difficult to write down the values of the terms a, α, b, β of the following expression from mere inspection of the gear. In link motions it is more difficult at present, but we are already seeing our way to easy rules. Here, then, is the problem which Mr. Harrison has solved :—

Given the ratio of length of connecting rod to that of the crank. Given that the distance of the valve to the right of its mid stroke (Fig. 1) is

$$y = c + a \sin(\theta + \alpha) + b \sin(2\theta + \beta),$$

b being small in comparison with a, show on a diagram the position of the piston and the value of y when θ has any value. Further, the laps XY and X′Y′ (Fig. 2) being given, show on the diagram the amounts of opening of the ports to steam, these being obtained by subtracting the laps from y or $-y$.

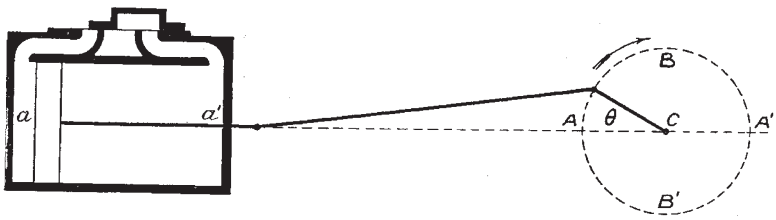

FIG. 1.—A is called the inner dead point.
A′ ,, outer ,, ,,
The motion from a to a' is called the *in* stroke.
,, ,, a' to a ,, *out* ,,

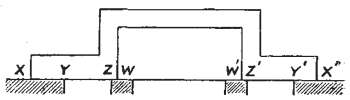

FIG. 2.—Valve shown in the middle of its stroke.
X Y and X′ Y′ are the *laps* (sometimes called the *steam laps*).
Z W and Z′ W′ are the inside laps (sometimes called the *exhaust laps*).

With centre C (Fig. 3) and radius CA or CA′ representing the crank, describe the crank circle ABA′B′. Draw BCB′ at right angles to ACA′. With centre on CA produced, and radius equal to length of connecting rod, describe the arc BOB′. Make angle $COC_1 = \beta - \alpha$ and $OC_1 = 2b$. We give the name "false centre" (relatively to both circles) to the point O.

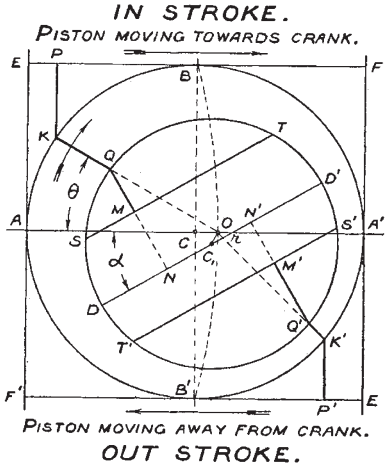

FIG. 3.—Mr. Harrison's diagram showing positions of piston and valve when crank makes an angle θ with inner dead point. The valve displacement to right of mid position (Fig. 2) being y, where
$y = c + a \sin(\theta + \alpha) + b \sin(2\theta + \beta)$.

With centre C_1 and radius a, describe the circle DQD′Q′. Draw DC_1D' making an angle with AA′ equal to α. Draw ST parallel to DD′ at a perpendicular distance from it equal to the lap XY of Fig. 2. Draw S′T′ also parallel to D′D at a perpendicular distance from it equal to the lap X′Y′ of Fig. 2.

Draw tangents at A, B, A′, B′. In the *in* stroke of the piston, when the crank moves from A to B to A′, let us show on EF the positions of the piston, and in the *out* stroke, when the crank moves from A′ to B′ to A, let us show on E′F′ the positions of the piston.

For any value of θ: Make AOK = θ, project K vertically to P; P shows the position of the piston, EP is its distance from the beginning of its stroke. OK cuts the valve circle in Q. The perpendicular distance QN of Q from DC_1D' is y, and the part of it QM is the opening of the left-hand port to steam. Similarly, in the *out* stroke, when the crank has passed through the angle AOK′ which is greater than 180°; project K′ to P′ to get the piston position in the out stroke. Let OK′ cut the valve circle in Q′; then the perpendicular distance Q′N′ is the distance of the valve to the left of its mid position (Fig. 2), and Q′M′ is the opening of the right-hand port to steam.

