MANUAL OF

WATER SUPPLY SANITATION

(RURAL)

DIRECTORATE GENERAL OF HEALTH SERVICES
MINISTRY OF HEALTH, GOVT. OF INDIA
NEW DELHI

MANUAL OF WATER SUPPLY SANITATION

PREFACE

The provision of an adequate, suitable and safe water supply is essential for the physical comfort and health of every individual. It is a known fact that in India the high incidence of guinea worm and the enteric diseases such as cholera, typhoid and dysenteries is mainly due to the use of 'UNSAFE' water supplies. These diseases are preventable provided water supplies are protected from contamination. Thus, the provision of 'SAFE' water is of vital necessity in a programme of promotion of public health.

This manual is intended as a guide on the general principles and sanitation procedures for providing safe water supplies in the villages of India. The recommendations contained herein are not to be considered as the last word in water supply sanitation but only as a preliminary guide to establishing minimum standards of safety. It is quite possible that certain practices in some parts of the country are satisfactory and economical. Also certain better practices might be evolved as a result of experience gained with the programme. All these could be incorporated in the future editions of the manual.

TYPES OF WATER SUPPLIES

The sources of water supply may be broadly classified into two categories : (1) Ground water, and

(2) Surface water. Ground water supplies may include wells and springs. Surface water supplies may include lakes, ponds or streams. Most surface waters are contaminated and cannot be consumed without proper treatment. Under normal conditions provision of reliable and economical treatment for village supplies is not available. Hence surface water supplies for villages are not recommended except under special circumstances. In such cases, if surface water must be used, it should be obtained with a minimum degree of contamination so that the type of purification required is simple. This manual is, however, confined to rural water supplies from ground water as these are the main sources in the rural areas.

CHARACTERISTICS OF GROUND WATER SUPPLIES

Water from the surface or very near the surface of the ground is more likely to be polluted than water which reaches the well through the subsoil. The subsoil strata influence the chemical and physical characteristics of ground water. Water which percolates underground is strained and filtered in passing through the layers of soil which lie between the surface and the water bearing stratum and most of the bacteria will be removed from the water provided, of course, that this layer of soil is of a kind through which water will be filtered and there are no natural or artificial channels in the soil or rock formations. The amount of intervening soil required to accomplish this filtering

process depends upon the composition and gradation of the soil.

Ground water is never chemically pure and some ground water is unsatisfactory for domestic use, such as those containing excessive amounts of iodine, fluorides, iron, chlorides, sulphates and certain gases in solution However, some of these waters may be rendered potable by simple treatment.

Generally it is the bacterial contamination of water that one has to contend with in the development of a well water supply. The conditions to be considered in developing a 'SAFE' supply from wells are location, depth, diameter, type and construction.

MINIMUM STANDARDS

There are certain minimum standards below which a water supply cannot be considered potable. In view of these standards, the basic features of 'SAFE' well water supply are discussed below.

Location of the well : A well should be located as far as practicable from sources of contamination such as latrines, septic tanks, cesspools, soakpits and similar structures. A safe distance depends upon the nature of the ground, soil or rock structure and direction of flow of ground water. Dense soils are more resistant to passage of pollution than lighter soils. Too much reliance should not, however, be placed on the type of soil, since soil strata differ considerably in thickness

and structure. Water from wells in limestone strata should always be under suspicion because of the tendency of limestone to fissure and permit passage of pollution for long distances.

Distance to source of contamination : Wherever possible wells should be placed upgrade and at a distance of at least 50 feet from septic tanks, soakage pits and such structures. In limestone and fissured rock areas, bacterial analyses of the water should be made and if contamination is found, continuous chlorination of the supply should be established. In general, all possible sources of contamination, present and future, from human and animal wastes should be obviated.

Flooding and drainage : The top of every pump platform or cover of a ground water supply should not be less than 2 feet above the highest flood water level. The contour of the ground should be such that water will drain away from the well. In the absence of natural drainage, properly protected fill sloping away from the well should be provided to assure drainage around the well. A depression where water collects on low ground along a stream or lake which may be flooded at times of high water should be avoided.

CONSTRUCTION

Diameter of the well : One may wonder what the size or diameter of a well casing has to do with the development of a safe water supply. Unfortunately, size has a lot of influence on the quality and depend-

ability of a well supply. For instance, it is more difficult to secure water tight walls and cover in a dug or large diameter well than in a tube well. Of course, for the bucket and rope lifting arrangement larger diameter dug wells are required but the chances of contamination in such cases due to improper construction of walls and cover and use of bucket and rope are much greater than for a tube well from which water is drawn by a hand or force pump.

KINDS OF WELLS

Wells are generally (1) dug or bored (2) drilled, and (3) driven.

Dug or bored wells : Dug well should be limited to shallow sources where yield is limited, necessitating storage of water. The walls of dug and bored wells should be water tight to a depth of at least 10 feet below the natural ground surface and perferably more, depending on the soil and subsoil conditions. It should project at least $1\frac{1}{2}$ feet above the ground level. This may be accomplished by the following types of construction:

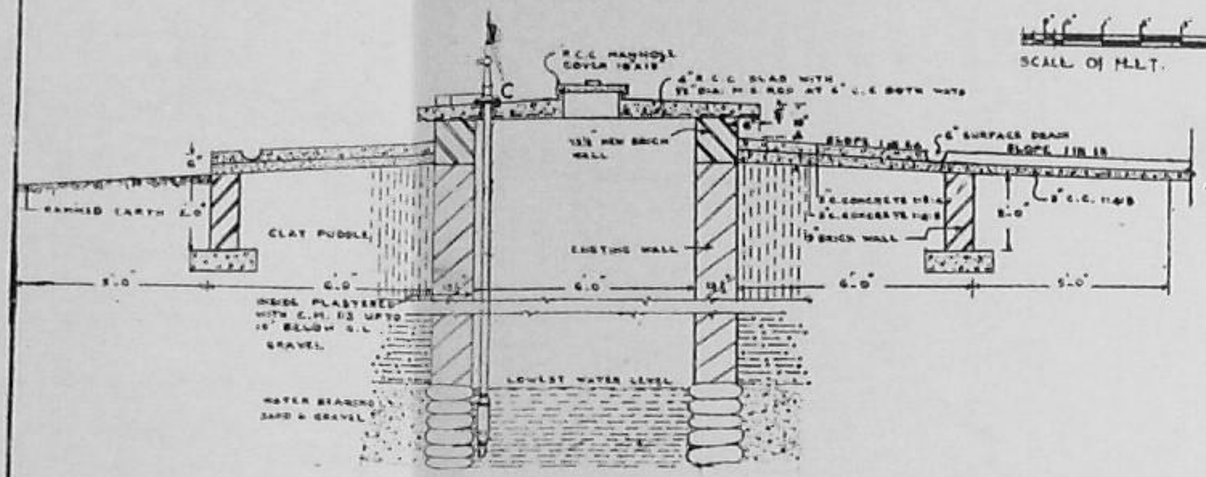
Concrete walls : A 1 : 2 : 4 mix concrete wall not less than 6″ thick and properly reinforced should be poured in one operation without construction joint up to 10 feet below natural ground. Brick or tile walls make a convenient interior form for pouring the concrete.

Puddled clay backed walls : Clay should be mixed with water to produce an effective mixture which will flow easily and settle into a solid mass surrounding the steining of brick, stone or tiles up to 10 ft. below natural ground.

Cover slab : The dug wells should be protected with a concrete cover that would seal off effectively spillage and rain water entering the well. The concrete slab may be precast on the surface near the well about 2 weeks before it is set in place. The slab should be at least 4″ thick and reinforced with M. S. rods of ½″ dia. placed 2″ above the bottom of the slab and placed 6″ apart in both directions to carry the loading and to prevent cracking A 2 feet square manhole should be provided in the slab with locking arrangement and the edges of the manhole cover suitably covered with concrete in the form of a raised lip so as to exclude spillage or rain water entering the well. Pipe sleeve if provided should be set in the cover slab when concrete is poured and it should project about 1″ clear of the cover slab. The details of a dug well with protective sidewall, cover-slab and appurtenances is illustrated in Fig. 1.

