examinations, not only in sports but also in routine school subjects; employers ask that potential employees should have passed "the Intermediate Certificate Examination or its equivalent".

The remedy is obvious: destroy every living being, every living cell, and declare The Great Examination a failure; thus the restless, progressing, competing life would stop, and we would have no more troubles with our educational systems.

## EUCALYPTUS OILS.

By A. R. PENFOLD, F.A.C.I., F.C.S.,
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THE mention of Eucalyptus oil recalls immediately its use for a cough or cold by placing three drops of the oil on a piece of sugar and the swallowing of the confection. A better method of treatment is by inhaling the oil from the surface of water which has been heated to boiling point. The efficacy of the oil, especially for the treatment of influenza and severe cold in the head is considerably enhanced by the addition of a few crystals of menthol to the oil. These particular uses are very well-known, but many other and, in my opinion, more important uses are not so well-known.

There is no better substance for the removal of grease stains and tar from clothes, even the most delicately coloured fabrics, than certain grades of Eucalyptus Oil which will be described later. Apart from their use as clothes cleaners, Eucalyptus Oils are very useful for the renovation of tapestry, car and furniture upholstery.

The industrial grades of Eucalyptus Oil, which will also be discussed in detail later, are without superior as solvents for tar, grease, raw rubber and paint. Admixtures of these oils with kerosene or petrol are excellent for the removal of grease from various parts of motor cars such as wheels, and for the cleaning of the hands after such work. No motorist should be without a bottle of industrial Eucalyptus Oil. Old paint and varnish brushes which have been neglected and placed on one side as useless are readily restored to a useful condition by soaking them in *Eucalyptus dives* Oil.

A unique use which was found for Eucalyptus Oils many years ago was for the separation of certain valuable minerals by a flotation process. In the heyday of mining in Australia large quantities of Eucalyptus Oils—industrial grades—were used at Broken Hill, Cobar and other great mining centres. Briefly the process was one for floating off valuable minerals containing lead or zinc by agitating the tailings which contained insufficient amounts of the metallic substances to be separated by ordinary methods, with water and air and facilitating the separation of the valuable minerals by the addition of small quantities of Eucalyptus Oils or other agents. When mining began to decline in Australia that provided an incentive to find other uses for Eucalyptus Oil. One of the most important and valuable of these new uses was the replacement to a very considerable extent of carbolic acid and other gas works by-products in the production of disinfectants for picture theatres and public places. It was found that Eucalyptus Oils could be incorporated with soaps—a process technically called emulsification—to form a clear liquid which would dissolve in water.

Eucalyptus Oils when tested under certain specified conditions against the Typhoid bacteria (*B. typhosus*) have been found to be many times stronger than carbolic acid as the following table shows.

| *Oil.* | *Rideal Walker Co-efficient.* |
|---|---|
| Carbolic Acid used as Standard .. .. .. .. | 1 |
| *Eucalyptus polybractea* (85% cineol) .. .. .. | 5 |
| *Eucalyptus Australiana* (62% cineol) .. .. .. | 5 |
| *Eucalyptus dives* (52% piperitone) .. .. .. | 8 |
| *Eucalyptus phellandra* (first hour) (50% cineol) | 6 |

Disinfectants or germicides prepared from Eucalyptus Oils are now regular articles of commerce. They are for all practical purposes at least equal, if not superior to disinfectants made from carbolic acid, cresol, etc. Moreover, they are non-poisonous, non-corrosive, and possess very pleasant odours.

One of the most notable achievements in the history of industrial chemistry in Australia was the discovery that a constituent called piperitone separated from one of the commonest Eucalyptus Oils, called *Eucalyptus dives*, could be converted into two valuable commercial substances called Thymol and Menthol.

Thymol is a white crystalline solid which before the discovery of its preparation from Eucalyptus Oil was obtained from Ajowan seeds grown in India. Thymol is one of the best preservatives known, particularly for gums, pastes, glues, distempers and furs. It is an extraordinarily powerful germicide, being 25 times stronger than carbolic acid. It is used medicinally as an antiseptic disinfectant for typhoid, diarrhœa and hook worm and as an ointment for certain skin diseases.

Menthol is also a white crystalline solid, but is much better known on account of its more general use. It is used largely as a local anæsthetic for neuralgia and rheumatism, in dental pastes, and very extensively by confectioners and others for flavouring purposes. It possesses a very high germicidal value being about twenty times stronger than carbolic acid, and is of considerable value in tooth pastes and mouth washes on account of its relatively low toxicity. As you are probably aware, natural menthol is obtained by freezing commercial Peppermint Oil, but until the new process became operative it was a relatively expensive article, being essentially a Japanese monopoly. The production of synthetic menthol, as the menthol prepared from Eucalyptus Oil is called, in Australia, Great Britain and America and Europe has forced the price of natural menthol to a very low level.

