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A NOTE ON WELL BORING.

W. M. SCHUTTE,

Agricultural Engineer to the Government of Bombay.



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A NOTE ON WELL BORING

BY

W. M. SCHUTTE,

Agricultural Engineer to the Government of Bombay.

Introductory.

1. In writing the following note my object is to state the general case in favour of the adoption of modern well boring in the Bombay Presidency. The subject is a complex one varying not only with the style of plant adopted to make the well, but with all the many factors which go to form the conditions met with in various parts of the world and the method of working. The following remarks on this important question of boring are the result of experiments; the statements are facts; and most of the matter contained herein is based on my own experience.

2. With the dissemination of knowledge bearing upon sanitation and a general recognition of the terrible risks of pollution in wells, and exposed receptacles containing drinking water supplied by surface drainage, the tendency is to dispense with the shallow dug well and open tank for drinking purposes. In India the village tank, although it has been the means of making large tracts inhabitable cannot be considered from a sanitary point of view in any other way but objectionable, and to have the most largely consumed article of our daily food absolutely immune from contamination would certainly be worth a tremendous amount of trouble and expense. The deep bored well certainly has its advantages in this respect even though it may be costly. Moreover whilst the one is scarcely ever failing both in quantity and quality the shortcomings of the other are sure to be emphasised during periods of extreme drought when our needs are most urgent, and especially is this applicable to India.

3. Much discussion of late seems to have been the result as to what is meant by artesian supply. The correct designation of "Artesian Well" so called from the province of Artois, in France, is a shaft sunk or bored through non-absorptive strata, until a water bearing stratum is tapped when the water is forced upwards by the hydrostatic pressure due to the superior level at which the rain water was received. The term artesian was originally only applied to wells which overflowed, but nearly all deep wells are now often so called, without reference to their level if they have bore-holes. A flowing well is certainly the thing to be aimed at, but if a good supply can be secured which will rise within suction limit from the surface, the result will more than justify the expense. To my mind the subject so far as India is concerned has been treated too much

from a theoretical and too little from a practical point of view. In England and America, and especially in America they think very little of taking a bore from two to three thousand feet deep. In England I have myself taken part in a prospecting campaign for coal, and it was considered a shallow bore if under 2,000 feet. One particular instance which I have in mind where a bore was taken 360 feet, the operations had to be abandoned owing to the enormous force of water, which by the way came up a 6" pipe and was sufficient to keep four Greiff sinking pumps working night and day for two years, which pumps delivered 112,000 gallons per hour. The water in this case was sweet and was used by the whole staff. In America well-drilling is carried to a fine art, men having no previous experience purchase a drilling set and soon become efficient in making a bore, in many cases estimating for bore-holes and taking up the business in much the same way as a builder or contractor would carry on his business.

4 It must not be concluded from this that identical conditions are available in India, because the majority of the people in India are not acquainted with this particular method of tapping water, and it is the object of this note to interest those who may find good water a necessity and who are contemplating a suitable means to that end. Contaminated or impure water may not make itself known by any taste or smell. Nothing but careful analysis will determine whether water be pure or not. A careful search, however, will usually trace the cause of some such epidemic as typhoid to a shallow well or surface supply for drinking purposes. The question is, therefore, what means are at our disposal to obviate this trouble. Many schemes have been devised by our Sanitary Engineers which have added immensely to the health of the people, there is still a vast field, however, which these schemes do not embrace, and it hardly seems necessary to point out that the only alternative to the expensive water works scheme is the drilled well, this is conceded by many authorities to be the only satisfactory and successful method of obtaining a pure and unfailing supply of water in nearly all places. The deep drilled iron-cased well, which shuts out all surface impurities and obtains the supply from the deeper seated water bearing stratum furnishes a pure wholesome water that has been purified and freed from bacteria by filtration through the sands and rocks of the earth.

5 Volumes are being written on the subject of pure water by leading Scientists, Educators and Engineers, and perhaps no time is more opportune than the present one to explain the method of boring in rock and soil to tap underground supplies of water. In practically every part of the world it is possible to obtain a pure and wholesome supply of water. To prove this fact it is only necessary to refer to the great desert lands which a few years ago were considered worthless, but are now being reclaimed by irrigation through drilled wells. The depth at which these pure and unfailing supplies of water are found varies in different localities, but it is apparent that nature has

practically everywhere provided us with an ample supply which we should take advantage of, and the water when tapped is generally either suitable for drinking, or irrigation purposes, or both

Conditions which govern Underground Supply—Run off

6 The greater part of the precipitation of rain on most areas is disposed of directly by run-off through surface streams. In arid regions, where the surface deposits are porous the run-off is relatively small, but owing to the fact that rain in these regions falls chiefly in sudden downpours, the annual run-off is not so small as would be indicated by the small annual precipitation. In places where the surface is composed of impervious strata the run-off is greater.

Absorption

7 The rain water that is not evaporated immediately or carried off by the streams sinks into the ground. Absorption by the underlying rocks takes place both directly and indirectly. Rain may fall on the surface of the rocks and be absorbed in their pores, fissures, and cavities, or it may be first absorbed by loose unconsolidated surface deposits and afterwards carried down into rocks, or it may be gathered into streams that flow over rock surface and from these gradually absorbed by the underlying rocks. The amount of rainfall that the rocks absorb indirectly is far greater than that which they absorb directly.

Strata in which Underground Water is usually found

8 A part of the underground water which has reached the lower levels occupies space along bedding, fault, joint and other planes, and although these several kinds of fractures mentioned are very numerous in the aggregate, they do not comprise the whole portion of the open space within rock. The pores between the particles that make up the rock nearly everywhere present and constitute a large part of the open space within it, this does not apply so very much to trap rock but more particularly to sandstone and such like strata. In such strata as trap rock the supply is mainly within fissures, faults, planes, joints, &c, whilst in sandstone the storage of water is mostly in the pore space. This pore space does not exist in any strata at great depths owing to the weight of overlying rock, which depth has theoretically been fixed at 6 miles.

Artesian

9 The conditions which govern a flowing well or proper artesian supply are only few in number, although some artesian

flows are found under conditions which are considered anomalous. The conditions for artesian flow are clearly stated by Veatch, who says —

“ Underground water in passing downwards may go beneath a relatively impervious layer which tends to confine it and produce a hydraulic head. In this respect underground water differs from surface water, which is always free on one side and cannot, except when artificially confined as by closed flumes produce analogous phenomenon. This natural confinement of the ground water causes water in wells to stand above the porous layer in which it is encountered, and is of vast economic importance, especially in arid regions where the water is very deep seated and has been transferred from a region of more bountiful rainfall ”

In order that a well may flow it is necessary that the following conditions be satisfied —

- (1) There should be sufficient rainfall
- (2) There should be relatively porous beds suitably exposed to collect and transmit the water
- (3) There should be less porous or relatively impervious layers so placed that they may confine the water collected
- (4) The level of the ground water at the source should be at a sufficient height above the mouth of the well to compensate for the loss of the head due to resistance and leakage

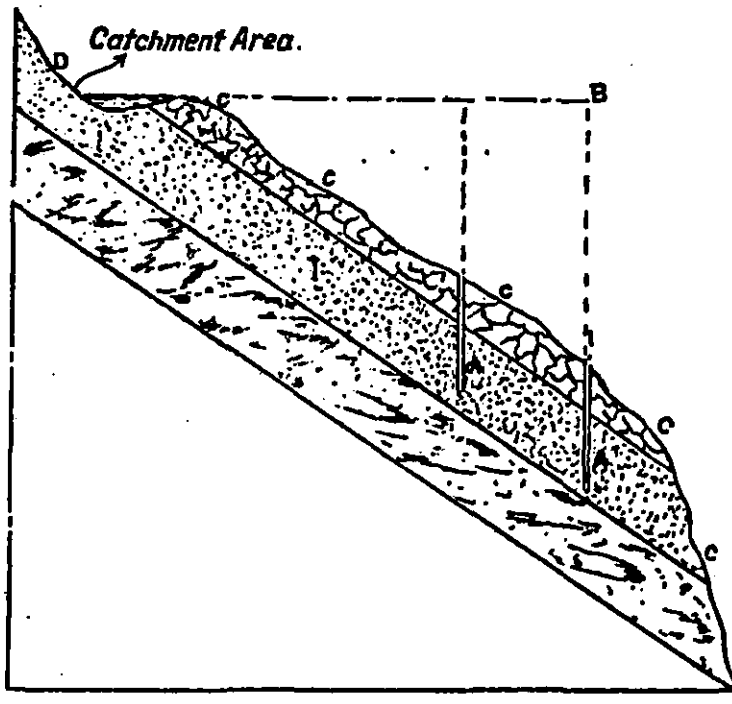
The arrangement of factors which produce a flow is by no means constant. These factors vary considerably from point to point, and relatively new combinations are to be constantly expected. Probably the commonest combination is that shown in the accompanying diagram (Fig I). Here the confining beds are clay and the porous bed is a sand which dips regularly in the direction in which the surface slopes. Water falling in the region marked “ Catchment area ” sinks into the sands and supplies the artesian wells on lower ground. (Of course the angle shown on diagram is exaggerated and is not found so acute in practice.) Although the foregoing are typical of a large class of artesian wells, flows may be obtained under several modifications of the conditions described, nevertheless the general principle remains

Method of tapping Water—Dug Well

10 The usual method adopted in India to tap water is to make a large excavation whether the strata is soil or rock. Of course this is an expensive and tedious process, sometimes bringing in its train ruin to the well owner if he is a poor cultivator and does not find water. The result of this tedious, precarious and expensive process is a *dug well* which necessarily takes its supply from the surface beds of water, for there is no means of shutting them out. This kind of well is fortunately falling into disuse in some countries and although improvement is very slow in India, nevertheless a better state of

Fig. 1.