Drilled wells : Drilled wells, properly built, are good water producers. They afford a satisfactory means of obtaining water either from sand and gravel strata

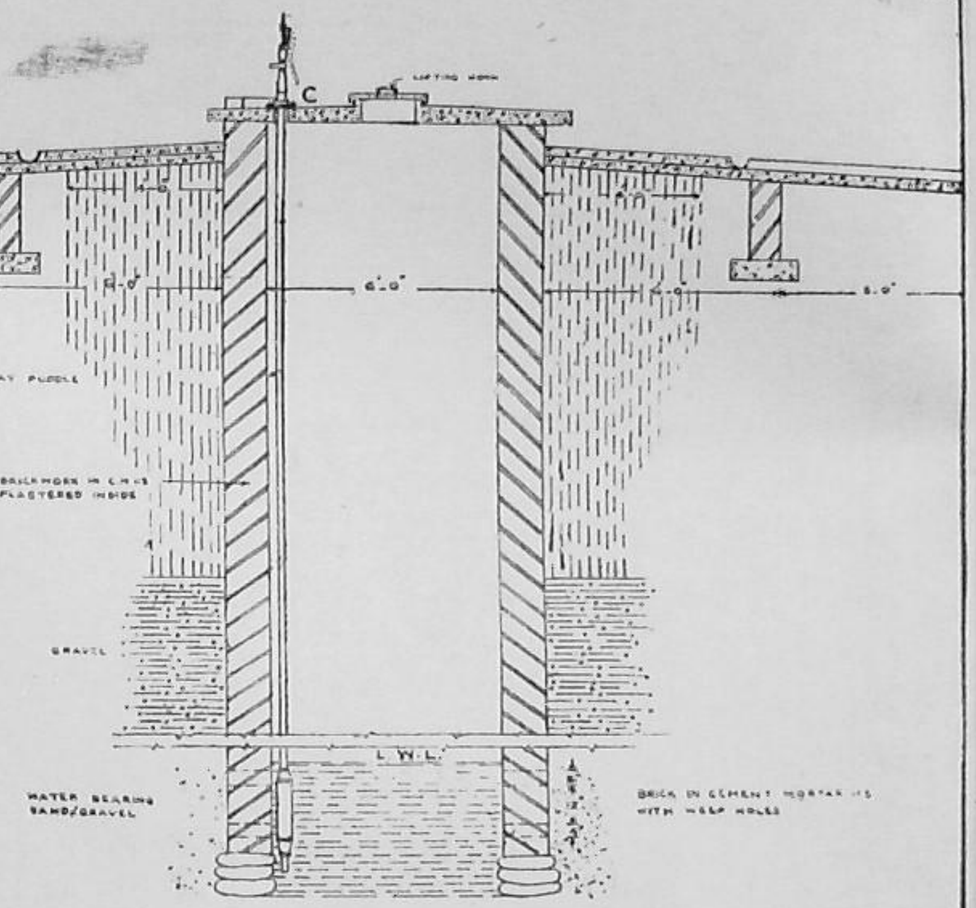
IMPROVEMENTS TO AN EXISTING DUG WELL



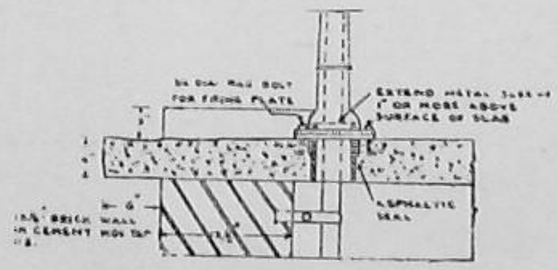
SECTION AT AB

CONSTRUCTION OF A DUG WELL WITH HAND-PUMP INSTALLATION

FIG.1



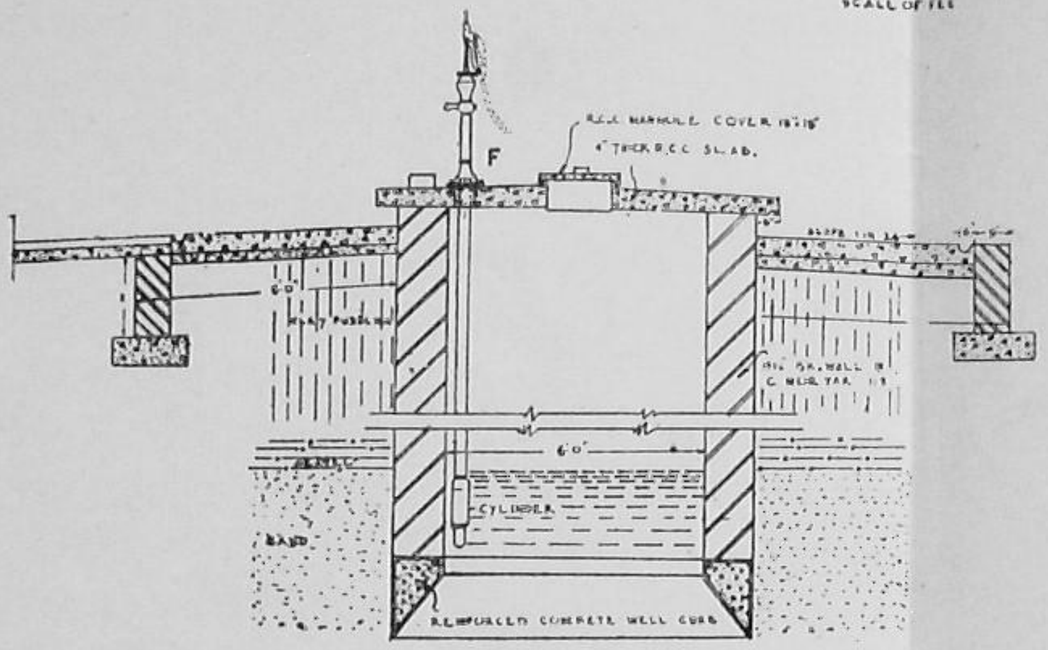
SECTION AT AB



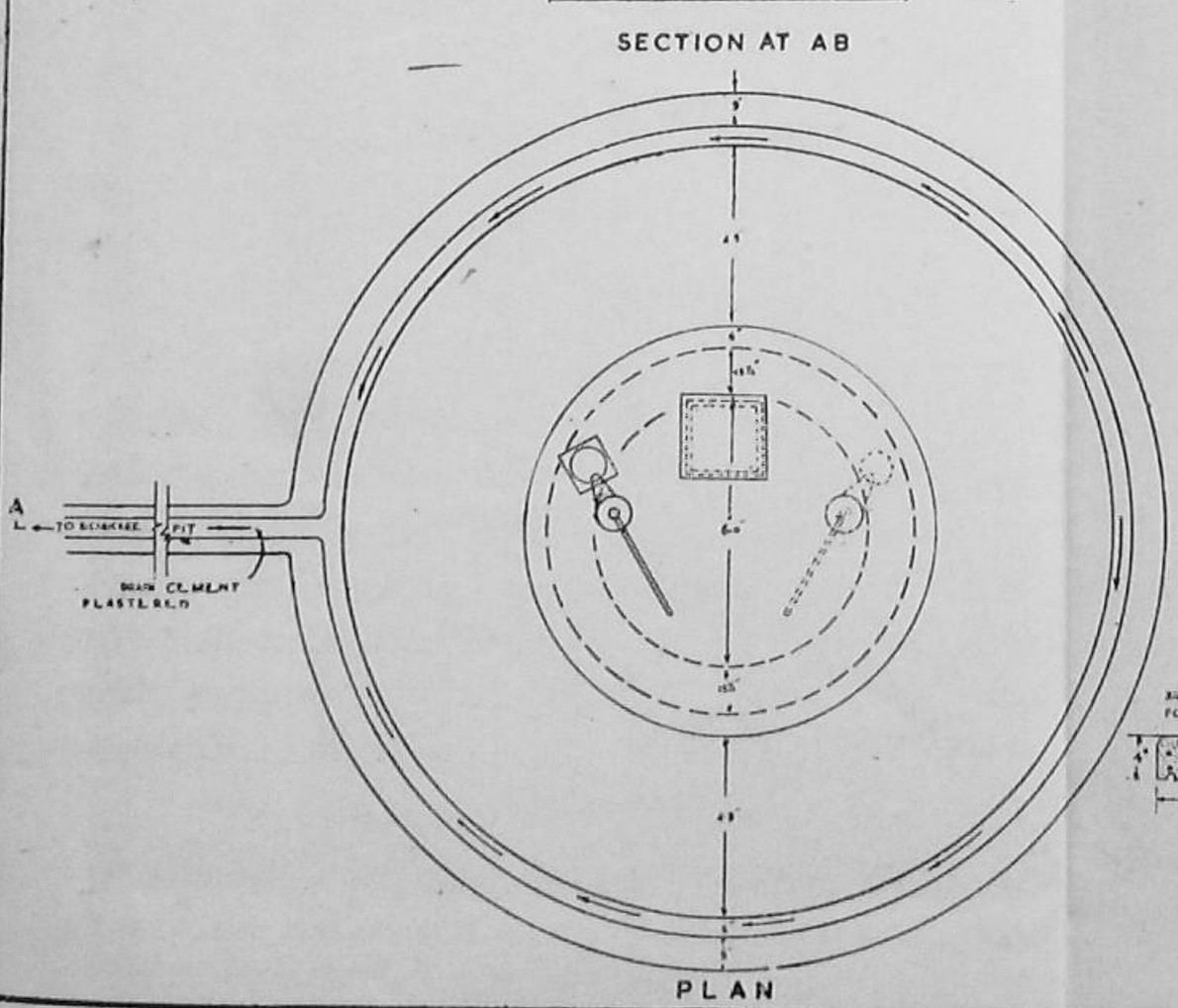
DETAIL AT C

DIRECTORATE GENERAL OF HEALTH SERVICES
MINISTRY OF HEALTH
NEW DELHI

A SUNK WELL WITH HAND PUMP INSTALLATION



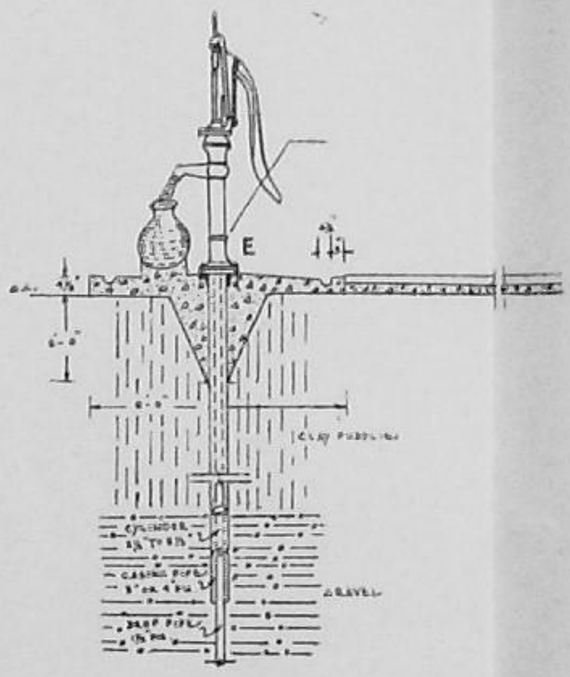
SECTION AT AB



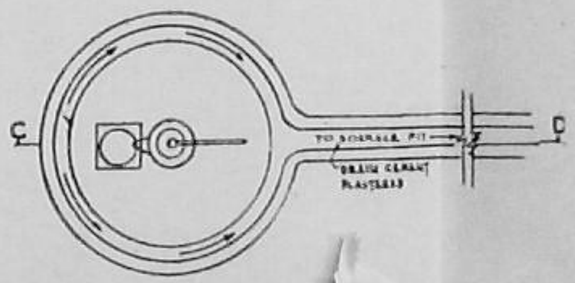
PLAN

DRILLED WELL WITH HAND PUMP INSTALLATION

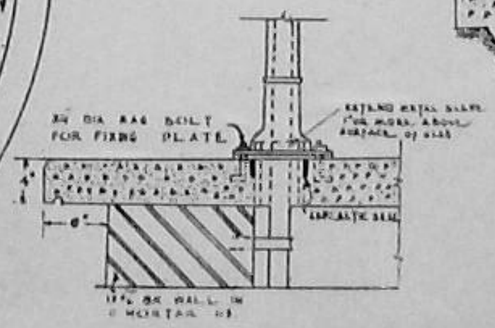
FIG 2.



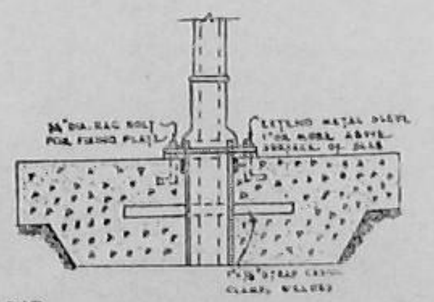
SECTION AT CD



PLAN



DETAIL AT F



DETAIL AT E

NOTE

Two pumps can be fixed opposite to each other where the water capacity of the well permits and where large population requires it.

DIRECTORATE
GENERAL OF HEALTH SERVICES
MINISTRY OF HEALTH
NEW DELHI

or from rock. They have many advantages as they are easily protected from contamination and flexible of construction for great depths.

The well casings should be strong and of corrosion resistant materials. The casing should never be used as a suction pipe or a working barrel for pump plungers. In a handpump installation the casing should extend about 1″ above the general level of the platform. The annular spacing between the casing and earth for water should be filled properly so as to support the casing and to prevent its movement, to prevent