugar, or sugar of milk, and, with a cylindrical roller, rolled out to such thickness that the weight of one of the cut troches will equal the weight of the mass, divided by the required number of troches. The thickness of the mass can be easily regulated and made uniform by Proctor's lozenge board, with adjustable sides. Slocum's lozenge board regulates the thickness by means of wedge-shaped strips of wood sliding in grooves. In Harrison's lozenge board the sides are stationary, while the bed is raised or lowered by a thumb screw placed at the end. Lozenges may be cut into squares or cut diamond-shaped with an oiled knife or spatula. A large-sized cork borer furnishes the round form; also special lozenge cutters may be employed (Figs. 147, 148, 149). A convenient method is to roll and divide the mass like pills, and then with a dusted spatula flatten each section into the troche form. For this method the mass should be rather soft; if not, the troches will crack around the edges. Another method is to place each rounded troche in a short glass tube of the desired diameter, and press it into shape with a cork attached to the end of a pencil or rod. Troches should be dried in a warm dry atmosphere. If the temperature be too high they will melt. Those containing volatile constituents are best dried in a desiccator.

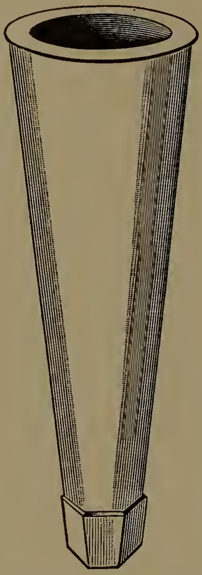
Gelatin Lozenges or Pastiles.—The base for the gelatin lozenge consists of gelatin, glycerin, and water; occasionally of acacia. The proportions vary with the objects to be obtained. For a soft readily soluble pastile use gelatin, one part; glycerin and water, each, two and one-half parts. For a firm, less soluble pastile, use gelatin, five parts; glycerin and water, each, six parts, and evaporate to fifteen parts; or gelatin, four parts; acacia, one part; glycerin, ten parts; and water, eight parts. The water is frequently replaced by some aromatic water, and acid on fruit juices. The gelatin is macerated with the water until thoroughly softened, after which the glycerin is added and the whole heated on a water bath until a clear solution is formed. The medicinal ingredients are then thoroughly mixed and the whole poured into suitable moulds, or, in the absence of moulds, the mass may be poured on to a greased plate, or into a thoroughly greased pasteboard box, and cut into the required number of lozenges. Substances

Fig. 147



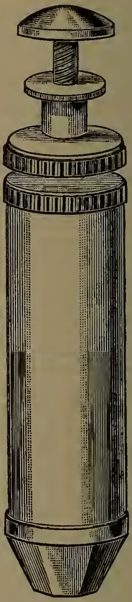
Plain tin lozenge cutter.

Fig. 148



Tin lozenge punch with steel cutter.

Fig. 149



Lozenge punch with spring.

containing tannin or those incompatible with gelatin cannot be used.

Chocolate Lozenges or Pastiles.—Chocolate lozenges are prepared by incorporating the powdered medicinal substance with 0.3 Gm. to 0.6 Gm. of sugar, some flavoring ingredient, and about 0.2 Gm. to 0.4 Gm. of chocolate. The whole is thoroughly mixed and heated on a water bath until a soft mass is formed. Then it is divided into the required number of lozenges, similarly to the method for gelatin lozenges. Lozenges of all sorts vary in weight from 0.3 Gm. to 1 Gm.

Fumigating pastiles are small, cone-shaped bodies composed of balsams, spices, charcoal, etc. The material in powder is formed into a mass with mucilage of tragacanth and pressed into cones between the thumb and two fingers. When dry and ignited they should burn slowly without flame.

Moxas are small cones intended for cauterization by burning. They are prepared similarly to fumigating pastiles and usually contain charcoal and potassium nitrate.

CONFECTIONS. ELECTUARIES.

These are a class of preparations that might well be discarded by American pharmacy, as they are seldom used. The medicinal substance is thoroughly incorporated with honey or fruit pulp, and sometimes glycerin is added to prevent dryness. The *Pharmacopœia* recognizes two confections, namely, confection of rose, used principally as a pill excipient, and confection of senna, used as a mild laxative.

CHAPTER XLIII.

GAUZE AND COTTON.

CARBASUS. GAUZE.

Medicated Gauze.—Fine cotton gauze similar to the best grades of cheese cloth is used for medicinal purposes. Medicated gauzes are usually prepared by plaster manufacturers. They are prepared by saturating gauze with a solution of the medicinal substance dissolved in some volatile solvent, accompanied by a little glycerin or fixed oil to prevent their becoming too dry. It is expressed to a given weight and the volatile liquid allowed to evaporate.

GOSSYPIUM. COTTON.

Medicated cotton is prepared similarly to medicated gauze, except that the absorbent cotton is employed instead of gauze. The styptic cotton of the *National Formulary* furnishes a good illustration of this class of preparation. Preserve them in tightly closed receptacles. The *pyroxylin, colloxylin,* or soluble gun cotton of the *Pharmacopœia* is an exception to the above class. It is formed by the action of nitric acid upon absorbent cotton in the presence of sulphuric acid, which serves to dilute the nitric acid and to take up the water liberated by the chemical action. When nitric acid acts upon cotton or cellulose, one of several products may be formed, depending upon the number of hydroxyl groups replaced by the nitric acid radical. The official pyroxylin consists chiefly of cellulose tetranitrate, $C_{12}H_{16}(NO_3)_4O_6$, corresponding with the reaction.

Reaction:

$$\underset{\text{Cellulose.}}{C_{12}H_{20}O_{10}} + \underset{\text{Nitric acid.}}{4HNO_3} = \underset{\substack{\text{Tetranitro cellulose.}\\ \text{(Pyroxylin.)}}}{C_{12}H_{16}(NO_3)_4O_6} + \underset{\text{Water.}}{4H_2O}.$$

It should be kept in cartons, as it decomposes more easily when kept in air-tight containers. It is used principally in the manufacture of collodion, for which see p. 257.

Politzer plugs are small balls of greased cotton to be introduced into the ear for the exclusion of the air, especially after an operation. Also to keep out water while bathing. They are prepared by drawing a piece of thread through a small pledget of absorbent cotton and greasing the pledget with simple cerate. This is then wrapped with a thin layer of greased cotton and the operation repeated until the plug is sufficiently large to fill the meatus of the ear. The thread is left sufficiently long to enable the removal of the plug from the ear.

CHAPTER XLIV.

ALKALOIDS AND DRUG ASSAY.

Alkaloids are vegetable bases found in various parts of many plants. They contain nitrogen, and are called alkaloids because, like the alkalies, they are alkaline in reaction and are capable of uniting with acids to form salts. Their names end in *ine* with the Latin *ina*, which serves to distinguish them from neutral principles of plants ending in *in* with the Latin *inum*. The term alkaloid has also been applied to bases obtained from animal sources, but these when obtained from living animal tissue are now known as *leucomaines*. Those secured from dead tissue are called *ptomaines*.

Most of the free alkaloids when pure exist as crystalline or amorphous powder, especially those containing oxygen. A few alkaloids like coninine and nicotine are liquid and contain no oxygen. They are sometimes called volatile alkaloids because, when air is excluded, they can be volatilized or distilled without decomposition. These decompose easily when exposed to air, but are less easily decomposed when combined with acids.

In plants the alkaloids are seldom free, but are confined with the natural acids of the plants. The presence of alkaloids in plants may be determined by separating the alkaloids by the shaking-out method, as given in the outline for the assay of alkaloids (p. 353). When the solvent is evaporated the residue is dissolved in acidulated water and tested with some of the alkaloidal reagents, which produce precipitates, from acid solutions. Those most commonly used are Mayer's reagent, which is the pharmacopœial solution of potassium mercuric iodide, and Wagner's reagent, a solution of iodine in potassium iodide. Dragendoneff's reagent is a solution of potassium and bismuth iodide, and Sonnenschein's reagent consists of phosphomolybdic acid.

The passage of the "Food and Drugs Act" by the Federal Government, and the passage of a somewhat similar law by nearly all of the States, has given pronounced importance to the pharmacopœial methods of assay. In quantitative analysis the student becomes thoroughly familiar with the inorganic assay methods, but not so with the organic or alkaloidal determinations. The *Pharmacopœia* furnishes detailed methods for determining the strengths of all important drugs for which reliable assay methods are known. These methods may be intelligently followed by anyone possessing a general knowledge of assay work. It is, therefore, unnecessary to treat each method individually, but rather to explain the general principles involved, and to place before the student such information as may enable him better to understand the changes and manipulations taking place. Since volumetric analysis plays an important part in drug assay work, a brief explanation seems advisable.

VOLUMETRIC ANALYSIS.

Volumetric Solutions.—Volumetric analysis is the quantitative estimation of substances by means of solutions of known strength, the quantity of substance being determined by the volume of the standard solution used. The strengths of volumetric solutions are based upon their combining power, compared with the valency of hydrogen.

$$\begin{array}{ccccccc} AgNO_3 & + & HCl & = & AgCl & + & HNO_3 \\ 168.68 & & 36.18 & & 142.29 & & 62.59 \end{array}$$

Thus, 36.18 parts of hydrochloric acid will unite with 168.68 parts of silver nitrate. Therefore, if 36.18 Gm. of absolute hydrochloric acid are dissolved in a liter of water, and 168.68 Gm. of silver nitrate in another liter of water, and the two solutions are mixed, there will be just enough acid to precipitate all the silver. The same will be true if any number of cubic centimeters of one solution be mixed with an equal number of cubic centimeters of the other solution. If one liter of a solution contains 36.18 Gm. of hydrochloric acid, each cubic centimeter would contain $\frac{36.18}{1000}$ or 0.03618 Gm., and would be equivalent to 0.16868 Gm. of silver nitrate, or to $\frac{1}{1000}$ of the combining weight, in grams, of any other substance with which it will unite, *e. g.*, 0.0557 Gm. of potassium hydroxide.

A normal solution is one that contains the combining weight, expressed in grams, of the active reagent in one liter of the solution. The combining weight or valency of a substance must not be confounded with the molecular weight.

The *Pharmacopœia* defines a normal solution, N/1, as one that contains in 1 liter the molecular weight of the active re-agent, expressed in grams, and reduced to the valency corresponding to one atom of replaceable hydrogen or its equivalent.

Hydrochloric acid contains one atom of replaceable hydrogen. Sodium hydrate and sodium chloride each contain one atom of sodium capable of replacing one atom of hydrogen. Therefore, their normal solutions should contain respectively HCl, 36.18 Gm.; NaHO, 39.75 Gm.; and NaCl, 58.06 Gm., in 1 liter. Sulphuric and oxalic acids each contain two atoms of replaceable hydrogen. Therefore, one liter of N/1 H_2SO_4, molecular weight 97.34, should contain 48.67 Gm. One liter of N/1 oxalic acid, $H_2C_2O_4.2H_2O$, molcular weight 125.08, should contain 62.54 Gm. Two molecules of potassium permanganate in oxidation give off five atoms of oxygen, which are equivalent to ten atoms of hydrogen; therefore, one-fifth of one molecule of potassium permanganate represents the number of grams for one liter of normal solution.

$$\frac{KMnO_4}{156.94} \div 5 = 31.388 \text{ Gm.}$$

Decinormal solutions are one-tenth the strength of normal, and are expressed as N/10. Centinormal solutions are one-hundredth the strength of normal, and expressed as N/100. Seminormal solutions are one-half the strength of normal, and are expressed as N/2. The following strengths are sometimes used: Twice the strength of normal, 2/N. One-twentieth normal, N/20. One-fortieth normal, N/40. One-fiftieth normal, N/50.

The *Pharmacopœia* gives complete directions for the manufacture of volumetric solutions, and under each, a list of articles with the amount of each article that is equivalent to 1 Cc. of the volumetric solution.

Many volumetric solutions change on standing. When this has occurred, instead of bringing them back to their original strength, many prefer to ascertain their strength and make the necessary correction each time they are used.

Example.— On exposure to air a decinormal solution of potassium hydroxide has absorbed carbon dioxide until 10.5 Cc. of the solution are required to neutralize 10 Cc. of decinormal acid. Hence, correction must be made for each cubic centimeter of solution used. If 10.5 Cc. were required instead of 10, then 1 Cc. of the solution is equal to $\frac{10}{10.5}$, or 0.952 Cc. Since 1 Cc. of the solution is the equivalent of only 0.952 of 1 Cc. of a standard solution, then whenever this solution is used, the number of cubic centimeters of the solution consumed must be multiplied by the factor 0.952.

