

COMPLETE FORMULARY

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FENNER'S COMPLETE FORMULARY

BEING THE

*Sixth Edition of Fenner's Formulary, greatly enlarged,
revised and entirely re-written.*

CONTAINING

WORKING FORMULAS

FOR ALL

OFFICIAL AND UNOFFICIAL PREPARATIONS GENERALLY USED OR
REQUIRED IN THE PRACTICE OF PHARMACY AND THE BUSI-
NESS OF THE CHEMIST, MANUFACTURING PHARMA-
CIST, MANUFACTURER OF PROPRIETARY MED-
ICINE, PHYSICIAN, PERFUMER, ETC.

A COMPLETE FORMULARY AND HAND-BOOK

*Of Valuable Information for Pharmacists, Manufacturers of
Chemical and Pharmaceutical Preparations, Physicians,
and Students of Pharmacy and Medicine.*

Compiled and written by

B. F E N N E R,

AUTHOR OF FENNER'S FORMULARY, FENNER'S WORKING FORMULÆ
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Sixth Edition.

WESTFIELD, N. Y.
B. FENNER, PUBLISHER AND PROPRIETOR.
1888.

PREFACE.

WHEN, in 1874, the first edition of FENNER'S FORMULARY (then a small pamphlet) was issued it was the pioneer in a new field of pharmacy, and furnished the first reliable line of formulas for elixirs and the so-called Elegant Preparations which were then coming rapidly into use.

Several editions of this work, each much enlarged and improved, have succeeded each other; but all have been, necessarily, crude and imperfect, representing, as they did, the developing stage of the art of Elegant Pharmacy.

Such as they were, however, they have been received, and adopted by the mass of American Pharmacists as the standard authority for the preparation of this class of galenicals.

During the past decade the advance of Pharmacy and the introduction of new drugs, chemicals and forms of medicine has been so great, that it has outrun the text-books extant, and there has grown up a great want and demand for a new and complete work which shall represent the Pharmacy of to-day as it is practiced throughout the land. The Pharmacopoeias and works of authority are all too conservative — representing only a small part of the preparations used. The Dispensatories and other commentaries on the Pharmacopoeias partake of the same general characteristics; while the Pharmaceutical Journals (which are the main repositories of unofficial formulas, the record of new preparations and of the advance of Pharmacy) lack the continuity and unity of purpose which is necessary to the value of books of reference and practical works on Pharmacy.

What druggists want, and demand, is a work that in one volume shall give reliable formulas for all or most of the preparations required in the polypharmacy of the present day, and in which they are certain to find, at a glance, some practical information on all subjects connected with or pertaining to the practice of their profession. To make such a work requires patient research and investigation, extended and repeated experiments, careful analyses and syntheses; a thorough knowledge of the wants, conveniences and capabilities of pharmacists, and of the practice of pharmacy as it is in all parts of the country; an intimate acquaintance with the standard textbooks and pharmaceutical literature of all countries; and, last but not least, the ability to collate, compare, condense, classify and arrange, and the genius and experience necessary to originate and formulate, preparations useful to those engaged in the trade.

Realizing the requirements of such a work, as well as its necessity, and knowing the great amount of time and labor necessary to produce it, the author, with great reluctance, and only after repeated solicitation from a great number of those who

were using the former editions of Fenner's Formulary, undertook the preparation of this volume. To embody in one book whatever is valuable to druggists of pharmacy, chemistry, materia medica, therapeutics and formulae has been his aim and purpose. How far it may fulfill that purpose, those who use it will decide.

The former editions of this work have been chiefly devoted to the Elegant Preparations, such as elixirs, fine syrups, medicinal wines, etc., but it was deemed expedient in this edition to include the official preparations as well, and whatever else was necessary to make, as its title indicates, A COMPLETE FORMULARY, to which those in search of information may turn, avoiding the trouble and annoyance of looking through so many books of reference before finding what they seek.

Many new and, as we think, valuable processes have been introduced, which are the outcome of long experience in the preparation of medicines, and as such are submitted.

We have endeavored to make a volume simple, practical, comprehensive, and plain — an every-day companion, counsellor and friend. It has been written mainly in the workshop or laboratory in the midst of the drugs and operations which it describes or directs. As such, no claim is made for its literary excellence, but it is earnestly hoped that it may contribute something of value to the practice and science of pharmacy, and something of pleasure and profit to Pharmacists into whose hands it may fall.

Westfield, N. Y., August, 1888.

INTRODUCTORY.

IN the arrangement of the formulas in this volume the plan of numbering them has, as in former editions, been adopted. This method saves frequent repetition of the formulas, makes them convenient for reference, and at the same time more particularly designates one from another, as there are in many instances several preparations bearing the same name yet differing in composition.

The official preparations are designated by their Latin titles as given in the Pharmacopoeias; but few others are thus distinguished, as they are generally called for or prescribed by their more common names. Prominence is also given to most of the official and to the elegant preparations by printing them in larger type than those of less importance.

Whenever a material difference exists in the formulas official in the U. S. P. and those of the Br., German, French, or other leading pharmacopoeias, the composition of the preparation as directed by the different authorities is given. Also, when there

is any important difference between the U. S. 1880 and 1870 pharmacopoeia preparations, the same is noted in the formula.

In the formulas copied from other works, when the original text is followed, the source from which they are derived is usually mentioned; but when formulas are collated from various sources, and re-arranged, re-written, or readjusted to suit the plan of this work, their authority is not generally given, as they are, mostly, public property, having become such by long usage and frequent publication in standard works.

In conformity with the popular usage in this country the quantities directed in the formulas are mostly in the commercial weight and measure of the U. S. The attempts to introduce metric weight and measure or parts by weight of solids and liquids have not met with a favorable reception in this country, although generally used in Continental Europe.

In the article on weights and measures which follows, directions will be found for readily converting weights or measures of one system into those of another.

As this work is intended mainly as a formulary, the description of pharmaceutical apparatus in general use, and the description of medicinal substances, except as given under general headings, is mostly omitted; for the same reason, the tests of chemicals, etc., are not generally given. A brief general description of crude medicinal substances will be found in PART I., and the general working processes employed in pharmacy are briefly described in PART II. For further descriptions, tests, etc., reference may be made to the pharmacopoeias, chemistries and other technical works. The medicinal uses and doses of most preparations are briefly given under their formulas, for convenient reference.

The formulas are, as far as is practicable, arranged in classes. The official formulas and those employed in regular pharmacy are included in PART III., and are classed according to their pharmaceutical similarity, as *elixirs, extracts, fluid extracts, spirits, syrups, etc.* Chemical elements and radicals are noted in their alphabetical order, their salts and combinations being included under the same general headings — as *Sodium and its salts. Potassium and its salts, etc.*

Standard proprietary remedies are included in PART IV., and classed according to their medicinal properties, uses, etc. — as *Ague Cures, Catarrh Remedies, Cough Remedies, etc.*

Toilet articles and perfumes are given in PART V., and are arranged as far as possible according to their uses as *Hair Preparations, Handkerchief Perfumes, Lotions, etc.*

Miscellaneous Preparations, in which are included those not otherwise classified, make up Part VI., and are arranged as far as possible according to their uses.

WEIGHTS AND MEASURES STANDARDS.

The United States Pharmacopoeia previous to the 1880 revision and all standard American text-books directed troy weight and apothecary measure. The present revision of the United States Pharmacopoeia directs metric weight and measure whenever definite weight and measure is mentioned, but parts by weight are generally directed. The British Pharmacopoeia and text-books direct avoirdupois weight and equivalent fluid measure. All of the Pharmacopoeias of continental Europe direct parts by weight, or metric weight and measure.

The **Grain** is the equivalent unit of the apothecary, troy and avoirdupois systems of weight. Apothecary and troy weight correspond, the terms of the former only being used by druggists.

The **Scruple** equals 20 grains. It is now seldom used, being expressed in grains instead.

The **Drachm** equals 60 grains or $\frac{1}{8}$ apothecary or troy ounce.

The **Ounce of apothecary or troy weight** equals 480 grains or $\frac{1}{12}$ of the apothecary or troy pound of 5,760 grains.

The **Ounce avoirdupois weight** (American commercial and British pharmaceutical standard) equals $437\frac{1}{2}$ grains or $\frac{1}{16}$ of the avoirdupois pound of 7,000 grains.

The **Pound of apothecary or troy weight** equals 5,760 grains or 12 apothecary or troy ounces of 480 grains.

The **Pound avoirdupois weight** (American commercial and British pharmaceutical standard) equals 7,000 grains or 16 avoirdupois ounces of $437\frac{1}{2}$ grains.

The **Gramme** is the unit of **metric** weight. A gramme equals 10 decigrammes or 100 centigrammes or 1,000 milligrammes or 15.43 grains.

The **Kilogramme** equals 1000 grammes or 35.27 av. ounces, and is equivalent to the litre.

A **Cubic Centimetre** of water at 4° C. (39° F.) weighs a gramme; therefore the gramme and cubic centimetre are equivalent. It equals $16\frac{1}{4}$ minims.

The **Litre** is the unit of metric fluid measure, and equals 1,000 cubic centimetres, or 10 decilitres or 100 centiliters or 33.84 Am. fl.ounces.

The **Minim** is a variable expression of fluid measure—the 480th part of a fluid ounce. The minim of American fluid measure of water at its greatest density weighs about 0.95 grain, being the 480th part of the American fluid ounce of 455.7 grains of water. The British minim being the 480th part of the British fluid ounce of 437 $\frac{1}{2}$ grains of water—weighs about 0.91 grain.

The **Fluid Drachm** equals 60 minims or $\frac{1}{8}$ fluid ounce.

The **American Fluid Drachm** of water weighs 56.96 grains, being $\frac{1}{8}$ of the American fluid ounce of 455.7 grains of water.

The **British Fluid Drachm** of water weighs 54.68 grains, being $\frac{1}{8}$ of the British fluid ounce of 437 $\frac{1}{2}$ grains of water.