CONDITIONS PRODUCING ARTESIAN WELLS.

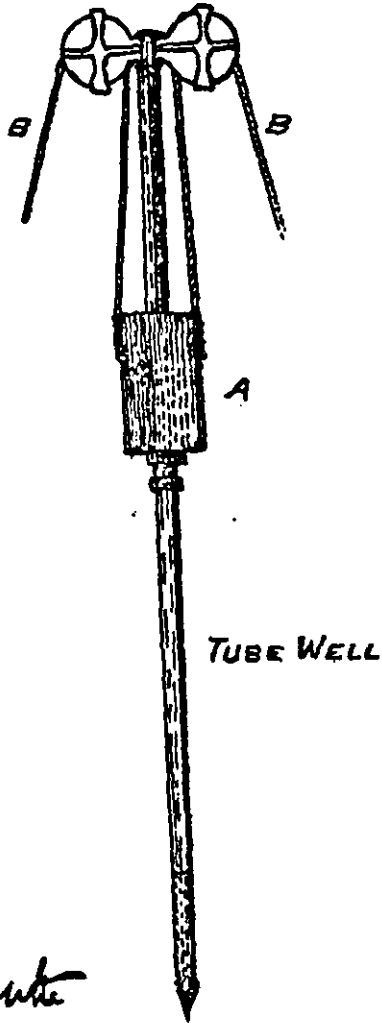


- A. Artesian wells.*
- B. Head of water if there be no loss by resistance and leaking.*
- C. Actual head or hydraulic gradient.*
- D. Outcrop.*

Mishra

Agricultural Engineer. B.P.

Fig 2.
METHOD OF INSERTING A
DRIVEN-WELL.



M. S. Schute
Agricultural Engineer.
B. P.

things is imminent. One of the greatest objections to a dug well, especially if the strata is rock, is the enormous expense incurred in excavating. The writer has only recently had brought to his notice a case where a cultivator in the Sholapur district spent Rs 1,700 to make a dug or blasted well in rock which gave him 750 gallons of water per hour. If a bore 3" diameter and 200 feet deep had been made double the supply could have been had at a total cost for boring of Rs 300.

11 Whether the water is used for drinking or irrigation purposes the supply if taken from an open and exposed shallow well is on one hand liable to be dangerous for the human consumption, and on the other hand may be uncertain when it is most needed. This of course does not apply to every well in every district, because there are a few wells in Gujarat and elsewhere varying in depth from 60 to 80 feet which give sufficient water to keep 4 to 6 mhotas employed for 8 hours daily. Moreover the supply is assured during the summer months and the level remains normal, these are, however, exceptional cases. The usual complaint is that a mhotas empties the well, and that the supply in the summer is uncertain. The only remedy is to augment the supply by having a bore hole made, and if the existing well is in soil a casing must be inserted, but if the well is in rock a casing is not necessary. The work of this Department is interesting in this connection, *vide* statement I.

Driven Wells

12 Another method of tapping water is to drive a hollow wrought iron tube into the earth according to the depth required. The water is admitted into the tube through a series of holes, which extend up the lower-most length to a height of $2\frac{1}{2}$ feet from the bottom. Specially tough lapwelded tubes are necessary to withstand the hammering and vibration to which they are subjected. Gas pipes are quite useless for the purpose. This kind of well is, however, for limited depths and supplies, and for strata which may be hard and compact. They are of no use whatever for rock and only to depth of 60 to 80 feet in soil. The type of well and form of rig used for driving these wells is shown on Fig (2) and the usual method of driving is as follows —

The spot for sinking having been chosen, a truly vertical hole is first made in the ground with a crow-bar and in this the properly rigged tube is inserted, all joints having first been made tight. When in position two men raise the monkey A by means of the ropes B standing opposite each other and equidistant from the tube, pulling the ropes at identical angles, and moving in time together, so that the tube may maintain a vertical position and follow a straight course. Should it deviate pressure must be used to bring it back again into a vertical position. Herein lies the great objection to this type of well and unless the first few feet of pipe are driven perfectly true the whole well will give trouble. There are men skilled in this class of work, but as it is only useful for very soft strata and

shallow depths it is not of much use in a country like India especially for irrigation purposes. It is not necessary, therefore, to make any further comments on this particular class of well.

The Bored or Drilled Wells

13 The drilled well is undoubtedly the best method of tapping water as it matters not whether the strata is soil, sand, clay or rock. A bore hole can be made almost any where and to any depth. The bore is made either by percussion (which churns up the rock to powder or mud) or by the Diamond or Calyx Drilling, which cuts out a solid core. Many firms of repute in Europe and America are makers of boring machines some of which are built having both the percussion and rotary appliance attached.

14 In Fig (3) is shown a type of Boring Machine which has been extensively used by the Agricultural Department and which has given every satisfaction. The machine in question was patented by Mr Musto, formerly Agricultural Engineer. This machine works on the percussion principle, its special feature being that instead of imparting to the tool a dead blow, a cam is employed which transmits a springing blow, and as the tool is slightly in suspension much quicker work is the result, boring from 3 to 4 times quicker than the ordinary derrick. The machine is known as the "Musto Patent Spring Stoke Boring Plant" and is a great improvement on the old method usually employed with the Cawn-pore Plant. It is, of course, only intended to bore to depths of 200 feet, but as it will either bore in rock or soil to this depth it certainly is a distinct advantage over the old method of giving to the tool a dead blow.

15 For greater depths than 200 feet a power machine must be used. There are many makers of power borers in America some of which are the Cyclone Co., Armstrong Co., and the Keystone Co. These firms make machines of various forms to bore on what is known as the "American Rope Boring System" which is shown in Fig (4). Much valuable work has been done in the U S A by means of this type of machine. In fact there are many flowing wells the water of which has been tapped by employing this type of drill. Both the dug and driven well are discarded in America and the drilled well acknowledged to be by far the best. To work with this kind of machine there is usually a most ingeniously contrived variety of tools for coping with the constant changes of strata to enumerate which would require a special work itself. America is not the only country, however, where boring is carried on. In England such firms as Islers, and Legrand and Sutchffe, have had many years experience in this class of work, and have bored many hundreds of wells in the British Isles. Perhaps one of the most remarkable bores, however, is that at Bourn, Lincolnshire, which supplies the town of Spalding. It was sunk by C Isler & Co, in the Oolitic beds and a depth of 100 feet it furnished a flow of 1,800 gallons per minute at a pressure of 10 lbs. to the sq inch reaching the