surface water flowing downward around the casing and to seal fissures, cracks and solution channels leading into the well. A mixture of cement and water properly grouted will do a successful job of sealing the casing. The details of a drilled well with sanitary protection of the casing and concrete cover slab is illustrated in Fig. 2.

Driven wells : When wells are driven, the ground is usually tight around the pipe and no grouting is needed except around the top where vibration from driving enlarges the hole. The space around the casing at the top should be cement grouted. A concrete platform similar to the one used for drilled wells results in quick runoff of surface water and holds the pipe securely in place.

LIFTING ARRANGEMENTS

Manual : Bucket and rope system : As stated already, the bucket and rope system is unsafe because

of the necessity for handling, which results in contamination of the well. This contamination can be avoided if one of the mechanical devices not touched by hand, such as Persian wheel driven manually or by bullocks or if the Boulton elevator is installed and properly covered. The former is illustrated in Figs. 3 and 4. It is necessary that these systems are popularized in places where force or handpump installations are not feasible.

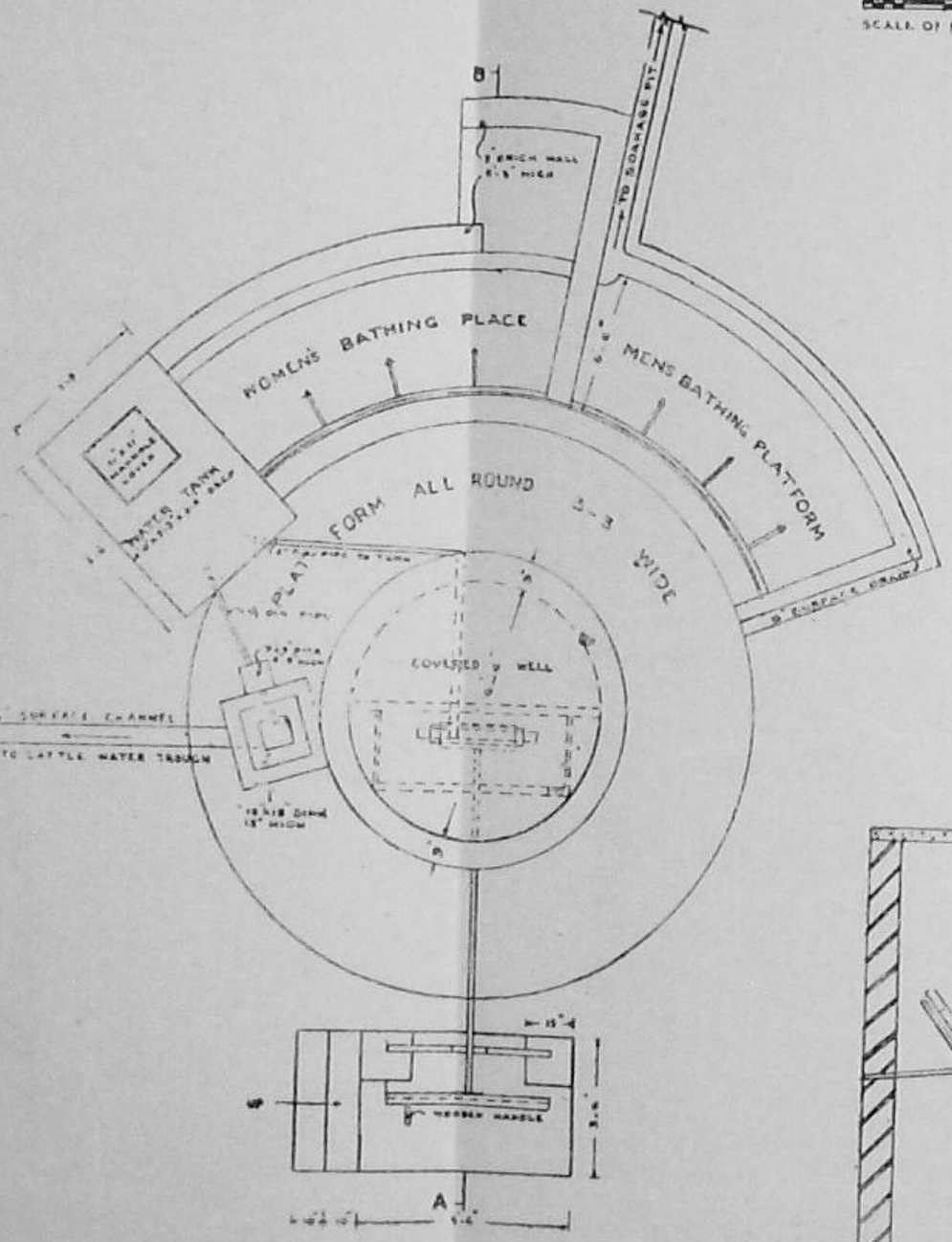
Pumps and pumping apparatus : Pumps in use for small water supplies are operated either by hand, windmill, petrol engine or electric motor. In most of the villages engine or motor driven pumps are out of question and it is the handpump or windmill that will be of use if it could be locally manufactured and serviced.

