The whole ſum to be divided in proportion to the merit; to be produced on or before the firſt Tueſday in January, 1766.

N. B. The perſons who gain any of the above premiums to leave one yard of the lace, and one pair of mitts, as the property of the Society.

218. WATCH FUSEE-CHAINS. To the perſon who ſhall, before the laſt Tueſday in December, 1766, have inſtructed in the beſt manner, in any one manufactory, the greateſt number of women and girls, not leſs than ſix, in making Watch Fuſee-Chains; Thirty Pounds.

N. B. Certificates are to be produced, that the ſeveral perſons ſo taught do actually gain their livelihood by making ſuch fuſee-chains at the time of the claim.

NUMBER XCIII.

A Method of Ploughing, peculiar to Egypt, *recorded by* Haſelquiſt *in his Travels for diſcovering the Natural Hiſtory of* Egypt *and* Paleſtine.

GENTLEMEN,

AS I eſteem your work a repoſitory for every thing that is either uſeful or curious in agriculture, I cannot reſiſt the temptation I have of communicating to you a method of ploughing, peculiar, I believe, to the Egyptian farmers.

This is recorded by Haſelquiſt in his Travels and Obſervations on Subjects of Natural Hiſtory, publiſhed by the celebrated Linnæus.

It is well known, that in ſome parts of Egypt very little rain falls in the whole year; the amazing fertility of their ſoil entirely depending on the annual overflowing of the Nile.

Farmers are very ſenſible, that when corn is ſown, the land ſhould not be over dry, as in that caſe it will frequently periſh, inſtead of germing, and putting forth its root and blade. Now, in Egypt, at one of their ſowing ſeaſons, the earth appears to be quite parched up, to which they are forced to apply an artificial remedy, or it

would be to little purpoſe for them to lay their corn in the ground: when they give the laſt ploughing, the bottom of each furrow is moiſtened with water, after a very eaſy and ſimple method.

From one of the plough-handles to the back of the ſhare there runs a ſmall tube for the conveyance of the water from the ploughman, who has a leathern bag full of it hanging over his ſhoulder, in the bottom of which bag is a pipe, which comes under the man's arm, and is by that means inſerted in the upper end of the tube above mentioned.

It is eaſy to conceive, that when the diameter of the bore of the tube is of a proper ſize, proportioned to the quantity of water that is to be laid into the bottom of the furrow, as the plough goes forward, and with its ſhare opens a furrow, the tube ſprinkles the bottom of it with water, thereby making a moiſt bed for the ſeed.

In Egypt, the effects of this ſlight watering are aſtoniſhing; and I have no doubt but that the practice might, to great advantage, be introduced in England.

In a dry ſpring, our farmers are greatly puzzled to get their barley and oats into the ground, as they frequently wait week after week for rain, till it is at length almoſt too late to ſow the corn at all: now, I ſhould imagine, that if ſome ſuch method as that above deſcribed could be invented or practiſed to moiſten the land on which the ſeed was to be ſown, it would nearly anſwer the ſame purpoſe as waiting for rain. It is amazing to think how ſmall a quantity of water, properly applied, will be of infinite ſervice.

When the water is applied in the manner above mentioned, the moiſtened earth and ſeed are covered by the next bout of the plough; ſo that there is no immediate danger of the water being exhaled by the attractive heat of the ſun: and indeed I have not the leaſt doubt but that, in this method of application, three gallons of water would do as much ſervice as twenty times the quantity ſprinkled over the ſurface of the land in the ordinary way with a watering pot or engine.

I could, you may well imagine, enlarge a great deal more on the subject; but I cannot conceive there is any necessity for doing it, as the intelligent part of your readers will undoubtedly understand my meaning.

I must, however, before I conclude, say a word or two more about Haselquist, to whom I am indebted for the above hint.

This gentleman was born in Sweden, being a disciple of the great Linnæus, and studying under him and others physic and botany. In this last science he made an astonishing progress, and, prompted by his public spirit, he undertook a voyage to Palestine, on purpose to examine into the natural history of that country, which had till then been unnoticed by any naturalist. In this voyage he made many discoveries of great importance, to which the learned of Europe are now no strangers.

It is true, he lost his life in the expedition, but he has left behind him a name that will continue to the latest ages; and his journal and observations were digested and published by the great Linnæus, who thought it a tribute justly due to the memory of his pupil and friend.

I should be glad if some of your practical correspondents would advise me with respect to the management of a part of my glebe. It is a field of nine acres, and consists of a thin coat of light earth over a hard gravel. It has not been in tillage for some years, and when it was, it bore no burthens of corn, as you may imagine. I generally feed it: the grass is sweet, but there is little of it, unless the weather happens to be wet in the spring and summer.

About the distance of two hundred yards from this field I have a clay-pit: now, some of my neighbours advise me to cover the surface with clay.

I should be glad to be informed how many loads I ought to lay on an acre, and whether, supposing the clay to be of a good quality, there is any likelihood of my being reimbursed my expences, being only tenant for life. I am, I thank my God, healthy, and about forty years of age; and, GENTLEMEN,

Your humble servant,

May 17, 1765. A KENTISH RECTOR.

NUMBER XCIV.

To the Editors of the MUSEUM RUSTICUM.

GENTLEMEN,

THE enclosed letter is from a gentleman of great consideration in this country, and a constant reader of your work. The better to convey his meaning, I have sent you his letter to me, which you will much oblige me by publishing as soon as possible *, or at least the substance of it, with such additional notes as you may think necessary to obtain the end proposed.

I am, GENTLEMEN,

Your humble servant,

Ireland, An ENGLISHMAN.
May 7, 1765.

The Letter above referred to, containing some Queries respecting the Uses to which the Refuse of Oil-Mills (Rape-Cakes and Linseed-Cakes) is applied.

*To **** *****, Esq;*

DEAR SIR,

I Know you sometimes correspond with the editors of the *Museum Rusticum*: you would oblige me very much by writing to those gentlemen to publish the several uses to which the refuse of oil-mills (rape-cakes and linseed-cakes) is put. I know it is used as a manure, and also given to horned

* We are very glad to embrace every occasion that presents itself, wherein we can oblige this practical and very sensible correspondent: we know him to be a true friend to agriculture, and could wish he would give us more frequent opportunities of complying with his requests. E.

A.VI.2

G. Sarton
Appreciation of Ancient and Medieval Science during the Renaissance (1450-1600)

had worked together to a large extent, for the simple reason that Arabic science was a development of Greek science and that Greek science had first reached the Christian West through the Arabic detour. The Renaissance broke that coöperation and put an end to it; in the fifteenth century, East and West were finally divorced and, from then on, proceeded each along its own way—the West exploiting the experimental method and making possible the gigantic advance of modern science which would occur in the seventeenth century, the East refusing to follow the new roads of discovery and shutting itself up in a cocoon of orthodoxy and scholasticism. The West lost religious unity and peace but gained more knowledge; the East stiffened its thought and manner and resigned itself to its fate. As the West was going ahead with the seven-league boots of experimental science while the East stood still, the distance between them increased steadily.

The best symbol of their separation was provided by the invention of typography, which the Muslim East spurned, while the Christian nations developed it as much as they could and made of it the main instrument of Western progress.

From 1450 to the end of the eighteenth century, that is, throughout the Renaissance and two centuries beyond it, civilization was largely understood in the sense of Western civilization,[4] and humanism meant the knowledge of classical antiquities. The Bible, represented by the *Vulgate*,[5] was an essential part of Latin culture. A new Oriental renaissance occurred only by the end of the eighteenth century when Anquetil-Duperron and Sir William Jones discovered Zend and Sanskrit writings and the complicated pattern of Indic cultures.[6] This introduced a new kind of humanism, more catholic than the Renaissance humanism. Their discovery of a new spiritual world was infinitely more important than the discovery of a new material world by Columbus, Vasco da Gama, Magellan, *e tutti quanti*, but it attracted less attention, and to this day the great majority of the so-called humanists (meaning the teachers of Latin and Greek) are still on the Renaissance level or below.

Many historians have described the Renaissance as a period of expansion and discovery, the main discovery (or rediscovery) being that of the Ancient World. That description is not incorrect, but it is lopsided. Our humanists speak as if the scholars of the Renaissance had discovered all the humanities, while they discovered only those of Greece and Rome, a pretty small part of the world. Looking at it from the point of view indicated above, one might say that the Renaissance was a period of isolation.

After the Renaissance, the West was fully equipped to continue and complete its conquest of the material world. This implied colonial expansion and the subjection of Eastern peoples to Western needs and greed. The Western nations did not simply exploit and enslave their

Eastern brothers; they did much worse, they failed to appreciate their spiritual heritage and tried to deprive them of it; it was not enough for them to conquer their material goods, they wanted to conquer their very souls. We are today paying the cost of their greed and of their stupidity.

The Renaissance discovered or rediscovered the Western past, and carried out its investigation of Western humanities, including science, with great thoroughness. In spite of the fact that science was not excluded from their survey it was preëminently a literary survey; even the scientific investigations, or most of them at least, were textual investigations. The humanities dominated every field of endeavor and therefore the philologists were at the helm.[7]

The humanities are essentially historical: they represent the accumulated wisdom and poetry of past ages. Hence, we might say that the main peculiarity of the Renaissance was its negative orientation; its creative activities concerned the past. The true scientific spirit on the contrary is focused upon the future; it is not interested in things that have already been published, but rather on those which are as yet unknown.

Each of these opposite tendencies can be and has been carried too far. We must study ancient wisdom, Western and Eastern, but that is not enough. The best teacher is nature, reality. We must appreciate the work of our ancestors without whose efforts we would still be ignorant and graceless; we must revere the best of them but never follow them blindly. Reverence for the past is good, but reverence for the truth, whether old or new, is infinitely more important. Renaissance scholars had too much reverence for the past; we have far too little.

Ours is a golden age of science, which is fine, but it is also a golden age of technology, business, management, an age of overorganization and dehumanization, and that is ominous and degrading.

The Middle Ages were dominated by theologians, the Renaissance by humanists; we are dominated by technocrats and administrators. Is that better? Must it be the end? Whereto do the technocrats and the administrators lead us? They do not want war any more than other people, but the results of their greed and efficiency cannot be anything else. That is amply proved by the history of our own times.

Could we not make a new start? The quest for the truth should not be weakened in any way, but the struggle for efficiency and for profits

EPILOGUE

might be moderated and slowed up. It would suffice to admit that material profits are not as desirable as many good people have been led to believe, and that there is infinitely more virtue and glory in creating beauty, justice, happiness than in creating wealth.

Will the leaders understand that? I am afraid not. Fortunately, whatever their greed for power and wealth may be, there will always be room for artists, philosophers, men of science, historians, humanists, if these be satisfied, as they should, to live in a bare competency or better still in blessed poverty.

THE APPRECIATION OF ANCIENT AND MEDIEVAL SCIENCE DURING THE RENAISSANCE (1450-1600)

by

George Sarton

IESHR, Vol 3, No3

A.VI.3

Cultural and Social Constraints on Technological Innovation and Economic Development : Some Case Studies*

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One of the unforgettable creations of Lewis Carroll was the Cheshire cat which, as everyone knows, was in the habit of smiling and vanishing until one day only the smile remained, mysterious and incorporeal. Theories concerning non-economic and cultural variables in economic development have today reached a high level of rarefication and sophistication while the empirical basis has attenuated to such a point that one is strongly reminded of the Cheshire cat's disembodied smile. In this paper we shall discuss some of these theories in the light of some empirical data. We shall be concerned mainly with those theories which have immediate relevance to techno-economic change in underdeveloped countries. By making a few historial case studies of technological innovation in India we shall try to identify the cultural, social and techno-environmental obstacles to change.[1]

Since it is not our aim to make an inventory of the theories regarding economic development and social and cultural change we shall only briefly refer to those which appear to be most useful and germane to our problem. A seminal contribution was made by Max Weber who pointed out that economic rationality was a cultural feature specific to the technologically and economically advanced countries.[2] Weber contrasted this with purely traditional action which is habitual or routinised[3] and, therefore, resistant to innovation.

A more detailed breakdown of the components of traditionalism is offered by Talcott Parsons.[4] In terms of his pattern variables one can further develop the rational-traditional dichotomy. Thus one can contrast achievement orientation, universalism, and specificity with

* Paper presented at the Seminar on Social and Economic History held at the Indian Institute of Advanced Studies, Simla.

ascription orientation, particularism and diffuseness. Such contrasting concepts help to focus attention on the crucial differences between the economically developed and the pre-industrial societies. But these are artificial dichotomics representing two ends of a continuum. Naturally they do not exactly correspond to empirical facts. Moreover, historic... experience indicates that societies move along the continuum, e.g. from particularism towards universalism. A set of dichotomies is no... of much use if we aim to explain social-cultural change.[5] (Max Black)

A cultural anthropologist approaches technological and ... change as a process of acculturation. If we look at the historical cases of culture-contact between the east and the west in modern times we notice one outstanding fact: the technological superiority, including military superiority, which made European expansion possible. The rate of diffusion of this technology in the areas which came under European domination (or into European contact) varied from country to country. This variation is explained by a cultural anthropologist in terms of the nature and structure of the recipient culture-system into which innovations must be absorbed if they are to function in the new setting. Melville J. Herskovits is a prominent exponent of this approach — study of technical and economic change through the application of the theory of cultural dynamics.[6]

Some sociologists take a nearly idealistic position and emphasise the influence of varieties of mental phenomena on economic development. Joseph J. Spengler, for instance, holds that "the state of a people's politico-economic development, together with its rate and direction, depends largely upon what is in the minds of its members, and above all upon the content of the minds of its elites . . ." Thus "the content of the men's minds" is the "potentially dynamic element, as the source whence issue change and novelty, in a world or universe otherwise essentially passive."[7] An awareness of the role of ideologies, mores, and customs is a useful corrective to environmental determinism. But the other extreme position is equally indefensible: most sociologists take a midway position. Hoselitz for instance, while recognising the importance of non-economic and non-physical variables, also recognises the significance of the historical fact that with change in the material economic environment the value systems also change.[8] This standpoint does not concede primacy to mental phenomena in social change. Hoselitz makes a significant point when he says that behaviour which is "apparently irrational" upon closer examination of environment ...

straints is found to have very good reasons behind it.[9] This is borne out by some recent anthropological studies in India.[10]

It is unnecessary to itemise all the concepts and theories that the recent discussions on social and cultural constraints on economic development have thrown up. The question is, what light does the historical experience of our country throw on the problem? In this paper it is not possible to answer this question. We can, however, study a few cases of technological innovation and we shall try to raise a few questions about the current theories and to suggest some tentative hypotheses.

In trying to do so we shall have to cross the artificial boundaries which divide history from the neighbouring disciplines. The application of conceptual tools developed in the neighbouring disciplines for the purpose of studying economic history is likely to be, from the methodological point of view, an interesting exercise.

In the selection of cases of technological innovation for detailed study our aim was to select, subject to the constraint of availability of data, cases representing different spheres of productive activity in different regions of India.

Silky case spun by silkworm larva to protect it as a chrysalis

II

If one looks into the bills of lading of the East India Company's ships or the accounts of 'investment' relating to the last half of the eighteenth century one will notice that a distinction is made between "country wound" silk and "filature silk".. The latter term referred to raw silk wound with the help of European machines according to a technique introduced by Italian silk-winders ('filatora', Italian=spinning). The "native wound" silk was produced by indigenous methods.

