small. This however does not appear to be the case always and then the size of the gall is not in any way affected by the presence of cysts.

Cysts are not formed in every gall. In fact, galls may be divided into two distinct classes as *cystiferous* or cyst-bearing and *acystiferous* or non-cyst-bearing. Examples of the former class are the shoot galls of *Cephalandra indica* Nees, *Pongamia glabra* Vent., *Melothria heterophylla* Cogn. and leaf galls of *Odina wodier* Roxb. (all by undescribed Cecidomyidæ) and also the leaf galls of *Mangifera indica* Lin. by *Oligotrophus mangiferæ* Felt. Examples of the latter class are shoot galls of *Momordica charantia* Lin. by *Lasioptera falcata* Felt. and the fruit gall of *Pongamia glabra* Vent. by *Asphondylia pongamiæ* Felt. The cysts of the shoot gall of *Melothria* and *Cephalanda* are longitudinal, sinuous, cylindrical tubes, made up of suberised cells. The cyst in the shoot gall of *Pongamia* is a short, stout, hard tube of ligninised cells. That of the leaf gall of *Odina* is a hard L-shaped, cylindrical structure opening on the surface of the gall and made up of ligninised cells.

Though this extremely interesting structure appears to have been observed by various previous workers, its true nature is not yet understood. The correlation between this curious structure and the growth, shape, size, etc., of the galls bearing them is under detailed investigation and the author hopes to report more about this on some future occasion.

Notes on Some Hydro-Electric Schemes in India.

By Dr. Ram Prasad.

IN these notes an attempt is made to point out some of the important features of Hydro-Electric development in India giving some details of a few of the systems. The development of power in the Mysore State is dealt with first, to show what can be accomplished in public service utilities through Government agency. Next, the two major Hydro-Electric schemes are described which were recently put into service, one in Northern India and the other in Southern India by the respective local Governments and are intended to help forward the industrial and incidentally agricultural development of the provinces by providing a plentiful supply of moderately cheap power over a wide area.

The localities where Hydro-Electric Power is generated in India may be divided into four sections:

(1) The Northern and Sub-Himalayan section including the Ganges canal network.
(2) The West Coast section near the Ghats.
(3) The Southern part of Deccan Plateau.
(4) The Southern section from the Nilgiri Hills downwards.

Under section (1) may be included:

(*a*) The Uhl River Hydro-Electric Project of the Punjab Government near the Himalayan foothills which will serve the Punjab. This scheme was started in 1926 and the 1st stage of 48,000 E.H.P. was put into service in March 1933.

(*b*) The Ganges Canal and Ramaganga Scheme of the Government of the United Provinces of Agra and Oudh which utilize the canal falls of the famous Ganges river canal systems. This scheme of 3,500 E.H.P. was put into service in 1931 and is intended to serve the western and middle section of U. P.

Under section (2) we may include the Hydro-Electric Power systems organized by Messrs. Tata & Sons of Bombay. This big network obtains its power from three generating stations which derive their water from artificial lakes constructed on the Western Ghats and supply the power requirements of Bombay, Poona and the surrounding territory including the G.I.P. and B.B. & C.I. Railways, through numerous sub-stations and transmission lines. The initial stages of the scheme were put into service before 1914 and the system has been gradually extended to its present capacity of about 250,000 E.H.P.

Under section (3) comes the Cauvery Power Scheme in the Mysore State which is the oldest Hydro-Electric system in India and derives its power from the waterfalls of the Cauvery near Sivasamudram where the Mysore plateau descends to the plains. This scheme was started in 1902 with a capacity of 5,000 E.H.P. mainly to supply power to the Kolar gold mines and has been gradually extended to meet the increasing demand of the mines and other growing industries in the State and has a capacity of 46,000 E.H.P. at present.

Under Section (4) comes the Pykara Hydro-Electric Project of the Madras Government on the slopes of the beautiful Nilgiri Hills. The scheme was begun in 1926 and the first stage of 22,000 E.H.P. was put into service in April 1933. This is intended to serve the industrial and agricultural districts of southern Madras Presidency and to link up with other projects that may be undertaken in Madras later on.