The **Fluid Ounce** equals 480 minims or 8 fluid drachms.

The **American Fluid Ounce** of water weighs 455.7 grains, and is $\frac{1}{16}$ of the American pint of 7,291.1 grains of water.

The **British Fluid Ounce** of water weighs 437 $\frac{1}{2}$ grains, and therefore corresponds with their weight standard (avoirdupois) ounce. It's $\frac{1}{20}$ of the British *Imperial* pint.

The **Pint** of American fluid measure (28.875 cubic inches) equals 7,680 American minims; 7,291.1 grains of water or 16 fluid ounces of 455.7 grains of water, at 60° F.

The **Imperial Pint** of British fluid measure (34.659 cubic inches) equals 9,600 British minims; 8,750 grains (1 $\frac{1}{4}$ pounds avoirdupois) of water or 20 British fluid ounces of 437 $\frac{1}{2}$ grains of water at 60" F.

The **Gallon** of American fluid measure (231 cubic inches) equals 61,440 American minims ; 58,328.9 grains of water or 8 American pints.

The **Imperial Gallon** of British fluid measure (277.274 cubic inches) equals 76,800 British minims; 70,000 grains (10 pounds avoirdupois) of water or 8 Imperial pints.

The relation of weight to fluid measure as above stated is calculated for distilled water at 15.6° C. (60° F.). The volume of water increases or decreases in a ratio varying with the temperature. At 15.6° C. (60° F.) its volume is 1.000938, as compared with 1.000000, its volume at its greatest density 4° C. (39° F.).

To convert the WEIGHTS of one system into those of another, the following simple rules may be observed : To convert

Troy to Avoirdupois.—Multiply the weight in tr. ounces by 1.097 for close, or by 1.1 for ordinary calculations. The product is the weight in av.ounces.

Avoirdupois to Troy.—Multiply the weight in av. ounces by 0.911 for close, or deduct one tenth for ordinary calculations. The product, or result, is the weight in tr. ounces.

Metric to Grains.—Multiply the weight in grammes by 15.43.

Metric to Troy Ounces.—Multiply the weight in grammes by 0.032.

Metric to Avoirdupois Ounces.—Multiply the weight in grammes by 0.035. In ordinary calculations, $28\frac{1}{3}$ grammes are considered equal to 1 ounce.

Grains to Grammes.—Multiply the weight in grains by 2, and divide by 13 . The quotient is the weight in grammes.

Troy to Metric.—Multiply the weight in tr.ounces by 31.1. The product is the weight in metric grammes.

Avoirdupois to Metric.—Multiply the weight in avoirdupois ounces by 28.35 . The product is the weight in metric grammes.

To convert the MEASURES of one system into those of another, the following simple rules may be observed : To convert

Apothecary to Imperial Fluid Measure.—Multiply the measure in apothecary fl.ounces by 1.041. The product is the measure in Imperial fl.ounces.

Imperial to Apothecary Fluid Measure.—Multiply the measure in Imperial fl.ounces by 0.96. The product is the measure in apothecary fl.ounces.

Metric to Apothecary Fluid Measure.—Multiply the measure in cubic centimetres by $16\frac{1}{4}$ to reduce to minims, or by 0.034 to reduce to fl.ounces. The litre equals about 2 pints, $1\frac{7}{8}$ Am. fl.ounces.

Metric to Imperial Fluid Measure.—Multiply the measure in cubic centimeters by 0.035 to reduce to Imperial fl.ounces.

Apothecary to Metric Fluid Measure.—Multiply the measure in fl.ounces by 29.53. The product is the measure in cubic centimeters. In ordinary calculations 30 cubic centimeters equal 1 fl.ounce.

Imperial to Metric Fluid Measure.—Multiply the measure in fl.ounces by 28.35 . The product is the measure in cubic centimeters.

HEAT MEASURES.

The only scales now used to any extent for registering temperature are those of Fahrenheit, Reaumur, and Celsius; the latter being known in most countries as the *Centigrade* scale. The Fahrenheit scale is chiefly used in America and Great Britain, the Reaumur in Germany, and the Centigrade in France and other countries of Europe, and in scientific calculations in nearly all countries.

Thermometric scales are calculated from the expansion of mercury or alcohol in a small vacuum tube having usually a bulb or reservoir at the bottom.

The CENTIGRADE scale assumes the temperature at which water freezes as 0°, and the temperature at which it boils with the barometer at 30 inches, as 100°, making 100° between the freezing and boiling point of water.

The FAHRENHEIT scale assumes the temperature at which water freezes as 32°, and the temperature at which it boils with the barometer at 30 inches, as 212°, making 180° between the freezing and boiling point of water.

The REAUMUR scale, which is seldom used in this country, assumes the temperature at which water freezes as 0°, and the temperature at which it boils with the barometer at 30 inches, as 80°, making 80° between the freezing and boiling point of water.

The following table shows a comparison of the scales from the freezing to the boiling point of water:

	C.	F.	R.	
Water	100	212	80	boils.
	95	203	76	
	90	194	72	
	85	185	68	
	80	176	64	
	75	167	60	
	70	158	56	
	65	149	52	
	60	140	48	
	55	131	44	
	50	122	40	
	45	113	36	
	40	104	32	
	35	95	28	
	30	86	24	
	25	77	20	
	20	68	16	
	15	59	12	
	10	50	8	
	5	41	4	
Water	0	32	0	freezes.

It will be seen by the foregoing scales that a Centigrade degree is $1\frac{4}{5}$ Fahrenheit, or $\frac{4}{5}$ Reaumur degrees ; that a Fahrenheit degree is $\frac{5}{9}$ Centigrade, or $\frac{4}{9}$ Reaumur degrees ; and that a Reaumur degree is $1\frac{1}{4}$ Centigrade, or $2\frac{1}{4}$ Fahrenheit degrees.

The following rules will be found convenient for reducing or converting one scale to another :

To reduce Centigrade to Fahrenheit.

RULE.—Multiply the given degrees Centigrade by $1\frac{4}{5}$ ($\frac{9}{5}$), and add 32 to the product.

*EXAMPLE.—How many Fahrenheit degrees in 25 Centigrade degrees?
 $25 \times \frac{9}{5} + 32 = 77$ Fahrenheit degrees.*

To reduce Reaumur to Fahrenheit.

RULE.—Multiply the given degrees Reaumur by $2\frac{1}{4}$ and add 32 to the product.

To reduce Fahrenheit to Centigrade.

RULE.— *Subtract 32 from the given degrees Fahrenheit and divide the remainder by $1\frac{4}{5}$ ($\frac{9}{5}$).*

EXAMPLE.—How many Centigrade degrees in 176 Fahrenheit degrees? $176 - 32 \div \frac{9}{5} = 80$ Centigrade degrees.

To reduce Fahrenheit to Reaumur.

RULE.—*Subtract 32 from the given degrees Fahrenheit and divide the remainder by $2\frac{1}{4}$ ($\frac{9}{4}$).*

To reduce Reaumur to Centigrade.

RULE.—Multiply the given degrees Reaumur by $1\frac{1}{4}$ **To reduce**

Centigrade to Reaumur.

RULE.—*Multiply the given degrees Centigrade by $\frac{5}{4}$*

In reducing Fahrenheit to other scales, or *vice versa*, 32 is added or subtracted, because the Fahrenheit scale is marked 32 where the other scales are marked 0, viz., at the freezing point of water. Bear in mind that in computing degrees below 0° Centigrade, or Reaumur, the product of the multiplication is a minus quantity, and that adding +32 to the minus quantity is the same as taking the difference between them. Recent American works on Pharmacy and Chemistry give both the Centigrade and Fahrenheit degrees, so there is no reason that the druggist should not soon be as familiar with the one as the other.

The temperature at which the specific gravity of substances is usually taken and recorded, is 15.6° Centigrade, or 60° Fahrenheit, or 12.4° Reaumur. In making experiments or calculations that require accuracy, this must be well understood, and the substances to be used must be brought to this temperature.

SUMMARY.

$$1^{\circ} \text{ C.} = 1.80^{\circ} \text{ F.} = 0.80^{\circ} \text{ R.}$$

$$1^{\circ} \text{ F.} = 0.55^{\circ} \text{ C.} = 0.44^{\circ} \text{ R.}$$

$$1^{\circ} \text{ R.} = 2.25^{\circ} \text{ F.} = 1.25^{\circ} \text{ C.}$$

C. degrees	× 9 ÷ 5 + 32 =	F. degrees.
C. “	× 4 ÷ 5	= R. “
F. “	-32 × 5 ÷ 9 =	C. “
F. “	-32 × 4 ÷ 9 =	R. “
R. “	× 9 ÷ 4 + 32 =	F. “
R. “	× 5 ÷ 4	= C. “

A unit of heat is the amount of heat necessary to raise a certain quantity of water one degree.

The French unit, called a *caloric*, is usually adopted. It is the amount of heat required to raise one kilo (2.2046215 lbs. avoirdupois) of water one degree centigrade ; that is, from 0° to 1° C.

SPECIFIC WEIGHT OR GRAVITY.

Specific weight or gravity is the weight of a substance compared with the weight of an equal volume of some other substance taken as a standard.

Distilled water at 15.6° C. (60° F.) is the standard with which all solids and liquids are compared to calculate their specific gravity.

The specific gravity of water is expressed by unity, as 1, 1.00, 1.000, 1.0000, etc., substances heavier than water being more than a unit, lighter than water, less than a -unit, expressed in decimals.

Air or hydrogen at 15.6° C. (60° F.), and the barometer at 30 inches, are the standards with which gases are compared to determine their specific gravity.

As applied to pharmacy the specific gravities of solids and liquids only are required, therefore the processes for estimating their specific gravity, only, will be considered

in this article. For the specific gravity of gases our readers are referred to the standard works on Chemistry.

Few druggists are provided with delicate specific gravity apparatus, and indeed it is unnecessary that they should be, for a few simple articles, always at hand, will suffice for the druggists' purpose as well the most elaborate and costly apparatus. A thermometer, a thin bottle and accurate balances or scales are all the apparatus required for finding the specific gravity of liquids and solids, and druggists seldom need to determine the specific gravity of gases.