The volumetric estimation of alkaloids is based upon the fact that they unite with acid to form salts, and thus neutralize a definite amount of acid. The alkaloid is obtained as pure as possible and dissolved in an excess of standard acid, and the excess of acid determined by titration with a standard alkali, using hematoxylin, cochineal, or iodeosin as indicator. The difference between the standard acid taken and the standard alkali used represents the amount of acid combined with the alkaloid. Most alkaloids that are estimated volumetrically are monobasic; therefore, 1 Cc. of decinormal acid is equivalent to 0.0001 of the molecular weight of the alkaloid expressed in grams.

The molecular weight of morphine is 300.92, which divided by 10,000 gives 0.030092, the amount of morphine capable of neutralizing or combining with 1 Cc. of decinormal acid. In case the alkaloid is dibasic the molecular weight should be divided by two and then by 10,000 to obtain the equivalent of 1 Cc. of acid.

Indicators.—Various indicators have been recommended for alkaloidal titration, but it is necessary to consider only those which have been most frequently used. Phenolphthalein cannot be used, as it is unaffected by free alkaloid. It is directed that *iodeosin* be used in the assay of nux vomica. It is colorless in acid solutions and rose in alkaline solutions. When iodeosin is used the method of manipulation is as follows:

Place the acid solution of the alkaloid in a flask or bottle, the volume of the solution being about 80 Cc. Add 20 Cc. of ether and five drops of the indicator. Then add N/50 alkaline solution, 1 Cc. at a time, shaking after each addition until the aqueous solution becomes rose colored. Next add 0.5 Cc. of N/10 acid, and again add N/50 alkali, $\frac{1}{10}$ Cc. at a time, until the solution becomes again rose-colored. The principal objection to iodeosin is that it is difficult to obtain it in good quality, and, furthermore, the solution does not keep well.

Hematoxylin.—The color of hematoxylin varies from yellow to orange in acid solutions, and from violet to purple in alkaline solutions. In this case an old solution affords better results than a fresh one. However, the end reaction varies with different alkaloids and has not proved as satisfactory as with *cochineal,* whose color is yellowish red in acid solutions, and violet in alkaline solutions. The change is not very pronounced, but with a little practice there is no difficulty in noting the end reaction, and it is preferred by nearly all chemists.

Too great care cannot be exercised in the preparation of standard solutions, for the slightest error here is marvellously magnified in the final result. The *Pharmacopœia* directs that the normal and decinormal potassium hydroxide solution be prepared by titration against pure potassium bitartrate, using phenolphthalein as an indicator. (See U. S. P., p. 552.) Many pharmacists prefer to use pure oxalic acid instead of potassium bitartrate with phenolphthalein as indicator.

The principal objection to both of these methods is that phenolphthalein must be used as indicator, but cannot be used in alkaloidal titration, as it is not affected by alkaloids. Since different results are obtained by using different indicators, it is important that the *indicator to be used in the determination* should be the same as was used in the preparation of the standard solutions. After the standard *alkaline* solution is prepared the standard *acid* solution is prepared according to the method given on p. 566 of the *Pharmacopœia.* Another method for the preparation of standard solutions is to prepare first an approximate solution of hydrochloric acid. Then accurately determine the strength gravimetrically by precipitating a portion of it with an excess of silver nitrate, collecting the precipitate, washing, drying, igniting, and weighing in the usual manner. From the results, calculate the amount of acid in the solution and dilute to the required strength. This standard hydrochloric *acid* solution is then used to prepare a standard *alkaline* solution.

The author prefers to prepare approximate standard solutions by either of the first two methods, after which accurately standardize the acid solution by the titration of a pure crystallized alkaloid.

Example.—Each cubic centimeter of the approximate N/10 acid solution is found to be equivalent to 4.5 Cc. of N/50 potassium hydroxide. Then 300.9 mg. of pure crystallized morphine is accurately weighed and dissolved in 15 Cc. of the acid solution, and diluted to 100 Cc. To 50 Cc. of this solution containing 7.5 Cc. of the acid solution and 150.45 mg. of morphine, add five drops cochineal solution, titrate with the approximate potassium hydroxide solution. If 13.5 Cc. of N/50 potassium hydroxide solution be required to neutralize the free acid, and 4.5 Cc. be equivalent to each cubic centimeter of acid, then $13.5 \div 4.5 =$ the number of cubic centimeters of free acid in the 50 Cc. taken, or $13.5 \div 4.5 = 3$. Since the 50 Cc. taken contained 7.5 Cc. of acid solution, then $7.5 - 3 = 4.5$, the number of cubic centimeters of acid that must have been combined with the 150.45 mg. of morphine. Had the solution been strictly decinormal, it should have required 5 Cc., since 1 Cc. of decinormal acid is equal to 30.09 mg. of morphine. Consequently, the approximate solution is too strong, and each 4.5 Cc. must be diluted to 5 Cc. If we have 900 Cc. of the approximate solution, it must be diluted to $\frac{900}{4.5} + 5 = 1000$. The approximate alkaline solution may now be standardized so that 5 Cc. is required to neutralize each cubic centimeter of decinormal acid, or, the factor may be determined and a correction made each time. The N/50 alkali is used to more accurately obtain the end reaction. The beginner should prepare his own standard solution and experiment with solutions containing *known* quantities of alkaloid until he is familiar with the end reaction, and is able to obtain accurate results.

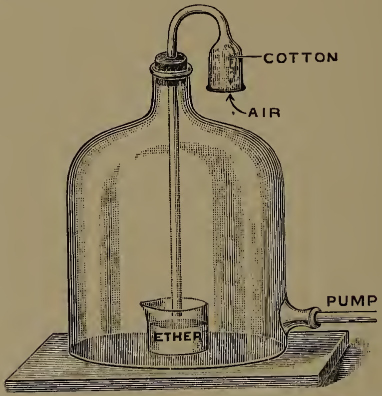
Alkaloids are associated with various complex substances from which they must be separated before they can be obtained in a sufficiently pure condition for estimation. In this separation we take advantage of the fact that certain solvents do not mix with water and are called *immiscible* solvents. They are ether, chloroform, benzene, petroleum benzin, and amyl alcohol. The first two are most frequently used. The salts of nearly all alkaloids are soluble in water, but practically insoluble in the immiscible solvents. The free alkaloids are soluble in the immiscible solvents, but practically insoluble in water. Alcohol occupies an intermediate place, being miscible with water and also with the immiscible solvents. It is a solvent for the free alkaloids and also for many of their salts. The above facts form the basis of nearly all alkaloidal assay. The method may be outlined briefly as follows:

ASSAY METHODS.

Two methods are used for the extraction of alkaloids from drugs. In the first, 10 Gm. of the drug in fine powder are usually taken and completely exhausted, either by maceration and percolation or by maceration and agitation for several hours with the solvent, after which the residue is filtered and washed. The second method is to take 15 or 20 Gm. of the drug and agitate for three or four hours with 150 or 200 Cc. of the solvent. Then take such an aliquot part of the liquid as will represent 5 or 10 Gm. of the drug. If the fine particles do not settle readily, 5 or 10 Cc. of water added to the liquid and shaken vigorously will cause the particles to agglutinate and leave the liquid perfectly clear. The solvent used in most cases consists of chloroform or ether, or a mixture of the two, with some alkali to liberate the alkaloid. Ammonium hydroxide is generally used, as fixed alkalies are apt to decompose some of the more sensitive alkaloids. The liquid obtained by one or the other of the above methods is received in a separator, 10 or 15 Cc. of water added, and a piece of litmus paper placed upon the surface. Then sufficient acid is added until a slight acid reaction is obtained. The whole is then gently shaken for two or three minutes and allowed to stand until the liquid separates into two layers. If the immiscible solvent used be heavier than water, like chloroform, it will be found at the bottom; if lighter, like ether, it will float upon the surface, in which case the aqueous solution may be easily drawn off. The immiscible solvent should then be washed with several portions of water to insure the complete removal of the alkaloidal salt. In case the immiscible solvent is heavy, so that it descends to the bottom of the separator, it must be drawn off into a second separator and the aqueous solution drawn into a beaker. The immiscible solvent in the separator may now be washed with water and separated as before. When shaking out alkaloids by means of immiscible solvents the operator must be certain that the alkaloid is completely removed from the solution before it is discarded. This is best accomplished by placing a small quantity of the liquid in a test tube and acidulating, if the solution be not already acid. Apply heat to remove any alcohol, ether, or chloroform that may be present, after which add a few drops of mercuric potassium iodide, test solution. If cloudiness appears it will indicate that the alkaloid is not all removed. Most of the extractive and coloring matter will be retained by the immiscible solvent, while the alkaloid in the form of a salt will be removed by the water. The alkaloid is further purified by placing the acid solution in a separator, adding a fresh portion of the immiscible solvent and ammonia to alkaline reaction, shaking and separating the two solutions and washing the aqueous solution with several portions of the immiscible solvent. The solvent is then removed by evaporation. If the solvent contain ether it may be evaporated by placing it over a vessel containing hot water. Chloroform may be evaporated over a water bath, in which case care may be taken to prevent loss of the residue by decrepitation. The best preventive is the addition of a few drops of amyl alcohol to the residue before it is entirely dry. The last traces of chloroform are sometimes difficult of removal, but may be hastened by the addition of a little ether. The residue may be weighed, or it may be dissolved in a definite quantity of N/10 acid and the excess of acid titrated with N/50 alkali. The number of cubic centimeters of N/50 alkali used divided by five to reduce it to decinormal, and the quotient subtracted from the number of cubic centimeters of decinormal acid taken, will give the number of cubic centimeters neutralized by the alkaloid. This multiplied by $\frac{1}{10000}$ of the molecular weight of the alkaloid will give the weight of alkaloid in the amount of drug taken. If 10 Gm. of drug were taken then the result must be multiplied by ten to obtain the percentage of alkaloid in the drug. (For details of method, see "Aconite" or "Belladonna.") Avoid violent agitation when shaking the separator, as it is apt to form an emulsion difficult to separate. A rotary motion helps to avoid this. If the emulsion does not separate upon standing it may be necessary to warm the mixture or possibly to evaporate the immiscible solvent and to begin the operation again. Another method directs that the whole be filtered through a tube, 2 cm. wide and 8 or 10 cm. long, filled with absorbent cotton. Sometimes a partial emulsion forms between the two liquids, which interferes with complete separation. This may frequently be broken by placing a tuft of cotton in the solution which may be carefully moved about in the emulsion and pressed into the bottom of the separator, so that the liquid must filter through it when it is drawn off. This operation is accomplished by the use of a fine-pointed glass tube curved in the form of a hook.

Fluidextracts and tinctures are sometimes evaporated to remove the alcohol, then taken up with acidulated water and filtered into a separator containing some immiscible solvent together with ammonia. The remainder of the method corresponds with that outlined above. In other cases the fluidextract is placed directly in a separator and shaken out with immiscible solvents, after making alkaline with ammonia.

Fig. 150



Apparatus for evaporation of volatile solvents.

Extracts are usually dissolved in some solvent in which they are readily soluble and then treated similarly to fluidextracts. The method for the assay of the preparations of a drug is with slight modifications similar to that used for the drug. Hence, special comments are unnecessary.

For the evaporation of immiscible solvents in alkaloidal assay work, W. H. Blome uses an apparatus similar to Fig. 150. The current of air being drawn over the surface of the solvent causes it to evaporate rapidly. The cotton filters the air, thus keeping out the dust.

PHARMACOPŒIAL ASSAY METHODS.

For the purposes of comparison and study of the pharmacopœial assay methods for different drugs, the greater number can be divided into two groups. However, there are a few drugs which it is necessary to consider individually. The first group contains *belladonna, hyoscyamus, stramonium, scopola, coca,* and *pitocupus.* The powdered drug is macerated with the immiscible solvent made alkaline with ammonium hydroxide and percolated until exhausted. The solvent containing the free alkaloid is shaken out with water acidulated with sulphuric acid. The aqueous solution containing the alkaloid as a sulphate is made alkaline and shaken out with the immiscible solvent. The solvent is evaporated and the residue dissolved in a definite quantity of N 10 acid, afterward being titrated with N/50 potassium hydroxide.