HANDPUMPS

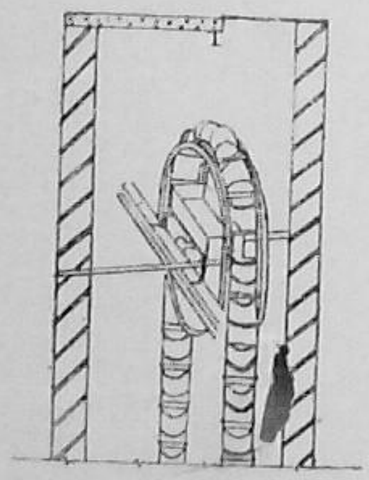
Hand pumps should be of the plunger type with cylinders, placed below the water level so that priming will not be necessary. The pump base should be of the solid one piece recessed type, cast integral with or threaded to the pump column or stand. Two piece open and adjustable base are not satisfactory. The pump spout should be of the closed, downward directed type. The open type pitcher pumps should not be used. Suitable type of handpumps and pump settings as described are illustrated in Figs. 1 and 2.

A DUG WELL WITH HAND OPERATED PERSIAN WHEEL

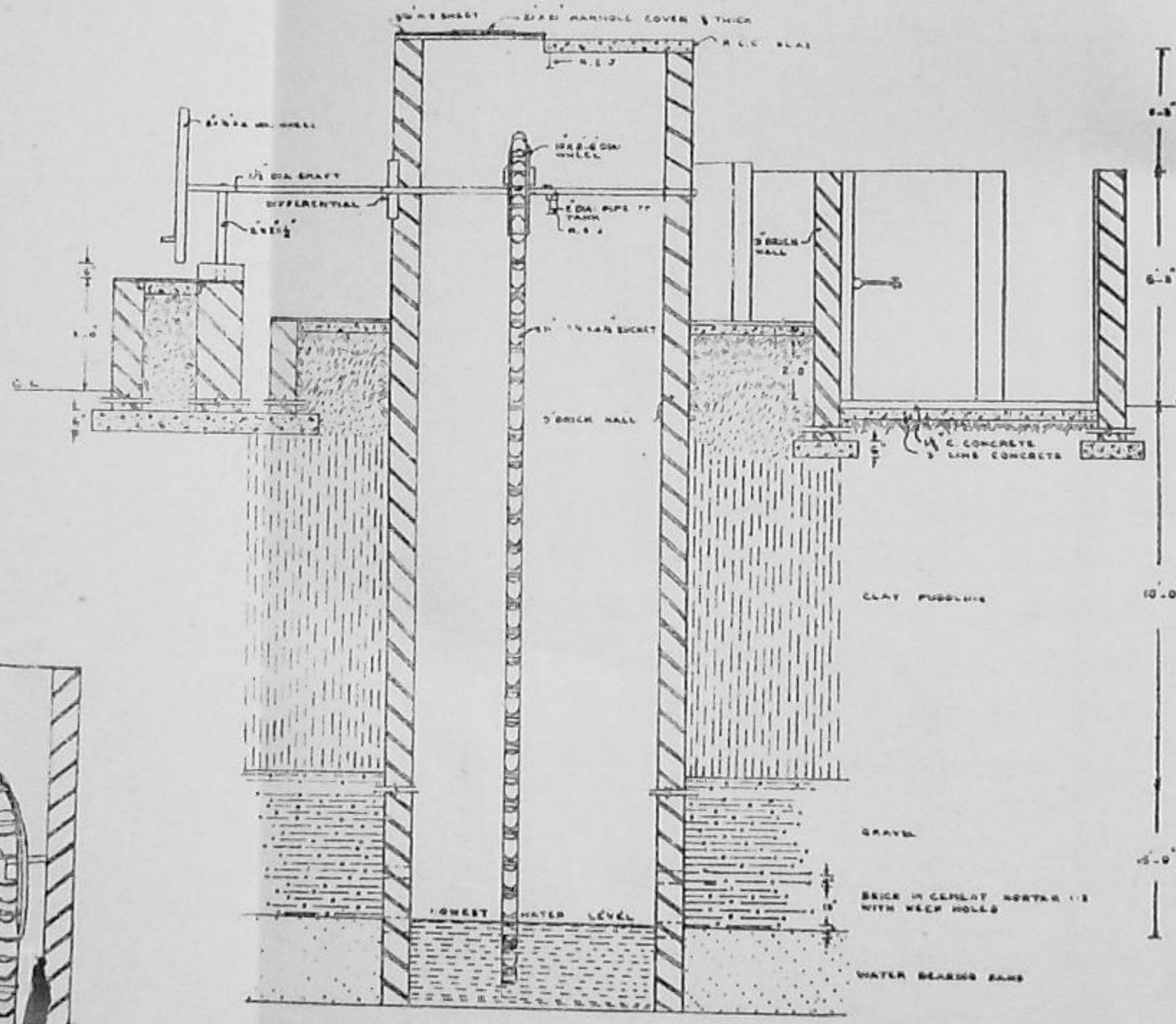
FIG. 3



PLAN



PERSPECTIVE VIEW
(PERSIAN WHEEL)