Besides these major Hydro-Electric schemes there are various small systems scattered in the Bombay Presidency, Tea Estates in south-west Madras, and on the Himalayan borders of Assam and Bengal. There are many undeveloped areas with possibilities of major schemes which in years to come will provide large blocks of power for the industrial and rural requirements of India.

The following statement gives some useful data regarding the major schemes now in service:—

No.	Name of the Scheme	Province	Height above Sea Level of Forebay	Head in feet used	Station Capacity	Quantity of Water required	Main Transmission Voltage	Other Details
1	Cauvery Power Scheme (C.P.S.)	Mysore State	2,000 ft.	410 ft.	46,000 E.H.P.	1,200 cusecs	76,000 & 37,000 volts	Francis Reaction Turbines
2	Tata Power Co. Group	Bombay Presidency	About 2,500 ft.	About 1,000 ft.	About 250,000 E.H.P.	3 stations each about 600 to 800 cusecs	110,000 volts	Impulse Wheels
3	Ganges Canal & Ramaganga Schemes	United Provinces	About 500 ft.	6 to 12 ft.	3,500 E.H.P. (I stage)	4,000 to 8,000 cusecs	37,000 volts	Francis Reaction Turbines (Vertical)
4	Uhl River or Mandi Hydro-Electric Project	The Punjab	6,000 ft.	1,800 ft.	48,000 E.H.P. (I stage)	150 cusecs	132,000 & 66,000 volts	Impulse Wheels
5	Pykara Hydro-Electric Scheme	Madras Presidency	7,000 ft.	3,080 ft.	22,000 E.H.P. (I stage)	60 cusecs	66,000 volts at present (later on 110,000 volts)	Impulse Wheels

THE CAUVERY POWER SCHEME.

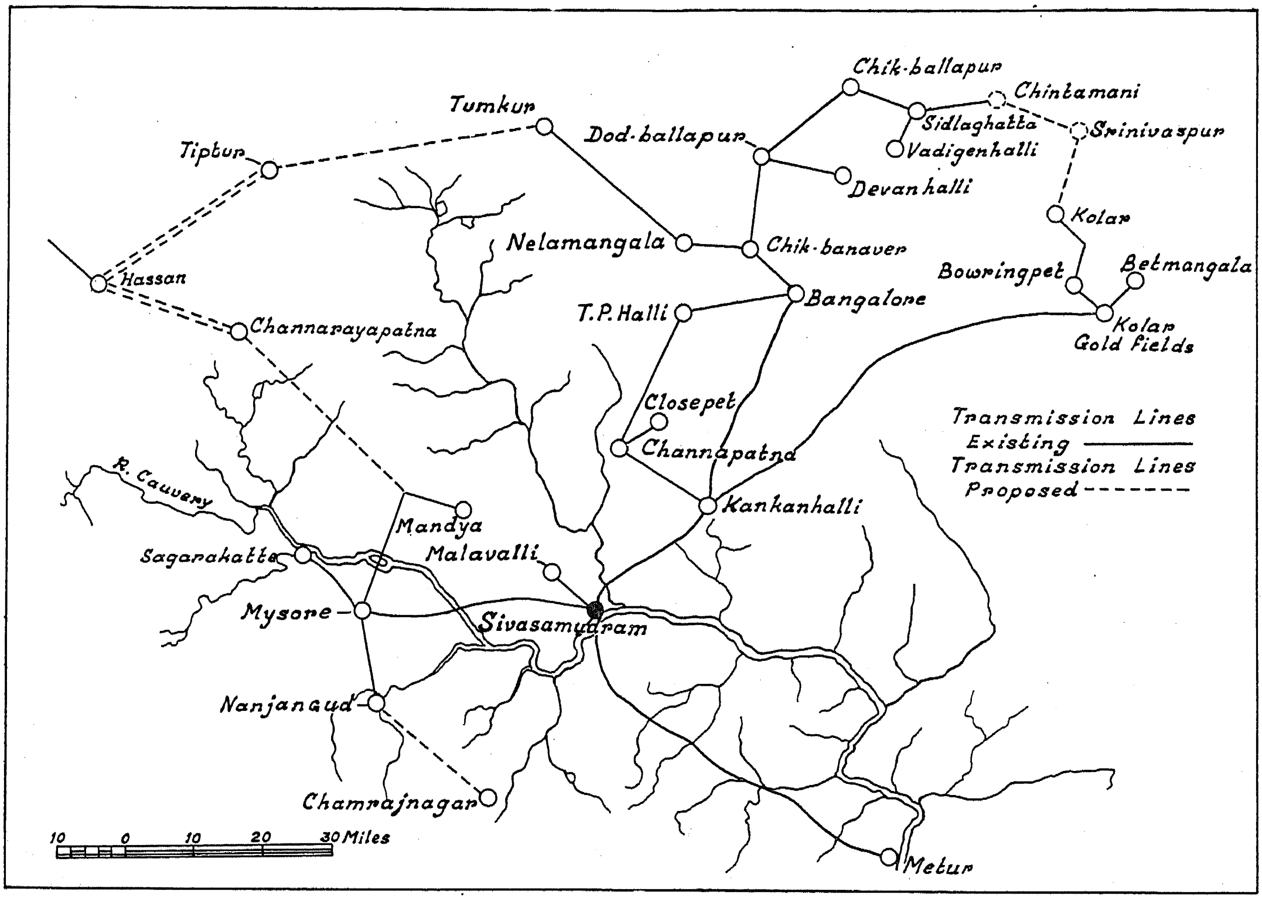
The Cauvery Power Scheme (C.P.S.) was started by the Government of Mysore in 1902 primarily to supply power to the gold mines at Kolar, at a distance of about 90 miles, with a generating capacity of about 5,000 E.H.P. and power was transmitted at 35,000 volts. During the last 30 years, as the demand for Kolar increased and new demands came up in Bangalore and Mysore, the capacity of the Generating station, Transmission lines, and the sub-stations was gradually increased, so that to-day the capacity of Sivasamudram Station is 46,000 E.H.P. and the voltage of power transmission is 76,000 volts.