The second group contains *guarana, hydrastis, ipecac,* and *physostigma.* The drug is shaken for a given time with the alkaline immiscible solvent and an aliquot part of the clear liquid taken. This represents a definite quantity of the drug. The remainder of the method is the same as the preceding, except that the residues from hydrastis and guarana are weighed in place of titrated.

The principal alkaloids of hydrastis are hydrastine and berberine. The latter is excluded by the *Pharmacopœial* method enployed for this drug, as the free alkaloid is practically insoluble in ether, and its salts are but sparingly soluble in water. In the case of the fluidextract a little potassium iodide is added before adding the alkali. This precipitates the berberine as a hydroiodide, which is removed by filtration.

Aconite.—Aconite is exhausted by maceration and percolation with a mixture of alcohol and water. The percolate is evaporated in a broad evaporating dish at a temperature not exceeding 60° C. The residue is dissolved in sulphuric acid rendered alkaline with ammonium hydroxide, and shaken out with ether. The ether is evaporated and the residue dissolved in a definite quantity of N/10 acid and titrated. The original method of the author directed the addition of 5 Gm. of powdered pumice stone to the liquid before evaporation. It is unfortunate that this was omitted from the process, as it aids solution and filtration. Aconitine is easily decomposed by heat, especially in aqueous solutions. For this reason the temperature of 60° C. should not be exceeded.

Conium.—The drug is shaken with a mixture of ether, alcohol, and ammonium hydroxide. An aliquot part of the liquid is acidulated and evaporated, the residue being allowed to stand until the ammonium sulphate separates. It is then filtered and the filter washed with alcohol, after which the alcohol is evaporated to a small volume. Then the acid solution is washed with ether to remove fatty matter. The solution is then made alkaline with sodium carbonate and shaken out with ether. The ether solution is acidulated with hydrochloric acid and evaporated. The residue is mixed with alcohol and again evaporated to insure the complete removal of the excess of hydrochloric acid. The residue is then weighed.

Cinchona.—The drug is shaken for five hours with a mixture of chloroform, ether, and ammonium hydroxide. An aliquot part of the clear solution is shaken out with acidulated water, and divided into two equal parts. From one portion the total anhydrous alkaloids are determined, by rendering the portion alkaline and shaking out with a mixture of chloroform and ether. Then evaporate and weigh. The second portion is shaken out in the same manner, using a definite quantity of ether. This gives the ether-soluble alkaloids, which consist principally of quinine with some quinidine and cinchonidine. The solubility in ether of the four principal alkaloids of cinchona, as given by Hesse, are: Quinine, 4.5 parts; quinidine, 22 parts; cinchonidine, 70 parts; and cinchonine, 526 parts.

Nux Vomica.—The total alkaloid for nux vomica, strychnine, and brucine are obtained by shaking out, according to directions for the second group. The residue is then dissolved in 3 per cent. sulphuric acid and the brucine destroyed by oxidation with nitric acid, neutralized and shaken out with chloroform, and, finally, evaporated and titrated. It is of the greatest importance that the directions be closely followed. The nitric acid used should bave a specific gravity of 1.42. If the acid be too weak the brucine will be imperfectly oxidized; if too strong or allowed to stand too long, a portion of the strychnine will be destroyed. The addition of 0.01 Gm. of sodium nitrate to the nitric acid insures a uniform oxidation.

Opium.—Morphine, the principal alkaloid in opium, does not behave toward solvents like other alkaloids, hence an entirely different procedure is necessary. The opium is exhausted with water, evaporated to a small volume, alcohol and ether added, and after agitation ammonium hydroxide is added. It is again agitated for ten or fifteen minutes. When crystals begin to appear it is then allowed to stand nine hours or overnight. The ether is decanted, and more ether added and decanted, to remove narcotine and other alkaloids. The crystals are then collected on a filter, washed, dried, and weighed. As morphine is sparingly soluble in the water used, and more soluble in an excess of alkali, it is important that the solution be as concentrated as possible before adding the alkali, also that an excess of alkali should be avoided. In any case some morphine will be lost in the mother liquid. The morphine obtained is apt to be impure, and the *Pharmacopœia* directs to determine the impurities by dissolving the morphine in lime water and weighing the impurities. This must be deducted from the weight of impure morphine obtained.

Colchicum.—*Seed and Corm.*—10 Gm. of the drug are occasionally agitated for twelve hours with a mixture of chloroform, ether, alcohol, and ammonia water. An aliquot part, representing 5 Gm., is evaporated to dryness and dissolved in 10 Cc. of ether. A little water is added and the mixture stirred until the ether evaporates. It is then filtered, the residue again treated with ether and water, and the whole filtered. The filtrate is then shaken out with chloroform. The chloroform is evaporated and the residue treated as before, and finally shaken out again with chloroform. Lastly, the chloroform is evaporated, and all remaining traces of it are removed by adding a little alcohol and again evaporating to dryness and then weighed. The object of repeated treatments with ether and water is to completely remove the alkaloid from the fatty resinous matter.

Jalap.—Jalap contains two resins, the most valuable being insoluble in ether. Hence, the *Pharmacopœia* directs first to extract with ether, then evaporate and weigh the residue as ether-soluble resin. The drug previously extracted with ether is reëxtracted with alcohol, and the alcoholic extract mixed with chloroform and water. After separation the chloroform is drawn off and the aqueous liquid again shaken out with chloroform. Finally, the chloroform is evaporated, the residue dried and weighed as ether-insoluble resin. This added to the ether-soluble resin gives the total resin in the jalap.

Assay of Spirits of Nitrous Ether.—The *Pharmacopœia* gives detailed directions for the assay, and in the appendix, under Gasometric Estimation, describes the apparatus and method of using. It therefore remains only to explain some of the manipulations and changes involved. The operation consists in filling the nitrometer with a saturated salt solution and running into it a definite quantity of the spirit. This is followed with potassium iodide solution, and then dilute sulphuric acid. The ethyl nitrite is decomposed according to the following equation:

$$\underset{\substack{\text{Ethyl}\\\text{nitrite.}}}{C_2H_5NO_2} + \underset{\substack{\text{Sulphuric}\\\text{acid.}}}{H_2SO_4} + \underset{\substack{\text{Potassium}\\\text{iodide.}}}{KI} = \underset{\text{Alcohol.}}{C_2H_5OH} + \underset{\substack{\text{Potassium}\\\text{acid sulphate.}}}{KHSO_4} + \underset{\text{Iodine.}}{I} + \underset{\substack{\text{Nitric}\\\text{oxide.}}}{NO}$$

The nitric oxide gas is measured as directed, observing temperature and pressure. The object of using the saturated salt solution is to increase the density of the water, in order that the solutions which are added will not mix readily with the water. Before weighing the spirits it is shaken with potassium bicarbonate to neutralize the acid, which is sure to be present in spirits kept for any length of time. As the gas is to be measured, it is important that all air be expelled by lifting the open arm or bulb until the salt solution completely fills even the bore of the stopcock. After closing the stopcock the open arm or bulb should be lowered before allowing the liquids to pass in, otherwise any gas that is formed would be forced upward through the liquid and lost. As there is an excess of the acid solution, it is not necessary to let all of it pass into the nitrometer. If a few drops are allowed to remain above the stopcock there will be no danger that air may enter the nitrometer.

Each cubic centimeter of gas is the equivalent of 0.0030673 Gm. of ethyl nitrite at 25° C. and 760 mm. pressure, which, multiplied by the number of cubic centimeters of gas obtained, gives the amount of ethyl nitrite in the amount actually taken. Then the amount taken is to the weight of ethyl nitrite obtained, as 100 is to the per cent. of ethyl nitrite in the solution.

Example.—If 31 Gm. of the spirits be diluted to 100 Cc., and 10 Cc. of this, equals 3.1 Gm. of spirits, are placed in the nitrometer, then 40 Cc. of nitric oxide be obtained. We have $40 \times 0.003067 = 0.12268$ Gm. of ethyl nitrate. $3.1 : 0.12268 :: 100 : X = 3.9$ per cent. of ethyl nitrate. The *Pharmacopœia* directs that a correction be made for variations from standard temperature and pressure. The temperature correction is one-third of 1 per cent. of the total percentage found, for each degree of temperature, additive if below and subtractive if above 25°.

The pressure correction is four-thirtieths of 1 per cent. for each millimeter, additive if above, subtractive if below, 760 mm. In the above problem, let it be supposed that the gas was measured at 20° C. instead of at 25° C. We will then have $3.9 \times 0.0033 \times 5 = 0.065$, to be added to $3.9 = 4.01$ per cent. Had the temperature been 30° instead of 25° C. then the 0.065 must be subtracted for the per cent. If the gas had been measured at a pressure of 720 mm. instead of 760 mm. the correction for pressure would be $(760 - 720) = 40 \times 0.00133 \times 3.95 = 0.22$, to be subtracted from $4.015 = 3.895$ per cent.

Assay of Amyl Nitrite.—The same method is employed for the assay of amyl nitrite as is used for spirits of nitrous ether. The reaction is:

$C_5H_{11}NO_2$ +	KI +	H_2SO_4 =	$C_5H_{11}OH$ +	$KHSO_4$ +	I +	NO
Amyl nitrite.	Potassium iodide.	Sulphuric acid.	Amyl alcohol.	Potassium acid sulphate.	Iodine.	Nitric oxide.

Assay of Solution of Hydrogen Dioxide.—The assay depends upon the reaction taking place between the hydrogen dioxide and potassium permanganate, in the presence of sulphuric acid. Both are reduced with the liberation of oxygen, as is shown by the following equation:

$$\underset{\text{Hydrogen dioxide.}}{5H_2O_2} + \underset{\text{Potassium permanganate.}}{2KMnO_4} + \underset{\text{Sulphuric acid.}}{3H_2SO_4} = \underset{\text{Potassium sulphate.}}{K_2SO_4} + \underset{\text{Manganous sulphate.}}{2MnSO_4} + \underset{\text{Water.}}{8H_2O} + \underset{\text{Oxygen.}}{5O_2}$$

One atom of oxygen is liberated from each molecule of hydrogen dioxide and the other atoms of oxygen are furnished by the potassium permanganate. Therefore, each cubic centimeter of N/10 potassium permanganate is equivalent to 0.001688 gm. of hydrogen dioxide. If a quantity of the solution, represented by one-tenth of the combining weight of the hydrogen dioxide, is taken, then the numbers of cubic centimeters of the N/10 potassium permanganate consumed will correspond to 0.1 per cent. of absolute hydrogen dioxide.

Assay of Formaldehyde.—The formaldehyde is mixed with a definite quantity of normal sodium hydroxide solution, then oxidized to formic acid by the action of hydrogen dioxide solution, which combines with the sodium hydroxide to form sodium formate.

$$\underset{\text{Formaldehyde.}}{2HCOH} + \underset{\text{Hydrogen dioxide.}}{HOOH} + \underset{\text{Sodium hydroxide.}}{2NaOH} = \underset{\text{Sodium formate.}}{2NaCOOH} + \underset{\text{Water.}}{2H_2O} + \underset{\text{Hydrogen.}}{H_2}$$

When reaction ceases, the excess of sodium hydroxide is titrated back with normal sulphuric acid. One molecule of sodium hydroxide is neutralized by the acid formed from one molecule of formaldedyde. Accordingly, 1 Cc. of normal sodium hydroxide solution so neutralized is equivalent to 0.02979 Gm. of absolute formaldehyde.

Assay of Pepsin.—The assay of pepsin depends upon the amount of hard-boiled egg albumin capable of digestion by a given quantity of pepsin under definite conditions. By varying the conditions different results are obtained. For this reason it is of the greatest importance that the directions be strictly followed. High temperature destroys pepsin, but a slight elevation above the 52° C. directed for the test, or more vigorous agitation than directed, increases the amount of albumin dissolved.

Assay of Pancreatin.—The assay of pancreatin is based upon the power which pancreatin possesses to convert starch into dextrine and maltose, or substances soluble in water. Unconverted starch forms a blue or purple color with iodine solution, while the converted starch produces at most only a reddish shade.

CHAPTER XLV.

NOTES ON ASSAY METHODS FOR VOLATILE OILS.

THE *Pharmacopœia* furnishes methods for the assay of a number of volatile oils, and in most cases the methods are so simple that they can be easily followed. However, a few comments upon the general principles involved may assist the student in understanding the details of the operation.

