belief that industry suffers an understandable lack of knowledge about these things that the Department of Scientific and Industrial Research has attempted to provide an information channel from the academic producer of research results to the potential user in industry*.

* Department of Scientific and Industrial Research. *Problems of Progress in Industry*, No. 12: *Human Sciences Aid to Industry*. Pp. iv + 27. (London: H.M.S.O., 1961.) 2*s*.

Human Sciences Aid to Industry, one of the popular series *Problems of Progress in Industry*, discusses some of the main lines of research in the human sciences. Sufficient information is given from studies sponsored either wholly or partly by the Department of Scientific and Industrial Research to stimulate responsible people to take a more active interest in the subject.

CHEMOTHERAPY OF MALARIA

THE importance of chemotherapy in the world-wide campaign for the eradication of malaria has been rapidly increasing. The clinician treating a limited number of malaria cases has at his disposal a complete series of effective drugs for treatment of all stages of the disease; but the malariologist dealing with a sick community, often in a region with limited public health services, may find socio-economic conditions a serious obstacle to making the fullest use of existing drugs or to using them at their full effectiveness for the purpose of malaria eradication.

A report*, prepared by the World Health Organization, considers, from the point of view of the malariologist, two broad questions: (1) What is the best use of antimalarial drugs? (2) What new drugs are needed? Some 16,000 antimalarial compounds have been studied and tested for antimalarial activity in recent years. The dozen or so which have survived this intensive screening and been found useful against human malaria are here given detailed consideration: the 4-aminoquinolines such as chloroquine, amodiquine, and their analogues; the 8-aminoquinolines (pamaquine, primaquine, etc.); the pyrimidines and biguanides (pyrimethamine, proguanil and chlorproguanil); and a few others such as the older drug mepacrine. The usually recommended dosages are reviewed together with results achieved in mass drug administration.

* World Health Organization. Technical Report Series. No. 226: Chemotherapy of Malaria—Report of a Technical Meeting. Pp. 92. (Geneva: World Health Organization; London: H.M.S.O., 1961.) 3 Swiss francs; 5*s*.; 1 dollar.

Drug combinations and associations with an additive to counteract the shortcomings of certain drugs used singly are discussed with other aspects of malaria chemotherapy including the various ways of increasing the duration of action of the antimalarials—of special importance because of the difficulty of persuading entire populations to take drugs regularly and frequently for long periods; the principles of planning and organizing field trials of antimalarials; the problem of drug resistance, and possible ways of preventing or overcoming it; the practical problems of mass drug administration; and the use of medicated salt, a promising method of mass drug administration with which considerable experience has now been amassed in areas as diverse as Brazil, Cambodia, Ghana, Netherlands, New Guinea and British Guiana. An annex reviews variations in the modalities of drug administration in antimalaria programmes throughout the world.

STAPHYLOCOCCAL CARRIAGE

THE carriage of staphylococci in sites such as the nose and throat, without the production of local or general disease, has become of increasing importance in recent years in relation to problems of cross-infection in hospitals and, to a lesser degree, among the population at large. The term 'carriage-rate' has never been accurately determined, however, and there is no general agreement regarding the sites to be examined, and even criteria of pathogenesis remain unsettled. An attempt at a quantitative survey of observations made from 1937 to 1959 in a number of countries—mainly in the British Commonwealth, Scandinavia and the United States—and based on material from many sites has recently been reported by E. Munch-Petersen. His findings have been summarized in a recent issue of *WHO Chronicle* (**15**, No. 11; November, 1961).

The carriage-rates in the general population and in hospitalized patients fluctuated very considerably from year to year and exhibited no obvious similarity in trend. A striking feature was the precipitate fall in rate among the hospital population during 1949, and possibly the outcome of the intensive use of antibiotics; but this fall left no impression on the subsequent trend, and the over-all hospital carriage-rate remained much the same. Nasal carriage-rates, taken alone, ranged widely: in the general population from 21·5 per cent (1953) to 49·2 per cent (1949); in hospital inmates from 32 per cent (1949) to 59·2 per cent (1959), again without any obvious pattern over the whole period. It is difficult to see why there should be such marked variations in carriage-rates in the same population from year to year, or why widely differing figures should be reported from different countries. The total rates for the general population ranged from a minimum of 13·6 per cent in some southern European countries to a maximum of 58 per cent in Germany; for hospital staffs and patients national rates varied between 28·1 per cent and 55·7 per cent. It is rare for two adjacent hospitals to have the same rate and there may even be differences between wards in the same institution.

The basis for these wide discrepancies may lie as much in variations of laboratory technique as in true differences of incidence. The methods of sampling, the sites sampled (the nose and skin of the hand are most generally used), the methods of culture and of performing coagulase and hæmolysin tests, all are subject to enough individual variation to cast doubt on the comparability of observations from different sources. At the moment it is only possible to reach some approximation to the true state of affairs. Not until there is a generally accepted method for determining staphylococcal carriage-rates, and generally accepted criteria of pathogenesis in staphylococci are available, will it be possible to

form any opinion as to the significance of variations in these rates.