Traditional technology

Before the introduction of the filature system, silk was wound with a few primitive implements. The silk-worms or the cocoons were placed in boiling water in earthen reeling basins heated with cow-dung fuel and silk thread was then wound off the cocoons upon reels made of bamboo; the reel, known as *nuttah* or *laya*, was fastened to a wooden spindle which the reeler twirled round with his hands.[11] The main faults of this technique were inequality in the thickness of the skein and frequent breaks which impeded operations in the weaving factory. The demand for "country wound" silk in Europe began to fall as Italian

Small bar with tapered ends used for twisting ... the thread

& loosely coiled bundle of yarn

and Spanish silk producers improved their techniques. The East India Company authorities were anxious to introduce some cheap reeling machine "suited to the genius of the country people" and sent some experts to Bengal for this purpose.[12]

In 1769 the Court of Directors decided to employ Italian craftsmen to introduce the modern filature machines and to train the Indian workmen. James Wiss, a native of Piedmont, was sent to Commercolly (or Kumarkhali), one of the important centres of silk production. He was helped by a team of Italian drawers and winders — J. Ruggeiro, Domenicus Poggio, C.F. Bricola and Augustus Della Casa. Three Italian craftsmen, Francis Clerici, Pielo Spera and Paulo Evra, were sent to the Rungpore *aurang* (manufacturing centre). Some more reelers from Nismes, Languedoc, were also employed. The aim was to introduce in all the *aurangs* in Bengal, the method of reeling of the Italian silk-winders of Novi. Tools and models were procured from Novi and London.[13] The machine introduced by Wiss in 1770 was moved by a winch. There was a furnace to heat the reeling basin. The Piedmont reel was larger than the Indian *nutta* and there was a mechanism for double-crossing and twisting the threads so as to give the silk a roundness and "a good body".[14]

Foreign technology

Crank of a wheel

Although the Italian technique was demonstrably superior to the "country winding' method, the filature system made very slow and halting progress. Unlike the country wound silk, the filature wound silk of Bengal could compete on equal terms with imports from Naples, Calabria, Aleppo and Valentia. The East India Company, therefore, aimed to gradually reduce purchase of "country wound" silk; in 1808 the Court of Directors decided on a policy of procuring only filature wound silk for export from India[15] From 1812 onwards the filatures set up by the company and private filatures taken over by the company, through long leases or outright purchase, stepped up production.[16] As a result of this expansion by 1823 the company found it possible to "convert the whole of its importation into filature wound silk", This was the result of more than fifty years of continuous effort.

The slow diffusion of the new technique was commonly explained by contemporary observers in terms of "native character". In one of their letters to the Silk Residents (i.e. East India Company's servants in charge of silk *aurangs*) the Bengal Board of Trade observed that the greatest obstacles to the innovation were "the wellknown habits and prejudices of the natives".[17] In the opinion of the Governor-General and his Council the native's bigoted attachment to ancient customs stood in the way of rapid conversion to the filature system.[18] Indian indolence and indifference to prospects of betterment were, according to the Chief Botanist of the Government, obstacles to any improvement in sericulture: "I know from long experience", writes Dr. Roxburgh, "that to avoid trouble the great body of the natives will forfeit many of their comforts"[19] Similar observations were made by almost all nineteenth century European authors who have written on the subject—Milburn, W. Nassau-Lees, Capt. T. Hutton, J.A.H. Louis, George Watt *et al*.[20]

We shall discuss later what the generalisations about "native genuis" are worth. But there can be no doubt that the Indian craftsman's attachment to ancient usages was reinforced by a marriage of myth and craft and that ubiquitous religiosity which affected every institution. In 1833 C. Shakespeare, the Resident at Sonamookhy, submitted to the Board of Trade a report on "the practices and prejudices of the Hindoo breeder of the silk worm". Since we have very little recorded information of this nature about the lower stratum of society in this period an extract from this report is given here. The *chassars* (i. e. the breeders of silk-worms), Shakespeare writes, "pretend to hold the insect in a degree of religious awe, and thus, as sacred, impose on themselves penalties for its salvation, handed down from one generation to another from time immemorial, which are strictly abided by in the progress of feeding the worm, more especially during the critical periods of the four ages, or sickness while moulting, during which the worm has reached two-thirds of its full growth, and until it ultimately closes itself in the pod. The intercourse of the sexes is forbidden. Girls (adults) and women, whether in their courses or parturient, are excluded. Men do not shave or perform their ablutions or oil their bodies, but remain clad in their dirty clothes. Fish, turmeric, garlic, onions, snuff, and tobacco, are prohibited, though they smoke outside their houses . . . To crown the whole conjuration, as a charm against evil spirits, an old shoe with a bundle of thorns in hung upon the *cheek* (Lattice-screen) of the door of the breeding-house". Shakespeare suggested that there might have been some substratum of rationality in the abstinence from tobacco, oil etc. "In Italy and France the breeders are particular in keeping their hands and clothes free from the taint of tobacco, snuff, garlic, onions and oils, as being dangerous poisons to the worm, pre-

cautions which the wily [sic.] Hindoo perverts to mysterious prohibitions, and the exclusion of others not initiated in the sanctity of his rites".[21] This description gives us a fairly good idea as to how thoroughly usages of the craft, mythical accretions and what, for want of a better name, has been called "religious awe" had intermingled. It is not surprising that this cultural feature appeared to the foreign innovators as the greatest obstacle to improvement of the craft.

But there were other factors which inhibited the rapid diffusion of the new technique. The new filature machines were not only unfamiliar, but also costly and complicated. The manufacture of some parts of the machine, especially the winch and cogwheel arrangement, required a higher degree of precision than the village blacksmiths and carpenters were capable of. They managed to produce a fair imitation of the machine in course of time.[22] But, unlike the European filature machine, the native imitation (which was, according to Buchanan-Hamilton, called *gayi*) had no mechanism for twisting the fibre as they were wound from the cocoon.[23] Thus the introduction of an innovation demands not only new skills from the primary participants but also a higher level of skill in connected areas of productive activity. The gravitational pull of a low general level of technique affects the area in which, through a particular innovation, technical efficiency is jacked up.

We must also note the fact that the introduction of the filature system ultimately led to a restructuring of economic relations through changes which, though not of fundamental importance to the society as a whole, were portentous to the *chassar*. The paraphernalia of the filature were so much more costly than the traditional *layi* or *nuttah*, rudely fashioned by the village carpenter, that the *chassars* could not afford them. Formerly the *chassar* or the women of his household could reel off the silk on the wooden reel. (In Japan also delicate-fingered women were supposed to be better winders than men). This "country wound" silk was procured by the East India Company's *pykars* (company's agents cum wholesale dealers). After the establishment of the filature technique, particularly after the decision of the company to purchase only filature silk for export, the predominant system was procurement of cocoons from the *chassars* through *pykars*; the cocoons were brought to the filatures owned or hired by the company or by private owners and the winding was done by *nacauds* (silk winders) who received very low wages.[24] "These *pykars* very often compelled the *chassars* to sell cocoons to them at their own prices. They added a handsome profit to these prices and then sold the cocoons to those

* significant

who were engaged in silk filatures. The role of the *pykars* was perhaps not so important in the production of Bengal wound silk".[25] Thus the *chassar's* position vis-a-vis the whole-sale dealer, the *pykar*, became weaker. Private capitalists set up small filatures; in the beginning of the nineteenth century Buchanan-Hamilton found many such filatures; they were let by the day.[26] In the 1870's we find the capitalists strongly entrenched in the business. Sir William Hunter noted that the raw silk industry was "conducted by capitalists entirely by means of hired labour". In most other industries the artisans enjoyed a greater degree of economic independence. "Weavers [of cotton textile presumably] work in their own houses, either on their own account or to order. Artisans either work for masters abroad, at a fixed rate of wages, or else carry on their work in their houses, and sell their productions to merchants". Compared to other industries there was a more "well-marked distinction between capital and labour" in the silk and indigo industries.[27] In the early 1880's the filature owners had established a complete ascendancy and the *chassars*, it is evident from Liotard's report, were at their mercy.[28] Some large European concerns of Calcutta had a network of filatures: Messers. Watson & Co. in Rajshahi, Midnapore and Maldah, L. Payen & Co. in Rajshahy, Murshidabad and Maldah, and Lyall & Co. in Murshidabad and Birbhum. *Chassars* in Rajshahi were "entirely in the hands of the European filatures of the district". Elsewhere there were native filature owners who, like the European filatures, bought cocoons from *chassars* through brokers. Whether the filature owner was European or native, the *chassar* was in a position of weakness for he had to sell at any price he was offered or see his cocoons spoilt.[29]

It is not our contention that the *chassar* could foresee all this. And one can only conjecture whether the *chassar* could understand the process which commenced with the separation of the use and ownership of the implements of production. But men are not normally blind to their interests. There can be little doubt that the *chassar* felt it in his bones that the new system weakened his position and increased his economic dependency vis-a-vis the *pykar* and the owners of the filature. And therefore the *chassars* did not welcome the filature system. But they slowly gave way, for the East India Company had all the resources at its command to push forward the filature system and the superior technical efficiency of the innovation was indisputable.

III

On March 14, 1794 the United States patent office granted a patent on a new machine for the ginning of cotton. The patentee was Eli Whitney, one of the originators of the interchangeable parts system which revolutionised the machine industry. The U.S. patent laws were only three years old and imitations of Whitney's ginning machine proliferated without any profit accruing to the patent holder. While people in the U.S. were stealing Whitney's design there were people abroad who were avidly curious about the new invention. A couple of months after the grant of the patent to Whitney the Court of Directors of the East India Company wrote to the Governor of Bombay about the "machine that has been invented for facilitating the operation for cleaning cotton from seeds and other foul particles".[30] The Directors were anxious to introduce this machine into India. Although the British cotton textile industry was expanding at a rapid rate the demand for Indian cotton was limited due to, among other reasons, indifferent cleaning.[31] Cleaning with the aid of the American gin, the Court of Directors believed, would enable the cotton of India to compete with American cotton in the Liverpool market. The increase of raw cotton import from India into England seemed very desirable to the East India Company: "If India can enter into successful competition for supplying the United Kingdom with a considerable portion of the raw material which constitutes the basis of her [U.K.'s] principal manufacture, it will be the means of bringing into cultivation wastes and jungles at present paying no [revenue] assessment; it will afford additional and permanent employment for the native population, create a medium of remittance... in lieu of that which it [Bombay] has lost by the cessation of export to Europe of Surat piece [i.e. textile] goods, and will operate to transfer to British ships and seamen a portion of the carrying of cotton, now for the greater part enjoyed by the shipping of other countries."[32]

In the first two or three decades of the nineteenth century the East India Company's sporadic and rather haphazard attempts to introduce the American gin in the Deccan were uniformly unsuccessful. The Court of Directors proceeded on the simplicistic assumption that if the machine was made available its use would spread: from time to time the Directors obtained gins from America through their agents and sent the machines to Bombay and Madras.[33]

The initial failures were mainly due to the total inexperience of the servants of the East India Company regarding the ginning machine.

The experiment conducted by the Bombay Government with gins sent by the Directors in 1817 failed because maladjustment of the machine caused injury to the staple.[34] The Bombay Government maintained that churkha was a superior machine![35] Even in 1829 Henry St. George Tucker could not obtain in England sufficient information about the gin and its method of operation; Tucker urged the Directors to facilitate "the multiplication of this machine."[36] The Court of Directors had to obtain written instructions from their agents in America.[37] Written instructions evidently did not suffice: in 1835 we find Ellenborough, President of the India Board, complaining that much of Indian cotton was spoilt by "the injudicious and inexperienced use of the saw gin".[38] However, in the 'forties the appointment of some botanical experts and the arrival of the American planters altered the situation. The Court of Directors decided in 1838 to hire experienced American planters to instruct the *ryots* in the methods of cotton cultivation and ginning. In 1840 ten planters were sent to India — three of them were sent to Bombay, three to Madras and the rest to Bengal. Vigorous efforts were made to induce the cotton grower to switch over to machine ginning.[39] But the availability of machines and technical expertise was not enough. The *ryots* clung to the indigenous cleaning tools with surprising tenacity.

In the Deccan two indigenous types of implements for cleaning cotton were in use. The simplest type was the foot-roller, known as the *payvatne* or *hattigudda* in Maharashtra. The cleaning was done, mostly by women and children, with some simple tools: an iron roller (*kuda*), a flat stone (*amkul*), two wooden soles (*pavuntigis*) and a three legged stool (*tevuntigi*). Cotton was placed on a flat stone and wooden soles were attached to the feet of the woman sitting on the stool; with her feet the woman rolled the iron roller backward and forward until the seed was separated from the cotton fibre which came out in a continuous web while the woman cleaned it of extraneous matters with her hands.[40] Although the process was slow and laborious the cleaning was thorough and no injury was done to the fibre (a defect inseparable from the faster mechanical means of cleaning).

The other indigenous cleaning method involved the use of a less simple tool known as the *churkha*, sometimes called the Madras *churkha* because it was commonest in that Presidency. The tool consisted of two wooden rollers with a small space in between: by rotating (by means of an endless screw) the rollers at unequal velocity the cotton, while passing through the rollers, was separated from the seed. Finnie,

an American planter who stayed for several years in Madras, and Drewett and Watson, engineers who experimented with the machine, found that the *churkha* cleaned cotton was cleaner than cotton cleaned by saw-gins. The only defect was that it turned out cotton-wool in a matted state with the fibre lying confused in different directions, causing trouble to the carders. The *churkha* and the foot roller were, of course, slow: the time factor was important because the exporters of cotton wanted to have it cleaned after the harvest as fast as possible before the outbreak of the monsoon made the unmetalled roads to the port unfit for use.[41]

From the point of view of technical efficiency, speed and outturn the Whitney gin was incomparably superior. It was known as the saw-gin because the cleaning was mainly done by means of wheels which were edged with teeth in the shape of saw-teeth; these separated the cotton fibre from the seed as the cotton passed through a narrow grating. The machine also contained a cylinder or roller (surrounded with brushes) which moved in the opposite direction from the wheels and brushed away the cotton from the saw wheels. The number of saw-wheels varied: machines used in India contained a smaller number of saws than those used in the United States. Those initially imported were all manually operated machines. Experiments made in Madras with gins turned by bullocks were not very successful. Steam-powered gins came into general use only towards the end of the nineteenth century.[42] We shall not try to pursue the story up to that point; let us try to identify the factors which obstructed and slowed down the diffusion of this innovation in the first half of the nineteenth century. Here was a machine which was efficient and relatively inexpensive and uncomplicated; it was being brought to the *ryot's* very door-step by American *sahibs* who knew the business of cotton growing and cleaning much more thoroughly than the English civilian *sahibs* who sat in the *adalat* or issued *hukumnamas* from a distant city; and, above all, it was sponsored first by the *Company bahadur* and then by the *sarkar* whom the *ryot* held in awe and reverence. Why did not the machine spread in the Deccan like wildfire, as it did in the cotton country elsewhere?

The stereotype of "native character" provided a ready answer which satisfied many people. Any attempt to introduce the ginning machine, the Governor in Council wrote from Bombay to the Directors in 1816, would be "altogether abortive" because "the general character of the people" was not favourable to innovations.[43] The Madras

Board of Trade observed that price incentives did not seem to work in India: the people, due to "indifference of habit", "show no great disposition" to take some trouble to gin the cotton to sell it at a higher price.[43a] "To supose that the natives of India, of themselves, will undertake any new scheme", wrote the Commercial Resident in the Ceded Districts to the Board of Trade in 1829, "is contrary to long and widespread experience. They are the children of very inveterate customs and prejudices... As to reasoning with the natives about the benefits of any new system or scheme, except in a very few instances, it is a vain attempt and a mere waste of time. They will coolly listen to such conversation, and then they will start the most absurd objections, give innumerable excuses, talk about their old customs, and at last go away determined not to try anything new".[43b] These are fairly typical statements: the official correspondence of the period is replete with vague generalities of this order.

There was, however, more to it than that. It is true that the *ryot* was not very prompt in responding to the opportunities created by the cotton programme of the Company. But this cannot be explained entirely in terms of the irrational mental bent, traditional inertia, non-material values or what have you. Behaviour which seems irrational from the standpoint of productive efficiency often has underlying reasons and when we examine those reasons the "apparent irrationality" disappears. [43c]

What were the reasons in this case? First, the Whitney gin, particularly the earlier models imported into India, were unsuited to the Indian cotton for the cotton-wool adhered to the seed more tenaciously than in the case of the American varieties.[44] If the gin wheels were adjusted very close to the grating to separate the seed, the staple of the Indian cotton was spoiled. As a matter of fact the American gin was suited for American cotton and was adopted in India in places (e.g. Dharwar) where the American cotton was naturalised. Secondly, the *ryot* lost about two percent in weight if he saw-ginned his cotton instead of cleaning it by *churkha*. Unless the gin-cleaned cotton could be sold at a higher price than *churkhaed* cotton the *ryot* was the loser. The brokers, however, were unwilling to differentiate in pricing between *churkhaed* and ginned cotton.[44a] Thirdly, transportation of the heavy cotton with seed from the farm to the ginning factory was expensive. It was cheaper to clean the cotton by *churkha* or foot roller locally and thus to reduce its weight before sending it to the town.