Being a medium head development (410 ft.) the original turbines of the Impulse type have been gradually replaced by the latest type of Reaction Turbines (Francis) equipped with suitable oil pressure governors. As the Cauvery river is laden with fine silt and sand several experiments had to be carried out in co-operation with the turbine manufacturers to minimise the wear and tear of the runners and wickets and suitable designs were arrived at and adopted. The question of "Erosion" of the turbine runners due to the liberation of nascent oxygen from the water under partial vacuum has also been successfully tackled by electric welding, and a modified design has also been adopted using chrome nickel steel for the manufacture of the runners. Similarly based upon local experience the design of the transformers and switch-gear have been modified to suit the requirements. Even this year, in order to increase the overall efficiency of the power station and also to increase the overload and stand-by capacity a new turbine and generator (8,000 E.H P.) are being installed and will replace three impulse wheel machines of a total 6,000 H.P capacity. The latest design of fabricated steel frame is being used for the generator and some improvements in the turbine design has also been effected. When this is completed the effective capacity will be given by:—

3 Generators of 8,000 E.H.P. each coupled to 9,000 B.H.P. reaction turbines and 7 generators of 4,000 E.H.P. each coupled to 5,600 B.H.P. reaction turbines. Power is generated at 2,200 volt, 3 phase 25 cycles and is stepped up to 76,000 volts by means of 5 Banks of Transformer of which 3 are of 10,000 KVA each, and 2 of 5,250 KVA each at 85% power factor.

Efficient and close regulation of the turbines by suitable governors and the voltage regulation of the generators by automatic voltage regulators enable easy handling of sudden peak loads (hoist load of mines) of nearly 3,000 H.P. without any appreciable change in the frequency or voltage at the receiving end.

From the Sivasamudram Power Station there are six main transmission lines of which two are for Kolar at 76,000 volts, and two carry the power at 76,000 volts to Kankanhalli, about half-way between Sivasamudram and Bangalore, where three Banks of Auto-Transformers step down the voltage to 37,000 volts for transmission to Bangalore over duplicate lines. Another two lines designed for 76,000 volts (now working at 35,000 volts) carry the power to Mysore where there is provision to link up the system with another power station that may be built at the Cauvery Reservoir about 10 miles from Mysore (Krishnaraja Sagara).



There are also two temporary lines at 37,000 volts now supplying power to Metur where the Madras Government are constructing a huge dam lower down across the Cauvery River for purposes of irrigation.