Fig 3.
THE MUSTO PATENT SPRING STROKE BORING
MACHINE

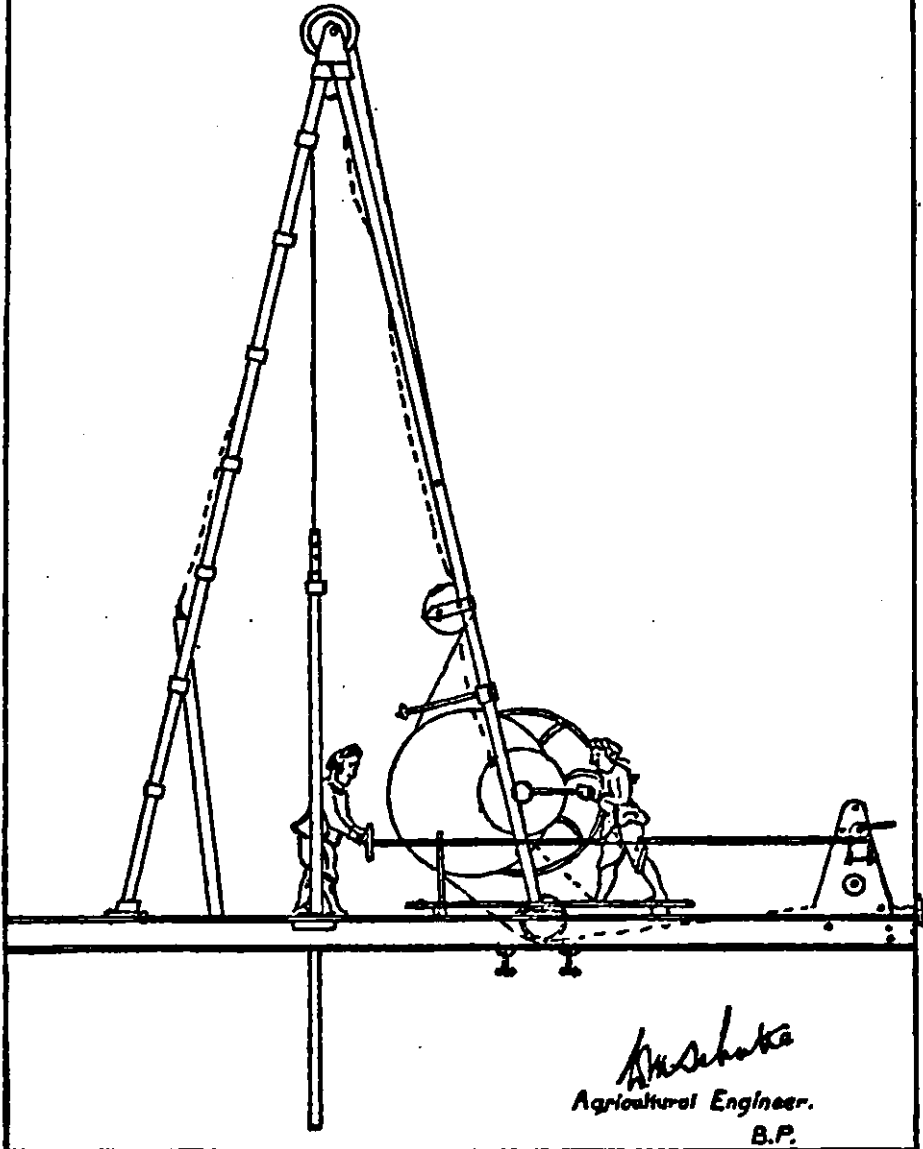
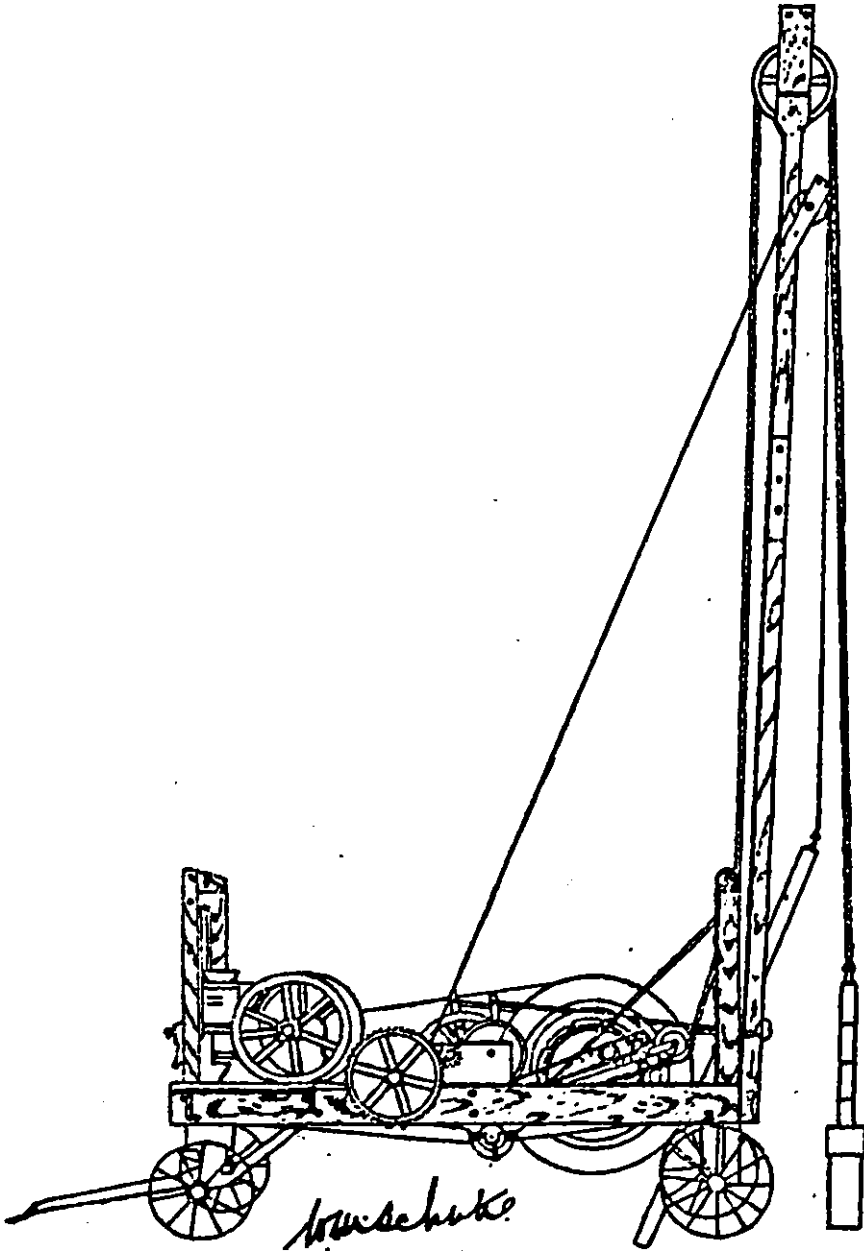


Fig 4.

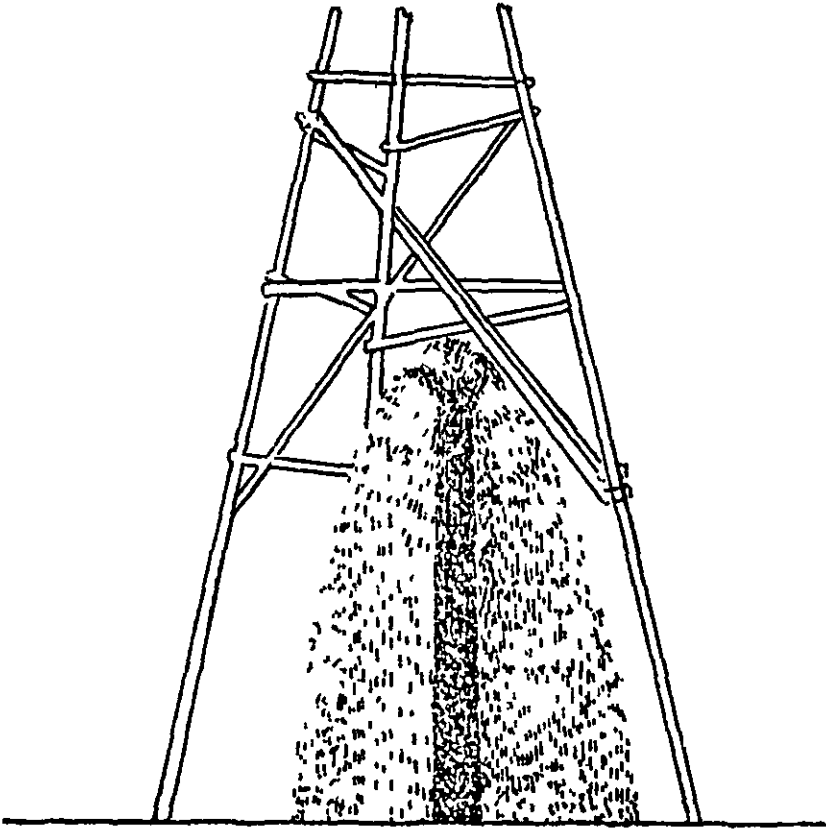
POWER BORING MACHINE ON
THE AMERICAN ROPE
SYSTEM



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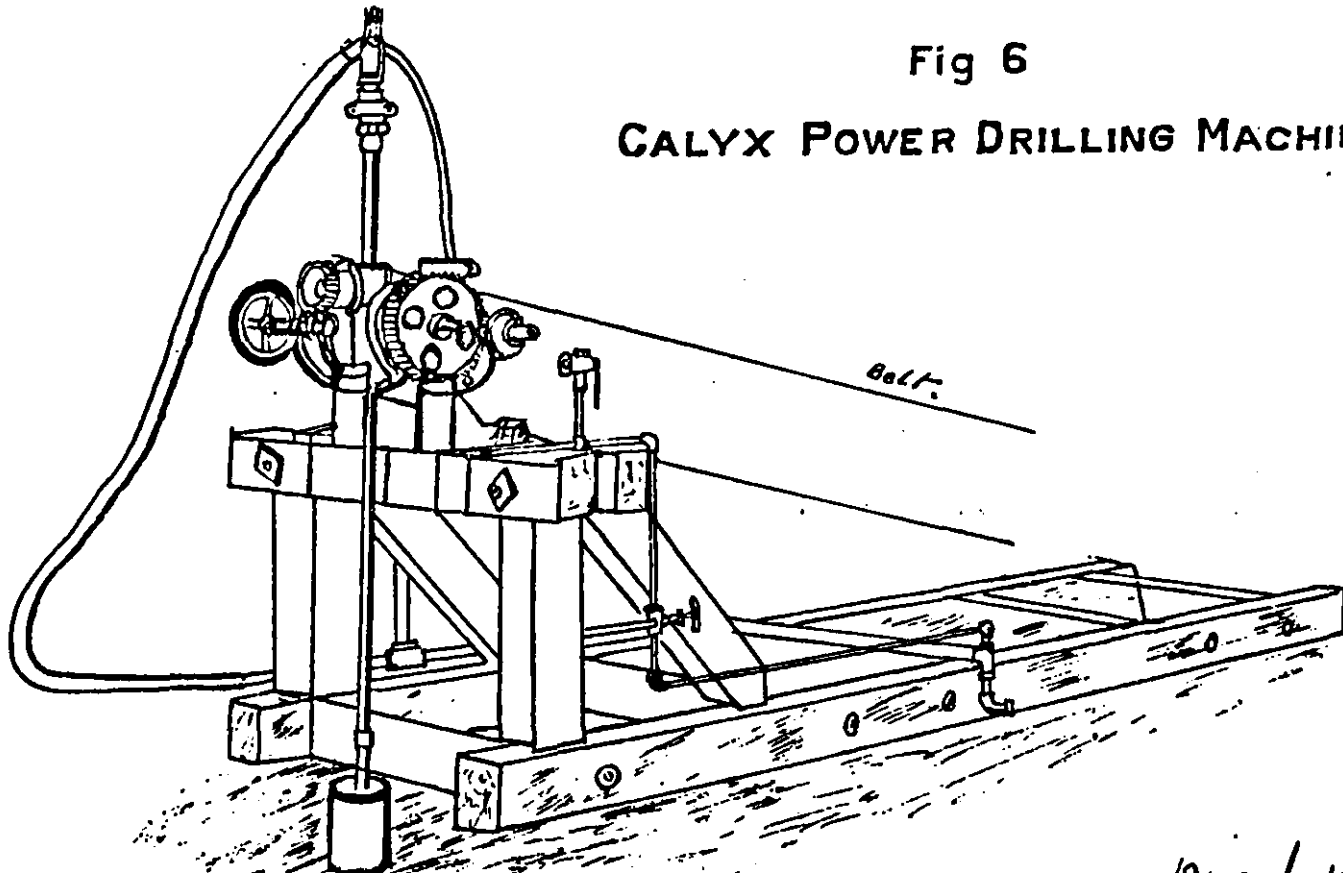
Fig 5

A FLOWING WELL



A. S. Chakraborty
Agricultural Engineer
B P

Fig 6
CALYX POWER DRILLING MACHINE



Belt.