The *kupas*, or cotton with the seed in it, was about three-fourths heavier than the cotton wool by itself.[44b] Fourthly, at the *ryot's* level of poverty maximal use of the products of the soil was imperative and growing cotton was much more than just growing and selling cotton. The seed was used as cattle feed. Oil was extracted from the cotton seed. If the *kupas* was taken to the distant ginning factory the seed could be used by the *ryot*. The cost of carrying the seed back to farm after ginning, supposing the gin owner was willing to give it away, was more than the worth of the seed, so taking the seed back from the ginning factory was not economical.[44c] Finally, the initial capital expenditure and the operating costs of the ginning machine were beyond the means of the *ryot*.

The market situation was one of the biggest obstacles to conversion to the new method of cotton cleaning. When an American planter started a gin house in Aroopoocottah the local *ryots*, brokers and *chettis* were invited to see the operation. Everyone marvelled at the foreign machine but the brokers doubted if the saw-ginned cotton would fetch a higher price than the *churkhaed* cotton.[45] The *ryot* was deep in debt having taken advances from the broker on the security of the coming crop. The broker's margin of profit was low: he was dependent on advances from the European agent in the port or a banker. The broker insisted on the lowest possible price and not only was he indifferent to the proper cleaning of cotton but was also in the habit of deliberately adulterating the cotton to increase its weight.

The low-cost *churkha* for separating the seed from the cotton-wool was owned by almost every *ryot* family in the cotton country and "formed a regular wedding present to the bridegroom". The foot roller was cheaper than the *churkha*, and with the aid of these tools the women and children of the household could clean the cotton at a minimum cost. Before the introduction of the saw gin the dealers or *bukharies* (bukhar=warehouse) used to employ people to clean cotton: this had to be done as soon as possible after the harvest before the monsoon made the unmetalled roads unusable and the transport of cotton laden bullock carts to the port difficult. But the implement with which the cotton was cleaned belonged not to *bukhari* but to the people he employed for a season.

The imported American and English gin machine cost between £40 and £50 and the cheapest machines built on that model in India and fitted with imoprted saws cost £15.[47] The operating cost of the imported gin was also high — about double that of the indigenous *churkha.*[47a] Mr. Finnie, the American planter in Tinnevelley, pointed out that it was desirable to give the ryots a simple tool for their own use in cleaning their cotton.[47b] He found it possible to sell gin machines only to wealthy *zamindars* or brokers.[48] Simple and relatively inexpensive machines like Mather's improved *churkha* and the so-called cottage gin were marketed but even these were beyond the means of the ordinary ryot.[48a] When the imported saw gin came into general use the gin-owners, who paid the labourers according to the weight of cotton cleaned, had a complete control over the *ryot* and the labourer.[49] The gin operator became suddenly a key figure who could make or break the farmer.[50] The failure of a labour force, anchored to pre-industrial norms to internalise the norms of the new productive organisation during industrialisation is a well known phenomenon. We find numerous instances of this. James Petrie, an engineer who constructed many ginning factories in India, pointed out that the workers' indifference to the discipline of the factory was a grave problem: "if they ask for a (religious) holiday for a feast and you say no, they will take it... it is of no use opposing them.[50a] . The other problem, according to Petrie, was the lack of skilled workers for servicing the gins. The village artisans did not even know the use of screws and bolts and ruined a gin when they tried to repair it.[50b] The government's effort to organise the private gin owners in Dharwar to raise a common fund for the repair and maintenance of gins was not welcomed by the owners.[50c] It seems that the latter were not quite prepared yet for the new forms of organisation and cooperation appropriate to emerging productive system.

IV

The two technical innovations we have studied so far, the filature in sericulture and the cotton ginnig machine, met with success although the process of diffusion and adaptation was slow. The case we are going to study now was an abortive effort in the 1870's to improve the indigenous method of iron smelting. The indigenous furnaces, built of mud and stone, were five to six feet in height and were thicker at the base (three to four feet in diameter) and tapered towards the top. The inside of the furnace, i.e. the crucible, was a truncated cone measuring about fourteen inches in diameter at the base and four inches at the top. The inside wall of the crucible was lined with cowdung

and mud. The iron ore was broken up into very small pieces, mixed with charcoal (in proportion of 1:5), and poured into the heated furnace from the top. The blast, produced by bellows worked manually, was continued for twelve hours without break. After closing the tuyere holes the furnace was tapped to let off the slag. The wall of the furnace was broken open and the metal, in the form of a lump of cinder, was removed and hammered and rolled about on the sun-hardened earth. The entire operation (14 to 16 hours) produced only twenty to twenty-five pounds of rather impure iron. An English mining engineer (from whose Survey Report the above description is taken) wrote: "the smelting furnace used by Tubal-Cain [a Biblical personality, descendent of Adam, and the legendary instructor of artificers in iron] might have been different to the Indian furnace of the present day [Fryar was writing in 1872] in point of superiority, but it could not, I think, have been inferior to it, either in construction or in the mode of working it, and it is, to say the least, discreditable to engineers especially, and to others generally, who from the United Kingdom of Great Britain and Ireland have for so many years lived in India, and ruled over its people, that little or nothing has been successfully accomplished by way of improving or superseding the native methods of making iron....[51]

There were two schools of thought about the means of improving iron manufacture in India. Col. E. T. Dalton, the Commissioner of Chota Nagpur, typified the group which believed that the western techniques should be introduced all at once instead of making piece-meal improvements in the indigenous method of production. "I believe", Dalton wrote in 1872, "it would answer better to start civilized methods at once."[52] The other school of thought — we may take Fryar as a representative of this school — believed that this was "beginning at the wrong end of progressive stages of improvement in the art." Fryar contended that the "sure way to successful results is to gradually engraft improvements on the native methods of manufacture".[53] Such an attempt was made by two British engineers employed in the Geological Survey of India. It was expected that engrafting of European techniques on Indian manufacturing methods, "ascending gradually in magnitude of works, from elementary appliances, to the higher and more expensive mechanisms", would be "a process of sound education" to the native workmen. In Fryar's opinion the best means of educating Indian artisans was by example: if a workshop could be established under European supervision, "the example would be speedily followed by people in other parts of the country".[54] The engineers believed that the demonstration effect would spread new techniques more rapidly than any formal training or propaganda.

The main technical improvement suggested by Engineer W. Olpherts was the replacement of the belows with a fan, worked by a 10-horse-power engine: such a fan would provide blast, powerful and constant, simultaneously to 16 furnaces which would be placed in a row along the air-channel from the fan. Olpherts also wanted to improve the method of working up the iron by hammering: for this purpose he suggested imported steam-powered double-acting hammers. With these implements, without any radical change in the design of the indigenous furnace, it was expected to increase output and save labour by 75 per cent. Engineer J. Donaldson further suggested that the iron bloom might be procured from the native iron smelters and worked in the government workshops into simple agricultural implements and household utensils which would be easily marketable.

These were minor improvements based on the theory of "engrafting" modern western techniques on the indigenous methods by slow degrees. The efforts of Olpherts, Donaldson and Fryar failed completely. The method of iron working and smelting underwent no substantial change in the next six seven decades: this is evident from the reports of R. S. Hole (1898) and Varrier Elwin (1942). What were the obstacles to improvement?

One of the problems was that Olpherts' innovation would disturb the existing work-groups. The supply of blast to the indigenous furnace by bellows was a laborious process: "In drawing the bellows out to fill the air, the lips [wooden lips of the bellows] are kept open, then they are suddenly closed, and a skinful of air forced into the furnace. As the right hand bellows is pressed inwards, to discharge its load of air into the furnace, the lips of the left-hand one are opened and drawn outwards to receive its load, and vice versa; thus as the hand holding one skin closes up the lips and presses inwards, the hand holding the other opens the lips and draws outwards, and by this means a continuous blast is produced".[55] The mechanical fan would have saved all this trouble. But the smelters and blacksmiths were accustomed to work as a family unit: "often one sees the wife or the daughter working the skins for their relative".[56] This is evident from the traditional folk-songs of the Agarias. In one of their love-songs the boy sings to the girl: "Come to the forest and cut a green tree|Come to the furnace

and blow the bellows for me". A Chokh Agaria song describes an idyllic companionship in work: "She presses down the bellows with the strength of her heels|He wields the hammer with all his might".[57] If the mechanical fan was used the dependents of the family would no longer perform a useful function in the traditional pursuit of the caste. The new technique would disrupt the pattern of relationship established as a result of the family functioning as a work-group within a system of well-defined division of labour. Thus the new technique meant to the Agarias much more than a minor change in the process of iron-working. Moreover, the mechanical fans and hammers would be under-utilised unless a dozen or more furnaces were worked in the same place. Thus a large number of iron-smelters would have to work in one work-shop. The iron-smelters were unaccustomed to this mode of working: "the native iron-makers build their tiny furnaces in their native jungles wherever the ores of the metal can be easily procured" and they often abandoned the primitive mud-and-stone furnace and moved elsewhere in search of ore and fuel.[58] It was only to be expected that Agarias would resist any techniques which threatened to disrupt their traditional way of life.

The entry of the government in the manufacture and marketing of iron implements was bound to disturb the existing network of economic interests. Engineer Donaldson proposed the procurement of iron bloom from the Agarias and manufacture of implements in government workshops. The famous ethnologist Dalton was at that time the Commissioner of Chota Nagpur: he pointed out flaws in the plan which Donaldson, in his ignorance of the social factors, had overlooked. The iron-smelters of Chota Nagpur, the Agarias, were "a Kol or Munda clan of the most primitive type, exceedingly shy of strangers".[59] They passed on the iron bloom to the Lohars or the caste of blacksmiths. The Agarias, Dalton observed, "have always been in the habit of dealing with Lohars and will not take to new customers, and Lohars, who have influence over them, will do all they can to retain the monopoly". In the Central Provinces and districts in the neighbourhood the Lohars and occasionally the Agarias were, at least up to the first decade of this century, bound in a traditionally patterned reciprocal relationship. The Lohars received a certain amount of rice from each cultivator and in exchange for this annual contribution the Lohars repaired the agricultural implements whenever necessary.[60] Since the Lohars were supported by the villagers' contribution of grain and performed services in exchange, R. V. Russell designated them as "village servants".[61] "In places where the Agaria caste is to be found, the Agarias perform this duty [repairing agricultural implements] receiving in payment a small percentage of the harvest at harvest time. Elsewhere the Lohar is a regularly appointed village servant".[62] At any rate, it was very difficult for the government sponsored workshop to obtain crude iron from Agarias, to sell crude iron to the Lohars or to introduce any innovation which would upset the traditional relationship between them.

Even if the Government could overcome that problem there was some doubt whether the products of the government sponsored workshop would be marketable. This is why, Mark Fryar advised the Government, it was "exceedingly hazardous and unadvisable... to smelt iron ores and manufacture the metal into merchantable forms on a large scale as is done at various places on the continent of Europe and in America [which] requires the expenditure of so large a sum of money...[63] Engineer Olpherts observed that the only commodities which were assured of a steady market were *koosia* iron (native ploughshare) and *tawa* iron (cooking utensil). Even such simple products were not as readily "merchantable" as the engineer imagined. We may refer to an earlier episode. In 1840 the Govrnment of Madras was surprised and disturbed to notice that the Port Novo manufactory the Government had sponsored was making excellent iron ploughs but the native cultivators were not buying them. Upon enquiry the Madras Board of Revenue discovered that the iron ploughs "have been found useless from their weight",[64] A whole network of problems is connected with the question — the weight of the plough, the traction power of the cattle, the breed of cattle available, standard of maintenance of the animals by the owners, the feeding and pasturing of cattle, the method of transporting the plough from the farmstead to the field under tillage, the fragmentation of holding etc.[65] A single innovation had numerous and almost unforeseeable consequences and upset a precarious equalibrium. This case perfectly exemplifies Mackim Marriott's thesis that in India there are such "tight interconnections among techniques" that "the introduction of an additional new technique may disrupt or require readjustments in many old techniques".[66]

Finally, the myths surrounding Agaria craftsmanship and primitive inertia were also obstacles to innovation. Among the Agarias the methods of the craft had almost become ritualised. They were so "ignorant and superstitions", wrote Dalton in 1972, that there was "little hope of their being induced to alter the system which they have work-

ed on since the use of the metal was first discovered".[67] One can appreciate Dalton's pessimism when one looks at the web of ancient myths and magic which, it appears, bound the Agaria even in this century.[68] Every detail of the craftsman's operation such as making of charcoal, the manufacture of bellows, the use of a charge without flux etc. was sanctified and established in terms of ancient myths; no operation was complete without invocations to the deities, *Lohasur Baba, Koelasur, Agysur* and the ancestors; abstinence from sexual intercourse on the eve of important operations, magical tests for finding whether the omens were good or not, use of dreams and divination for locating the smithy, recitation of *mantras* and charms to obtain good iron etc. were indispensable. It has been suggested that the reason why the tribe clung so long to a demonstrably inefficient technique was that the technique was fully established in the myths and therefore regarded as unquestionable if not infallible.[69]

V

To categorise the different types of tradition-oriented behaviour we have observed in these cases, we might use the typology developed by Hoselitz.[70] This typology is in some respects similar to W. G. Summer's categories of folkways, though Hoselitz offers a more precise set of pigeonholes ranged along a continuum from the simple habitual behaviour (which are neither normative nor self-conscious nor formalized) to the most complex value-endowed forms of action. Thus Hoselitz has three criteria of differentation — normative nature, the extent of selfconsciousness, and degree of formalisation. This enables us to distinguish between (a) habit, (b) usage, (c) norm, (d) and ideology.

Habitual behaviour, unrelated to the value system, creates "a disposition toward certain forms of action which are relevant in a situation in which patterns of production are changed". We find an opposite instance of habits dysfunctional to new patterns of production from the experience of an English engineer who set up a gin factory and gin-repairing workshops in India. James Petrie was sent by the East India Company to Coimbatore and he worked, unaided by any European, with the help of India workers trained by himself. He found the Indian workers "very teachable and in very short time, they learned to make up the machines".[71] But certain habits of the workers were so ingrained that Petrie had to compromise with them. The Indian workers were, for instance, in the habit of squatting instead of standing while at their work: this made their adaptation to European machines difficult, for those machines were not designed for a squatting operator.[72]

To a nineteenth century western observer the binding force of usage (routinised action unendowed with any high value) seemed to be the most remarkable characteristic of Indian society. The Hindoo, Monier-Williams wrote wonderingly, "sleeps and wakes, dresses and undresses, sits down and stands up, goes out and comes in, eats and drinks, speaks and is silent, acts and refrains from acting, according to ancient rules".[73] Whether this was true or not, Indian craftsmanship was certainly characterised by the routization of certain methods: the craftmen were prone to do a job as their fathers used to do it and almost every movement was regulated by usages which were often reinforced by categorical imperatives derived from myths. Buchanan-Hamilton's report on his economic surveys in the first decade of the nineteenth century is replete with instances. We shall take a simple case. "Some of the curd-men (Dahiyars) boil it [milk] others do not, and adhere obstinately to their custom. A man whose father did not boil the milk when he was going to make butter, would incur severe disgrace, were he to introduce into his economy this inovation; and on the contrary he, who once has boiled milk, will on no account omit that operation..." Another interesting instance is the loyalty of members of the oil-presser caste to the mode of operation of each sub-group. Sir H. Risley noted that in eastern Bengal the *telis* extracted oil from *til* in a particular manner (boiling oil seeds in large vats) and any departure from the custom entails forfeiture of caste. Radhakamal Mukherjee was given a detailed description of the methods of extraction of the *gachua telis* who "will never think of using a mill with a [trickle] hole" and the *kalus*, another subcaste of the oil-presser caste, who invariably use a *ghani* (oil mill) with a trickle hole for the removal of oil. In more recent times Prof. Nirmal Kumar Bose observed in Seraikella (Orissa) a pattern of segmentation in the oil-presser communiy and the formation of sub-castes which, he thought, could in part be explained in terms of differences in the form and use of the implements of production. It is clear from his account of the sub-castes of the *ek-baladias* (the oil-pressers who employ only one bullock to rotate the pestle in the mill which has a trickle hole (the *do-baladias* (who employ a pair of bullocks and use a mill which has no hole) and the *shikhriya kalus* (who use a type of oil mill different in some respects from the mills used by the other two subcastes), how strong and uncompromising is the attachment of each group to the methods peculiar to each.

In the veneration for ancient customs myths played an important role. C. Shakespeare's description of "the practices and prejudices of the Hindoo breeder of the silk works" gives us some idea of the nature of craft myths. Similar instances have been given of the function of myths in the life and work of an Agaria.