The following are the simple directions for...

CALCULATING THE SPECIFIC GRAVITY OF LIQUIDS.

FIRST.—Take a thin bottle that will hold three or four ounces;¹ paste strips of paper on two opposite sides and weigh the bottle accurately, marking the weight in grains,² on one of the strips. Then weigh in the bottle just 1000 grains of distilled water at a temperature of 15.6° C. (60° F.) and mark the strips of paper on each side of the bottle just at the surface of the water, when the bottle is standing perfectly level. Mark 1000, the weight of the water, under the weight of the bottle and add them together for the gross weight, then empty the bottle and it is ready for use.

SECOND.— Having brought the liquid to be calculated to the required temperature, 15.6° C, (60°F.), pour it into the bottle previously used, until its surface comes just level with the water-level marks on the strips of paper; then weigh it accurately, noting the gross weight in grains.

THIRD.— Find the difference between the gross weight of the first and second operations. If the weight of the first operation is greater than the second, *subtract* the difference from 1000 and point off three places as decimals. If the weight of the first

¹ A long-necked bottle, that 1000 grains of water will fill into the neck, is the most accurate. Specific gravity bottles, made very light and designed to hold 100 or 1000 grains, or 50, 250 or 500 grammes, may be obtained of dealers in chemical ware. ² Metric weight may be used instead of grains. Grains are mentioned because American druggists are so much more familiar with this weight than with the metric system.

operation is less than the second, add the difference to 1000 and point off three places as decimals.

EXAMPLE 1. The gross weight of a bottle with 1000 grains of water is 1723 grains; the gross weight of the same volume of a liquid in the same bottle is 1671 grains. What is the specific gravity of the liquid ? $1723 - 1671 = 52$ difference.

$$1000 - 52 = 0.948 \text{ specific gravity of liquid.}$$

EXAMPLE 2. The gross weight of a bottle with 1000 grains of water is 1723 grains; the gross weight of the same volume of a liquid is 2184 grains. What is the specific gravity of the liquid ?

$$2184 - 1723 = 461 \text{ difference.}$$

$$1000 + 461 = 1.461 \text{ specific gravity of liquid.}$$

This method of determining the specific gravity of liquids is quite accurate, and very convenient when the bottle is once prepared. It is also adapted to small quantities of liquids as it can be calculated for 100 grains or 10 grains in the same general manner. It can be used also for light or heavy liquids, which is another convenience.

The Hydrometer is an instrument used for determining the specific gravity of liquids. There are many kinds, but nearly all act on the same principle, viz.: The depth to which they sink in the liquid, which is shown by the graduated scale in the stem of the instrument. It is not accurate enough for fine work, and cannot be used for small quantities of liquids.

The Hydrometer is principally useful for showing the proof of spirits, the degree of acids, syrups, etc., but is not adapted to the general work of calculating specific gravity in the business of the pharmacist.

The spirit Hydrometer will not answer for heavy liquids, nor the acid nor syrup Hydrometer for the light liquids.

The Government Hydrometer for spirits which has the thermometer scale attached is of much value in estimating the proof of spirits.

CALCULATING THE SPECIFIC GRAVITY OF SOLIDS.

The druggist is so seldom required to calculate the specific gravity of solids, that mere mention, only, of the methods will be given here.

Solids heavier than water are first weighed in the ordinary way, and then, by suspending them to one side of the balance by a fine thread, are immersed in water and weighed. The ordinary weight divided by the loss of weight in water gives the specific gravity of the solids.

Solids lighter than water are first weighed, and then attached or tied to some heavy metal of known weight and specific gravity; the two substances are then weighed and immersed in water together and the loss of weight of the lighter substance found by deducting the loss of weight of the heavy metal, previously found, from the total loss. The original weight of the lighter substance is then divided by its loss of weight in water, as shown by the former operation and the result is the specific gravity of the substance.

Solids soluble in water are first weighed by the balance and then weighed suspended in some liquid in which they are insoluble, as Naphtha, Alcohol or Oil. The weight in the liquid subtracted from the ordinary weight gives the loss of weight; the ordinary weight is divided by the loss of weight thus obtained, and the quotient multiplied by the specific gravity of the liquid in which the solid was weighed—this gives the specific gravity of the solid.

Powdered substances are first weighed, and their weight added to that of the specific gravity bottle and 1000 grains of water, as described for calculating the specific gravity of liquids. The powder is then put in the bottle and enough distilled water at 15.6° C. (60° F.) added to fill it to the water-level marks on the bottle. It is then weighed and its weight subtracted from the gross weight previously obtained; this shows the loss of weight in water. The ordinary weight of the powder is now divided

by the loss of weight as shown by the subtraction; the quotient is the specific gravity of the powder.

PART I .

DRUGS AND MEDICINAL SUBSTANCES.

The substances used in the art of pharmacy are obtained from every part of the known world, and are selected from all departments of the mineral, vegetable, and animal kingdoms. The mineral kingdom contributes the greater portion, the vegetable a great variety, and the animal a fair percentage of the substances which are known in the commercial world as "Drugs."

The collection and preparation of "drugs" for the market constitutes a very great industry, second in importance to none of the commercial industries of the world. In the limited space which we have to devote to this subject, mere mention only of what is most important to druggists can be made, as its elaboration would, of itself, fill a volume.

MINERAL DRUGS.

Nearly every mineral known is, in some form, made use of in pharmacy. Minerals and mineral salts were the first substances employed in medicine. The science of chemistry owes its early advancement to the researches of the alchemists and apothecaries in mineral substances, and the legends of medicine and pharmacy are mainly based upon the wonderful powers and qualities attributed to minerals.

The collection of native mineral substances does not come within the province of pharmacy, and at present but few mineral salts are prepared by pharmacists. That task, which was formerly a necessary part of the education and business of the apothecary, now being given over to manufacturing chemists, who have better facilities and conveniences for doing it.

In chemistry, all elementary mineral substances are called bases or radicals, from their property of combining with acids to form salts.

The following table of elementary substances includes the minerals, which, with their various combinations and salts, comprise a large share of the so-called "chemicals" used in pharmacy.

TABLE OF ELEMENTARY SUBSTANCES.

U. S. P., 1880.

ELEMENTS.	Sym- bol.	Atomic Weight.	EQUIVA- lent.	ELEMENTS.	Sym- bol.	Atomic Weight.	EQUIVA- lent.
Aluminium	Al	27	13.5	Molybdenum	Mo	95.5	42.75
Antimony	Sb	120	120	Nickel	Ni	58	29
Arsenic	As	74.9	74.9	Niobium	Nb	94	94
Barium	Ba	136.8	68.4	Nitrogen ³	N	14	14
Beryllium (Gluci- num)	Be	9	9	Osmium	Os	198.5	99.25
Bismuth	Bi	210	210	Oxygen ⁴	O	16	8
Boron	B	11	11	Palladium	Pd	105.7	52.85
Bromine	Br	79.8	79.8	Phosphorus	P	31	31
Cadmium	Cd	111.8	55.9	Platinum	Pt	194.4	97.2
Caesium	Cs	132.6	132.6	Potassium	K	39	39
Calcium	Ca	40	20	Rhodium	Rh	104.1	52.05
Carbon ¹	C	12	6	Rubidium	Rb	85.3	85.3
Cerium	Ce	141	70.5	Ruthenium	Ru	104.2	52.1
Chlorine ²	Cl	35.4	35.4	Scandium	Sc	44	22
Chromium	Cr	52.4	26.2	Selenium	Se	78.8	39.4
Cobalt	Co	58.9	29.45	Silicon	Si	28	14
Copper	Cu	63.2	31.6	Silver	Ag	107.7	107.7
Didymium	Di	144.6	72.3	Sodium	Na	23	23
Erbium	E	165.9	82.95	Strontium	Sr	87.4	43.7
Fluorine	Fl	19	19	Sulphur ⁵	S	32	16
Gallium	G	68.8	34.4	Tantalum	Ta	182	182
Gold	Au	196.2	196.2	Tellurium	Te	128	64
Hydrogen	H	1	1	Thallium	Tl	203.7	203.7
Indium	In	113.4	56.7	Thorium	Th	233	116.5
Iodine	I	126.6	126.6	Tin	Sn	117.7	58.85
Iridium	Ir	192.7	96.35	Titanium	Ti	48	24
Iron	Fe	55.9	27.95	Tungsten	W	183.6	91.8
Lanthanum	La	138.5	138.5	Uranium	U	238.5	119.25
Lead	Pb	206.5	103.25	Vanadium	V	51.3	51.3
Lithium	Li	7	7	Ytterbium	Yb	172.7	172.7
Magnesium	Mg	24	12	Ytterium	Y	89.8	89.8
Manganese	Mn	54	27	Zinc	Zn	64.9	32.45
Mercury	Hg	199.7	99.85	Zirconium	Zr	90	45

¹ Carbon: 11.9736.

² Chlorine: 35.370.

³ Nitrogen: 14.021

⁴ Oxygen: 15.9633.

⁵ Sulphur: 31.984.

Inorganic Chemical Products.

The process by which substances unite to form other substances or compounds is called *chemical action*, and the force with which they so unite is called *chemical*

attraction or *affinity*; mineral chemical substances are called *inorganic*; vegetable and animal chemical substances are called *organic*.

Inorganic Chemical products are produced by the union of mineral bases with acids, and the salts thus composed constitute a large share of the chemicals of pharmacy and commerce. The salts thus formed bear the names both of the base and acid of which they are composed; for examples, acetate of potassium or potassium acetate, sulphate of iron or ferrous sulphate, bi-chloride of mercury or mercuric chloride, etc.

The names of chemical salts are distinguished by certain prefixes or terminations, which indicate in a measure the proportions of the combinations. For a full understanding of these, and chemical nomenclature in general, the reader is referred to standard words of chemistry.

VEGETABLE DRUGS.