SECTION AT AB

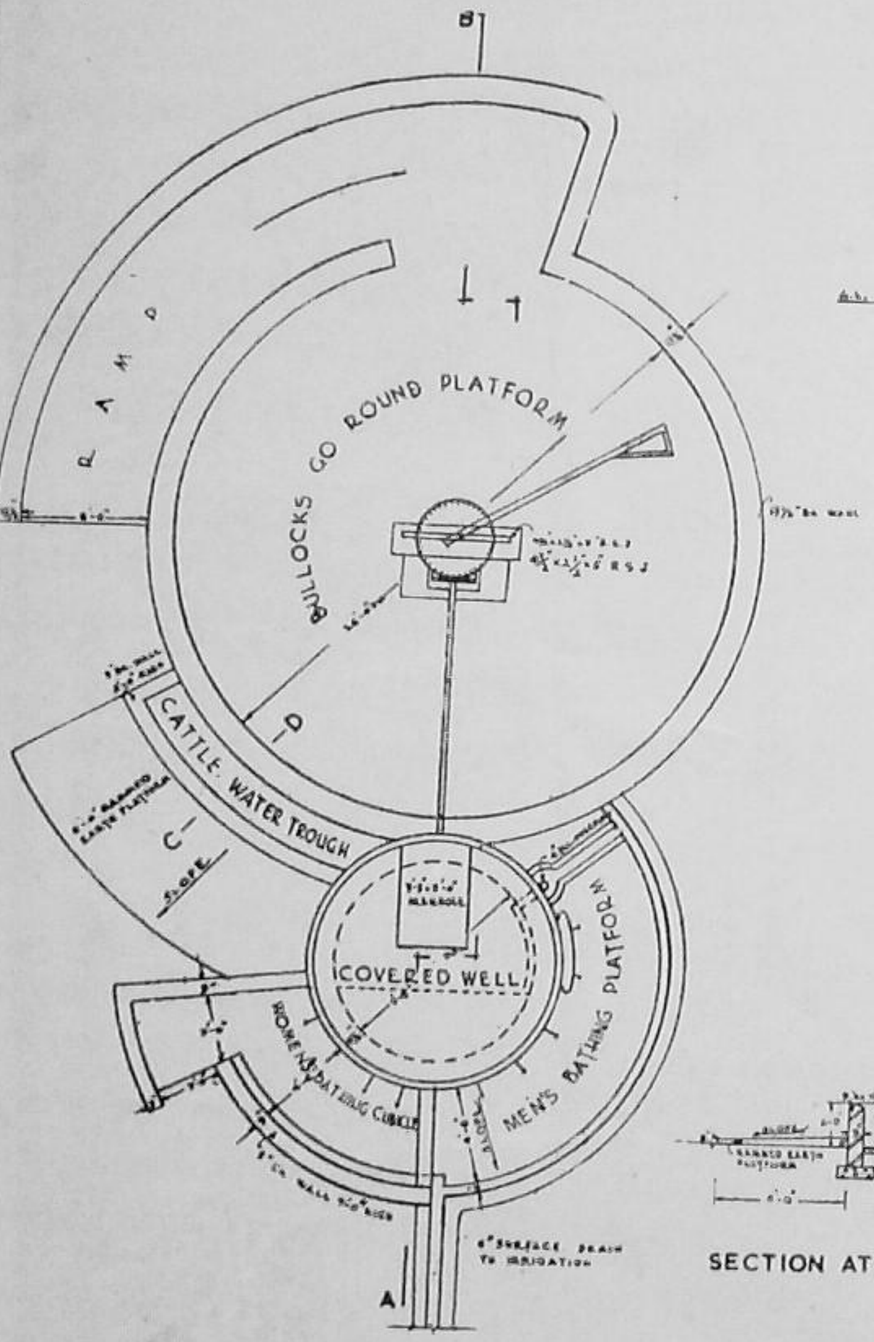
DIRECTORATE GENERAL OF HEALTH SERVICES
MINISTRY OF HEALTH
NEW DELHI

A DUG WELL WITH PERSIAN WHEEL

(BULLOCK OR CAMEL DRIVEN)

FOR IRRIGATION, DRINKING & OTHER DOMESTIC USES

FIG 4.



PLAN

SECTION AT CD

SECTION AT AB

PERSPECTIVE VIEW

DIRECTORATE
GENERAL OF HEALTH SERVICES
MINISTRY OF HEALTH
NEW DELHI

WINDMILLS

Where prevailing wind velocities would permit of such installations, windmills are dependable and need to be popularized. Some windmills are known to operate at wind velocities as low as 3 m.p.h. Except for the initial outlay these installations are devoid of routine maintenance expenditure.

MISCELLANEOUS

Gravel packed wells : Gravel used for gravel packing of wells should be thoroughly washed and chlorinated before being placed in the well.

Springs : These are basically surface or shallow ground water sources and should be developed and used with due regard for sanitary protection as for wells.

Artesian wells : In the free flowing type, water flows to the surface with little or no pumping required. In the other type, water rises to a level above the impervious subsoil stratum but not to the surface. These wells are generally safe because the water comes from below an impervious soil stratum.

Disinfection of wells : Upon completion, every well should be disinfected with chlorine. Bleaching powder solution should be applied to the contents of the well uniformly at a dosage of not less than 100 p p.m. and water held over for about 3 to 4 hours before being baled out. The water will then be ready for use.

Example : A newly constructed well of 10 ft. internal diameter has 20 ft. depth of water. It is required to dose the water with bleaching powder at 100 p. p.m. of available chlorine. (approximately Q gallons $=5d^2h$. d=diameter in ft. h=depth of water in ft.)

$$\text{Quantity of water in the well} = 3.14 \times \frac{10}{4} \times 20$$

$\times 6.25 = 9830$ gallons. 1 p. p m. of bleaching powder dosage is equivalent to 1 lb. for a lakh of gallons

Bleaching powder (with 25% available chlorine) required for a dosage of 100 p. p.m. as chlorine

$$= \frac{9830 \times 100 \times 100}{100000 \times 25}$$

$=39.3$ or *40* lbs.

LIST OF SANITARY DEFECTS

A partial list of sanitary defects on well water supplies where hand operated pumps are used may be of assistance in examining such supplies readily.

(a) *Improper location of wells :* Well in a pit or depression. Less than 50 feet from latrine, cesspool, lake or river. Drainage toward well flooded by surface water.

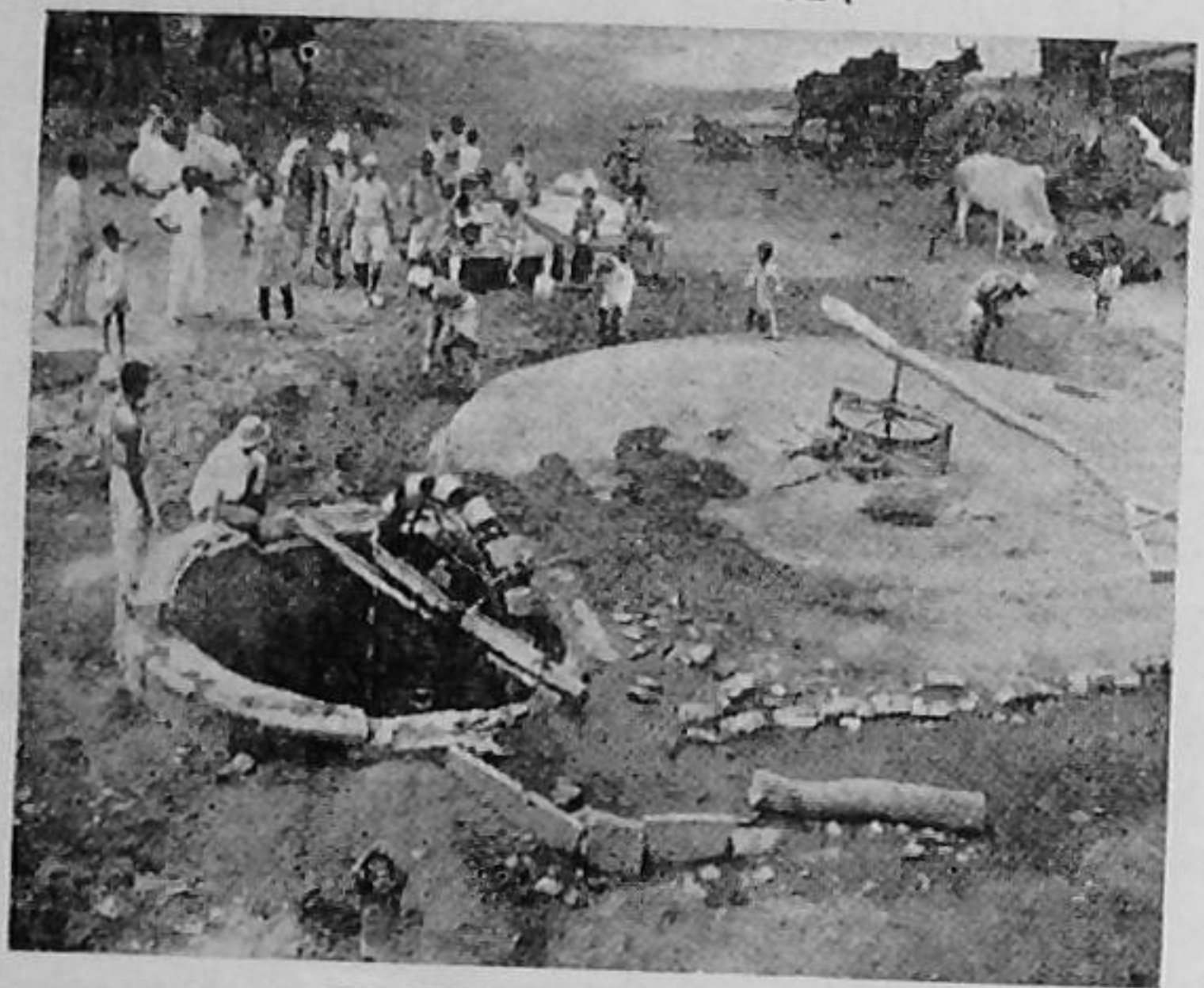
(b) *Pumps :* Split type of pump may admit leakage; loose fastening to casing or pump platform; leaky or defective stuffiing box on pumphead; lack of stuffing box; cracked metal on water chamber; open top for priming pump; open slot type admits contamination

to inside of pump; leaks at base of pump; open spout as in pitcher-type pump.

