impression from conversation with doctors in the mining areas that frequency of painful digestion and inability to take food are general symptoms.

With reference to occupational, scrotal, and penile cancer I have had the records of the Royal Victoria Infirmary, Newcastle-upon-Tyne, examined for the last two years, and I find that in 1928 fourteen operations concerned with these types of malignant disease were performed; three of the patients were coal miners, two were gas stokers and chemical workers. Five were men aged 50 to 60, three 60 to 70, and three 70 to 80. During 1929 sixteen patients were operated on for the same malady; of these eight were coal miners, one a worker in oils, and one in pitch; four were aged 50 to 60, five 60 to 70, and five 70 to 80.

Smoke, fume, and excessive heat with alternating exposure to cold are the harmful agents. In such an inquiry as I have been making two forms of illness have to be considered: there are the minor forms which cause a good deal of discomfort and temporary disablement, and which may be regarded as complaints of the workmen—for example, loss of appetite, pain after food, and vomiting, the lighter forms of skin troubles such as itchiness, boils, and "keens" on the hands; and there are the more serious forms of illness which result in cancer. The occupational operations we have been dealing with concern the manufacture of products obtained from the combustion of coal. There is a difference in regard to the manipulation of the raw material and the products obtained from it. The products obtained from coal are the more harmful. Chimney-sweeps, for example, have for long exhibited a high liability to scrotal cancer; so, too, have briquette makers, workers in mineral oils, arsenic grinders, colour mixers, and workers in tar and its derivatives. With "pitch cancer" we have long been familiar.

In Germany tar distillation is the cause of a higher percentage of accidents than any of the other operations. Pitch breakers there suffer considerably, too, from eczema, but cases of cancer are comparatively few. In Upper Silesia, however, of thirty anthracene workers who had been employed for over ten years twenty-two suffered from skin eruptions, and three, with six to eight years' service, had been operated on for scrotal cancer. In France coke-men and tar workers suffer from dermatitis, but cancer is less frequently met with than in Great Britain. Cancer is infrequently observed in the United States. Dr. Thacher of the Chicago By-products Coke Corporation informs me that the ailments of the men in his employment are the same as those of the men following other trades in the district—namely, severe colds and influenza; he also states that a few of the men suffer from gastric ailments. Heart disease is a common cause of death, but, in his opinion, he does not regard this circumstance as in any way related to their occupation. During the last three years one workman died from cancer of the stomach.

Twenty years ago Sir Thomas Legge drew attention to the fact that blast furnace tar and pitch do not possess the same carcinogenic properties as those of coal tar. The pitch obtained from coke ovens and gas works and used for making briquettes is said to be the cause in Great Britain of more than one-half of the notifiable cases of cancer. Drs. Bridge and Henry, in an investigation between 1920 and 1927, found that of 163 cases of cancer occurring among briquette workers, in 11 per cent. the disease was located in the scrotum, and in 71.2 per cent. in the head, arms, etc.; that out of 103 cases among tar distillers 39.8 per cent. were affected in the scrotum and 37 per cent. in the head, limbs, etc.; while in 47.3 per cent. of the men employed in gas works the disease was located in the scrotum, and in 23.6 per cent. in the head and elsewhere. Interesting information is also supplied by Dr. Prosser White in his encyclopaedic work *Occupational Diseases of the Skin*, by Dr. O'Donovan, and by Dr. Scott of Broxburn in his helpful monograph upon the incidence of cancer among workers in shale oils and their derivatives.

A microscopic examination of the blood does not reveal anything absolutely definitive. This may be due to the fact that the work is carried on in the open air, and is to some extent interchangeable. In some cases the blood shows a marked deficiency of leucocytes or white corpuscles; in others the number of these cells is practically normal.

Although the atmosphere of by-product coke ovens and the conduits which carry the liquid and gaseous material away from them is redolent of fume, there are, as already stated, certain classes of workers engaged in the transit of the material whose health appears to be more severely affected than others in the industry, such as workers at the top ovens, at the hydraulic mains, the men who adjust the valves in the shafts leading into the hydraulic mains, and those who break up the solid pitch—all these are liable to be adversely affected by dust, heat, and fume.

While the main incidents of the industry from a health point of view are painful and irritating conditions of the skin, some of which exhibit a tendency to become malignant, there are also the stomach troubles to which reference has been made; of these it may be said that the severity of the pain experienced by the workman, the physical debility that ensues, and the consequent loss of time, together form a triad of circumstances which call for recognition and careful consideration dietetically, medically, and industrially.

