OUR ASTRONOMICAL COLUMN.

THE BIRTH OF THE MOON.—Prof. W. H. Pickering in *Popular Astronomy* (October, 1919) endeavours to reconcile Sir George Darwin's estimate of the moon's age (less than 60,000,000 years) with recent geological opinion, which demands a period of 1,200,000,000 years since the formation of the earth's crust. He suggests that the matter of the moon left the earth at that remote epoch, but remained for ages circulating round the earth as a cloud of fragments. In this form its tidal influence would be small, and the earth would for long retain its assumed primitive rotation period of some four hours. Gravity in the tropics would be much reduced by centrifugal force. Prof. Pickering seeks thus to explain the existence of the huge reptiles like the Atlantosaurus and the Diplodocus, also the fact that heavy reptiles like the Pterodactyls had the power of flight. He suggests that the moon was consolidated from the cloud of fragments in the middle of the Cretaceous period, and quotes geological authorities for a great invasion of land areas by the sea and tremendous volcanic activity at that epoch, which he ascribes to the great tides which the moon would have raised when so near the earth. That epoch would agree well enough with Sir George Darwin's estimate of the moon's age, supposing it to date from its consolidation, not from its leaving the earth.

DISTANCES OF THE STARS OF TYPE F.—Mr. C. F. Lundahl discusses the distances of these stars in *Meddel. Lunds Astr. Obs.* (series ii., No. 21). He works on the same lines as Prof. Charlier in his recent memoir of the B stars; that is, he assumes a constant absolute magnitude, and deduces the distance of each star from its apparent magnitude. The F stars have a wider range of absolute magnitude than those of type B, but the great majority of them are included in a range of about 2 mag.; hence tolerable results for the distances may be expected. In fact, he states that 60 per cent. of the stars the parallax of which has been measured agree with his values within the limits of probable error. He quotes Prof. Plummer's research on the same stars, which was based on the assumption that they were moving parallel to the galactic plane. As that method showed an agreement with measured values for only 40 per cent. of the stars, Mr. Lundahl concludes that his own assumption is nearer the truth. He notes from his results that ζ Tucanæ and η Cassiopeiæ are evidently dwarf stars, while Polaris and still more Canopus are notable giants. The density of distribution of F stars is estimated by two independent methods which give respectively 8 and 4 cubic siriometers for one star of this type (a sir. = 1,000,000 astr. units).

ABSOLUTE MAGNITUDE AS A FUNCTION OF COLOUR.—Mr. F. H. Seares indicates a relation between colour and absolute magnitude in stars of the same spectral type (Proc. Nat. Acad. Sci., July, 1919). The colour is determined photographically by taking graduated exposures of the star on an isochromatic plate with and without a yellow filter. The ratio of exposure times that give images of equal intensity in the two cases is a measure of the colour. The method has been tested on about 150 stars the absolute magnitude of which has been otherwise determined. The following are the results deduced:—Giant stars of types G and K are decidedly redder than dwarfs: also in type B the brighter stars are redder, but the difference is less marked. On the other hand, in type A the fainter stars are redder, while in types F and M the curve is too flat to permit of the absolute magnitude being found from the colour. Thus the method can be applied only if the spectral type is known, but it promises to be a useful supplement to the spectroscopic method. Experiments are being made to examine whether the necessity of knowledge of the spectral type can be evaded by taking three series of exposures with screens of different colours; if this were possible, the method could be applied to much fainter stars.

CROSS-CIRCULATION AS A PHYSIOLOGICAL METHOD.

IN the mutual co-ordination and integration of the physiological processes in a complex organism, in which actions exerted by the environment on a particular part affect the whole and the functional activity of one organ has its influence on numerous others, there are two chief methods adopted. One is by means of the central nervous system, in which messages received from the periphery along certain nerve-fibres are reflected back, as it were, to outgoing nerve-fibres, setting into play the appropriate muscular or other response, it may be in a distant part of the organism. This method has been compared to a telephone exchange. The other is by means of the blood. Owing to the continual circulation of the same mass of liquid through all parts of the body, it will readily be seen that a chemical substance, produced in any one part and passing into the blood-vessels supplying this part, must be carried, sooner or later, to all other parts, and give rise to effects in any tissue or organ sensitive to it. We have here an actual transport of material, the materials carried, when they result in changes in distant organs, being known as "chemical messengers" or "hormones."

