envelope, using the data from several stars, indicates roughly a Jacobian equipotential curve in the XY-plane. The amount of matter in a typical ring, on a rough estimate, is 10^{-8} times the mass of the brighter component. Assuming that the average tendency to expansion is less than 1 km./sec., most of the mass of the binary would be exhausted in 10^8 years. If angular momentum were lost with this mass, as seems probable, a system of the type of *U Sagittæ* or even of Plaskett's star could gradually evolve until it became a typical *W Ursæ Majoris* binary. If the evolutionary trend continued in the direction of bringing the two components together, some mechanism must exist to take care of the excess angular momentum; and here an interesting view is propounded: one possibility might be the transformation of a *W Ursæ Majoris* system into a slowly rotating red dwarf and a group of attending planets which absorb the greater portion of the angular momentum of the binary in their orbits.

DEVELOPMENTS IN THE HEAT TREATMENT OF MILK

THE Society of Dairy Technology, at its meeting at the Conway Hall, London, on April 21, discussed developments in the heat treatment of milk.

Mr. A. Rowlands dealt with the bacteriological aspects. He said that heat treatment is now accepted as an essential process in the handling of liquid milk and in the manufacture of most dairy products. Because of its relatively high resistance to heat, complete destruction of the tubercle bacillus is the accepted criterion of satisfactory heat treatment. There is abundant evidence of the large margin of safety provided by treatment of milk at $145-150^{\circ}\text{F}$. ($62.8-65.6^{\circ}\text{C}$.) for thirty minutes as required in Great Britain for holder pasteurization. Nor is there any doubt about the safety of milk treated in commercial plants at 161°F . (71.7°C .) for fifteen seconds as required in the high-temperature short-time process: the holding time in commercial plants is, in general, appreciably longer than fifteen seconds. There is, however, need for a laboratory apparatus in which the time of heating and cooling is minimal and in which the time of holding can be controlled positively. Such an apparatus is necessary to obtain more exact information about the time-temperature combination required to destroy tubercle bacilli and other pathogens and non-pathogens in the higher temperature range.

Commercially, the improvement in the keeping quality of milk resulting from heat treatment is extremely important, and Mr. Rowlands said it is difficult to see how the community could be supplied with milk possessing an adequate keeping quality without heat treatment. Raw milk sometimes contains large numbers of thermoduric bacteria derived mainly from unsterile utensils used on farms, but, fortunately, these types have only a slight effect on the keeping quality of the pasteurized milk stored at normal household temperatures. At these temperatures spoilage is generally the result of contamination of milk after pasteurization from the surfaces of coolers, pipe-lines, storage tanks, bottle-fillers and bottles. Pasteurization, coupled with efficient cleaning and sterilization of all plant to prevent subsequent re-contamination, ensures a keeping quality adequate to satisfy consumer requirements. Nevertheless, the

thermoduric bacteria derived from the raw milk sometimes make it difficult to comply with colony count standards which might be applied to the bottled milk. These thermoduric bacteria are for the most part slow dye-reducers and are unlikely to account for failure to comply with the half-hour methylene-blue test standard now in use officially for the examination of pasteurized milk in England and Wales.

Pasteurization does not destroy spores, and there is evidence that some spore formers cause stimulation of acid production by the lactic acid streptococci. Spore-forming aerobes are also associated with the fault 'broken' or 'bitty' cream; this fault is readily apparent in tea or coffee in the form of large particles of curdled cream floating on the surface. Research in progress at Shinfield has shown that the fault is caused by *Bacillus cereus* and *mycoides*; both produce an enzyme (lecithinase), and broken cream is thought to be associated with the action of this enzyme on the lecithin fraction of the fat-globule surface membrane.

Thermophiles, which were at one time a serious problem with the holder process of pasteurization, cause little trouble with the high-temperature short-time process. Temperatures used with the latter are above the optimum for the growth of thermophiles. Recently it has been found that thermophiles are sometimes concerned in the spoilage of sterilized milk. Thermophiles, the spores of which possess unusual resistance to heat, survive the commercial sterilization process and later proliferate at a stage during the slow cooling of the stacked bottles.

Dr. R. Seligman dealt with the history of pasteurization from the engineer's point of view. He divided the time which has elapsed since Pasteur's day into two periods, the first ending in 1922. During this period little attention was given by British engineers to the design and development of equipment for the heat treatment of milk, and Great Britain was obliged to depend largely on imported equipment. In contrast, during the second period most of the equipment developed and now in general use throughout the world had its origin in patents first granted to British engineers.

A German patent granted to Fesca in 1881 marked the first real contribution of the engineer in the field of heat treatment of milk. This was a continuous heater, and later, as the Danish or rotary pasteurizer, it was used extensively for many years in Europe and America. Internal tubular heaters, either with the tubes permanently fixed in position or with the inner tube detachable to facilitate cleaning, were developed early in the present century. Heaters of the latter type were used for regenerative heating, as were also surface heaters or coolers of the Baudelot type.