BATHS AS ARTIFICIAL CLIMATES.

THE TREATMENT OF RHEUMATISM IN WINTER.*

BY

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SINCE the attention of the medical profession has been directed to the chronic rheumatic diseases two lines of advance have been energetically followed, especially in England and America—namely, the investigation and treatment of the infective element in these diseases, and the use of orthopaedic methods for the rectification of posture, avoidance of pressure upon inflamed joints, and prevention and cure of deformity. Good work on these lines has brought relief in many intractable cases, and is a welcome contribution to the campaign against rheumatism.

It is, however, possible to approach this problem from another and equally logical point of view. Five years ago an international committee on rheumatism, consisting of a small group of medical men who had long experience of rheumatic diseases in the northern countries of Europe, came into existence. They held conferences in France, Holland, Germany, Czechoslovakia, Hungary, Austria, and England.¹ The committee, now an international league, has become a small connecting link between larger national bodies in these countries as well as in Russia and America. Many of their members are specializing entirely in this group of diseases; some are workers at university clinics, physicians or directors of hospital departments, of special hospitals for rheumatism, or of bath clinics in towns; others are engaged in the treatment of rheumatism on a large scale in spas and health resorts. It is clear from the various reports on rheumatism issued by the Ministries of Health and Social Welfare, especially in England, that this large group of diseases has a vast incidence in cold climates, and that it is chiefly responsible for crippling and disablement in great industrial populations, not tending to shorten life, but spreading like a blight over the working period of life. The problem, apart from its medical interest, is also of great economic importance.

In the view of the league such a mass of invalidity in the best years of life demands an organized and co-operative effort for special investigation and special methods of treatment. Existing provision of this kind, especially for the treatment of early cases, is at present so fragmentary that only an insignificant fraction of the vast number of rheumatic persons can benefit by it.

The league attaches great importance to the investigation of causation. Its provisional statement² comprises four prime factors: a cosmic or external influence—

*An address (abridged for publication) given to the Tunbridge Wells Division of the British Medical Association, March 19th, 1930

climate, surroundings, and occupation; a constitutional anomaly which causes some to suffer while others escape; a defective function of the skin; and a factor of infection. These factors operate so variably and unequally that sometimes one and sometimes another appear to be dominant, with the result that diagnosis and treatment become an individual study.

What are the conditions that make infection operative?⁵ To obtain a true picture of the etiological field all such conditions, whether essential or accidental, must be elucidated. The merulius is not a sufficient cause for dry rot in timber; there must also be a deficiency of oxygen and heat. I confess to an inveterate belief that one of the essential conditions in the production of rheumatic diseases is the influence of cold and damp. In a biological sense climate signifies the energies outside ourselves, from which are drawn the stimuli necessary to life. The healthy organism reacts to them favourably; but if from any cause it has lost physiological contact, if a warm-blooded animal fails in its normal reactions to the stimulus of cold in a medium many degrees cooler than itself—if, that is to say, external cold no longer generates internal heat—then another series of less favourable reactions will occur. The demand made upon physiological heat production is very variable, both in the same locality and in different localities. The maximum demand is made in northern climates, especially in winter and spring, and the minimum demand in equatorial regions at all seasons of the year.

In the young and healthy the impressions of cold appear to evoke a perfect response and adaptation. The whole sensitive keyboard can be safely played upon; but in age and disease the limits of safety may be confined to a few notes. The activity of the heat-generating muscular system is an important element: with active locomotor organs it is possible to make good any loss of heat by muscular exercise. That is impossible for rheumatic persons who are deprived of their activity. There is one law for the fit and another for the frail, and the exposure which brings vigour to the one is dangerous to the other. It follows that for each person there is an ideal external temperature which best promotes the harmonious working of the functions, and an ideal range of temperature within which their reactions may be exercised.

The well-known results of severe exposure of healthy subjects, or slight exposure of sensitive subjects, may be summarized as follows:

(a) *Low Temperature of the Skin.*—In health, with an air temperature of 10° C. (50° F.), the uncovered parts of the skin are from 3° to 4° C. cooler than the covered part.¹ Upon undressing in a cold room the skin cools down, the loss of body heat increasing by at least a third. A marked lowering of skin heat is therefore an immediate result of exposure, and becomes a protection against further loss of heat.