The myths, magic and the blind acceptance of ancient customs retarded the diffusion of any technical innovation. But we must remember that the routinisation of craft-operations ensured a continuity in skill-transmission: it was an essential means of transmission in the absence of literacy and institutionalised technical training outside the caste-kinship network. Moreover, there was sometimes a substratum of rationality, although it was much overlaid with mythopoeic accretions. C. Shakespeare points out that customs similar to the Indian *chassar's* were observed by European cocoon growers to preserve the health of the silk worm. The myths are perhaps the particular idiom of a culture and a gap of empathy makes it difficult for us to judge their meaning in the culture-system to which the myths are integral.

Among the norms which controlled the peasant or the artisan the most important one was an ethical code inherent in the traditionally patterned interdependence. We have seen how the Agarias were unwilling to break up their traditional relationship with Lohars whom they supplied iron bloom. The Lohars and sometimes the Agarias were virtually village servants in parts of Central India, receiving portions of the harvest and rendering services to the cultivator. The economic relationship between the Agaria and the Lohar, as described by Dalton, was not perhaps as highly developed as the *jajmani* system. But in both the systems we notice some family resemblances in the bases of reciprocity in the discharge of functions of each group. In Bengal and Bombay the market forces had, perhaps, an eroding effect on this traditional relationship. It has been recently suggested that the cultivation of cash crops might have led to a new basis of economic exchange: Harper calls it the Malanad system and contrasts it wth the *jajmani* system described by Wiser. At any rate the network of economic interdependence gave the village artisan a security that sometimes outweighed economic incentives which in other circumstances would have removed his celebrated inertia.

In our case studies we have come across examples of intricate interconnections between techniques. The Port Novo iron-ploughs did not sell in the 1840's because of the low traction power of the cattle, inadequate feeding of the cattle, problem of carrying the heavy plough to the field and so forth. The ginning machines were at first quickly discarded because the village blacksmiths did not even know the use of screws and bolts. The filature machine could be very imperfectly copied by the carpenter and blacksmith. Apart from the bearers of an innovation and the immediate participants new skills had to be acquired at secondary levels. Moreover, at the sheer subsistence level the necessity of making maximal use of everything produced on the soil made innovation a complex problem, for the primary displacement gave rise to many secondary displacements and the over-all result might make the innovation uneconomic from the farm-unit's stand point. The use of cotton-seed for cattle-feed and oil explains the *ryot's* unwillingness to part with the cotton without extracting the seed. An inadequate appreciation of what we have called secondary displacements often led a foreign observer to infer that it was the "native character" or the pre-industrial mentality which was to blame.

We can think of an innovation in the sphere of productive activity as a longitudinal wave starting with certain inputs and leading to a predictable result. But in the cases we have studied the repercussions resemble spherical waves which touch society at remote and widely dispersed points and cause disturbances which are almost unforeseeable. This is perhaps the result of what has been called the "multi-dimensionality" of all social behaviour including economic activity in folk societies. This was a particularly striking feature of the Agaria way of life.

For some reason very little attention is commonly paid to one aspect of the process of substitution of simple and inexpensive tools with more effifficient and costly machines. It is our contention that the resistance of the *ryot* to the saw-gin or of the *chassar* to the filature machine was in part, perhaps largely, due to their unwillingness to accept the separation of the use and possession of the implements of productions. The new machines which the foreigners brought were owned by those who were not actual users of the machines but had the money to invest. It is well known how this happened in Europe, how as a result of "separation from the means of production" as Landes tersely puts it, "the workers become a hand". We have observed how a similar process was going on India: the strengthening of the control of the intermediary (the *pykar*, the cotton broker) over the producer and

the subordination of the producer to the gin owner and the filature owner. This transformation in the producer's position was con-comitant with the innovations. The producer's resistance to this transformation, rather than mere irrationality which is commonly attributed to them, might have been at the root of their resistance to innovation. It was not always rejection of change itself, but rejection of a change for the worse.

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10. Two brilliant efforts in this direction are Marvin Harris's easy on "The Cultural Ecology of India's Cattle' *Current Anthropology*. vol. VII, No. 1,

pp. 51-54, and MacKim Marriott's "Technological Change in overdeveloped rural areas" *Economic Development and Cultural Change* vol. 1, 1952-53, pp. 261-72.

11. James Wiss' note accompanying Court of Directors' despatch to Governor-General in Council at Bengal, 8 Apr. 1808. *Reports and Documents connected with the proceedings of the East India Company in regard to the culture and manufacture of cotton-wool, raw silk and indigo in India* (London, 1836) pp. 12. This collection of documents is referred to in the rest of the paper as R.D. Reports of Dr. Francis Buchanan-Hamilton on his Sarvey of Eastern India in 1807-11 have been used extensively in this paper, the reports were edicted by R. Montgomery-Martin *The History, Antiquites, Topography and Statistics of EasternIndia... surveyed under the orders of the Supreme Government and collected from the original documents at the East India House* (London, 1838). A description of native winding method in vol. II, p. 872.

12. R.D., iv. *et. seq.* In 1757 the Court of Directors sent Richard Wilder to Cossimbazar, the Company's chief "factory". In 1766 Joseph Pouchon succeeded Wilder who died in 1761. Neither of them succeeded in improving the indigenous reeling method.

13. *ibid*, xi. There were two Italian master craftsmen under whose supervision the others were to work: J. Wiss and W. Aubert. The latter died in Madras in 1771 before he could begin his work. The credit for introducing the Italian system in Bengal goes to Wiss of Kumarkhali and J. Robinson, an Englishman who directed the Italians at the Rangpore *aurang*. In 1776 Wiss and some of the Italians went home and they were replaced by J. Brigante, James Frushard and J. L. Baumgartner who arrived in Bengal in 1781 after an adventurous journey in course of which they were captured by the French and the Spaniards. *vide* R.D., xvii.

14. J. Wiss' instructions printed by order of Court of Directors. Court to Governor-General in Council, Bengal, 8 Apr. 1808. R.D., 12. Buchanan-Hamilton (Martin) *op cit.* vol. III, pp. 263-4; vol. II, p. 872.

15. Court of Directors to Governor-General in Council, Bengal, 8 Apr. 1808. R.D., 12.

16. Court of Directors to Governor-General in Council, Bengal, 2 June, 1812. R.D., 29.

17. Board of Trade to Silk Residents, 31 March, 1813. R.D., 62.

18. *vide* R.D., xiii.

19. Dr. Roxburgh, Superintendent of Company's Botanical Gardens, to Bengal Board of Trade, 23 Nov. 1812. R.D., 67.

20. Milburn *Oriental Commerce, loc. cit.* For his advocacy of an economic paternalism to guide the inert native see W. Nassau-Lees *Tea cultivation, cotton and other agricultural experiments in India* (London, 1863) pp. 184. Capt. T. Hutton on "the obstinate and caste-enchained ryots" in *Remarks on the Cultivation of Silk in India* (Cal. 1870). pp. 12-14. J. A. H. Louis *A few words on the present state and future prospects of sericulture in Bengal* (Cal. 1882) pp. 14-15. Sir George Watt on the "ignorance and deepseated inimical religious judice" of Indian people. *A Dictionary of the Economic Products of India* (Cal. 1983), vol. vi. Part III, "Silk" p. 60.

21. C. Shakespeare, Resident at Sonamookhy, to Bengal Board of Trade. 2 Apr. 1833. R.D., 149-50. Dr. Surajit Sinha found very similar practices among the Ho breeders of silk-worm less than ten years ago. (verbal communication).

22. R.D., 12 *et seq.*

23. Buchanan-Hamilton (Martin) *op. cit.* vol. III, pp. 263-4.

24. R.D., xxx, *et. seq.* cf. N. K. Sinha *The Economic History of Bengal* (Cal., 1956) vol. I, pp. 181, on the wages of nacauds.

25. N. K. Sinha *op. cit.* pp. 182.

26. Buchanan-Hamilton (Martin) *op. cit.* vol. II, pp. 872.

27. W. W. Hunter *A Statistical Account of Bengal* (London, 1876) vol. VIII, pp. 87. That Hunter's observations were true of all the silk manufacturing centres in general is evident from a near contemporary report by L. Liotard *Memorandum on Silk in India* (1883).

28. L. Liotard *op. cit.* George Watt *op. cit.* vol. VI, part II, pp. 29-31.

29. In 1916 the "Imperial Silk Specialist", H. Maxwell-Lefory conducted an enquiry; at that time there was not much English capital in the silk industry; Maxwell-Lefory had a great deal to say about the exploitative practices of the *Mahajan* or the *bania*. Vide *Report on an enquiry into the Silk Industry in India* (Cal. 1916) vol. I, pp. 4-5.

30. Court of Directors to Governor in Council at Bombay, 21 May, 1794. R.D., 15.

31. Court of Directors to Governor in Council at Bombay, 29 Aug. 1810. A.D., 36.

32. Court of Directors to Governor in Council at Bombay, 6 Mar. 1832. R.D., 216.

33. Governor in Council, Bombay, to Court of Directors, 20 Dec. 1817. Court to Governor in Council, Bombay, 27 Nov. 1818. Same to same, 4 Nov. 1829. R.D., 65, 81, 149.

34. Governor in Council, Bombay, to Court of Directors, 20 Dec. 1817. R.D., 65.

35. *ibid.* Governor in Council, Bombay, to Court of Directors, 30 June, 1931. R.D., 195.

36. Henry St. George Tucker's Memorandum on Indian Cotton, January, 1829. R.D., 167.

37. Court of Directors to Governor in Council, Bombay, 4 Nov. 1829. Same to Governor in Council, Madras, 18 Aug. 1830. R.D., 149, 183.

38. Ellenborough (President of the Board of Commissioners for the Affairs of India) to the Chairman of the East India Company, 27 Feb. 1835. R.D., 283.

39. J. Forbes Royle *On the culture and commerce of cotton in India and elsewhere* (London, 1851) pp. 240. J. Talboys Wheeler *Handbook to the Cotton Cultivation in the Madras Presidency* (Madras, 1862) pp. 29-30.

40. T. Drewett *Notes on cotton gins and cotton ginning* (Bombay, 1886) pp. 1-8 Wheeler *op. cit.*, pp. 19. *Gazetteer of Bombay Presidency*: Dharwar (Bombay, 1884) p. 366. *Gazetteer of Bombay Presidency*: *Sholapur* (Bombay, 1884) p. 230.

41. T. Drewett *op. cit.*, pp. 11 Forbes Watson *Report on cotton gins* (London, 1879) Part II, p. 201. T. J. Finnie's letter dt. 26 Jan. 1846. Wheeler *op. cit.*, pp. 94, 19.

42. Wheeler *op. cit.*, 19. Experiments were made in the late 1840's by Dr. Wight and Finnie with bullock-powered gin machines. Steam ginning came to Bombay earliest. Three steam ginning factories were started in Khandesh in 1860-65, but they were not very much used because they injured the staple. *Gazetteer of Bombay Presidency*: *Khandesh* (Bombay, 1880) pp. 158. Steam ginning started in Tinnevelley in 1894. *Madras District Gazetteer*: *Tinnevelly* (Madras, 1917).

43. Governor in Council, Bombay, to Court of Directors, 18 Dec. 1816. R.D., 61.

43a. Secretary, Board of Revenue at Madras to Secretary, Government of Fort St. George, 17 May 1819. R.D., 83.

43b. Commercial Resident in the Ceded Districts to Board of Revenue, Madras, 29 March, 1819. R.D., 95.

43c. *Vide* Bert. F. Hoselitz 'Problems of adapting and communicating modern techniques to less developed areas'. *Economic Development and Cultural Change*, II, 1953-54, p. 251.

44. T. Drewett, Engineer. *op. cit.* pp. 8. Memorandum by T. J. Finnie, American Planter, 16 Nov. 1847. Wheeler *op. cit.* p. 111. In the 1870's Maccarthy's gin, Manchester Cottage gin etc. were made to suit the special needs of Indian cotton.

44a. Parliamentary Papers. House of Commons 1947, vol. 42, pp. 387. Dr. R. Wight to Secretary, Government of Fort St. George, 29 Sept. 1945.

44b. *ibid.* Bengal Board of Trade to Bengal Government, 26 Oct. 1931. R.D., 199.

44c. *ibid.* T. J. Finnie's report from Tinnevelly, 26 Jan. 1946. Wheeler *op. cit.* p. 94.

45. T. J. Finnie's letter, 23 Sept. 1847. Wheeler *op. cit.* p. 124.

45a. *loc. cit.* *Cotton Supply Reporter*, 1 Jan. 1867. *Annual Report of the Cotton Supply Association, Manchester*, no. 5, Sept. 1862. *Report of Commis-*

sioners appointed...to enquire into the working of the Cotton Frauds Act (IX of 1863).

46. H. R. Pate *Madras District Gazetteer*: *Tinnevelly*, vol. I, pp. 213.

46a. Governor in Council of Bombay to Court of Director 18 Dec. 1816. R.D., 61.

47. P.P.H.C. 1847-48, vol. 9, cd. 511. Report from select Comm. on Growth of cotton in India. J.F. Royle's evidence, Q. 438.

47a. T. J. Finnie's letter 17 May 1947, J.W., pp. 135. The cost of cleaning a candy of 500 lb. of cotton with *churkha* was Rs. 4-14a.-8pp. and with the imported gin, Rs. 10-3a.-10p. It is not clear whether Finnie's estimates excludes overheads such as rent of the gin house, cost of superintendence etc. See also Finnie's letter dt. 11 Sept. 1849. J.W., 149.

47b. T. J. Finnie's letter 16 Nov. 1847. J.W., 111.

48. T. J. Finnie's diary 21 Oct. 1946 letter dt. 25 Oct. 1846, J.W., 116.

48a. J. F. Royle *Cotton Culture* pp. 540. J.W., 188. As the Bengal Board of Trade had pointed out, the women and children who formerly did the work of cotton cleaning "could neither afford to obtain, nor...understand the use of such machines". Bengal Board of Trade to Govt. of Bengal, 25 Oct. 1931, R.D., 199.

49. The gin-factories owned and managed by cotton dealers were known as *pirais* in Madras: each dealer employed 50 to 100 "coolies". *Mad. Dist. Gaz.*: *Finn.* vol. I, H. R. Pate, pp. 213-14. Steam ginning factories first started in 1894, were owned by big European concerns such as Ralli Bros., Dymes & Co., A & R. Harvey & Volkart Bros.

50. Vide S. Leacock & D. G. Mandelbaum "A nineteenth century development project in India: the cotton improvement programme". *Economic Development and Cultural Change*, vol. III, no. 4, July 1955, pp. 348.

50a. Parl. Papers, House of Commons. 1847-48, vol. 9, cd. 511, Q. 2180-82.

50b. *Gazetteer of Bombay Presidency Dharwar* (Bombay, 1884) pp. 370.

50c. *ibid.* pp. 371-2, 374.

51. M. Fryar, Mining Engineer attached to the Geol. Survey of India, 30 Jan. 1872 to Secretary, Government of India. Agriculture, Revenue and Commerce Dept. Proceedings of the Governor-General in Council. Sept. 1872. no. 5. (Appendix).

52. Ag. Rev. & Comm. Prog. Sept. 1872 no. 6, Col. E. T. Dalton, Commissioner of Chota Nagpur to Under Secretary, Government of Bengal, 19 July 1872.

53. M. Fryar. *Loc. Cit.*

54. *ibid.*

55. M. Fryar *Loc. Cit.*

56. *Loc. Cit.*

57. Verrier Elwin's translation. *The Agaria* (O.U.P. 1942) pp. 169.

58. M. Fryar's note.

59. Ag. Rev. & Comm. Prog. Sept. 1872. no. 6 E. T. Dalton to Under-Secretary Government of Bengal, 19 July, 1872.

60. W. N. Crooke *Tribes and Castes of North Western Provinces* (London, 1896) vol. III, pp. 380. R. V. Russell *Central Provinces District Gazetteer: Sugar pp.* 135.

61. R. V. Russell *The Tribes and Castes of the Central Provinces of India* (London, 1916) pp. 51.

62. F. R. R. Rudman *Central Provinces District Gazetteer: Mandla* (Bombay, 1912) vol. A. pp. 51.

63. M. Fryar's note *Loc. cit.*

64. Revenue & Agriculture Consultations 4 Jan. 1841 nos. 5-6. Madras Board of Revenue to Chief Secretary, Fort St. George, 19 Nov. 1840. Apropos of the reluctance to use the iron ploughs we may cite Verrier Elwin's account of the reluctance of the Baigas to use an iron plough since its use would repay with harshness the generosity of the land, tearing her breasts and breaking her belly. cf. Elwin *The Baiga* (London, 1939). This may well be the mythologisation—rationalisation in reverse—of purely material considerations such as those mentioned above in the text.