The following table may be interesting:—

Sub-Station	Distance from Gen. Stn.	Normal load as measured at Gen. Stn.	Type of Load
Kolar	95 miles	25,000 E.H.P.	Mining load including deep mine hoists, water pumps, air compressors, crushing and mechanical load and general lighting all over.
Bangalore	65 miles	13,000 E.H.P.	Textile mills, oil and flour mills, saw mills, minor industries, irrigation pumps, city water supply, and general lighting all over.
Mysore	35 miles	4,000 E.H.P.	Textile mills, rice mills, oil mills, saw mills, city water supply, minor industries, irrigation pumps and general lighting all over.
Metur (Temporary)	63 miles	2,400 E.H.P.	Concrete mixers, hoists, mortar mills, stone crushers, water pumps, water supply and general lighting all over.

There is a future demand for power in the western and north-western sections of the Mysore State where there are big tropical forests and moderately high mountains where coffee and tea plantations are coming up. Possibilities for the manufacture of pulp and paper out of bamboo or other suitable trees are very favourable and will require large blocks of power. If conditions permit the power lines may be extended to this area and also supply power to the Mysore Iron Works for driving their motors and if possible for smelting purposes. Later on if power demands justify it, another generating station of about 30,000 or 40,000 E.H.P. may be constructed at the north-western corner of the State by harnessing the Sharavati River near Jog Falls (910 ft.), one of the highest falls in the world.

By means of medium voltage (4,600 volts) and low voltage (2,300 volts) networks, nearly the whole of the southern and eastern part of the Mysore State has been electrified and power is being used for irrigation pumps and general lighting in nearly 25 small towns and 50 villages. The final supply to the consumers is at 220 volts by step-down transformers.

Before long this number will be increased many times and electricity will serve even the humblest villages in this area. This is very desirable as Mysore has no coalfields, oil-wells, or even a seaport to import fuel at low rates.

Continuity of service to the consumers is a very important feature which is maintained by means of double or quadruple circuit power lines, suitable sectionalizing stations, and automatic switching and protective equipment of the most up-to-date design. At the important sub-stations which derive power over long distance transmission lines such as Kolar and Bangalore suitable synchronous motors (condensers) have been installed for improving the power factor of the load and incidentally limiting the voltage fluctuations within reasonable limits. Distribution of energy is done through 2,300 volt, 3 phase 25 cycle power lines in towns and cities and through 4,600 volt, 3 phase 25 cycle power lines in rural areas.

The C. P. S. being a Government concern, power is supplied directly to the ultimate consumer so that the cost of retail power supply is kept low and in case of need, all the resources of the Electric Department are available for keeping up the service or effecting repairs, etc. The localities served by the Cauvery power are inhabited by communities in various stages of civilization and culture and it is remarkable how the so-called illiterate and apparently backward agriculturists and farmers have taken to electricity to replace manual and bullock power. The ancient and crude appliances are being replaced by up-to-date equipment and the earning capacity of the farmers has been appreciably increased. Small land-holders purchase electrically-driven pumps from the Government on easy hire purchase system and earn decent profits from their 5 or 10 acres of land on which are grown potatoes, onions, ordinary vegetables, flowers and sometimes fruits and sugarcane. Even domestic cooking by electricity is becoming popular in some towns, the cost of energy being ½ anna per unit for this purpose whereas it is 1 anna for general rural power supply for 10 H.P. or less. At present the entire staff of the Cauvery Power scheme is manned by Indian engineers and workers who have had suitable technical training in India and abroad. The latest developments in the design of machinery and equipment are carefully studied by the technical staff and every opportunity is availed of to bring the power station and transmission line maintenance and operation up-to-date. Recently a 37,000 volts system was successfully linked with the major 76,000 volts network by means of star-connected auto-transformers equipped with delta-connected tertiary windings that eliminate the higher harmonics. Differential current relay protection for generators and transformers, balance current and reverse power relay protection for the transmission lines, cut off faulty apparatus or power lines from the other good sections, and help easy location of faults, quick repairs and effective service. The insulators for the transmission lines are installed after rigorous tests and the design of the lines aims at a high factor of safety at reasonable costs. Suitable bird guards, locally made, have effectively eliminated the troubles from birds on the power lines.