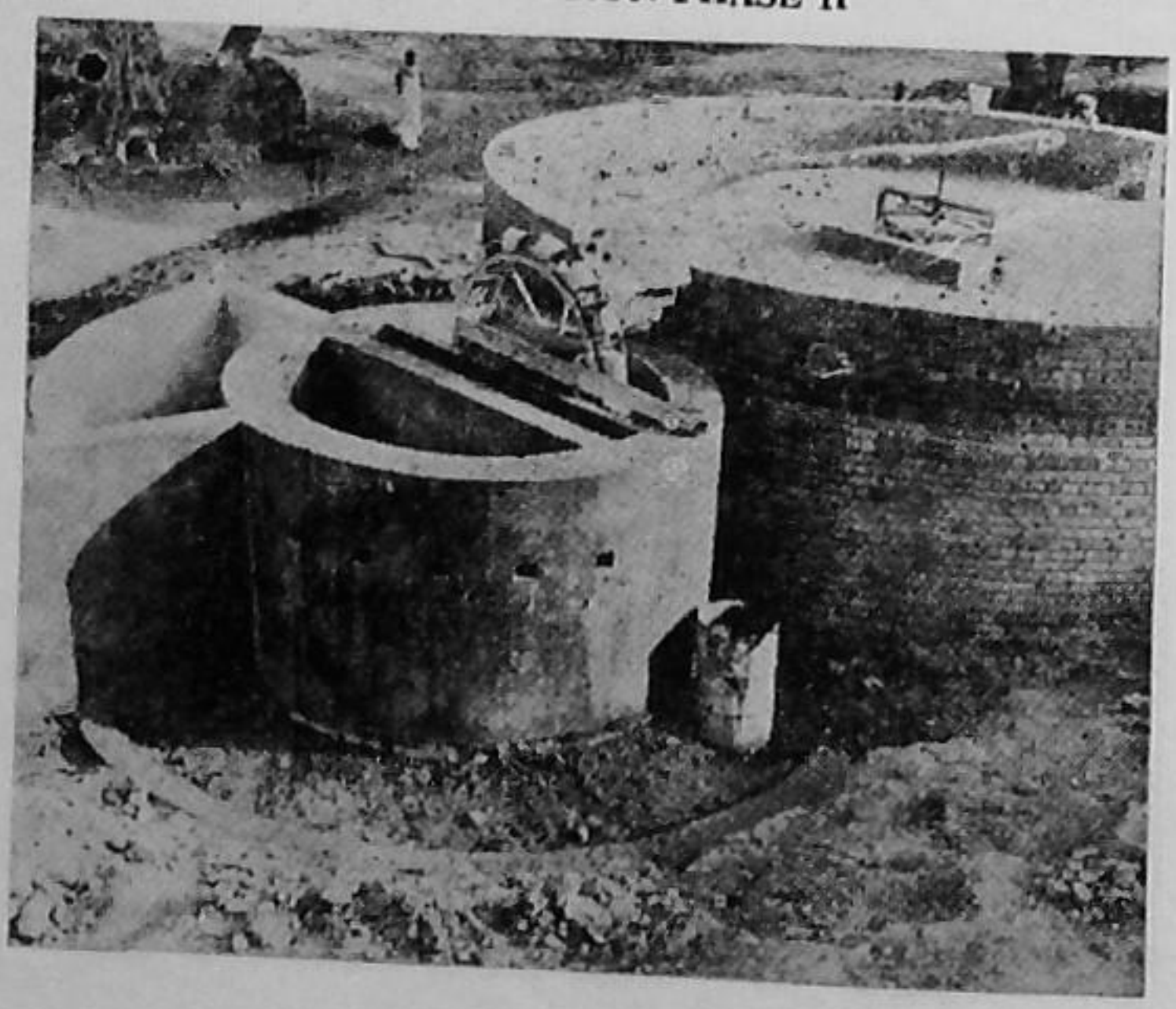
(c) *Platform :* Wooden platforms; cracks in cement platforms; platforms not sloped away from pump (drainage not good and depressions holding water); pump base set below surface of platform; platform below ground surface; manhole covers not embedded with a raised lip to keep away spillage and rainwater.

(d) *Casing or steining :* Prick and stone-masonry not encased with concrete or puddled clay up to 10 feet below G.L.; no outside protecting casing; cracked or leaky casing; casing not carried one inch above the platform into the base of the pump; annular spacing at top of casing not covered; casing used as a suction pipe.