65. cf. *Indigenous Agricultural Implements of India: an all India Survey* (Indian Council of Agricultural Research, Delhi, 1960) ch. VI *passim*. This survey indicates that even today very little iron is used in the construction of indigenous ploughs.

66. Mr. Marriott 'Technological change in overdeveloped rural areas' *Economic Development and Cultural Change*, vol. I, Dec. 1952. pp. 261.

67. Ag. Rev. & Comm. Progs. Sept. 1872, no. 6. Col. E. T. Dalton to Under-Secretary, Government of Bengal, 19 July 1872.

68. Verrier Elwin *The Agaria* (O.U.P. 1942) pp. 173-81; pp. 86 *et. seq.*

69. *ibid.* pp. 86.

70. Bert. F. Hoselitz 'Tradition and Economic Growth' *Tradition, Values and Socio-economic Development* Eds. R. Braibanti & J. J. Spengler (Durham, 1961) pp. 87 *et. seq.*

71. Parl. Papers. House of Commons. 1847-48, vol. 9, ed. 511. Report from Select Committee. Q. 2053, 2180-82.

72. *ibid* Q. 2184.

73. Monier-Williams *Brahminism and Hinduism* (New York, 1891) pp. 352, quoted by W. G. Summer *op. cit.* pp. 92. I have been unable to check up the reference.

74. R. M. Martin *op. cit.* vol. III, Report on Purniya pp. 317-18.

75. Radhakamal Mukherjee *The Foundations of Indian Economics* (London, 1916) pp. 127-31.

76. Nirmal Kumar Bose *Hindu Samajer garan* [The Structure of Hindu Society] (Calcutta, 1949) pp. 60. ch. IV *passim*.

77. William H. Wiser *The Hindu Jajmani System* (Lucknow, 1936).

78. E. B. Harper 'Two systems of economic exchange in village India' *American Anthropologist*, vol. 61, 1959, pp. 760.

79. cf. MacKim Marriott *op. cit.* pp. 262.

80. *vide* Bert. F. Hoselitz 'Main concepts in the analysis of social implication of technical change'. *Industrialization and Society* (UNESCO, 1963) pp. 12.

81. David S. Landes 'Technological change and development in western Europe 1750-1914'. *The Cambridge Economic History* (Cambridge, 1965) vol. VI, pp. 276.

1914. §The Taxila Inscription of the year 136. J. F. Fleet. 992; 1915, 314.—F. W. Thomas. 1915, 155, 531.—R. Chanda. 1920, 319.—H. K. Deb. 1922, 37.
1915. A New Gaṅga Record, and date of Śaka 380. J. F. Fleet. 471.—L. Rice. 1919, 236.
1915. §Inscriptions in the Victoria and Albert Museum. L. D. Barnett. 337.
1915. §An Aramaic Inscription from Taxila. L. D. Barnett. 340.—A. Cowley. 342.
1915. §Sanskrit Inscription in the R.A.S. L. D. Barnett. 505.
1915. §*Agniskandha* and the Fourth Rock-Edict of Aśoka. S. K. Aiyangar. 521.
1916. Two Kharoṣṭhī Inscriptions (from Shāh-Dheri and from Taxila). F. W. Thomas. 279.
1916. §Archæological Work in Hyderabad, Deccan. J. F. Fleet. 572.
1916. §The New Aśoka Edict at Maski. L. Rice. 838.
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1918. §New Light on Ancient India. V. A. Smith. 543.
1919. §Khāravela. R. Chanda. 395.

Arts, Crafts, and Manufactures

1830. Gold Ring of Hindu Fabrication found at Montrose in Scotland [read 1830]. J. Tod. 559.
1836. §Cambay: its harbour, arts, etc. P. B. Lord. p. lxxvii.
1837. §Cultivation and preparation of cotton. Dr. Lush. Addenda, 17.
1839. On Iron. H. Wilkinson. 383.
1839. Indian Iron and Steel. J. M. Heath. 390.
1843. Introduction of the American plough into India. J. M. Heath. 92.
1843. Quarrying and Polishing Granite (among Hindus and Egyptians), etc. T. J. Newbold. 113.
1846. Indian Agriculture in the Bombay Provinces. A. Gibson. 93.
1861. Agricultural, manufacturing, and commercial resources of India. W. Balston. 416.
1863. Cost and Construction of Railways in India. J. C. Marshman. 397.

1875. A Jade Drinking Vessel of Jehangir. E. Thomas. 384.
1883. Suggestions of Origin in Indian Architecture. W. Simpson. 49, 545.
1888. Andamanese Music with Notes on Oriental Music and Instruments. M. V. Portman. 181.
1888. §Architecture in India. W. F. Sinclair. 272, 461.
1888. §Spellicans (game) in the Dīgha Nikāya. 303.
1888. §The Cross and Solomon's Seal as Indian emblems. 541.
1889. §The Kalasa or water-pot in Indian architecture. W. F. Sinclair. 690.
1893. System of Letter-numerals used in S. India. C. Bendall. 789.
1896. §Antiquity of Eastern falconry. W. F. Sinclair. 793.
1898. §The Indian boomerang. R. Sewell. 379.
1910. §Originality in Mughal Painting. A. K. Coomaraswamy. 874.
1911. §The Use of the Abacus in India. J. F. Fleet. 518.
1912. §Ginger. E. Hultzsch. 475; 1914, 93.—F. W. Thomas. 1912, 1093.
1912. §"A History of Fine Art in India and Ceylon." V. A. Smith. 508.
1913. §The Aṅgula of Six Yavas. R. Shamasastry. 153.
1914. The Kalās. A. Venkatasubbiah and E. Müller. 355.
1915. The Ancient Indian Water-clock. J. F. Fleet. 213.
1915. The telling of Time in Ancient India. F. E. Pargiter. 699.
1916. §An Indian Game: Heaven or Hell (with folding table). F. E. Pargiter. 539.

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1879. Specimen of the Zoongee (or Zurngee) Dialect of a Tribe of Nagas. Rev. Mr. Clark. 278.
1895. The Khamtis. P. R. Gurdon. 157.
1897. §Peculiar pillars at Dimāpūr in Assam, and Arakan. R. F. St. A. St. John. 423, 641.—W. F. Sinclair. 623.
1900. Aśwākrāntā, near Gauhati. P. R. Gurdon. 25.
1902. Languages spoken between the Assam Valley and Tibet. S. Konow. 127.

1906. Modifications of the Karma Doctrine. E. W. Hopkins. 581.
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1906. Studies in Buddhist Dogma: The three bodies of a Buddha. L. de la V. Poussin. 943.
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1912. Jātakas at Bharaut. E. Hultzsch. 399.
1912. §The Buddhist Monastic terms *samatittika*, *sapadana*, and *uttari-bhanga*. A. F. R. Hoernle. 736.
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1917. §Vajrapani in Buddhist Iconography. S. d'Oldenburg. 130.

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1827. Various Classes of Population, Trades, etc., in Bareilly [read 1826]. R. T. J. Glyn. 467.
1833. Disputation respecting Caste, by a Buddhist Ashu Ghosha. Translated by B. H. Hodgson. 160.
1833. Marriage Ceremonies of Hindus and Mahommedans in South India. C. Mackenzie. 170.
1833. Flag representing the Introduction of the Caste of Chalias or Cinnamon-peelers into Ceylon. A. Johnston. 332.
1834. Female Infanticide in Cutch. A. Burnes. 193, 285.
1834. The Country of Sindh: (Society, Government, Manners, Customs). J. McMurdo. 223.
1834. Account of the Phansigārs or Gang-robbers, and of the Shūdgarshids or Tribe of Jugglers. J. A. R. Stevenson. 280.
1837. Notes on the Thags. Lt. Reynolds. 200.
1858–60. Traits of Indian Character. W. H. Sykes. 223.
1861. Manners, Customs, and Religious Opinions of the Lurka Coles. W. Dunbar. 370.

1866. Social Condition of Natives of Bengal. J. Long. 44.
1884. The Pariah Caste in Travancore. S. Mateer. 180.
1894. Certain Features of Social Differentiation in India. J. A. Baines. 657.
1907. Marriage of Cousins in India. W. H. R. Rivers. 611.
1910. The Brahmins of Malabar. K. Ramavarma Raja. 625.
1913. §The Vrātyas. A. B. Keith. 155.

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1827. The Banyan Tree, as found in Greek and Roman authors [read 1824]. G. H. Noehden. 119.
1833. On White Elephants. J. Low. 185.
1833. Wild Dog of the West Ghats. W. H. Sykes. 405.
1833. The Kolisurra Silk-worm of the Deccan. W. H. Sykes. 541.
1837. §Oil and cordage plants of the Dekhan. W. H. Sykes. Addenda, 22.
1839. Some Indian Fishes. T. Cantor. 165.
1839. Cultivation of Cotton in India. J. M. Heath. 372. *See* 1837, Addenda, 17.
1843. Experiments on the Dhak Gond, an exudation of the Butea Frondosa. E. Solly. 145.
1846. The Fossil Fauna of the Sewalik Hills. H. Falconer. 107.
1846. Fossils found at the Island of Perim in the Gulf of Cambay. A. Bettington. 340.—Notes thereon. Prof. Owen. 417.
1850. (XII) Culture of China Tea Plant in Himalayas, 1835 to 1847. J. F. Royle. 125.
1862. Cultivation of Imphee in Bombay Presidency in 1860. N. A. Dalzell. 39.
1862. Production of Tea in Assam and India. J. C. Marshman. 315.
1862. Cultivation of Cotton in Dharwar District. J. C. Marshman. 351.
1878. Tea Cultivation in Kumaon and Garhwāl. J. H. Batten 131.
1888. §Animals classed as "deer" in the Jātakas. 542.
1892. §The Pummelo. G. Bonavia. 379.
1891. The Cātaka. E. B. Cowell. 599.

1912. §Imaginative Yojanas. J. F. Fleet. 229.
1912. §The Kambojas. G. A. Grierson. 255.—G. K. Nariman. 255.
1912. §The Yojana and the Parasang. J. F. Fleet. 462.
1912. §Some Hindu Values of the Dimensions of the Earth. J. F. Fleet. 463.
1912. §Ancient Territorial Divisions of India. J. F. Fleet. 707.
1913. §A Passage in the Periplus. J. Kennedy. 127.—F. W. Thomas. 420.
1913. §Proposed Identification of two S. Indian Place-names in the Periplus. W. H. Schoff. 130.
1916. §Map of the Earth. F. E. Pargiter. 537.
1916. §Some Notes on the *Periplus* of the Erythræan Sea. J. Kennedy. 829.
1917. §Some River Names in the Rigveda. M. A. Stein. 91.
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1918. §Udyāna and Urdi. F. W. Thomas. 311.
1920. Identification of the "Ka-p'i-li Country". V. A. Smith. 227.

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1827. Memoir of Sirmōr [read 1823]. G. R. Blane. 56.
1827. The Bhills [read 1824]. J. Malcolm. 65.
1827. Memoir on Bundelkhund [read 1825]. J. Franklin. 259.
1827. The Valley of Setlej River in the Himalaya Mts. (with remarks by H. T. Colebrooke) [read 1825]. A. Gerard. 343.
1833. Island and Bridge of Sivasamudram in the Caveri River. Rāmaswāmi Mudeliar. 305.
1834. The River Indus. J. McMurdo. 20.
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1843. Mineral resources of S. India: copper, 150; magnesite, 161; chromate of iron, 167; gold, 203; manganese, 212; lead, 215; corundum, ruby, and garnet, 219; diamond, 226. T. J. Newbold.
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1843. The Rivers Nile and Indus. T. Postans. 273.
1846. The Geology of Southern India. T. J. Newbold. 138, 213, 315; 1848, 1, 20; 1850, 78.
1846. From Peshawar to Shāh-Bāz Ghari. C. Masson. 293.
1846. The Manchur Lake, and Aral and Narra Rivers. T. Postans and R. C. Knight. 381.
1846. Report on Chota Nagpore. S. T. Cuthbert. 407.
1862. The Non-existence of "True Slates" in India. T. Oldham. 31.
1863. Topography of East and West Berar (*re* Production of Cotton). M. Taylor. 1.
1863. Reh Efflorescence of N.W. India, and waters of some rivers and canals. H. B. Medlicott. 326.
1870. Rashiduddin's Geographical Notices of India. H. Yule. 340.
1871. Malabar, Coromandel, Quilon, etc. C. P. Brown. 147.
1875. The Valley of Choombi. A. Campbell. 135.
1878. Geological Notes on the River Indus. G. W. Vyse. 317.
1884. Sites of Brahmanābād and Mansūrah in Sindh, and others. M. R. Haig. 281.
1892. §Prosecution of Indian Ethnography. 884.
1898. §Palk's Bay and Strait. D. Ferguson. 377.
1899. §"Chiniot" of Babar's first compaign in India. D. G. Barkley. 132.
1904. Hastivanj. H. Beveridge. 269.—G. A. Grierson. 537.
1907. §Capt. Thomas Bowrey. D. Ferguson. 672.—R. C. Temple. 1060.
1907. §The Khasis and the Austric theory. 743.
1909. §Dhamiāk and Bakrāla. G. Tate. 168.
1914. §Varendra. F. J. Monahan. 97.
1922. An unidentified Territory of S. India. K. V. Subrahmanya Aiyer. 161.

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Hinduism: ancient, to about 1000 A.D.

1827. The Philosophy of the Hindus [read 1823–7]. H. T. Colebrooke. 19, 92, 439, 549; 1830, 1.
1833. The Hindu and Theban Hercules. J. Tod. 139.
1833. The Vedānta System. V. Kennedy. 412.
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Sikhism

1848. (IX) The Civil and Religious Institutions of the Sikhs. H. H. Wilson. 43.
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VIII.

ECONOMIC SCIENCE AND STATISTICS.*

* Meteorological Statistics have been included in section I, and Statistics of Earthquakes in section II.

30

The Alloy for Gold is called Matam which is a Composition of 3 parts of Silver and 1 of Copper — Each Veesum (the weight of 1 gr) ~~addition~~ which of in lieu of as much loss of the original quantity of a color of gold. ~~(of any color)~~ Constitutes the loss of one color i. e. If 1. Veesum of Gold is taken from one Gold fanams weight ~~of gold~~ (6 grs) of the 10th Color and one Veesum of alloy (=Matam) be added it becomes of the 9th Color &ca —

The Palaces built by Hyder or his Son Tippoo are as much as I have seen all constructed after one plan of which however I do not feel myself in the least adequate to give a discription, — But as the brilliancy or liveliness of the colors with which they are painted have attracted the Notice of all who have had an opportunity of seeing them — — I think an account of the Colours will here not be in the wrong place.

The Gold color lavishly applied tho not a particle of ~~this or~~ any other Metal but Tin is used, is one of the best counterfeits in its Kind that can be imagined —

To make this Color, the following ~~compound~~ Articly for what is called Gunnah (brought from some Northern Countries) Must be got ready — viz. 2. Sur of Linseed Oil, 1 Sur of Chundra=:Som (Yellow Resin) 6 Drachms Dickamalie (Aloe soccotrina) 6 Drachms of Musambram a yellowish green Resin mixed with small bits of woods Burnt it smells much like Benjamin but as I got it from the Bazar like Asa foetida; — & 3 Drachms

of

Centre for Policy Studies Dharampal Archives CPS-EA-06 www.cpsindia.org of Kastoorie Kyssoo ~~or a fine. Kind of Turmeric~~ [This is by no means the Common Turmeric as the name expresses but probably the Curcuma rotunda Lin- Or the Amomum Zedoaria rotunda - The plant of which it is the bulb is not cultivated here but is brought by the Lingabaljies from ~~the~~ some more Western Countrys

In order to prepare the Gunnah take a mud pot. Coat the bottom of it with red Earth & after it is heated put the Resin (Chandrasam) in it and liquefy it - then mixed with the Linseed Oil which must have been Made to boil in another pot previously. Add then the rest of the mentioned articles finely powdered and boil ~~it~~ the mixture with a slow fire for about 2 hours, or until a drop taken out of it with a stick & put upon a plank may be drawn ~~out~~ when cool in ~~a~~ long ~~fine~~ thin threads.