Assay of Aldehydes.—The method for the assay of such oils as bitter almonds, cinnamon, lemon, and the synthetic benzaldehyde depends upon the fact that sodium acid sulphite forms with aldehydes a compound soluble in water. In the case of oil of cinnamon, the cinnamic aldehyde first forms with the acid sulphite a sparingly soluble compound, thus:

$$\underset{\substack{\text{Cinnamic}\\\text{aldehyde.}}}{C_8H_7COH} + \underset{\substack{\text{Sodium}\\\text{bisulphite.}}}{NaHSO_3} = \underset{\substack{\text{Sodium cinnamaldehydroxy-}\\\text{sulphonate.}}}{C_8H_7COH.NaHSO_3.}$$

By continued heat two molecules of the sparingly soluble compound is broken up into cinnamic aldehyde and the soluble compound, thus:

$$2C_8H_7COHNaHSO_3 + \text{heat} = \underset{\substack{\text{Cinnamic}\\\text{aldehyde.}}}{C_8H_7COH} + \underset{\substack{\text{Sodium sulphocinnamalde-}\\\text{hydroxysulphonate.}}}{C_7H_7CH,\ NaSO_3.\ \ COH.\ \ NaHSO_3}$$

By supplying additional quantities of the bisulphite solution and heating, all the aldehyde may be converted into the soluble compound. The operation is conducted in a 100 Cc. flask with a long neck, graduated to tenths of a cubic centimeter. When the aldehyde is all combined, the solution is cooled to 25° and enough of the bisulphite solution is added to raise the bottom of the uncombined oil to the zero mark. The number of cubic centimeters of uncombined oil subtracted from the amount taken gives the amount of aldehyde present. In the case of the oils of bitter almond, lemon, and the benzaldehyde, the same principle is involved, except that the bisulphite is formed by the action of hydrochloric acid on normal sodium sulphite. The bisulphite formed combines with the aldehyde, and the solution becomes alkaline. By the cautious addition of hydrochloric acid a point may be reached where the solution remains neutral and all the aldehyde is combined with the sulphite. In the pharmacopœial test, the amount of alcohol is determined by the amount of N/2 hydrochloric acid required to maintain a neutral solution when added to a mixture of the oil with a neutral solution of sodium sulphite. The reaction may be seen from the following equation, using citrol as the aldehyde:

$$\underset{\substack{\text{Hydro-}\\\text{chloric acid.}}}{2HCl} + \underset{\substack{\text{Sodium}\\\text{sulphite.}}}{2Na_2SO_3} + \underset{\text{Citrol.}}{C_9H_{15}COH} = \underset{\text{Citroldihydrosulphonate.}}{C_9H_{16}(NaHSO_3)_2COH.} + \underset{\substack{\text{Sodium}\\\text{chloride.}}}{2NaCl.}$$

Two molecules, each of hydrochloric acid and sodium sulphite, are required for one molecule of the aldehyde. Hence, 1 Cc. of N/2 hydrochloric acid is equivalent to

$$\frac{\text{molecular weight of aldehyde}}{2 \times 1000 \times 2}$$

With citrol x = 0.037745.

Assay of Alcohol.—Alcohols present in oils are usually partially free, and partially combined as an ester, which is a combination of an alcohol and an organic acid. In this case it is best to determine the ester by saponification. and then to convert the free oil into an ester by acetylization, and again saponify to determine the total alcohols. The details of this method are included in the pharmacopœial method for the assay of peppermint oil. The ester is first determined by the saponification of a known weight of the oil with an excess of N/2 alcoholic potassium hydroxide solution. The mixture is boiled for one hour in a flask connected with an upright condenser. Then the excess of potassium hydroxide is determined by titration with half normal sulphuric acid solution, which amount deducted from the amount of N/2 potassium hydroxide solution taken, gives the amount required to saponify the oil. Each cubic centimeter of this N/2 potassium hydroxide is equivalent to

$$\frac{\text{molecular weight}}{1000 \times 2}$$

= 0.09834 Gm. of menthol acetate. Hence, to find the per cent., multiply the number of cubic centimeters by (0.09834 × 100) and divide by the weight of the oil taken.

$$C_{10}H_{19}C_2H_3O_2 + KOH = C_{10}H_{19}OH + KC_2H_3O_2.$$

Menthol acetate.	Potassium hydroxide.	Menthol.	Potassium acetate.

For the determination of the total alcohol, a fresh portion of oil may be taken or the residual oil from the above operation may be thoroughly washed and a portion of it placed in a flask together with the glacial acetic acid and anhydrous sodium acetate. The flask should be connected with a reflex condenser by means of a ground-glass joint. The mixture is boiled for one hour, and after cooling the oil is separated, washed with water, and finally, with sodium hydroxide to remove the free acid. It is dried with fused calcium chloride. The alcohol is then determined by the saponification of a weighed quantity of the acetylized oil as previously given. Each cubic centimeter of N/2 potassium hydroxide solution required is equal to 0.07749 Gm. of free menthol. The amount of acetylized oil taken does not represent the same amount of the original oil, since it has increased in weight by acetylization. The amount of the increase is equal to the difference between the equivalents of the acetic ester and the free menthol, multiplied by the number of cubic centimeters of potassium hydroxide required for saponification, or 0.09834 − 0.07749 = 0.02085, or approximately 0.021 Gm. for each cubic centimeter of N/2 potassium hydroxide. This multiplied by the number of cubic centimeters N/2 required gives the amount to be subtracted from the weight of acetylized oil taken, in order to obtain its equivalent of original oil. To obtain the total per cent. of menthol, multiply 0.07749 by the number of cubic centimeters of N/2 potassium hydroxide required, and by 100 divided by the weight of original oil. Oil of rosemary containing bornyl acetate and borneol is assayed by the above method. Oil of santol is assayed for total alcohol only. Oil of rose is assayed by determining its saponification number by the usual method.

Assay of Phenols.—The pharmacopœial method for the assay of phenols rests upon the fact that they form soluble compounds with alkalies.

In the case of cloves and pimento the oil is placed in a flask with a long neck, graduated to tenths, and shaken with the potassium hydroxide solution. After separation sufficient potassium hydroxide solution is added to raise the lower surface of the uncombined oil to zero. The volume of uncombined oil subtracted from the amount taken gives the amount of phenol present in the oil. The method for oil of thyme is practically the same except that less alkali is used and the operation is conducted in a burette.

Assay for Cineol.—The pharmaceutical method for the assay of oils of eucalyptus and cajuput depend upon the formation of cineol phosphate insoluble in cold benzin, but decomposed by hot water. The oil is dissolved in benzin, which is placed in a freezing mixture, and phosphoric acid added, drop by drop, until the white magma begins to turn yellow or pink. Then it is poured upon a rapid force filter, washed with cold benzin and dried by pressure between porous plates. The dried cineol phosphate is then placed in a cylindrical graduate, decomposed by hot water, and the volume of cineol measured.

PART III.

DISPENSING.

Most operations involved in dispensing have already been treated in Part II. There remains, however, a few special subjects which apply to the prescription that must be considered individually.

CHAPTER XLVI.

THE PRESCRIPTION.

The paper upon which a prescription is written is called a "prescription blank." It should be of good quality, of strong texture, and not easily torn. In size it should be five inches long by three and one-half inches wide. In the upper left-hand corner should be printed the prescription symbol ℞. For convenience the physician's name, address, and telephone number should also appear upon the blank, in case it becomes necessary for the pharmacist to consult the physician. The word prescription is derived from the Latin *præscribere, præ,* before, and *scribere,* to write; to write before. The term "prescription" is applied to the written order given a patient, and also to the medicine compounded by the pharmacist, when the physician's written order is presented to him. These may be distinguished as the "Written Prescription," and the "Compounded Prescription."

THE WRITTEN PRESCRIPTION.

The written prescription may be divided into four parts—the *superscription,* the *inscription,* the *subscription,* and the *signature.*

The Superscription.—The superscription bears the date, and also the name of the patient. The latter is especially necessary when the medicine is for a babe or a young child. Many superscriptions contain only the symbol ℞, which is doubtless a combination of the plain R for recipe and the symbol ♃. The latter is the symbol of Jupiter, and formerly preceded the formula or prescription. This symbol supplied the place of an ancient custom of beginning a prescription with an invocation to the gods. While many physicians know of its origin, doubtless many use it without a thought of its superstitious meaning, but use it in place of recipe, meaning "take thou."[1]

The Inscription.—The inscription contains the names of the ingredients, which should be written in Latin. This is so because the Latin language is not subject to change, and is used by intelligent physicians in all parts

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[1] Those interested in the history of the prescription should read the book entitled The Prescription, by Dr. C. O. Wall.

of the civilized world. Therefore, a prescription written in France, Germany, or Russia may be compounded in the United States. Furthermore, each name indicates a particular substance, while *common* names are frequently applied to different substances. The common name "snake root" may mean either cimicifuga, senega, or serpentaria, and has been applied to more than a dozen other plants, several of which are used medicinally. Again, the same plant may be known by different names in different localities. Hydrastis is recognized by at least fourteen common names in the United States. Such facts prove the absurdity of complying with the public's frequent demand that physicians should write prescriptions in the English language. It is also often better for the patient that he should not know what he is taking; hence, pharmacists should be cautious about supplying such information. Physicians seldom write the names of ingredients with full Latin endings, but usually abbreviate. This practice is unobjectionable when not carried to such an extent as to obscure the meaning. The names of the ingredients are followed by the quantities of each, which if written in the old system is expressed by the symbols gr., ℈, ʒ, ℥, and Roman numerals. If written in the metric system they are expressed by Arabic numerals followed by the abbreviations Gm. or Cc. These abbreviations are frequently omitted when the decimal point is used. In Europe the denomination is understood, as solids and liquids are always weighed. When the decimal system is employed, a line should be used in place of decimal points.

The Subscription.—The subscription, or the directions to the dispenser, are written in Latin, but are generally abbreviated, Ft. Sol. (Fiat solution), let there be made a solution; M. Ft. Colly. et fill., misce, fiat collyrium et filtra; mix, make eye wash, and filter. For other abbreviations employed, see list, page 388.

The Signature.—The signature, or directions to the patient, should be written in English, thus avoiding any possibility of mistake in translating. The practice of writing "as directed," or "take as directed," cannot be too severely condemned, as it leaves the dispenser with no knowledge of the dose. Hence, an *overdose* may be most easily dispensed. Furthermore, the patient may forget the dose, especially when taking more than one mixture during the day. Let the directions be followed by the name, address, and telephone number of the prescriber.

The following prescription serves to illustrate:

Superscription:

For C. Adair, March 12, 1909.

℞

Inscription:	Strychninæ sulphatis	gr. ss
	Ipecacuanhæ	gr. ij
	Extracti belladonnæ foliorum	gr. ij
	Massæ hydrargyri	℈ ij
	Extracti colocynthidis compositi	℈ ij
Subscription:	Misce et divide in pilulæ numero viginti.	
Signature:	Signa, one pill night and morning.	

Dr. Blank,
30 Arbor Street.
Phone, 211.

R or ℞ is an abbreviation for the verb *recipe,* which means "take thou," and might be written, "take a given quantity of the given ingredients." Hence, when placed at the beginning of a prescription it applies to or governs the amount of each ingredient contained therein. Therefore, the *quantities,* when written in Latin, are placed in the accusative case, and are the direct objects of the verb *recipe.* The *ingredients* are all in the genitive case.

Strychninæ, Ipecacuanhæ, Belladonnæ, and *Massæ* are all genitive singular feminine nouns of the first declension.

Sulphatis is a genitive singular masculine noun of the second declension.

Extracti and *Hydrargyri* are genitive singular neuter nouns of the third declension.

Foliorum is a genitive plural feminine noun of the first declension.

Colocynthidis is a genitive singular feminine noun of the third declension.

Compositi is the genitive singular of compositum, an adjective qualifying the noun extractum, with which it must agree in gender, number, and case.

CHAPTER XLVII.

SYNOPSIS OF PRESCRIPTION LATIN.

In this chapter it is purposed to outline only so much of Latin grammar as is serviceable in prescription reading, hence the title.