During recent years investigations were carried out to utilize the tall varieties of trees grown in the Mysore forests, for transmission line supports, and a special species (Balega) which is white-ant proof has been found satisfactory after tests. These poles are now being used after they are creosoted with creosote oil manufactured by the Mysore Iron Works.

The manufacture of porcelain insulators required by the Electric Department, has been undertaken by Government and the requirements are being supplied. In this connection the co-operation and help of the Indian Institute of Science with regard to the electrical and mechanical tests has been very valuable. Attempts are being made to fire the insulators in electric kilns.

For the distribution system, step-down transformers are being made by the department in their own laboratories successfully.

The C.P.S. has been progressive since its inception and has pioneered in many respects. There is field for expansion in the matter of electro-chemical industries and electrification of railroads.

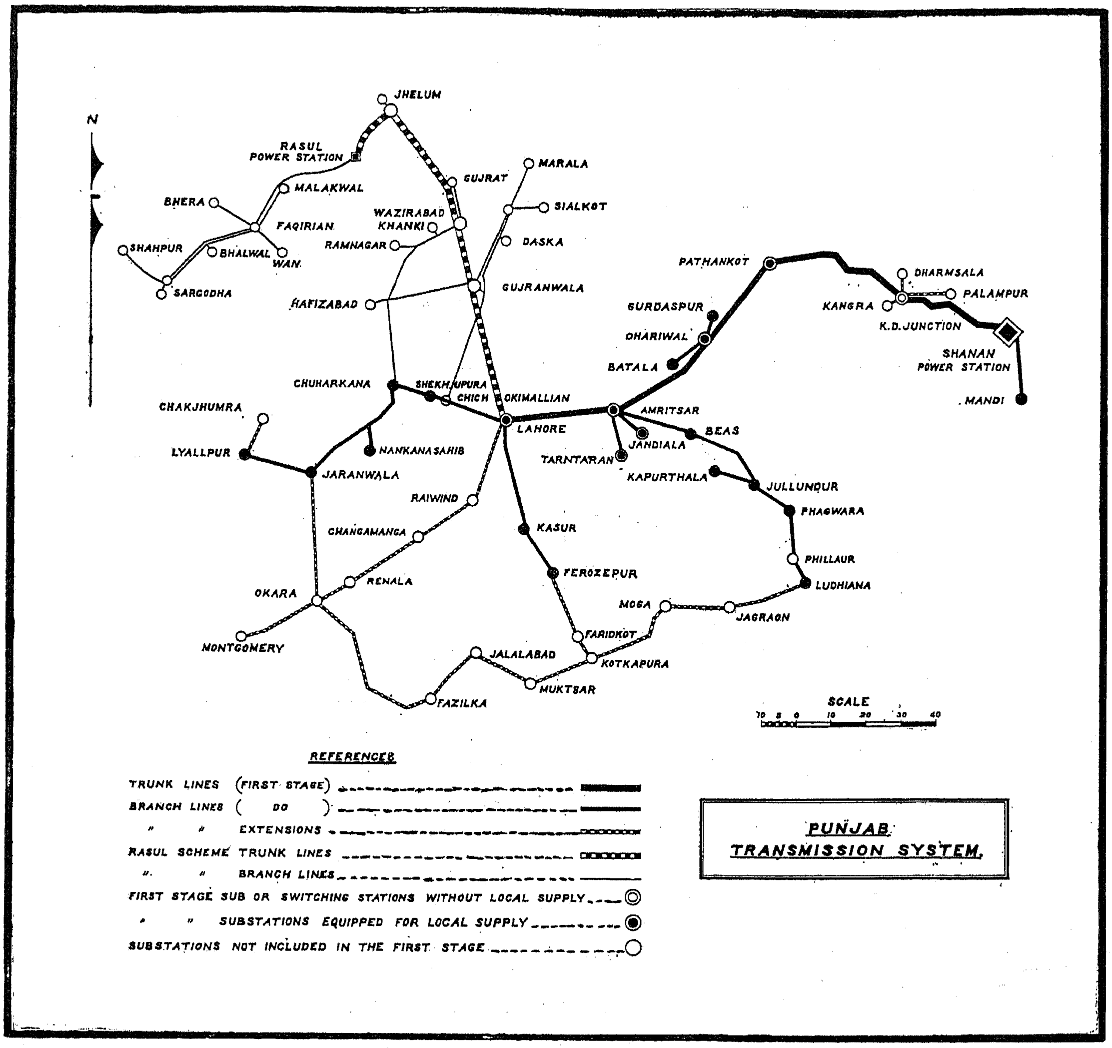
THE UHL RIVER OR MANDI HYDRO-ELECTRIC SCHEME.