Take then one Ser of Tin and beat it as thin as a Gold Leaf mix it afterwards with ~~a fourth part of a~~ one Quarter Ser of ~~by heat Liqui:fied~~ Glue liquified & mix and beat it together, untill it is a homogeneous mass ~~as equally Mixed as it possibly can be~~ - Wash it then with water and ~~add~~ keep it for use & after this ~~a piece of~~ add another small quantity of Glue ~~and Water~~.

In order ~~now~~ to make a Silver colour nothing is required but ~~the~~ to lay the just mentioned ~~mass moistened with a little water is to be rubbed~~ mixture of Tin & glue on the planks or Wall ~~where~~ & to rub it with

it.

~~it is required~~ with a Serpentine Stone until ~~a fine~~ the Silver Color appears. — and if a Gold Color is required — The Gunnah is at 3 successive days laid thinly over the Silver Colord Spot with a brush —

To Make a white colour take 4 parts of white lead and 1 of ~~Glue~~ Gum arabic mix it with water & when wanted, add as much water as sufficient to use it as a paint. —

To Make a Green color take 2 seer of linseed Oil & 1 Seer of Chandrasam, mix it as ~~before~~ mentioned of the Gunnah. Mix then lay ~~it~~ with a brush over the white & ~~then~~ powder ~~the~~ Verdigrees thro' a fine piece of Cloth over it. ~~[illegible]~~

A red colour is made by four parts of Zunnober & one of Gum rubbed together & mix'd with water when wanted for use —

For making a Pink Colour take white lead, Potie (cotton impregnated with a red water-color sold in the Bazar) & mix it with Gum Arabic and Water together —

Yellow is made by Orpiment 4 parts & one of Gum arabic — rubbed together with water —

~~Black is done with the Charcoals of the Cocoanut Shell mix'd with a little Gum & Water~~. For blue they take 2 parts of white lead & one of Indigo and mix it with Gum & water together

To Make the Ground for any Color take Sankasuddie or the finest levigated white Pipe Clay. mix it with a little ~~Glue~~ Gum & water & lay it on the wall or plank which ~~you wish to Color & then rub it~~ is to be color'd, rubbing it afterwards with a Stone until

Names of Grains &c.ca cultivated in the Bongalore District —

Linnaean Names.	English Names.	Telinga Names.	Canary Names.	Moor Names.
Cynosurus coracana	Natcheny	Choda	Raghie	Raghie
Paspalum frumentaceum		Aruga	Haraka	Kodara
Oryza sativa	Rice	Wadloo	Nelloo	Dhaun
Panicum pilosum		Wargoo	Barugoo	Barikee
Panicum italicum		Korra	Nalvinyl	Kogonie
Triticum aristatum	Wheat	Godam	Godhee	Khaun
Phaseolus Mungo	Green Gram	Pessara	Hesaroo	Moogo
Phaseolus minimus	Black Gram	Minumma	Pruddoo	Maash Wurtoo
Cytisus Cajan	Red Gram	Kanda	Togarie	Turvar
Dolichos Annuma		annuma	devara	Ballar
Dolichos Woolawa	Horse Gram	Woolava	Hurultee	Kulley
Cicer arietinum	Bengal Gram or Chick pea	Sennaga	Kadla	Harbarie
Verbesina Calendulacea	Oil Seed	Werrinuvva	Huchelloo	Rautel
Sesamum orientales	Gingelie oil Seed	Nuvva	Walleloo	Mitautel
Ricinum communes	Lampoil Seed	amadah	Harloo	Arandukatel
Carthamus tinctorius	Saflor	Casumba		
		cotarneer		
Arachis hypogea	Ground Nuts	Waroo Sennaga	Nelagallekay	Velautie Mungoo
Hibiscus esculentus		Benda		Bhendee
Tricosanthus cucumerina		Potla	Pohla	Chicondah
Cucumis acutangulus & Pentandrius		Neeny & Shity Bheerakay		Turay
Trigonella faenu graecum		Mentaloo		Methee
Phaseolus aconiti folio affinis		Kavraundoo		

until it becomes quite smooth) After this is dry the before
mentioned colors are laid. — Frame.

R? ST|233|53. 1962-3. Bangalore

A.VI.F

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ABBREVIATIONS

A.B.O.R.I.	Annals of the Bhandarkar Oriental Research Institute, Poona.
A.I.O.C.	All India Oriental Conference.
B.V.	Bharatiya Vidya, Bombay.
I.C.	Indian Culture, Calcutta.
I.H.Q.	Indian Historical Quarterly, Calcutta.
Ind. Ant.	Indian Antiquary, Bombay.
J.A.	Journal Asiatiquè, Paris.
J.A.O.S.	Journal of the American Oriental Society, New Haven.
J.A.S.B.	Journal of the Asiatic Society of Bengal, Calcutta.
J.R.A.S.	Journal of the Royal Asiatic Society, London.
M.R.	Modern Review, Calcutta.
P.O.	Poona Orientalist, Poona.
Z.D.M.G.	Zeitschrift der Deutschen Morgenländischen Gesellschaft.

———————

REVIEW

Scientific Healing Affirmations: By Paramahansa Yogananda. Published by Self-Realisation Fellowship, Los Angeles, California, (U.S.A.) pp. 76, Price 75 cents.

The book is intended as a practical guide mainly for the members of the Self-Realisation Fellowship. The first part of the book deals with the theory of healing and the second part with scientific healing affirmations. The healing of the body, mind and soul by means of proper training in the use of will-power, feeling and reason is the principle on which suggestions by way of affirmations are offered. The author maintains that one can acquire power over life-energy by auto-suggestions and various affirmations which stimulate the power of will, faith and reason. The affirmations are in the nature of Vedic hyms where man prays to the higher powers to free him from physical ailments, mental suffering, emotional unrest etc. The author has attempted a combination of some of the salient features of the yōga system with the present day psychological methods of concentration and training in the attitudes of mind.

The following are some of the affirmations.

"Heavenly Father, Thou art mine for ever
In everything that is good I worship
Thy presence. Through the windows
Of all pure thoughts I behold Thy goodness." (page 51)

"Home I came in shadows dark,
Home I came with matter's muddy mark.
I am blind; Thy light is there
It is may fault that I cannot see
Beneath the darkness line
Thy light doth shine
Thy light doth shine." (page 55)

"Heavenly Father, Thy cosmic life and
I are one. Thou art the ocean;
I am the wave: we are one." (page 56)

"My vagrant thoughts against me stood,
And held my mind from reaching Thee.
Teach me to own again, oh, own again,
My matter-sold mind and brain,
That I may give them to Thee
In prayer and ecstacy
In meditation and reverie." (pages 63-64)

The book is well-written and the get-up is very good.

J. Rudrappa

Page

Rev. letter from Bengal dated 4 July 1817 paras 130 @ 136 } 1 @ 5

25 1816. Complaints preferred by European Distillers, who recommend a mode for redressing their grievances } 7 @ 22.

AVI. 8

Certificates of several Medical Men tending to shew the bad effects arising from the use of Arrack – one of these, Dr Luxmore, states the mode of manufacture, & gives an Account of several Experiments he has made on Rabbits. } 22 @ 48.

10 Aug. – App.t of a Commee for investigating the qualities of native Spirits, with directions for their guidance } 49 @ 53.

—— Medical Board directed to afford every assistance in the prosecution of the enquiries —— } 54 @ 55.

19 Septr – The Medl. Bd submit their opinions on this subject; with hints for a proper conduct of the Investigations. —— } 55 @ 75.

3 Novr – For the avoidance of delay, the Commee are informed that the presence of all the Members is not necessary to proceed in their operations. } 75 @ 78.

16 —— Mr Trower appd Collr of the 24 Pergunnahs & Member of the Arrack Committee —— } 78 @ 80.

The Commee informed of the above, & expedition in the enquiries enjoined —— } 80 @ 82.

25 —— apply for Documents & recommend the Appt. of Messrs Williamson & Young in consequence of Mr Reynolds' departure for Europe } 82 @ 85.

29 — Acquiescence in the above —— 86 @ 87.

20 Febry 1817. Detailed Report of the Commee shewing the fallacy of the grounds assumed by the European Distillers & the several Medical Men, & proving that the N. Arrack does not possess those poisonous qualities ascribed to it – Enquiries were instituted with respect to the European Rum, the Copper & Pewter Vessels required in making } 87 @ 137

which, are supposed to injure it considerably. Recommend a similar prohibition to that enforced in the W. I. Islands against the use of new Rum ——

Page

Meetings of the Committee

25 Nov.^r 1816 Addressed the letter to Gov.^t entered at page 25 —— 231 @ 235.

6 Dec. — After reading the remarks of Mess^rs Blaquière & [illegible], D^r Williamson & M^r Young were requested to make Chemical Experiments on the Arrack —— 235 @ 248

9 —— Examination of two Native Spirit Venders —— 248 @ 262.

11 —— M^r Young mentions a circumstance of proposed substitution of Arrack for Rum in the supply to an European Reg.^t – More Native Venders examined —— 263 @ 281.

16 —— M^r Young submits the result of his Chemical Exp.^ts – the examination of Venders & Distillers continued – & a letter addressed to the Judge of Beerbhoom to obtain information respecting Baker Balls —— 281 @ 300

20 —— The Contents of four Bottles N. Spirits bought by L^d Moira's Servant proved to be Rum – proceed in the questioning of Distillers —— 300 @ 316.

23 —— Interrogation of D^r Luxmore & another Distiller – 316 @ 328

17 Jan.^ry 1817 M^r Featherstone, Surgeon of H. M. 24^th Reg.^t questioned as to the deleterious effect of N. Spirits – Translation of the Examinations of Baker makers – Rep.^ts of D^r Williamson & M^r Young —— 329 @ 384

Letter from Government

5 April – Gov.^t remark on the Report furnished by the Commee demonstrating the non-existence of Deleterious Ingredients – highly approve of the zeal displayed throughout the Investigations, the information resulting from which will prove of the greatest consequence – the Committee is dissolved —— 385 @ 393

[IOR: Boards Collections Vol. 611]

List of the Ingredients of the Baker Balls

	Seers	Chittacks
Bark of Otta Tree	15.	—
do of Bhate Tree	—	4
do of Doodeh Tree	—	4
do of Shurrum Tree	—	4
do of Cotta Moob Tree	—	2
Loll Sueie (a Wood)	—	4
Reer Somadah (a Wood)	—	4
Besolan — (D:)	—	4
Yoopee — (do)	—	2
Bark of Mapa Moodie	—	4
do of Roorootchee	—	1
do of Sookoon	—	1
do of Chalookoi	—	1
do of Ribeltee	—	1
do of Sal Poijee	—	1
do of Uagor	—	1
do of Bale	—	1
do of Goleincha	—	1
do of Roorkooallee	—	4
do of Haroah	—	2
do of Jeetee	—	2
do of Barsae		2
Leaves of Carroobee flower	—	1
do of Boollee		2

Leaves

	Seers	Chittacks
Leaves of Cheeta		1
Hatooee (a Wood)		4
Yeopolnee (Do)		4
Cuilmeg (Do)		1
Cheer Cheriah (Do)		1
Choochia Nut (stock of)		1/2
Anuntmool (Root)		1
Ekermool (do)		1
Autsurree (Wood)		2
Bhautu (do)		1
Chilly (Capsicum)		1
Echsenee (Wood)		1
Leaves of Akund		1
Yadeva (Wood)		1
Boylab (Do)		1
Bangjutta (Do)		1
Leaves of Juroeta		1
Fruit of Doltoreh		1/2

Seesterroh

	Seers	Chittacks
Jecaterroh — (Wood)	–	1
Conticarry — (D°)	–	1
Bark of Ohkund	–	1
– D° – of Chekkur Ratch		1

These Ingredients are to be well beaten to powder, after which the following Spices are added, also well pounded. —

Geera (Country Carraway Seed)		1
Mouree		1
Peepoolee		1
Chye		1
Black Carraways		1
Norkoolee		1
Tyj Pattah		1
Cuchur		1
Gundonotta		1
Cardamum		1

Dinnoowch

	Seer.	Chittaks
Dunnoowek		4
Mouree		4
Soolop		4

The subsequent process is stated in the Depositions. The whole of these Ingredients cost fourteen annas —

they

(pp 349) They sell them when prepared for Rs 1-4 a

(pp 341) ball of two markers each

regissent les mouvements de la langue y ont leur insertion; soit que la langue refroidie eût déja perdu sa vitalité, qui ne dure gueres long-tems dans les muscles des animaux à sang chaud, comme j'ai déja fait observer, (sect. 26.) et particulièrement dans la langue.

Je suis, &c.

A. VOLTA.

Octobre 25, 1792.

V. *Further Particulars respecting the Observatory at* Benares, *of which an Account, with Plates, is given by Sir* Robert Barker, *in the LXVIIth Vol. of the Philosophical Transactions. In a Letter to* William Marsden, *Esq. F. R. S. from* John Lloyd Williams, *Esq. of* Benares.

Read January 31, 1793.

DEAR SIR,

In conformity with your request, I have now the pleasure of sending you an account of the measurement of the different parts of the Benares observatory, called *maun-mundel*, as taken by myself, with a two-foot rule, and a rod of ten feet very exactly divided. An account of the use of the different instruments, though very imperfect, was given me on the spot, by several learned Brahmins who attended me; one of whom is professor of astronomy in the new founded college at Benares. They all agreed that this observatory never was used, nor did they think it capable of being used, for any nice observations; and believe that it was built more for ostentation, than the promotion of useful knowledge.

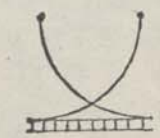
In my inquiry into the particulars of the building, I have been assisted by my friend the Nabob ALI IBRAHIM KAUN, and I believe this account may be relied on.

A.* The large quadrant, called in Arabic, *kootoop-bede*; in Hindoo, *droop*, the name of the north polar star. This instrument is built of stone, fixed in mortar, and clamped with iron in a very clumsy manner; between most of the stones are spaces of $\frac{1}{16}$ part of an inch. The stile, in its length from north to south, measured 39 feet $6\frac{1}{2}$ inches; the height of the south end, 5 feet $4\frac{1}{4}$ inches; height of the north end, 22 feet 3 inches. This stile consists of two walls $11\frac{1}{2}$ inches thick, with a flight of 27 steps between; and on the outer edge of each of these walls are fixed two iron rings. The distance between the two rings is 5 feet $8\frac{1}{2}$ inches; from the uppermost to the top, 18 feet 8 inches; from the lower one to the bottom, 15 feet and $\frac{1}{2}$ an inch; both sides are nearly alike. The rings are, each of them, $\frac{3}{4}$ of an inch in thickness, and they are let into the wall between two stones; the holes through which the object is to be viewed are $\frac{5}{16}$ths of an inch in diameter, $\frac{5}{8}$ths of which space, in each, is covered by the projection of the stone. The radius of one of the quadrants, on which the hour lines are marked, from the outer part of the wall of the stile to the inner edge of the arc, is 9 feet and $\frac{3}{4}$ths of an inch; that of the other, 9 feet one inch. The width of the rim of the quadrants, which are inclined to a line perpendicular to the shadow falling from the gnomon, is 5 feet $10\frac{1}{4}$ inches. The quadrant is divided into 6 *gurries*, and each *gurry* into 10 *pulls*.

On the outer wall of the stile, fronting the east, at the

* The references are to the plates annexed to Sir ROBERT BARKER's account.

height of 10 feet and 10 inches from the base, are fixed two iron pins, each forming a centre, from which circular lines are drawn, intersecting each other, as in the annexed representation;



with a parallel line drawn underneath, which has the hour, or *gurry* and *pull* lines marked on it. The wall is plastered; and there are, on other edifices fronting the east, similar lines drawn; the use of which, I understood, was to ascertain the time of the day.

B. An equinoctial dial, called *gentu-raje*.—It is a circular stone, fronting north and south, but inclining towards the south. The diameter of the south face is 2 feet $2\frac{3}{4}$ inches, a perpendicular line falling from the top will give one foot distance from the bottom of the inclined plane. In the south front of this stands a small stone pillar, distance 3 feet 8 inches; a line drawn from the centre of this dial to the point on the top of the pillar, will, by its shadow, give the time of the day. On the *nadir* side of this dial, the stone is 4 feet 7 inches diameter; on the centre of which is a small iron stile, with a hole in it, perpendicular to its plane; and in the perpendicular line of the chord are placed two small irons. A line passing through the hole in the stile, and each end applied to the forementioned irons, gives a shadow, which denotes the hour, &c.