Pronunciation.—In this paragraph Latin pronunciation can be discussed only very superficially. By the English method here adopted the student should in general endeavor to pronounce Latin words as he would were they English words. The sounds of the letters are the same as in English, including the short and long vowel sounds. The following hints are supplementary only:

a. The Latin alphabet has no *w*, otherwise it is the same as the English.

b. (1) *ch* = *k*, as in *chloroform; c* = *s* and *g* = *j* before *e, i, y, æ, œ, eu; charta, cera, geum.*

(2) Final *es* and *os* like *ease* and *dose.*

(3) *y* = *i*, *æ* and *œ* equal *e* in all cases; *au* = *awe; eu* like *you; ei* = *i* in *pie.*

(4) Final *a* as in *spatula,* but *ā, dā, quā* as in *day, e. g., bacca.*

(5) A vowel ending an accented syllable has its long English sound, but has its short sound when followed by a consonant in the same syllable, *e. g.,* hy″-ŏs-cy-ā′-mus.

(6) A word has as many syllables as vowels and diphthongs; join consonants to vowels according to ease of pronunciation.

c. The rules usually given for quantity and accent are as follows:

(1) A syllable is long in quantity when it has (1) a long vowel, (2) a diphthong, or (3) a short vowel followed by *x, z,* or two consonants; and is short when it contains a short vowel, or vowel followed by another vowel or *h.*

(2) Accent words of two syllables on the first, words of more than two syllables on the next to the last syllable *if long,* but if *short* accent the second from the last syllable.

English and Latin Compared.—*Declension.*—In Latin there are no words for the English articles *a* and *the.* Furthermore, in English we express word relations and such ideas as time, direction, possession, etc., by combinations of prepositions with nouns, whereas the Latin oftener accomplishes this by suffixing to the body of the word, called the *base,* syllables which serve as prepositions. Thus, if we suffix *a* to *chart,* the base of the Latin word for paper, we have *charta,* "the paper," as subject of the sentence. If we suffix *æ* we have *chartæ,* "of the paper," corresponding to the English possessive form; if *am,* we get *chartam,* "the paper," as object of a verb. Adding *ā* gives *chartā,* the ablative form meaning sometimes, "on the paper." These four changes in the word *charta* exemplify the four "cases" of nouns used in pharmaceutical Latin—nominative, genitive, accusative, and ablative. Together they illustrate the meaning of declension, or the changing of the form of nouns and adjectives to show case, number, and gender. In Latin there are five such declensions of nouns, distinguished by the genitive ending, singular number.

DECLENSION OF NOUNS.

Prescription Latin consists mostly of nouns and adjectives together with a few verbs, adverbs, prepositions, and conjunctions.

First Declension.—The genitive singular of first declension nouns ends in -*ae*, the nominative in -*a*. All except four of the nouns[1] in *a* belong to this declension, are feminine, and declined as follows:

Mistura, a or the mixture; base, *mistur*-[2]

Singular.

Nom. mistūr*a*, a mixture (as subject).
Gen. mistūr*æ*, of a mixtura.
Acc. mistūr*am*, a mixture (as object).
Abl. mistūr*ā*, with, by, from, in a mixture.

Plural.

Nom. mistūr*æ*, mixtures (as subject).
Gen. mistūr*ārum*, of mixtures.
Acc. mistūr*ăs*, mixtures (as object).
Abl. mistūr*īs*, with, by, from, in mixtures.

Similarly decline aqua, belladonna, capsula, drachma, scatula, uncia.

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[1] Aspidosperma, cataplasma, physostigma, and coca.

[2] The base sometimes coincides with the stem, sometimes not.

Second Declension.—The genitive singular of second declension nouns ends in *-i*, the nominative of the masculines in *-us* (*os*), of the neuters in *-um* (*on*). There are no feminines. All except eight of the nouns[1] in *-us* are of this declension and are declined as follows:

Syrupus, a or the syrup; base, *syrup*.

Singular.

Nom. syrup*us*, the syrup (as subject).
Gen. syrup*ī*, of a syrup.
Acc. syrup*um*, the syrup (as object).
Abl. syrup*ō*, with, by, from, in a syrup.

Plural.

Nom. syrup*ī*.
Gen. syrup*ōrum*.
Acc. syrup*ōs*.
Abl. syrup*īs*.

Similarly, decline phosphorus, daucus, hyoscyamus, cactus, octarius,[2] congius.[2] Greek nouns in -os[3] are declined like—

Prinos, black alder; base, *prin-*

	Singular.	Plural.
Nom.	prin*os*.	prin*ī*.
Gen.	prin*ī*.	prin*ōrum*.
Acc.	prin*on*.	prin*ōs*.
Abl.	prin*ō*.	prini*īs*

Likewise decline diospyros, and cissampelos.

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[1] Rhus, fortius, cornus, fructus, haustus, potus, quercus, spiritus.

[2] Genitive in *-iī*

[3] Flos, floris, is of the third declension.

The models for neuter nouns are:

Unguentum, ointment; base, *unguent-*

	Singular.	Plural.
Nom.	unguent*um.*	unguent*a.*
Gen.	unguent*ī.*	unguent*ōrum.*
Acc.	unguent*um.*	unguent*a.*
Abl.	unguent*ō.*	unguent*īs.*

Similarly, decline ferrum, granum, infusum, cuprum, trillium, hordeum.

Diachylon, lead plaster; base, *diachyl-*

	Singular.	Plural.
Nom.	diachyl*on.*	diachyl*a.*
Gen.	diachyl*ī.*	diachyl*ōrum.*
Acc.	diachyl*on.*	diachyl*a.*
Abl.	diachyl*ō.*	diachyl*īs.*

Decline erythroxylon, hæmatoxylon, liriodendron, phoradendron, toxicodendron.

Third Declension.—The genitive singular of third declension nouns ends in *-is,* the nominative in *-a, -e, -i, -o, -y, -c, -l, -n, -r, -s, -t, -x.* The base is always the genitive singular deprived of *-is.* All of the remaining cases are formed by adding the case ending to the base, except where in neuters the accusative and nominative singular are the same. The masculines and feminines are declined alike, the neuters somewhat differently. The following is a partial classification of these nouns according to the nominative and genitive singular endings.

TYPES OF THIRD DECLENSION NOUNS.

	Gender.	Nom.	Gen.	Paradigm.	Meaning.
1.	Neut.	-a	-atis	stigm*a*, stigm*atis*	brand, mark.
2.	Mas.	-as	-atis	bor*as*, bor*atis*	borate
3.	Neut.	-ar	-aris	cochle*ar*, cochle*aris*	spoon
4.	Neut.	-e	-is	secal*e*, secal*is*	rye, grain
5.	Neut.	-en	-inis	gram*en*, gram*inis*	grass
6.	M. and N.	-er	-eris	æth*er*, æth*eris*, M.	ether
				pip*er*, pip*eris*, N.	pepper
7.	Fem.	-es	-is	mol*es*, mol*is*	huge bulk
8.	Fem.	-is	-is	dos*is*, dos*is*	dose
9.	Fem.	-is	-idis	mac*is*, mac*idis*	mace
10.	Mas.	-is	-tis	nitr*is*, nitr*itis*	nitrite
11.	Mas.	-is	-eris	pulv*is*, pulv*eris*	powder
12.	Mas.	-o	-onis	sap*o*, sap*onis*	soap
13.	Fem.	-do	-dinis	hiru*do*, hiru*dinis*	leech
14.	Fem.	-go	-ginis	fuli*go*, fuli*ginis*	soot
15.	Fem	-io	-ionis	præscript*io*, -script*ionis*	prescription
16.	Fem.	-on	-onis	lim*on*, lim*onis*	lemon
17.	Mas.	-or	-oris	liqu*or*, liqu*oris*	fluid
18.	Mas.	-os	-oris	fl*os*, fl*oris*	flower
19.	Fem.	-ns	-ndis	jugl*ans*, jugl*andis*	walnut
20.	Neut.	-c	-ctis	la*c*, la*ctis*	milk
21.	Mas.	-ol	-olis	menth*ol*, menth*olis*	menthol
22.	Neut.	-l	-lis	chlor*al*, chlor*alis*	chloral
23.	Neut.	-ur	-uris	sulph*ur*, sulph*uris*	sulphur
24.	Fem.	-rs	-rtis	pa*rs*, pa*rtis*	part
25.	Fem.	-ps	-pis	ade*ps*, adi*pis*	fat
26.	Fem.	-x	-cis	corte*x*, corti*cis*	bark

Important Exceptions.—Asclepias, -adis, f.; Mas, maris, m. *Rhus*, *rhois* (gen.) rhum (acc.).

PARADIGMS.

Bilis	Oleas	Potio
Base, *bil-*	*olea-t-*	*potio-n-*
Bile	Oleate	Potion

Singular.				Termination
Nom.	bīl*is*	oleās	potiō	
Gen.	bīl*is*	oleāt*is*	potiōn*is*	-is
Acc.	bīl*em*	oleāt*em*	potiōn*em*	-em
Abl.	bīl*e*	oleāt*e*	potiōn*e*	-e

Plural				Termination
Nom.	bīlē*s*	oleā*tēs*	potiō*nēs*	-es
Gen.	bīl*ium*	oleā*tum*	potiō*num*	-ium, -um
Acc.	bīl*īs*	oleā*tēs*	potiō*nēs*	-is, -es
Abl.	bīl*ibus*	oleā*tibus*	potiō*nibus*	-ibus

Pix	Semen	Mel
pic	*semin*	*mell*
Pitch	Seed	Honey

Singular				Termination
Nom.	pix	sēmen	mel	
Gen.	pic*is*	sēmin*is*	mell*is*	-is
Acc.	pic*em*	sēmen	mel	-em
Abl.	pic*e*	sēmin*e*	melle	-e

Plural				Termination
Nom.	pic*ēs*	semin*a*	mell*a*	-es, -a
Gen.	pic*um*	semin*um*	mell*um*	-um
Acc.	pic*ēs*	semin*a*	mella	-is, -a
Abl.	pic*ibus*	semin*ibus*	mell*ibus*	-ibus

Fourth Declension.—Four or five nouns of this declension are neuter, a couple of dozen feminine, and the rest masculine. None of the neuters and but few feminines (botanical names) have pharmaceutical importance. Masculine and feminine nouns are declined alike, having the same form in both nominative and genitive singular, ending in *-us*. This when dropped gives the base. The ablative plural of dissyllable nouns in *-cus* ends in *-ubus*, *e. g.*, quercus, quercubus.

PARADIGM.

Pulsus, pulse; base, *puls-*

	Singular.	Plural.
Nom.	puls*us.*	puls*us.*
Gen.	puls*ūs.*	pulsu*um.*
Acc.	puls*um.*	puls*ūs.*
Abl.	puls*ū.*	puls*ibus.*

Decline, also, spiritus, ficus, auctus, æstus, abscessus, vomitus.

Fifth Declension.—Nouns of the fifth declension have practically no pharmaceutical significance. The genitive singular ends in *-eī*, and are declined as follows:

Diēs; base, *di.* Day.

	Singular.	Plural.
Nom.	di*ēs.*	di*ēs.*
Gen.	di*ēī.*	di*ērum.*
Acc.	di*em.*	di*ēs.*
Abl.	di*ē.*	di*ēbus.*

Most nouns of this declension are declined in the singular only. The student may decline abiēs, eluviēs, glaciēs, and collūviēs in both numbers.

Indeclinable Nouns.—There are also a large number of indeclinable nouns, *i. e.*, such as have the same form in all cases. Buchu, coca, indigo, koumiss, sago, and sassafras are a few of the commonest.

ADJECTIVES.

Latin adjectives have special forms for use: (1) With each case; (2) in both numbers; and (3) for all genders. Each adjective must, therefore, have at least twenty-four such forms; when there is used with a noun that adjectival form which corresponds with it in gender, number, and case, the adjective is said to "agree" with the noun in those three particulars, as is demanded by the laws of Latin grammar.

There are two classes of adjectives. The first class is called adjectives of the first and second declensions, since its case endings correspond to noun forms of those declensions. They are thus declined:

Albus, white; base, *alb-*

	Singular.			Plural.		
	Mas.	Fem.	Neut.	Mas.	Fem.	Neut.
Nom.	alb*us*	alb*a*	alb*um*	alb*ī*	alb*æ*	alb*a*
Gen.	alb*ī*	alb*æ*	alb*ī*	alb*ōrum*	alb*ārum*	alb*ōrum*
Acc.	alb*um*	alb*am*	alb*um*	alb*ōs*	alb*ās*	alb*a*
Abl.	alb*ō*	alb*ā*	alb*ō*	alb*is*	alb*is*	alb*is*

Niger, black; base, *nig-*

	Singular.			Plural.		
	Mas.	Fem.	Neut.	Mas.	Fem.	Neut.
Nom.	nig*er*	nigr*a*	nigr*um*	nigr*ī*	nigr*æ*	nigr*a*
Gen.	nigr*ī*	nigr*æ*	nigr*ī*	nigr*ōrum*	nigr*ārum*	nigr*ōrum*
Acc.	nigr*um*	nigr*am*	nigr*um*	nigr*ōs*	nigr*ās*	nigr*a*
Abl.	nigr*ō*	nigr*ā*	nigr*ō*	nigr*īs*	nigr*īs*	nigr*īs*

Decline exsiccatus, -a, -um; elixus, -a, -um; ruber, -bra, -brum; ater, -tra, -trum; eximius, -a, -um; inscius, -a, -um.