By far the greater number of substances used in medicine are of vegetable origin. Nearly every plant that grows has at one time or another played its part in the history of Pharmacy, and newly-discovered ones, with "wonderful virtues," are still being brought to light from "lands beyond the sea."

But little attention is now given by Pharmacists to gathering and curing vegetable drugs; that branch of the business, which was in former time an important part of the trade of the Apothecary, being given over to collectors and others who have better facilities for carrying it on. Vegetable substances are, or should be, gathered at the season when they contain the greatest amount of medicinal value, and are prepared for market in various ways, which depend largely upon the intelligence, experience and convenience of the collectors.

A brief mention of crude vegetable drugs, and the methods employed for preparing them for the market may not be superfluous.

Balsams.—Many substances of quite different consistence and composition are classed as Balsams. They are generally gathered by puncturing pustular cells in the bark, or by making cuts or incisions in the bark or wood of certain trees or plants. They are liquid, semi-solid or solid.

Barks.—Barks are gathered in the early spring just after the sap has started to flow. The bark may then be readily stripped from the branches, trunk or root, and it contains as much or more medicinal value than at any other season. The bark from twigs or small branches is easiest removed by heating them over a fire and then pounding them with a billet of wood. The trunk-bark of trees is generally removed in slabs or strips, the outer portion being shaved or hewed off and discarded, the inner bark only being used ; the root-bark has usually to be shaved off. Barks are dried in the open air or by moderate heat in kilns, evaporators, or other heating apparatus, and come into the market in the form of quills, small slabs, stripes, or broken in small pieces. They are then cut, crushed, ground, or powdered as desired for sale or use.

Berries.—Under the common name of berries are included many of the smaller fruits, like strawberry, raspberry, etc.; the small fleshy fruits, like juniper, ash, and laurel, and the dry, unripe berries, like cubeb, spice, and pepper. The juices of some berries are used, while others are gathered and dried by suitable heating apparatus, to prepare them for the market.

Buds.—A few kinds of leaf-buds, like Balm of Gilead, are gathered, dried, and used in medicine; but the term is usually used in Pharmacy to designate undeveloped flower-buds, of which cloves and cassie-buds are examples. They are gathered in their proper season, and dried in the open air for the market.

Flowers.—Flowers should be gathered in their early blossoming before they have passed their prime; many, even, are best gathered when the buds are opening. They are usually gathered with as little of the stalk as possible, except in the case of plants and herbs, which are gathered entire at the season of flowering. Flowers should be dried with as little exposure as possible, and packed away in a dry, cool place.

Fruit.—Fruit is a botanical name for all kinds of vegetable-growths enclosing and including seeds; but different kinds of fruit are classed and named according to their peculiarities: as fleshy fruits, of which apples and berries are examples, stone fruits, of which the peach and cherry are examples, and dry fruits, which include nuts, capsular and other dry fruits, seeds, etc. Fruits are generally gathered when the seeds are ripe, and are dried, preserved, or otherwise treated according to their nature and use. Fleshy and stone fruits should be dried in an evaporator or other suitable drying apparatus, while the dry fruits are either sufficiently dry when ripe, or may be dried in the open air. Many of the fruits are classed commercially as berries, nuts, seeds, capsules, etc.

Gums and Gum-Resins.—Among the natural vegetable substances which are collected and put upon the market, a certain class of gums and gum-resins may be included. They are the exudations from plants either from the stings of insects, or from incisions made for the purpose of collecting the gum or gum-resin. The collection of gums and their preparation for the market forms a very large and important industry.

Besides the gums and gum-resins, there are many substances known commercially as gums which are of an entirely different character—as opium, which is a concremented juice, and catechu, which is properly an extract.

Herbs.—In pharmacy herbs are understood to be the upper portion of small plants, including the leaves, flowers and small stalks, the larger stalks and roots being discarded. Commercially, the smaller plants, which are gathered entire, are also classed with herbs. Herbs should generally be gathered when in blossom, carefully dried without artificial heat, and packed away in a cool, dry place.

Plants.—Plants, as the term is understood botanically, include all vegetable-growths, great or small; but in pharmacy the name is generally applied to small plants which are gathered and used entire. They should be gathered about the season of flowering, and dried without artificial heat.

Leaves.—Leaves should be gathered when the plants or trees are at their fullest prime. With plants, this is generally a little before the flowering season ; and with

trees and shrubs, usually a little before the ripening of the fruit. Leaves should be dried without artificial heat and packed away in a cool, dry place.

Nuts.—Nuts are properly classed with fruits. They are gathered when ripe, thoroughly dried and prepared in various ways for the market.

Roots.—Commercially considered, roots are the parts of plants which grow in the ground; in pharmacy, however, they are divided into several classes according to their nature—as root, rhizome, rootlets, bulb, cormus, tuber, etc., the three latter not being properly classed with roots. Roots should generally be gathered after the leaves are off the plants in the fall, or before they start in the spring. The bark, only, of many woody roots is used, while some are gathered, entire, being cut, sliced, crushed or otherwise prepared for market. The rhizome is the main portion of the root or rootstock, to which the rootlets, if any, are attached. Of the roots which consist of rhizome and rootlets, some are used entire, while others, only the rhizome or rootlets may be used.

The bulb, cormus and tuber are classed with roots commercially, but are botanically dissimilar. Bulbs are usually sliced and dried ; cormus and tuber may be sliced or dried whole.

Seeds.—Many of the so-called "seeds," as caraway, cardamom, coriander, fennel, etc., are classed in pharmacy as fruit. The botanical distinction being, that when two or more separate seeds are enclosed by a pericarp or envelope, the structure is called fruit, while the seed itself is a single ovule, containing the embryo and its nutriment. Seeds are generally gathered when ripe and dried if necessary by natural heat. Some of the fruits which are commercially classed as seeds require artificial heat.

Woods.—The greater part of the woods used in the drug-business are for dyeing purposes. A few, however, are used as medicine. They are generally furnished to druggists in chips, or shavings, or ground to the proper fineness for use.

Pharmaceutical and Chemical Products.

The many products which are derived from vegetable substances may conveniently be classed as pharmaceutical and chemical. In the former class may be included such as are generally prepared by pharmacists in their business, and in the latter, such as are usually prepared by the larger manufacturing chemists. Of the former class, fluid extracts, solid extracts, tinctures, spirits, syrups, etc., and of the latter, the alkaloids and their salts, vegetable acids, alcohol and distilled spirits, etc., may be mentioned.

ANIMAL DRUGS.

But few animal substances, comparatively, are used in medicine, yet in the aggregate the drugs derived from the animal kingdom form quite a percentage of the druggists' stock.

In the early days of medicine, animal substances were used to a great extent—the most ridiculous and foolish use being made of them—but, as the science of medicine has emerged from its early superstitions, they have been mostly dropped, and only such as are of known value retained.

The fats and oils obtained from animal tissue constitute the greater portion of animal-matter used in pharmacy. Some expensive animal substances, such as musk and ambergris are used quite extensively in perfumery. Pepsin, pancreatin, albumen, the meat extracts, etc., are used internally. Cantharides is most used externally, and many other animal substances have various uses in medicine or pharmacy.

Pharmaceutical and Chemical Products.

The pharmaceutical products prepared from animal substances are mainly the cerates, ointments and plasters, in which animal fats and wax are used as bases. Several tinctures also are prepared from animal substances, such as cantharides, castor, musk, etc. The chemical products consist mainly of a few alkaloids and their salts, and may include pepsin, pancreatin, etc., as they are not usually prepared except by manufacturing establishments.

PART II.

WORKING PROCESSES.

The processes which are here noted are such as druggists do or may employ in their business, without expensive apparatus or special pharmaceutical education. Many other processes are employed by chemists and large manufacturers which it would be needless to detail here, as they would not be used by druggists generally.

DIALYSIS.

The process by which certain substances are separated from other substances with which they are combined in solution, by means of the diffusibility of liquids through a thin membrane, is called Dialysis.

The physical principle, involved in this operation, is that of the diffusion of liquids, called *endosmosis* and *exosmosis*. Although this process is not officinal, it may be frequently employed to advantage in pharmacy, and it no doubt merits more consideration than it has heretofore received.



In pharmacy, dialysis is employed to separate what are known as *colloid* (gluelike) substances, from their combination in solution with crystallizable substances. This is accomplished by means of an apparatus called a Dialyzer, a simple form of which is here illustrated.

This apparatus may be made by any druggist, without expense, and is sufficient for the requirements of most retail dealers. Larger apparatus may be made on the same principle. It consists of an ordinary white glass 7-inch lamp-shade, the bottom of which is covered over with parchment paper, which is large enough to extend up the sides of the shade nearly two inches, and which is held in place by two rubber bands.

The solution to be dialysed is placed in the apparatus thus constructed, and floated on distilled water, contained in any convenient earthenware vessel. (An earthenware milk-pan which is shown in the cut, is convenient for this purpose, or an ordinary wash-bowl may be used.) The dialyzer may be suspended by a string from above, or set upon bottles in the earthenware vessel, so that the surface of the liquid in the dialyzer may be about on a level with the surface of the water in the vessel.

Parchment paper for this purpose may be made by immersing firm, unsized paper in a mixture of two measures of Sulphuric Acid with one measure of water, and afterward washing it thoroughly with pure water to remove all traces of acid. It may also be bought, at a small price, of jobbers or dealers in pharmaceutical apparatus.

Dialysis is applicable only to aqueous solutions, and the process is used sometimes to obtain the colloid, and sometimes the crystalloid, principles from their solutions. The colloid substances are always retained in the floating vessel or dialyzer, while the crystalloid substances are found in the water with which the dialysis is conducted. In working the process to obtain the colloid substances, the water in the vessel should be changed every day; but in working it to obtain the crystalloids, as little water as is necessary for the purpose should be used, for it has subsequently to be evaporated to obtain the crystallizable substance. Gum arabic is a familiar example of a colloid, and sugar, of a crystalloid substance. If they are both represented in a solution, the gum will be retained in the floating vessel, while the sugar will gradually be transferred to the water, in which it floats.