I feel that in view of what has been written about the usefulness of Eucalyptus Oils your interest has been aroused. I have good reason for this belief because a similar reaction was detected when a broadcast address on Eucalyptus Oil was given by me from Station 2BL on 15th March, 1934. I assume that you wish to know more about Eucalyptus Oils—what they are; how they are obtained; the nature of the trees yielding these important economic products, and the part of the tree utilised for their production.

Most of the readers of this new Magazine, ENVIRONMENT, have a certain first-hand acquaintance with the beautiful Eucalyptus trees which form about three-quarters of the vegetation of this great Continent. To the majority of people these trees are popularly known as "Gum Trees" although the gummy substance exuded from them is not a gum. The exudation commonly observed is a very astringent substance, and is called Kino. These Kinos, when obtained in large quantities,

as from certain trees in Western Australia, are utilised to a limited extent in tanning, *i.e.*, the conversion of hide into leather. Eucalyptus trees are typically Australian, although some species are found in New Guinea, Timor and the Philippine Islands. The beautiful avenues and plantations to be seen in New Zealand, North and South America, Africa, India and many other parts of the world were planted from seed sent from Australia. Eucalyptus Trees in their native habitat are found widely distributed over the Continent of Australia, from the sandy desert regions of low rainfall, where the dwarfed and stunted forms called Mallees abound, to the coast and mountain regions where the tall, luxuriant trees attain gigantic dimensions. Various species are at home at sea level, whilst a few thrive on the snow line of the Australian Alps. In the rich country of the North Coast of New South Wales and the Gippsland district of Victoria some of the large trees attain a height of 100 feet from the ground level to the first branch, and it is from this species that some of our best timber is obtained.

In view of the very wide range of distribution it is quite natural that these trees should have attracted the attention of the early settlers, and one of the first natural products exported from Australia in 1788 was a sample of Eucalyptus Oil. Surgeon General White, the Surgeon to the first Fleet and first Settlement, distilled about a quarter of a gallon of the oil from the leaves of a well-known Eucalyptus Tree called the Sydney Peppermint, which was found on the foreshores of Port Jackson. The oil was sent to England for test, and it was found to be more efficacious for the removal of colicky complaints than the oil obtained from the well-known English Peppermint Herb, being less pungent and more aromatic. The tree was thus aptly named the Sydney Peppermint. Good specimens of this tree are still to be found at French's Forest, the Lane Cove River, and the Hawkesbury River districts, and stills for its commercial production on a limited scale are in operation at Brookvale, near Manly.

In passing, it might be as well if some reference was made to the derivation of the word "Eucalyptus". "Eucalyptus" is derived from two Greek words, "eu" meaning *well* and "kalypto" meaning *I cover,* and this is in reference to the lid (operculum) which seals the flower until it is thrown off in the process of opening.

It is this characteristic feature which readily distinguishes the Genus *Eucalyptus.*

Eucalyptus trees form a very valuable asset to Australia on account of the useful products derived from them. As I am treating of Eucalyptus Oils it is unnecessary for me to make mention of the other useful products, but I cannot allow the opportunity to pass without directing attention to the value of our hardwood timbers.

Eucalyptus Oils are known to chemists and technologists as essential oils and it is probably advisable at this stage for me to give a definition of an essential oil. Essential oils are the odoriferous oily substances obtained almost exclusively from plant sources. These oils, sometimes and more correctly called volatile oils are obtained from various parts of plants by distillation in a current of steam. Essential or volatile oils are generally liquid, though some may be semi-solid or solid. They occur in the most varied parts of plants. For example in the Pines, oil is present in most parts of the tree, whilst in the rose it is confined to the flower, in the orange family chiefly to the flowers and the peel of the fruit, whilst in the Eucalypts oil is obtained for commercial purposes solely from the leaves.

The word "essential" is derived from the word "essence" which, according to modern dictionaries is an extract obtained by distillation or otherwise from a plant or drug, hence the word "essential oil". The volatile or essential oils, as the name implies, readily evaporate. Fixed oils, many of which are also obtained from plant sources, such as Linseed Oil, Olive Oil, and Castor Oil, do not evaporate, hence the difference between the two great groups of oils. Cod Liver and Shark Liver Oils, obtained from animal sources, are also fixed oils, as they do not evaporate like the volatile or essential oils.

Essential oils distilled from the Eucalypts are very useful commercial products, and are exported from the Commonwealth of Australia to the extent of 100,000 gallons per annum. These oils have been examined by notable chemists since the earliest days of the Colony and the work has been continued uninterruptedly at the Sydney Technological Museum since 1900 to the present day.

Eucalyptus Oils are complex mixtures of many substances, of which 50 important ones have been separated. At a later date I shall give some particulars

about these important constituents for the benefit of those readers who wish to become acquainted with the chemistry of the Eucalyptus Oils.