The genitive singular, masculine, and neuter of adjectives in -*ius* ends in -*iī*; *e. g.*, dub*iī*.

The second class of adjectives are called adjectives of the third declension, since their forms correspond to third declensions noun forms. It is to be noticed that their genitive singular always ends in -is. They are designated as adjectives of three, two or one termination, according as they have in the nominative singular, separate forms for all genders, the same form for masculine and feminine, or only one form for all genders. They are thus declined:

Acer, acrid.

	Singular.			Plural.		
	Mas	Fem.	Neut.	Mas.	Fem.	Neut.
Nom.	ăc*er*	ăcr*is*	ăcr*e*	ăcr*ēs*	ăcr*ēs*	ăcr*ia*
Gen.	ăcr*īs*	ăcr*is*	ăcr*is*	ăcr*ium*	ăcr*ium*	ăcr*ium*
Acc.	ăcr*em*	ăcr*em*	ăcr*e*	ăcr*ēs* (*īs*)	ăcr*ēs* (*īs*)	ăcr*ia*
Abl.	ăcr*ī*	ăcr*ī*	ăcr*ī*	ăcr*ibus*	ăcr*ibus*	ăcr*ibus*

Fortis, strong.

	Singular.		Plural.	
	Mas. and Fem.	Neut.	Mas. and Fem.	Neut.
Nom.	fort*is*	fort*e*	fort*es*	fort*ia*
Gen.	fort*is*	fort*is*	fort*ium*	fort*ium*
Acc.	fort*em*	fort*e*	fort*ēs* (*īs*)	fort*ia*
Abl.	fort*ī*	fort*ī*	fort*ibus*	fort*ibus*

Duplex, twofold.

	Singular.		Plural.	
	Mas. and Fem.	Neut.	Mas. and Fem.	Neut.
Nom.	duplex	duplex	duplic*ēs*	duplic*ia*
Gen.	duplic*is*	duplic*is*	duplic*ium*	duplic*ium*
Acc.	duplic*em*	duplex	duplic*ēs*	duplic*ia*
Abl.	duplic*ī*	duplic*ī*	duplic*ibus*	duplic*ibus*

Elegans, elegant.

	Singular.		Plural.	
	Mas. and Fem.	Neut.	Mas. and Fem.	Neut.
Nom.	elegans	elegans	elegant*ēs*	elegant*ia*
Gen.	elegant*is*	elegant*is*	elegant*ium*	elegant*ium*
Acc.	elegant*em*	elegans	elegant*ēs*	elegant*ia*
Abl.	elegant*ī* (*e*)	elegant*ī* (*c*)	elegant*ibus*	elegant*ibus*

Uber, fertile.

	Singular.		Plural.	
	Mas. and Fem.	Neut.	Mas. and Fem.	Neut.
Nom.	ūber	ūber	*ū*ber*ēs*	ūber*a*
Gen.	ūber*is*	ūber*is*	*ū*ber*ium*	ūber*um*
Acc.	ūber*em*	ūber	*ū*ber*ēs*	ūber*a*
Agl.	ūber*ī*	ūber*ī*	*ū*ber*ibus*	ūber*ibus*

Like the models, decline salūber, -bris, -bre; voltālis, -e; solūbilis, -e; dulcis, -e; potens, -tis; sufficiens, -tis; effervescens, -tis; simplex, -plicis; versicolor, -ōris.

Comparison of Adjectives.—The comparative degrees of Latin adjectives are formed by adding *ior* (Mas. and Fem.) and *ius* (Neut.) to the base of the positive; the superlative is formed by adding *issimus, issima, issimum,* thus:

Rarus, rarior, rarissimus.

Mitis, mitior, mitissimus, etc.

The superlative is declined like albus, and the comparative is always declined as follows:

Fortior, stronger.

	Singular.		Plural.	
	Mas. and Fem.	Neut.	Mas. and Fem.	Neut.
Nom.	fortior	fort*ius*	fortiōr*ēs*	fortiōr*a*
Gen.	fortiōr*is*	fortiōr*is*	fortiō*rum*	fortiō*rum*
Acc.	fortiōr*em*	fort*ius*	fortiōr*es* (is)	fortiōr*a*
Abl.	fortiōr*e* (*ī*)	fortiōr*e* (*ī*)	fortiōr*ibus*	fortiōr*ibus*

Form and decline the comparative and superlative degrees of aptus, -a, -um, and gravis, -e.

Numeral Adjectives.—These are little used in prescriptions. The ordinals, primus, secundus, tertius, etc. (first, second, third, etc.), are declined like albus. Of the cardinals, *unus, duo, tres* are the only declinable ones found in prescriptions. Tres, tria (three) is declined like the plural of fortis. Ūnus (one) and duo (two) are declined as follows:

	Singular.			Plural.		
	Mas.	Fem.	Neut.	Mas.	Fem.	Neut
Nom.	ūnus	ūna	ūnum	du*o*	du*æ*	du*o*
Gen.	ūn*īus*	ūn*īus*	ūn*īus*	du*ōrum*	du*ārum*	du*ōrum*
Acc.	ūn*um*	ūn*am*	ūn*um*	du*ōs*	du*ās*	du*o*
Abl.	ūn*ō*	ūn*ā*	ūn*ō*	du*ōbus*	du*ābus*	du*ōbus*

VERBS, ADVERBS, CONJUNCTIONS, AND PREPOSITIONS MOST COMMONLY USED IN PRESCRIPTIONS.

Verbs used in prescription writing usually appear in the imperative mood, or in the third person singular and plural of the subjunctive mood. Examples are:

Solve, dissolve.
Repete, repeat.
Signa, mark.
Divide, divide.
Pone, put.
Adde, add.
Consperge, sprinkle.
Fiat, let it be made.
Detur, dentur, let it, let them, be made.
Obducantur, let them be coated.

Recipe, take.
Misce, mix.
Tere, triturate.
Mitte, send.
Extende, spread.
Cola, strain.
Da, give.
Fiant, let them be made.
Misceantur, let them be mixed.
Repetatur, let it be repeated.
Suffiat, may suffice.

PREPOSITIONS, ETC.

Ab, from, by, with ablative.
Ad, to, with accusative.
Ante, before, with accusative.
Circa, circum, about, around, with accusative.
Cum, with, with ablative.
Ex, e, from, out of, with ablative.
In, in, with accusative.
Pro, for, with ablative.
Post, after, with accusative.
Super, upon, with accusative.
Secundum, according to, with accusative.
Sine, without, with ablative.
Non, ne, not (adverb).
Ana, abbrev. āā, of each.
Et, que, on end of words, and (conjunction).
Ut, so that (conjunction).
Quantum satis, abbrev. q. s., as much as is needed.

LATIN TERMS AND ABBREVIATIONS USED IN PRESCRIPTIONS.

Term or phrase.	Abbreviation.	Meaning.
Ablutio		A washing
Absente febre	Abs. febr.	In the absence of fever
Accuratissime	Accuratiss.	Most carefully
Acerbus		Sour
Ad	Ad	To, up to
Ad conciliandum gustum		To suit the taste
Ad defectionem animi	Ad def. animi	To fainting
Adde, addantur, addendus, addendo		Add, or let them be added, to be added, by adding
Ad duas vices	Ad 2 vic.	At twice taking
Ad gratam aciditatem	Ad grat. acid.	To an agreeable sourness

LATIN TERMS AND ABBREVIATIONS USED IN PRESCRIPTIONS.

Term or phrase.	Abbreviation.	Meaning.
Ad hibendus		To be administered
Ad libitum	Ad. lib.	At pleasure
Ad move, admoveratur, admoveantur	Admov.	Apply, let it be applied, let them be applied
Ad partes dolentes	Ad part. dolent.	To the painful parts
Ad secundum vicem		To the second time
Adstante febre	Adst. febre	When the fever is on
Ad tertiam vicem		For three times
Adversum	Adv.	Against
Æqualis, is, e	Æq.	Equal
Ætas		Age, time of life
Aggredient febre	Aggred. febre	While the fever is coming on
Agita or agitetur	Agit. agitet.	Shake, or let it be shaken
Albus, a, um	Alb.	White
Alternis horis		Every other hour
Alter		The other
Amplus		Large
Ana	ā or āā	Of each
Ante	Ant.	Before
Aqua	Aq.	Water
Aqua bulliens	Aq. bll.	Boiling water
Aqua fervida	Aq. ferv.	Hot water
Aqua phagedenica flava	Aq. phaged. fl.	Yellow wash
Aqua phagedenica nigra	Aq. phaged. nig.	Black wash
Aqua saturni	Aq. saturn.	Lead water
Aquila alba	Aquil. alb.	Calomel
Argilla	Argill.	Clay
Aromaticus, a, um	Arom.	Aromatic
Bacillum	Bacill.	Bougie
Balneum	Baln.	A bath
Balneum arenæ	Baln. aren.	Sand bath
Balneum maris	Baln. mar.	Salt-water bath
Balneum vaporis	Baln. vap.	Steam bath
Bene	Ben.	Well
Bis in die	B. or bis. i. d.	Twice a day
Bolus	Bol.	A large pill
Bonus		Good
Brevis, is, e	Brev.	Short
Bulliat, bulliant	Bull.	Let it, or them, boil
Cæruleus, a, um	Cærul.	Blue
Calefactus, a, um	Calef.	Warmed
Capiat	Cap.	May be taken
Capsula	Caps.	Capsule
Capsulæ amylaceæ	Caps. amyl.	Cachets
Capsulæ gelatinosæ	Caps. gelat.	Gelatine capsules

LATIN TERMS AND ABBREVIATIONS USED IN PRESCRIPTIONS

Term or phrase.	Abbreviation.	Meaning.
Carbasus	Carbas.	Lint
Celeriter	Celer.	Quickly
Charta	Chart.	Paper
Chartula	Chartul.	Small paper
Charta cerata	Ch. cer. or chart. cerat.	Waxed paper
Charta pergamentoria	Chart. pergam.	Parchment paper
Cibus	Cib.	Food
Cito dispensetur	Cito. disp.	Let it be dispensed quickly
Clausus, a, um	Claus.	Closed, or enclosed
Cochlear	cochl.	Spoon
Cochlear magnum	cochl. magn.	A large or table spoon
Cochlear modicum	Cochl. mod.	A medium or dessert spoon
Cochlear parvum	cochl. parv.	A small or tea spoon
Cœna or cena	Cœn.	Supper
Cola or coletur	Col., colet.	Strain, or let it be strained
Collunarium	Collun.	A nose wash
Collyrium	Collyr.	An eye wash
Compositus, a, um	Comp.	Compound
Congius	Cong.	Gallon
Consperge	Consp.	Dust or sprinkle
Contra		Against
Contunde or contusus	Contus.	Bruise or bruised
Coque	Coq.	To boil
Cujus libet	Cuj. lib.	Of whatever you please
Da, dentur, or detur	D.	Give it, or they may be given
Da or dentur tales doses	D, Dent. t. d.	Give, or let there be given, such doses
Decanta	Dec.	Pour off.
Decoctum	Dec. or decoct.	Decoction
De die in diem	De d. in d.	From day to day
Detur or dentur	Det., dent.	Let there be given
Diebus alternis	Dieb. alt.	Every other day
Digere or digeretur	Dig.	Digest, or it may be digested
Dispensetur or dispensentur	Disp.	Let there be dispensed
Divide, dividatur, or dividendus, a, um	Div. or divid.	Divide, or it may be divided; to be divided
Dolor		Pain
Dosis or doses	Dos.	Dose or doses
Durante dolore		While the pain lasts

LATIN TERMS AND ABBREVIATIONS USED IN PRESCRIPTIONS.