This power scheme put into service in March 1933 is located at Jogindernagar and derives its water power from the snowbound Uhl River, a tributary of the Beas in the Punjab, where, diverted for power, the Uhl River runs at an elevation of about 6,000 ft., and a tunnel about $2\frac{2}{3}$ miles long had to be driven through the hill to take out the water to the outer slope where a head of 1,800 ft. could be obtained. Further drops of 1,200 ft. and 750 ft. are available lower down and will be utilized later when required.

The project has been designed for 48,000 E.H.P. in the first stage of development based on the natural flow of the river, about 150 cusecs, not reinforced by storage. The ultimate capacity is expected to be about 96,000 E.H.P. when a reservoir for the storage of 2,000 million c.ft. of water is constructed. If the power stations at the two lower slopes are constructed their capacities will be 64,000 E.H.P. and 40,000 E.H.P. respectively. The combined ultimate output of the 3 power stations would then be 200,000 E.H.P. Compared with the three Tata Schemes near Bombay with an aggregate installed capacity of 250,000 E.H.P., which form the largest group of Hydro-Electric undertakings in India, the Uhl river scheme stands second in order of power output with an installed capacity in its first stage of 64,000 E.H.P. When developed to its final stage it will rank as one of the major schemes in the world.

In the power station are now installed 4 generators each of 16,000 E.H.P., 11,000 volts, 3 phase 50 cycles 428 R.P.M. driven by single jet pelton wheel turbines. The step-up transformer equipment comprises two banks of transformers each of 24,000 Kw. 11,000/132,000 volts and of the outdoor type. This is the first scheme in India to transmit energy at 132,000 volts, the highest hitherto attempted being that of the Tatas at 110,000 volts. Double circuit transmission lines at 132,000 volts are laid out from Jogindernager to Lahore—a distance of 173 miles—and branch lines are also laid out operating at 66,000 volts from Amritsar to Ludhiana (88 miles), Lahore to Lyallpur (89 miles) and to Ferozpur (50 miles).

In about 15 towns a complete system of local distribution is provided by which retail supply is given direct to the consumers similar to C.P.S. in Mysore. But in those localities where there are already licencees, power will be supplied in bulk to the licencees, for distribution as in Lahore, Amritsar and Jullundher. A bulk supply to Kapurthala and other neighbouring States will probably be taken very soon.



The primary object of this scheme is stated to be to give effect to the desire that Government should help forward the industrial development of the province by providing a plentiful supply of cheap power over a wide area. The Punjab possesses no coal of commercial value and the cost of imported coal is about Rs. 25 per ton, more than half of which covers freight charges.

When the branch lines are extended to rural areas as in Mysore, it is hoped that power will be taken up by agriculturists for pumping water in non-irrigated tracts and also for the relief of water-logged areas and for farming operations. Supply is being offered for industrial purposes on a tariff which by its terms will continuously favour the consumer who uses electricity in increasing quantity.