W. Schutte
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B.P.

surface with a rush as depicted in Fig (5) The bore was continued for an additional 34 feet with the result that the flow was increased to 3,480 gallons per minute and has permanently remained at this figure The well is 13" diameter Another remarkable well bored by the same firm is at Keigley Yorkshire It is 250 feet deep in the upper beds of the Millstone grit and at 243 feet it tapped a supply of 15,000 gallons per hour rising to 40 feet above the surface The bore is lined with 60 feet of 6" tube starting from 1 foot above ground and 40 feet of 5" perforated tube commencing at 60 feet below the surface Beyond that there is no lining *

Prospecting

16 For prospecting where the core is indispensable and especially in very hard strata the rotary process is usually employed having a diamond drill Those drills are frequently used in countries where gold and coal is required These drills are now extensively being used even for water as they can be worked with chilled shots in rock and with Device cutter in soil This Department has got one 5" power drilling machine, Fig (6), which is being worked successfully for the last 2 years

Casing Tubes for Bore Holes

17 The usual method of lining or casing a bore when very soft strata are encountered is to follow the tool with a plain piece of steel or iron pipe just sufficiently large to allow of the tool working freely inside it This casing is usually left in the ground when the desired depth is reached and the supply of water enters from the bottom and rises to the ground level or into the well as the case may be Not infrequently does this tube become choked This has led to the invention of a tube called the convoluted tube well, which is manufactured in various sizes for discharges ranging from 5,000 to 45,000 gallons per hour

Convoluted Tube Well

18 The method of sinking and working these tube wells is as follows —If the tube is required to augment the supply of water to an existing well and the desired quantity of water from the tube well has been decided upon, the tube well estimated to yield the nearest quantity above the required amount should be selected Now assume that the tube selected is 40 feet in length, the bore tube of a few inches larger diameter than the diameter of the tube well should be sunk in the well to a depth of not less than 50 feet below the bottom of the well The tube well is lowered into the bore tube and sufficient plain pipe is added to the tube well, to bring the upper end of the plain pipe not less than 7 feet below the normal spring level in the existing well, the bore tube may now be

* Extract from Isler Well Boring

withdrawn and the tube well is ready for use. So long as the water in the well is not lowered more than would exceed the critical velocity for the material forming the well floor, there is no need to cement or otherwise seal the well floor, the tube well will yield its supply in addition to the yield of the existing well. In cases where the yield of the well is small, due to a small well, to the floor of the well being in a bad water-bearing stratum, or to other causes, it is advisable to seal the well floor with cement concrete, the water level in the well may then, if desired, be reduced below that level which would represent the critical velocity for the material forming the well floor, but this lowering should not be carried to excess, in other words, very little more water than the amount the tube is designed to discharge should ever be pumped from these tube wells. Convoluted tube wells may be sunk direct into the ground and worked by attaching the pump to the upper end of the plain tube, the plain tube then becomes the suction pipe of the pump, this arrangement is particularly convenient where the spring level is within the suction action of pumps worked on ground level, or where the water has been tapped under pressure and has risen to within suction limit. Considerable care, however, should be exercised in fixing the pump level relatively to water level as various forms of pumps differ very considerably in efficiency on different suction lifts, generally the suction should be as short as possible.

19 In situations where the spring level is at a depth below ground surface too great for the suction action of a pump worked from the surface, the pump may be placed in a chamber below ground level and within convenient suction distance of the reduced water level. For this reason it is often convenient to sink these tube wells in existing wells which provide sufficient space, the tubes may then be worked by persian wheels, chain pumps, mholes, or power pumps. Where the water level is very considerably below ground level, the Ashley or other deep well pump should be employed and in order to obtain the full discharge of the tube well the plain tube should be of larger diameter than the straining tube. The tube well in question is shown in Fig (7)

Raising Water

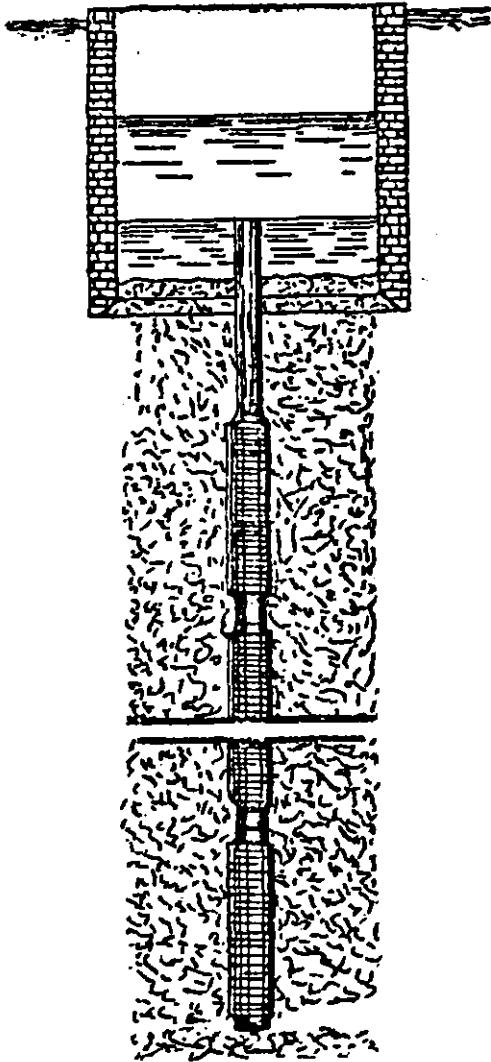
20 In the case of a flowing well pumping is not required. There are many cases, however, where the water is delivered below the surface, in which case it is necessary to use some sort of pumping arrangement. If the water is within suction limit or within 25 feet of the surface the working barrel of the pump can be placed at ground level, but if the water level is beyond this depth then some sort of deep well pump or lift must be employed. It is beyond the scope of this note to attempt a description of the multifarious forms of pump which are in common use, but to those methods which embrace the subject before us, a short description is necessary.

Wind Mill

21 In districts where wind can be utilized there are many forms of pumps specially designed either for low or high lifts, which

Fig 7.

METHOD OF FIXING A CONVOLUTED
TUBE WELL IN AN EXISTING WELL.