In many cases there is difficulty in discovering to which of these modes of communication a particular reaction is due. Thus when muscular exercise is taken, the depth and rate of breathing increase. We know that carbon dioxide is produced in the combustion process that affords the energy for the muscular work. This passes into the blood, and may be in itself sufficient to set into greater activity the nerve-centre controlling the muscles of respiration. On the other hand, it might be that sensory nerves in the muscle are stimulated by the movements, and that the appropriate message is conveyed by nervous channels, or both chemical and nervous factors may be involved. Perhaps a clearer case is that of the pancreas, which pours its powerful digestive juice into the small intestine as the food arrives there from the stomach. We know now that the chief, if not the only, way by which this co-ordination is effected is that the acid of the gastric contents causes the formation of a chemical messenger in the walls of the intestine. This, passing into the blood, ultimately reaches the pancreas and excites it to activity, but it was for a long time believed to be a nervous reflex. Again, the origin of wound-shock has recently been shown to lie mainly in the production in the injured tissues of poisonous compounds, which are carried by the blood to the rest of the body and cause widespread damage to the capillary blood-vessels, resulting in a failure of blood-supply throughout the body. At the same time the co-operation of nervous factors has not been altogether excluded.

The analysis of many problems of this kind has been greatly assisted by the various methods known as "cross-circulation." It is obvious that if we can make a connection between the blood-vessels of one animal (A) and those of another (B), any chemical messenger produced in A must affect B also, whereas a process in A brought about entirely by the nervous system will have no effect on B. In this mode of experiment the blood of A may either be allowed to circulate through the whole of B, and *vice versa*, or some particular organ only of B may be supplied from A, this organ being cut off from the circulation of B. The details of the procedure cannot be described here, but some recent improvements in the technique may be referred to. The chief difficulty lies in the fact that when the blood comes into contact with any foreign surface that is wetted by it, such as the glass or india-rubber tubes connecting the two animals, clotting occurs. This may be obviated by making the blood incapable of clotting. A substance extracted from the heads of leeches will do this, but it is at the present time almost impossible to obtain it. Other substances having the same effect are too poisonous. Since the blood does not clot in the uninjured blood-vessels themselves, Hédon in France and Dale and Laidlaw in this country have made use of pieces of vein to connect the blood-vessels required. The latter workers desired only to divert the blood from one vein of an animal into another of the same animal, so that no great internal pressure was present, and it was sufficient to pass a short metallic tube (Crile's canula) over each end of the piece of vein, reflecting the ends over the tube and tying them. When this is done, and the tube is introduced into a blood-vessel, the blood comes into contact only with the lining of a normal blood-vessel. Hédon, wishing to connect the artery of one animal with that of another, took a metallic tube long enough to enclose nearly the whole length of the piece of vein and reflected the ends over this. The vein was thus adequately supported against the pressure of the blood in the arteries.

Bazett and Quinby, in the current issue of the *Quarterly Journal of Experimental Physiology* (vol. xii., No. 3), describe a method in which the fact is made use of that if blood is in contact only with a foreign surface not wetted by it, clotting is absent for a long time. They coated the interior of the glass and rubber tubes used with a mixture of paraffin and vaseline, and by interposing a specially constructed stopcock were able to connect the circulation of the two animals or return to normal at will.