Term or phrase.	Abbreviation.	Meaning.
Ejusdem	Ejusd.	Of the same
Emplastrum epispasticum	Empl. epist.	Blistering plaster
Emplastrum lyttæ	Empl. lytt.	Blistering plaster
Emplastrum vesicans or vesicatorium	Empl. vesic.	Blistering plaster
Enema	En.	An enema, a clyster
Epistomium	Epist. or epistom.	A stopper
Epistomium elasticum	Epist. elast.	A rubber stopper
Epistomium vitreum	Epist. vitr.	Glass stopper
Ex aqua	Ex aq.	From or with water
Ex modo præscripto	e. m p.	As directed
Ex qua formentur	Ex qua form.	From which there may be formed
Extende	Extend.	To spread
Extende supra alutam	Ext. sup. alut.	Spread upon leather
Extende supra corium	Ext. sup. cor.	Spread upon leather
Fervidus, a, um	Ferv.	Hot
Fiat or fiant	F. or ft.	Let there be made
Fiat lege artis	F. l. a.	Let there be made according to (by the law of) art
Fiat secundum artem	F. s. a.	Let there be made according to art
Filtra	Filt.	Filter
Flavus, a, um	Flav.	Yellow
Fluidus, a, um	Flu.	Fluid
Frigidus, a, um	Frig.	Cold
Fuscus, a, um		Brown
Gargarisma	Garg.	Gargle
Gradatim		By degrees or gradually
Gramma or grammata	Gm.	Gramme or grammes
Granum or grana	Gr.	Grain or grains
Gutta or gutte	Gtt. or gutt.	Drop or drops
Guttatim	Guttat.	By drops
Haustus	Haust.	Draught
Hora	H.	An hour
Hora decubitus	H. D.	At the hour of going to bed
Hora somnis	Hor. somn.	At bedtime
Infunde	Inf.	Pour in, infuse
Lege artis	L. a.	According to art
Leviter	Levit.	Lightly
Magnus, a, um	Mag.	Large
Massa	Mass.	Mass
Mica panis	Mic. pan.	Crumb of bread
Minimum	M. or min.	A minim

LATIN TERMS AND ABBREVIATIONS USED IN PRESCRIPTIONS.

Term or phrase.	Abbreviation.	Meaning.
Misce bene	M. bene	Mix well
Misce caute	M. caute	Mix cautiously
Misce or misceantur	M. or misc.	Mix, or let them be mixed
Mistura	Mist.	Mixture
Mitte mittatur	Mit.	Send, or let there be sent
Mitte or mittantur tales	Mit. tal.	Send, or let there be sent, such
Modicus, a, um	Mod.	Moderate (sized)
Mora		Delay
More dictu	More dict.	In the manner directed
Mortarium		A mortar
Niger, nigra, nigrum	Nig.	Black
Non-repetatur	Non-rep.	It is not to be repeated
Numero	No.	By or in number
Obduce or obducatur	Obduc.	Cover, or let it be covered
Obductus, a, um	Obduct.	Covered or coated
Octarius	O.	Pint
Oleosus, a, um	Oleos.	Oily or made of oil
Oleum	Ol.	Oil
Olla	Oll.	Jar
Omni hora	Omn. hor.	Every hour
Omni mane	Omn. man.	Every morning
Omni nocte	Omn. noct.	Every night
Optimus, a, um	Opt.	Best
Para, paretur, or paratus	Par.	Prepare, let it be prepared, or prepared
Pars, or partes	P. or part	Part or parts
Partes æquales	P. or part. æq.	Equal parts
Parvus, a, um	Parv.	Small
Pilula pilulæ	Pil. or pilul.	Pill or pills
Post cibum	P. e. p. cib. or post. cib.	After food
Post prandium	P. or post prand.	After dinner
Pro re nata	P. r. n.	As occasion arises; as needed; occasionally
Pulvis or pulveres	P. or pulv.	Powder or powders
Pulvis grossus	Pulv. gross.	Coarse powder
Pulvis subtilissimus	Pulv. subt.	Very smooth powder
Quantum libet or quantum placet	Q. l. or q. p.	As much as you please
Quantum satis, quantum sufficit, or quantum sufficiat	Q. s.	A sufficient quantity
Quotidie		Daily

LATIN TERMS AND ABBREVIATIONS USED IN PRESCRIPTIONS.

Term or phrase.	Abbreviation.	Meaning.
Recipe	R., recip.	Take thou
Redactus in pulverem	Red. in pulv.	Let it be reduced to powder
Repetatur	Rept.	Let it be repeated
Ruber, rubra, rubrum	Rub.	Red
Scatula	Scat.	Box
Secundum artem	S. a.	According to art
Secundum legem	S. l.	According to law
Semen or semina	Sem.	Seed
Si opus sit	Si op. sit.	If it is best, necessary
Signa or signature	Sig.	Mark (label), or let it be marked (labelled)
Simplex	Simp.	Simple
Singulorum	Sing.	Of each
Solutio	Sol. or solut.	Solution
Solve or solvatur	S. or solv.	Dissolve, or let it be dissolved
Spiritus vini rectificatus	S. v. r.	Alcohol
Spiritus vini tenuis	S. v. t.	Diluted alcohol
Spissus, a, um	Spiss.	Hard
Statim	Stat.	Immediately
Stilus		Pencil, stick, or crayon
Sume or sumatur	Sum.	Take, or let there be taken
Talis or tales	Tal.	Such
Ter in die	T. or ter i. d.	Three times a day
Tere	Ter.	Rub or triturate
Una		Together
Uncia		An ounce
Unctulus		Besmeared, anointed
Unguentum	Ungt.	Ointment
Ustus, a, um	Ust.	Burned
Ut dictum	Ut dict.	As directed
Vitreus, a, um or vitrum	Vitr.	Of glass, or glass

CARDINALS.

Unus	one	Quindecim	fifteen
Duo	two	Sexdecim	sixteen
Tres	three	Septemdecim	seventeen
Quatuor	four	Octodecim or duo de viginti	eighteen
Quinque	five	Novemdecim or un de viginti	nineteen
Sex	six	Viginti	twenty

CARDINALS.

Septem	seven	Viginti unus or unus et viginti	twenty-one
Octo	eight	Trigenta	thirty
Novem	nine	Quadraginta	forty
Decem	ten	Quinquaginta	fifty
Undecim	eleven	Sexaginta	sixty
Duodecim	twelve	Septuaginta	seventy
Tredecim	thirteen	Octoginta	eighty
Quatuordecim	fourteen	Nonaginta	ninety
Centum	one hundred		

CHAPTER XLVIII.

DISPENSING.

Dispensing is the term applied to the preparation or compounding of medicines. Sometimes this involves the manufacture of a preparation from the drug, but usually it consists in putting together preparations previously made. The manufacture of pharmaceuticals should be conducted in a laboratory, especially constructed for that purpose, while the dispensing should be done at a table or desk designed for this object alone. The general arrangement of the prescription table will be influenced largely by the contour of the building and the location of the desk. When possible the desk should be placed in a room by itself, so that the dispenser may be undisturbed while at work. Many plans have been devised for the construction of the prescription table, but in each case the personal equation necessarily plays an important part. The student is not expected to design a prescription table, and the pharmacist who contemplates doing so is advised to visit several prescription stores and combine the features best suited to his location. The prescription department of any good pharmacy should be its main feature, and receive the greatest attention. Let it be so situated that it will receive abundant light, but be not of easy access to customers, who are too apt to ask questions or attempt to converse with the operator while he is dispensing. These interruptions distract his attention and increase the liability of mistakes. The prescription table should be equipped with the best material. This applies not only to medicines, but also to boxes, glassware, corks, paper, etc. The patient frequently judges the contents of a package by its external appearance. A cheap label carelessly applied to a bottle or a box which is as carelessly wrapped will not tend to elevate one's opinion as to its contents.

RECEIVING THE PRESCRIPTION.

Where many prescriptions are being received, or when a prescription is to be called for later, it is advisable to give the customer a check. These checks should be printed especially for this purpose, and should be arranged in three parts, each part bearing the same number and easily detached. The part passed to the patient may be in the form of a small card showing the business address. The other parts may be small with only the number. One of these should be attached to the prescription, but the remaining number should not be detached from the second until the prescription is compounded and wrapped, when the third check should be placed upon the outside of the package. Some pharmacists give the customer a check and write a corresponding number on the prescription.

Never study a difficult or poorly written prescription in the presence of the patient, as he is then apt to question your ability to either read or compound it.

COMPOUNDING PRESCRIPTIONS.

Upon receiving the prescription read it carefully, and do not attempt to compound it until you thoroughly understand it, noting the dose of each ingredient, and especially when the remedies are poisonous. In case there is an overdose, or that any obscurity renders it necessary to consult the prescriber, do so without arousing suspicion in the mind of the patient. Tell him that the prescription will be ready in a given time and ask him to call again, or say that you will deliver the prescription. Use tact and judgment when calling the attention of a physician to an error, otherwise it may result in the loss of his patronage. Most physicians are reasonable, and will appreciate your kindness in calling attention to an error. By law the pharmacist is equally responsible with the physician for dispensing a mistake made by the latter. In some cases many physicians prescribe unusually large doses, and such quantities should be indicated by writing out the amounts in addition to the usual methods, or by placing several exclamation points after the quantities that the pharmacist may know that this dose was intentional.

As to the order of writing the label and compounding the prescription there are two methods, each having its advantages. Some number the prescription and write the label first, then compound. This affords the dispenser an opportunity to familiarize himself with the prescription, and also permits the ink to dry before applying the label to the bottle. The other method is to compound the prescription and *then write the label.* With this method there is less danger of placing the wrong label upon a bottle or box. Serious mistakes have occurred by placing upon a liniment bottle a label intended for a mixture to be taken internally. When possible it is advisable to work upon but one prescription at a time. However, it often happens that a mixture must stand for a time, and in that case the dispenser may work upon another prescription. In such cases the careful pharmacist leaves the prescription with the mixture. Most important of all, the dispenser should concentrate his mind upon his work. Make it a practice, not only when dispensing but when manufacturing, to always read the label three times—once when taking the container, once when weighing the amounts, and again when returning the container to its proper place. Also note the appearance of the substance, as a mistake may thus be prevented. There is no excuse for dispensing morphine sulphate for quinine sulphate, even though it has been so labelled, as quinine is a soft and pliable substance, while morphine crystals break with a slight noise when pressed or cut.

When dispensing incompatible liquids study to mix them in the order producing the least precipitation, and keep the precipitate in as finely divided condition as possible. It is usually best to dissolve salts before placing them in a bottle. When more solids are prescribed than will dissolve, do not dissolve them with heat, as they will crystallize out on cooling. Reduce to fine powder before adding to the liquid and dispense with a shake label. When the solid settles quickly it may be permissible to add a little acacia or tragacanth to hold it in suspension while the dose is being measured. Try to dispense liquids as clear as possible. Filter eye washes, and keep solutions and bottles sterilized. Use the best quality of corks, and select one of such size that the smaller end will just enter the neck of the bottle. With a little pressure it may be forced sufficiently far to hold without requiring a cork screw to remove it.

Use a cork press when necessary, but never compress a cork between the teeth. Avoid dispensing a partially filled bottle, as patients are often apt to imagine that they are being defrauded of a portion of their medicine.