It will, no doubt, surprise many readers to learn that there are over 350 species of Eucalypts, of which about 200 have been examined for essential oil, but less than 20 yield oils of commercial value. It is, therefore, not every "Gum Tree" that is met with which contains the right kind of oil or sufficient of it for commercial exploitation. It will suffice for the purpose of this article if a brief description is given of the limited number of species of Eucalypts which yield the present day Eucalyptus Oils of commerce, and a note of the districts in which they occur in commercial quantities.

First there is the Blue Mallee which is abundant in the Wyalong district of New South Wales and the Bendigo district of Victoria. It is called *Eucalyptus polybractea.* One thousand pounds of the leaves and terminal branchlets of this material yield approximately 20 pounds of oil. The oil is very rich in a water-white liquid called cineol, and it is this substance which is credited with curative properties for coughs, colds, and chest complaints. It is one of our best known medicinal oils for internal use, and is therefore much sought after by chemists and pharmacists. The substance, cineol, which has an odour resembling camphor, is the principal constituent of all Eucalyptus Oils used for medicinal and pharmaceutical purposes. As a matter of fact the principal Pharmacopœia standards of the world require a commercial Eucalyptus Oil for medicinal purposes to contain not less than 70% cineol. This very interesting substance may be obtained as a solid a few degrees below the freezing point of water. It is easily separated from Eucalyptus Oils rich in cineol by freezing, and is purified by separating the other constituents which remain in the liquid state by centrifugal force. It is a commercial article, and is obtainable at a comparatively low price.

Another species of Eucalypt which yields an oil containing about 70% cineol is *Eucalyptus Australiana. Eucalyptus Australiana* is a pretty foliaceous tree, which occurs in commercial yielding stands in the southern part of New South Wales as at Cobargo, Eden, Quaama, Nerrigundah, Nelligen, and in the Jenolan Caves district around Oberon, Rockley, Tarana and Burraga. This Eucalyptus Oil, apart from its high content of cineol

(70%) contains about 3% or 4% of citral which is one of the principal components of commercial Lemon Oil, thus giving it a very refreshing aroma. This oil is quite clear and water-white and is the finest Eucalyptus Oil for medicinal and pharmaceutical purposes which has yet been produced. In Victoria, especially around Bendigo, enormous belts of Ironbark Trees (*Eucalyptus sideroxylon*) grow in conjunction with other species known as White Gum (*Eucalyptus leucoxylon*) and Apple Jack (*Eucalyptus elæophora*), and these yield large quantities of commercial Eucalyptus Oil containing about 70% cineol. One thousand pounds of foliage of these species yield 15 to 20 pounds of oil.

I mentioned earlier in this article the many uses which have been found for Eucalyptus Oils in the production of pharmaceutical soaps, embrocations, ointments, and in confectionery. I also mentioned their value for the removal of grease stains and tar from clothing. It is the Eucalyptus Oils rich in cineol which I have just described that are utilised for these purposes.

There are other Eucalyptus Oils which cannot be utilised for medicinal and pharmaceutical purposes because they do not contain cineol and if they do it is not present in sufficient quantity to meet the requirements of the various Pharmacopœia standards which are issued by various nations. You will remember I mentioned a minimum of 70% cineol. These oils which contain little or no cineol consist of a complicated mixture of liquids which on separation of their components have found considerable use in industry. The constituents to which I refer are known as phellandrene and piperitone. The properties of these two interesting substances will be described in a later article dealing with the chemistry of Eucalyptus Oils. These oils which contain phellandrene and piperitone are used solely for industrial purposes. They are obtained from a number of species of Eucalypts which occur in enormous belts in New South Wales and Victoria.

The commonest one is *Eucalyptus dives*, a Broad-leafed Peppermint, which occurs in the coastal ranges extending from New South Wales right into the North East corner of Victoria. It contains more oil in the leaves than any other species of Eucalypt, something like 40 pounds being obtained from one thousand pounds of foliage. This is the oil which was first used in the

mineral flotation process for the recovery of valuable ores at the Broken Hill mines. It also contains 50% piperitone, which is the constituent that is converted into synthetic thymol and synthetic menthol.

Another important industrial oil of which some thousands of tons have been produced is that obtained from another Narrowleafed Peppermint called *Eucalyptus phellandra*. This species is particularly abundant in the Braidwood district and the Tumut-Batlow-Tumbarumba district of New South Wales. The oil contains from 35% to 50% of cineol with about 40% of phellandrene. The presence of so much phellandrene precludes its use for medicinal purposes, but it is one of the most useful industrial oils which are used for the production of commercial disinfectants. The oil has also been used in the production of boot polishes, and for the manufacture of paint removers, fruit sprays, rubber cements, and for mineral flotation.