In conducting the process of dialysis it should be continued so long as the water in the lower vessel contains appreciable traces of the soluble crystalloid, or other substance, which the process is designed to remove. Dialysed iron is probably the most familiar colloid preparation made by dialysis.

DISTILLATION.

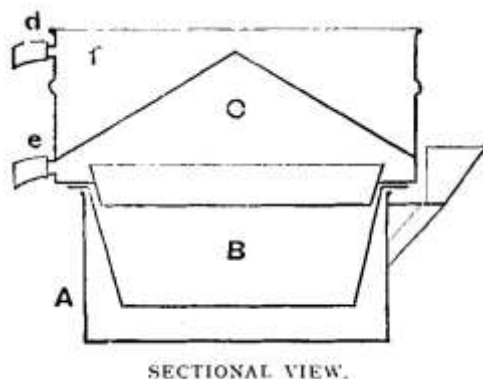
The process of vaporizing a liquid or other substance, by the aid of heat, and then condensing the vapor to a liquid by cold, in an apparatus called a still, is known as Distillation.

FENNER'S WATER-BATH AND STILL is a convenient, simple apparatus for evaporating and distilling. It consists of a cylindrical, shallow vessel, A, into which is fitted the shallow evaporating pan, B (which serves as the vessel for open evaporation, and also for evaporation during distillation); and the conical still top, C, in which the vapor, which rises, is



FENNER'S WATER-BATH AND STILL.

condensed during the process of distillation. This apparatus is constructed specially for evaporating and distilling; it is low and shallow, having a large bottom surface, fitting it well for rapid evaporation and distillation. Fenner's Water-bath Percolator and Still may be employed for the same purposes, but as it is constructed for percolation also, corresponding sizes do not present so large a surface for evaporation and distillation as does the Water-bath and Still.



Druggists will find it a great convenience to have the Water-bath and Still, as well as the Water-bath Percolator and Still, for they are often both required at the same time.

This process is used for separating liquids of a less from those of a greater specific gravity; for separating liquids from soluble substances which they hold in solution; for separating volatile substances from grosser matter with which they are associated, and for purifying and freeing liquids from objectionable matter.

As applied to pharmacy, distillation is employed for recovering alcohol from many preparations which are required to be concentrated by evaporation, such as fluid extracts, solid extracts, etc., for distilling medicinal waters and spirits, for obtaining ethers, essential oils, etc., and for many other purposes.

Although distillation is frequently directed in the Pharmacopoeia, no advice nor instructions are given in regard to it, it being assumed that druggists are sufficiently familiar with the process to enable them to conduct it properly. A few suggestions, however, may not here be amiss.

To distill medicated waters or other aqueous substances no water-bath is required, the distillation of such liquids being more rapid, and equally as satisfactory, without it. If herbs, leaves, flowers, seeds or other similar substances are to be distilled, they should be protected from contact with the bottom of the still by a false bottom, so that they may not "scorch," and sufficient water should be used with them to prevent the extract which collects at the bottom from "burning down." At least, double the quantity of water that is taken of the drug should be used.

To obtain oils from medicinal plants, seeds, etc., the most approved method is to pass a current of steam through the herbs, or other substances, by which the particles of oil are vaporized and carried over with the steam and condensed, being afterwards gathered from the surface of the water.

To distill or recover Alcohol or any substance of less specific gravity than water, the liquid should be placed in the water-bath and the heat communicated to it, by heating the water surrounding it. The boiling point of the alcohol or other lighter liquid being lower than the boiling point of water, it is vaporized and condensed in the still; the heavier liquids and extractive matter remaining in the water-bath.

When drugs are percolated with alcohol, or a partly alcoholic menstruum, the menstruum remaining in the drug can be recovered by transferring the moist drug to the water-bath of the still and distilling in the usual manner. If the water-bath percolator and still is used, it is unnecessary to transfer the drug, as the still top can be adjusted, heat applied, and the distillation completed without further trouble.

The process of distillation is a very important and economical one in pharmacy, and is much less employed than it should be.

EVAPORATION.

As applied to pharmacy, evaporation is the process by which, with the aid of heat, the volume of liquids or other substance may be reduced. It is employed for many purposes in the practice of pharmacy, and is so familiar to druggists, that but little need be said regarding it in this article.

The vessels used for evaporating should be broad and low, or shallow, to give a larger surface for the application of heat and the escape of vapor. Evaporating dishes are made of glass, iron (enameled or glazed), platinum, porcelain, tin, etc.

Heat is applied in various ways for the purpose of evaporating—by the ordinary methods, by water-bath, sand-bath, steam, heated air, etc.

For rapid evaporation, heat over an open fire or by means of steam is best; but for making many preparations, such as extracts, fluid extracts, etc., slower evaporation is necessary, that the preparation may not be injured by the heat. For this purpose the water-bath² is the most convenient for druggists' use, as by it the heat can be regulated and maintained at any desired temperature. In large establishments the vacuum pan, which is still better for the purpose, is employed. This consists of a large pan and chamber covering it, from which the air is removed by means of an air-pump, causing the liquid in the pan to evaporate at a much lower temperature than in the open air.

The most serviceable, cheap, evaporating dish, is the ordinary graniteiron stove skillet, or frying-pan. Any ordinary evaporating dish may be set in a vessel of water,

² The water-bath which forms a part of FENNER'S WATER-BATH AND STILL is very convenient for the purpose of evaporation. It is shown in the sectional view on page 28 by the vessels A and B. FENNER'S WATER-BATH PERCOLATOR (see page 46) may also be used for the same purpose, it being necessary only to put the liquid to be evaporated into the percolator and leave off the cover.

which will answer as a water-bath. A sand-bath may be made by partly filling an iron basin with sand and setting the evaporating dish in it.

For very slow evaporation a warming closet may be made, by fastening a box against the wall and heating it with a lamp placed underneath a hole in the bottom; smaller holes should also be provided in the upper surface for the escape of vapor. This box can be so arranged with shelves that a number of evaporating dishes may be placed in it at the same time.

EXPRESSION.

The process of expression is employed more or less for many uses in pharmacy, the apparatus and manner of working being governed by what is required to be done.

In making tinctures, fluid extracts, etc., a considerable quantity of menstruum is left in the drug after the percolation is completed, and it is economy to recover it by pressure in a tincture press or other suitable apparatus; pressure is also employed as the chief operation in some processes for making fluid extracts (see Fluid Extracts). In choosing a tincture press for any purpose, it is not economy to get the smallest sizes, a one- or two-gallon press being none too large for most pharmaceutical work. The drugs to be expressed should be inclosed in a coarse burlap bag or cloth, and the pressure should be long continued rather than too quick and forcible, that the liquid may have time to become separated from the drugs. In pressing pulpy or mucilaginous drugs it is an advantage to mix them with some loose non-absorbing material, rice chaff, for example, to facilitate the operation. Fruit juices, in a small way, are best expressed by hand pressure, except such fruits as lemon, orange, etc., which can be pressed with a lemon squeezer. In a large way, fruit may be pressed in large wooden presses, the layer presses being the best variety for this purpose. In using small presses nothing is gained by trying to press too much at a time, the operation being more satisfactory in moderate quantities.

There are several good kinds of presses to be had for pharmaceutical purposes, the "Enterprize" being as convenient and serviceable as any. There are several so-called

“pressure percolators” now sold, but, in our opinion, they are not convenient percolators, and they certainly fail to do the work of a press.

FILTRATION.

The process of separating insoluble matter from liquids, by means of any substance or medium which will prevent its passage, is called filtration.

Filtration, as it is employed in pharmacy, is usually conducted by means of filtering paper contained in a conical receptacle called a funnel;* but larger operations are carried on by other contrivances which will admit of a more rapid filtration.

The process of filtration is so familiar that it needs no explanation; but a few suggestions are here made for the benefit of the inexperienced.

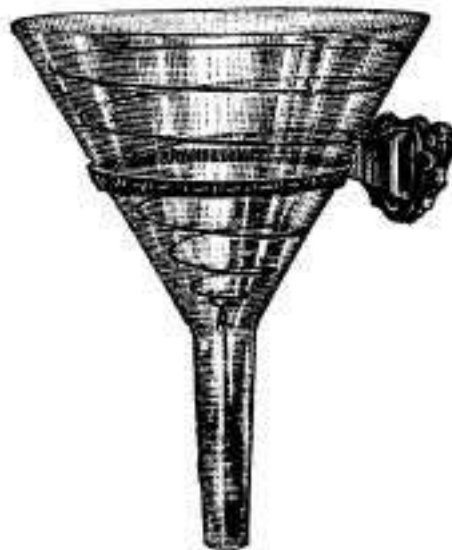
*FENNER'S SPIRAL FILTER RACK is a convenience for keeping the filtering paper off the sides of the funnel when filtering. It is made of tinned steel wire, of different sizes to fit different size funnels.

It is simple, cleanly, durable, efficient and cheap. The cut shows it as it is adjusted in the funnel ready for use.

Heat often assists the process of filtering heavy liquids or oils. It may be conveniently applied by putting a filter inside of Fenner's water-bath percolator, and applying heat by means of the water-bath. For supporting the funnel during filtration, Fenner's Funnel Rack, which is shown in the cut, is very convenient.

Further remarks on filtering will be found in the article on " Economy in Percolating and Filtering," page 43.

In filtering a liquid which contains a precipitate (unless the precipitate is designed to clear the liquid, as magnesia or pumice-stone are used) the liquid should be poured carefully off and filtered first, the precipitated portion being added after most of the liquid has passed through the filter; this makes the process more rapid.



The first portion that passes through the filter should be returned to it and re-filtered, as, when the filter is dry, it admits of the passage of small particles which are retained when its fibers have had time to swell by the absorption of moisture.

In filtering liquids containing albuminous or gummy precipitates, it is also advantageous to put a coarse cotton cloth strainer on the inside of the filter paper; this catches the precipitate or albuminous substance, which may be removed with it, or in which it may be pressed to strain out the liquid, and thus make the filtration more rapid.