(b) *Contracted Peripheral Circulation.*—The capillary bed is more or less closed with areas of complete stasis, which is a chronic condition in sensitive subjects under repeated exposure.

(c) *Inactivity of the Sweat Glands.*—It is a cardinal fact that transpiration, or true sweating, is in abeyance in cold climates, and can only be produced artificially by strong exercise or external heat.

(d) *Lowering of the Temperature of the Body.*—In proportion as the response to cold by production of heat fails, oxidation and metabolism are defective, and the exposed body loses heat like an inanimate object.

(e) *Lowering of Resistance to Additional Exposure, and especially to Infection and Injury.*—Lode² has shown that rats with a temperature artificially lowered by 4° to 5° C. are extremely vulnerable to infection, 85 per cent. dying of inoculated staphylococcus, pneumococcus, or tubercle, as against 12 per cent. of normal animals. Pasteur's classical experiment may be recalled, showing that poultry after standing in cold water easily fall victims to chicken cholera. It seems clear that repeated or prolonged chilling causes alterations in the tissues, with diminished power of forming antitoxins.

The effects of heat in baths are exactly the contrary. (a) Baths raise the temperature of the skin, so that the

skin becomes not the coolest, but the hottest part of the body; (b) they increase the circulation by opening up the capillary bed (the plethysmograph shows increased bulk of a limb immersed in a hot whirlpool); (c) they powerfully increase the activity of the sweat glands, which may have been in abeyance for years; (d) they temporarily raise the temperature of the blood, and, if it is subnormal, repeated baths may raise it permanently; (e) they increase the resistance to cold and injury, and in all probability to infection also.

We may now ask, What are the observed functional disturbances in the early stages of chronic rheumatic disease? It is a striking fact that they are precisely, one after another, the observed effects of exposure to cold in frigo-sensitive persons.⁶

The following table shows the surface temperatures in a woman, aged 37, with arthritis following sea-bathing.⁷

Surface Temperatures in Arthritis.

	Before Treatment.	After Treatment.	Normal (Di Gasparo). ⁸
Dorsum of left foot	25° C.	31.4°	32.4° C.
Dorsum of right foot	Colder (off the scale)	31.3°	
Left knee	25.8°	—	35.1°
Right knee	26.0°	—	
Dorsum of left hand	30°	31.3°	32.5°
Dorsum of right hand	30.3°	31.6°	

A habitual inactivity of the skin, with contracted peripheral vessels, is an observation familiar enough to students of rheumatism. Schulhof⁹ has described the partial closure of the superficial capillary beds. The lowering of resistance to cold and injury are admitted, and it would be difficult to believe that the same is not true of resistance to infection. It would seem, therefore, that there is a group of functional disturbances, making up a clinical entity, which is caused by exposure to climate and is cured by heat in baths, and that these disturbances accompany the development of rheumatic disease. They may, in fact, be regarded as the departures from physiological health to which warm-blooded animals are liable in a cold climate.

What may be described as "chronic chill" is a fruitful field for investigation, at present but little explored. The act of "catching cold" is constantly done, and happily by homely remedies is easily undone, but what is its significance as a cause of disease? Shade,¹⁰ who studied the effects of chill in a German division during a severe winter, records how 2,700 men were exposed to an exceptional degree of cold and damp. Although they were men of three years' field service, "chill diseases" were increased fourfold. He concludes that damp cold brought on rheumatic diseases, and dry cold and wind respiratory troubles.

I suggest that there are large numbers of chilled or chilly persons going about their ordinary avocations with inactive skin, showing areas often 5° or 6° C. below normal, with a body temperature usually subnormal, and with contracted peripheral circulation. They are not yet ill, but they show an exaggerated liability to disease. I agree with van Bree¹¹ that the organism often goes on resisting up to a point, until suddenly a barrier seems to be broken down, and rheumatism, perhaps progressive arthritis, sets in, which can hardly be checked.