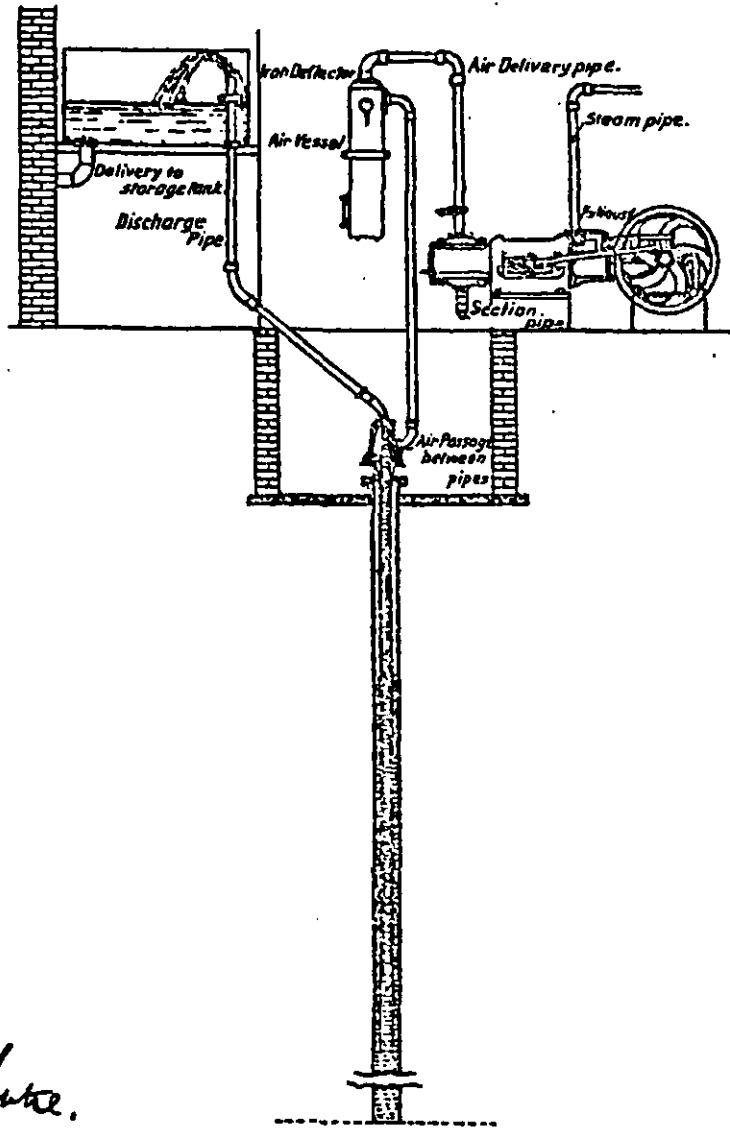


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Fig 8

METHOD OF PUMPING FROM A BORE HOLE
BY MEANS OF THE AIR-LIFT SYSTEM

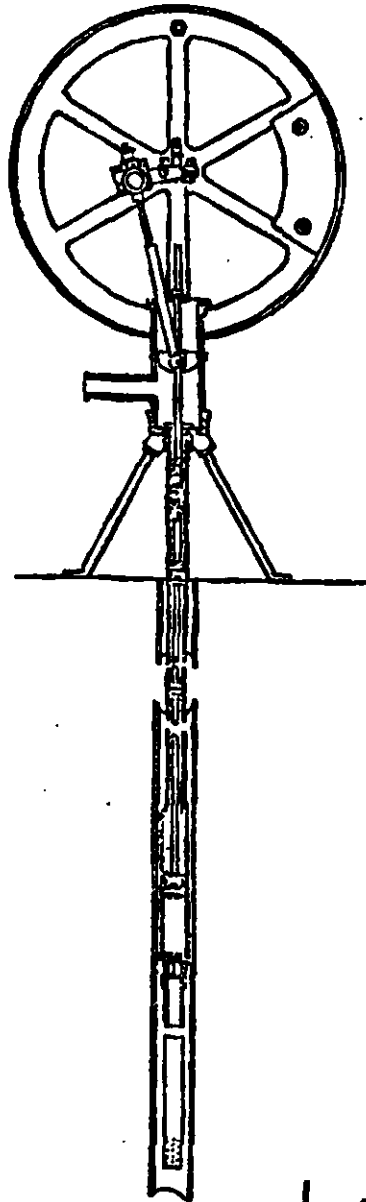


K. Schute.

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Fig 9.

PORTABLE PUMPS FOR DEEP WELLS.

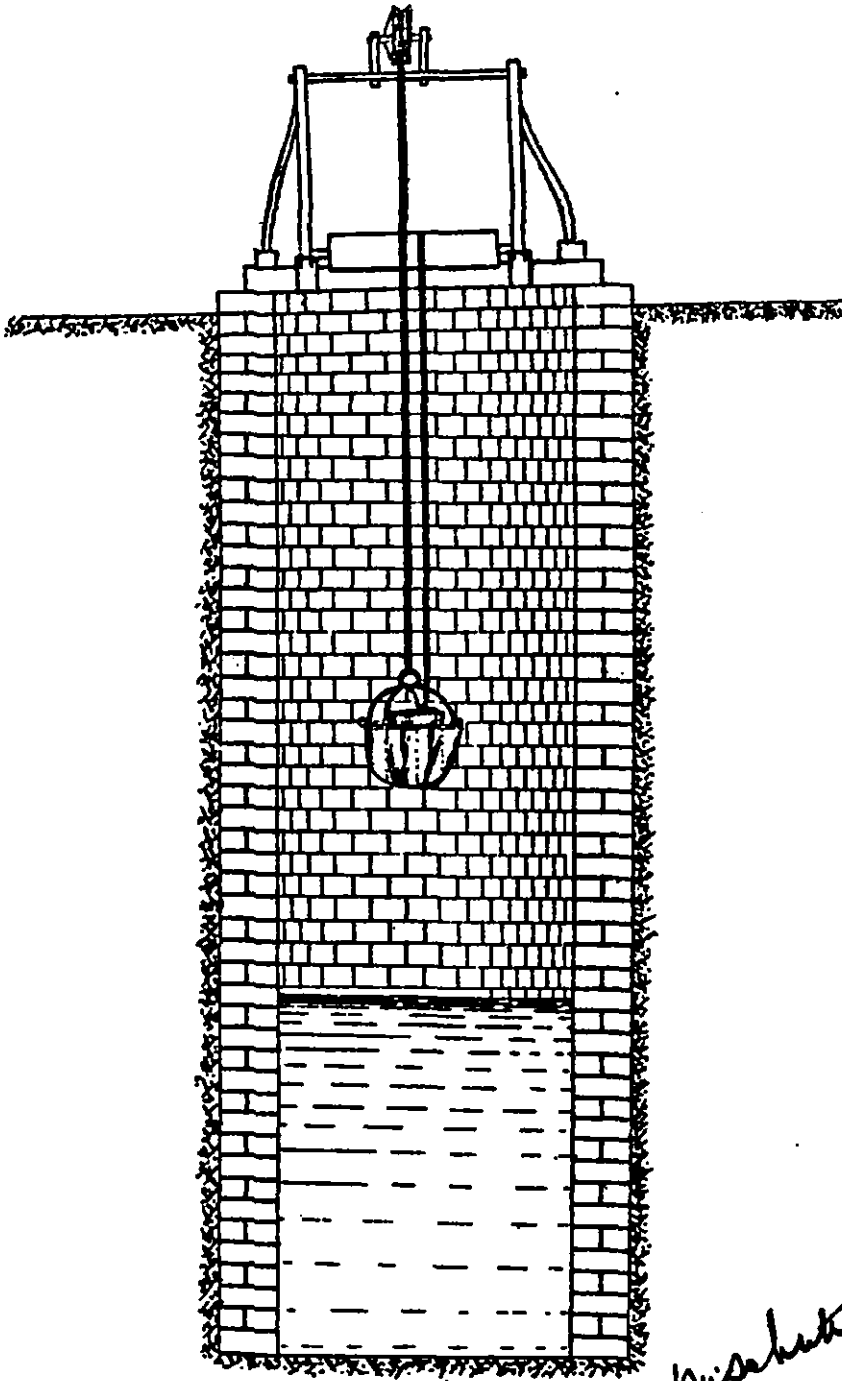


Louis H. H. H.

Agricultural Engineer. B.P.

Fig 10.

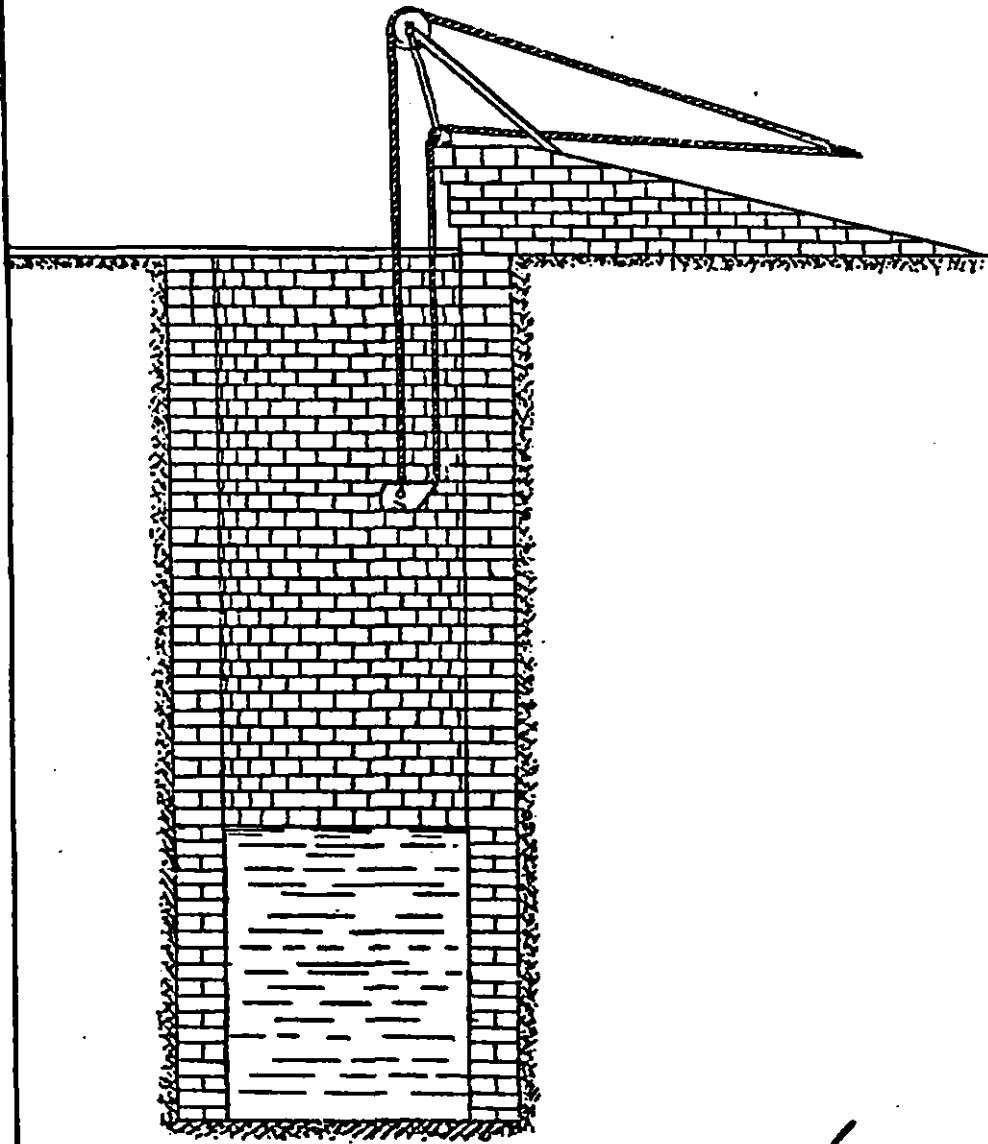
LEATHER MHOTE ARRANGEMENT.



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Agricultural Engineer. B.P.