It is easy to see how we get the openings of the ports to exhaust in exactly the same way. Lines joining O with S, T, S′, T′ show the angular positions of the crank when admission and cut off take place. In fact, we see that this diagram gives us the positions of the piston when admission, cut off, release and compression occur both in the *out* and *in* strokes. It gives us an easy way to study how changes in b and β enable us (even when the laps are equal) to balance, or even more than balance, the inequality of admission of steam on the two sides of the piston due to shortness of connecting rod.

It is easy to see how such a diagram may be modified for problems concerning cut off valves on the back of the main slide valve.

The same expedient of false centres may be used to show the velocity or acceleration of a slide.

In a modified diagram Mr. Harrison sometimes lets the two circles coincide, using two false centres.

The solution is a close approximation to the truth in all the usual cases, because b is always small in comparison with a.

JOHN PERRY.

INSECTS AS CARRIERS OF DISEASE.[1]

THE recent researches of bacteriologists into the *rôle* played by insects as carriers of infection, and the hunt after microbes to locate their natural habitat, is a necessary procedure before it becomes possible to enter on a scientific crusade against them. In those diseases which may be caused by infection carried by insects, it is a more hopeful task to deal with the insects which we can see, than to deal with the microbe which lurks unseen and unheeded. At the same time, it is an uncomfortable thought that insects which we have regarded as undesirable but harmless may be the cause of a serious illness.

The bacteriologist has now shown a fair-sized category of diseases to be caused by microbes, and having arrived so far the hygienist steps in and wants to know firstly, what is the habitat of these microbes outside the human or animal body if they have one, and secondly, by what means they are conveyed to the body from their resting-place outside or from one patient to another?

[1] "On the *Rôle* of Insects, Arachnids and Myriapods, as carriers in the spread of Bacterial and Parasitic Diseases of Man and Animals. A critical and historical study." By Dr. G. H. F. Nuttall (from the *Johns Hopkins Hospital Reports*, vol. viii.).

That certain diseases may arise from the "bites" of insects has been surmised long before the microbial origin of disease was known, many theories were naturally based on insufficient evidence because the key to the riddle had not then been found. In some of the earliest records of epidemics any concurrent phenomena was thought to be the cause, thus the plague at Nimeguen, in Holland, in the seventeenth century, was said to be announced by swarms of insects and meteors.

All observations are of use, although in the light of present knowledge they may not bear the same interpretation as was originally put upon them; as a suggestion for investigation by experimental methods they may serve a purpose.

Dr. George H. F. Nuttall in this monograph has been at great pains to collect observations on the point from all sources, and has supplemented these with some experimental researches of his own.

Insects—using the term in its popular sense—may play a passive *rôle* in the propagation of disease. It is obvious that flies, for instance, after soiling their bodies in contaminated matter, may afterwards infect articles of food, especially milk; and no doubt many cases of typhoid fever are caused in this way. In India, where typhoid fever attacks so many of our troops, the refuse matter is placed outside the camp, and it has been suggested that articles of food in the camp might become infected by dust carried by the wind when it blows from the direction of the refuse matter; but it is more than likely that flies carried by the wind play a more important part, for they would seek out the food. The same may be said of cholera; in fact, an instance is given where milk was left out in the open in a jail in India at the time of a cholera epidemic, and it became infected with the cholera microbe by means of flies, whereas milk left out in another yard where there were no cholera cases and which was separated from the other yard by a high wall did not become infected.

In playing an active *rôle* insects may conceivably cause infection by "biting" after having "bitten" an individual suffering from an infectious disease or after feeding on contaminated substances, for instance, the body of an animal dead of anthrax. Experiments in this direction do not seem to have been very successful in the cases of bugs and fleas, which were the insects experimented with; but it was shown that anthrax and plague microbes do not survive more than a few days at most in the bodies of the insects. Even if the "bite" of an infected insect is harmless, it might be otherwise if the insect were crushed on the spot bitten, and the place scratched; such a procedure might be fraught with danger supposing the insect had recently been feeding on infected matter.