It is well known that a change of climate is sometimes a cure for rheumatism;¹¹ as a prophylactic it is much more powerful. For those who need and cannot get it, the elements of a tropical climate might well be artificially produced. I would suggest that baths operate as an "artificial climate," and should be used deliberately as such. This conception is strengthened by an appeal to the long-established habits of northern nations. In bleak and exposed climates the inhabitants have from time immemorial used a people's bath. Its essential feature is always hot vapour, with vigorous stimulation of the skin. The Russians, Finns, Swedes, North American Indians, Eskimos, and also, it seems, the Celtic races in pre-Roman Britain, all used more or less primitive vapour baths, in

which the body was exposed to an intense degree of moist heat. The contemporary practice is equally widespread. The baths of Finland have been well described by Kajava.¹² The circulation, contracted by the cold, is literally whipped into activity in these baths. Another form of artificial climate with vapour at lower temperatures was the Roman bath, which was originally taken from the East and became a part of the Roman civilization in Britain and Gaul. The eastern Hammams have always utilized vapour with surface stimulation and passive movement, but in the so-called "Turkish" bath, introduced into Britain in 1856, only dry heat is used.

In the northern people's baths, ancient and modern, the essential elements are: heat, moisture, surface stimulation by switching and friction, and time. It is idle, perhaps, to speculate whether the disuse in England of sweating baths may be partly responsible for the prevalence of rheumatism and catarrh. But I would submit that heat and moisture, so employed, can, like a hot or tropical climate, rectify the disturbances caused by exposure to cold; that in rheumatic affections, by increasing the circulation, they can prevent the localization of the disease in the joints, disperse swellings already formed, relieve pain, restore the power of movement, and improve if not re-establish the resistance to cold; that, in short, the "bath complex" (heat, moisture, and movement) is, in skilful hands, an exceedingly powerful remedy, perhaps the most powerful, in the prevention and treatment of rheumatic diseases.

Certain indispensable conditions of success remain to be noticed. The question is asked whether the hot bath can produce permanent results. Slow diseases need slow remedies, and chronic rheumatism especially requires a slow, repetitive, and cumulative treatment. In prescribing an artificial climate a little advance should be made from day to day. It is necessary that the bath should be repeated before the surface and deep temperatures and circulation have lost the effect of the preceding treatment. In other words, the climatic influence is, so far as possible, continuous, and the effect gradual and cumulative, as in nature. The poor success of baths in a cold climate is often due, in my belief, to the mistaken doctrine that rheumatic patients require "hardening" or "toning up." It is impossible to counteract chronic disorders of temperature and circulation if after a brief exposure to heat a rheumatic subject is allowed to pass into a cold dressing-room or the open air. To produce results analogous to those of a hot climate the active agency of the bath must be supplemented by a thermal environment¹³ in which the patient remains for a few hours each day. All risk of intercurrent chilling must be carefully avoided. Two cases of my own (among many) may illustrate this point.

A middle-aged lady with Parkinson's disease and rigid and painful muscles was recommended to a British spa for long-continued hot pool baths. In the pool, so long as the shoulders were covered, she was free from pain and moved with comparative ease, but exposure to the air even in the pool room, and later in the dressing room, immediately brought back her pain and stiffness. She returned no better for her treatment.

Another chilly subject, a farmer, with severe subacute arthritis of middle life in hands and knees, went south to an Italian spa for hot mud baths. In these baths the pain and stiffness were very soon alleviated, and the warmth of the local climate and of the heated hotel prevented any sensation of chill throughout the cure. He came back walking with comfort, the disease arrested, and the process of cure established.

It is something more than a fanciful analogy that in many chronic diseases man reverts a little towards the condition of cold-blooded or hibernating and immobile animals, and it is not unreasonable to suppose that prolonged and gentle and increasing warmth, like that of the spring, is more likely to restore the warm-blooded state and to overcome chronic chill than brief or alternating exposures. But such a conception would, if accepted, involve the application of a different practice to rheumatic illness from that which usually obtains, and which is undoubtedly proper in other forms of illness.

No single kind of bath is a specific for rheumatism, but four methods may be mentioned which are justified by age-long experience and by precise modern investigation.¹⁴

1. *The hot pool*, with more or less prolonged immersion. Recently, in Transjordan, I have seen the Bedouin resorting

in winter to the natural thermal pools, not for brief immersions, but very often for the greater part of the day. Their tolerance of heat is extraordinary. A danger with which hydrologists are familiar was brought to mind at another pool near Tiberias, where the bath-keeper stated that his wife was cured of an intractable rheumatism by sitting for hours in the Roman pool—a treatment which, however, brought on heart trouble. The risk of "thermal debility" in baths is not to be forgotten, and should be carefully guarded against by "heart cooling."