CONSTRUCTION PHASE I

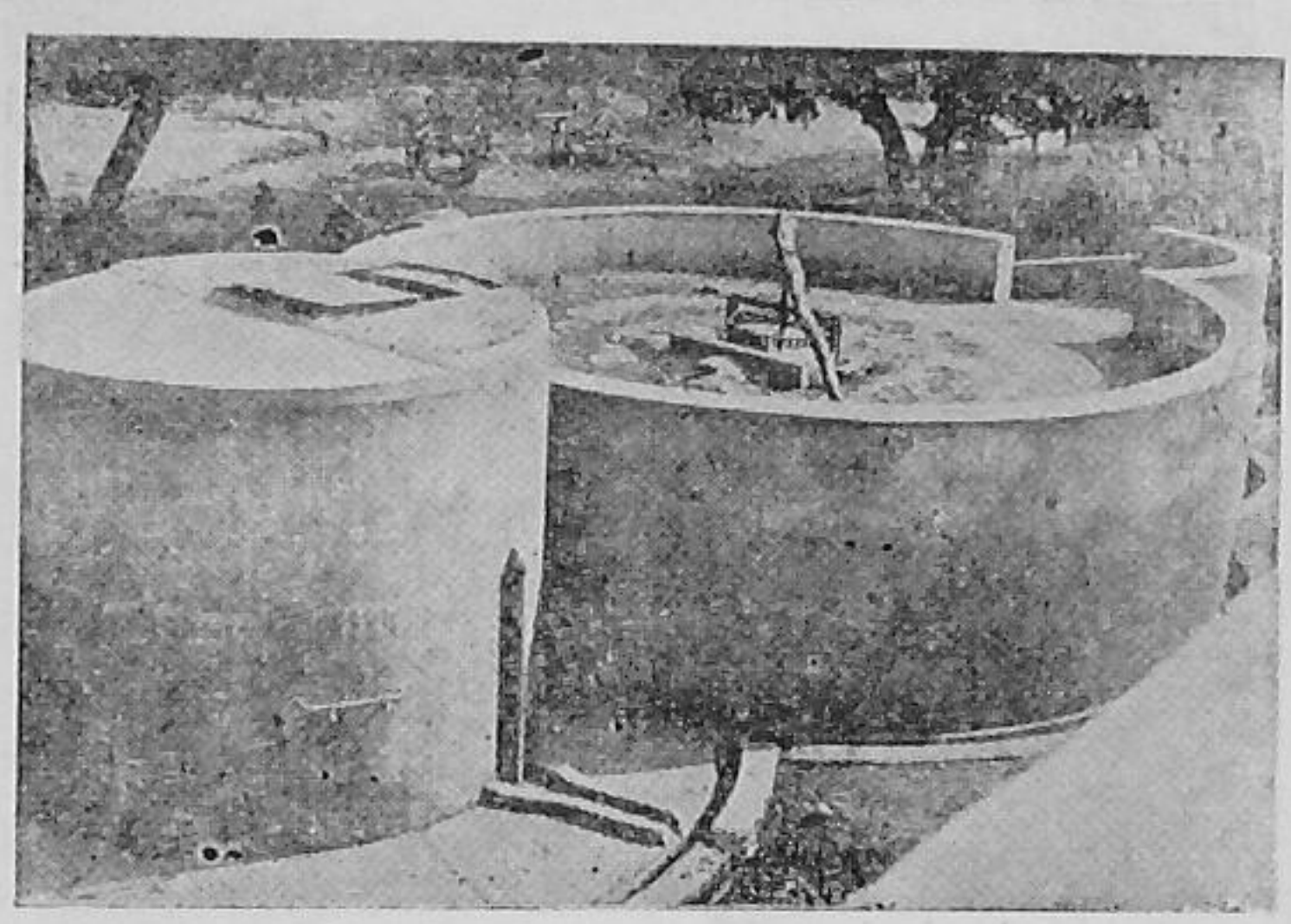


CONSTRUCTION PHASE II

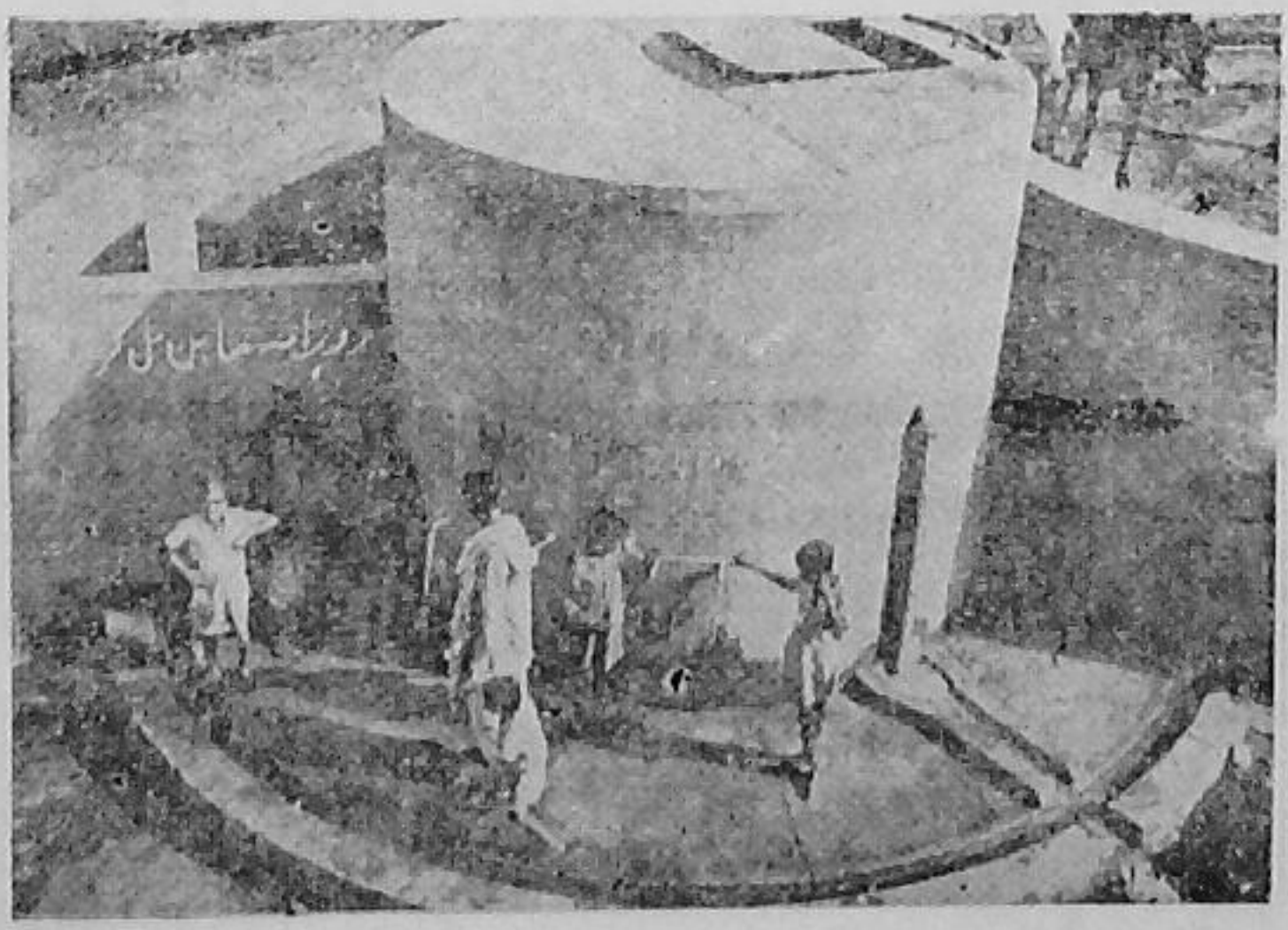


DUG WELL WITH
(BULLOCK OR

CONSTRUCTION PHASE III

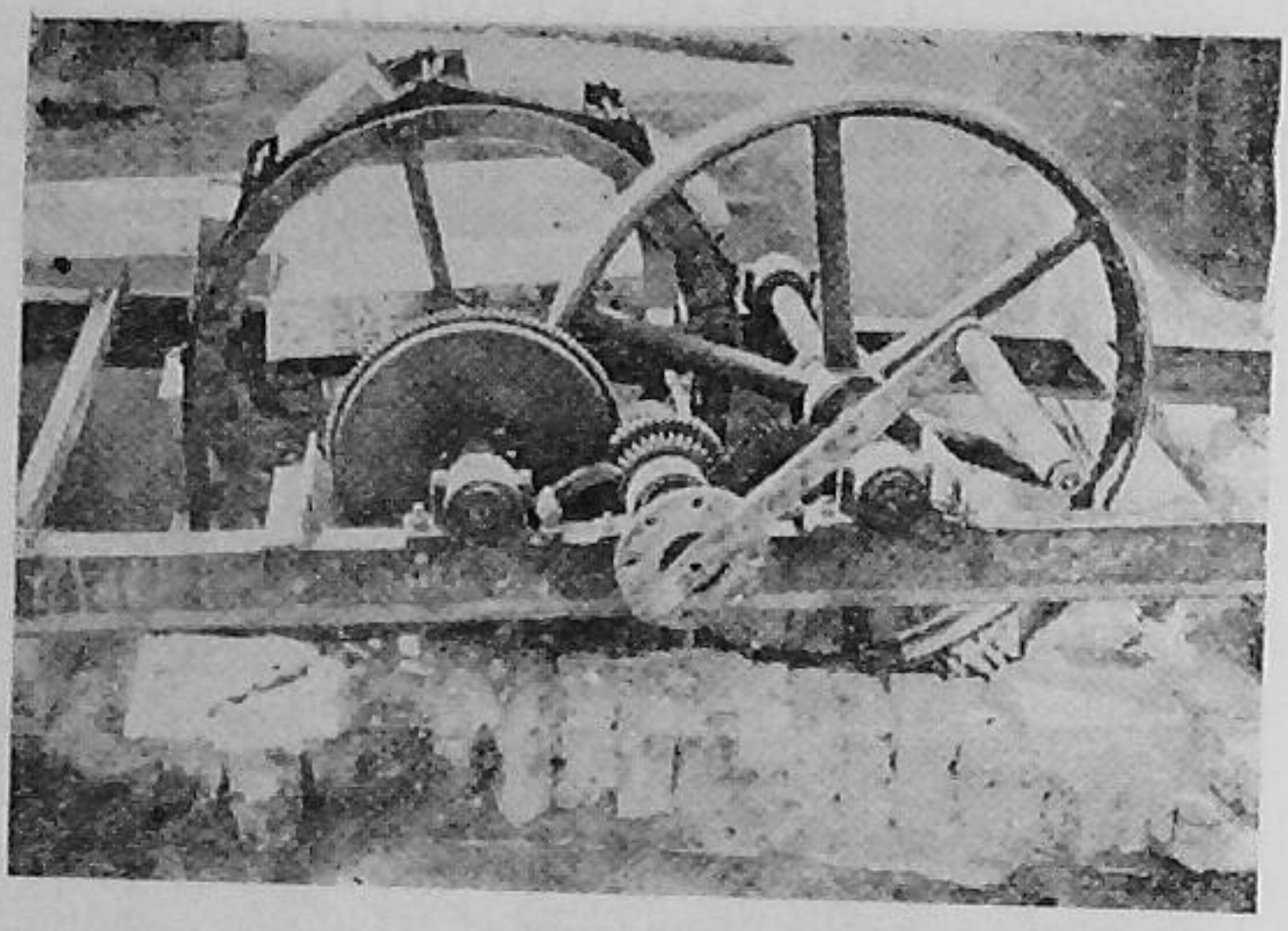


COMPLETED PHASE IV

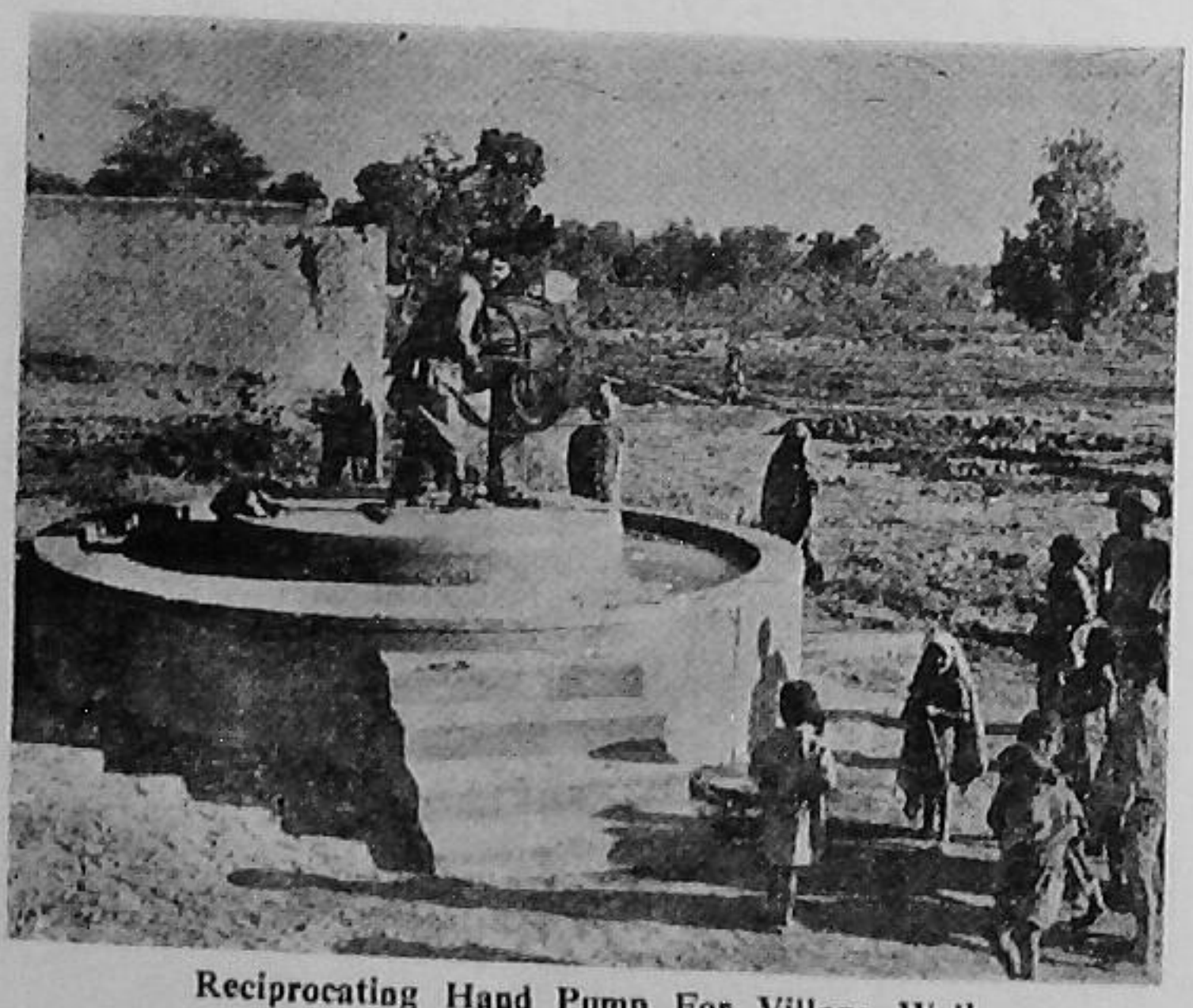