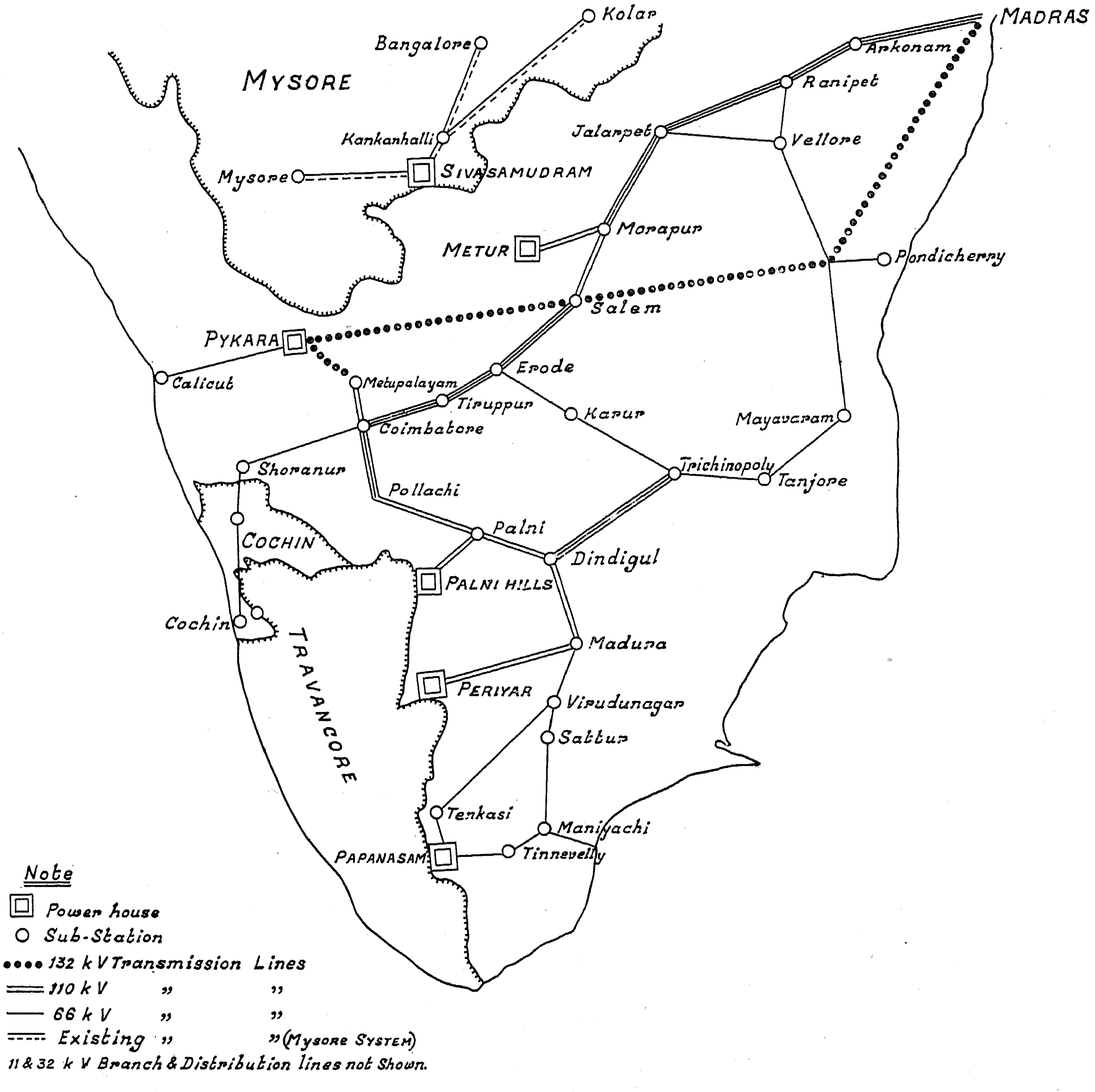
THE PYKARA HYDRO-ELECTRIC SCHEME, MADRAS.

The present scheme makes use of the waters of the Pykara River which drains the Nilgiri plateau at an altitude of about 7,000 ft. about 15 miles from Ootacamund. At the northern edge of the plateau the river drops to nearly half its altitude, within a short distance making up a total maximum head of about 4,000 ft. available for power. But at present only a head of about 3,080 ft. is utilized for power purposes. The catchment area of the river is about 38 sq. miles receiving an average rainfall of 80 to 100 inches. The amount of water flowing in the river in different parts of the year is variable, ranging from 20,000 cusecs in July to 15 cusecs in May. Hence the necessity of a storage reservoir to supply the average quantity of water required for power. If the full extent of the reservoir capacity be developed (3,000 million ft.), about 90,000 H.P. can be developed at the

Pykara station, and 30,000 H.P. from the tail water at a site a few miles below the main power house.