2. *Muds*. With these, higher temperatures than in baths can be used in local applications, and the desired local and general reaction very accurately produced. Here again heart cooling is indispensable.

3. *Vapour*, with or without switching. Besides being the most soothing of all procedures for tension and pain, vapour may be made the most stimulating of all external applications. A wide range and flexibility of application give it an essential value in cold climates. The prolonged use of vapour at various and progressive grades of temperature is extraordinarily valuable.

4. *Salt*. Local and general applications of brines are entirely justified in arthritic cases, and form one of the most powerful of surface treatments.

A cure for rheumatism in the warmth of summer is traditional in most countries, and is well justified by what has been already set forth. But it is reasonable to suppose that artificial climates are likely to be most needed by frigo-sensitive persons when the external conditions are most unfavourable. It is true that certain forms of arthritis are at their worst in the hot months of the year, but rheumatic persons usually suffer most in winter and spring.

Except at Bath, the systematic treatment of rheumatism in the winter months is little practised in England. An interesting example of what can be done in a cold country with mud baths is furnished by recent reports from Russia.¹⁵ For a number of years very good results have been obtained with hot sedimentary muds in the summer season in Southern Russia. A careful trial of the same treatment by means of exported muds has now been carried out in the winter season in several northern cities. In the winter of 1914-15 a thousand military patients were treated in this manner in Leningrad, the men being housed in warm buildings and carefully protected from intercurrent chill. Professor Alexandroff states that the results obtained from winter treatment in the towns have proved in no respect inferior to those experienced in the summer, and that there are now in Russia several properly organized clinics for this form of treatment in winter.

It would seem that the incidence of rheumatic diseases in England is the most serious in the world. No one who is conversant in any degree with the complex character of these diseases will advocate one method of approach or one line of treatment to the exclusion of others. The Ministry of Health, in its pronouncement at the International Conference on Rheumatism at Amsterdam in 1927, and in more than one report, has foreshadowed a threefold programme for investigation and treatment: (1) centres for physical treatment in towns; (2) development of spa hospitals; (3) an arthritis unit or units for intensive study in association with the medical schools. To this programme those who are responsible for the international league have given their unreserved support.

My present purpose is to endeavour to indicate, from a rather wide experience, what appear to me to be the essential features and conditions of success of a centre for physical treatment in a northern climate. In the first place, the centre must have for its nucleus a bath clinic, with its proper therapeutic elements—namely, heat, moisture, mechanical stimulation, and time. The bath and its surroundings will actually represent a climate in miniature, and it will operate by counteracting climatic influences in those who are injuriously affected by them. This means the establishment, or perhaps rather the re-establishment, in England of people's baths, where the functional disturbances associated with rheumatism can be relieved, and the development of rheumatic diseases prevented, especially in the cold months of the year.

To serve this purpose a large warmed building will be required, with a temperature approaching 70° F. in all its parts. The main feature will be the central pool or pools of moving water with its complement of gases, at the selected degree or degrees of heat. In association with

these, departments will be provided for treatment either by mud, with the proper mud kitchen, or by vapour at various temperatures, or by thermal brine. Light and artificial sunshine will certainly have a place, as well as a judicious selection of local and accessory physical treatment. There will also be ample accommodation for manipulations, movements, frictions, and switching, and couches for packs and prolonged and quiet resting. An artificial climate will pervade the place, and winter gardens with a subtropical temperature, refreshment rooms, library, games and recreations, and a gymnasium, may properly be included in the scheme. Last but not least, fountains of soft drinking water, hot and cold, will be provided in all departments for treatment, inasmuch as the free use of water internally is of great assistance to the external treatment of rheumatism.

The great majority of rheumatic persons, both in the early and later stages of the disease, and many others who suffer from chill, might well be recommended to spend from two to three hours a day in a medical establishment of this description. Men and women after the day's work would take with advantage a couple of hours for treatment, rest, and recreation at such a bath clinic. For all serious cases, especially of arthritis, warmed hostels should be available in close proximity.

Apart from the great towns, where the need for such

facilities is probably the greatest, there are British marine resorts well suited for a winter cure, where rheumatic cases are already treated with benefit, and it is not inconceivable that at some future time the people's bath clinics may also be established at the spas and along the coasts.

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A BLOOD SERUM TEST OF GENERAL PARALYSIS.