With respect to the tsetse-fly disease in domesticated animals, there is conclusive experimental proof that the fly carries the micro-organism or hæmatosine in this case from diseased to healthy animals.

The filariae, according to Manson, go through changes in the stomach of the mosquito, and finally make their way out into water in which the insects have died, and man becomes infected by drinking the water. In this case and in malaria the insect seems to act as an intermediary host to man. The mosquito—of which one species, the anopheles, seems to be mostly concerned—takes up the organism in the blood of the malarious subject, and, according to Manson, infects soil or water by dying in it; Ross and others, however, say it infects healthy persons by biting them after biting a malarious patient.

It is interesting to note that most of our previous notions as to the localities and time of year that malaria occurs, and the precautions adopted to prevent being attacked still hold good, *mutatis mutandis*, for the mosquito theory. C. B. S.

ETHNOGRAPHICAL MUSEUMS.

IN NATURE of September 14, attention was called to the rapid progress of ethnographical museums in Germany, and to the unsatisfactory state of ethnography in our own country. Since that time two things have happened which confirm the view then taken of the position of our national collections.

In the first place, one of the distinguished keepers of the Museum für Völkerkunde in Berlin has recently visited London, and has stated that the enlargement of the museum or its supercession by a completely new building will be seriously considered in the near future. When it is remembered that the Museum für Völkerkunde is already so enormously superior to anything which we have in this country, that it stands absolutely in a class by itself, it can easily be guessed that the projected improvements threaten to leave us in a position of inferiority positively humiliating. For even as matters now stand, the German collections are nearly ten times as good as our own.

The second occurrence to which we have alluded, is the issue of a report upon European anthropological museums by Mr. George A. Dorsey, of the Field Columbian Museum, who made a tour of the principal European cities in the autumn of last year. Extracts from his report have been published in the form of a short paper in the *American Anthropologist* for July, 1899, and it is therefore accessible to every one who feels any interest in the subject.

Mr. Dorsey begins by complaining that the collections illustrating the various branches of anthropology in Europe are all scattered about in different buildings. In London, if you wish to study man as an animal, you must go to the British Museum of Natural History in Cromwell Road, or to the Royal College of Surgeons; if you wish to study primitive art and industry, you must go to Bloomsbury. In Paris you must wander from the Jardin des Plantes to the Trocadéro, and so on in other cities. The great fields of anthropology are nowhere adequately represented in a single building, and the advantages of concentration are lost.

After this preliminary condemnation, Mr. Dorsey proceeds to discuss several museums in detail. He has a well-merited word of praise for the Pitt-Rivers collection in the University Museum at Oxford, where the development of different branches of human industry may be studied in a manner impossible anywhere else. Coming to Berlin, he thinks that the Museum für Völkerkunde contains the largest amount of ethnographical material to be found in any one museum in the world; and he is inclined to believe that it possesses a greater number of specimens than any other two museums combined. The one drawback is that, large as the building is, it has long proved inadequate to the enormous expansion of the collections, and is in consequence terribly overcrowded. As we have already seen, this is an inconvenience which will in all probability soon be remedied.

Of the ethnographical collections in London, our American critic has naturally something to say. After noticing that, from the ethnographical point of view, London, like Paris, is disappointing, he continues: "The large hall [gallery] devoted to this subject in the British Museum is not well adapted to the purpose for which it is used; it is rather inaccessible, poorly lighted, and does not admit of a ready scientific classification of the objects therein deposited. Naturally, this hall contains many of the rarest and most valuable objects that have ever been obtained by any museum in the world; but owing to the causes already mentioned, and to the crowding of the cases, it is practically impossible for the visitor in a short time to form any idea of the value of the collection. There are many rare and unique specimens, but the collection as a whole cannot be regarded as well illustrating