The first stage put into service in April 1933 utilizes a head of 3,080 ft. to develop a maximum of 22,000 E.H.P. using about 60 cusecs. The storage reservoir now constructed impounds about 84 million c.ft. It may be noted that the Pykara scheme is the highest head plant in the British Empire including North and South America and believed to be one of the 5 highest head plants operating anywhere in the world. The total length of the pipe line from the forebay to the generating station is about 10,000 ft. made up of sections of 27″, 24″ and 21″ pipes.

The generating plant consists of three units each consisting of 10,900 B.H.P. impulse turbines driving an alternator 7,810 KVA. at 11,000 volts, 50 cycles, 600 R.P.M. Provision has been made for the installation of 4 bigger units each of 17,000 H.P. For stepping up the voltage to 66,000 volts, at present there are 2 banks of transformers each 7,810 KVA. 11,000 volts′ 66,000 volts′ 110,000 volts. In the later stages when the power demand increases the voltage of transmission may be increased to 110,000 volts.



For the present the main centre of load is expected to be Coimbatore, about 50 miles from the power house and the transmission in voltage at present is 66,000 volts. All the transformers, switch-gear and lightning arresters are of the outdoor type. The receiving station at Coimbatore is also of the outdoor type and contains 4 banks of transformers each of 3,000 KVA. 66,000 volts' 22,000 volts' 11,000 volts. A double circuit 66,000 volts transmission line leads to Tiruppur and Erode, which at present are operating at 22,000 volts. In addition to this there are sub-stations at Erode, Tiruppur, Pollachi, Palghat and Iyerpad; the last one for tea factories in the Annamalais. Erode is connected to Salem and Metur and Pykara to Ooty directly.

There are possibilities of power being taken to Cochin, Travancore, Madras and Trichinopoly. When Metur Power Station is linked with Pykara, a 110,000 volt line will supply power to Madras City also.

Diffusion of Diseases.

THE League of Nations Regional Health Conference which met at Cape Town in November last year discussed the extension of yellow fever beyond barriers heretofore effective, but rendered possible by the improved methods of travel by railway trains, aeroplanes and motor cars. Major-General J. D. Graham's report points out the danger of the extension of this disease from West Africa to East Africa and from there to the Asiatic countries, and emphasizes the need of adopting suitable measures to combat the possibilities of the introduction of this new scourge into India.

Almost every mechanical invention seems to contain the germs which endanger human life and we realize the risks only after the invention has been harnessed for the service of mankind. The steam engine which introduced the industrial revolution, possessed enormous potentialities for opening up the countries for economic and cultural development and few could suspect at the moment that railway service would become the means for the spread of diseases. Wherever man moves, he carries with him obviously, in spite of the greatest precautions, the vectors of disease and especially where services are introduced for carrying large masses of population occupying different hygienic levels, the danger of a rapid spread of infection, is real and acute. If railway trains are intended to promote wider human intercourse, to develop trade and commerce, to carry knowledge and civilization to remote parts of the country, they have been the effective means of equalizing the incidence of diseases also. In spite of the utmost precautionary measures, diseases escape the vigilance of custom house offices without paying the duties. Nature seems to mock at us in our efforts to secure only the good and eschew the bad and if the facilities of rapid transport confer a boon on us, we have to be prepared to accept the evils brought in its train. Medical research and the quarantine regulations may mitigate their severity but cannot avoid them.

Probably in the case of yellow fever we have in our power the means of effectively combating its extension. We know the breeding habits of the different species of mosquitoes and the researches of the Ross Institute have placed at our disposal the remedial measures for controlling or destroying the entire mosquito population. Malaria is now well under control and Medical Science should be engaged not only in restricting the spread of yellow fever but in totally wiping it out, for so long as it is permitted to exist even in remote and isolated tracts, its extension to wider areas is almost a certainty. Civil aviation which links up the large towns where sanitary arrangements are satisfactory, is not the real source of danger, but flights undertaken to establish records and those in the nature of sensational stunts constitute a real menace, especially when there is a forcible landing in inhospitable and disease-ridden country. In India, the introduction and rapid extension of bus traffic, which has undoubtedly opened up the country side, has become the means of disseminating diseases. The problems of cultural development and the promotion of commerce and trade are closely associated with those of the preservation of health and physical efficiency of man and Science cannot afford to relax its vigilance or view with detached interest the rapid extension of traffic in the country.