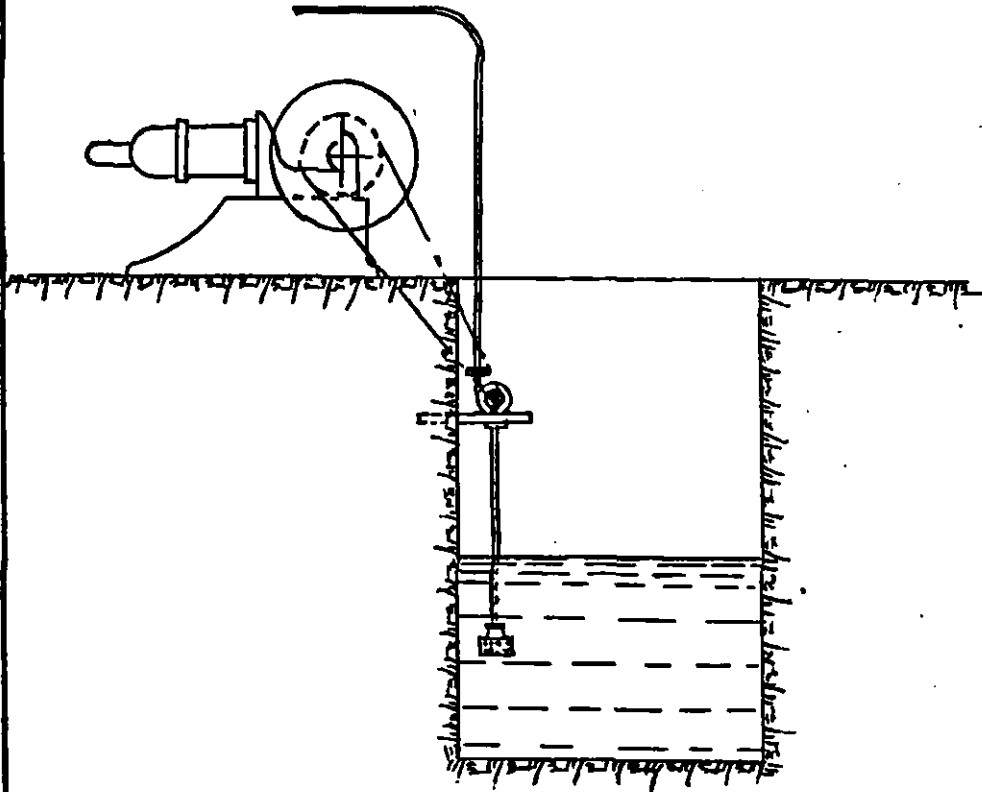
Fig II
IRON
MNOTE ARRANGEMENT.



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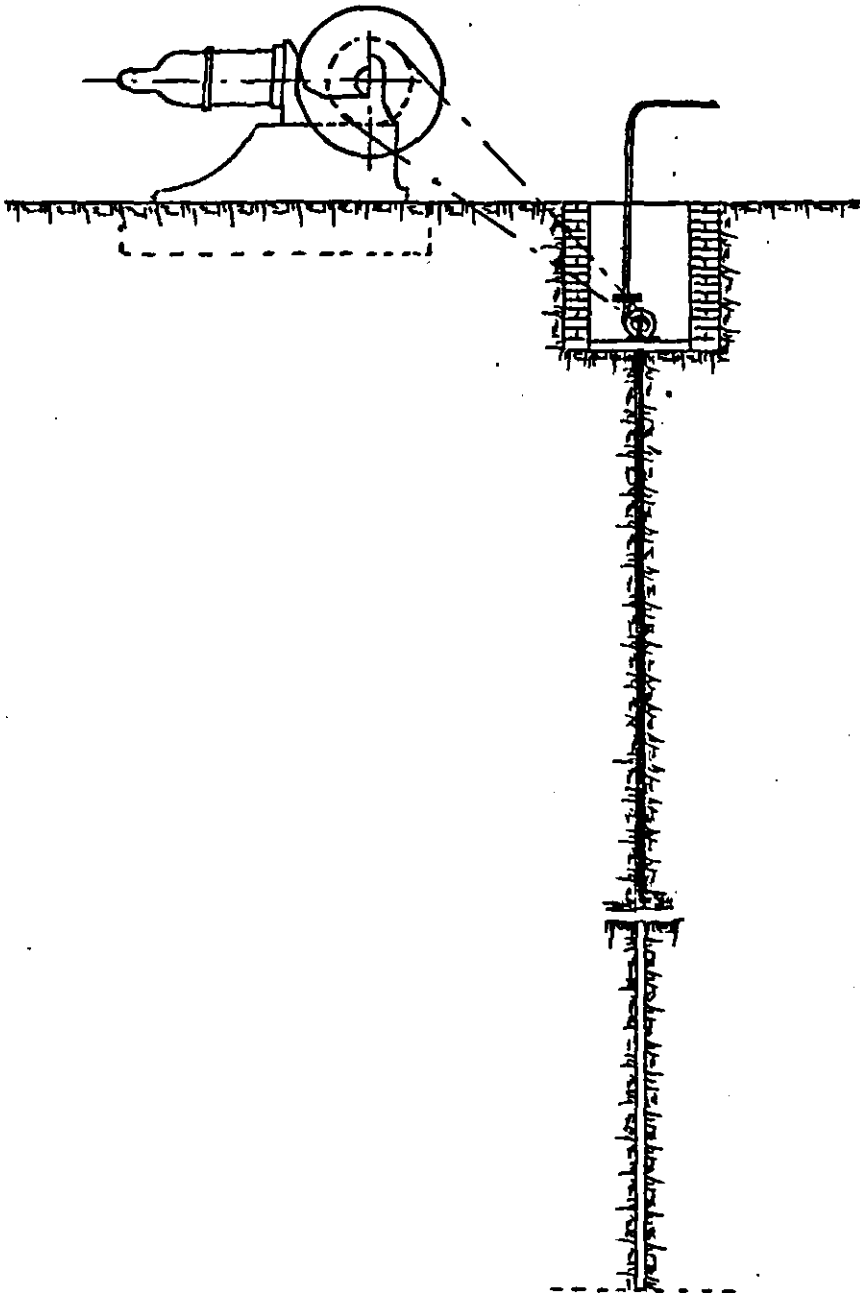
Fig 12
A TYPICAL PUMPING-PLANT FIXED ON
A WELL



M. S. Chatter
Agricultural Engineer.
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Fig 13.

A PUMPING PLANT FIXED TO A
BORE-HOLE



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can be attached to a wind mill and arranged to pump water into an elevated tank from which the water can be distributed to crops, or buildings, but as there are very few districts where this source of power can be absolutely depended upon, especially for irrigated crops, it cannot be extensively used

Air Lift System

22 This sort of lift is extensively used in America and its merits are being rapidly recognized in England and on the Continent. It is remarkably simple owing to the entire absence of working parts in the bore hole. The water is made to flow in a gentle stream from the bore, and is entirely free from pulsation. This is achieved by the force of a column of air under great compression being conveyed into an annular space between an inner pipe which forms the rising main for the water and an outer pipe which is still within the lining tube of the well. The effect of this pressure is to make the water rise in the central pipe, and this continues till the water level in the central pipe has descended to the level of the bottom of this tube. The air then escapes up this tube, taking the water with it and lifting it to the desired height. It cannot be recommended, however, for small bore holes. The system is shown in Fig (8)

Deep Well Pump

23 Many modifications from the pump shown in Fig (9) are possible which will meet the case of bore holes having a small diameter, and which can be arranged to suit any depth. This sort of pump can be fitted to a bullock-gear or oil engine provided the quantity of water in the tube well justifies such expense. There are many such bores in Gujarat but which are in existing wells and the usual mhothe arrangement is employed as shown in Figs (10) and (11). The quantity of water pumped by this method in the majority of wells is 1,500 gallons per hour, the cost of which varies in the various districts, *vide* statement IV. To put down a power plant for such a small quantity of water would not be economical, but if a bore hole is made from the bottom of the well or from the surface direct it is possible in some cases to increase the supply to the extent of 10 koses, even though the bore hole is not more than 4" diameter and less than 100 feet from the surface. A tube well capable of yielding this supply has been inserted in a well near Ahmedabad which keeps a 4" centrifugal pump and 8 B H P Oil Engine employed for 10 hours daily. Before the introduction of a tube well the water contained in the existing well was sufficient to keep one mhothe working for the whole day, but after the introduction of a tube well the amount was increased tenfold, a fact which proves the fallacy of having a large open excavation presumably to store water. The existing arrangement is shown in Fig (12) and the correct arrangement in Fig (13). Some of the old methods of pumping are known as the persian wheel and mhothe. The new methods are the reciprocating deep well pump, and centrifugal pump, the latter, where possible, being by far the most effective and economical. Cost of pumping by means of mhothes varies in different districts as shown on statement IV and alternate method power pumping is shown in statement V.

Scaled Tube Wells

24 During the course of the last 10 years this Department is trying to solve the problem of village water supplies and has achieved a great success in this line. Many of the surface tube wells have been made by this Department for pumping out water for daily use. One of such wells is illustrated on page 24 Fig (14). It has been now experienced that such wells are of utmost importance especially in the villages, frequently met with severe famines such as in Dharwar, Sholapur and Bijapur Districts.

Boring in Gujarat

25 The volume of water obtained as a result of boring from the total number of bores taken by the Agricultural Department in Gujarat from 1907 until September 1922 amounts to 1,916,000 gallons per hour which is sufficient to irrigate about 8,000 acres of sugarcane or supply 4,595,400 people with drinking water.