A plaited filter is generally used, except when a filter-rack is employed, then the ordinary folded (quartered) filter is used.

Besides filtering through paper, other means are often employed by druggists. Syrups and heavy liquids may be filtered through a flannel or cotton strainer, or felt filters that are made expressly for this purpose. Charcoal and sand, in alternate layers, are employed for filtering light liquids when larger quantities are to be filtered.

A little charcoal in powder, or powdered pumice-stone sprinkled in the filter, will often assist to clear preparations that are difficult to filter clear.

FINENESS OF POWDER.

To properly obtain the soluble constituents of drugs by the process of percolation, they should be so comminuted or divided that the menstruum may readily dissolve all soluble matter.

To this end, different drugs are directed to be reduced to different degrees of fineness as experience has shown to be best suited to their nature.

The United States Pharmacopoeia has adopted the following standard for the fineness of powders:

<i>A very fine</i> powder	{ should pass through a sieve having 80 or more meshes to the linear inch,	} equals No. 80 powder.
<i>A fine</i> powder	{ should pass through a sieve having 60 meshes to the linear inch,	} equals No. 60 powder.
<i>A moderately fine</i> powder	{ should pass through a sieve having 50 meshes to the linear inch,	} equals No. 50 powder.
<i>A moderately coarse</i> powder	{ should pass through a sieve having 40 meshes to the linear inch,	} equals No. 40 powder.
<i>A coarse</i> powder	{ should pass through a sieve having 20 meshes to the linear inch,	} equals No. 20 powder.

Other degrees of fineness than the foregoing are often directed.

It is desirable for the purpose of percolation that the powder used should be as uniform as possible, it is therefore directed in the Pharmacopoeia that "not more than a small proportion of the powder should be able to pass through a sieve having ten meshes or more to the linear inch." While this direction is valuable for securing a uniform powder and thereby promoting the process of percolation, it is, in our opinion, unwise to specify this limit; for in reducing drugs to different fineness of powder by any process which druggists may command, it is obvious that, unless the powder is very fine, quite a proportion of it will be much finer than the coarsest powder which will pass through the sieve having the required number of meshes to the inch. If this portion is separated from the coarser powder by sifting, that which remains will not truly represent the entire substance of the drug from which it was prepared.

In preparing a powder, therefore, for percolation the entire quantity of drug which is taken should be reduced to a powder that will pass through a sieve having the required number of meshes; or, if this produces a powder too fine for successful percolation, a coarser sieve should be used; for it is better to use a coarser powder

than to remove any portion of the drug which would be represented by the finer powder.

For the reasons stated the powders directed in the formulae of the U. S. P., are, as a rule, too fine for successful percolation by the majority of druggists, and better results will be secured by using about one grade coarser powder than is designated.

Drugs are usually reduced to the required degree of fineness for percolation by grinding in a drug mill, but when finer powders are required the old, time-honored mortar and pestle comes into play. But few druggists, however, attempt to make what are known in the market as "powdered drugs." They are usually bought of reliable houses who make a business of putting them up.

Drugs "ground for percolation " may also be bought in the market, but as they always come in bulk without the guarantee of a reliable house, they are liable to adulteration, or to be ground from old or worthless drugs, and it is much better for the druggist to grind them himself, as needed, from reliable crude drugs.

INFUSION AND DECOCTION.

The process of INFUSION consists in steeping drugs at a temperature below the boiling point of water, in an aqueous or other menstruum, for the purpose of extracting their soluble medicinal constituents. For this purpose, "infusion pots," which contain a perforated cup or receptacle for the drug, which is surrounded by hot water during the operation, are furnished by manufacturers of chemical ware. A covered granite-ware, or earthen-ware, vessel will answer the same purpose; the water-bath percolator is however the best adapted of any apparatus for the purpose of infusion, as the heat can be maintained and the liquid drawn off by the stop-cock whenever it is desired. For making infusions, boiling water is usually poured upon the drug and the heat continued to nearly the boiling point for from one to two hours.

The process of DECOCTION consists in boiling the drugs in an aqueous menstruum for fifteen minutes or longer to obtain their soluble properties. This may be done in an open' or covered vessel, but the process is now but little employed. The water-

bath percolator is a very convenient apparatus for decoctions, as the heat may be maintained to boiling for any length of time, and the liquid then drawn off by the stop-cock.

MACERATION.

When percolation came to be the officinal process for exhausting drugs, maceration, the process of our forefathers, was mostly abandoned, but we are glad to see that in the present pharmacopoeia its value is again recognized, and that many preparations, which have of late been made by percolation, are now again made by maceration. In addition to this, the new pharmacopoeia, in making most of the tinctures and some extracts, gives the very much needed direction to macerate twenty-four hours with a portion of the menstruum before packing in the percolator. Maceration is the necessary primary step to successful percolation. It softens the drug, dissolves its soluble properties and loads the menstruum with them, ready to be carried away by the subsequent process of percolation.

The new British Pharmacopoeia (1885) directs maceration for from twenty-four to forty-eight hours as a preliminary step to percolation in making tinctures, etc. The German, French, and other continental European authorities direct maceration mainly for obtaining the strength of drugs; and although percolation, when properly conducted, has great advantages over any other process for obtaining the strength of drugs, without maceration it fails to accomplish its full purpose.

Whenever percolation is employed, sufficient time should be given for maceration to loosen and dissolve the soluble properties of the drug. If alcohol is the menstruum employed, the maceration may be conducted after packing the percolator; but if water forms a portion of the menstruum, the drug should first be macerated with a portion of the menstruum sufficiently long to allow it to swell before it is packed in the percolator.

Any convenient covered vessel may be used for macerating drugs designed to be percolated. For small quantities, glass, specie or salt mouth jars, earthen-ware fruit jars, or covered granite-ware stew-pans, are very convenient, even tin cans will not

be injurious for most drugs. Drugs to be thus macerated should be thoroughly moistened with a portion of the menstruum and covered to prevent exposure and evaporation. When preparations are prepared entirely by maceration, the drugs should be put in a suitable glass jar or vessel, the menstruum added, and be frequently agitated for several days.

PERCOLATION.

The directions for percolation are very complete and minute in the present pharmacopoeia; they are therefore repeated here in full;

"The process of percolation or displacement directed in this (1880) Pharmacopoeia consists in subjecting a substance or substances in powder contained in a vessel called a percolator, to the solvent action of successive portions of menstruum, in such a manner that the liquid as it traverses the powder in its descent to the recipient, shall be charged with the soluble portion of it, and pass from the percolator free from insoluble matter.

"When the process is successfully conducted, the first portion of the liquid or percolate, passing through the percolator will be nearly saturated with the soluble constituents of the substance treated; and if the quantity of menstruum be sufficient for its exhaustion, the last portion of the percolate will be destitute of color, odor and taste, other than that possessed by the menstruum itself.

"The percolator most suitable for the quantities contemplated by this Pharmacopoeia should be nearly cylindrical, or slightly conical, with a funnel-shaped termination at the smaller end. The neck of this funnel-end should be rather short, and should gradually and regularly become narrower toward the orifice, so that a perforated cork, bearing a short glass tube, may be tightly wedged into it from within until the end of the cork is flush with its outer edge. The glass tube, which must not protrude above the inner surface of the cork, should extend from one and one-eighth to one and one-half inch (three or four centimetres), beyond the outer surface of the cork, and should be provided with a closely fitting rubber tube, at least one-fourth longer than the percolator itself, and ending in another short glass tube, whereby the rubber tube may be so suspended that its orifice shall be above the surface of the menstruum in the percolator, a rubber band holding it in position.

"The dimensions of such a percolator, conveniently holding 500 grammes of powdered material, are preferably the following: Length of body, fourteen inches (36 centimetres); length of neck, two inches (5 centimetres); internal diameter at top, four inches (10 centimetres) ; internal diameter at beginning of funnel-shaped end, two and one-half inches (6.5 centimetres) ; internal diameter of

the neck, one-half inch (12 millimetres), gradually reduced at the end to two-fifths of an inch (10 millimetres). It is best constructed of glass, but, unless so directed, may be constructed of a different material.

"The percolator is prepared for percolation by gently pressing a small tuft of cotton into the space of the neck above the cork, and a small layer of clean and dry sand is then poured upon the surface of the cotton to hold it in place.

"The powdered substance to be percolated (which must be uniformly of the fineness directed in the formula, and should be perfectly air-dry before it is weighed) is put into a basin, the specified quantity of menstruum is poured on and it is thoroughly stirred with a spatula, or other suitable instrument, until it appears uniformly moistened. The moist powder is then passed through a coarse sieve—No. 40 powders, and those which are finer, requiring No. 20 sieve, whilst No. 30 powders require a No. 15 sieve for this purpose. Powders of a less degree of fineness usually do not require this additional treatment after the moistening. The moist powder is now transferred to a sheet of thick paper and the whole quantity poured from it into the percolator. It is then shaken down lightly and allowed to remain in that position for a period varying from fifteen minutes to several hours, unless otherwise directed; after which the powder is pressed, by the aid of a plunger of suitable dimensions, more or less firmly, in proportion to the character of the powdered substance and the alcoholic strength of the menstruum; strongly alcoholic menstrea, as a rule, permitting firmer packing of the powder than the weaker. The percolator is now placed in a position for percolation, and, the rubber tube having been fastened at a suitable height, the surface of the powder is covered by an accurately fitting disk of filtering paper, or other suitable material, and a sufficient quantity of the menstruum poured on through a funnel reaching nearly to the surface of the paper. If these conditions are accurately observed, the menstruum will penetrate the powder equally until it has passed into the rubber tube and has reached, in this, the height corresponding to its level in the percolator, which is now closely covered to prevent evaporation, and the apparatus allowed to stand at rest for the time specified in the formula.