BY

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LANGE's gold-sol test depends on the capacity of pathological cerebro-spinal fluid to bring about a coagulation in a gold-sol whose hydrogen-ion concentration lies between pH 6.1 and pH 6.3. This coagulation is ascribed to one or several globulin fractions (Cruickshank,¹ Felton,² Fischer,³ Weston,⁴ Mellanby and Anwyl-Davies,⁵ and others). Lange tried to extend his test to serum, but was unsuccessful; the difficulty lies in the fact that every serum, if tested like cerebro-spinal fluid, gives a strong parietic curve ascribed to globulin. I have devised a serological test of general paralysis, evolved in the course of work on the pathogenesis of the disease and of certain physiological and pathological features of the cerebro-spinal fluid. My object in this article is to describe this test and its clinical application; the work on which it is based, and my views about the cause of the reaction, will appear in another scientific journal.

THE GEL TEST.

By a process of sensitization to be described below I have been able to produce a gold-sol which, for a period long enough to enable the experimenter to examine a considerable number of serums, gives distinct and easily distinguishable colour reactions in normal and parietic serum (or, probably, in the serum of any patient whose cerebro-spinal fluid would show a parietic curve). I have also found that one drop from several cubic centimetres of glycerin which has been poured into a test tube containing a small amount of solidified serum and allowed to stand at room temperature for one minute or longer gives an instantaneous characteristic reaction with sensitized gold-sol. The serum before solidification must be shaken for a few seconds with decolorizing charcoal. The solidification is effected by heating to 80° C.; boiling is permissible, but it distinctly weakens the reaction.

Preparation of the Gold-sol.

I prepare the gold-sol according to Eicke's method, but with one or two very slight modifications. I always distil the water over potassium permanganate in a Jena glass still. Further, having added 1.5 c.cm. of a 5 per cent. solution of potassium permanganate drop by drop at

intervals of about one second to the 500 c.cm. of distilled water (containing 0.5 c.cm. of 10 per cent. gold chloride and 2.5 c.cm. of a 5 per cent. solution of dextrose), beginning when its temperature has reached 90° C., I continue with a 1 per cent. solution of potassium carbonate, gradually increasing the intervals between the drops from about two to five seconds as the colour change approaches. As soon as the colour change occurs I rapidly remove the flame. The gold-sol is now ready for immediate use and can be cooled in plugged 100 c.cm. Erlenmeyer flasks under a cold-water tap.

Apparatus Required.

The requisites are as follows: (a) stock solutions, preferably kept in Jena glass flasks, of gold-sol prepared by the above method, and normal hydrochloric acid; (b) one 50 c.cm. beaker, one 100 c.cm. beaker, both preferably of hard glass; (c) one 50 c.cm. burette, one 25 c.cm. burette, and one 2 c.cm. burette (graduated in 0.01 c.cm.); (d) one dropping pipette (Dreyer's pattern), and one 10 c.cm. pipette; (e) a number of straight button-end dropping tubes*; and (f) a number of test tubes, extra strong, 4 in. by 1/2 in. A simple device (not essential, but particularly useful for dealing with large numbers of serums) can be obtained from S. W. Bush, Sir William Dunn School of Pathology, Oxford. It has been made according to my instructions, and consists of a solid duralumin pan with a stout copper inlet serving as a lid, and holding a thermometer and fifty test tubes of the size described above. I recommend that three Dreyer pipettes should be kept and calibrated as follows: one pipette marked at 0.5 c.cm. and 0.9 c.cm.; two pipettes marked at 0.1 c.cm. and 0.5 c.cm. The first pipette serves for measuring the saline, the other two for measuring the cerebro-spinal fluid. I always work with 0.5 c.cm. of cerebro-spinal fluid dilutions, adding 2.5 c.cm. of gold-sol.

"Adjustment" of the Gold-sol.

To adjust the gold-sol the procedure is as follows:

1. Four test tubes, each containing a 1 in 10 dilution of normal cerebro-spinal fluid in 0.4 per cent. saline, are set up.
2. The 50 c.cm., 25 c.cm., and 2 c.cm. burettes are filled with gold-sol, distilled water, and normal hydrochloric acid respectively.
3. 12.5 c.cm. of gold-sol are run into the 50 c.cm. beaker.
4. 19.5 c.cm. of distilled water are run into the 100 c.cm. beaker.

* Obtainable from Henry W. Bush and Co., Ltd., Rembrandt Works, Lavington Street, London, S.E.1. Price list No. 465, 1929, Catalogue No. 816.