Boring in Deccan and Karnatic

26 In the Deccan and Karnatic the boring seems to be useful for agricultural purposes only in Districts of Kolaba, Thana and Ratnagiri. In other districts majority of bores are useful for drinking purposes but not for agricultural ones as the quantity tapped is very very poor in comparison to that in Gujarat and other districts existing along the coastline. The statement II on page 7 gives the idea of the quantity of the water tapped in the districts of Deccan and Karnatic. The Department has done very few bores in the districts which are not mentioned and hence details are not given.

The Water Finder

27 To assist in the location of underground currents in rock the writer has found the Water Finder of immense value. This instrument only locates the current, and the spot indicated must afterwards be tested by means of the Boring Machine. The instrument is fully described in a separate bulletin.

General Procedure of the Agricultural Department in Case of Enquiry

28 All applications for boring should be sent to the Deputy Director* of Agriculture of the Division concerned. When enquiries

* (1) The Deputy Director of Agriculture, Gujarat, Surat (Ahmedabad, Kaira, Panch Mahals, Broach and Surat)

(2) The Deputy Director of Agriculture, N C D, Nasik (East Khandesh, West Khandesh and Nasik)

(3) The Deputy Director of Agriculture, S C D, Poona. (Ahmednagar, Poona, Sholapur and Satara)

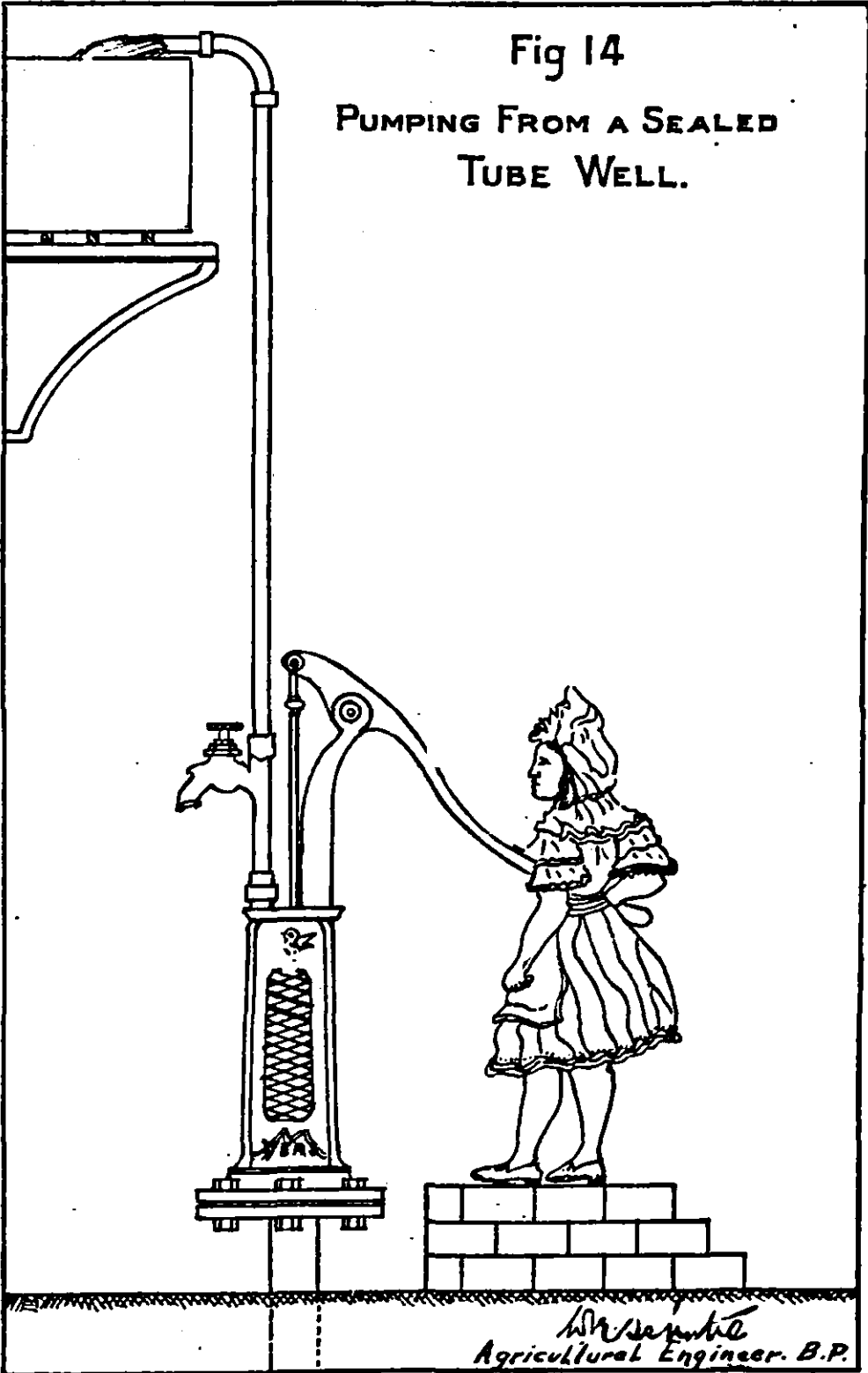
(4) The Deputy Director of Agriculture, S D, Dharwar (Belgaum, Bijapur and Dharwar)

(5) The Deputy Director of Agriculture, Konkan, Ratnagiri (Thana, Kolaba, Ratnagiri and Kanara)

(6) The Deputy Director of Agriculture, Sind, Karachi (Karachi, Hyderabad, Thar and Parkar, Larkhana, Sukkur, Nawabshah and Upper Sind Frontier)

Fig 14

PUMPING FROM A SEALED
TUBE WELL.



are addressed to the Deputy Directors, they are usually answered immediately and a copy of the rules in force is sent (*vide* rules printed at end), and the enquiry recorded. A form of agreement is also sent with the rules which the applicant is asked to sign and return to the office of the Deputy Director of Agriculture of the Division concerned. On receipt of this, the application is registered and the applicant is informed when a machine can be sent to his site. At the close of the work, pumping operations are conducted from which the success or otherwise of the bore can be determined.

STATEMENT I

STATEMENT OF PARTICULARS OF THE WORK DONE FROM
1907 TO 1922*Gujarat*

Increased No of koses,	No of bores made in					Total No of bores	No of koses *
	Kaira.	Ahmed abad	Broach.	Surat	Panch Mahals.		
1	112	66	7	16	5	206	206
1 25	2	8				5	6 25
1 5	17	18		1		31	46 5
1 75	7	8				10	17 5
2	103	26	9	4	2	144	288
2 25	1	1				1	2 5
2 5	4	8				12	30
3	69	10	1	1		81	243
3 5	2			1		3	10 5
3 75	Nil	5				5	8 75
4	84	8	3	7		102	408
4 5	2	2				4	18
5	35	2		1		38	190
5 5	Nil		1		Nil	1	5 5
6	25	4	1		1	31	186 0
7	5			1		6	42
8	11	1	1			13	104
9	1			1		2	18
10	5	1				6	60
11	1					1	11
15	1					1	15
						Total	1,916 5

Total No of gallons tapped —1,916,000 per hour

* One kose is taken as 1,000 per gallons hour

STATEMENT II

STATEMENT OF PARTICULARS OF THE WORK DONE FROM
1912 TO 1922

Deccan and Karnatic

Name of District	Increase in bores															
	25	5	75	1	125	15	175	2	25	3	35	4	45	5	6	to 10
1 Thana	21	25	14	29	8	12	2	6	3	4	1	4	1	2		1
2 Kolaba	2	4	2	2	..			2					1		1	
3 Nasik	14	5	2	5		2		2			.		1			
4 Satara	8	2		3		..						1				
5 Poona	11	5	1	2		3										
6 Sholapur	16	3	1	2		2										
7 Bijapur	17	1	3			1		.								
8 Dharwar	31	4	1					1								
9 Ratnagiri	4			4												
Total	124	49	24	47	8	20	2	11	3	4	1	5	3	2	1	1

Total No of gallons tapped —256,000 per hour

* One kos is taken as 1,000 gallons per hour

STATEMENT III

STATEMENT SHOWING THE TOTAL NUMBER OF BORES MADE
FROM 1907 TO 1922 IN EACH DISTRICT

Kaira	523	Satara	31
Ahmedabad	106	Bijapur	34
Broach	31	Sholapur	27
Panch Mahals	25	Dharwar	46
Surat	38	Belgaum	7
Thana	161	Ratnagiri	12
Nasik	46	Kanara	5
Kolaba	25	Nagar	15
East and West Khandesh	14	Sindh	10
Poona	31	Outside Presidency	10

Total No of bores 1,197

STATEMENT IV.