"To begin percolation, the rubber tube is lowered and its glass end introduced into the neck of a bottle previously marked for the quantity of liquid to be percolated, if the percolate is to be measured, or of a tared bottle, if the percolate is to be weighed; and by raising or lowering this recipient, the rapidity of percolation may be increased or lessened as may be desirable, observing, however, that the rate of percolation, unless the quantity of material taken in operation is largely in excess of the pharmacopoeial quantities, shall not exceed the limit of ten to thirty drops in a minute. A layer of menstruum must constantly be maintained above the powder, so as to prevent the access of air to its interstices, until all has been added, or the requisite quantity of percolate has been obtained. This is conveniently accomplished, if the space above the powder will admit of it, by inverting a bottle containing the entire quantity of menstruum over the percolator in such a

manner that its mouth may dip beneath the surface of the liquid, the bottle being of such shape that its shoulder will serve as a cover for the percolator.

"When the dregs of a tincture, or similar preparation, are to be subjected to percolation, after maceration with all or with the greater portion of the menstruum, the liquid portion should be drained off as completely as possible, the solid portion packed in a percolator, as before described, and the liquid poured on, until all has passed from the surface, when, immediately, a sufficient quantity of the original menstruum should be poured on to displace the absorbed liquid, until the prescribed quantity has been obtained."

The foregoing officinal directions cover the whole *general* subject of percolation, and the remarks which follow are intended as *special* consideration of improved methods, and the difficulties which may arise in applying a general rule to the treatment of a variety of substances.

The fineness of powder to be used for percolation has been discussed under the article on fineness of powders, but it may be here repeated that the powders directed in the formulae of the pharmacopoeia are, as a rule, too fine for successful percolation, and that the mass of druggists will have "better luck" to choose a grade coarser powder than is specified in the officinal formulae.

Moistening the drug is discussed in the officinal process, and in the article on maceration, and it need only be remarked that it is of great importance to have the drug thoroughly and evenly moistened. Many druggists are in the habit of putting the drug in the percolator and pouring the menstruum upon it to moisten it, without even stirring it up; this should never be done, for, frequently, a portion of the drug will "cake" so that it will not become moistened during the entire process of percolation. The drug should always be moistened in a basin or other vessel, before putting into the percolator.

Macerating before percolating is discussed in the article on maceration. It may be here repeated, however, that when water is used as a portion of the menstruum for percolation, the drug should be moistened with the menstruum and allowed to macerate for twenty-four hours, in order that it may swell before, instead of after, packing in the percolator.

Packing the percolator. In packing the percolator much depends upon the nature of the drug, the fineness of the powder, etc. Loose, fibrous, or bulky drugs, such as arnica, stillingia, buchu, etc., cannot be packed very firmly, but should be made as compact as possible; heavy drugs, such as aconite root, valerian, golden seal, etc., do not require so much pressure, but will pack much firmer; soft, spongy, or gummy drugs, such as rhubarb, colocynth or squill, should not be packed very firmly; coarse powders, as a rule, should be packed more firmly than fine. The percolator should be packed from the outside towards the centre and as evenly as possible. A disc of paper and then a cover of perforated tin should be placed upon the surface of the powder after it is packed to secure the even distribution of the menstruum as it is poured upon the drug. A glass or earthenware weight may be used with advantage to hold the drug in its place. It should generally be allowed to macerate for some time after the menstruum is poured on before beginning to percolate.

The flow of percolate maybe regulated by the rubber tube, as directed in the officinal process; by a loose cork in the bottom of the percolator; or, if the water-bath percolator is used, by the stop-cock. The rapidity with which the percolate should flow, depends very much upon the nature of the drug, and the quantity required to be obtained as compared with the quantity of drug being percolated; for example, fluid extracts should not be percolated so rapidly as tinctures, nor aconite as rapidly as buchu.

With a certain class of drugs, the alcoholic or hydro-alcoholic menstruum, with which the percolation is conducted, may be forced out by adding water after the menstruum has disappeared from the surface of the drug, and thereby make a saving of alcohol; but with others, which soften or make precipitates with an aqueous menstruum, the percolation must be conducted to the end with the same menstruum. The menstruum remaining in the drug after percolation, may be pressed out with a tincture press and the alcohol recovered from it by distillation.

Drugs Difficult to Percolate.

Many drugs present difficulties to the ordinary methods of percolation and require special treatment; this is generally given in the formulae in which they are found ; but they may be classed in a general way as follows :

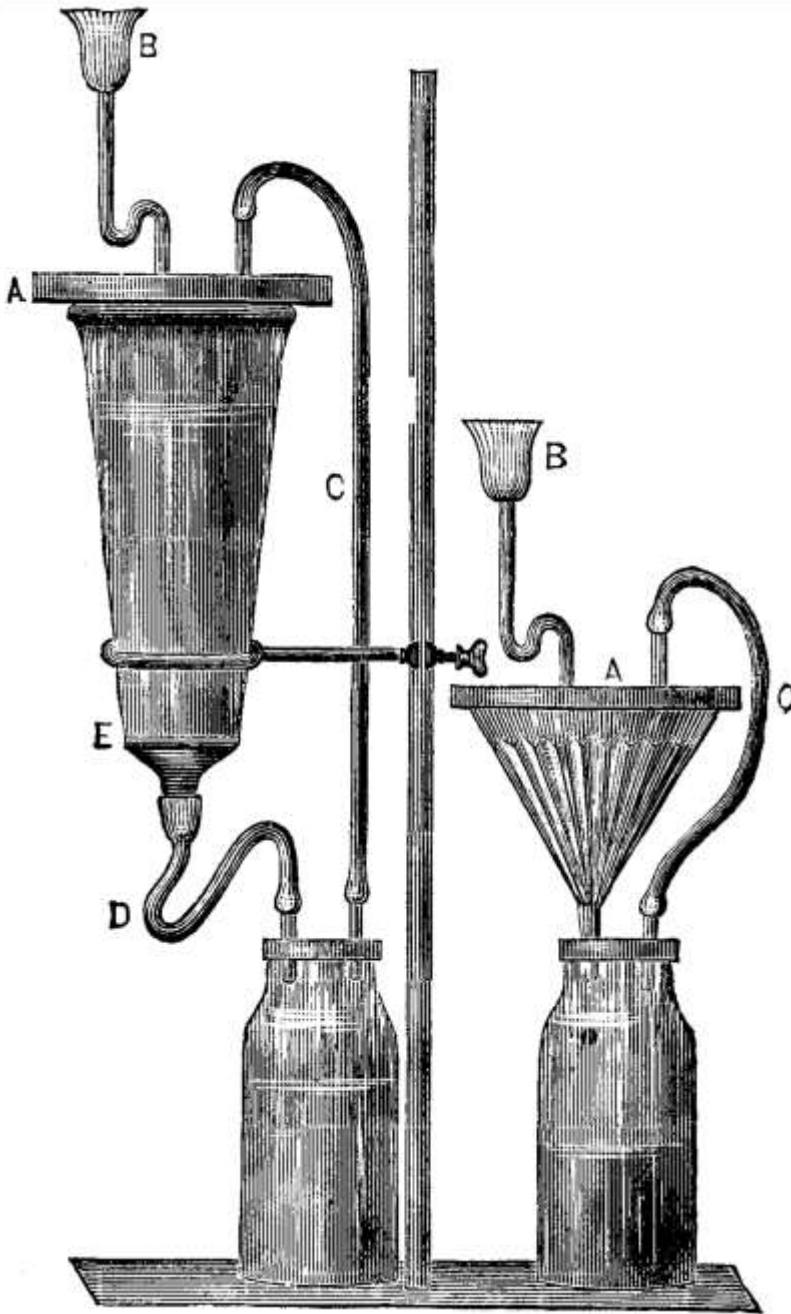
1. Drugs that soften or make a pulpy mass upon the addition of the menstruum, such as orange, gentian, rhubarb, squill, colocynth, etc. Such drugs should be well moistened and macerated before packing; they should be rather coarsely powdered and rather loosely packed, and the percolation, when begun, should be conducted rapidly, and continued to the end with the same menstruum.
2. Gums and gum-resins which agglutinate or mass together when the menstruum is added. These should be mixed with an equal bulk of sand, sawdust, or rice chaff, and not packed, but placed loosely, in the percolator, and the percolation conducted in the usual manner.
3. Bulky drugs, like arnica, buchu, chamomile, etc. Although these drugs are not difficult to percolate, they absorb so much menstruum that the expense of making their preparations is considerably increased. These should be packed as firmly as possible, and held down in the percolator with a weight during the process of percolation.

Economy in Percolating and Filtering.

Much loss of Alcohol occurs by evaporation when the ordinary percolator or filtering funnel are left uncovered during percolation or filtration. To remedy this difficulty a simple apparatus may be constructed by any druggist who will take the trouble. It is shown in use in the following cut:

A, is the wooden cover, large enough to fit the top of a percolator or funnel; it is bound with a wooden hoop, whose lower edge projects about half an inch below the under surface of the cover; to the wooden hoop is tacked a piece of moderately thin-sheet rubber, so that the cover when completed, is like a drum-head, and, when it is used to cover a percolator or funnel, will make, by its elasticity, an air-tight covering.

B, is a funnel tube, so bent as to prevent evaporation or access of air. Through it, fresh menstruum or other liquid may be introduced into the percolator or funnel. A glass or metal tube answers the same purpose, and may be stopped with a cork. This



tube may be adjusted by boring a hole in the wooden cover and punching a smaller hole in the rubber, so that it will fit snug around the tube.

C, is a rubber tube attached at one end to a glass tube in the cover (which passes through the rubber as heretofore described), and at the other end to a tube in the stopper of the receiving bottle. This tube allows the air to pass from the receiving bottle into the percolator, and as the liquid fills the bottle the air is forced from it into the percolator or funnel.

D, is a rubber tube attached to the percolator that connects with a tube in the stopper of the receiving bottle, through

which the percolate passes; if the lower end of the percolator is too large for the rubber tube, a perforated cork, into which a glass tube is inserted, may be placed in the neck of the percolator for this purpose, as is directed in the pharmacopoeia process. By raising or lowering the percolator or the receiving bottle the flow of the percolate can be made more or less rapid, as it works on the principle of the syphon. The receiving bottle may be made of any wide-mouth bottle, holes being bored in the cork for the insertion of the tubes to which the rubber tubing is attached.