Although the annual figures for carriage-rates of all pathogenic staphylococci follow no particular course, evidence from many sources in industrialized countries shows that this is not the case with regard to the proportions of penicillin-resistant organisms. There has been a steady increase in the proportion of resistant organisms in each host category over the years, an increase greatest in the hospital group but significant even in members of the general public with no overt signs of infection.

These findings raise many questions about the origin and spread of resistant strains. They are certainly consistent with the general impression of a relationship between the increased use of penicillin and the growth of resistant strains. (The slight downward trend noted for resistant strains in hospitals since 1955 may be the result of the use of broad spectrum antibiotics.) It has to be borne in mind that penicillin, with other antibiotics, is being used on a large scale for preserving food and controlling animal diseases in many countries. It is increasingly present in milk and cheese, and quite large numbers of hospital, veterinary and farm workers are intermittently or continuously exposed to small concentrations of the antibiotic. These are all factors likely to promote the emergence of resistant strains in man, quite apart from the effects of inadequate or injudicious chemotherapy in clinical practice. Whether diseases caused by resistant organisms are more infectious or more serious than those produced by sensitive staphylococci is another matter and difficult to assess.

FLAME-ARC COMBINATION

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THE existence of appreciable ionization in flames was implied already in 1600 by the discovery of W. Gilbert, physician to Queen Elizabeth I, that flame gases would discharge an electroscope. More recently, effects of electric fields on flames involving changes in rate of propagation or in shape of flame have been reported (see, for example, refs. 1–3). Within the past few years, the potentialities of utilizing both the movement of flame ions in an applied field and the forces acting on the gas due to such ion movement have been seriously considered from a practical point of view. Examples of the effects sought are: electrolysis of flame gases to collect (or re-direct) desirable intermediates or charged carbon particles; the use of secondary ionic wind effects to increase mixing rates (and hence intensities of combustion), to alter heat transfer to solid surfaces, to modify length of flame and so forth. It was indeed found[4] that in the case of laboratory flames, appreciable changes in magnitude, location and form of carbon deposition, in heat transfer to surrounding surfaces and in mixing-rates could be achieved in this manner. The application of a magnetic field to rapidly moving combustion products has resulted[5] in direct generation of electricity at appreciable power-levels—though at inappreciable efficiencies.

Several of the other applications mentioned would similarly be of considerably greater and less specialized interest if their efficiencies were higher. The difficulty ultimately lies in the relatively low ion concentrations generated. The work reported here is part of an attempt to remedy this situation. This phase is not concerned with the form or feasibility of applications—these have been discussed in other publications. The present aim is to increase the energy and ion contents of the gas by increasing final temperatures beyond magnitudes available from heats of combustion of stoichiometric mixtures.

In principle, the simplest method of achieving this effect without external energy sources is by means of some heat exchanger re-circulating a part of the heat of the products to the unignited reactants. In the steady state, the final rate of heat efflux must, of course, equal the influx-rate of chemical energy. In between the initial and final states, however, temperature and ion concentration can be increased on 'borrowed heat' and the desired result is accomplished over a limited region. In practice, this system is severely limited. In premixed reactants, the ignition temperature confines maximum preheat to a very low value. Separating the reactants is undesirable because it leads to a rate of burning controlled by the mixing and hence a severely reduced intensity of combustion. The more fundamental obstacle lies in the melting point of any heat exchanger. The additional gas enthalpy corresponding to the highest such temperature limited in this manner is quite low by comparison with those corresponding to attainable heats of combustion.

This fact leads to a more general statement of the problem. The desirable trend towards ever higher temperatures of the working gas is at present halted by the large gap which exists between the maximum temperature at which gas can be contained without melting the container and the minimum temperature at which ion concentration is sufficient for control to be exercised by means of fields. In attempting to narrow this gap from the flame end, it follows from the above that additional heat supplied to the gas must not pass through solid walls—indeed, must not be transferred as thermal energy at all.

No such limitations apply to releasing energy in the gas by means of an electrical discharge, and for purposes of the present work a 'plasma-jet type' arc seemed the most convenient. A compromise between such a device and a gas burner was designed. Fig. 1 illustrates one form of the apparatus. The power supply consisted of 60 nickel–iron cells (of 1·2 V. each) and the circuit included an arc-welding starter unit and a variable external resistance of 0·4 ohm maximum value. The external resistance was kept approximately equal to that of the arc.

It was necessary to minimize oxidation of, and other chemical attack on, the hot tungsten cathode, and to safeguard against explosion within the body of the burner caused by ignition there, or by flashback. The nitrogen stream alleviated attack on, and ignition by, the hot surface. Flashback can be

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