ANNUAL COST PER ACRE OF IRRIGATING SUGARCANE BY MEANS OF THE MHOPE

Index letter	Name of District	Average lift in feet	No of acres irrigated.	No. of bullocks per mhope.	Total cost of Irrigation per acre per annum.			Remarks.
					Rs	a	p	
A	Dharwar	45	2	4	812	0	0	Figures in each case given by cultivators the names and addresses of whom are in the office of the Agricultural Engineer
B	Belgaum	80		2	127	8	0	
C	Jalgaon	87			140	0	0	
D	Satara	86			250	0	0	
E	Sholapur	40		4	107	0	0	

STATEMENT V

ANNUAL COST PER ACRE OF IRRIGATING SUGARCANE BY MEANS OF A CENTRIFUGAL PUMP

Index letter	Name of District	Average lift in feet.	No of acres irrigated	B H. P of Engine	Size of pump	Annual expenses per acre per annum.			Remarks.	
						Rs	a	p		
A	Dharwar	45	15	6½	2½"	84	6	6	Figures estimated by the Agricultural Engineer in case a power plant is installed	
B	Belgaum	80	20	6½	3"	59	4	9		Do do
C	Jalgaon	87	15	6½	2½"	84	9	7		Do do
D	Satara	86	20	10	3"	160	12	9	In this plant two pumps are taken into consideration owing to very great difference in the lowest and highest water levels	
E	Sholapur	40	20	8	3"	75	11	8		

NOTICE

OFFICE OF THE DEPUTY DIRECTOR OF AGRICULTURE,
DIVISION

The Deputy Director of Agriculture is prepared to undertake the boring of wells on the following terms —

Rules

1 The Deputy Director of Agriculture to provide the men and the implements for boring Periodical supervision to be effected by the Agricultural Engineer and his Boring Overseer

2 The well owner will have to pay at the rate of Rs 2 per day from the arrival of the machine until its removal except Sundays and Holidays and the days of actual work or of accident due to mishap to tools or breakages, provided it is proved the machine stands idle for want of coolies or the supply of material to carry on boring operations

Charges for boring by hand machines in wells or on surface (beyond 50 feet) will be as under —

	North Gujarat and Thana.		Deccan and Karnatak.	
	Successful.	Unsuccessful	Successful	Unsuccessful.
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
1st stage, 1 to 50 feet	1 8 0	1 0 0	1 0 0	0 12 0
2nd stage, 51 to 100 feet	2 0 0	1 4 0	1 8 0	1 0 0
3rd stage, 101 to 150 feet	2 8 0	1 8 0	2 8 0	1 4 0
4th stage, 151 to 200 feet and above.	3 0 0	2 0 0	2 8 0	1 8 0

In cases of power machines all the above charges will be increased by annas 8 per foot

No bores will be stopped by the Department unless the maximum depth of one of the stages is reached unless a satisfactory supply is previously met with. Bores stopped by well owners before reaching the maximum depth of any of the above stages will be charged for the full stage and not for the actual depth bored

3 In case the power borer is employed, the owner is to pay for the fuel and lubricating oil used, whether the bore is successful or otherwise and also to pay and provide coolies (10 to 12 per hand machine and 4 to 6 per power machine), coal, &c, necessary for working the sets, either *hand or power*, satisfactory, whenever ready for work, from the *arrival* of the machine to its *removal* whether water is tapped or not

4 The Lap-welded piping and standard shoe will have to be provided by the owner himself on the clear understanding that the Department will not be in any way responsible for the breakage of same while driving and any subsequent losses due to same. It is, therefore, of the utmost importance to purchase best Lap-welded pipes and not old, second hand stuff

5 Well owners must take the machine and its accessories from the Railway Station or from another well to the site to be bored, and must, after the bore has been completed, take the machine and the accessories to the Railway Station or to the next site for boring at the option of the mechanics in charge. Further, in case of breakdown well owners must cart parts necessary for replacement either to or from the Railway Station as the case may be. Any demurrage caused by well owners failing to remove the goods will be recovered from them. Well owners are also expected to store the machine in the Monsoon whenever necessary, free of cost

6 No guarantee can be given to find water but every endeavour will be made to do so

7 Only a few bores will be carried deeper than 200 feet with hand borer except by special arrangement and the boring will be stopped at any depth at the discretion of the Deputy Director of Agriculture

8 If the work is stopped accidentally owing to broken pipe the expense will be borne *entirely* by the *well owner* himself in addition to the *flat-charges*

9 With a view to prevention of accidents and injury to the machine the owner must at all times take all reasonable precautions to prevent persons from wandering round the well and interfering with men and machine and must keep a watchman in charge from the day of the arrival of the machine until it is removed. He is expected to use his personal influence in support of the Boring Assistant in securing this end, and the Deputy Director of Agriculture will abandon any boring if it be found impossible to prevent interference and annoyance from this source

10 On completion of the work a statement will be submitted to the well owner showing the amount which is to be paid to this Department

11 Boring is considered successful when 200 gallons of water in rock and 500 in alluvium are tapped

12 In the case of brakish water being tapped, the Deputy Director of Agriculture will decide what steps should be taken

13 Before boring the well owner should state the capacity and depth of water in his well in Kos or otherwise and this will be taken as the basis for subsequent calculations

14 The Department is not responsible for the money or anything advanced to the Mukadam without the consent of the Deputy Director of Agriculture

15 Applications should be made to the Deputy Director of Agriculture of each Division

16 The well owner will have to pay a deposit of Rs 25 and 50 for hand and power machines, respectively, with a view to safeguard Government machinery and other goods and to avoid minor troubles It will be deducted from the boring bill sent by this Department after completion of work and will be forfeited in case of refusal of accepting the machine when his turn comes

17 This Department will not be responsible for any loss to crops whilst boring operations are in progress This includes erection, actual boring, fishing, extracting and dismantling

18 The Department cannot give any guarantee to make a bore even when the agreement is signed and the desposit paid, but every endeavour will be made to take up the work as soon as a machine is available The agreement actually comes into force when the Depatmental orders are issued for a bore hole to be made

19 These rules are liable to alterations at any time as may be thought necessary, but the well owner will be bound only by those rules in force at the time when his boring is actually commenced

Exploratory Boring

20 Bores of 50' depth taken previously to well sinking or for shallow tube wells will be called Exploratory Borings and will be charged at Rs 1-8 per foot for successful and Re 1 for unsuccessful bores

(Sd)

Deputy Director of
Agriculture

OFFICE OF THE DEPUTY DIRECTOR OF AGRICULTURE,
DIVISION

Form of Agreement between the Agricultural Department and the Well Owner to be signed by Well Owner or Land Owner, as the case may be, before boring is granted

1 I agree to make all payments as per clauses Nos 2, 3, 5 and 17 in the Notice Form

2 I agree to provide the coolies and carts whenever necessary for working, moving, erecting and dismantling the boring plant and any of its accessories in any case

3 I agree to provide the necessary piping of best make and standard shoe necessary for boring and to take the responsibility of all sorts of losses by breakages, bent, &c, while driving same

4 I agree to supply 10 coolies for hand boring machine and the number necessary for the power machine which number shall be determined by the Deputy Director of Agriculture

5 I agree to pay in the deposit of Rs 25/50 as per clause No 16 in the Notice Form

6 I agree to pay in cash all charges on my account by the Department for making the first bore before a second bore is commenced or the first bore is deepened

7 I agree to note that my deposit will be forfeited in case I refuse to start work and supply labour or any other assistance immediately on an official request

8 I agree to be responsible for any loss or demurrage to Government machinery from the arrival of the machine until it is removed and to engage a watchman for this work

9 I agree on receipt of statement of account to pay the same within one month to the Deputy Director of Agriculture

10 I hereby state that the capacity of my well at present is koses or mhotes and the depth of water is feet

11 I agree to note that this agreement actually comes into force when departmental orders are issued for the bore hole to be made and the work actually commenced

Witness,

Address of the place where bore
is required

Patil

or

(Signature)

(Talathi)

of

Dated

Post

District

**LIST OF AGRICULTURAL BULLETINS PUBLISHED BY THE DEPARTMENT
OF AGRICULTURE (1908 TO 1922-23) AND KEPT FOR SALE AT THE
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No.	Year.	Subject.	Price.		
			Rs.	a.	p.
82	1908	Locusts in India, by H. M. Lefroy, Imperial Entomologist, Pusa	0	8	0
83	1909	Cultivation of Broach Cotton in Dharwar, by M. L. Kulkarni, Divisional Inspector of Agriculture, S. D.	0	4	0
84	1909	Night-soil—A Valuable Manure, by G. K. Kelkar, Assistant Professor of Agriculture, Agricultural College, Poona (Kanarese)	0	4	0
85	1909	Kalar in Sind, by G. S. Henderson, Deputy Director of Agriculture, Sind	0	4	0
86	1910	First Experiments in the Treatment of Grape-Vine Mildew in the Bombay Presidency, by W. Burns, Economic Botanist	0	14	0
87	1910	An Examination of the Seed Supply of the Broach District, by G. D. Mehta	0	4	0
89	1910	The Salt Land of the Nira Valley, by Harold H. Mann, Principal, Agricultural College, Poona, and V. A. Tamhane, Laboratory Assistant, Agricultural College, Poona	0	5	0
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48	1911	Poona Furnace (Marathi)	0	7	0
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50	1912	An Examination of the Seed Supply of the Ahmednagar District, Part II.	0	8	0
51	1912	Third Year's Experiments in the Treatment of Grape-Vine Mildew	0	8	0
52	1912	Muscovado Sugar Machinery and its scope for Gul Manufacture in India.	0	8	0
53	1912	A Method of improving the Quality of Cotton Seed	0	7	0
54	1912	A Note on Steam Ploughing	0	10	0
55	1913	An Examination of the Seed Supply of the Poona District	0	8	0
56	1913	Present State of the Dairying Industry in Bombay	0	8	0
57	1913	Improvement of the Indigenous Plough of Western India	0	12	0
59	1914	Common Salt and its use as Manure in the Konkan Division	0	8	0
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63	1914	Substitutes for Rab	0	8	6
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65	1914	A list of diseases of Economic Plants occurring in the Bombay Presidency	0	4	0
67	1914	An Examination of the Seed-Supply of the Sholapur District	0	8	0
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70	1915	Improvement of Cotton in the Bombay Presidency (except Sind)	0	8	6
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			Rs.	2.	p
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102	1920	Investigations of Potato Cultivation in Western India	..	1	15 0
103	1920	The Book of the Mango	.	3	5 0
104	1920	The Ganeshkhund Botanical Garden, Kirkee (Its Genesis and Development)	..	0	15 9
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