C. A brass circle in the line of the equator, facing north and south. It has a moveable index, turning on a pivot in the centre; the circle is divided into 360 degrees, or *unse*, subdivided again into 60′, and again into 6″, and into $\frac{1}{4}$ths. This instrument is called *cund-brit*, or *cranti-brit*, but I could not learn the use of it.

D. A double circular wall, with a round pillar in the centre, as described by Sir ROBERT BARKER. The floor being broken, and uneven, renders the height of the outer wall irregular, but it measured from 8 feet 1 inch, to 8 feet 3 inches; diameter inside, 27 feet $6\frac{1}{2}$ inches; thickness of the wall, 2 feet. The inner wall is 18 feet within; thickness of this wall, 1 foot $5\frac{1}{2}$ inches. The diameter of the centre pillar, 3 feet $7\frac{1}{2}$ inches.

At the four cardinal points, on the top of the outer wall, are four iron pins, with small holes in them, through which, the Pundits say, wires are designed to be drawn at the time of observation, which wires intersect each other at the centre of the pillar. The tops of both the walls are graduated, or divided into degrees; and it is said, that by the shadow of these wires falling on the walls, the sun's declination is found.

In addition to the foregoing, which are described in the plates alluded to, on the south-east quarter of the building is a large black stone, 6 feet 2 inches diameter, fronting the west; it stands on an inclined plane. I could not learn the use of this instrument; but was informed that it never had been completed. There is no other building of any consequence, nor does it appear there ever was.

I fear, that from the want of sufficient knowledge of the science of astronomy, I have not been able to describe the

different instruments, and their uses, satisfactorily; however, you may rely on the measurements being taken with the greatest exactness.

For the following description I am indebted to our chief magistrate, the Nabob ALI IBRAHIM KAUN.

"The area, or space comprising the whole of the buildings and instruments, is called in Hindoo, *maun-mundel*; the cells, and all the lower part of the area, were built many years ago, of which there remains no chronological account, by the Rajah MAUNSING, for the repose of holy men, and pilgrims, who come to perform their ablutions in the Ganges, on the banks of which the building stands.

"On the top of this the observatory was built, by the Rajah JEYSING, for observing the stars, and other heavenly bodies; it was begun in 1794 Sumbut, and, it is said, was finished in two years. The Rajah died in 1800 Sumbut.

"The design was drawn by JAGGERNAUT, and executed under the direction of SADASHU MAHAJIN; but the head workman was MAHON, the son of MAHON a pot-maker of Jeypoor. The pundit's pay was five rupees per day; the workmen's two rupees, besides presents; some got lands, or villages, worth 3 or 400 rupees yearly value; others money."

I am, &c.

Benares
March 25, 1792.

J. LL. WILLIAMS.

CHAPTER XV.

CONCLUDING OBSERVATIONS.

The purpose of the writer has now been accomplished, namely, to place before the reader some simple account of the nature and peculiarities of Hindu Astronomy.

No doubt much has been omitted which might have been advantageously inserted for a complete appreciation of the subject, but it is hoped that sufficient has been stated to present a general sketch which may enable those interested to retain a grasp of its principal features. It may, however, be desirable before leaving the subject, to offer a few remarks even at the risk of repetition.

The author's object has been, in the first place, to point in some measure to, and emphasize, the extreme antiquity of the science of Astronomy, as found in India: secondly, to give such a description as to enable the general reader to note not only the similarities to, but also the differences from, the astronomical science of the West, with a view, by such comparison, to form his own estimate of the origin of the one system, or of the other: thirdly, to show that even in the Paganism and mythology of the Hindus there is a substratum of worth so far as these are connected with their system of Astronomy.

Upon the first point (the antiquity of that system), it may be remarked, that no one can carefully study the information collected by various investigators and translators of Hindu works relating to Astronomy, without coming to the conclusion that, long before the period when Grecian learning founded the basis of knowledge and civilization in the West, India had its own store of erudition. Master minds, in those primitive ages, thought out the problems presented by the ever recurring phenomena of the heavens, and gave

birth to the ideas which were afterwards formed into a settled system for the use and benefit of succeeding Astronomers, Mathematicians, and Scholiasts, as well as for the guidance of votaries of religion.

No system, no theory, no formula, concerning those phenomena could possibly have sprung suddenly into existence at the call, or upon the dictation of a single genius. Far rather is it to be supposed that little by little, and after many arduous labours of numerous minds, and many consequent periods passed in the investigation of isolated phenomena, a system could be expected to be formed into a general science concerning them.

Further, as Bailly has truly remarked, Astronomy cannot be numbered among those arts and sciences which in a more peculiar manner belong to the sphere of imagination, and which by the wonderful energy of vigorous and splendid genius are often brought rapidly to perfection. It is, on the contrary, by very slow advances that a science founded upon the basis of continued *observations*, and profound mathematical researches, approaches to any degree of maturity. Many ages, therefore, must have elapsed before the motion of the sun, moon and planets could be ascertained with exactness; before instruments were invented to take the height of the pole and elevation of the stars; and before the several positions in the heavens could be accurately noted on descriptive tables or a celestial globe.

It is in the light of such considerations as these, that the investigator of the facts relating to Hindu Astronomy is compelled to admit the extreme antiquity of the science. As far back as any historical data, or even any astronomical deduction, can carry the mind, the conception of the ecliptic and the zodiac is presented to view in a system. It is very reasonable therefore to infer that an unknown number of centuries must have elapsed previously, during which the primitive philosophers established their ideas in the connected manner indicated in the conception referred to. The same observation and inference may be applied to the reasoning powers brought into play in the science of mathematics and kindred subjects, in which even in their most abstruse aspects, the Hindus, at any rate amongst the higher and more educated castes, have shown a deeply reflective capacity. In some quarters, an attempt has been made to minimise these faculties upon grounds which, in the opinion of the present writer, are not only inadequate, but which show in the critics themselves a want of appreciation of the true merits of Hindu Astronomy. An impartial investigation of the crcumstances relating to the question whether the Grecian Astronomy (which is the parent of our system), was original in its nature, and was copied by the Hindus, places it beyond doubt that the Hindu system was essentially different from and independent of the Greek.

Some of the dissimilarities, as well as some of the similarities in the two systems have been shown in the preceding chapters. As to the former, it may be truthfully asserted that nothing like the *fixed* ecliptic with its fixed concomitant arrangement of lunar Asterisms is to be found in the Ptolemaic and later systems. Neither do we find in these latter, anything like the method employed by the Hindus in estimating long periods of time, nor that of determining longitudes of the sun, moon, and planets from their position in a Nacshatra. Moreover, it is only necessary to refer to the method adopted by Hindu Astronomers for determination of longitudes by the calculated rising of the signs, and used also in finding the horoscope, and the nonagesimal point, and the culminating point on the ecliptic; there is no such method in our system. Even the process of calculations employed in regard to everything stated in Siddhantas, appears to exhibit a fundamental difference in the Hindu system, from processes employed in the science of the West. Again, it may be asked, where is there anything similar to the Palabha, or equinoctial shadow of the gnomon, used in that system, as an equivalent for the latitude of a place, and where is there anything like the formula entitled the Valana, in the projection of an eclipse?

Further, is there anything with us corresponding to the Hindu radius, estimated in 3,438 minutes of arc? These are unique, and go far to establish the contention that, whatever be the origin of the Hindu system, it certainly was not, in these and other particulars, copied from the Grecian or any European system.

Lastly, it has been the author's desire, by the preceding explanations, to dispel some of the supercilious ridicule cast by some Western critics upon Hindu methods of dealing with astronomical time, and upon their mythology. Such ridicule would appear to be unmerited, since the subject of it has been misunderstood. So far from the extraordinary numbers of years employed in computation by Hindu Astronomers being absurd, it has been shown that they were absolutely necessary to their peculiar system and methods, for ensuring accuracy. The astronomical mythology, likewise, of the Hindus, grotesque and barbarous as some of their stories may appear, had within it much that was valuable in point of instruction. No nation in existence can afford to compare its latter day tenets of science with its earliest theories and cosmography, without a smile at the expense of ancestors; but the Hindus, in this view, may, with not a little justifiable pride, point to their sciences of Astronomy, of Arithmetic, Algebra, Geometry and even of Trigonometry, as containing within them evidences of traditioned civilization comparing favourably with that of any other nation in the world.

APPENDIX I.

With regard to the supposed actual observations of the planets by the Hindu Astonomers at the epoch of the Kali Yuga, Laplace, after speaking of the Chinese and their scrupulous attachment to ancient customs which extended even to their astronomical rules, and has contributed among them to keep this science in a perpetual state of infancy, proceeds thus in his "Exposition du Systeme du Monde":—

"The Indian tables indicate a much more refined astronomy, but everything shows that it is not of an extremely remote antiquity. And here, with regret, I differ in opinion from a learned and illustrious astronomer (M. Bailly) who, after having honoured his career by labours useful both to science and humanity, fell a victim to the most sanguinary tyranny, opposing the calmness and dignity of virtue to the revilings of an infatuated people, who wantonly prolonged the last agonies of his existence.

"The Indian tables have two principal epochs, which go back, one to the year 3102 the other to the year 1491 before the Christian Era. These epochs are connected with the mean motions of the sun, moon, and planets, in such a manner that one is evidently fictitious; the celebrated astronomer above alluded to, endeavours in his Indian astronomy to prove that the first of these epochs is grounded on observation. Notwithstanding all the arguments brought forward with the interest he so well knew how to bestow on subjects the most difficult, I am still of opinion that this period was invented for the purpose of giving a common origin to all the motions of the heavenly bodies in the zodiac.

"In fact, computing, according to the Indian tables from the year 1491 to 3102, we find a general conjunction of the sun and all the planets, as these tables suppose, but their conjunction differs too much from the result of our best tables to have ever taken place, which shows that the epoch to which they refer was not established on observation.

"But it must be owned that some elements of the Hindu astronomy seem to indicate that they have been determined even before the first epoch. Thus the equation of the sun's centre, which they fix at 2·4173°, could not have been of that magnitude, but at the year 4300 before the Christian era.

"The whole of these tables, particularly the impossibility of the conjunction at the epoch they suppose, prove on the contrary that they have been constructed, or at least rectified, in modern times.

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"Nevertheless, the ancient reputation of the Indians does not permit us to doubt that they have always cultivated astronomy, and the remarkable exactness of the mean motions which they assign to the sun and moon necessarily required very ancient observations."

It would appear from a paper on the "Trigonometry of the Brahmins," published in the "Transactions of the Royal Society of Edinburgh," Vol. IV. (1798), eight years after his first paper on "The Astronomy of the Brahmins," that Playfair was induced to modify his opinion with regard to Bailly's belief as to the origin of the Kali Yuga, to which he had referred in the construction of the Indian astronomical tables.

He says, "I cannot help observing, in justice to an author of whose talents and genius the world has been so unseasonably and so cruelly deprived, that his opinions, with respect to this era, appear to have been often misunderstood.

"It certainly was not his intention to assert that the Kali Yuga was a *real* era, considered with respect to the mythology of India, or even that at so remote a period the religion of Brahma had an existence.

"All I think Bailly meant to affirm, and certainly all that is necessary to his system, is that the Kali Yuga, or the year 3102 before our Era, marks a point in the duration of the world before which the foundations of astronomy were laid in the east, and those observations made from which the tables of the Brahmins have been composed."

APPENDIX II.

There are innumerable stars which, as far as we know, never change their relative situations, in consequence of which they are said to be fixed. Thus, three stars always form the same triangle, and with a fourth the same trapezium, and the manifold figures, which they may be conceived to represent when they are supposed to be joined by spherical arcs, have ever retained the same form and situation, or nearly so, since creation, and may continue so through endless time.

This fixity of character of the stars was recognised in the most remote ages, and with the Hindus it was the foundation upon which their system of astronomy was built. With them the path of the sun (the ecliptic) has its position also sensibly fixed with reference to the stars, although this is not the case with the great circle called the equinoctial, which has not that immoveable character. The celestial equator is continually changing in position, and the co-ordinates of the stars which are referred to it, that is, their Right Ascensions and Declinations, undergo changes yearly of a complex nature, whereas their changes in longitude are all of a character appreciably simple. The apparent slow motion of the equinoctial and solstitial points along the ecliptic, technically called the precession, is really a retrogression, by means of which all stars appear to move backwards at a mean annual rate of 50·1 seconds, causing an annual augmentation to their Longitudes of the same amount, so that if we have a table of Longitudes of stars for any one year (as for the beginning of the century 1800) then the mean Longitude for any other time may be found by simply adding or subtracting 50·1 seconds to each, for each succeeding or preceding year.

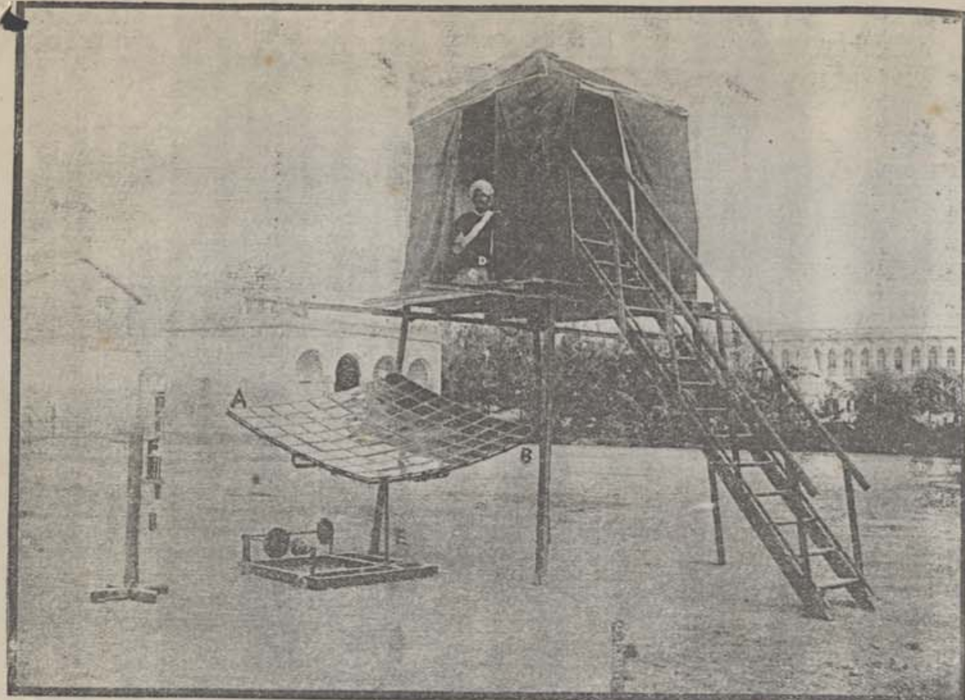
Again, the changes in the Latitudes of stars are so minute that some writers have supposed the Latitudes to be invariable; this, however, is not quite true, for from an examination of many of the principal stars, and by a comparison of their Latitudes after long intervals of time, it is found that some almost insensible changes do take place. Thus, out of a number of stars whose Latitudes were examined in 1815 and compared with those of the same stars as given for the year 1756, it was ascertained that in no case had the Latitudes altered annually by so much as ·32 of a second, and in some the changes were almost inappreciable. So that in a table of Latitudes and Longitudes, rectified for the beginning of a century, the Latitudes may in general be depended upon within less than half a minute during the century, and the Longitudes at any time by applying the correction for precession.

The following table of zodiacal stars is taken from Dr. Gregory's Astronomy, 1802. By means of this table and a table of the moon's Longitude, he says, we may ascertain how often a given fixed star may be eclipsed by the moon in a given year. It will even be found useful now for projecting the position of the ecliptic on photographic charts of zodiacal stars at the present day. For if two prominent stars of the photograph be recognised whose latitudes are known, then circles may be conceived drawn about each star at distances equal to their Latitudes, estimated according to the scale of the photograph, and they will have a portion of the ecliptic as a common tangent; the points of the contact being points of the ecliptic having the same Longitudes as the stars. Thus, they serve for determining the Longitudes and Latitudes of the other stars of the photograph.

The ordinary phenomena of the solar system, such as eclipses of the sun and moon, the numerous occultations of planets and fixed stars, their conjunctions and oppositions, all occur either on the ecliptic or within a few degrees of it, and in a clear sky they may in general be observed with the unaided eye. To a diligent student of astronomy the order of their occurrence soon becomes familiar, and by aid of the table a simple calculation will give the time and position of each in succession.