PERSIAN WHEEL

CAMEL DRIVEN)



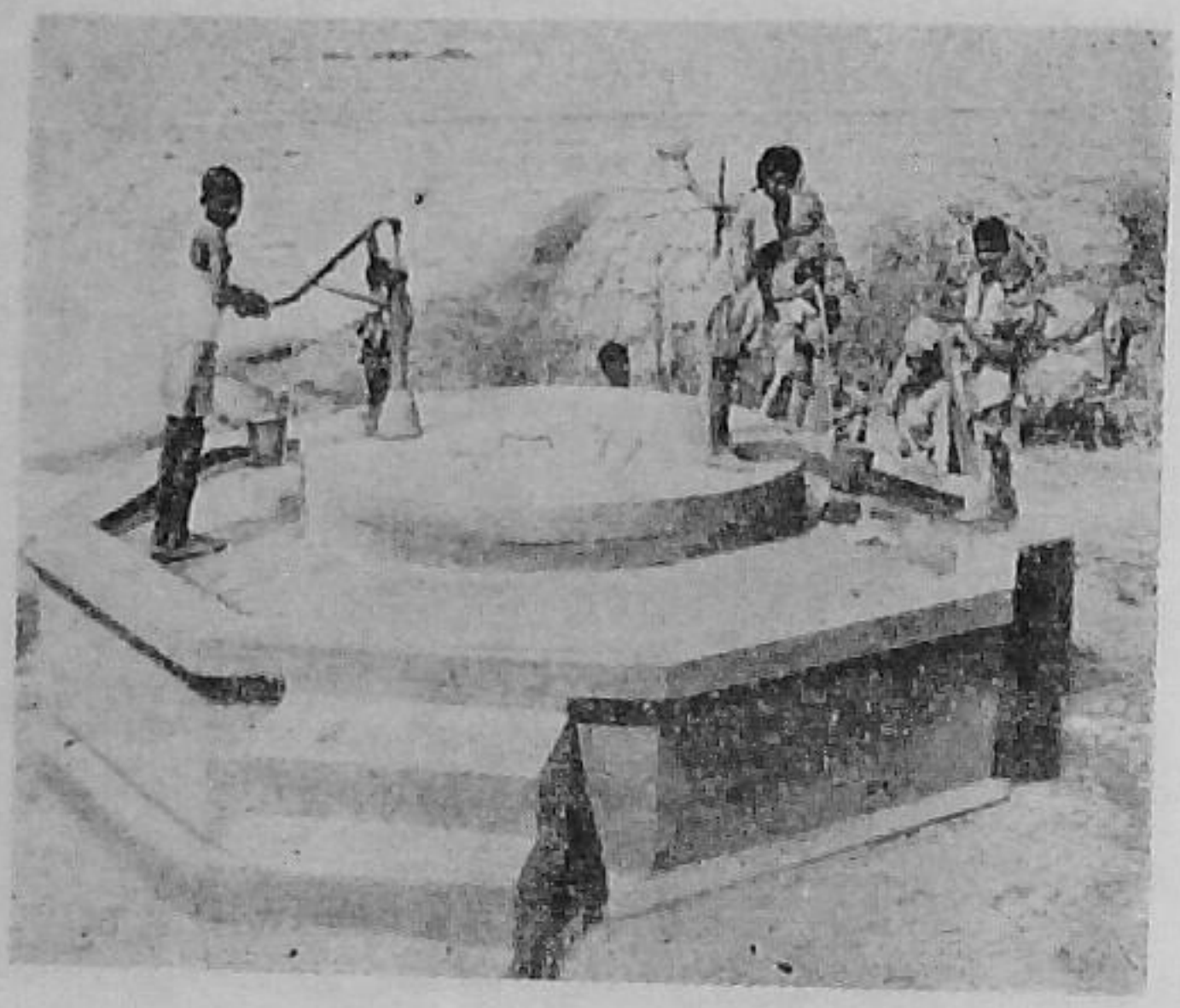
Driving Mechanism—For Hand Operated Persian Wheel



Reciprocating Hand Pump For Village Well

Village Well with Wind Mill Pump

Sanitary Spring



Hand Pump Installations For Village Well