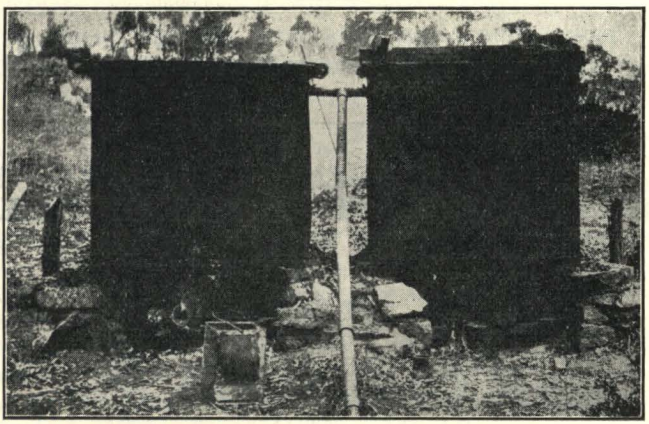
Another interesting species of Eucalypt is the Lemon Scented Gum Tree of Queensland, *Eucalyptus citriodora* which has been cultivated so extensively in the gardens of the suburbs of Sydney, particularly in the western suburbs. The native habitat of this smooth-barked tree is around the Mount Morgan district, Queensland, but as just mentioned it is extensively cultivated as an ornamental tree not only in New South Wales, but in Victoria as well. It is a unique oil, differing from all other Eucalyptus Oils in its composition. It does not contain cineol, phellandrene or piperitone, but consists largely of a substance with a typically citronella odour called citronellal, which is present to the extent of from 70% to 85%. About 1,000 pounds of the leaves and terminal branchlets yield from 8 to 10 pounds of oil. The market for the oil is very restricted, owing to competition with commercial citronella oils from Java and Ceylon. On the other hand it possesses a superior aroma to these oils and will always bring an enhanced price in the market. It is used at present as a scented liquid for masking the odour of various preparations such as commercial disinfectants and as a source of raw material for the production of citronellol, an alcohol used in the production of synthetic otto of rose. It is anticipated that with more efficient methods of production and cultivation a very considerable export market

will develop when the price of the oil is reduced to about 2s. 6d. to 3s. per pound. Its wholesale price at present is 5s. per pound.

There are one or two other species of commercial yielding Eucalypts such as *Eucalyptus Macarthuri* (the Paddy's River Box which occurs so luxuriantly in the Moss Vale and Wingello districts of New South Wales), *Eucalyptus cneorifolia* (the Narrowleaf Mallee from Kangaroo Island, South Australia), and one or two others which I will not attempt to describe in this article. My object has been to give a brief popular account of the principal species which yield the most interesting Eucalyptus Oils of commerce.

I have not yet given you any information about how these oils are produced on the commercial scale.

It is quite likely that some of my readers who have visited the remote parts of the Southern District of New South Wales, such as Braidwood, Bungendore, and perhaps Tarana and Oberon in the Bathurst district



Type of Still in general use.

have noticed 400 gallon ship's tanks utilised by local distillers for the production of Eucalyptus Oil. The principal species of Eucalypts which I have described, with the exception of the Blue Mallee, occur in rough and mountainous country, and it has been found that the ordinary 400 gallon ship's tank provides the most suitable

kind of still for use in that type of country. As a general rule two of these tanks are coupled together, as shown in the illustration, and about 1,000 pounds of leaves and terminal branchlets are placed into each tank and 80 to 100 gallons of water added. The lids are suitably sealed with clay and fastened to the tank by means of iron clips or stirrups. A fire is placed beneath the tank and as the water boils it carries the oil over with the steam. Both steam and oil are condensed in long lengths of 2-inch piping (which are connected to the tanks and are carried for a distance of about 50 feet beneath running water in a creek) and collected in a suitable receptacle, usually a 4-gallon petrol tin. The oil is skimmed off the surface of the water and placed in a convenient container such as a 40-gallon petrol drum for transport to a rail or boat head.

Although the stills are crude they are, nevertheless, very efficient if handled in an intelligent manner. They are portable, easily dismantled, and can be moved about from district to district as required.

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(An article by the same author, on the chemistry of Eucalyptus Oils, will appear in the following number of this magazine.)

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# EARLY MEASUREMENTS AND UNITS OF MEASUREMENT, AND HOW WE OBTAINED THE SYSTEMS WE USE TO-DAY.

## Part III. The C.G.S. System.

By Edgar H. Booth, M.C., B.Sc., F.Inst.P.
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This is the third, and presumably the last article in this series.* It introduces the system of standards and of units universally employed by scientists, and one which is adopted internationally (with few exceptions) for general usage. It is not now a Continental or a

*I plead guilty to having written the two preceding ones also—this Magazine, Vol. I, No. 1, pp. 23-35, and Vol. I, No. 2, pp. 39-43.