Table of the Longitudes, Latitudes and Magnitudes of the most remarkable fixed stars that the Moon can eclipse or make a near appulse to, exactly rectified to the beginning of the year 1800.

	Name of Star.	Mag.	Longitude. s.	°	′	″	Latitude. °	′	″	
δ	Piscium	4	0	11	21	34	2	9	44	N
ε	Piscium	4	0	14	44	33	1	5	37	N
ζ	Piscium	4	0	17	4	48	0	13	11	S
δ	Arietis	4	1	18	3	7	1	48	7	N
η	Tauri (*Alcyone*)	3	1	27	12	7	4	1	36	N
γ	Tauri	3	2	3	0	23	5	45	30	S
ε	Tauri	3	2	5	40	0	2	35	37	S
α	Tauri (*Aldebaran*)	1	2	6	59	43	5	29	2	S
β	Tauri	2	2	19	47	0	5	21	59	N
ζ	Tauri	3	2	21	59	38	2	13	29	S
η	Geminorum	4	3	0	39	0	0	55	4	S
μ	Geminorum	3	3	2	30	25	0	50	34	S
γ	Geminorum	2	3	5	18	43	6	46	12	S
ε	Geminorum	3	3	7	8	53	2	2	28	N
δ	Geminorum	3	3	15	43	52	0	12	19	S
β	Geminorum (*Pollux*)	1	3	20	27	57	6	40	4	N
γ	Cancri	4	4	4	15	14	3	10	22	N
δ	Cancri	4	4	5	55	32	0	4	13	N
ξ	Leonis	4	4	13	51	46	3	1	57	S
ο	Leonis	4	4	21	28	1	3	46	1	S
η	Leonis	4	4	25	6	46	4	51	9	N
α	Leonis (*Regulus*)	1	4	27	3	12	0	27	27	N
ρ	Leonis	4	5	3	35	48	0	8	29	N
τ	Leonis	4	5	18	43	10	0	31	21	S
υ	Leonis	4	5	22	14	55	3	2	51	S
β	Virginis	3	5	24	19	10	0	41	36	N
ο	Virginis	3	6	0	34	33	5	4	42	N
η	Virginis	3	6	2	2	39	1	22	24	N
γ	Virginis	3	6	7	23	4	2	48	57	N
α	Virginis (*Spica*)	1	6	21	3	13	2	2	11	S
α	Libræ	2	7	12	17	52	0	21	48	N
12	Libræ	3	7	18	13	0	1	49	14	S
γ	Libræ	3	7	22	20	32	4	24	41	N
η	Libræ	4	7	24	34	56	4	2	52	N
χ	Libræ	4	7	24	58	10	0	1	1	N
θ	Libræ	4	7	27	4	35	3	29	24	N
λ	Libræ	4	7	27	41	9	0	6	53	N
δ	Scorpii	3	7	29	46	51	1	57	17	S
π	Scorpii	3	8	0	8	58	5	26	15	S
β	Scorpii	2	8	0	23	56	1	2	18	N
υ	Scorpii	4	8	1	51	13	1	39	52	N
σ	Scorpii	4	8	5	0	36	4	0	23	S
α	Scorpii (*Antares*)	1	8	6	58	21	4	32	17	S
τ	Scorpii	4	8	8	40	5	6	5	21	S
γ	Sagittarii	3	8	28	28	26	6	56	48	S
μ	Sagittarii	4	9	0	25	21	2	22	24	N
λ	Sagittarii	4	9	3	31	54	2	5	31	S
φ	Sagittarii	3	9	7	33	11	3	55	22	S
σ	Sagittarii	3	9	9	35	40	3	24	55	S
τ	Sagittarii	3	9	12	2	25	5	2	33	S
ο	Sagittarii	3	9	12	11	59	0	53	36	N
π	Sagittarii	4	9	13	27	44	1	28	7	N
β	Capricorni	3	10	1	15	18	4	36	46	N
ε	Capricorni	4	10	17	24	23	4	57	31	S
γ	Capricorni	4	10	18	59	16	2	32	6	S
δ	Capricorni	3	10	20	44	28	2	33	40	S
ι	Aquarii	4	10	25	55	40	2	3	47	S
θ	Aquarii	4	11	0	28	5	2	43	22	N
λ	Aquarii	4	11	8	47	6	0	22	57	S
φ	Aquarii	4	11	14	20	58	1	2	8	S



BHANUTAP.

cooks. It is eminently fitted to fulfil the dream of Prince Peter Kropotkin who says : –

"And when the communal kitchen—the common bake-house of the future, is established and people can get their food cooked without the risk of being cheated or poisoned, the custom will no doubt become general of going to the communal kitchen for the fundamental parts of the meal, leaving the last touches to be added as individual taste shall suggest "(*The Conquest of Bread*, pp. 86-87)."

This communal kitchen and the *Bhanutap* can go a long way to solve the fuel problem of the future. In one part of India at least, *viz.* in the Panjab, the communal kitchen may already be said to exist to some extent and the *Bhanutap* can be most profitably used in such kitchens. The difficult of supplying hot meals after sunset can be met by the use of the '*Norwegian* stoves' or 'hot cases' in which, with the aid of substances which are bad conductors of heat, food can be kept hot and even boiling for hours without any connection with a source of heat.

The *Bhanutap* can not only serve culinary purposes but the inventor has succeeded in working a small model steam engine and melting tin, lead, and zinc, with the heat concentrated with this apparatus. As the inventor, like many other inventors, is inadequately endowed with the qualities of a pushing, canvassing man of business, and more especially as Indian capitalists, like most other capitalists, are chary of making investments in untried lines, his invention has hitherto remained as a mere scientific curiosity; but he is prepared to prove to the satisfaction of any intelligent man who may be willing to invest a few thousand rupees in making the apparatus on a large scale that the investment cannot fail to be profitable. He has no doubt that a *Bhanutap* installation costing not more than two thousand five hundred rupees will

suffice to work a stean-engine of at least three or four horse-power. This power when applied to lifting well water has been estimated by Mr. Alfred Chatterton to suffice for .rrigating at least fifty acres of cultivation in a dry tract. It appears from the published results of an experiment publicly made that 225 pieces of mirrored glass, each 4 inches square, were found to concentrate sufficient heat to melt 1lb. of zinc. This means a temperature of at least 700° Fahrenheit whereas only 212° Fharenheit is required for producing steam. In view of these and other still more encouraging results, the inventor is prepared to undertake the erection of *Bhanutap* installations for the use of chemists, perfumers, dyers, lac-manufacturers, varnish-makers, type-founders and others who have to use large quantities of fuel. It is to be hoped that the invention may be utilised in these and other directions by private capitalists, joint-stock companies, landholders and other men of wealth.

The inventor indicates the possibilities of his invention in the following words:

"Solar heat may also be converted into electricity by means of the dynamo, worked with a combination of the *Heliotherm* and the steam engine, and the electric energy, thus generated, may be accumulated in storage batteries for use at night or in cloudy weather, as a heating agent, a motive power, or an illuminant.

No fuel is, of course, needed in any operation in which the *Heliotherm* is used, except in the absense of solar heat in the shape of direct sunshine or accumulated electric energy. As India is a land of sunshine, it is not difficult to realize what enormous amount of heating and motive energy may to be obtained from solar heat for use in households, steam mills, manufactories and workshops, and what a powerful impetus may thus be given to industries in this country.

The following account of the origin and development of the *Bhanutap* may prove interesting to many readers:

"Inquiries are often made as to how the idea of the *Heliotherm* originated. The following brief account is given with a view to meet such inquiries and others that may be made.

The inventor of the *Heliotherm* comes from the Himalayan town of Almora and, having had to reside at Allahabad, he was often struck by the difference between the temparature of his native town and that of his new residence. It occurred to him that if some of the solar heat, which is diffused in the atmosphere and is the source of so much inconvenience in hot weather, could be concentrated by some means, it might be made serviceable as a substitute for fire. He tried some experiments with double convex lenses, but as the focus produced by a lens, however intense, occupies a very small area, the problem of obtaining a focus of solar heat of sufficient intensity and area to be of use for domestic and industrial purposes, remained unsolved for sometime. The inventor, feeling an uncomfortable glare of sunshine, reflected by a whitewashed wall in his house, which was close to him, on a bright day in January or February, 1897, observed that the wall was acting as a reflector, and this observation suggested the idea that if a number of brighter reflectors than a whitewashed wall, such as mirrors, were so arranged as to reflect the heat of the sun at one spot at the same time, the intensity of the heat would increase with the number of reflectors used, and that the area heated would be that covered by the combined reflections of the sun from the mirrors. He procured a number of small mirrors and arranged them in rows, one standing above another, and placed them at such inclinations that the reflections of the sun from all of them coincided at one spot in a side of a packing case placed in front of them. The result was a focus of sufficient intensity to burn the area covered by it. But the focus only lasted a short time, for, as the place moved away the sun, the reflections from the mirrors ceased to coincide. This suggested the necessity of attaching the mirrors to a frame at such inclinations that they should produce a focus, and of making the frame capable of being turned so as to keep facing the sun throughout the day. The mirrors were attached to a frame now represented by the frame AB (*vide* the illustration) and were supported upon elevating screws designed to place them at required inclinations and the frame was suspended upon the top of a post like the post E so that it could be turned freely from east to west and *vice versa* and from north to south and *vice versa*. The frame was at first turned with the hand, but was afterwards provided with automatic machinery, moved by the clockwork F, which keeps it facing the sun throughout the day. It was also connected with the grooved conical pulley visible in the diagram, which compensates for the movement of the sun between the tropics.

The apparatus thus became fit to make solar heat available as a substitute for fire at all hours of the day and in all seasons of the year when there is sunshine. A patent to protect it was applied for on 25th July, 1899, and was granted by the Government of India with effect from 15th March, 1900. The apparatus was exhibited at the Industrial Exhibition of Calcutta in December, 1901, and was awarded a gold medal. Improvements were patented on 9th January, 1903, by which the cost of making the apparatus has been greatly reduced."

against England! She was not incapable of ruling herself before England came. Have one hundred and fifty years of English tutelage produced in her such deterioration? As we have seen, she was possessed of high civilization and of developed government long before England or any part of Europe had emerged from barbarism. For three thousand years before England's arrival, Indian kingdoms and empires had held leading places in Asia. Some of the ablest rulers, statesmen, and financiers of the world have been of India's production. How is it, then, that she loses her ability to govern herself as soon as England appears upon the scene? To be sure, at that time she was in a peculiarly disorganized and unsettled state; for it should be remembered that the Mogul Empire was just breaking up, and new political adjustments were everywhere just being made,—a fact which accounts for England's being able to gain a political foothold in India. But everything indicates that if India had not been interfered with by European powers, she would soon have been under competent government of her own again.

A further answer to the assertion that India cannot govern herself—and surely one that should be conclusive—is the fact that, in parts, she is governing herself now, and governing herself well. It is notorious that the very best government in India to-day is not that carried on by the British, but that of several of the native States, notably Baroda and Mysore. For you know there are certain native States which, while in a general way under British rule, are yet allowed to manage their own affairs to some extent. In these States, particularly in Baroda, the people are more free, more prosperous, more contented, and are making more progress, than in any other part of India. Note the superiority of both these States in the important matter of popular education. Mysore is spending on education more than three times as much per capita as is British India, while Baroda has made her education free and compulsory, a thing which no part of British India has dreamed of. Both of these States, but especially Baroda, which has thus placed herself in line with the leading nations of Europe and America by making provision for the education of all her children, may well be contrasted with British India, which provides education, even of the poorest kind, for only one boy in ten and one girl in one hundred and forty-four.

The truth is, not one single fact can be cited that goes to show that India cannot govern herself,—reasonably well at first, excellently well later,—if only given a chance. It would not be difficult to form an Indian parliament to-day, composed of men as able and of as high character as those that constitute the fine parliament of Japan, or as those that will be certain to constitute the not less able national parliament of China when the new constitutional government of that nation comes into operation. This is only another way of saying that among the leaders in the various states and provinces of India there is abundance of material to form an Indian National Parliament not inferior in intellectual ability or in moral worth to the parliaments of the Western world.

There is a new spirit in India; there is a new rising of hope and of determination among the Indian people, which is taking shape in the "New National Movement." It is the awakening and the protest of a subject people. It is the effort of a nation, once illustrious, and still conscious of its inherent superiority, to rise from the dust, to stand once more on its feet, to shake off fetters which have become unendurable. It is the effort of the Indian people to get for themselves again a country which shall be in some true sense their own, instead of remaining, as for a century and a half it has been, a mere preserve of a foreign power,—in John Stuart Mills' words, England's "cattle-farm." The people of India want the freedom which is their right,—freedom to shape their own institutions, their own industries, their own national life. They want a recognized and an honorable place both in the great brotherhood of humanity and in the great brotherhood of nations. They ought to have it.

Let me not be misunderstood. This does not necessarily mean—and this is clearly recognised by the leaders of the Indian people—separation from Great Britain; but it does mean, if retaining a connection with the British Empire, becoming citizens, and not remaining forever helpless subjects and voteless helots in the hands of irresponsible masters. It does mean that India shall be given a place in the Empire essentially like that of Canada or Australia, with such autonomy and home rule as are enjoyed by these free, self-governing colonies. Is not this demand just? Not only the people of India, but many of the best Englishmen, answer unequivocally, Yes! In the arduous struggle upon which India has entered to attain this end,—and arduous indeed her struggle must be, for holders of autocratic and irresponsible power seldom in this world surrender their power without being compelled,—surely she should have the sympathy of the enlightened and liberty loving men and women of all nations.

These remarks were made by the Rev. Dr. J. T. Sunderland of America at the forty-second Annual Meeting of the Free Religious Association held in Boston.

SOLAR HEAT AS A SUBSTITUTE FOR FIRE

THE difficulties created by the steadily rising prices of food in India are being greatly aggravated by the increasing difficulty in the supply of fuel. While the high prices of food are due to enormous exports of wheat, rice and other food-stuffs which India makes in return for the foreign manufactures which she uses, and the foreign intelligence which she employs, the high prices of fuel are not due to enforced exports but to a limited natural supply. The fuel difficulty is being increasingly felt in most parts of India and is reducing the production of food grains by compelling people to make fuel of cow-dung which should be utilised as manure. It is this difficulty which has induced the Lahore Exhibition Committee to offer a special prize for a *chulha* or stove, designed to cause a saving in fuel. Such a stove, if invented and largely used, will, doubtless, supply a great need, but its usefulness can only be confined to the cooking of food and other small operations requiring the aid of fire. An invention of far greater utility has already been placed before the public by an Indian inventor, Pandit Sri-Krishna Joshi of Almora, now residing at Allahabad. The invention is an apparatus for utilising solar heat as a substitute for fire and has been appropriately named '*Bhânutâp*'. It is also called 'Heliotherm'. It is illustrated in the annexed plate and is described, in the inventor's own words, as follows:—

Solar heat has hitherto been allowed to remain confined to its natural functions; but it is capable, like other natural energies, of being turned to artificial uses. The apparatus represented by the annexed diagram accumulates solar heat to serve as a substitute for fire. The mirrors attached to the frame AB are placed at such inclinations that they all cast the reflection of the sun at the same spot, *viz.*, the bottom of the body to be heated which is represented in the diagram by the vessel D. The focus thus produced serves as the heating agent.

The machinery, consisting of the wheels, cords and clock-work, shown in the photograph, moves the frame AB, so that the mirrors continue to face the sun throughout the day. The focus is thus kept to the spot where it is required to act as the heater. The machinery works automatically, being moved by the weight which is generally let down by the clock-work F.

The intensity of heat at the focus depends upon the number of mirrors used, and the area of the focus depends upon the size of the mirrors.

This invention was first patented nine years ago and was exhibited in its original shape at the Industrial Exhibition of Calcutta in 1901 when it was awarded a gold medal and was highly spoken of by the press. It has since been considerably improved and the improvements have been secured by a subsequent patent.

We have seen the improved *Bhânutâp* at work and partaken of the products of solar cookery, which are very palatable and, being free from contact with smoke or coal gas, may be expected to be perfectly wholesome. As a means of cooking food, it is available to all who can afford a few hundred rupees for buying and installing the apparatus. Although men of humbler means cannot buy the apparatus for household use, it can be profitably used in boarding houses, hotels, messes, jails and similar establishments and by bakery confectioners and pastry