For low-temperature pasteurization, batch pasteurizers of the coil-vat or spray-vat type were in widespread use during the early years of the present century. Owing to the protracted period of heating and cooling, these possessed many disadvantages and were entirely unsuitable for dealing with large quantities of milk. Flow-retarding tanks in which the milk flowed continuously through a number of tanks in series were introduced by Heulings in 1895. Later, the so-called 'absolute' holders with independent heaters and coolers gained some prominence. Patents granted to a British engineer, Tarbot, in November 1922 marked a major advance in the process of holder pasteurization, for he was the first

to accomplish the automatic holding of milk for a fixed time at the required temperature and without risk of contamination of the pasteurized milk with raw or partly pasteurized milk.

In 1923 a major development occurred which was later to revolutionize the methods in general use for the heat treatment of milk. This was a patent granted to Dr. Seligman for a heat exchanger of the plate type, and he explained that the plate-heat exchangers now used so extensively in the milk industry were developments of the 1923 British patent. The original cast plates have now been largely replaced by pressed stainless-steel plates with bosses or grooves to provide the necessary turbulence.

Special holder-plates, developed originally for the retardation of flow of milk treated at the higher temperatures, have been largely replaced by flow holders of the tubular type for the high-temperature short-time process. These tubular holders are accurately proportioned to the rate of flow, which is itself accurately controlled to secure the necessary holding time of fifteen seconds. The introduction of the high-temperature short-time process has also demanded accurate control instruments, and the 'diversion valve', designed automatically to divert underheated milk from the main stream, has been perfected. Electrical heating, originated by Beattie and Lewis in Liverpool in 1917, is now in use commercially in some high-temperature short-time plants in the United States.

A. ROWLANDS

AMERICAN EDUCATION

IN the United States the Office of Education forms one department of the Federal Security Agency. In his annual report to the Federal Security Administrator for 1949, the Commissioner for Education directs attention to inadequacies in the educational system which sound very familiar to educationists in Great Britain. The teacher shortage, for example, bears a striking similarity to the position in Britain. During 1948-49 approximately 28,000,000 children enrolled in the elementary and secondary schools, and a startlingly rapid increase in this number has already begun. By 1960 the number of children enrolled in elementary and secondary schools will be about 37,000,000, with the most rapid increase occurring in the three school years beginning in 1952, 1953 and 1954. The available teachers fell far short of the number needed even to staff the classes assembling in the autumn of 1949. This shortage exists largely among elementary school teachers, and in many communities the shortage of teachers has resulted in classes of more than fifty children. In others education has been curtailed by dividing the school day into two sessions, one group of children attending in the morning and another in the afternoon. Thousands of classes are taught by teachers who hold only emergency or temporary certificates.

Income is a significant factor in recruiting and keeping teachers in the profession, but is by no means the only one. The status which the teacher occupies in the community, the regard of the public for the work of the schools, the opportunity to live a normal life unhampered by local conventions and projects and a number of other psychological and social factors are no less important. In too many communities in the United States teachers are required to adapt their own tastes, conduct and social activities to those of members of the school board or other

prominent citizens. They are often expected to lead an abnormally restrained and inhibited life compared with the life of the parents who impose such restrictions.

The critical shortage of teachers is matched by an arresting lack of schools. If all the needed teachers were available to-day many would have no suitable rooms in which to conduct their classes. A shortage of school buildings is in part the result of the depression of the 30's and in part the result of restrictions on construction during the war years. As a result, many children must attend classes conducted in obsolete, insanitary and frequently dangerously dilapidated structures. Many of the buildings which are physically sound are inadequate in terms of the functions of modern education. Some teachers during 1948-49 were conducting their classes in church basements, factories and stores and other unusual locations. It is difficult to say how serious is the shortage of classrooms; but, assuming thirty to be a suitable number in any one class, the number of new classrooms required each year to accommodate new enrolments up to 1958 will be approximately 25,000.

One interesting section in the report deals with the place of Communism in the schools. In the spring of 1949 the Educational Policies Commission of the National Education Association issued a report which makes four specific recommendations.

(1) Young citizens should have an opportunity to learn about the principles and practices of totalitarianism, including those represented by the Soviet Union and by the Communist Party in the United States.

(2) Teaching about Communism or any other form of dictatorship does not mean advocacy of these doctrines. Such advocacy should not be permitted in American schools.

(3) The schools should continue with vigour their programmes for giving young citizens a clear understanding of the principles of the American way of life and a desire to make these principles prevail in their own lives and in the life of their country.

(4) Members of the Communist Party of the United States should not be employed as teachers.

These proposals are supported by the Commissioner, who argues that children are not sent to school to be indoctrinated with a closed system of philosophy or the political views of the teachers. To the extent that education becomes dogmatic indoctrination, it ceases to be education.

"The Communist embraces and teaches dogma. He is, by his Party membership and sympathy, committed to a closed system of thought. He has given his allegiance to a predetermined set of principles which are not to be evaluated in the light of evidence or examined on the basis of results. He is not free to serve the truth as the evidence may uncover that truth. He has therefore surrendered his right to teach in a nation of free people. In this the Communist is not alone, of course; but the fact that there are those others whose commitments prevent them in some measure from pursuing the truth does not justify the retention of Communists."

The report also contains valuable sections giving details of educational research and statistics, the administration of grants, programmes of organisation and administration, programmes of instruction, programmes for improving the professional status of teachers, and, finally, the position of the United States in international educational relations.

T. H. HAWKINS