LABELLING.—A few pharmacists write all labels with the typewriter. This plan has the advantage of distinctness, but there are those who do not like the appearance of a typewritten label. Let the inferior penman use the typewriter, but the good penman does not require this assistance. However, many inferior penmen are, with practice, enabled to write a label both neat and distinct, and this should always be accomplished when possible. First, number the prescription, placing the number upon the upper right hand corner, with the date underneath. Follow this with the price charged for the medicine. The author prefers to use a triplicate numbering machine, stamping the number first upon the prescription, then upon the label, also upon the back of the label, if it is for a bottle, or, if for a box, upon the bottom of the box. In case of renewal this enables one to find the right prescription even if one number is destroyed. In case of two or more boxes having been ordered for the same patient, it enables the patient to keep the right cover upon the right box. *Never place one label over another.* In case of renewals the old label may be easily removed by placing a wet cloth or blotter over the label for a few minutes. It may be more quickly removed by warming over a gas flame, as the vapor from the moist blotter quickly penetrates the label. On bottles, place the label above the middle, see that it is straight, then, placing a thin paper over it, smooth it down by rubbing from the centre to the edges. Mixtures containing suspended particles should bear a "shake label" placed above the regular label. If placed at the bottom it may be overlooked, especially as sometimes the wrapper is removed from the top of the bottle *only*. Place labels for external use in the same position, and these should be placed on all bottles containing substances for such use. Prescriptions containing poisons should *not* be labelled poison unless so directed by the physician. If the prescription is one difficult to compound, or one whose ingredients require special order in mixing or manipulation, these facts should be plainly stated upon the prescription. Thus, in case of renewal it can be duplicated, otherwise a slight change may cause the patient both annoyance and suspicion. When a prescription is put up it should be signed by the dispenser and passed to a second person. The dispenser should state from memory the names of the ingredients he has compounded and the amounts of each. Let the helper observe whether the statement corresponds with the prescription, and also compare the label with the directions and number upon the prescription. He should then place his initials upon the prescription, to indicate by whom it was checked. As soon as the prescription is compounded it should be immediately neatly wrapped. A good quality of paper should be employed and only sufficient used to make a neat package. The best method of wrapping a box or a bottle is to proceed much as in folding packages, except to seal the ends with wax. For this purpose, do not use ordinary sealing wax, as it is too hard. A good formula is as follows: Rosin, 8 parts; yellow wax, 1 part; Venice or Canada turpentine, 1 part, and color to please the taste. However, do not use black sealing wax, as it is inadvisable to suggest a funeral while the patient is yet able to take his medicine.

Cleaning Utensils.—It is of the greatest importance that every article about the prescription table or room should be scrupulously clean. Graduates, mortars, etc., when once used should be immediately cleansed and restored to their proper places. Oils or fats may be removed from the mortar by rubbing with sawdust or soft paper. Dampened newspapers will prove better than dry ones. This treatment should be followed by a liberal allowance of soap and water. For the removal of particles from the inside of bottles, use very coarse sand or fine gravel. If shot is used, the bottles should be finally rinsed with nitric acid to remove adhering particles of lead. A mixture of sulphuric acid with a solution of potassium or sodium dichromate is invaluable for the removal of organic matter from the interior of flasks or bottles. For scouring mortars, etc., powdered pumice stone or whiting is commonly used, but in most cases bone ash is more successful. The disagreeable odor of substances, as iodoform and assafetida, may be removed both from the hands and utensils by rubbing with linseed meal.

OWNERSHIP OF THE PRESCRIPTION.

This question has caused endless discussion, and various decisions have been rendered. It is still a mooted question. However, there should be but one answer, and that is that the prescription is a written order to some pharmacist to be filled. The pharmacist, having filled the order, should keep the prescription on his own file for his own protection. Should the patient request the original, the pharmacist should offer a copy unless forbidden to do so by the physician. In some States the law requires that prescriptions calling for certain substances shall be kept on file for a period of five years, and that no copy shall be given. Some physicians direct that their prescriptions shall never be copied or refilled without their order.

REFILLING OF PRESCRIPTIONS.

Upon this subject the pharmacist uses his discretion. Some pharmacists refill every prescription presented, while others refuse to refill any prescription calling for habit-forming drugs like morphine or cocaine. Doubtless many other drugs should be placed under the ban, as many cases of broken health are due to the continued use of what seemed to be only a harmless medicine.

FILING PRESCRIPTIONS.

Numerous methods have been suggested for keeping prescriptions on file, but only a few will be here considered. Doubtless the oldest method is the scrap-book form, where the prescriptions were literally pasted in a book. The objection to this method is the time required to paste them in, and in case of renewal the dispenser must have open before him a large book which occupies the valuable space of the prescription table. Another method is to file them in cases of 1000 each, with a special card, marked with the hundred number, between each hundred. Some prefer to place each hundred in a manila envelope and keep these envelopes in a case, or better still in a sectional filing cabinet. Others fasten together the prescriptions from each day's work, and enclose them in a manila wrapper, stamping the date upon the outside. A convenient method is to file them like cards in a filing case, with the number between each hundred. When a prescription is taken out for renewal a marker of colored cardboard may be inserted in its place.

CHAPTER XLIX.

INCOMPATIBILITIES.

A FEW generalizations may assist one in remembering incompatibilities, but the best method of attaining proficiency is to acquire a knowledge of the physical, chemical, and physiological properties of the substances dispensed. For this reason the subject should not be studied until one has had at least one course in qualitative analysis and pharmaceutical manufacturing, accompanied by a study of pharmacopœial preparations. Numberless incompatibilities *may* theoretically occur, but those actually occurring are comparatively few. Incompatibilities are divided into three classes—therapeutic, pharmaceutical, and chemical.

THERAPEUTIC INCOMPATIBILITIES.

If one drug have a stimulating and another a depressing effect upon the heart, they are said to be therapeutically incompatible, because their medicinal actions are antagonistic to one another. Since this is a question purely of medicinal effect, it comes more properly within the scope of the physician than that of the pharmacist. Hence, upon this point the latter should not presume to question the knowledge of the former. This is especially true when we remember that drugs therapeutically incompatible with one another when given in full doses may produce most beneficial effects administered in smaller ones.

PHARMACEUTICAL INCOMPATIBILITIES.

These are more properly called physical incompatibilities, because they are produced by *physical* changes occurring while compounding. For instance, an alcoholic tincture of a resinous drug is precipitated without chemical change by mixing with an aqueous preparation. This class of incompatibilities is of the most frequent occurrence, and the drug requires skill in compounding. By careful study of physical incompatibilities it will be observed that they are due to the insolubility of the substance in the resulting compound, consequently a thorough knowledge of the solubilities of substances in various solvents and combinations of solvents is essential. In a work of this kind it is impracticable to enter into a study of the solubility of individual substances, but a few general statements may be made, accounting for nearly all physical incompatibilities.

Gums, mucilaginous or *albuminous substances* are soluble in water, but insoluble in from 55 to 85 per cent. alcohol. Many inorganic salts soluble in water are insoluble or only sparingly soluble in alcohol. Therefore, aqueous solutions of many of the above substances are precipitated by the addition of alcohol.

Resins, balsams, and *stereoptines* and most *volatile oils* are soluble in alcohol but sparingly soluble in water.

For this reason these and almost all strong *alcoholic fluidextracts* and *tinctures* are precipitated by water.

Most *free alkaloids* are soluble in alcohol but insoluble in water, while the salts of the alkaloids are soluble in water.

DISPENSING PHYSICAL INCOMPATIBILITIES.

Proper dispensing prevents many incompatibilities, but if impossible to prevent separation, the dispenser should endeavor to produce a homogeneous preparation, or one capable of easily mixing by agitation. It is, therefore, important that all precipitates should be as finely divided as possible. Cold dilute solutions yield finer precipitates than hot concentrated ones. The order of mixing also exerts a decided influence upon the resulting precipitate. When resinous tinctures or fluidextracts are prescribed with an aqueous fluid, they should be added in a thin stream to the aqueous liquid with gentle agitation. Violent agitation frequently causes the precipitate to adhere to the sides of the bottle.

When solutions of gums or albuminous substances are to be mixed with alcoholic solutions, the alcoholic solutions should be added to the gum or albuminous solutions until a permanent precipitate commences to form. Then reverse the operation. In some cases precipitation may be prevented entirely by diluting the solutions, or by first mixing antagonistic solutions with some other ingredient prescribed with them.

Incompatibilities may arise from mixing two nearly saturated solutions of substances differing in degrees of solubility. The most soluble salt will take the solvent from the less soluble one, thus causing precipitation of the latter. This may be prevented by diluting the solutions before mixing.

When aromatic waters are used as solvents for inorganic salts, the aromatic principle is frequently thrown out of solution.

Alcoholic solutions of organic substances frequently separate into two immiscible layers upon the addition of some inorganic salt, as when chloral hydrate and some of the bromides or chlorides are dissolved in an elixir. If the solution be stronger than about ten grains of each to the drachm, chloral alcoholate will separate. This may be prevented by diluting the solution and increasing the dose proportionately.

In cases where a salt is precipitated or prevented from passing into solution by the presence of alcohol, the difficulty may be overcome by the addition of water. However, if by so doing the bulk of the prescription be increased, the dose must be *proportionately* increased. Such a change should be noted on the prescription and communicated to the physician. Sometimes it may be possible to substitute one solvent for another without materially changing the bulk or action of the prescription. For instance, the prescription calls for more than 25 gr. of boric acid to the ounce of water; the acid cannot be dissolved except with the aid of heat, and then a part will crystallize out upon cooling, but the substitution of glycerin for a part of the water retains the whole in solution. The same is true of phenol, in which case alcohol or glycerin may be substituted for a portion of the water. In cases where it is not permissible to change the solvent or to increase its volume, the substance should *not* be dissolved by heat, as the excess crystallizes in large crystals or compact masses incapable of mixing by agitation. It should be finely powdered, so that it may be easily diffused throughout the mixture. When the insoluble portion or precipitate is light, it is sometimes held in suspension by the addition of sugar or syrup. If heavy, tragacanth is better, and if prescribed with resinous tinctures or fluidextracts, they should be placed with the powdered tragacanth in a dry bottle and shaken together. Then the water should be added in divided portions and emulsified by agitation. Many solid substances like chloral, camphor, menthol, thymol, salol, antipyrine, acetanilide, etc., become damp or form liquids when triturated together. Some of these form chemical compounds, while others are considered as physical changes, or at least form such feeble combinations that they may be separated by ordinary solvents. Incompatibilities such as these cannot easily be prevented, but when they become only damp the addition of some absorbent powder helps to retain them in powdered form.[1]

CHEMICAL INCOMPATIBILITIES.

As the name implies, this class of incompatibilities arises from the action of two or more substances upon one another, forming new compounds. However, all chemical changes should not be considered as incompatibilities. Generally the term is applied to those only which are undesirable or unintentional. Physicians

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[1] For table of dry solids that act upon each other see Ruddiman's Incompatibilities in Prescriptions, p. 269.

formerly prescribed salicylic acid and sodium bicarbonate together, intending to produce sodium salicylate. This cannot be considered an incompatibility. Chemical incompatibilities usually make themselves known by the formation of a precipitate, or an insoluble compound, by effervescence, or by a change in color. Chemical changes frequently take place in prescriptions, and pass unnoticed without any of the above changes becoming manifest. If the changes be slight, it is customary to dispense the prescription in the best possible manner, but if the new compound be physiologically different from that prescribed, and especially when substances actively poisonous are formed, the physician should be consulted. In cases where the chemical action is weak, it may be prevented, or, at least, the resultant compound may be held in solution by the addition of syrup or glycerin. This is true of alkaline earths, many metallic oxides and hydroxides, and some organic and inorganic salts. A *very* common incompatibility is the liberation of carbon dioxide from carbonates by the addition of substances containing acids. When carbonate of ammonia is prescribed with syrup of squill the acetic acid in the syrup liberates the carbon dioxide. In this and in all similar cases where gas is evolved the mixture should be made in a mortar. If the reaction be very slow, the mixture should be heated until the reaction ceases before putting in a bottle; otherwise the accumulation of gas may burst the bottle or blow out the cork.

Strong oxidizing agents, like potassium chlorate, permanganates, chromic acids, and silver salts, should be cautiously mixed with organic matter, as violent explosions are apt to occur. When it is necessary to mix them, powder separately and mix on paper with a horn or wooden spatula.

A frequent source of incompatibilities is the combination of alkaloidal salts with alkalies or alkaline carbonates resulting in the precipitation of the free alkaloids. Combined with iodides and the bromides, they form insoluble alkaloidal salts; or with other metallic salts, they form insoluble double salts. In such cases the presence of about 15 per cent. of alcohol prevents the precipitation.

Tannic acid and vegetable astringents precipitate alkaloids, glucosides, albumin, and gelatin. It also forms inky compounds with nearly all iron salts, and insoluble tannates with many other inorganic salts.

Spirits of nitrous ether soon becomes acid on standing and should be neutralized before dispensing with alkaline iodide or bromide. Otherwise iodine or bromine will be liberated. The ethyl nitrate in the spirits is decomposed by alkaline hydrates and forms new compounds with some organic bases. With morphine it produces a yellow color. Nitrosomorphine and pseudomorphine are said to be formed. With antipyrine in acid solutions it forms the green isonitroso-antipyrine. With fresh tincture of guaiac it assumes a blue color, which soon changes to red.

Almost numberless chemical incompatibilities may be formed. For a more detailed study of the subject, the student is referred to Ruddiman's *Incompatibilities in Prescriptions*.

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