These improvements in the technique of cross-circulation should render it possible to investigate problems hitherto difficult to solve. There is one disadvantage in it which must not be overlooked. This is the fact that a fall in the blood-pressure in one animal causes an inflow from the other when there is complete intercommunication between the two. Thus one of the animals may be seriously depleted if the low pressure lasts for any length of time. For this reason the production of wound-shock in one animal by the products of tissue-injury of another seems impossible, because the fall of blood-pressure, which is the most marked symptom of the state, would in itself drain blood from the normal animal and produce a similar state merely by loss of blood, apart from the action of a chemical substance. W. M. BAYLISS.

NICKEL-CHROMIUM STEEL FORGINGS.

DURING the war there was a considerable development of the use of alloy steels, in particular of those containing nickel and chromium. These uses were of the most varied kinds, not the least important being in the construction of internal-combustion engines used in aircraft, where service conditions are very severe. It is not surprising, therefore, that difficulty in complying with the specifications was encountered in manufacture, and much novel experience has been accumulated by technical workers in this field of steel metallurgy.

At the autumn meeting of the Iron and Steel Institute two important papers relating to this class of steel were presented: one was by Messrs. Andrew, Greenwood, and Green, of the metallurgical research department of Sir W. G. Armstrong, Whitworth, and Co.; the other by Mr. R. H. Greaves, of the research department, Woolwich Arsenal. It is interesting and significant to note that the latter paper is entitled "Metallurgical Communication No. 1, from the Research Department, Woolwich."

Messrs. Andrew, Greenwood, and Green, who took up the investigation of defects in the final tests of nickel-chromium forgings, have carried out their work in a most thorough and exhaustive way, following up the manufacture of these from the original casting to the finished article. It needs considerable courage for the investigators in a works to publish evidence showing manifest defects in the products of the firm's work, and the authors are to be commended for their honesty in taking this step. It is but rarely that such cases are met with.

The manufacture of a hollow forging may be divided broadly into three distinct sets of operations: casting, forging, and heat treatment. The authors emphasise the operation of casting as the most important of all, because any defects present in the ingot, generally speaking, persist throughout up to the final treatment. It is essential that not only the metal but also the mould-walls should be clean, and that all loose sand must be prevented from getting into the mould. As a method of assisting in the achievement of these results, the authors suggest the use of a tundish with sloping walls lined with basic material. They say that if the metal were run directly into this from the iron ladle, the sloping walls of basic material would act as a cleanser, since the slag would adhere to the sides of the dish. The cleansing action would be similar to that brought about with mercury when poured through a paper cone with a fine orifice at the bottom. They recommend that ingots should be cast wide-end up, and that the smallest size consistent with requirements should be used. They recommend further a high-ladle, but a low-casting, temperature, since this is found to be advantageous in cleansing the metal. The macrostructure of the ingot is determined by the temperature and method of casting. High-casting temperatures are to be avoided because they give rise to excessive segregation, ghost lines, etc., and coarse crystallisation.

The authors advise that, after casting, the ingot should not be allowed to cool more than is unavoidable, but should be solid forged as soon as possible. This breaks up the crystals, thus refining them. It also assists in the diffusion of the carbon and thus renders the mass more homogeneous. The effect is to produce a much stronger material the thermal treatment of which can be undertaken with greater safety. In carrying this out with large forgings, very slow heating up to the temperature range, 730–760° C., must be adopted. Above this the rate of heating may be quicker. The authors suggest further that they have obtained evidence that mechanical work can be overdone, and that the greater the amount the more prone is the tendency to a laminated fracture. A somewhat similar point was made by M. Charpy in a recent paper published on "The Hot Deformation of Iron and Steel." With regard to the final heat treatment the authors say that the temperature of oil-hardening appears to make little or no difference to the mechanical properties; *the* important factor is the time at the temperature in question. This should be as short as possible, since a prolonged heating even at 850° C. coarsens the grain-size and causes a deterioration in properties.

The paper by Mr. Greaves deals with the "temper brittleness" of a nickel-chromium steel containing 3·5 per cent. of nickel, 0·6 per cent. of chromium, 0·5 per cent. of manganese, and 0·25 per cent. of carbon. This term is applied to the condition induced