E, shows the perforated diaphragm of the percolator.

With this simple arrangement percolation or filtration can be carried on for any length of time without exposure or loss by evaporation.

WATER-BATH PERCOLATION.

The process of water-bath percolation consists in subjecting the powder contained in a percolator, surrounded by water, to the action of a warm menstruum during the entire process of maceration and percolation. By the means of the water-bath the menstruum and powder are kept at any desired degree of heat for any length of time.

It is claimed for this process, that the heat employed is of great aid in effecting the solution of the soluble constituents of the substance or substances which are being exhausted, and therefore, that it is much more rapid, efficient and economical than the ordinary method of percolation.

By consulting the solubility tables, which may be found in the pharmacopoeia and other standard works, it will be seen that the medicinal principles of vegetable drugs (especially the alkaloids and other substances in which their value chiefly consists), are from several to several hundred times more soluble in boiling water or alcohol than in cold. Although the heat employed in water-bath percolation is seldom so high as boiling alcohol or water, yet the solubility of the medicinal principles is relatively increased according to the heat employed ; and, as the object of percolation is to exhaust the drug of its soluble medicinal agents no other argument than this for the application of heat during percolation seems necessary, for it is evident that the value of the drug is much more faithfully represented in preparations made in this manner, and, that in making fluid or solid extracts, or other concentrated preparations, a much less quantity of menstruum is required to exhaust the drug, than when cold percolation is employed.

As the question may be asked by many if heat does not injure the preparations, it may be here stated that the degree of heat directed cannot be injurious, as it is insufficient to volatilize any of the medicinal principles of the drugs.

The process of water-bath percolation as applied to pharmaceutical preparations and the apparatus,
FENNER'S WATER-BATH PERCOLATOR AND STILL,
were patented February 7, 1882.

The process is an application of the well-known fact that a heated menstruum dissolves the soluble portions of drug's much more readily and to a much greater extent than the same menstruum when cold.

The apparatus is constructed with the view of serving its purpose in the best possible manner, and since its introduction it is coming rapidly into use in all parts of the country.

The following is a description and sectional view of the apparatus :

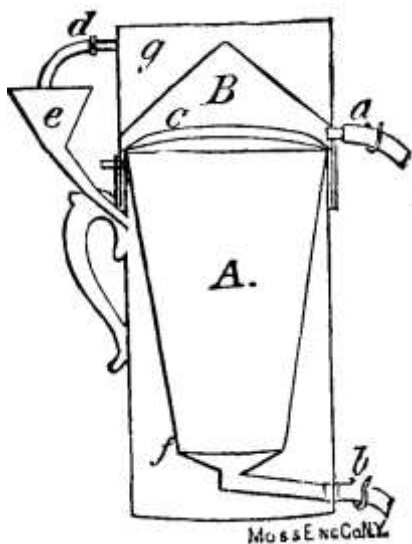
It consists of a Percolator, A, suspended in a water-bath and connected externally by a stop-cock through which the percolate is received, and a Still, B, which may be adjusted whenever it is needed.

The percolator. A, is also the vessel into which liquids are put for evaporation and distillation.

The percolator may be removed by unscrewing the stop-cock at b, and lifting it out of the water-bath. It should be removed after using in order to dry the apparatus.

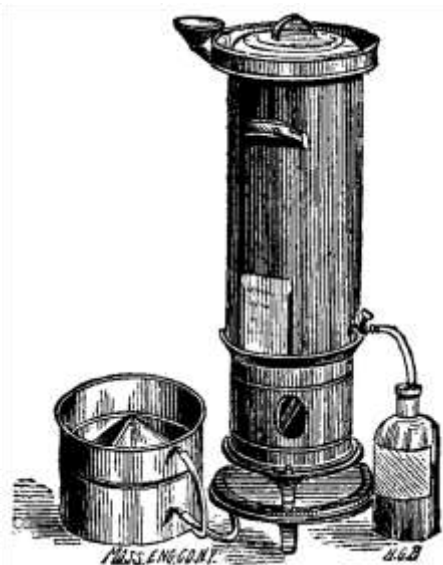
The perforated diaphragm at / prevents the drug packing in the neck of the percolator and thereby hindering percolation.

The flow of the percolate can be regulated by the stop-cock ; it also serves to draw off the residue after distillation or evaporation.



The vessel surrounding the Percolator is designed for water which is to be heated when desired, forming a water-bath for the Percolator and its contents. The Still B, can be adjusted when desired, by setting it into the percolator or water-bath. The vapor rises to the inner surface of the cone of the Still, is condensed by the cold water on the outer surface of the cone, and the distillate is discharged in the form of a liquid at a, being conducted through a rubber tube to any convenient receptacle.

The following cut represents the Water-bath Percolator and Still detached and in use as a percolator. When used for distilling, the cover of the percolator is to be removed and the still top adjusted as heretofore described. When used for evaporating, the cover of the percolator is to be removed, and the evaporation conducted in the ordinary way.



The water-bath percolator can be used as readily for cold percolation as for warm, and, in short, when all things are considered it is the most serviceable, economical and convenient percolator in use.

These Water-bath Percolators and Stills are now being used to a large extent in all parts of the country, and the reports received from parties who have thoroughly tested them are very flattering.

At no distant day the process of water-bath percolation is bound to supersede the ordinary method of percolating as completely as percolation, when it was introduced, superseded the process of maceration.

The method of conducting water-bath percolation is as follows:

The powdered drug is to be moistened with a portion of the menstruum and either packed in the percolator at once, or after macerating twentyfour hours, as the formula may direct. A certain quantity of menstruum (as directed in the formula) is then to be poured upon the drug and it is allowed to macerate for a specified time in a warm place. It is then to be heated (as directed in the formula) for a certain length of time

and the percolation then begun and continued until the drug is exhausted, or until the required amount of percolate is obtained.

The same general directions for packing the percolator, keeping the drug covered with the menstruum, regulating the flow of the percolate, etc., as are specified in the officinal process, should be observed.

In the formulae contained in this book for making preparations by water-bath percolation, it is directed after packing in the percolator and adding menstruum to the drug, to "set in a warm place" for a certain length of time to macerate; by this it is meant that the percolator and its contents should be heated from 30° to 35° C. (86° to 95° F.) by any convenient means. In summer a warm place in the store will suffice; in winter a shelf by the stove or other heating apparatus will do; or a box, with a hinged door and holes in the bottom about the size of the bottom of the percolators, may be fastened to the side of the wall and the heat may be maintained by a coal oil lamp placed beneath the percolator.

In large establishments warming closets heated by steam pipes or other means may be arranged. It is not absolutely necessary that heat should be maintained during maceration, but better results will follow if it is.

The direction in the formulae "heat very moderately" means that the temperature should not be higher than from 40° to 45° C. (104° to 113° F.); "heat moderately" means that the temperature should not exceed 60° to 65° C. (140° to 149° F.) — a higher temperature than this is seldom necessary.

After the percolation is concluded, if sufficient Alcohol is retained in the drug to be of value, it may be recovered by distillation. The amount of alcohol or other menstruum retained varies with the nature of the drug—from one-fourth to more than its entire original weight. In making any considerable quantity of a preparation, it is important to save this menstruum, which would otherwise be wasted, by distillation, as stated in the article on distillation.

SOLUTION.

Solution is the process of dissolving solids or fluids by means of other solids or fluids which combine with them and hold them in a liquid state. The most common forms of solutions are those in which a liquid is dissolved in another liquid, as, for example, an essential oil in alcohol, or a solid in a liquid, as sugar in water; but some solutions are made by the action of solid substances upon each other, as when camphor and hydrate of chloral are combined.

No special apparatus is required for making solutions. Many are made cold, while some are aided by heat with such appliances as druggists usually possess. The solution of some substances is facilitated by reducing them to a fine powder, while others, as scale salts, etc., are best dissolved without being made fine. In dissolving by the aid of heat the water-bath is much employed.

WASHING PRECIPITATES.

The object of washing fresh precipitates is to free them from soluble salts, or other substances with which they are associated, which are soluble in water.

The usual manner of washing fresh precipitates, in a small way, is to pour them upon a wet muslin strainer and filter water through them until the soluble matter has all been washed out.

This method is open to several objections: 1st, exposure to the atmosphere, which rapidly oxidizes many salts, especially the iron salts, rendering them insoluble; 2d, waste, as considerable of the precipitate is washed away by this method; 3d, inconvenience, as it requires the continued attention of the operator.

Another method is to wash the precipitate in a large jar or earthenware crock, by pouring upon it a quantity of water and stirring thoroughly, then allowing the precipitate to settle, drawing off the supernatant fluid with a syphon, pouring on more fresh water, and thus continuing until the soluble matter is washed out; and then draining the precipitate upon a muslin strainer.

The best method, however, is to make the precipitate in a tall jar or crock, rilled full of water; then, having fastened a piece of rubber tubing to each end of a stick, insert it in the jar in such a manner that a stream of water passing through one rubber tube will reach to the bottom of the vessel, while the water at the top of the jar will be carried off by means of the other tube, which acts as a syphon. The water to wash the precipitate can be supplied from a water-pipe, or from a bucket set above the washing apparatus, into which the tube is inserted as a syphon. The same result will be accomplished by running the tube, through which the water is supplied, to the bottom of the jar and allowing the water to overflow at the top.

It will be seen that by this means the precipitate is continually washed, and that it is not exposed, nor wasted, as only clear water is drawn off at the top of the jar, because the precipitate has time to settle away from the surface of the water where the waste tube is attached. Precipitates are rapidly and thoroughly washed by this method. When the soluble substances have all been washed out, the precipitate should be poured upon a muslin strainer to drain, the water may then be pressed out and the precipitate dissolved, or dried. as required.